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Characterization of stable and diversified CGMS (A) and restorer (R) lines of pigeonpea developed at Sardarkrushinagar

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Abstract

India is the largest pigeonpea growing country. Pigeonpea has vivid scopes under varied agricultural situations due to mammoth flexibility in crop duration, growing situations and utilities. Despite these potential advantages, the productivity of pigeonpea has been stagnant for the last fifty years. The heterosis breeding using genetic male sterility has been tried to break the plateau in productivity but could not be exploited commercially due to inherent problem associated with the system. Appreciating that genetic diversity is the backbone of any successful hybrid development programme, efforts were made to identify different sources of cytoplasmic genetic based male sterility. The commercially viable cytoplasmic genetic based male sterility system was identified using cytoplasm of wild species viz. *Cajanus scarabaeoides*. In order to avoid any catastrophe due to genetic homogenization, efforts were made to diversify both 'A' and 'R' lines. Diversified and stable 53 A and 55 R lines were developed under different genetic backgrounds and were grown at Sardarkrushinagar for characterization. These lines exhibited immense phenotypic variability and were grouped as per maturity, growth habit, seed size and seed colour. The data indicated that different A and R lines can be selected on the basis of maturity group for good nicking. GT 33A, GT 87A, GT 311A among A lines and GTR 3, GTR 23, GTR 34, GTR 52 and GTR 53 among R lines were the earliest in maturity and nicked with each other. They had different grain colour and size there by making it possible to develop hybrids with grain attributes as per consumers' preference.

Keywords : CGMS, restorer line, pigeonpea

Pigeonpea is the second most important pulse crop grown in India and plays an important role in subsistence agriculture. India is the largest pigeonpea growing country cultivating pigeonpea on 3.9 million-hectare with an annual production around 2.6 million tonnes and productivity of 672 kg/ha. Pigeonpea is a crop having vivid scopes under varied agricultural situations due to mammoth flexibility in crop duration (80 to 300 plus days), growing situations (solo / intercrop; rainfed / irrigated; *kharif* / *semi-rabi* / *rabi*) and purpose (green manuring / fodder / fuel / vegetable / grain/thatched huts). The crop has immense potential of both vertical and horizontal production enhancement. Despite these potential advantages, the productivity of pigeonpea has been stagnant for the last fifty years.

The concerted endeavors to break yield stagnation culminated in the development of genetic male sterility system. Despite good number of heterotic GMS based hybrids (ICPH-8, PPH-4, CoH-1, CoH-2, AKPH-4101 and AKPH-2022), the hybrids could not be adopted commercially due to inherent problem associated with the system (1, 2). Sardarkrushinagar Dantiwada Agricultural University took up an extensive programme to find out the versatile and commercially viable cytoplasmic genetic based male sterility system using wild species. The efforts resulted in the isolation of CGMS system using cytoplasm of *Cajanus scarabaeoides*. (3). The fertility restorer genes were also identified (4) and first ever CGMS based hybrid was identified in 2004 (5, 6). The protocol for commercial seed production in 4 A : 1 B/R lines as the case be for maintenance of A line and hybrid seed production has been developed (7).

Table 1. Characterization of different stable CGMS based A lines developed at Sardarkrushinagar

Sr. No.	CGMS lines	Recurrent Parent	Days to flower	Days to maturity	Plant height	Branches/plant	Pods/plant	Seeds/pod	Pod length	100-seed weight	Plant type	Flower colour	Seed colour	Yield/plant (g)
1	GT-288A	MS-288F	96	140	136	5.5	136	3.7	4.1	9.6	NDT	Y	CW	41
2	GT-33A	Pusa-33	78	136	132	6.3	108	3.8	4.1	8.7	NDT	Y	R	28
3	GT-87A	ICPL-87	93	132	76	5.7	96	3.9	4.2	9.1	SDT	Y	R	26
4	GT-100A	GT-100	88	137	107	5.6	135	3.9	4.4	10.2	DT	Y	CW	36
5	GT-289A	SKNP-289	95	141	75	4.7	87	4.0	4.7	10.6	DT	R	R	29
6	GT-290A	SKNP-290	83	142	96	4.5	127	3.7	4.7	9.9	DT	Y	R	24
7	GT-301A	BDN-2	122	175	125	7.1	160	3.6	4.2	9.7	NDT	Y	CW	48
8	GT-302A	SKNP-88-3	110	153	138	6.8	129	3.7	4.1	10.1	NDT	Y	CW	40
9	GT-303A	SKNP-9523	106	148	181	8.5	146	3.5	4.1	9.7	NDT	Y	CW	41
10	GT-304A	T-15-15	110	168	162	9.6	153	4.0	4.6	10.3	NDT	Y	CW	54
11	GT-305A	T-21	105	148	130	6.1	141	3.7	4.2	9.9	NDT	Y	R	44
12	GT-306A	ICPL84060	108	156	124	11.0	126	3.5	4.1	8.9	NDT	Y	R	36
13	GT-307A	BSMR736	116	162	112	8.0	112	3.0	3.4	9.7	NDT	Y	R	32
14	GT-308A	ICPL87051	101	148	132	10.0	187	3.8	4.2	9.3	NDT	R	CW	44
15	GT-309A	B-12	112	159	129	9.0	143	3.6	4.1	9.6	NDT	Y	CW	38
16	GT-310A	BDN-31	96	143	89	14.0	148	3.6	4.6	9.4	NDT	Y	CW	34
17	GT-311A	Pusa33-1	78	136	132	6.3	115	3.8	4.1	8.7	NDT	Y	CW	29
18	GT-401A	ICPL-5507	119	159	142	4.6	118	3.8	4.1	10.6	NDT	Y	R	27
19	GT-402A	ICPL-7078	117	162	146	5.3	142	3.9	4.2	10.2	NDT	Y	CW	32
20	GT-403A	AGS-5	126	178	152	6.8	129	4.1	4.3	10.1	NDT	Y	CW	32
21	GT-404A	AGS-28	118	173	161	4.3	142	3.7	4.0	9.3	NDT	Y	CW	36
22	GT-405A	AGS-30	119	174	139	5.4	118	3.5	3.8	9.4	NDT	Y	CW	32
23	GT-406A	BSMR-736	126	181	149	6.2	124	3.4	3.7	9.8	NDT	Y	CW	32
24	GT-501A	ICPL-7622	108	160	152	6.4	129	3.3	3.5	10.0	NDT	Y	CW	35
25	GT-502A	AGS-89	128	180	162	5.4	132	3.6	3.7	9.2	NDT	Y	CW	36
26	GT-503A	AGS-65	113	161	158	8.8	149	3.2	3.4	10.2	NDT	Y	R	36
27	GT-504A	AGS-46	124	171	154	6.9	152	4.1	4.3	9.1	NDT	Y	CW	31

Cont...

Table 1. Conti.....

Sr. No.	CMS lines	Recurrent Parent	Days to flower	Days to maturity	Plant height	Branches/plant	Pods/plant	Seeds/pod	Pod length	100-seed weight	Plant type	Flower colour	Seed colour	Yield/plant (g)
28	GT-505A	AGS-55	110	157	164	7.4	146	3.8	3.9	9.1	NDT	Y	CW	40
29	GT-601A	AGS-132	121	166	145	6	85	5	6.4	10.0	NDT	Y	CW	30
30	GT-602A	AGS-130	123	167	160	8	205	5	6.2	9.1	NDT	Y	CW	32
31	GT-603A	AGS-123	118	165	185	6	130	5	6.0	8.0	NDT	Y	CW	35
32	GT-604A	AGS-102	127	167	145	8	295	5	5.4	7.1	NDT	Y	R	40
33	GT-605A	AGS-101	116	164	190	8	305	4	6.3	8.0	NDT	Y	R	32
34	GT-606A	AGS-100	126	172	170	6	180	5	6.2	9.1	NDT	Y	R	36
35	GT-607A	AGS-99	127	170	180	9	310	4	5.2	9.0	NDT	R	CW	35
36	GT-608A	AGS-98	130	175	145	7	230	4	4.5	8.7	NDT	Y	CW	26
37	GT-609A	AGS-96	128	174	165	8	230	5	5.5	9.0	NDT	Y	CW	38
38	GT-610A	AGS-95	100	145	130	6	140	4	4.6	9.2	NDT	Y	R	39
39	GT-611A	AGS-94	129	169	165	8	305	4	5.0	8.5	NDT	Y	R	42
40	GT-612A	AGS-93	99	143	130	4	120	5	5.3	7.2	NDT	Y	CW	45
41	GT-613A	AGS-91	98	140	165	9	305	5	5.7	7.5	NDT	Y	CW	41
42	GT-614A	AGS-84	124	159	165	5	120	4	5.2	8.2	NDT	Y	R	23
43	GT-615A	AGS-76	127	170	125	4	120	4	4.7	9.0	NDT	R	CW	26
44	GT-616A	AGS-58	122	168	165	5	100	4	5.2	8.2	NDT	Y	CW	53
45	GT-617A	AGS-57	97	142	155	8	220	4	5.4	8.5	NDT	Y	CW	29
46	GT-618A	AGS-53	100	146	160	5	230	5	5.8	9.0	NDT	Y	CW	32
47	GT-619A	AGS-52	103	149	180	9	310	5	5.7	8.1	NDT	Y	R	34
48	GT-620A	AGS-50	119	170	175	7	315	4	5.1	7.9	NDT	Y	CW	38
49	GT-621A	AGS-49	98	142	150	5	185	4	5.2	8.2	NDT	Y	R	45
50	GT-622A	AGS-45	124	172	155	5	180	4	5.3	9.1	NDT	Y	CW	41
51	GT-623A	AGS-44	136	177	160	9	320	4	5.7	11.0	NDT	Y	CW	46
52	GT-624A	AGS-9	126	171	155	8	240	5	5.3	9.2	NDT	Y	CW	33
53	GT-625A	GAUT-97111	129	168	150	6	245	6	6.8	11.1	NDT	Y	CW	36

Table 2. Characterization of different stable restorer (R) lines developed at Sardarkrushinagar

Sr. No.	Re-storer	Pedigree	Characters										
			Days to flower	Day, to maturity	Plant height	Branches/plant	Pods/plant	Seeds/pod	Pod length	100-seed weight	Plant type	Flower colour	Seed colour
1	GTR-1	Back cross of derivatives of <i>C. sca</i> x <i>C. cajan</i> -ICP 8710	99	142	155	10.2	195	4.1	4.2	10.0	NDT	Y	R
2	GTR-2	F_1 <i>C.sca</i> x <i>C. cajan</i> fertile] x QMS-2 BC ₅	118	172	137	6.3	176	4.2	4.6	9.5	NDT	RSY	CW
3	GTR-3	CMS 17G-II F_2 (Fertile)-1 Derivatives of <i>C. sca</i> x <i>C. cajan</i>	102	138	146	5.6	165	4.3	4.3	10.2	NDT	Y	CW
4	GTR-4	SKNP 98-13	100	138	143	6.5	153	5.1	5.2	10.5	NDT	Y	R
5	GTR-5	<i>A. sca</i> x ICPL 87119 BC ₃ F_2 x ICPL 87119	113	170	146	6.5	176	4.2	4.3	10.3	NDT	Y	R
6	GTR-6	GT-100 (Derivative) fertile BC ₁ F_2 x GAUT 88-9	111	155	172	9.1	188	4.3	4.2	8.5	NDT	Y	CW
7	GTR-7	ICP-8976 Med. Duration	130	210	185	8.4	136	3.5	4.0	9.4	NDT	Y	CW
8	GTR-8	AGS 70 Mid late white seeded	97	145	127	10.3	143	3.4	4.1	9.2	NDT	Y	CW
9	GTR-9	GAUT 92-17 Early white seeded	92	137	139	9.2	162	4.2	4.2	9.5	NDT	Y	CW
10	GTR-10	ICP-9260 Med. Duration Red Seeded	103	148	153	13.1	207	3.7	4.0	10.1	NDT	Y	R
11	GTR-11	GT-100	95	145	90	4.2	130	3.9	4.1	10.1	DT	Y	CW
12	GTR-12	ICP-14722	110	165	100	4.3	122	3.5	4.2	9.7	NDT	Y	R
13	GTR-13	ICP-13	88	142	110	3.4	140	3.6	3.9	9.7	NDT	Y	R
14	GTR-14	ICP-10650	89	146	125	5.3	123	3.3	4.3	10.1	NDT	Y	R
15	GTR-15	ICP-10874	105	159	125	4.2	130	3.6	4.2	10.2	NDT	Y	R
16	GTR-16	ICP-11376	100	156	110	6.4	160	3.8	4.1	9.9	NDT	Y	R
17	GTR-17	ICP-11492	115	167	165	4.3	180	3.5	3.6	9.8	NDT	RSY	R
18	GTR-18	AGS-10	100	158	150	6.1	155	3.9	4.0	10.2	NDT	Y	CW
19	GTR-19	P-376 2K	109	158	136	7.0	112	4.3	4.5	9.1	NDT	Y	R
20	GTR-20	ICP-50	101	148	122	8.0	84	3.3	3.4	9.0	NDT	Y	R
21	GTR-21	ICP-132	118	168	14	6.0	96	4.0	4.3	8.9	NDT	Y	R
22	GTR-22	ICP-204	110	162	154	8.0	107	3.0	4.1	9.5	NDT	Y	W
23	GTR-23	ICP-95	94	136	128	12.0	142	3.0	3.8	9.0	NDT	Y	R
24	GTR-24	P-445 2K	117	161	186	9.0	162	4.0	4.3	9.6	NDT	Y	CW
25	GTR-25	P-246 2K-1	124	172	127	6.0	55	3.0	3.2	9.2	NDT	Y	R
26	GTR-26	P-182 2K	104	152	165	12	65	3.4	4.2	9.82	NDT	Y	R
27	GTR-27	P-408 2K	106	154	165	8	115	4	4.5	10.03	NDT	Y	CW
28	GTR-28	P-195 2K	97	140	112	7	135	4	4.3	10.12	NDT	Y	R

Cont...

Cont...

Table 2. Conti....

Sr. No.	Re-storer	Pedigree	Characters										
			Days to flower	Days to maturity	Plant height	Branches/plant	Pods/plant	Seeds/pod	Pod length	100-seed weight	Plant type	Flower colour	Seed colour
29	GTR-29	P-195 2K	100	144	105	8	110	4	4.5	9.9	NDT	Y	R
30	GTR-30	ICP-283	101	146	95	5	60	3	3.5	9.1	NDT	Y	R
31	GTR-31	288 A x 74-2 F3 (C. sca x C. cajan)	110	161	190	8	140	4	4.2	10.4	NDT	Y	CW
32	GTR-32	(288 A x ICPL 87119) x GAUT 88-3	104	152	165	12	124	3.7	4.1	10.3	NDT	Y	CW
33	GTR-33	F ₃ Bulk (288 A x 42-1)	102	153	168	11	121	3.6	3.9	10.1	NDT	YWR	R
34	GTR-34	ICP-132	93	136	144	5	62	3.7	4.1	10.0	NDT	Y	CW
35	GTR-35	F ₅ derivatives SKNPCH 10-1-2-1-2	98	142	84	5	95	4	5.2	9.0	DT	Y	R
36	GTR-36	F ₄ derivatives SKNPCH 6-3-1-4	102	154	160	8	72	4	3.2	8.2	NDT	Y	R
37	GTR-37	F ₅ derivatives SKNPCH 10-2-4-1-2	100	146	148	7	108	3	3.3	8.3	NDT	Y	CW
38	GTR-38	F ₄ derivatives SKNPCH 9-2-4-3	110	164	155	7	122	4	4.1	7.6	NDT	Y	CW
39	GTR-39	F ₄ derivatives SKNPCH 9-2-4-2	113	172	165	8	203	4	3.8	9.2	NDT	Y	CW
40	GTR-40	F ₄ derivatives SKNPCH 9-2-4-4	115	168	161	10	258	4	3.2	8.2	NDT	Y	CW
41	GTR-41	F ₅ derivatives SKNPCH 10-4-1-1	112	162	170	10	66	4	4.5	7.3	NDT	Y	CW
42	GTR-42	F ₄ derivatives SKNPCH 8-1-1-5	102	151	152	7	97	4	4.1	7.3	NDT	Y	CW
43	GTR-43	F ₄ derivatives SKNPCH 6-3-1-3	120	172	164	5	125	4	4.2	8.3	NDT	Y	R
44	GTR-44	F ₄ derivatives SKNPCH 8-1-1-2	124	173	175	10	165	4	4.4	9.2	NDT	Y	R
45	GTR-45	F ₅ derivatives SKNPCH 2-11-3-2	98	142	167	6	138	4	4	7.6	NDT	Y	R
46	GTR-46	F ₄ derivatives SKNPCH 3-12-1-3-2	97	148	140	6	136	4	4.2	8.2	NDT	Y	R
47	GTR-47	F ₄ derivatives SKNPCH 4-4-2-1-2	100	146	126	4	148	4	4.2	7.5	NDT	Y	CW
48	GTR-48	F ₄ derivatives SKNPCH 8-1-1-1	98	140	127	3	107	4	4.5	8.1	NDT	Y	CW
49	GTR-49	F ₄ derivatives SKNPCH 5-2-3-2	96	139	138	5	87	4	3.8	8.1	NDT	Y	R
50	GTR-50	F ₄ derivatives SKNPCH 8-1-1-3	100	142	142	3	76	4	4.3	9.2	NDT	Y	CW
51	GTR-51	F ₄ derivatives SKNPCH 2-4-2-1	96	142	120	3	97	4	4.3	8.3	NDT	Y	CW
52	GTR-52	F ₄ derivatives SKNPCH 3-3-4-1	90	135	112	6	148	4	4.2	8.8	NDT	Y	R
53	GTR-53	F ₄ derivatives SKNPCH 4-2-3-1	87	137	127	5	211	4	4.4	7.9	NDT	Y	CW
54	GTR-54	F ₄ derivatives SKNPCH 8-4-1-1	107	154	152	6	118	4	4.0	8.1	NDT	Y	CW
55	GTR-55	F ₄ derivatives SKNPCH 9-2-2-1	98	142	118	7	132	4	4.2	8.2	NDT	Y	R

DF=Days to flower, DM=Days to maturity, PH=Plant height (d), BP=Branches/plant, PP=Pods/plant, SP=Seeds/pod, PL=Pod length (cm), TW=Test weight (g.), PT=Plant type, FC=Flower colour, SC=Seed colour

Table 3. Group assortment of different A and R lines developed at Sardarkrushinagar according to maturity, growth habit, seed size and seed colour.

Maturity Group			Growth Habit		Seed Size		Seed colour	
Early	Medium	Late	Non-determinate	Determinate	Medium < 10g	Bold >10g	Creamy White	Red
A lines								
GT-288A, GT-33A, GT-87A, GT-100A, GT-289A, GT-290A, GT-303A, GT-305A, GT-307A, GT-309A, GT-311A, GT-610A, GT-612A, GT-613A, GT-617A, GT-618A, GT-619A, GT-621A,	GT-301A, GT-302A, GT-304A, GT-306A, GT-307A, GT-309A, GT-401A, GT-402A, GT-403A, GT-404A, GT-405A, GT-501A, GT-502A, GT-503A, GT-504A, GT-505A, GT-601A, GT-602A, GT-603A, GT-604A, GT-605A, GT-606A, GT-607A, GT-608A, GT-609A, GT-611A, GT-614A, GT-615A, GT-616A, GT-620A, GT-622A, GT-623A, GT-624A, GT-625A	GT-406A	GT-288A, GT-33A, GT-87A, GT-301A, GT-302A, GT-303A, GT-304A, GT-305A, GT-306A, GT-307A, GT-308A, GT-309A, GT-310A, GT-311A, GT-401A, GT-402A, GT-403A, GT-404A, GT-405A, GT-406A, GT-501A, GT-502A, GT-503A, GT-504A, GT-505A, GT-601A, GT-602A, GT-603A, GT-604A, GT-605A, GT-606A, GT-607A, GT-608A, GT-609A, GT-610A, GT-611A, GT-612A, GT-613A, GT-614A, GT-615A, GT-616A, GT-617A, GT-618A, GT-619A, GT-620A, GT-621A, GT-622A, GT-623A, GT-624A, GT-625A	GT-100A, GT-289A, GT-290A,	GT-288A, GT-33A, GT-87A, GT-290A, GT-301A, GT-303A, GT-305A, GT-306A, GT-307A, GT-308A, GT-309A, GT-310A, GT-311A, GT-401A, GT-402A, GT-403A, GT-404A, GT-405A, GT-406A, GT-501A, GT-502A, GT-503A, GT-504A, GT-505A, GT-601A, GT-602A, GT-603A, GT-604A, GT-605A, GT-606A, GT-607A, GT-608A, GT-609A, GT-610A, GT-611A, GT-612A, GT-613A, GT-614A, GT-615A, GT-616A, GT-617A, GT-618A, GT-619A, GT-620A, GT-621A, GT-622A, GT-624A,	GT-100A, GT-289A, GT-302A, GT-304A, GT-308A, GT-401A, GT-402A, GT-403A, GT-501A, GT-503A, GT-601A, GT-623A, GT-625A	GT-288A GT-100A, GT-301A, GT-302A, GT-303A, GT-304A, GT-308A, GT-309A, GT-310A, GT-311A, GT-402A, GT-403A, GT-404A, GT-405A, GT-501A, GT-502A, GT-504A, GT-505A, GT-601A, GT-602A, GT-603A, GT-607A, GT-608A, GT-609A, GT-612A, GT-613A, GT-615A, GT-616A, GT-617A, GT-618A, GT-620A, GT-622A, GT-623A, GT-624A, GT-625A	GT-33A, GT-87A, GT-289A, GT-290A, GT-305A, GT-306A, GT-307A, GT-308A, GT-309A, GT-310A, GT-311A, GT-401A, GT-402A, GT-403A, GT-404A, GT-405A, GT-501A, GT-503A, GT-601A, GT-602A, GT-603A, GT-604A, GT-605A, GT-606A, GT-607A, GT-608A, GT-609A, GT-610A, GT-611A, GT-614A, GT-619A, GT-621A,
R lines								
GTR-1, GTR-3, GTR-4, GTR-8, GTR-9, GTR-10, GTR-11, GTR-13, GTR-14, GTR-20, GTR-23, GTR-28, GTR-29, GTR-30, GTR-34, GTR-35, GTR-37, GTR-45, GTR-46, GTR-47, GTR-48, GTR-49, GTR-50, GTR-51, GTR-52, GTR-53, GTR-55	GTR-2, GTR-5, GTR-6, GTR-12, GTR-15, GTR-16, GTR-17, GTR-18, GTR-19, GTR-21, GTR-22, GTR-24, GTR-25, GTR-26, GTR-27, GTR-31, GTR-32, GTR-33, GTR-36, GTR-38, GTR-39, GTR-40, GTR-41, GTR-42, GTR-43, GTR-44, GTR-54,	GTR-7,	GTR-1, GTR-2, GTR-3, GTR-4, GTR-5, GTR-6, GTR-7, GTR-8, GTR-9, GTR-10, GTR-12, GTR-13, GTR-14, GTR-15, GTR-16, GTR-17, GTR-18, GTR-19, GTR-20, GTR-21, GTR-22, GTR-23, GTR-24, GTR-25, GTR-26, GTR-27, GTR-28, GTR-29, GTR-30, GTR-31, GTR-32, GTR-33, GTR-34, GTR-36, GTR-37, GTR-38, GTR-39, GTR-40, GTR-41, GTR-42, GTR-43, GTR-44, GTR-45, GTR-46, GTR-47, GTR-48, GTR-49, GTR-50, GTR-51, GTR-52, GTR-53, GTR-54, GTR-55	GTR-11, GTR-35,	GTR-2, GTR-6, GTR-7, GTR-8, GTR-9, GTR-12, GTR-13, GTR-16, GTR-17, GTR-19, GTR-20, GTR-21, GTR-22, GTR-23, GTR-24, GTR-25, GTR-26, GTR-29, GTR-30, GTR-34, GTR-35, GTR-36, GTR-37, GTR-38, GTR-39, GTR-40, GTR-41, GTR-42, GTR-43, GTR-44, GTR-45, GTR-46, GTR-47, GTR-48, GTR-49, GTR-50, GTR-51, GTR-52, GTR-53, GTR-54, GTR-55	GTR-1, GTR-3, GTR-4, GTR-5, GTR-10, GTR-11, GTR-14, GTR-15, GTR-18, GTR-27, GTR-31, GTR-32, GTR-33, GTR-39, GTR-40, GTR-41, GTR-42, GTR-43, GTR-44, GTR-45, GTR-46, GTR-47, GTR-48, GTR-49, GTR-50, GTR-51, GTR-52, GTR-53, GTR-54, GTR-55	GTR-2, GTR-3, GTR-6, GTR-7, GTR-8, GTR-9, GTR-11, GTR-18, GTR-22, GTR-24, GTR-27, GTR-31, GTR-32, GTR-34, GTR-37, GTR-38, GTR-39, GTR-40, GTR-41, GTR-42, GTR-47, GTR-48, GTR-50, GTR-51, GTR-53, GTR-54,	GTR-1, GTR-4, GTR-5, GTR-10, GTR-12, GTR-13, GTR-14, GTR-15, GTR-16, GTR-17, GTR-19, GTR-20, GTR-21, GTR-23, GTR-25, GTR-26, GTR-28, GTR-29, GTR-30, GTR-33, GTR-35, GTR-36, GTR-37, GTR-38, GTR-39, GTR-40, GTR-41, GTR-42, GTR-43, GTR-44, GTR-45, GTR-46, GTR-47, GTR-48, GTR-49, GTR-50, GTR-51, GTR-52, GTR-53, GTR-54, GTR-55

Appreciating that genetic diversity is the backbone of any successful hybrid development programme; nation wide efforts were made to identify different sources of CGMS based sterility. At present four different types of wild cytoplasm, i.e. A₁ types from *Cajanus sericeus* (3); A₂ types from *Cajanus scarabaeoides* (3, 9); A₃ types from *Cajanus volubilis* (10) and A₄ types from *Cajanus cajanifolius* (11) have been established for male sterility. That apart, ICRI SAT has also utilized cultivated pigeonpea (*Cajanus cajan*) for sterility development (A₅). Extensive work has been done at Sardarkrushinagar to diversify both A and R lines for successful hybrid programme against the background of A₂ cytoplasm using *Cajanus scarabaeoides* 53 stable CGMS lines and 55 stable restorers lines has been identified (Table 1, 2). The same were grown for characterization and were accordingly grouped as per maturity, growth habit, seed size and seed colour (Table 3).

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Yield enhancement in pigeonpea through heterosis by exploiting Indo-African germplasm

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Abstract

Experimental materials comprising 45 hybrids derived from 10 diverse parents in diallel mating design were grown along with parents in randomized block design replicated thrice during *kharif* 2004 to study the magnitude of heterosis in pigeonpea [*Cajanus cajan* (L.) Millsp.]. The analysis of variance revealed significant genotypic differences among the parents and hybrids for all the traits evincing enormous genetic diversity among the materials studied. Mean squares due to parents v/s hybrids were significant for all the traits except seeds per pod and 100-seed weight, revealing blatant differences in the performance of parents and crosses in F_1 generation. High heterosis was observed for seed yield per plant, number of branches per plant, number of pods per plant, harvest index and shelling percentage, whereas low to moderate heterosis was demonstrated for the remaining traits. Out of 45 crosses studied, 30 and 19 crosses substantiated significant positive heterobeltiosis and standard heterosis for seed yield per plant, respectively. Such crosses are likely to give better transgressive segregants and could be used for isolation of superior genotypes for yield enhancement in pigeonpea. Ten best crosses selected on the basis of *per se* performance viz., GT-100 with ICP-12116, ICP-12161, Banas and ICP-11912; Banas with ICP-9140 and ICP-11488; GT 101 with ICP-12161 and ICP-12116; ICP-12161 with ICP-9135, and ICP-13555 with ICP-9135 exhibited significant desirable standard heterosis for seed yield per plant as well as other important yield components like number of branches per plant, number of pods per plant, pod length, harvest index and per cent pod damage. These crosses may be exploited for developing high yielding cultivars in pigeonpea.

Keywords : Heterosis, Indo-African derivatives, pigeonpea

Introduction

Pigeonpea is the most preferred pulse crop in consumption all over India. Over 80 per cent of the global pigeonpea area is in India. The crop has wider oddities in crop duration (80 – 300 plus days), growing situations (solo/intercrop; rainfed/irrigated; *kharif/semi-rabi/rabi*) and purpose (fodder / vegetable / fuel / grain / green manuring / fertility building). However, low inherent yield, pod borer complex and abiotic stresses (drought, water inundation) are the greatest tripping stone in realizing attainable yield. Further, the productivity of pigeonpea has been stagnant around six to seven tons for the last fifty years. Lately efforts to break this yield plateau have been successful through heterosis breeding. Both genetic male sterility based (ICPH-8, PPH-4, CoH-1, CoH-2, AKPH-4101 and AKPH-2022) and cytoplasm genetic male sterility based hybrids

(GTH 1 & ICPH 2671) have been identified, though genetic male sterility based hybrids could not be exploited due to inherent seed production problem with the system (1, 2). Lately identification of different and stable cytoplasmic sterility system (A_1 , A_2 , A_3 and A_4) with potent and subjective fertility restoration system has made it possible to exploit heterosis at commercial scale in pigeonpea. Empirically narrow genetic base restricts crop improvement programme and in pigeonpea only a few lines have been exploited in breeding programme for bringing around genetic ameliorations. Thus, broadening genetic base is the priority area in pigeonpea yield enhancements programme. The exotic germplasm that evinced immense complimenting genetic variability to Indian counterparts (3) can be useful both for broadening the narrow genetic base and providing good combination for adequate exploitation of heterosis in pigeonpea.

Materials and methods

Four diverse indigenous genotypes of pigeonpea [*Cajanus cajan* (L.) Millsp.] viz., GT-100, GT-101, Banas and ICP-11912 and six exotic lines viz., ICP-9140 and ICP-9135 (Kenya), ICP-12116 and ICP-12161 (Tanzania), ICP-11488 (Myanmar) and ICP-13555 (Canada) were crossed in a diallel mating fashion excluding reciprocals during *rabi* 2003. The resultant 45 hybrids were grown with 10 parents during *kharif* 2004-05 in randomized block design in three replications at the Main Pulses Research Station, S. D. Agricultural University, Sardarkrushinagar. Each entry comprised single row of 4 m length with a row-to-row and plant-to-plant spacing of 90 cm and 30 cm, respectively. The standard agronomic practices were adopted to raise the crop. Observations were recorded on seed yield per plant (g), days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, number of pods per plant, pod length (cm), seeds per pod, 100-seed weight (g), harvest index (%), shelling percentage and per cent pod damage. Analysis of variance was carried out as per linear model proposed by Panse and Sukhatme (4).

Results and discussion

The analysis of variance (Table 1) revealed significant differences among the parents and hybrids for all the traits, indicating enormous genetic diversity among the material studied. Significant mean squares due to parents v/s hybrids for all the traits except seeds per pod and 100-seed weight further substantiated the differences in the performance of parents and crosses in F_1 generation.

The range of relative heterosis, heterobeltiosis and standard heterosis are presented in Table 2. High heterosis was observed for seed yield per plant, number of branches per plant, number of pods per plant, harvest index and shelling percentage. Low to moderate heterosis was observed for the remaining traits. Moll (5) reported that higher magnitude of heterosis was associated with genetic diversity of parents.

An examination of overall performance of hybrids over mid parent, better parent and standard parent for seed

Table 1. Analysis of variance for seed yield per plant and its components in pigeonpea.

Source	df	Seed yield per plant (g)	Days to 50 % flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of pods per plant	Pod length (cm)	Seeds per pod	100-seed weight	Harvest index (%)	Shelling percentage	Per cent pod damage
Replications	2	6.57	85.50	246.21	364.45	2.87	383.22	0.11	0.01	0.71	4.17	31.67**	4.44
Parents (P)	8	1125.49**	1175.49**	2043.44**	3608.92**	31.00**	6265.55**	3.60**	2.90**	7.25**	762.02**	547.49**	166.45**
Hybrids (H)	35	3196.16**	481.20**	728.86**	811.52**	36.11**	65432.14**	3.37**	0.67**	9.69**	719.94**	545.67**	355.46
P V/s H	1	19203.01**	1229.59**	3686.66**	6324.64**	248.10**	511940.32**	1.69*	0.19	0.76	878.67**	483.87**	211.43**
Error	160	27.95	91.92	95.51	180.82	1.52	606.88	0.34	0.13	1.06	4.83	4.81	4.38

*and ** significant at 5 % and 1 % levels, respectively.

yield per plant revealed that 39, 30 and 19 hybrids manifested significant positive heterosis, heterobeltiosis and standard heterosis, respectively (Table 2). Further, the hybrids evincing significant relative heterosis, heterobeltiosis and standard heterosis in desired direction for various components traits indicated that number of desirable specific combinations though varied in different characters yet the specific combinations may be selected for seed yield and individual characters.

These promising hybrids exhibited significant desirable standard heterosis for important yield components too like number of branches per plant, number of pods per plant, pod length, harvest index and per cent pod damage. Significant and positive heterosis for seed yield (6), number of branches per plant (7), number of pods per plant (8 and 9) and pod length (10) has been reported. It is also evident from the Table 3 that all yield contributing factors affected in different extent toward heterosis for seed yield per plant. This may be due to competition among the yield components for sum total of metabolic substances produced by the plant and the conditions favouring the development of individual component. Therefore, desired level of each component should be aimed in

a selection programme. All the superior hybrids presented in Table 3 showed high sca effects indicating thereby importance of non-additive gene effects in the heterotic response of these hybrids.

Ten best crosses selected on the basis of *per se* performance viz., GT-100 with ICP-12116, ICP-12161, Banas and ICP-11912; Banas with ICP-9140 and ICP-11488; GT 101 with ICP-12161 and ICP-12116; ICP-12161 with ICP-9135, and ICP-13555 with ICP-9135 exhibited significant desirable standard heterosis for seed yield per plant as well as other important yield components like number of branches per plant, number of pods per plant, pod length, harvest index and per cent pod damage among which pods per plant seemed most important attribute in all the best ten specific combinations (Table 3). Out of these ten specific combinations, first six represented combinations of Indian x African germplasm while African x African and Indian x Indian represented two crosses each. This indicated the significance of broadening genetic base and its utility of exploiting Indian x African germplasm for exploiting heterosis in pigeonpea. These crosses may be used for developing high yielding hybrids in pigeonpea.

Table 2. Range of heterosis over mid-parent (MP), better parent (BP) and standard parent (SP) along with number of crosses showing significant heterosis in desired direction for various characters in pigeonpea.

Character	Range of heterosis over			Number of crosses showing significant desirable heterosis		
	MP	BP	SP	MP	BP	SP
Seed yield per plant (g)	-82.80 - 858.65	-89.22 - 601.28	-93.33 - 147.62	39	30	19
Days to 50 per cent flowering	-16.41 - 3.47	-10.94 - 14.87	30.21 - 40.23	26	3	0
Days to maturity	-16.64 - 5.97	-11.34 - 12.14	-1.03 - 31.48	35	7	0
Plant height (cm)	-9.60 - 65.75	0.08 - 93.75	46.42 - 140.67	4	0	0
No. of branches per plant	-14.85 - 220.34	-34.59 - 139.24	-56.07 - 100.54	36	27	5
No. of pods per plant	-54.76 - 717.78	-74.27 - 697.80	-74.26 - 355.96	38	35	18
Pod length (cm)	-29.36 - 39.12	-35.23 - 45.70	-56.07 - 6.68	21	10	0
Seeds per pod	-20.92 - 28.95	-33.33 - 30.16	-16.98 - 46.03	19	13	0
100- seed weight (g)	-25.31 - 34.29	-33.80 - 27.76	-38.89 - 27.07	10	6	2
Harvest index (%)	-76.84 - 395.51	-86.84 - 316.79	-95.37 - 70.91	30	16	3
Shelling percentage	-66.45 - 227.46	-73.37 - 175.93	-79.92 - 2.40	27	18	0
Per cent pod damage	-81.42 - 137.07	-77.053 - 170.19	-58.82 - 256.12	26	21	4

Table 3. Promising hybrids for seed yield per plant with standard heterosis along with their SCA effect and component traits showing significant desirable standard heterosis in pigeonpea.

Promising hybrids	Seed yield per plant (g)	Standard heterosis	SCA effect	Significant desirable standard heterosis for component traits
GT-100 x ICP-12116	130.00	147.62**	60.10**	PP,HI
Banas x ICP-9140	122.55	133.43**	53.25**	PP
ICP-12161 x ICP-9135	114.50	117.33**	68.74**	PP
GT-100 x ICP-12161	112.50	114.29**	32.78**	BP,PP
GT-101 x ICP-12161	109.00	107.62**	39.19**	BP,PP,PPD
GT-101 x ICP-12116	101.25	92.86**	38.26**	PP,HI
GT-100 x Banas	94.63	80.33**	6.87**	PP
GT-100 x ICP-11912	90.00	71.42**	30.74**	PP
ICP-13555 x ICP-9135	89.27	70.04**	37.24**	PP,PL,PPD
Banas x ICP-11488	80.33	52.95**	30.05**	PP,PPD

*and ** significant at 5 % and 1 % levels, respectively.

Where, BP= number of branches per plant, PP= number of pods per plant, PL= pod length, HI= harvest index and PPD= per cent pod damage.

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Divergence analysis in grain amaranth species

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Abstract

Divergence analysis in grain amaranth (*Amaranthus* spp.) involving genetically diverse fifty genotypes drawn from different species viz., *A. hypochondriacus* (L), *A. cruentus* (L), *A. paniculatus* (L) and *A. edulis* (L) was conducted on yield attributes. On the basis of magnitude of D^2 statistics, these were grouped in nine clusters. The clustering pattern revealed that the genetic diversity was not necessarily parallel to the geographic diversity. The multivariate analysis using D^2 statistics revealed that days to flowering contributed maximum towards total divergence followed by protein content and number of branches/plant. The inter cluster distance was maximum between cluster I and V followed by III and V and II and III suggesting that these groups of genotypes were highly divergent from each other.

Keywords : Divergence analysis, amaranth species, yield attributes.

Introduction

The improvement in economic yield and success of hybridization programme mainly depends upon the variability present in parents. It is likely that good combinations arise if the parents having high genetic variability involved in hybridization programme. The quantification of the degree of divergence among biological populations helps the plant breeder to recognize the importance of genetic diversity in selecting the genetically diverse parents, for heterosis breeding programme (1). The D^2 statistic proposed by Mahalanobis (2) is one of the potent techniques of measuring genetic divergence based on multiple characters. Sufficient information is not available about the genetic divergence in grain amaranth. The present study was undertaken to work out the divergence among the species on different traits.

Material and methods

The experimental material comprised 50 genotypes of diverse geographic and genetic origin of grain amaranth species [*A. hypochondriacus* (L), *A. cruentus* (L), *A. paniculatus* (L) and *A. edulis* (L)]. Out of these 35 were obtained from National Bureau of Plant Genetic Resources, New Delhi while rest were procured from All India Co-ordinated Research Project on Underutilized Crops, Regional Research Station,

S.D. Agricultural University, Sardarkrushinagar, Gujarat. The experiment was conducted in randomized block design with 3 replications in 3 artificially created environments through different dates of sowing i.e. 1st November 2004, 15th November 2004 and 1st December 2004 at AICRP on Underutilized Crops, Regional Research Station, Sardarkrushinagar. Each genotype was sown in 3 m long single row keeping spacing of 45 cm between rows and 15 cm between plants within rows in all the three environments. Data were recorded on seed yield/plant (g) and its component traits like, days to flowering, plant height (cm), inflorescence length (cm), number of branches/plant, days to maturity, straw yield/plant (g), harvest index (%), 1000-seed weight (g) and protein content (%). The data pooled over environments were subjected to multivariate analysis, using Mahalanobis's generalized distance D^2 (2). The genotypes were grouped into different clusters according to Tocher's method as described by Rao (3) and Anderson (4). The contribution of different characters towards divergence was also estimated. Arunachalam and Ram (5) advocated the use of equal number of varieties from each region in order to find out a true picture of association existing between geographical and genetic divergence. It was not so in this study because the objective here was to pinpoint genetically diverse and desirable parents for initiating effective and intensive grain amaranth breeding programme.

Table-1. Composition of different clusters in grain amaranth

Cluster No.	Total genotypes	Genotypes
I	9	IC-32195, 35696, 120588, RAM-4, RGAS-92-10-1, SKNA-7, SKNA-18, SKNA-21 .GA-2.
II	19	IC-17947,38045,38047,38101,38122,38131, 38145, 38237, 38340, 38353, 38561, 38599, 38635, 42008, 42306, 42310, 42345, 95597, Annapurna.
III	11	IC-38615, 38625, RAM-3, Suvarna, EC-277971 321563. 321567, 359417-1,359417-2,359440-1. GA-1.
IV	5	IC-38042,38102,38107, 38147,38188.
V	2	IC-21 925, EC-359411.
VI	1	RAM-2
VII	1	IC-4998
VIII	1	EC-198135
IX	1	EC-321561

Table 2. Intra and inter-cluster distance (D) between 50 genotypes of grain amaranth [$D=(D^2)^{1/2}$]

Cluster	I	II	III	IV	V	VI	VII	VIII	IX
I	4.19	15.35	8.56	12.93	17.47	5.73	8.73	9.20	10.84
II		4.52	17.27	6.90	11.25	15.40	15.49	13.38	16.99
III			5.47	14.60	17.37	9.13	10.52	12.36	7.95
IV				5.24	9.04	13.05	13.78	12.86	14.59
V					3.60	16.11	16.25	16.38	15.69
VI						0.00	3.91	6.15	8.10
VII							0.00	4.63	6.95
VIII								0.00	9.75
IX									0.00

Results and discussion

Group constellation

Analysis of variance revealed significant differences among the genotypes for all the characters. On the basis of D^2 analysis the genotypes were grouped into 9 clusters. The composition of clusters is presented in Table 1. The maximum number of genotypes (19) fell in cluster-II, followed by cluster III (11). cluster I (9), cluster IV (5), cluster V (2), whereas single genotype each was grouped into cluster VI, VII, VIII and IX. The inter-cluster distance ranged from 3.91 to 17.47, whereas inter-cluster distance was 0.00 to 5.47

(Table 2). The intra-cluster distance was zero for cluster VI, VII, VIII and IX as they were made up of single genotype. The maximum intra-cluster distance was observed for cluster III (5.47). The inter cluster distance was maximum between cluster I and V (17.47) followed by cluster III and V (17.37) and cluster II and III (17.27).

The pattern of genotypes occurring in clusters cutting across geographical boundaries clearly demonstrates that geographical diversity need not be related to genetic diversity. These results are in conformity with the results reported by Joshi and Rana (6). Shukla *et al.* (7) and Verma *et al.* (8). It may therefore be

concluded that genotypes with the same geographical origin might possess different backgrounds with wide divergence in their features. In spite of geographical separation other forces are also responsible for divergence. Genetic drift, exchange of genetic stocks, history of selection and selection in different environments could have also caused greater diversity than geographical diversity as reported by Shukla et al. (7). It is therefore suggested that genotypes belonging to different clusters having maximum distance should be selected for hybridization for generating highest possible variability in the yield and quality traits.

Components of Intra-cluster D^2

Cluster means for seed yield and its component traits are presented in Table 3. The days to flowering contributed maximum towards divergence (42.53%) as reported by Shukla et al. (7) followed by protein content (22.78%), number of branches per plant (17.22 %), plant height (7.59%) and inflorescence length (5.55%). Cluster V included genotypes having maximum seed yield/plant and number of branches. The entries falling in cluster II had the minimum days to flowering, days to maturity, plant height and straw yield/plant along with maximum harvest index that indicated the suitability of this cluster for selection of early, dwarf high yielding parents. Whereas the genotypes falling in cluster III had maximum mean value for days to flowering, days to maturity with minimum harvest index and seed yield/plant. The genotypes occurring in cluster VI had maximum inflorescence length and straw yield/plant, while those falling in cluster IX had the genotypes with minimum inflorescence length, 1000-seed weight and protein content. The cluster VIII and I included entries which had highest protein content and 1000-seed weight, respectively. Moderate mean values for almost all the characters were observed in cluster VII except number of branches/plant. The branching pattern was absent among the genotypes of cluster I, III, VI, VII, VIII and IX hence, the mean values for this trait were depicted as zero in these clusters (Table 3).

Thus, for creating wide spectrum of variability and promising derivatives intercrossing of genotypes of cluster II and V would be desirable for hybridization among genetically diverse parental genotypes for earliness and dwarfness might be helpful in bringing the new gene pool in population and expanding the range of adaptation.

Table 3. Cluster means for seed yield/plant and its component traits in grain amaranth.

Cluster	No. of entries	Seed yield per plant (g)	Days to flowering	Plant height (cm)	Inflorescence length (cm)	Number of branches/plant	Days to maturity	Straw yield/plant (g)	Harvest index (%)	1000-seed weight (g)	Protein Content (%)
I	9	13.61	59.41	136.01	89.35	0.00	96.47	69.70	15.89	0.69	15.20
II	19	13.11	35.66	73.83	69.34	5.03	84.60	46.70	21.88	0.79	15.09
III	11	8.45	70.37	129.80	56.51	0.00	99.68	67.61	10.98	0.69	14.52
IV	5	15.38	44.87	101.16	82.86	5.13	85.40	57.45	21.34	0.72	14.60
V	9	16.23	42.17	113.64	77.54	6.58	90.84	66.05	18.58	0.83	11.99
VI	1	12.08	57.56	134.99	93.40	0.00	96.78	70.47	14.74	0.75	13.04
VII	1	11.13	57.33	117.28	84.76	0.00	95.66	59.53	15.83	0.79	11.94
VIII	1	13.91	48.78	101.49	75.58	0.00	92.44	47.76	21.72	0.90	12.77
IX	1	10.08	66.22	119.16	49.53	0.00	96.11	56.15	15.83	0.68	11.72

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Heterosis for some economic characters in potato (*Solanum tuberosum* L.)

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Abstract

The degree of heterosis varied from cross to cross for all the traits in potato. The highest relative heterosis for tuber yield was observed by the hybrid K. Laukar x DP-9904 (35.15 %). None of the hybrids exhibited significant positive heterobeltiosis for tuber yield per plant, whereas, maximum number of hybrids exhibited significant positive heterobeltiosis for number of tubers per plant. High heterosis was observed for number of tubers per plant and number of leaves per plant, while, low heterosis values were observed for tuber yield per plant, average weight of tubers, harvest index and number of stems per plant; moderate heterosis for days to maturity, plant height, fresh weight of tops per plant and dry matter per cent. In general, frequency of heterotic crosses was higher among the crosses involving parents with average x average gca effects.

Key words: Heterosis, potato, economic characters

Introduction

Tuber yield is the most important economic trait in potato. Hence, information on tuber yield potential of parents/ hybrids is of major importance in a systematic crossing programme. Crosses between closely related parents provide little or no positive heterosis and for increasing tuber yield, crosses from genetically distant and divergent parents have to be obtained. The existence of a "heterotic threshold" in the cultivated potato has been suggested beyond which greater heterozygosity does not result in more vigorous progenies. The nature and magnitude of heterosis helps in identifying superior cross combinations giving high degree of useful heterosis and in characterization of parents for their future use in breeding programme. The relative heterosis and heterobeltiosis are important as they provide an idea about the role of dominance and over dominance type of genetic control of character. In the present study, characters viz. number of stems per plant, number of tubers per plant, tuber yield per plant, average weight of tubers, harvest index and tuber dry matter content are known to be important for most of the economic

characters. This makes it necessary to study the heterosis in the crosses for these characters. The knowledge of heterosis of these economic traits that could be effectively utilized in selecting for the desired characters in breeding programme. Therefore, the present investigation was carried out with the object to estimate heterosis of various yield attributing characters in potato.

Materials and method

The experimental material comprised of 39 genotypes which consisted of seven lines, four testers and their 28 hybrids obtained by crossing in Line x Tester mating design. The experiment was conducted in randomized block design with four replications at Potato Research Station, S. D. Agricultural University, Deesa (Gujarat) during Rabi- 2003-04. Each genotype was represented by two rows of 15 dibbles at 20 cm spacing between plants and 50 cm between rows. Recommended package of practices were followed for the raising of successful crop. Observations were recorded on ten randomly selected plants in each entry and in each replication and their mean values were calculated.

Data on different characters were analysed on mean values based for experimental design. Analysis of variance for the experimental design was carried out as per the procedure of Panse and Sukhatme (1), while, analysis of variance component comprised of using means squares due to genotypes and error by manipulation of expected mean squares suggested by Allard and Bradshaw (2).

The formulae used in estimation of heterosis over mid parent, better parent and standard check (K. Badshah) for each character was suggested by Fonseca and Patterson (3).

Results and discussion

The analysis of variance revealed highly significant differences among the genotypes, parents, hybrids (except harvest index) and parents vs. hybrids (except fresh weight of tops per plants, tuber yield per plant and harvest index) for most of the traits under study, indicating considerable amount of variability among the experimental materials.

In the present study, low magnitude of heterosis was observed for tuber yield per plant. These results indicated the presence of narrow genetic base in the population. Thus, the improvement of this character can be attained by selection of superior parents followed by crossing and making selection of superior clones from the progeny. These findings are in agreement with the report of Luthra *et al.* (4).

Among all the 28 hybrids, three hybrids viz. MF-1 X K. Chipsona-2, MF-1 X K. Chipsona-1 and MF-1 X DP-9904 exhibited the highest significant positive heterosis over mid parent, better parent and standard check K. Badshah, respectively for number of tubers per plant.

On the basis of *per se* performance for tuber yield per plant character, the highest value showed by the hybrid K. Laukar x K. Chipsona-2 (685.0 g) followed by hybrids K. Laukar x DP-9904 (682.5 g) and K. Laukar x TPS-13 (667.5 g). The highest relative heterosis

Table 1. Analysis of mean sum of squares for the different characters of potato.

source of variation	d.f.	Days to maturity	Plant height (cm)	No. of stems / hill	Fresh Wt. of tops/ plant (g)	No. of leaves/ plant	No. of tubers / plant	Tuber yield/ plant (g)	Av. wt. of tubers (g)	Harvest index (%)	Dry matter (%)
Replications	3	34.06*	26.82	0.14	5774.06**	76.75**	0.06	26505.07*	54.45	51.61**	1.75
Genotypes	38	57.64**	203.45**	0.85**	4833.76**	28.20**	19.52**	34227.23**	1097.25**	16.17	3.64**
Parents	10	106.35**	476.75**	1.17**	5298.91**	19.57**	2.47**	19992.88*	835.32**	10.64	3.94**
Hybrids	27	34.80**	105.98**	0.72**	4830.28**	20.85**	22.42**	39880.77**	993.64**	17.95	3.33**
Parents vs Hybrids	1	187.18**	101.94*	1.15**	276.21	312.72**	19.59**	23925.01	6513.83**	23.20	8.93**
Error	114	9.17	19.42	0.07	1040.78	6.90	0.79	8687.11	125.60	12.94	0.82

* and ** are significant at $p=0.05$ and $p=0.01$ levels, respectively

Table 2. Best performing crosses with standard heterotic values for tuber yield and its components in potato

Characters	Best performing crosses (per se performance)	Best heterotic crosses (Standard heterosis %)
Days to maturity	1. K.Jyoti x DP-9904 (90.75) 2. K.Laukar x K.Chipsona-1 (91.25) 3. K.Laukar x K.Chipsona-2 (92.00)	1. K.Jyoti x DP-9904 (-13.16**) 2. K.Laukar x K.Chipsona-1 (-12.68**) 3. K.Laukar x K.Chipsona-2 (-11.96)
Plant height (cm)	1. MF-1 x K.Chipsona-2 (54.58) 2. J-92-148 x TPS-13 (52.70) 3. MS-91-1326 x DP-9904 (49.93)	1. MF-1 x K.Chipsona-2 (74.08**) 2. J-92-148 x TPS-13 (68.10**) 3. MS-89-60 x DP-9904 (59.25**)
No. of stems/ hill	1. IPS-98-34 x K.Chipsona-2 (3.15) 2. MS-91-1326 x K.Chipsona-2 (3.00) 3. K.Jyoti x K.Chipsona-2 (2.80)	1. IPS-98-34 x K.Chipsona-2 (94.85**) 2. MS-91-1326 x K.Chipsona-2 (87.50**) 3. K.Jyoti x K.Chipsona-2 (75.00**)
Fresh weight of tops per plant	1. K.Laukar x DP-9904 (262.5) 2. IPS-98-34 x K.Chipsona-1 (255.0) 3. K.Laukar x TPS-13 (235.3)	1. K.Laukar x DP-9904 (73.13**) 2. IPS-98-34 x K.Chipsona-1 (67.21**) 3. K.Laukar x TPS-13 (54.26**)
No. of leaves/plant	1. IPS-98-34 x K.Chipsona-2 (23.70) 2. MF-1 x K.Chipsona-2 (22.30) 3. J-92-148 x DP-9904 (21.40)	1. IPS-98-34 x K.Chipsona-2 (73.81**) 2. MF-1 x K.Chipsona-2 (63.37**) 3. J-92-148 x DP-9904 (56.77**)
No. of tubers/plant	1. MF-1 x K.Chipsona-2 (15.12) 2. MF-1 x K.Chipsona-1 (13.80) 3. MF-1 x DP-9904 (11.97)	1. MF-1 x K.Chipsona-2 (142.97**) 2. MF-1 x K.Chipsona-1 (121.68**) 3. MF-1 x DP-9904 (93.96**)
Tuber yield/plant	1. K.Laukar x K.Chipsona-2 (685.0) 2. K.Laukar x DP-9904 (682.5) 3. K.Laukar x TPS-13 (667.5)	1. K.Laukar x K.Chipsona-2 (35.64**) 2. K.Laukar x DP-9904 (35.14**) 3. K.Laukar x TPS-13 (32.17*)
Av. weight of tuber (g)	1. J-92-148 x DP-9904 (113.5) 2. MS-91-1326 x TPS-13 (91.6) 3. K.Jyoti x K.Chipsona-2 (82.6)	1. J-92-148 x DP-9904 (29.54**) 2. MS-91-1326 x TPS-13 (4.55) 3. K.Jyoti x K.Chipsona-2 (5.74)
Harvest index (%)	1. K.Laukar x K.Chipsona-2 (77.09) 2. MS-89-60 x K.Chipsona-1 (74.99) 3. K.Jyoti x K.Chipsona-2 (74.98)	1. K.Laukar x K.Chipsona-2 (4.46) 2. MS-89-60 x K.Chipsona-1 (1.61) 3. K.Jyoti x K.Chipsona-2 (1.60)
Dry matter (%)	1. MS-91-1326 x K.Chipsona-1 (22.15) 2. IPS-98-34 x K.Chipsona-2 (21.22) 3. MS-89-60 x K.Chipsona-2 (20.95)	1. MS-91-1326 x K.Chipsona-1 (24.78**) 2. IPS-98-34 x K.Chipsona-2 (9.97*) 3. MS-89-60 x K.Chipsona-2 (8.54*)

* and ** significant at 0.05 and 0.01 levels respectively

for this character was registered by hybrid K. Laukar x TPS-13 (25.14%) followed by hybrids K.Laukar x K.Chipsona-2 (22.81%) and K. Jyot x K.Chipsona-2 (21.3%). The highest standard heterosis was observed in hybrid K.Laukar x K. Chipsona-2 (35.64 %) followed by hybrids K. Laukar x DP-9904 (35.14) and Laukar x TPS-13 (32.17 %). Out of 28 hybrids, none of the hybrids exhibited significant positive heterobeltiosis for tuber yield per plant, where as, maximum number of hybrids exhibited significant positive heterobeltiosis for number of tubers per plant.

With regards to the average weight of tubers, only one hybrid (J-92-148 x DP-9904) had significant and positive heterosis over mid parent, better parent and standard check. In general, it was observed that significant and positive heterosis for tuber yield resulted from the heterosis in different yield attributes, but the results indicated negative heterotic effects in majority of the hybrids and resulted in low to moderate tuber yield of hybrids under study. These findings are supported by the results obtain by Luthra *et al.* (4) and Mishra *et al.*(5).

A comparison of five best hybrids expressing heterobeltiosis for tuber yield was made with the heterotic response for other yield components (Table 3). It was revealed that the positive heterobeltiosis for tuber yield resulted from the yield attributes viz. number of stems per hill, total number of tubers per plant, average weight of tubers, harvest index and dry matter per cent. Among all the these yield attributes, total number of tubers per plant was observed to be the most important yield attribute as it had shown positive heterosis in most of the cross combinations consistently, where as, other yield attributes were not consistent and had indicated different cross combinations for realization of heterosis for tuber yield per plant.

In general, frequency of heterotic crosses was higher among the crosses involving parents with average x average and good x average gca effects.

Table 3. Comparative study of five best heterotic crosses for tuber yield and its component characters in potato

Best heterotic crosses	Tuber yield / plant (g)	Days to maturity	Plant height (cm).	No. of stems/ hill	Fresh wt of tops/ plant (g)	Total no. of leaves/ plant	No. of tubers / plant	Average Wt. of tubers(g)	Harvest index (%)	Dry matter (%)
K. Jyoti x K.Chipsona-2	16.24 (A x A)	1.08 (G x G)	-24.98** (P x G)	-14.50* (A x G)	5.00 (A x A)	49.30** (A x G)	16.40* (P x G)	0.47 (G x P)	1.34 (A x A)	-6.53 (A x A)
IPS-98-34 x K.Chipsona-1	10.80 (A x A)	8.29** (A x A)	-6.65 (P x P)	-9.27 (G x A)	32.47** (G x A)	19.78 (G x A)	49.33** (G x A)	-23.56* (A x P)	-7.22* (A x A)	-0.51 (G x A)
K.Laukar x K.Chipsona-2	10.17 (G x A)	-0.27 (G x G)	-25.25** (A x G)	-36.64** (A x G)	-4.97 (A x A)	-14.69 (A x G)	8.67 (A x G)	-9.72 (G x P)	3.00 (G x A)	-3.20 (A x A)
K.Laukar x DP-9904	9.77 (G x A)	-4.80* (G x A)	-36.71** (A x P)	-33.04** (A x A)	17.98 (A x G)	-14.30 (A x A)	20.70* (A x P)	-3.60 (G x G)	-3.57 (G x A)	-3.08 (A x A)
IPS-98-34 x K.Chipsona-2	8.27 (A x A)	1.34 (A x G)	-19.24** (P x G)	-3.82 (G x G)	15.58 (G x A)	68.26** (G x G)	28.52** (G x G)	-17.39 (A x P)	0.66 (A x A)	8.43* (G x A)

*, ** significant at 0.05 and 0.01 levels respectively

A = Average general combiner, P= Poor general combiner and G= Good general combiner

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Genetic divergence in Indianbean [*Lablab purpureus* (L) Sweet.]

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Abstract

The relative contribution of different component traits to the total diversity was studied in 48 genotypes of Indian bean to quantify the degree of divergence and to select genetically diverse parents for obtaining desirable combinations. Mahalanobis's D^2 statistics was employed to measure the genetic divergence of 48 genotypes of wal grown at sardarkrushinagar during *rabi*- 2002 for nine characters. Six different clusters were formed with a wide range of intercluster distances (10.85 to 53.37) suggesting considerable diversity among the genotypes. Clustering pattern indicated that geographical distribution could not be taken as the sole criterion of genetic diversity. The D^2 analysis revealed that days to flowering (47.25 %), days to maturity (24.91 %), test weight (9.84 %) and pod length (9.04 %) contributed maximum towards genetic divergence. The presence of substantial genetic diversity among the parents revealed that they can be utilized in breeding programme for the improvement of yield in indian bean.

Keywords : Indian bean, Genetic divergence, D^2 statistics.

Introduction

The D^2 statistics proposed by Mahalanobis (1) is one of the potent techniques of estimating the genetic divergence based on multivariate analysis Moll *et al.* (2). This technique measures the forces of differentiation at two levels, viz. intra-cluster and inter-cluster levels, and thus, helps in the selection of genetically divergent parents for exploitation in hybridization programme. In addition to that, D^2 statistics measures the degree of diversification and determines the relative contribution of each component character to the total divergence. The genotypes grouped together are less divergent than the ones which are placed in different clusters. The clusters which are separated by the greatest statistical distance shows the maximum divergence. The present study, therefore, aims in order to assess the genetic diversity present among the 48 different genotypes.

Material and methods

Fourty eight different genotypes of wal were grown at Sardarkrushinagar during *rabi* 2002 in a randomized block design with two replications. The material was

grown in 4 row plot of 4 m length with a spacing of 45 x 15 cm. To raise the crop, irrigation was given at critical stages. The observations were recorded for grain yield (g/plant) and 8 other yield contributing traits viz., days to 50 per cent flowering, days to maturity, plant height (cm), number of pods / plant, pod length (cm), number of effective branches per plant, seeds / pod and 100-seed weight (g).

Genetic divergence was estimated using Mahalanobis's D^2 statistics and the populations were grouped on the basis of minimum generalized distance using the method described by Rao (3).

Results and discussion

The analysis of variance revealed highly significant differences among the genotypes of all the characters studied indicating thereby the existence of genetic variability among the genotypes. Wilk's criterion suggested highly significant differences among the genotypes for the aggregates of 9 characters studied.

The results on clustering of 48 genotypes carried out following Tocher's method are presented in Table 1.

Table 1. Composition of different clusters in Indianbean

Clusters	Number of genotypes	Genotypes included
I	32	NV-36, ND-39, NV-105, NV-11, NV-107, Kokan-7, NV-19, NV-34, NV-32, NV-94, NV-96, NV-52, GW-1, NV-25, Gujarat-1, IGP-21, Kokan-5, AKW-9305, NV-37, ND-15, ND-26, NV-22, Kokan-6, ND-20, NV-71, ND-35, ND-19, ND-34, ND-27, ND-33, ND-38, Anand-3.
II	12	NV-30, ND-32, NV-39, NV-14, NV-44, ND-29, NV-29, ND-23, AKW-9312, ND-28, Kokan-4, AKW-9303.
III	1	ND-41
IV	1	AKW-9306
V	1	NV-56
VI	1	ND-25

Overall, six clusters were formed. Cluster-I was found to be the largest with 32 genotypes indicating genetic closeness among the genotypes and having less genetic diversity. Cluster-II was the second largest cluster with 12 genotypes and 4 other clusters were consisted single genotypes.

moderate to high inter-cluster distances. However, genotypes from different clusters, showing maximum inter-cluster distances may be selected for hybridization to generate statistical variability for grain yield / plant and its components.

The clustering pattern of the genotypes (Table 1) revealed that genetic diversity was not always related with geographical diversity. Murthy and Arunachalam (4) have stated that genetic drift and selection in different environments might cause greater diversity among genotypes than geographical distance. Malhotra *et al.* (5) in greengram, Dikshit *et al.* (6) in rajmash found no parallelism between genetic diversity and geographical origin. Therefore, geographic diversity is not adequate as an index of genetic diversity. The grouping of the genotypes from heterogeneous sources in one cluster is to be expected in the study because of free exchange of breeding material among different regions, as a consequence, the character constellation that might be associated with particular region, in nature, lose their individually under human interference.

The cluster means for different characters are presented in Table 3. All the clusters, in general, exhibited moderate to high mean values for different characters studied. The cluster-V depicted the highest mean values for grain yield per plant (34.42) followed by cluster-I (31.26) and cluster-VI (26.41) indicated that for the improvement of grain yield per plant, the genotypes from the above clusters should be selected for utilization in breeding programme. Cluster-I also exhibited the high mean values for number of pods / plant. Whereas, cluster-III for number of effective branches / plant, cluster-V for 100-seed weight and cluster-VI for pod length and seeds / pod exhibited high mean values (Table 4). Cluster-IV exhibited the lower mean values for days to 50% flowering and days to maturity, while cluster-VI expressed lower values for plant height.

Intra and inter-cluster distances (D) were computed between all pairs of six clusters (Table 2) The intra cluster distances ranged from 0.00 in four clusters (cluster III to cluster VI) to 12.65 in cluster II. The inter cluster distances ranged from 10.85 between cluster III and cluster V to 53.37 between cluster I and cluster IV. High inter cluster distances were also observed between cluster-I and cluster-II (39.91), cluster-IV and cluster-V (34.32), cluster-IV and cluster-VI (32.60) and cluster III and cluster IV (32.00). All the clusters showed

The per cent contribution of 9 characters towards total genetic divergence was estimated to assess the relative significance of individual traits in determining the inter-cluster distances (Table 4). Days to 50 per cent flowering (47.25%) contributed maximum towards total genetic divergence followed by days to maturity (24.91%), 100-seed weight (9.84%) and pod length (9.04%). Grain yield did not cause and divergence, whereas other remaining characters cause divergence with very low percentage. This results are contrary to the findings of Malhotra and Singh (7) in blackgram.

Table 2. Average intra (diagonal) and inter-cluster distances, D in Indian bean

Cluster	I	II	III	IV	V	VI
I	8.68	39.91	25.14	53.37	23.65	24.81
II		12.65	18.89	17.92	21.08	22.69
III			0.00	32.00	10.85	15.48
VI				0.00	34.32	32.60
V					0.00	17.17
VI						0.00

Table 3. Intra cluster mean values (D) for different characters in Indian bean

Character	Grain Yield	Days to flower	Days to mature	Plant height	Pods / Plant	Pod length	Branches/ plant	Seed/ pod	Test weight
Cluster									
I	31.26	111.55	137.09	62.32	41.72	4.25	4.29	3.56	21.58
II	25.08	77.50	132.92	57.43	34.51	4.70	4.02	3.73	21.88
III	23.39	91.00	139.50	56.70	34.00	4.30	4.60	3.80	19.44
IV	18.22	65.50	123.00	44.30	24.30	4.40	2.90	3.40	21.94
V	34.42	92.50	142.50	63.90	39.30	4.90	4.10	3.80	25.57
VI	26.41	95.50	124.50	27.70	29.30	5.90	4.00	3.90	23.10

Table 4. Cluster contribution to total genetic divergence in Indian bean

Sr. No.	Character	per cent of total times character contributed highest to total genetic divergence
1.	Grain yield per plant (g/plant)	0.00
2.	Days to 50 per cent flowering	47.25
3.	Days to maturity	24.91
4.	Plant height (cm)	2.22
5.	Number of pods / plant	0.71
6.	Pod length (cm)	9.04
7.	Number of effective branches / plant	4.52
8.	Seeds / pod	1.51
9.	100- seed weight (g)	9.84

where grain yield largely contributed the genetic divergence. However Murthy and Arunachalam (4) hold the opinion that divergence can be on the basis of characters other than yield. This may be attributed to high intensity of selection practiced for these traits for the improvement in wal.

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Relative performance of minor millets in arid Gujarat

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Abstract

A study was conducted with two genotypes each of Minor Millets viz. Proso Millet (var. GPUP-19, K-1), Barnyard Millet (K-1, VL-171), Foxtail Millet (SIA-326, PS-4) and Finger Millet (VR-708, GPCL-26) during kharif-2003 to study the potential of cultivation of these millets and also to identify their suitable variety for the region. During the season the area received a total of 993.4 mm rains but 86.6% of this was received up to August 4th and thus the crop grew only on post rainy moisture available from 27 days after sowing (DAS) to harvest experiencing progressive moisture deficit condition from 28 DAS to harvest at 81 DAS. The results indicated that the grain yield of minor millet and their respective genotypes varied from 513-1786 kg/ha. Among these, Foxtail Millet gave maximum grain yield followed by Proso Millet, Finger Millet and Barnyard Millet. Variety PS-4 of Foxtail Millet, K-1 of Proso Millet, GPCL-26 of Finger Millet and VL - 171 of Barnyard Millet produced 29.0, 18.0, 2.0, and 17.0 per cent more grain yield as compared to the other variety tested.

Key words: Minor millets, relative performance, arid Gujarat

Introduction

Small millets is a crop of harsh environments having poor soil and less water requirement. Owing to their drought tolerance character, it is cultivation in drought prone areas to provide food and fodder security to desert dwellers (1). Small millets are staple food crop in Southern and hilly area of country. Cheena or Proso millet is an important minor millet grown in India. The crop is able to evade drought by its quick maturity. Grains of Cheena are used in different ways as cooked grain, flour for making *chapaties*, parched etc. It can be used in making *kheer*. Cheena makes a good poultry feed also. The straw is good fodder for cattle. *Sawan* or Barnyard millet is a grain crop of lesser importance. It is very drought resistant but it also capable of withstanding water logging conditions. *Kakun* or Italian millet is also known as Foxtail millet and German millet. It is generally grown as a rainfed crop in India. It provides approximately 15-17 per cent of the total food consumed in China (2). *Mandua* or ragi, known in English as "Finger Millet" is an important minor millet grown in India. In fact, it is the main cereal crop for monsoon season in some hill area's. The germinating grains are malted and fed to infant also. It is also good for pregnant woman. The

small millets is a potential crop in the arid region of Kutch, yet it has not received due attention for its adaptability. In the present investigation, an effort was made to study the adaptability and identify the suitable genotypes for this region.

Material and methods

Eight genotypes of four minor millet viz; Proso millet (*Panicum miliaceum* L.), Barnyard millet (*Echinochloa frumentacea* L.), Foxtail millet (*Setaria italica* (L.) Beauv.) and Finger millet (*Eleusine coracana* Gaerth) were evaluated in randomized block design with four replications during kharif 2003 at Central Arid Zone Research Institute, Regional Research Station, Kukma, Bhuj 22° 41' 11" to 24° 41' 47" North latitude and 68° 9' 46" to 71° 54' 47" East longitude, Kutch(3). Each plot 4 X 2.5 m size accommodated ten 4.0 m long rows spaced 25 cm apart. Plant to plant distance was maintained at 10cm by thinning. The recommended package of practices were followed to raise the crops. Observations on various yield and yield attributing characters were recorded on five randomly selected plants from each plot. The data were subjected to the analysis of variance following Panse and Sukhatme (4).

Results and discussion

The performance of minor millets varieties for yield and its component is given in Table 1. Plant height ranged from 50 cm K-1 (Proso millet) to 101.33 cm PS-4 (Foxtails millet) with a mean of 70.20 cm. The no. of tillers per plant ranged from 1 SIA-326 (Foxtail millet) to 10 K-1 (Proso millets) with mean of 4.25 where as no. of effective tillers per plant ranged from 1 SIA-326 (Foxtail millet) to 9 K-1 (Proso millet) with a mean of 4. The no. of leaves per plant ranged from 8 K-1 (Barnyard millet) to 65, K-1 (Proso millet) with a mean of 62.37. The ranged observed for the leaf weight (gm) was 0.76gm VR-708 (Finger millet) to 2.55gm GPUP-19 (Proso millet) with a mean of 1.52gm where as stem weight (gm) ranged from 3.45 (gm) VL-171 (Barnyard millet) to 17.52 (gm) GPUP-19 (Proso millet) with a mean of 7.27 (gm). The leaf to stem ratio ranged from 0.133 PS-4 (Foxtail millet) to 0.431 GPCL-26 (Finger millet) with a mean of 0.236. The ranged observed for the days to maturity was 67 SIA-326 (Foxtail millet) to 104 VR-708 (Finger millet) with a mean of 82.25. The grain yield ranged from 513 (kg/ha) K-1 (Barnyard millet) to 1786 (kg/ha) PS-4 (Foxtail millet) with a general mean 973 (kg/ha). The varieties K-1, VL-171 (Barnyard millet) and SIA-326, PS-4

(Foxtail millet) produced taller plants compared to grand mean.

The varieties GPUP-19, K-1 (Proso millet) and GPCL-26 (Finger millet) produced more effective number of tillers per plant where as GPUP-19, K-1 (Proso millet) and SIA-326, PS-4 (Foxtail millet) recorded early flowering compared to grand mean. The varieties K-1, VL-171 (Barnyard millet) and GPCL-26 (Finger millet) produce more leaf to stem ratio where as varieties GPUP-19, K-1 (Proso millet) and SIA-326, PS-4 (Foxtail millet) recorded higher grain yield.

The variety PS-4 of Foxtail millet, K-1 of Proso millet, GPCL-26 of Finger millet and VL-171 of Barnyard millet produced 29.0, 18.0, 2.0 and 17.0 per cent more grain compared to the other variety tested. The difference between various millets and their genotypes varied significantly.

The varieties PS-4 and SIA-326 of Foxtail millet were superior in yield performance as well as in their early maturity under this soil moisture condition of arid Gujarat. Hence these varieties are suitable for direct utilizations or can be used for further breeding programme.

Table 1. Mean performance of minor millet varieties for yield and its components

Minor Millets	Varieties	Plant height (cm)	No. of tillers/plant	No. of effective tillers/plant	No. of leaves/plant	Days to flowering	Leaf weight (gm)	Stem weight (gm)	Leaf to stem ratio	Days to maturity	Grain yield (kg/ha)
Proso Millet	GPUP-19	58.6	7	6	37	50	2.55	17.52	0.145	77	821
	K-1	50.0	10	9	65	46	1.75	10.93	0.162	74	969
Barnyard Millet	K-1	78.0	2	2	8	66	2.21	6.21	0.351	83	513
	VL-171	74.6	2	2	12	70	1.15	3.45	0.327	86	603
Foxtail Millet	SIA-326	92.6	1	1	17	53	1.13	6.03	0.164	67	1384
	PS-4	101.3	3	3	15	56	0.77	5.62	0.133	75	1786
Finger Millet	VR-708	54.6	4	4	10	83	0.76	4.15	0.179	104	848
	GPCL-26	51.6	5	5	15	75	1.86	4.26	0.431	92	862
Grand mean		70.2	4.25	4	22.37	62.37	1.52	7.27	0.236	82.25	973
CD at 5 %		4.0	0.06	0.81	1.88	2.60	0.05	0.154	0.042	3.05	35
S Em ±		1.0	0.02	0.38	0.88	0.86	0.025	0.072	0.019	1.00	17

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Effect of irrigation and weed management practices on weeds and yield of wheat (*Triticum aestivum* L.) under middle Gujarat conditions

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Abstract

A field experiment was carried out on wheat crop cv. GW 496 during *rabi* seasons of 1997-98 and 1998-99 at Anand (Gujarat) to find out the scheduling of irrigation as well as efficient weed management practices for control of weeds and yield of wheat. Water management practices did not show significant effect on dry weight of weeds and weed control efficiency, however, irrigation scheduled at 0.9 IW/CPE ratio recorded significantly higher grain yield but it was at par with irrigation applied at critical crop growth stages. The reverse trend was observed in respect of straw yield of wheat. Significantly lower dry weight of weeds, higher values of weed control efficiency, grain yield, harvest index, net realization and CBR were noticed under post emergence application of isoproturon @ 1.0 kg ha⁻¹. All the weed control treatments proved significantly superior in respect of dry weight of weeds, weed control efficiency, grain yield and harvest index over unweeded control.

Key words : Weed Management, pre-emergence, post-emergence, wheat

Introduction

Wheat is one of the most important food crops cultivated in almost all the countries of the world. Among the various factors responsible for yield losses, weed and water management are the most important. Weeds are one of the major constraints for the poor yield of wheat crop as they compete with the crop plants for moisture, mineral nutrients, light and space. The acute problem of both grassy weeds along with some broadleaf weeds is also not common in many parts of the country, which often results in huge yield losses and make the weed management issue more complex (1). The severe crop weed competition results in reduction of yield to the extent of 18-73 per cent (2). Weeds growing along with crop, use more water and nutrients as compared to crop plant because they are having good competitive ability given by nature. Water and weed management play a pivotal role in boosting up wheat production. Therefore, prudent use of irrigation water and weed management practices is highly imperative and important to boost up the yield of wheat. Keeping these in view, the present experiment was planned to study the effect of irrigation and weed management

practices on weeds and yield of Rabi wheat under middle Gujarat conditions.

Materials and methods

A field experiment was laid out on wheat cv. GW-496 at College Agronomy Farm, Gujarat Agricultural University, Anand during two consecutive *rabi* seasons of the year 1997-98 and 1998-99. The soil of the field was sandy loam in texture having low in available nitrogen and medium in available phosphorus and high in available potassium with pH 8.2. Twenty four treatment combinations were studied, which consisted of three irrigation treatments (I₁: Irrigation at critical crop growth stages viz. crown root initiation, tillering, late jointing, boot, flowering, milking and dough, I₂: Irrigation at 0.7 IW/CPE ratio and I₃: Irrigation at 0.9 IW/CPE ratio) irrigated in main plot and eight weed management practices (W₁: pendimethalin @ 1.0 kg ha⁻¹ pre-emergence, W₂: 2,4-D (Ethyl ester) @ 0.75 kg ha⁻¹ as post emergence (30 DAS), W₃: isoproturon @ 1.0 kg ha⁻¹ pre-emergence, W₄: isoproturon @ 1.0 kg ha⁻¹ post emergence (30 DAS), W₅: oxyfluorfen @ 0.25 kg ha⁻¹ pre-emergence, W₆: sulfosulfuron @ 0.025 kg ha⁻¹ post emergence, W₇: weed free

(Two hand weedings at 20 and 40 DAS) and W_0 : unweeded control) were superimposed in sub plot treatments were laid out in split plot design with four replications. The seeds of GW-496 @ 125 kg/ha were sown by manually at 22.5 cm row spacing on 26 and 17 November during 1997-98 and 1998-99, respectively. Full dose of phosphorus and half dose of nitrogen were applied in the form of diammonium phosphate and urea at the time of sowing in manually opened furrows and remaining half dose of nitrogen was applied next day of the first irrigation as per the irrigation treatments. Required quantity of herbicides applied as per the treatments using Knapsack sprayer fitted with flat fan nozzle by mixing them in 500 L of water on hectare basis. The other package of practices was adopted to raise the wheat crop as per the recommendations. The observations of dry matter of weeds were taken from randomly selected four spots by using 0.25 m² iron quadrat from net plot area. Weed control efficiency (WCE) was calculated on the basis of formulae suggested by Mani et al. (3). The grain and straw yield was harvested from the net plot area and subjected to statistical analysis. Net realization and CBR values were also worked out by considering the prevailing market price on the basis of pooled grain and straw yields.

Results and discussion

Effect of irrigation management

Dry weight of weeds and weed control efficiency were not influenced significantly due to different water management treatments during both the years and in pooled analysis (Table 1). Though the higher dry weight of weeds was observed under 0.7 IW/CPE ratio as compared to other treatments in pooled analysis. This might be due to poor growth of main crop under less number of irrigations at wider interval provided favorable environment for more growth of weeds as compared to other treatments. Similar results were also reported by Naik et al. (2).

The results on periodical plant height and yield attributes revealed that plant height, no. of spikelets/ear, no. of grains/ear, grain weight/ear and harvest index (%) were found to be non-significant due to water management treatments (Table 2). Irrigation applied at critical crop growth stages and at 0.9 IW/CPE ratio both being at par with each other and recorded significantly higher ear length and test weight as compared to 0.7 IW/CPE ratio. Different water management treatments showed significant influence

on grain and straw yields of wheat during second year and in pooled analysis (Table 3). Among the water management treatment, 0.9 IW/CPE ratio produced significantly higher grain yield of wheat than that of recorded under irrigations applied at 0.7 IW/CPE ratio but it was at par with treatment receiving irrigations at critical crop growth stages. Significant increase in grain yield was due to more availability of moisture and nutrients under increasing irrigation frequency, which led to more translocation of sources to sink for the formation of seed. These results are in accordance with the results of Choubey et al. (4). Irrigation at 0.7 IW/CPE ratio recorded significantly the lowest grain yield of wheat. The lower yield under said treatment might be due to less number of irrigations received at wider interval as compared to other treatments, this create moisture stress at various physiological growth stages which directly affect the growth, yield attributes and thereby final yield of wheat. Bandyopadhyay (5) also observed similar results. While, irrigations applied at critical crop growth stages and at 0.9 IW/CPE ratio recorded identical but significantly higher straw yield than that of irrigations applied at 0.7 IW/CPE ratio during second year and in pooled results. Similarly, application of irrigation at 0.9 IW/CPE ratio recorded higher net realization of Rs. 19519 ha⁻¹ with CBR value of 1:2.56.

Effect of weed management practices

Weed management practices exerted their significant influence on dry weight of weeds and weed control efficiency during both the years and in pooled analysis (Table 1). Post emergence application of isoproturon @ 1.0 kg ha⁻¹ recorded significantly lower dry weight of weeds as compared to rest of the treatments but it was at par with two hand weedings at 20 and 40 DAS and pre-emergence application of pendimethalin @ 1.0 kg ha⁻¹ during both the years and in pooled results. However, it was at par with isoproturon @ 1.0 kg ha⁻¹ applied as pre-emergence during first year and in pooled results while that of post-emergence application of 2,4-D (Ethyl ester) @ 0.75 kg ha⁻¹ was also remained at par in pooled results. Amongst herbicidal treatments, post emergence application of sulfosulfuron @ 0.025 kg ha⁻¹ recorded significantly the highest dry weight of weeds over rest of the treatments during both the years and in pooled results. However, unweeded control recorded significantly the highest dry weight of weeds during both the years and in pooled results. Post emergence application of isoproturon @ 1.0 kg ha⁻¹ at 30 DAS recorded maximum weed control efficiency, it

was closely followed by hand weeding twice carried out at 20 and 40 DAS and pre emergence application of pendimethalin @ 1.0 kg ha⁻¹ during both the years and in pooled results while, isoproturon @ 1.0 kg ha⁻¹ as pre-emergence in first year and in pooled and 2,4-D (Ethyl ester) @ 0.75 kg ha⁻¹ as post emergence in pooled. Similar results were also reported by Singh and Singh (6).

Among various yield attributes, ear length, grain weight /ear, test weight and harvest index were recorded significantly higher under post-emergence application of isoproturon @ 1.0 kg ha⁻¹ as compared to rest of the treatments except hand weeding done at 20 and 40 DAS and pre-emergence application of pendimethalin @ 1.0 kg ha⁻¹ (Table 2). Significantly higher grain yield of wheat was recorded under post emergence application of isoproturon @ 1.0 kg ha⁻¹ but it was at par with two hand weedings done at 20 and 40 DAS and pre emergence application of

pendimethalin @ 1.0 kg ha⁻¹ during both the years and in pooled analysis (Table 3). The superiority of these treatments might be due to weed free environment provided under these treatments resulted in to maximum utilization of all the growth factors. Similar results were also reported by Pandey *et al.* (7). Significantly the lowest grain yield of wheat was obtained under unweeded control during first year and in pooled results, but it was at par with the application of sulfoflufuron @ 0.025 kg ha⁻¹ during second year. Straw yield was found to be significant only during second year. Post emergence application of sulfoflufuron @ 0.025 kg ha⁻¹ recorded significantly higher straw yield as compared to rest of the treatments but it was at par with pre-emergence application of isoproturon @ 1.0 kg ha⁻¹. The maximum net realization and CBR of 20847 Rs ha⁻¹ and 1:2.75 were recorded under post emergence application of isoproturon @ 1.0 kg ha⁻¹, respectively.

Table 1. Effect of irrigation and weed management on dry weight of weeds at harvest and weed control efficiency in wheat

Treatments	Dry weight of weeds (kg ha ⁻¹) at harvest			Weed control efficiency (%)		
	1997-98	1998-99	Pooled	1997-98	1998-99	Pooled
IRRIGATION MANAGEMENT						
I ₁ : At critical crop growth stages	137.86	155.81	146.84	78.89	77.59	78.24
I ₂ : At 0.7 IW/CPE ratio	136.11	158.74	147.43	79.75	74.47	77.11
I ₃ : At 0.9 IW/CPE ratio	134.05	157.56	145.81	79.31	78.02	78.67
S. Em. ±	2.49	4.82	2.71	0.5	0.9	1.2
C. D. at 5 %	NS	NS	NS	NS	NS	NS
C.V. %	10.5	17.3	14.8	3.7	6.4	5.2
WEED MANAGEMENT						
W ₁ : Pendimethalin @ 1.0 kg ha ⁻¹ PE	17.97	19.07	18.52	97.27	97.10	97.19
W ₂ : 2,4-D (Ethyl Ester) @ 0.75 kg ha ⁻¹ POE	40.74	45.27	43.0	93.77	93.22	93.49
W ₃ : Isoproturon @ 1.0 kg ha ⁻¹ PE	21.54	51.58	36.56	96.73	92.25	94.49
W ₄ : Isoproturon @ 1.0 kg ha ⁻¹ POE	10.97	12.07	11.52	98.33	98.17	98.25
W ₅ : Oxyfluorfen @ 0.25 kg ha ⁻¹ PE	39.13	125.51	81.82	94.21	81.27	87.74
W ₆ : Sulfoflufuron @ 0.025 kg ha ⁻¹ POE	287.11	309.33	278.22	56.21	53.64	54.93
W ₇ : Two hand weedings	13.03	13.99	13.51	98.02	97.88	97.95
W ₈ : Unweeded control	658.57	682.17	670.37	0.00	0.00	0.00
S. Em. ±	4.9	9.8	14.6	0.6	0.9	2.2
C. D. at 5 %	13.8	27.7	48.8	1.6	2.4	7.5
C.V. %	12.4	21.6	18.3	2.5	3.9	3.3

PE: Pre-emergence, POE: Post emergence, DAS: Days after sowing, HW: Hand weeding

Table 2. Effect of irrigation and weed management on growth and yield attributes of wheat (mean of two years)

Treatments	Plant height (cm)		Ear length (cm)	No. of spikelets/ear	No. of grains/ear	Ear weight (g)	Grain weight/ear	Test weight (g)	Harvest Index (%)
	30 DAS	At harvest							
IRRIGATION MANAGEMENT									
I ₁ : At critical crop growth stages	42.57	97.31	7.80	14.08	34.70	2.16	1.49	44.72	44.85
I ₂ : At 0.7 IW/CPE ratio	42.43	91.38	7.44	14.20	32.63	2.00	1.46	42.98	46.06
I ₃ : At 0.9 IW/CPE ratio	43.06	96.27	7.78	13.91	34.45	2.25	1.50	44.72	45.07
S. Em. $\pm$	0.33	1.71	0.05	0.10	0.77	0.05	0.02	0.39	0.5
C. D. at 5 %	NS	NS	0.10	NS	NS	0.15	NS	1.19	NS
C.V. (%)	6.2	4.9	4.9	5.4	18.1	18.7	4.4	7.0	9.0
WEED MANAGEMENT									
W ₁ : Pendimethalin @ 1.0 kg ha ⁻¹ PE	43.23	95.25	8.17	14.04	33.83	2.13	1.56	45.00	46.51
W ₂ : 2,4-D (Ethyl Ester) @ 0.75 kg ha ⁻¹ POE	42.81	94.17	7.38	14.00	32.83	2.07	1.43	43.54	45.21
W ₃ : Isoproturon @ 1.0 kg ha ⁻¹ PE	40.78	94.42	7.33	13.83	34.04	2.20	1.45	43.25	44.72
W ₄ : Isoproturon @ 1.0 kg ha ⁻¹ POE	43.57	95.13	8.33	14.08	34.83	2.19	1.61	46.13	47.12
W ₅ : Oxyfluorfen @ 0.025 kg ha ⁻¹ PE	40.63	95.21	7.38	14.63	34.83	2.17	1.43	44.21	44.85
W ₆ : Sulfosulfuron @ 0.025 kg ha ⁻¹ POE	43.13	95.21	7.29	13.71	34.21	2.10	1.41	43.08	44.50
W ₇ : HW at 20 and 40 DAS	43.70	95.17	8.13	14.04	33.50	2.12	1.57	45.75	45.97
W ₈ : Unweeded control	43.64	95.33	7.38	14.17	33.33	2.11	1.37	42.17	43.73
S. Em. $\pm$	0.37	0.41	0.11	0.20	0.92	0.06	0.02	0.4	0.8
C. D. at 5 %	1.02	NS	0.30	NS	NS	NS	0.04	1.15	2.1
C.V. (%)	4.2	2.1	7.0	7.0	13.2	14.7	4.8	4.6	8.1
I x W Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Effect of Irrigation and weed management on yields, harvest index and economics of wheat

Treatments	Grain yield (kg ha ⁻¹)			Straw yield (kg ha ⁻¹)			Net realization (Rs. ha ⁻¹)	Cost: benefit ratio (CBR)
	1997-98	1998-99	Pooled	1997-98	1998-99	Pooled		
IRRIGATION MANAGEMENT								
I ₁ : At critical crop growth stages	5209	5091	5150	6477	6293	6385	19244	1:2.52
I ₂ : At 0.7 IW/CPE ratio	5070	4814	4942	5923	5726	5824	18591	1:2.56
I ₃ : At 0.9 IW/CPE ratio	5221	5132	5176	6364	6288	6326	19519	1:2.56
S. Em. $\pm$	58.8	59.6	41.8	193.8	40.22	98.9	—	—
C. D. at 5 %	NS	206.1	128.9	NS	139.2	304.9	—	—
C.V. %	6.4	6.7	6.6	17.5	3.7	12.8	—	—
WEED MANAGEMENT								
W ₁ : Pendimethalin @ 1.0 kg ha ⁻¹ PE	5364	5091	5227	6104	6020	6062	19082	1:2.45
W ₂ : 2,4-D (Ethyl Ester) @ 0.75 kg ha ⁻¹ POE	5059	5004	5032	6204	6052	6128	19186	1:2.61
W ₃ : Isoproturon @ 1.0 kg ha ⁻¹ PE	5077	4993	5035	6417	6200	6309	19307	1:2.62
W ₄ : Isoproturon @ 1.0 kg ha ⁻¹ POE	5430	5224	5327	6033	5969	6001	20847	1:2.75
W ₅ : Oxyfluorfen @ 0.25 kg ha ⁻¹ PE	5105	4989	5047	6337	6136	6237	18372	1:2.43
W ₆ : Sulfosulfuron @ 0.025 kg ha ⁻¹ POE	5077	4905	4991	6179	6329	6253	17672	1:2.33
W ₇ : Two hand weedings	5429	5075	5252	6396	6036	6216	20128	1:2.64
W ₈ : Unweeded control	4791	4818	4805	6347	6073	6210	18359	1:2.59
S. Em. $\pm$	84.9	56.1	50.6	279.8	66.8	143.3	—	—
C. D. at 5 %	240.0	158.8	141.7	NS	188.9	NS	—	—
C.V. %	5.7	3.9	4.9	15.5	3.8	11.1	—	—

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Effect of zinc, fertility levels and FYM on growth and yield of wheat varieties under North Gujarat agro climatic conditions

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Abstract

Field experiment was taken up during *rabi* seasons of 2002-03 and 2003-04 to investigate the effect of zinc, N, P levels and FYM on growth and yield of wheat varieties GW-1139 (*durum*) and GW-496 (*aestivum*) under North Gujarat agro-climatic conditions. Applied zinc brought remarkable increase in total tillers, earhead length, test weight, grain and straw yield as well as protein content, nitrogen and zinc content of grains and straw. Full RDF (120-60-0 NPK ha^{-1}) did not differ significantly from 75 per cent RDF in terms of yield. However, Full RDF helped to raise N and Zn content in grains and straw. FYM @ 10t ha^{-1} brought significant improvement in growth and yield attributes as well as grain and straw yields except plant height and test weight over no FYM. It also enhanced the content of N, P and Zn in grains and straw. Between the varieties, GW 496 was found higher yielder than GW 1139. Among the treatment combinations, 5.0 kg Zn ha^{-1} + 75% RDF (90-45-0 NPK ha^{-1}) + 10 t FYM ha^{-1} with variety GW 496 realized maximum BCR.

Key words: Zinc, FYM, fertility levels, BCR, wheat varieties

Introduction

Wheat, the most important staple food crop of India, occupies a stable position amongst food grains and its adaptability to a wide range of agro climatic conditions. The productivity of wheat in India is 2.74 t ha^{-1} , which is quite low as against the advanced countries like U.K. and France with 6.8 and 6.4 t ha^{-1} , respectively(1). Increased use of high analysis fertilizers under intensive agriculture with low or no addition of organic manures has created micronutrient deficiency in the soil. Deficiency of zinc has emerged in some parts of the country at an alarming rate and particularly in North Gujarat where the soils are sandy. Addition of organic manure like FYM helps in maintaining soil fertility and productivity. The integrated concept of nutrient supply through efficient use of organic and inorganic sources is a sound practice. Considering the importance of wide spread deficiency of zinc in sandy soils and integration of organic manures with inorganic fertilizers to irrigated wheat, an experiment was conducted to study the effect of zinc, fertility levels and FYM on wheat varieties under North Gujarat agroclimatic conditions.

Materials and methods

The experiment was conducted during *winter (rabi)* seasons of 2002-03 and 2003-04 at Regional Research Station, S.D. Agricultural University, Sardarkrushinagar on sandy loam soil with pH 7.85, organic carbon 0.33%, available N, P, K and Zinc 167.1, 46.6, 192 kg ha^{-1} and 0.55 ppm, respectively. The experiment was laid out in a factorial randomized block design with four replications. The treatments consisted of two wheat varieties viz., GW 496 (*aestivum*) and GW 1139 (*durum*); three zinc levels viz., 0.0, 2.5 and 5.0 kg Zn ha^{-1} ; two fertility levels viz., 100% RDF (120-60-0 NPK kg ha^{-1}) and 75 % RDF (90-45-0 NPK kg ha^{-1}) and two FYM levels viz., 0.0 and 10 t ha^{-1} . For N, P and Zn, the sources used were Urea, DAP and ZnSO_4 . The mean maximum and minimum temperatures during the growing seasons of winter 2002-03 and 2003-04 were 23.4° C and 10.0° C, respectively. After harvest of crop, yield data were recorded and soil and plant samples were collected and analyzed for soil status and contents of N, P and Zn.

Table 1. Effect of Variety, zinc, fertility level and FYM on growth parameters, yield and yield attributes and protein content of wheat

Treat- ment	Plant height (cm)		Total tillers meter row length ⁻¹		Ear head length (cm)		Test weight (g)		Grain yield (kg ha ⁻¹)		Straw yield (kg ha ⁻¹)		Protein content (%)		BCR							
	2002- 2003- Pooled		2002- 2003- Pooled		2002- 2003- Pooled		2002- 2003- Pooled		2002- 2003- Pooled		2002- 2003- Pooled		2002- 2003- Pooled									
	03	04	03	04	03	04	03	04	03	04	03	04	03	04								
VARIETY																						
V ₁ (GW496)	73.31	72.29	72.80	67.94	66.48	67.21	9.04	9.02	9.03	55.22	54.25	54.74	3404.17	3576.86	3490.51	5310.19	5363.74	5336.96	14.19	14.02	14.10	2.20
V ₂ (GW1139)	70.12	69.14	69.63	69.13	67.63	68.38	7.85	7.77	7.81	58.72	59.88	58.80	3245.53	3453.43	3329.48	5062.66	5113.89	5088.27	14.06	13.90	13.97	2.08
S.E.m. ±	1.03	1.03	0.72	0.78	0.80	0.55	0.09	0.09	0.06	0.83	0.52	0.72	50.04	52.63	35.92	77.90	78.72	54.78	0.11	0.11	0.08	
C.D. at 5%	2.90	2.91	2.01	NS	NS	NS	0.24	0.26	0.17	2.33	1.47	2.01	140.83	148.10	99.56	219.24	221.54	151.84	NS	NS	NS	NS
ZINC (kg ha ⁻¹)																						
Z ₁ (0.0)	70.27	69.23	69.75	66.13	63.06	64.59	7.58	7.51	7.55	50.67	51.44	51.06	2468.29	2596.30	2532.29	3850.00	3889.12	3869.56	13.7	13.50	13.60	1.61
Z ₂ (2.5)	72.15	71.19	71.67	69.03	68.06	68.55	8.82	8.82	8.82	59.89	59.06	59.48	3659.03	3852.32	3755.67	5708.57	5765.74	5737.15	14.3	14.10	14.20	2.37
Z ₃ (5.0)	72.73	71.72	72.22	70.44	70.03	70.23	8.93	8.86	8.90	60.35	59.19	59.77	3847.22	4036.81	3942.01	6000.70	6061.57	6031.13	14.4	14.20	14.30	2.45
S.E.m. ±	1.26	1.27	0.89	0.96	0.98	0.68	0.10	0.11	0.08	1.02	0.64	0.89	61.29	64.45	44.00	95.41	96.41	67.10	0.13	0.13	0.10	
C.D. at 5%	NS	NS	NS	2.69	2.76	1.88	0.29	0.31	0.21	2.85	1.80	NS	172.48	181.39	121.96	268.52	271.33	185.99	0.39	0.31	0.27	
Fertility levels (NP K kg ha ⁻¹)																						
F ₁ (90-45-0)	71.04	69.93	70.48	68.08	66.08	67.08	8.32	8.28	8.30	56.44	56.02	56.23	3302.93	3473.61	3388.27	5152.93	5104.78	5178.86	13.7	13.50	13.60	2.16
F ₂ (120-60-0)	72.40	71.40	71.90	68.98	68.02	68.50	8.57	8.51	8.54	57.50	57.10	57.30	3346.76	3516.67	3431.71	5219.91	5272.84	5246.37	14.5	14.30	14.40	2.12
S.E.m. ±	1.03	1.04	0.72	0.78	0.80	0.55	0.08	0.09	0.06	0.83	0.52	0.72	50.04	52.63	35.92	77.90	78.72	54.78	0.11	0.11	0.08	
C.D. at 5%	NS	NS	NS	NS	NS	NS	0.24	0.22	0.17	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.32	0.31	0.22
FYM (t ha ⁻¹)																						
F ₁ (0.0)	70.64	69.55	70.10	65.73	63.98	64.85	8.19	8.10	8.14	57.00	56.50	56.75	2880.40	3026.85	2953.63	4492.90	4538.74	4515.82	13.50	13.4	13.45	2.01
F ₂ (1.0)	72.80	71.87	72.33	71.33	70.13	70.73	8.70	8.69	8.69	56.94	56.63	56.49	3769.29	3963.43	3866.36	5879.94	5938.89	5909.41	14.70	14.52	14.62	2.28
S.E.m. ±	1.03	1.04	0.72	0.78	0.80	0.55	0.08	0.09	0.06	0.83	0.52	0.72	50.04	52.63	35.92	77.90	78.21	54.78	0.11	0.11	0.08	
C.D. at 5%	NS	NS	NS	2.19	2.26	1.53	0.24	0.25	0.17	NS	NS	NS	140.83	148.10	99.56	219.24	221.54	151.84	0.32	0.31	0.22	
C.V. %	9.96	10.15	9.96	7.88	8.29	7.99	7.02	7.53	7.20	10.07	9.85	9.96	10.42	10.43	10.32	10.40	10.41	10.29	5.57	5.57	5.53	

Table 2. Effect of Variety, Zinc, Fertility level and FYM on Nitrogen, Phosphorous and Zinc content of wheat.

Treatment	Nitrogen content in grain (%)				Nitrogen content in straw (%)				Phosphorous content in grain (%)				Phosphorous content in straw (%)				Zinc content in grain (ppm)				Zinc content in straw (ppm)			
	2002-03	2003-04	Pooled		2002-03	2003-04	Pooled		2002-03	2003-04	Pooled		2002-03	2003-04	Pooled		2002-03	2003-04	Pooled		2002-03	2003-04	Pooled	
VARIETY																								
V ₁ (GW 496)	2.21	2.35	2.28	1.27	1.31	1.29	0.99	1.04	1.01	0.59	0.65	0.62	8.14	8.63	8.38	6.92	7.36	7.14						
V ₂ (GW1139)	2.21	2.35	2.28	1.27	1.31	1.29	1.00	1.06	1.02	0.59	0.65	0.62	8.13	8.70	8.41	6.96	7.47	7.22						
S.E.m. ±	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05	0.05	0.07	0.07	0.05	0.05	0.06	0.04						
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS						
ZINC (kg ha⁻¹)																								
Z ₁ (0.0)	2.10	2.30	2.20	1.20	1.30	1.25	1.00	1.00	1.00	0.60	0.60	0.60	7.84	8.40	8.12	6.70	7.20	6.95						
Z ₂ (2.5)	2.20	2.40	2.30	1.30	1.30	1.30	1.00	1.10	1.05	0.60	0.70	0.65	8.22	8.80	8.51	7.00	7.50	7.25						
Z ₃ (5.0)	2.23	2.47	2.35	1.33	1.37	1.35	1.00	1.10	1.03	0.60	0.70	0.65	8.24	8.78	8.78	7.10	7.60	7.35						
S.E.m. ±	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.06	0.06	0.05	0.08	0.08	0.06	0.06	0.07	0.05						
C.D. at 5 %	0.06	0.06	0.04	0.03	0.03	0.03	NS	NS	NS	NS	0.018	0.01	0.13	0.24	0.16	0.19	0.20	0.14						
Fertility levels (NPK kg ha⁻¹)																								
R ₁ (90-45-0)	2.1	2.30	2.21	1.20	1.30	1.25	1.00	1.00	1.00	0.60	0.60	0.60	7.90	8.40	8.15	6.70	7.20	6.95						
R ₂ (120-60-0)	2.3	2.40	2.35	1.30	1.35	1.33	1.00	1.10	1.05	0.60	0.70	0.65	8.38	8.90	8.64	7.10	7.70	7.40						
S.E.m. ±	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.005	0.005	0.005	0.06	0.07	0.05	0.05	0.06	0.04						
C.D. at 5 %	0.05	0.05	0.04	0.03	0.03	0.03	NS	NS	NS	NS	0.015	0.010	0.18	0.19	0.13	0.15	0.16	0.11						
FYM (t ha⁻¹)																								
F ₁ (0.0)	2.1	2.20	2.15	1.20	1.30	1.25	1.00	1.00	1.00	0.60	0.60	0.60	7.8	8.30	8.05	6.60	7.10	6.85						
F ₂ (10)	2.3	2.40	2.35	1.30	1.40	1.35	1.00	1.10	1.05	0.60	0.70	0.65	8.5	9.00	8.64	7.20	7.80	7.50						
S.E.m. ±	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.005	0.005	0.005	0.06	0.07	0.05	0.05	0.06	0.04						
C.D. at 5 %	0.05	0.05	0.04	0.03	0.03	0.03	NS	NS	NS	NS	0.015	0.010	0.18	0.19	0.13	0.15	0.16	0.11						
C.V. %	5.57	5.57	5.52	5.57	5.58	5.51	5.59	5.60	5.52	5.61	5.59	5.51	5.59	5.57	5.73	5.59	5.58	5.52						

Results and discussion

Effect of varieties

Between the varieties, GW 496 significantly surpassed GW 1139 with respect to plant height and earhead length during both the years and on pooled basis (Table 1). For grain and straw yield, GW 496 was found significantly higher yielder than GW 1139. The yield attributes like number of total tillers as well as N, P, Zn and protein content were not influenced by the varieties (Table 2). However, higher test weight was observed with GW 1139 (*durum*). The increase in yield of GW 496 is mainly attributed to its longer earhead, more grains per ear and height of plant. Lower yield of durum wheat could be ascribed to light textured soils having poor water retentive capacity. Such varietal differences have been reported by Patra (2), Kharub and Gupta (3).

Effect of Zn

Application of Zn significantly influenced number of total tillers, earhead length and test weight of grains (Table 1). In pooled data, the per cent increase in total tillers with 5 kg Zn ha⁻¹ over control and 2.5 kg Zn ha⁻¹ was to the tune of 19.81 and 3.25 %. Similarly, it increased earhead length to the extent of 17.80 and 17.05 per cent. Though, Zn application brought significant improvement in test weight in individual years, but failed to express its effect on pooled basis. The per cent increase in grain and straw yield due to 5 kg Zn ha⁻¹ over control was to the extent of 55.06 and 55.96 per cent during first and second year, respectively, whereas in pooled basis, Zn response was found linear. Pooled data indicated increment of N, P and Zn content in grains and straw (Table 2). Higher response of Zn application might be due to inadequate availability of Zn in the soil and additional application might have helped to enhance absorption of other nutrients also. These findings are in conformity with those of Reddi and Patil (4) and Shukla and Warsi (5).

Effect of fertility levels

Application of 75% RDF behaved as good as that of 100% RDF in case of plant height, number of total tillers and test weight of grains during both the years and in pooled data (Table 1). Only earhead length was increased with 100% RDF. Reduction of fertility level to 75% RDF reflected equal effect as that of 100% RDF on grain and straw yield. However, 100% RDF significantly improved N and Zn content in grains and straw in individual years and on pooled basis

(Table 2). The results clearly indicated that curtailing of 25% N and P did not decrease the yield but nutrient content of produce.

Effect of FYM

FYM application @ 10 t ha⁻¹, significantly increased total tillers and earhead length over control during both the years and on pooled basis (Table 1). FYM could not improve plant height and test weight of grains. However, it had remarkable effect on yield. FYM @ 10 t ha⁻¹ increased mean grain and straw yield to the tune of 30.90 and 30.86 % over control. These findings are in agreement with those reported by Singh (6) and Sushila and Giri (7). Similarly, N and Zn content in grains and straw were improved by FYM application (Table 2). The increase in yield might be due to improvement of soil properties and availability of nutrients.

Based on two years results, it is concluded that, maximum yield and net return from wheat were achieved by adopting variety GW-496 applying 10 t FYM ha⁻¹ along with 5.0 Zn kg ha⁻¹ and 75% RDF (90-45-0 NPK kg ha⁻¹) in sandy soil of North Gujarat.

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Effect of dose and time of application of isoproturon on weeds, yield attributes and yield of wheat (*Triticum aestivum* L.)

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Abstract

A field experiment was conducted during *rabi* 2003-04 at College Agronomy Farm, Anand Agricultural University, Anand to study the effect of dose and time of application of isoproturon on weeds, yield attributes and yield of wheat on loamy sand soil. The results revealed that two hand weedings done at 20 and 40 DAS and the post-emergence application of isoproturon @ 1.0 kg ha⁻¹ (30 DAS) both being at par with each other and they recorded significantly the highest values of yield attributes, grain yield, harvest index, weed control efficiency and also recorded significantly lower dry weight of weeds at harvest over rest of the weed control treatments. However, total number of tillers plant⁻¹ and straw yield were not affected. Same treatments had also recorded higher values of net realization and CBR as compared to rest of the treatments.

Key words: Isoproturon, weed control, WCE, hand weeding, wheat

Introduction

Wheat is one of the most important staple food crops cultivated in almost all the countries of the world. Among major wheat producing countries, India ranked second next to China with regards to wheat production in the world. In India, it is cultivated over an area of 27.30 million ha with the production of 72.75 million tonnes having an average productivity of 2670 kg ha⁻¹ (1). Whereas, in Gujarat it is cultivated in about 7.91 lakh hectares of land with total production of 20.96 lakh tonnes having an average productivity of 2650 kg ha⁻¹ (2). The low productivity of wheat in India is mainly governed by number of agronomical factors like delayed in sowing, untimely weed control measures, injudicious use of irrigation, imbalanced fertilization etc. Among these, weeds are one of the major constraints for the poor yield of wheat as they compete for growth factors. The severe crop weed competition results in reduction of yield to the extent of 18-73 per cent depending on the intensity and weed flora (3). Due to scarcity of manpower at critical period of crop-weed competition, the manual weeding is difficult for removal of weeds. Moreover, it is costly, cumbersome and time consuming. Hence, it is imperative to adopt broad-spectrum herbicides as an

alternate means to control the weeds timely and effectively during critical period of crop-weed competition. Isoproturon being the member of substituted urea group of herbicide characterized for their broad-spectrum weed control in wheat (4). Keeping these in view, the present investigation was undertaken to find out optimum dose and time of application of isoproturon for effective control of weeds in wheat.

Materials and methods

A field experiment was carried out during *rabi* season of the year 2003-04 at College Agronomy Farm, Anand Agricultural University, Anand. The soils of the experimental field was loamy sand in texture having low in available nitrogen and organic matter, medium in available phosphorus and rich in available potassium. Fourteen weed management treatments consisted of W₁: Isoproturon @ 0.5 kg ha⁻¹ PE, W₂: Isoproturon @ 0.5 kg ha⁻¹ early POE, W₃: Isoproturon @ 0.5 kg ha⁻¹ POE (30 DAS), W₄: Isoproturon @ 0.75 kg ha⁻¹ PE, W₅: Isoproturon @ 0.75 kg ha⁻¹ early POE, W₆: Isoproturon @ 0.75 kg ha⁻¹ POE (30 DAS), W₇: Isoproturon @ 1.0 kg ha⁻¹ PE, W₈: Isoproturon @ 1.0 kg ha⁻¹ early POE, W₉: Isoproturon @ 1.0 kg ha⁻¹ POE

(30 DAS), W_{10} : Pendimethalin @ 0.75 kg ha⁻¹ PE, W_{11} : 2,4-D (Ethyl ester) @ 0.75 kg ha⁻¹ POE (30 DAS), W_{12} : One HW at 20 DAS, W_{13} : Two HW at 20 & 40 DAS and W_{14} : Weedy check were laid out in randomized block design with four replications. The seeds of GW-496 @ 125 kg /ha were sown by manually at 22.5 cm row distance on November 17, 2003. The entire quantity of phosphorous (60 kg P₂O₅ ha⁻¹) in the form of di-ammonium phosphate and potash (40 kg K₂O ha⁻¹) in the form of murate of potash along with 50 per cent of total amount of nitrogen (60 kg N ha⁻¹) in the form of urea were applied uniformly in opened furrows as basal. Remaining 50 per cent of nitrogen (60 kg N ha⁻¹) was top dressed in the form of urea at crown root initiation stage next day after first irrigation. Herbicides were applied as per the treatments using knapsack sprayer fitted with flat fan nozzle. Early post emergence herbicides were applied after first irrigation, which was applied at 17 DAS. The recommended package of practices was adopted to raise the crop. The observations of weed density and their dry matter were taken randomly from 0.25 m² by using iron quadrat of 50 x 50 cm size from each net plot at 3 randomly selected spots and data on weed density was transformed in to square root

before its statistical analysis. Weed control efficiency (WCE) was calculated on the basis of formula suggested by Mani *et al.* (5).

Results and discussion

Effect on weeds

Results given in Table 1 indicated that weed management practices significantly influenced the density and dry weight of weeds. Significantly lower density and dry weight of weeds recorded at 20 DAS under one hand weeding done at 20 DAS and two hand weedings carried out at 20 and 40 DAS as compared to rest of the treatments except pre-emergence application of isoproturon @ 1.0, 0.75 and 0.5 kg ha⁻¹ and pendimethalin @ 0.75 kg ha⁻¹. The minimum density and dry weight of weeds under above treatments might be due to their treatment effect. Whereas, dry weight of weeds recorded at harvest was found significantly lower under two hand weedings (20 and 40 DAS) being at par with post emergence application of isoproturon @ 1.0 kg ha⁻¹ (30 DAS) and both were significantly superior to the rest of the treatments. The lower dry weight of weeds

Table 1. Effect of weed management practices on density and dry weight of weeds

Treatments	Weed density		Dry weight of weeds		WCE (%)
	(No m ⁻²)	at 20 DAS)	20 DAS (g m ⁻²)	At harvest (kg ha ⁻¹)	
W_1 : Isoproturon @ 0.5 kg ha ⁻¹ PE	1.996	(3.48)	0.22	184	84.7
W_2 : Isoproturon @ 0.5 kg ha ⁻¹ early POE	11.662	(135.50)	11.25	177	85.3
W_3 : Isoproturon @ 0.5 kg ha ⁻¹ POE (30 DAS)	11.395	(129.34)	11.75	179	85.1
W_4 : Isoproturon @ 0.75 kg ha ⁻¹ PE	1.996	(3.48)	0.20	183	84.8
W_5 : Isoproturon @ 0.75 kg ha ⁻¹ early POE	11.554	(132.99)	11.50	178	85.1
W_6 : Isoproturon @ 0.75 kg ha ⁻¹ POE (30 DAS)	11.485	(132.40)	12.25	172	85.7
W_7 : Isoproturon @ 1.0 kg ha ⁻¹ PE	1.993	(3.47)	0.17	180	85.0
W_8 : Isoproturon @ 1.0 kg ha ⁻¹ early POE	11.751	(137.58)	11.25	181	84.9
W_9 : Isoproturon @ 1.0 kg ha ⁻¹ POE (30 DAS)	11.327	(127.80)	11.75	11	88.1
W_{10} : Pendimethalin @ 0.75 kg ha ⁻¹ PE	1.996	(3.48)	0.19	175	85.4
W_{11} : 2,4-D (Ethyl ester) @ 0.75 kg ha ⁻¹ POE	11.875	(140.51)	11.75	201	83.3
W_{12} : HW at 20 DAS	1.564	(1.95)	0.12	189	84.3
W_{13} : Two HW at 20 & 40 DAS	1.564	(1.95)	0.12	10	99.2
W_{14} : Weedy check	11.995	(143.38)	12.38	1200	0.00
S. Em. $\pm$	0.30	0.33	12.07	1.69	
C. D. (P=0.05)	0.86	0.96	34.42	4.81	
C.V. (%)	8.13	9.90	10.49	4.17	

* Figures given in the parenthesis indicate original values

PE : Pre-emergence Early POE : Early post emergence POE : Post emergence DAS : Days after sowing

Table 2. Effect of weed management practices on growth, yield attributes and yield of wheat

Treatments	Plant height (cm)		Total no. tillers/ plant	Effect tillers/ plant	Ear length (cm)	No. of spikelets/ ear	No. of grains/ ear	Test weight (g)	Grain yield kg/ha	Straw yield kg/ha	Harvest index (%)
	At Harvest										
	20 DAS										
W ₁ : Isoproturon @ 0.5 kg ha ⁻¹ PE	45.00	95.00	6.70	3.23	6.83	13.28	33.63	43.73	5306	6306	45.7
W ₂ : Isoproturon @ 0.5 kg ha ⁻¹ early POE	45.00	95.50	6.72	3.35	6.80	13.20	33.63	43.58	5319	6013	46.9
W ₃ : Isoproturon @ 0.5 kg ha ⁻¹ POE (30 DAS)	45.25	95.75	7.00	3.50	6.93	13.28	33.05	43.55	5594	6056	48.0
W ₄ : Isoproturon @ 0.75 kg ha ⁻¹ PE	45.50	95.50	6.70	3.20	6.80	13.10	33.68	43.53	5312	6465	45.0
W ₅ : Isoproturon @ 0.75 kg ha ⁻¹ early POE	45.50	95.00	6.72	3.35	6.98	13.43	33.85	43.53	5348	5986	47.2
W ₆ : Isoproturon @ 0.75 kg ha ⁻¹ POE (30 DAS)	45.00	96.25	7.15	3.45	7.10	13.23	33.83	43.40	4694	5222	52.2
W ₇ : Isoproturon @ 1.0 kg ha ⁻¹ PE	42.25	94.25	6.85	3.53	6.95	13.38	33.88	43.00	5174	6438	44.6
W ₈ : Isoproturon @ 1.0 kg ha ⁻¹ early POE	45.50	96.00	6.73	3.30	6.68	13.20	33.33	43.63	5438	5979	47.6
W ₉ : Isoproturon @ 1.0 kg ha ⁻¹ POE (30 DAS)	45.50	97.50	7.12	4.00	8.25	14.75	35.88	46.23	6035	5408	52.7
W ₁₀ : Pendimethalin @ 0.75 kg ha ⁻¹ PE	45.25	96.75	6.75	3.60	7.13	13.45	33.48	43.63	5431	5479	49.8
W ₁₁ : 2,4-D (Ethyl ester) @ 0.75 kg ha ⁻¹ POE	45.00	96.50	6.75	3.60	7.13	12.85	33.75	43.50	5403	5792	48.3
W ₁₂ : HW at 20 DAS	48.19	96.75	6.70	3.55	6.80	13.50	33.48	43.63	5403	5764	48.4
W ₁₃ : Two HW at 20 & 40 DAS	48.25	97.50	7.30	4.10	8.50	14.85	35.94	46.33	6229	5271	54.2
W ₁₄ : Weedy check	48.75	97.75	6.65	2.05	6.48	12.80	31.93	41.98	3958	5153	43.4
S.E.m. ±	0.93	2.61	0.18	0.11	0.12	0.43	0.69	0.80	113.45	306.59	1.03
C. D. (P=0.05)	2.66	NS	NS	0.31	0.34	1.21	1.96	2.29	323.62	NS	2.93
C.V. (%)	4.07	5.42	5.27	6.45	3.34	6.39	4.07	4.66	4.20	10.55	4.25

under these treatments may be due to effective control of weeds at an early stage of crop growth resulted in to lower dry weight of weeds. Under weedy check treatment no control measures were taken though out the crop season might have favoured the growth of the weeds resulted in significantly the highest dry matter accumulation of weeds. The similar results are substantiated with the results of Singh and Singh (2006). In general, all the weed control treatments gave more than 83 per cent weed control efficiency, however, maximum weed control efficiency was achieved under post emergence application of isoproturon @ 1.0 kg ha⁻¹ at 30 DAS followed by two hand weedings done at 20 and 40 DAS.

Effect on crop

The results revealed that the growth, yield attributes and grain yield of wheat were significantly influenced due to different weed management treatments (Table 2). Plant height recorded at 30 DAS was significantly higher under weedy check as compared to other treatments barring one hand weeding at 20 DAS and two hand weedings done at 20 and 40 DAS. Significantly the lowest plant height was recorded under pre-emergence application of isoproturon @ 1.0 kg ha⁻¹ might be due to phytotoxic effect on crop growth, however, this toxic effect was gradually disappeared with the advancement of the crop growth after 30 DAS. These results are in accordance with the results of Walia *et al.* (7). The grain yield of wheat and yield attributes like effective tillers plant⁻¹, ear length, number of spikelets ear⁻¹, number of grains ear⁻¹ and test weight were recorded significantly higher under two hand weedings carried out at 20 and 40 DAS, followed by post emergence application of isoproturon @ 1.0 kg ha⁻¹ (30 DAS) and both were found significantly superior to rest of the treatments. The higher yield attributes under the said treatments might be due to effective control of weeds led to reduced crop-weed competition resulted in enhanced the availability of moisture and nutrients thereby improvement in yield attributes and ultimately the grain yield. Straw yield did not differ significantly due to different weed management practices. The present findings are supported by Singh and Singh (6) and Tiwari and Vaishya (8). Harvest index was also recorded significantly higher under two hand weedings at 20 and 40 DAS but it was at par with post emergence application of isoproturon @ 0.75 and 1.0 kg ha⁻¹ at 30 DAS.

Table 3. Economics as influenced by different weed management practices

Treatments	Yields (kg ha ⁻¹)		Total cost of production (Rs. ha ⁻¹)	Gross realization (Rs. ha ⁻¹)	Net realization (Rs. ha ⁻¹)	Cost:Benefit ratio (CBR)
	Grain	Straw				
W ₁ : Isoproturon @ 0.5 kg ha ⁻¹ PE	5306	6306	13998	41556	27558	1:2.97
W ₂ : Isoproturon @ 0.5 kg ha ⁻¹ early POE	5319	6013	13998	41442	27444	1:2.96
W ₃ : Isoproturon @ 0.5 kg ha ⁻¹ POE (30 DAS)	5594	6056	13998	43397	29399	1:3.10
W ₄ : Isoproturon @ 0.75 kg ha ⁻¹ PE	5312	6465	14118	41709	27591	1:2.95
W ₅ : Isoproturon @ 0.75 kg ha ⁻¹ early POE	5348	5986	14118	41619	27501	1:2.95
W ₆ : Isoproturon @ 0.75 kg ha ⁻¹ POE (30 DAS)	4694	5222	14118	43513	29395	1:3.08
W ₇ : Isoproturon @ 1.0 kg ha ⁻¹ PE	5174	6438	14238	40724	26486	1:2.86
W ₈ : Isoproturon @ 1.0 kg ha ⁻¹ early POE	5438	5979	14238	42251	28013	1:2.97
W ₉ : Isoproturon @ 1.0 kg ha ⁻¹ POE (30 DAS)	6035	5408	14238	46030	31792	1:3.23
W ₁₀ : Pendimethalin @ 0.75 kg ha ⁻¹ PE	5431	5479	15058	41852	26794	1:2.78
W ₁₁ : 2,4-D (Ethyl ester) @ 0.75 kg ha ⁻¹ POE	5403	5792	14350	41875	27525	1:2.92
W ₁₂ : HW at 20 DAS	5403	5764	14158	41855	27697	1:2.96
W ₁₃ : Two HW at 20 & 40 DAS	6229	5271	14658	47292	32634	1:3.23
W ₁₄ : Weedy check	3958	5153	13658	31313	17655	1:2.29

Selling price : Wheat grain : Rs. 7.0 kg⁻¹
Wheat straw : Rs. 0.70 kg⁻¹

Input price: Pendimethalin Rs. 520 kg⁻¹
Isoproturon Rs. 360 kg⁻¹
2,4-D (EE) Rs. 300 kg⁻¹

Economics

The maximum net realization of Rs. 32634 ha⁻¹ was achieved under two hand weedings done at 20 and 40 DAS, followed by post emergence application of isoproturon @ 1.0 kg ha⁻¹ at 30 DAS (Rs. 31792 ha⁻¹). Both these treatments secured the highest but equal CBR values of 3.23 (Table 3). The profitability of two hand weedings and post emergence application of isoproturon in wheat crop was also reported by Khajanjani *et al.* (9). Whereas, the lowest net realization and CBR values were recorded under weedy check.

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Effect of P and S and their interaction on yield, protein content and gum content of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] crop

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Abstract

A field experiment was conducted during *Kharif* season of 1999-2000 on a loamy sand to study the individual and interaction effects of P and S on cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] crop. Individual application of P and S increased significantly seed and stover yield over control. The combined application of P and S (40 kg P_2O_5 ha⁻¹ + 40 kg S ha⁻¹) significantly recorded the maximum seed (15.54 q ha⁻¹) and stover (33.10 q ha⁻¹) yields, which was 55.5 and 55.6 per cent higher over control, respectively. The application of P and S also at these rates increased the protein and gum content of the clusterbean seed.

Keywords : Interaction, protein content, gum content, cluster bean

Introduction

Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] is an industrially important *kharif* leguminous crop, with over 1-8 million hectares of land under its cultivation in India. It is a high export potential crop. The cluster bean seeds are used in industries for manufacturing vegetable gum, which has got a number of industries uses such as food, paper, textiles, ceramics, paints, cosmetics, pharmaceuticals, synthetic resins etc. Cluster bean seeds are used as concentrate feed for cattle, which contains high value of protein. Gum and protein values determine the quality of seed and the same could be improved by P and S application. Therefore, keeping its importance in view a study on the effect of P and S on yield, gum and protein of cluster bean seed was initiated.

Material and methods

A field experiment was conducted in *kharif*, during 1999-2000 with cluster bean crop (cv. GG-1) at Agronomy Farm, C. P. College of Agriculture, Gujarat Agricultural University. The soil of the site had the characteristics as follows, well drained, loamy sand, sand 85.8%, silt 7.2 %, clay 7.00 %, pH (1:2.5) 7.9; EC 0.11 dSm⁻¹ and Organic carbon 0.17 %. The soil contained 212, 37 and 9.6 kg ha⁻¹ of N, P and S

respectively. Available N and P in the soil was determined following the methods of Subbiah and Asija (1) and Olsen *et al.* (2) respectively. Available S was extracted by the method of William and Steinbergs (3) and determined as per the procedure described by Cheshin and Yien (4). The protein content of seed was obtained by multiplying the nitrogen content with 6.25 (5). The gum content in seed was determined by Dubois method (6).

Application rate of P and S (kg ha⁻¹) for each was 0, 20, 40 and 60 which were supplied through DAP and Gypsum respectively. Recommended dose of N (25 kg N ha⁻¹) was applied and N in DAP was counter balanced through urea.

The experiment was conducted in 2⁴ factorial experiment in confounded design with four replications. Each replication was divided into four in complete blocks of 4 plots, in which 16 treatment combinations were so allotted that X and Y components of two factors interaction (P x S) were confounded one in each replication.

Results and discussion

Seed yield

Seed yield of cluster bean increased significantly following P application, being highest at P₄₀ level of

P resulted in significantly higher seed yield as compared to control, whereas, P_{40} and P_{60} level were statistically at par with each other (Table 1). Similarly, application of S significantly influenced the seed yield, being highest at S_{30} level, which was at par with S_{60} . The individual application P (40 kg P_2O_5 ha⁻¹) and S (40 kg S ha⁻¹) caused 38.9 and 29.7 per cent increase in seed yield over control respectively. The interaction effect also significantly influenced the yield of cluster bean seed. Among the 16 treatment combinations, the combination $P_{40}S_{40}$ (40 kg P_2O_5 ha⁻¹ + 40 kg S ha⁻¹) recorded the maximum seed yield (15.54 q ha⁻¹) followed by the combination $P_{40}S_{60}$ and $P_{60}S_{40}$. Results are in accordance with the findings of Meena *et al.* (7) and Sharma and Room Singh (8). All levels of P with varying levels of S also resulted in significant increase in the seed yield over control, yielding highest at $P_{40}S_{40}$.

Stover yield

Cluster bean stover yield also increased significantly by the individual application of P and S in graded manner over control, being highest at P_{40} and S_{40} levels. However, the differences in stover yield at P_{40} and P_{60} as well as S_{40} and S_{60} were non significant (Table 1). Interaction between P x S was also found to be significant. The highest stover yield of 33.10 q ha⁻¹ was obtained with $P_{40}S_{40}$ (40 kg P_2O_5 ha⁻¹ + 40 kg S ha⁻¹) treatment combination which was statistically

at par with $P_{40}S_{60}$ and $P_{60}S_{40}$. Similar results were also reported by Tiwari and Pandey (9) and Meena *et al.* (7).

Protein content

Protein content increased with increasing levels of P (Table 2). The highest protein content (28.24%) was at 40 kg P_2O_5 ha⁻¹. Sulphur application also increased this content linearly up to the highest level. These results are in conformity with Badole and Vmale (10) and Bhadoria *et al.* (11). P x S interaction increased the protein content. The maximum protein content was at $P_{40}S_{40}$ while the minimum was at P_0S_0 level. Phosphorus and Sulphur are the important constituents of some amino acids molecules and therefore resulted in increase in protein content.

Gum content

Phosphorus and Sulphur increased the gum content of cluster bean seed, the highest was at 60 kg ha⁻¹ individual application of P and S. Phosphorus increased the gum content by 13.3 per cent and sulphur by 7.1 per cent. The results are in agreement with result obtained by Bhadoria *et al.* (11). P x S interaction increased the gum content of cluster bean seed (Table 2). The highest gum content was at the $P_{60}S_{60}$ level. Beneficial effect of P and S on gum content is due to the increase in carbohydrate synthesis.

Table 1. Effect of P and S and their interaction on cluster bean yield (q ha⁻¹)

Treatment (kg ha ⁻¹)	Seed Yield					Stover Yield				
	S_0	S_{20}	S_{40}	S_{60}	Mean	S_0	S_{20}	S_{40}	S_{60}	Mean
P_0	8.62	9.02	10.95	11.28	9.96	18.42	19.21	23.07	24.02	21.18
P_{20}	10.26	12.90	13.76	12.72	12.41	21.84	27.48	29.31	27.09	26.43
P_{40}	11.25	14.06	15.54	14.55	13.84	23.88	29.95	33.10	30.99	29.48
P_{60}	12.07	13.17	14.42	14.14	13.45	25.71	28.65	30.71	30.12	28.65
Mean	10.54	12.29	13.67	13.17		22.46	26.17	29.05	28.05	
C.D. at 5%										
P	0.21					0.44				
S	0.21					0.44				
P x S	0.41					0.89				

Table 2. Effect of P and S on protein content (%) and gum content (%) of cluster bean seed

Treatment (kg ha ⁻¹)	Protein content (%)					Gum content (%)				
	S ₀	S ₂₀	S ₄₀	S ₆₀	Mean	S ₀	S ₂₀	S ₄₀	S ₆₀	Mean
P ₀	24.80	25.00	26.20	25.97	25.49	25.69	26.10	27.55	27.30	26.66
P ₂₀	25.39	26.30	27.09	26.42	26.30	27.30	28.00	28.62	28.15	28.27
P ₄₀	27.05	28.34	28.97	28.61	28.24	28.17	29.49	29.42	29.71	29.20
P ₆₀	27.34	27.97	29.16	28.23	28.18	28.61	29.64	31.14	31.39	30.20
Mean	26.14	26.90	27.86	27.31		27.44	28.31	29.19	29.39	
C.D. at 5%										
P	0.60					0.71				
S	0.90					0.71				
P x S	1.22					2.18				

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Impact of land use on forms and availability of P in Terai soils of Eastern India

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Abstract

The total P content in soil having different land use pattern were in the order of tea garden > forest > cultivated land > orchard. The ratio of total inorganic P to organic P decreased in the following sequence: cultivated land > orchard > forest > tea garden. In cultivated land and forest soils Ca-P was the dominant fraction while reductant soluble P was the dominant inorganic P form in orchard and tea garden soils. However, Al-P and Fe-P occupied the second and /or third highest position in all the land uses. Al-P and Fe-P were the main contributors towards plant available P as it maintained significant relationship with dry matter and P-uptake by wheat grown in Neubauer Seedling Technique. Al-P alone can explain 81.7, 36.2 and 84.2 per cent variation in P uptake in forest, tea garden and cultivated land soils respectively, while Fe-P can explain 38.2 per cent variation in orchard soil.

Keywords : Forms of P, land use pattern, P uptake, terai soils

Introduction

The soils of terai region of eastern India are either under forest cover or used for agricultural production such as tea garden, orchard and field crop cultivation. Phosphorus in soil present in organic and inorganic forms. Besides parent material, climatic factors, vegetation and fertilizer use, land use pattern also plays a vital role in governing physico-chemical properties, nutrient dynamics and fertility of the soil (1, 2, 3). Only 10-30 per cent of the freshly applied phosphate is utilized by the first crop and rest transforms into different insoluble P compounds which also serve as a potential available source for the succeeding crops (4). It was also reported that crops have preferred one or more inorganic P forms (5). Information on the influence of land use on the relative distribution of soil P forms and availability is meager for terai soils of West Bengal; therefore, the present experiment was conducted.

Materials and methods

Fifteen surface (0-15cm) soil samples from each land use pattern i.e. forest, tea garden, cultivated land and orchard were collected from different parts of terai agro climatic region of West Bengal. This zone is situated

in 26° 1/2' and 26°56' north latitude and 88° 7' and 89°53' eastern longitude (6). Soils are developed primarily from the deposition of alluvium brought down by various rivers flowing through this area from northern hills-the Himalayas. Based on the modern classification soils belonged to the orders Inceptisol and Entisol.

The processed soil samples were analyzed for physico-chemical properties by standard methods. Fractionation of soil P was done by the modified method of Chang and Jackson and after Peterson and Corey (7). Organic P was computed as the difference between total P and total inorganic P.

To assess the biological availability of the soils 100 wheat seedlings were grown for 17 days period by 'Naubauer Seedling Technique' in Petri dish (11 cm x 7 cm) containing 100 g soil and 50 g nutrient free quartz. Phosphorus uptake data were calculated from dry matter yield of whole plant (root + shoot).

Results and discussion

The important characteristics of the soils used are presented in Table 1. Soils of tea garden and orchard are strongly to moderately acidic while soils of forest

Table 1. Relevant physico-chemical properties of soils under different land use patterns

Land use pattern Soil parameter	Tea garden		Orchard		Cultivated land		Forest	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
pH (1:2.5)	3.70 - 5.54	4.78	3.84 - 5.85	4.68	4.80 - 7.13	5.67	4.64 - 6.90	5.34
ECx10 ⁻² (dSm ⁻¹)	0.33 - 5.94	1.33	0.34 - 7.40	1.63	0.48 - 4.41	1.44	0.57 - 4.07	1.46
Org.C (g kg ⁻¹)	4.5 - 25.4	14.2	7.0 - 18.3	13.9	7.0 - 12.4	8.9	9.3 - 26.2	16.5
Clay (g kg ⁻¹)	112 - 172	139	102 - 174	143	154 - 254	192	92 - 182	130
Silt (g kg ⁻¹)	180 - 331	273	174 - 425	275	200 - 323	262	234 - 491	328
CEC [cmol(p ⁺)kg ⁻¹]	9.75 - 28.8	18.22	9.75 - 24.1	18.16	4.67 - 13.56	10.44	9.33 - 26.68	18.36
AEC [cmol(p ⁺)kg ⁻¹]	2.04 - 5.66	4.17	2.45 - 4.65	4.06	1.68 - 4.45	3.40	2.85 - 5.38	4.05
Exchangrable Al [cmol(p ⁺)kg ⁻¹]	0.91 - 3.18	1.85	0.23 - 4.77	2.47	0.17 - 0.80	0.47	0.17 - 2.39	1.21
Exchangrable (Ca + Mg)[cmol(p ⁺)kg ⁻¹]	0.50 - 2.80	1.28	0.85 - 4.20	1.77	2.85 - 9.80	4.68	2.10 - 9.35	4.75
Exchangrable K. [cmol(p ⁺)kg ⁻¹]	0.03 - 0.80	0.23	0.02 - 0.82	0.16	0.02 - 0.19	0.10	0.03 - 0.23	0.14

Table 2. Forms of soil P (mg kg⁻¹) under different land use patterns

Land use pattern P Forms	Tea garden		Orchard		Cultivated land		Forest	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Total P	293 - 1737	1020	293 - 1343	792	425 - 1212	801	293 - 1868	871
Total org. P	33 - 1312	616	43 - 672	271	16 - 443	242	47 - 1574	505
Total inorg. P	193 - 837	404	165 - 895	520	222 - 1154	558	150 - 637	365
Ca-P	Trace - 279	64	128 - 405	108	104 - 561	298	30 - 468	173
Fe-P	50 - 258	100	10 - 253	108	27 - 668	168	36 - 236	79
Al-P	9 - 197	64	20 - 278	116	12 - 112	40	9 - 300	53
RS-P	39 - 404	166	5 - 411	167	5 - 114	41	5 - 180	71
OC-P	3 - 16	10	6 - 19	13	5 - 35	11	3 - 12	7
Bray-P1	9 - 97	29	1 - 54	18	1 - 110	25	1 - 79	7

and cultivated land are moderately acidic to neutral in reaction. Except tea gardens, which are marginally low to high, soils, are medium to high in organic carbon. Texturally, soils varied from loamy sand to loam.

Soils of tea garden contained the highest amount of total P and the magnitude in different land use patterns was in the following order tea garden > forest > cultivated land > orchard (Table 2). Substantially higher amount of total P (1020 mg kg⁻¹) in tea garden than the others (792-871 mg kg⁻¹) was probably due

to higher P fertilization for tea cultivation. The sequence of land use pattern with respect to organic P content was : tea garden > forest > orchard > cultivated land. Lowest amount of organic P in cultivated land soils was ascribed to the least amount of organic matter content in these soils. The ratio of total inorganic P to organic P was the highest in cultivated land (2.31) followed by orchard (1.92), forest (0.72) and tea garden (0.66). In cultivated land and forest soils Ca-P was the dominant inorganic P fraction followed by Fe-P, reductant soluble P (RS-P), Al-P and occluded

Table 3. Simple correlation coefficients (r) between soil P forms and dry matter yield and P uptake by wheat

Land use pattern P Forms	Tea garden		Orchard		Cultivated land		Forest	
	A	B	A	B	A	B	A	B
Al-P	0.872**	0.638*	0.580*	0.351	0.558*	0.924**	0.767**	0.911**
Fe-P	0.782**	0.536**	0.655**	0.652**	0.460	0.822**	0.770**	0.888**
Ca-P	0.288	0.517*	0.002	0.439	-0.011	0.154	-0.280	-0.252
OC-P	0.023	-0.394	0.340	0.231	0.457	0.421	0.484	0.406
RS-P	0.570*	0.253	0.347	-0.001	0.039	-0.287	0.603*	0.700**
Total Inorg. P	0.834**	0.633*	0.693**	0.638*	0.372	0.750**	0.392	0.506
Org.P	0.181	-0.0003	0.262	-0.006	0.321	0.018	0.341	0.170
Total P	0.540*	0.285	0.657**	0.424	0.591*	0.806**	0.431	0.321

A and B stand for dry matter yield and P uptake by wheat, respectively

* and ** indicate 5% and 1% level of significance, respectively

Table 4. Stepwise multiple regression (R) between soil P fractions and P uptake (Y) by wheat

Equations	R ²	ΔR ²	Equations No
Forest soils			
Y = 1.10 + 0.093 Al-P	0.817	-	1
Y = 0.39 + 0.077 Al-P + 0.018 RS-P	0.861	0.041	2
Tea garden soils			
Y = 7.17 + 0.047 Al-P	0.362	-	3
Y = 12.45 + 0.052 Al-P - 0.566 OC-P	0.578	0.216	4
Cultivated land soils			
Y = 1.98 + 0.216 Al-P	0.842	-	5
Orchard soils			
Y = 2.77 + 0.035 Fe-P	0.382	-	6

P (OC-P), but in orchard and tea garden soils RS-P was the dominant fraction followed by Al-P/Fe-P, Ca-P and OC-P. Available P (Bray-1) content in tea garden, orchard, cultivated land and forest soils ranged from 9 to 97, 1 to 54, 1 to 110 and 1 to 79 mg kg⁻¹ with an average of 29, 18, 25 and 7 mg kg⁻¹, respectively.

Barring few exceptions, dry matter yield and P uptake by wheat had a significant relation with Al-P and Fe-P in all the land use patterns (Table 3). Thus, Al-P and Fe-P were the active inorganic P forms which controlled the P supply in these soils. Mongia and Bandopadhyay (8) and Ravindra and

Ananthanarayana (9) working with acid soils of India reported similar results. Significant positive relation of total P with dry matter yield and P uptake in some cases was simply an indirect contribution of total inorganic P to total P, as organic P did not show any significant relationship with either of the plant parameters. The increase of dry matter yield ($r = 0.603^*$) and P uptake ($r = 0.700^*$) by wheat in forest soils with increase in RS-P indicated that this form also acted as a potential source of available P through solubilisation or removal of Fe(OH)₃ coating around the soil particles by organic acid produced during mineralization of organic residues and thereby release of soluble Fe-P.

Based on the above information, stepwise multiple regression analysis was worked out between total P uptake and inorganic P fractions (Table 4). It showed that 86 per cent of the variation in P uptake under forest land use was explained by Al-P and RS-P. In case of tea garden soils, Al-P and OC-P jointly contributed 57.8 per cent variability in P uptake by wheat. However, Al-P and Fe-P alone can explain 84.2 and 38.2 per cent variation in P uptake in cultivated land and forest soils, respectively. Thus, the result revealed that with an exception of orchard soils, Al-P was the major source of plant available P, as it alone can explain 81.7, 36.2 and 84.2 per cent variation in P uptake of forest, tea garden and cultivated land soils respectively, while in orchard soils Fe-P controlled the P supply to wheat. These observations were in conformity with those of Sharma *et al.* (10) and Mongia and Bandopadhyay (8).

Though, all forms of P in soil are known to supply the nutrient to the soil solution, their relative contribution to labile pool from where plants absorb the nutrient depends mainly on the solubility and relative abundance of several phosphate compounds as influenced by the characteristics of the soils. In acid soils, although Fe-P and Al-P are less soluble, yet crops have utilized more of these forms of P, which might be due to their relative high share to soil P (5). Thus, to assess available P status of soils, the contribution of different inorganic P fractions to available phosphorus in different land use patterns should be taken into consideration.

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Effect of soil amendments on improvement of soil physical condition and crop growth of pigeonpea

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Abstract

A field study was conducted during *kharif* 2000 to 2002 at the Narmada Irrigation Research Project, Anand Agricultural University, Khandha on the clayey textured soils of the Narmada command to study the effect of soil amendments for physical soil improvement as well as pigeonpea crop growth. The studies showed the highest pigeonpea grain yield was obtained as 2032 kg/ha for the treatment 15 t/ha gypsum. Results also revealed that soil organic amendments, i.e. application of gypsum and pressmud improve the soil properties, organic carbon, infiltration rate and water holding capacity. The net profit was maximum with the application of 15 t/ha gypsum.

Keywords : Amendments, physical condition, pigeonpea

Introduction

Pigeonpea is an important stable legume crop of command area. Two major soil types deep black and alluvial soil are found in the phase I of the Narmada command. The black soil is clayey in texture having very poor physical condition. The infiltration rate is low which causes run off, poor aeration and water lodging and effect the crop production adversely with a view to improve the infiltration rate to the soil as well as crop growth the present study was undertaken.

Materials and methods

The field experiment consisted of seven treatments of soil amendments viz. Control (T_1), Gypsum 5 t/ha (T_2), Gypsum 10 t/ha (T_3), Gypsum 15 t/ha (T_4), pressmud 5 t/ha (T_5), pressmud 10 t/ha (T_6) and pressmud 15 t/ha (T_7). Pigeonpea (BDN-2) crop was sown during June, with 8 kg/ha seed rate at an inter row spacing 90 cm x 20 cm. The experiment was laid out in randomized block design with four replications. The experimental site was clayey in texture, low in organic carbon (0.31%), medium in available K_2O (1012 kg/ha). The pH is 7.57 and EC is 1.23 dSm^{-1} in 1:25 ratio. All package of practices required for the crop were followed.

Results and discussion

Grain and haulm yield

The perusal of data in table 1 and 2 showed that the

significant difference were observed in grain yield and haulm yield of Pigeonpea due to different soil amendments during all the three years and on pooled basis. More or less consistent results were observed during entire study. Application of 15 t/ha gypsum being at par with 15 t/ha pressmud gave significant higher grain yield than rest of treatments during 2000 and 2003. 15 t/ha gypsum being at par with 10 t/ha gypsum and 15 and 10 t/ha pressmud established its significant superiority during 2001. On pooled basis, the treatment of application of 15 t/ha gypsum and pressmud gave almost equal were significantly superior that rest of the treatments. In general application of pressmud or gypsum @ 15 t/ha increase the grain yield 38 and 30 percent respectively over without soil amendments. The results on haulm yield revealed similar trend to grain yield. Application of either pressmud or gypsum ranging from 5 to 15 t/ha increased the haulm yield to the tune of 20 to 37 percent.

Soil physical condition

Data presented in Table 3 show that soil amendments i.e. application of pressmud and gypsum improve the soil properties, organic carbon, infiltration rate and water holding capacity. In respect to the organic carbon content of the soil was higher in the treated plots. Application of 15 t/ha pressmud recorded higher values.

Infiltration rate was improved with the application of soil amendments viz., gypsum, pressmud, highest

Table 1. Grain yield (kg/ha) of pigeonpea influenced by different soil amendments.

Treatment	2000	2001	2002	Pooled
Control	1646	1569	1197	1471
5 t Gypsum	1883	1850	1475	1736
10 t Gypsum	1990	2097	1563	1883
15 t Gypsum	2271	2211	1615	2032
5 t pressmud	2008	1792	1442	1747
10 t pressmud	1845	1963	1560	1789
15 t pressmud	2081	2014	1620	1905
C.D. at 50%	229	296	166	132
C.V.%	9.98	13.10	9.39	10.99

Table 2. Haulm yield pigeonpea influenced by different soil amendments.

Treatment	2000	2001	2002	Pooled
Control	2034	1883	1451	1789
5 t Gypsum	2256	2214	1554	2006
10 t Gypsum	2445	2506	1613	2188
15 t Gypsum	2831	2652	1607	2363
5 t pressmud	2463	2160	1581	2069
10 t pressmud	2306	2356	1599	2088
15 t pressmud	2569	2419	1754	2247
C.D. at 50%	289	353	210	177
C.V.%	10.10	12.90	14.44	12.33

Table 3. Effect of organic amendments on soil pH, EC (dSm⁻¹) O.C.(%) Infiltration rate (cm/hr) and WHC (%)

Treatment	pH (1.25)	EC (dSm ⁻¹)	O.C (%)	Bulk Density	Infiltration rate (cm/hr)	WHC (%)
Control	7.558	1.60	0.345	1.295	1.105	58.775
5 t Gypsum	7.368	1.35	0.420	1.295	1.590	59.225
10 t Gypsum	7.395	1.30	0.420	1.295	1.710	60.025
15 t Gypsum	7.322	1.05	0.485	1.295	1.728	61.050
5 t press mud	7.535	1.33	0.457	1.287	1.795	60.800
10 t pressmud	7.560	0.93	0.485	1.287	1.867	62.275
15 t pressmud	7.585	0.78	0.540	1.285	1.920	62.875
S.Em+	0.04	0.22	0.02	0.01	0.05	0.24
C.D.5 %	0.13	NS	0.06	-	0.14	0.72
C.V.%	1.20	36.95	9.54	0.80	0.80	5.79

Table 4. Economics of treatment

Treatments	Grain yield (kg/ha)	Haulm yield (kg/ha)	Gross realization (Rs/ha)	Cost of cultivation (Rs/ha)	Net realization (Rs/ha)
Control	1471	1789	26538	9875	16663
5 t Gypsum	1709	2006	30650	11125	19525
10 t Gypsum	1883	2188	33715	12375	21340
15 t Gypsum	2047	2363	36613	13625	22988
5 t pressmud	1747	2069	31378	10875	20503
10 t pressmud	1789	2088	32055	11875	20180
15 t pressmud	1905	2247	34193	12875	21318

Selling price of pigeon pea 15.0 Rs/kg Cost of Gypsum Rs.250/- per ton
Selling of Haulm 2.5 Rs/kg Cost of pressmud Rs.200/- per ton.

being under the treatment of 15 t/ha pressmud which was about twice than the control. Similar observations were made by Bharambe *et al.* (1).

Water holding capacity (WHC) was higher following the application of pressmud at 15 t/ha which was at par with pressmud at 10 t/ha, gypsum 15 t/ha. The considerable reduction in pH and EC showed that soil amendments studied, were found effective in the clay soil in Narmada command area under pigeon pea cropping system.

Economics

The data presented in Table 4 revealed that the application of 15 t/ha gypsum realized the maximum net realization of Rs. 22,988 ha⁻¹ which was followed by 10 t ha⁻¹ gypsum and 15 t ha⁻¹ pressmud which

gave Rs. 21,340 and Rs. 21,318 ha⁻¹ respectively in comparison to control and rest of the treatments.

From the forgoing results it becomes evident that soil amendments like gypsum and pressmud improving the physical characters like infiltration rate and WHC of clay soil increase grain yield as well as monetary net realization.

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Influence of biofertilizers on growth and yield of African marigold (*Tagetes erecta* L.)

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Abstract

The response of *Azotobacter* and Phosphobacterin (PSB) on African marigold was studied during 2002-03. The treatments comprised of N at 0, 50, 75 and 100 % of the recommended dose and *Azotobacter* and/or Phosphobacterin (PSB). Application of 75 % recommended dose of N + *Azotobacter* + Phosphobacterin proved to be the most effective in increasing all parameters and yield of African marigold.

Key words : Marigold, phosphobacterin, *azotobacter*

Introduction

African marigold is an important commercial flower crop in Gujarat. The conventional nutritional applications create threat to soil health. Use of bioinoculants in this crop can be safer and more economic choice. Hence, the present investigation with *Azotobacter* and PSB on African marigold was taken up.

Material and methods

The experiment was conducted during 2002-03 at the Regional Horticultural Research Station, Gujarat Agricultural University, Navsari. The bioinoculants used were *Azotobacter* and Phosphobacterin (PSB) and the variety of African marigold subjected to treatment was "Sierra Orange". The treatments were T₁ (*Azotobacter* + PSB + 100 % N), T₂ (*Azotobacter* + PSB + 75 % N), T₃ (*Azotobacter* + PSB + 50 % N), T₄ (*Azotobacter* + PSB only), T₅ (*Azotobacter* + 100% N), T₆ (*Azotobacter* + 75 % N), T₇ (*Azotobacter* + 50 % N), T₈ (*Azotobacter* alone), T₉ (100 % N only) and T₁₀ (Control). The standard dose of N,P and K for this crop is 200: 50 : 50 kg/ha. Biofertilizer was applied in the form of slurry by dipping the seedlings for a few minutes before transplanting. The treatments were replicated three times in a Randomized Block Design. Data were recorded on various parameters of growth and flowering.

Results and discussion

The study revealed that all the treatment combinations increased plant height significantly over control (72.13 cm). However, maximum plant height (101.0 cm) was observed under T₁. As *Azotobacter* is free living bacteria and have specific role in fixing atmospheric N in soil which enhances the soil fertility. Likewise, PSB solubilizing the fixed soil phosphorus and readily hydrolyzes the organic phosphate and degraded them in the soil through production of organic acids (1). Similar improvement in plant height was also reported by Gupta (2) in African marigold and Kaloti (3) in China aster.

The number of branches per plant and leaf area was significantly increased by all the treatment combinations over control (7.13 and 5.90 cm², respectively). Maximum number of branches per plant (17.47) and leaf area (13.88 cm²) were observed in T₂. Increased in number of branches and leaf area under the treatments involving *Azotobacter* could be attributed to its increased ability towards absorption of nutrients, whereas in case of PSB, availability of phosphate ion is increased and due to its solubilizing effect branching is proliferated. Similar finding was reported by Rajadurai *et al.* (4) in African marigold and Siddiqui (5) in mulberry.

Table 1. Influence of bioinoculants with graded doses of nitrogen on various growth and flowering parameters of African marigold (*Tagetes erecta* L.)

Treatments	Plant height (cm)	No. of branches per plant	Leaf area (cm) ²	Plant spread (cm)		Days to 1 st flower bud initiation	Days to 50 % flowering	No. of Petals per flower	Wt. of single flower (g)	No. of flower per plant	Yield of flowers (q/ha)
				N-S	E-W						
T ₁ - Azotobacter + PSB + full N	101.00	13.53	11.95	36.07	30.13	52.80	72.78	155.72	7.73	33.26	65.40
T ₂ - Azotobacter + PSB + ¾ th N	90.33	17.47	13.88	37.47	31.47	52.60	65.70	185.07	8.53	40.54	72.22
T ₃ - Azotobacter + PSB + ½ th N	80.87	12.87	10.23	32.13	27.33	57.47	80.23	135.53	6.77	27.66	54.26
T ₄ - Azotobacter + PSB + No N	74.67	9.73	7.44	28.40	24.13	57.92	85.17	85.20	6.20	19.20	36.17
T ₅ - Azotobacter + full N	95.27	13.47	11.65	35.73	29.93	53.93	73.12	150.74	7.50	30.64	64.49
T ₆ - Azotobacter + ¾ th N	84.67	14.93	12.22	36.80	31.00	52.67	70.03	166.42	7.67	36.55	65.61
T ₇ - Azotobacter + ½ th N	79.20	12.73	9.42	32.00	27.27	57.82	81.01	124.42	6.37	25.99	51.09
T ₈ - Azotobacter alone	73.80	8.57	6.71	28.13	24.20	58.87	85.91	78.70	5.90	18.07	33.33
T ₉ - Full dose of N only	88.33	12.8	10.59	36.80	31.40	54.93	80.25	159.46	7.07	30.22	62.38
T ₁₀ - Control	72.13	7.13	5.90	25.47	22.26	59.73	90.63	74.62	4.06	15.59	30.03
C.D. at 5 %	5.03	2.20	1.69	2.96	3.41	3.41	10.44	12.69	0.68	0.68	4.92

Influence of biofertilizers on growth and yield

The plant spread North- South (37.47 cm) and East- West (31.47 cm) were maximum under T₂. However, minimum spread North-South (25.47 cm) and East-West (22.26 cm) were observed under control. It may be due to the use of *Azotobacter* and PSB with various doses of N leading to increased availability of N and P for plant growth and development. Deshmukh (6) reported the same in gaillardia.

Days to 1st flower bud initiation (952.6 days) and days to 50 % flowering (65.7 days) were minimum under T₂. However, maximum days to 1st flower bud initiation (59.73 days) and for 50% flowering (90.63 days) were observed under control. The early flowering observed in T₂ could be attributed to altered C:N ratio favouring reproductive growth. These findings are corroborated with that of Manjusha (7) in tomato.

Number of petals per flower and weight of single flower (185.07 and 8.53 g, respectively) were recorded maximum under T₂. However, these parameters were minimum (74.62 and 4.06 g, respectively) under control. Improved number of petals per flower and weight of single flower under *Azotobacter* and PSB treatments might be due to more availability and absorption of N and P for flower development. Kaloti (3) in china aster also reported similar findings.

Number of flowers per plant and flower yield also exhibited significant differences amongst the treatments. Number of flowers (40.54) per plant and flower yield (72.22 q/ha) were maximum under T₂. However, these parameters were minimum in control (15.59 and 30.03 q/ha, respectively). Increased in the number of flowers per plant and yield of flower under *Azotobacter* and PSB treatments might be explained in the light of the fact that these treatments resulted in considerable higher number of branches, leaf area and plant spread thus, increasing the number of flower and flower yield. The basic principle is that the *Azotobacter* enhance the absorption of immobile plant nutrient, whereas PSB increases the solubilization of P, thus ensuring the increased availability of nutrients. Similar findings have also been reported by Gupta (2) in African marigold, Kaloti (3) and Kumar *et al.* (8) in china aster.

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Evaluation of gerbera (*Gerbera jamesonii* Bolus) varieties in low cost polyhouse under south Gujarat condition

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Abstract

Six varieties of gerbera (*Gerbera jamesonii* Bolus) propagated through tissue culture were evaluated in low cost polyhouse under South Gujarat conditions, for their growth, yield and quality parameters. The results revealed that variety 'Charmander' produced attractive pink coloured flowers and recorded early flowering (30 days) with highest yield of flowers (9.67 per plant), number of rows of petals (6), flower diameter (9.53 cm), flower stalk length (47.50 cm) and fresh weight of flower (17.07 g). It had more suckering habit (2.47). The next best variety with high yield of flowers (8.33 per plant) was 'Dardanella' having attractive red flower, producing the flowers with larger diameter (9 cm), number of rows of petals (5) and fresh weight of flower (16.57 g).

Key words : Gerbera, varietal evaluation, low cost polyhouse

Introduction

Gerbera is an important commercial cut flower, suitable for export and domestic markets. It is commonly known as Transvaal Daisy, Barberton Daisy or African Daisy. It produces very attractive flowers. It is an important crop grown throughout the world in a wide range of agroclimatic conditions. It is native of Natal and Transvaal. The genus gerbera was named in the honour of German naturalist, Traugott Gerber (1). It belongs to the family Asteraceae which consist of many other important cut flowers viz., aster, dehalia, chrysanthemum, gaillardia, marigold, etc. The genus gerbera consist of about forty species of hardy and perennial flowering plants, of which *Gerbera jamesonii* Bolus is only under cultivation. Protected cultivation of gerbera is a new concept. The success of hi-tech floriculture project depends on the selection of proper varieties. As these varieties are recently introduces, their performance is not studied systematically under South Gujarat agroclimatic conditions. Keeping in view its high returns in terms of money and export potential, the present investigation was under taken.

Materials and methods

The present investigation was carried out using Completely Randomized Design (CRD) with three replications and six varieties of gerbera propagated

by tissue culture viz, 'Miracola', 'Meriva', 'Dardanella', 'Winter Queen', 'Yellow Mestique' and 'Charmander' in the polyhouse at Soil and Water Management Research Unit, Navsari Agricultural University, Navsari from October-2004 to April-2005. The composition of potting medium was Nursery soil (Soil and FYM in 1:1 proportion), sand, saw dust and rice husk in 2:1:1:1 proportion. The observations were recorded on growth, yield and quality parameters.

Results and discussion

Growth parameters

Spread of the plant : Plant spread was found to be significantly affected in different varieties. The varieties 'Dardenella' produced higher spread (58.73), which was at par with variety 'Miracola' (57.23). Maleek (2), Singh and Mandhar (3) and Manjusha *et al.* (4) also found such type of the results in gerbera. The variation in plant might be due to differences in genetic makeup of the varieties.

Plant height : Variety 'Dardanella' recorded maximum plant height (28.40 cm) which was followed by variety 'Miracola' (22.20 cm) it was in accordance with the findings of Choudhury *et al.* (5) and Dhane *et al.* (6). The variation in plant height might be due to differences in genetic makeup of the varieties.

Table 1. Varietal influence of gerbera on growth parameters

Sr. No.	Varieties	Plant spread (cm)	Plant height (cm)	Number of leaves	Number of suckers per plant	Length of leaves (cm)	Breadth of leaves (cm)
1	Miracola	57.23	22.20	13.53	2.00	27.27	9.83
2	Meriva	46.63	20.70	12.60	1.87	24.50	8.73
3	Dardanella	58.73	28.40	14.27	2.27	33.70	11.50
4	Yellow Mistique	41.30	20.13	11.33	1.07	23.63	8.47
5	Winter Queen	42.40	20.20	12.07	1.60	22.53	8.07
6	Charmander	47.70	21.90	15.27	2.47	32.37	10.93
	C.D. at 5%	1.86	0.73	0.76	0.44	1.27	0.58
	C.V. %	2.13	1.86	3.26	13.28	2.62	3.40
	SEM±	0.60	0.24	0.25	0.14	0.41	0.19

Table 2. Varietal influence of gerbera on flowering parameters

Sr. No.	Varieties	Days for first flower bud initiation (FBI)	Days for FBI to Flower opening	Days for 50% flowering	Number of rows of petals	Length of flower stalk (cm)	Diameter of flower (cm)	Fresh weight of flower (g)	Colour of flower
1	Miracola	35.67	22.00	66.00	5.00	37.27	8.50	14.20	Red
2	Meriva	49.33	20.33	72.00	2.00	45.93	7.40	14.53	Yellow
3	Dardanella	38.00	21.67	63.00	5.00	44.40	9.00	16.57	Red/Brown
4	Yellow Mistique	53.33	27.67	91.00	3.00	38.40	6.93	8.13	Yellow
5	Winter Queen	57.67	26.33	92.00	5.00	43.90	8.10	14.03	White
6	Charmander	30.00	17.00	46.00	6.00	47.50	9.53	17.07	Pink
	C.D. at 5%	1.97	1.51	3.41	—	2.11	0.54	0.60	—
	C.V. %	2.51	3.78	2.67	—	2.77	3.69	2.40	—
	SEM±	0.64	0.49	1.11	—	0.69	0.18	0.20	—

Number of leaves per plant : 'Charmander' recorded significantly highest number of leaves per plant (15.27), which was followed by variety 'Dardanella' (14.27). These findings are in conformity with the results reported by Bhattacharjee (7), Maleek (2) and Kumar and Yadav (8).

Number of suckers per plant : Variety 'Charmander' produced maximum suckers per plant (2.47) and was significantly superior over all other varieties except 'Dardanella' (2.27) which remained at par. The present findings confirm well with the findings of Maleek (2), and Thomas et al. (9). It might be due to the difference in the varieties, soil type and location.

Length and Breath of leaf : Maximum length (33.70 cm) was recorded by variety 'Dardanella' which was at par with variety 'Charmander' (32.37 cm) it was in confirmation with result reported by Maleek (2) in gerbera under Konkan agro-climatic conditions. While, variety 'Dardanella' produced maximum breadth of leaves (11.50 cm) which was at par with variety 'Charmander' (10.93 cm).

Flowering characters

Days for first flower bud initiation: Early flower bud initiation was observed in variety 'Charmander' (30 days). It was followed by 'Miracola' (35.67 days) and 'Dardanella' (38 days). The variation in plant might be due to differences in genetic makeup of the varieties.

Number of days from flower bud initiation to flower opening: Variety 'Charmander' took minimum days for flower bud initiation to flower opening (17 days).

Days to 50 per cent flowering: Variety 'Charmander' took minimum days for the commencement of 50 per cent flowering (46). The present findings are also confirmed well with the findings of Maleek (2) and Singh and Mandhar (3).

Number of rows of petals: Maximum number of rows of petals (6) were found in variety 'Charmander' which was followed by variety 'Dardanella' (5), 'Miracola' (5), 'Winter Queen' (5).

Length of flower stalk : Maximum length of flower stalk (47.50 cm) was found in variety 'Charmander' and it was at par with variety 'Meriva' (45.93). These findings are in accordance with the result reported by Singh and Mandhar (2) and Kandpal *et al.* (10). The variation in plant might be due to differences in genetic makeup of the varieties.

Diameter of flower : The variety 'Charmander' produced significantly big sized flowers (9.53 cm) which was at par with variety 'Dardanella' (9 cm). It was in the range of those reported by Maleek (2), Kandpal *et al.* (10) and Mahanta *et al.* (11). It might be due to the difference in the varieties, soil type and location.

Fresh weight of flower : The maximum fresh weight of flowers (17.07 g) was observed in variety 'Charmander' which was at par with variety 'Dardanella' (16.57 g). It was in confirmation with those of Maleek (2) and Mahanta *et al.* (11). The variation in plant might be due to differences in genetic makeup of the varieties.

Colour of flower: The varieties 'Miracola', 'Meriva', 'Dardanella', 'Yellow Mistique', 'Winter Queen', and 'Charmander' reported the colours Red, Yellow (center green), Red/Brown, Yellow, White and Pink, respectively.

Yield characters:

Number of flowers per plant and per square meter: Variety 'Charmander' recorded significantly maximum flowers per plant (9.67) and per sq.m (38.67) which was followed by variety 'Dardanella'. The present findings also confirm well with reports of Reimherr *et al.* (12), Maleek (2), and Kandpal *et al.* (10).

Table 3. Varietal influence of gerbera on yield parameters.

Sr. No.	Varieties	Flowers per plant	Flowers per sq.m
1	Miracola	8.00	32.00
2	Meriva	7.33	29.33
3	Dardanella	8.33	33.33
4	Yellow Mistique	4.67	18.67
5	Winter Queen	5.67	22.67
6	Charmander	9.67	38.67
	C.D. at 5%	0.94	3.75
	C.V. %	7.24	7.24
	SEM±	0.30	1.22

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Population fluctuation of *Helicoverpa armigera* (Hubner) Hardwick on okra crop in relation to weather parameters

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Abstract

Studies on population dynamics of *Helicoverpa armigera* (Hubner) Hardwick infesting okra was made during 2004 and 2005 in *kharif* season at Agronomy farm of Anand Agricultural University, Anand. The incidence of the pest began from 4th week of August and continued up to 3rd week of October with a peak activity in 3rd week of September but higher incidence was noticed in September. The larval population showed significant positive correlation with maximum and mean temperature in 2004, while significant negative correlation with mean temperature in 2005. The rainfall had significant negative correlation with larval population in 2004. The association between *H. armigera* and other weather parameters (minimum temperature, relative humidity, vapour pressure, sunshine hours and wind speed) was not established during both the years.

Keywords : Okra, weather parameters, relative humidity

Introduction

Okra is one of the most popular vegetable crop belonging to the family Malvaceae. In Gujarat, it occupies an area of 35190 ha with a production of 272699 MT and productivity 7.74 MT/ha, while in Anand, it occupies an area of 1315 ha with a production of 5918 MT and productivity 4.50 MT/ha (1). Incidence of insect pests is one of the prime factors in production of okra. The okra crop is attacked by many species of insect pests right from germination to harvest in Gujarat (2). Earlier, *H. armigera* was considered as one of the minor pest of okra but in recent past become a serious limiting factor in the state. Its infestation affects the quality and quantity of fruit production, which ultimately reduce the market price. There is no information available regarding population dynamics of *H. armigera* vis-à-vis okra. Therefore, an attempt was made to know the population fluctuation of *H. armigera* on okra crop and pinpoint the main period of activity of the pest, which could be utilized in formulating the strategies of Integrated Pest Management.

Materials and methods

The okra (var. Parbhani kranti) crop was sown at Agronomy farm, Anand Agricultural University, Anand in the 3rd and 2nd week of July for the years 2004 and

2005, respectively in an area of 400 m². All the recommended agronomical practices were followed for raising the crop. In order to record the *H. armigera* larval population, crop area was divided into four equal quadrates. From each quadrates, twenty plants were selected randomly, number of larvae were recorded at weekly interval starting from one week of germination till the harvest of crop. Data thus, obtained were correlated with abiotic factors for determining the fluctuation of *H. armigera* population by using correlation coefficient analysis.

Results and discussion

During 2004, *H. armigera* incidence (Table 1) on okra crop commenced 0.90 larva/plant from 35th standard week (4th week of August) and it was continued till 42nd standard week (3rd week of October). The activity of *H. armigera* gradually increased and reached to peak level (3.40 larvae/plant) during 38th standard week (3rd week of September). The maximum temperature, minimum temperature, mean temperature, morning relative humidity, evening relative humidity, morning vapour pressure, evening vapour pressure, mean vapour pressure, bright sunshine, rainfall and wind speed recorded during the peak activity of *H. armigera* was 34.30 °C, 25.40 °C, 29.80 °C, 90.30 %, 55.60 %, 72.90 %, 23.40 mm, 22.10 mm, 22.70 mm, 7.60 hrs,

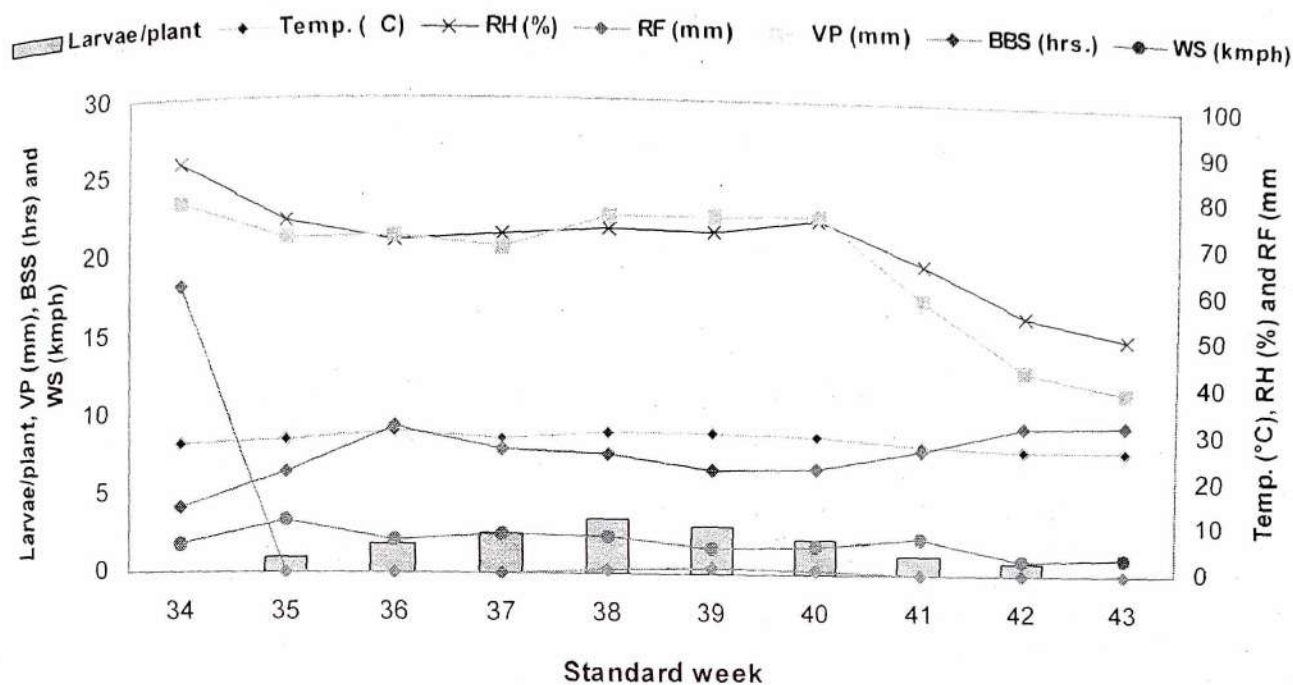


Fig. 1 : Seasonal activity of *H. armigera* on okra in relation to abiotic factors (2004)

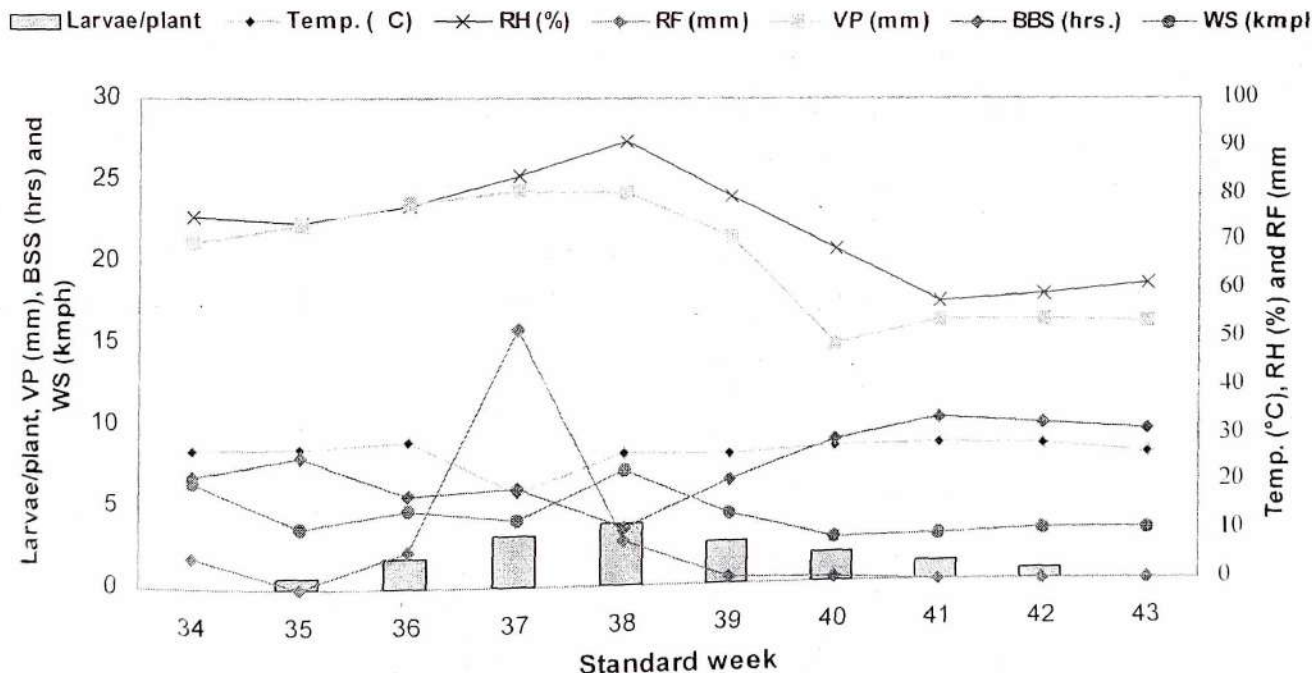


Fig. 2 : Seasonal activity of *H. armigera* on okra in relation to abiotic factors (2005)

0.80 mm and 2.40 kmph, respectively (Fig. 1). Thereafter, the pest population gradually decreased and found 3.00, 2.20, 1.30 and 0.80 larvae per plant on 39th, 40th, 41st and 42nd standard week (4th week of September to 3rd week of October), respectively.

The pest population was disappeared on okra crop from 4th week of October (43rd standard week). The decrease in pest population on okra crop was may be due to other preferable hosts available in the area.

Table 1. Effect of abiotic factors on incidence of *H. armigera* on okra during kharif 2004.

Table 1. Effect of abiotic factors on incidence of <i>M. dimorpha</i>																
Std week	Month and week	Larvae/plant	Abiotic factors										Bright sun-shine (hrs)	Rain fall (mm)	Wind speed (kmph)	
			Temperature (°C)			Relative humidity (%)			Vapour pressure (mm)							
			Max	Min	Mean	Morn-ing	Eve-ning	Mean	Morn-ing	Eve-ning	Mean					
34	August	III	0.00	30.00	24.60	27.30	93.60	78.40	86.00	22.70	23.90	23.30	4.10	60.40	1.80	
35		IV	0.90	31.80	24.40	28.10	87.20	61.10	74.10	21.50	20.80	21.10	6.40	0.00	3.30	
36	September	I	1.80	34.40	25.30	29.80	85.90	53.90	69.90	21.90	20.70	21.30	9.20	0.00	2.10	
37		II	2.50	32.90	24.60	28.70	87.10	56.10	71.60	21.40	19.90	20.60	7.90	0.00	2.50	
38		III	3.40	34.30	25.40	29.80	90.30	55.60	72.90	23.40	22.10	22.70	7.60	0.80	2.40	
39		IV	3.00	35.60	24.40	30.00	88.90	56.10	72.50	23.00	22.50	22.70	6.60	1.60	1.60	
40	October	I	2.20	33.50	25.40	29.40	90.30	60.00	75.10	22.90	22.80	22.80	6.80	1.00	1.80	
41		II	1.30	33.30	21.90	27.60	83.90	48.20	66.00	18.70	16.60	17.60	8.00	0.00	2.30	
42		III	0.80	35.10	18.60	26.80	84.20	26.40	55.30	15.40	10.90	13.10	9.60	0.00	1.00	
43		IV	0.00	35.80	18.10	26.90	79.80	21.50	50.60	14.40	9.20	11.80	9.70	0.00	1.10	

Table 2. Effect of abiotic factors on incidence of *H. armigera* on okra during kharif 2005.

Std week	Month and week	Larvae/plant	Abiotic factors										Bright sun-shine (hrs)	Rain fall (mm)	Wind speed (kmph)
			Temperature (°C)			Relative humidity (%)			Vapour pressure (mm)						
			Max	Min	Mean	Morn-ing	Eve-ning	Mean	Morn-ing	Eve-ning	Mean				
34	August	III	0.00	32.10	24.30	28.20	91.70	60.30	76.00	22.00	20.50	21.20	6.90	6.00	6.40
35		IV	0.70	32.70	24.80	28.70	88.20	61.20	74.70	22.20	22.40	22.30	8.00	0.00	3.70
36	September	I	1.80	34.10	25.80	29.90	87.60	68.20	77.90	23.00	24.30	23.60	5.60	7.40	4.70
37		II	3.20	22.10	16.30	19.20	97.10	71.00	84.00	23.50	25.10	24.30	6.10	52.60	4.10
38		III	3.80	30.20	24.50	27.30	97.40	84.80	91.10	23.80	24.70	24.20	3.50	9.00	7.10
39	October	IV	2.60	30.50	23.40	26.90	95.40	64.70	80.00	22.00	21.00	21.50	6.50	1.20	4.30
40		I	1.80	33.30	23.10	28.20	88.80	49.10	68.90	21.10	8.50	14.80	8.80	0.70	2.80
41		II	1.20	35.90	21.10	28.50	81.80	34.00	57.90	17.80	14.70	16.20	10.10	0.00	2.90
42		III	0.70	35.70	20.60	28.10	80.50	37.80	59.10	16.70	15.70	16.20	9.80	0.00	3.10
43		IV	0.00	34.20	18.70	26.45	83.70	39.10	61.40	17.30	14.90	16.10	9.30	0.00	3.10

During the year 2005 (Table 2), the *H. armigera* pest population (0.70 larva/plant) appeared on 35th standard week (4th week of August) in middle Gujarat condition. The next week of the pest appearance i.e. 36th standard week (1st week of September) it was found 1.80 larvae per plant. The higher (2.60 to 3.80 larvae/plant) activity of the pest was noted during 37th to 39th standard week (2nd to 4th week of September). The meteorological parameters like maximum temperature, minimum temperature, mean temperature, morning relative humidity, evening relative humidity, mean relative humidity, morning vapour pressure, evening vapour pressure, mean vapour

pressure, bright sunshine hours, rainfall and wind speed was recorded during the higher pest activity period as 22.10 to 30.50 °C, 16.30 to 24.50 °C, 19.20 to 27.30 °C, 95.40 to 97.40 %, 64.70 to 84.80 %, 80.0 to 91.10 %, 22.00 to 23.80 mm, 21.00 to 25.10 mm, 21.50 to 24.30 mm, 3.50 to 6.50 hrs, 1.20 to 52.60 mm and 4.10 to 7.10 kmph, respectively (Fig. 2). The pest was found at peak level (3.80 larvae/plant) on 38th standard week. Thereafter, the population of *H. armigera* was found in decreasing trend till 42nd standard week (3rd week of October). The activity of this pest was not registered on okra crop after 42nd standard week (3rd week of October).

Table 3. Correlation coefficient (r) between *H. armigera* numbers and abiotic factors on okra crop

Year	Abiotic factors											
	Temperature (°C)			Relative humidity (%)			Vapour pressure (mm)			Bright sunshine (hrs)	Rain fall (mm)	Wind speed
	Max	Min	Mean	Morning	Evening	Mean	Morning	Evening	Mean			
2004	0.605*	0.282	0.866*	0.213	-0.325	-0.311	0.213	0.056	0.113	0.529	-0.565*	0.006
2005	-0.481	-0.416	-0.532*	0.367	0.222	0.269	0.239	0.263	0.274	0.045	-0.039	-0.254

* Significant at 5 % level.

Thus, from foregoing results the activity of the pest was noticed during 35th standard week (4th week of August) to 42nd standard week (3rd week of October) in both the years. The major activity of *H. armigera* was found during September month on okra crop. Tripathy *et al.* (3) reported that the *H. armigera* was present on okra crop during August and September. According to Ahmed *et al.* (4), the average infestation of *H. armigera* was 9.85 % in May, which increased to 33.55 % in August and gradually decreased to 8.32 % in October on okra crop in Pakistan. Above reports strongly support the present conclusion.

The correlation coefficient values (Table 3) revealed that the maximum and mean temperature had significantly positive correlation with *H. armigera* population on okra crop during first year. The correlation between *H. armigera* incidence and maximum and mean temperature in present study supported by the reports of Jawalkar *et al.* (5) and Mehto *et al.* (6). In second year, mean temperature had significantly negative correlation with pest population that also supported by the report of Patil and Kulkarni (7). The significantly negative correlation was established between *H. armigera* incidence and rainfall in first year. The present study supported by Bijjur and Verma (8), Patil and Kulkarni (7), Tripathy *et al.* (3), Chaudhary *et al.* (9), Ganesaraja *et al.* (10) and Jawalkar *et al.* (5). The effect of maximum temperature and rainfall in second year as well as minimum temperature, wind speed and bright sunshine hours in both the years did not influence the *H. armigera* population that is supported by the report of Dhawan and Simwat (11). Similarly, relative humidity also did not influence the population of the pest, it also supported by the report of Li-Jian *et al.* (12). So these reviews are in agreement with present studies of seasonal activity of *H. armigera* and correlation of the pest with abiotic factors.

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Population fluctuation of stem borer, *Chilo partellus* Swinhoe infesting maize in relation to weather parameters

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Abstract

Studies on population dynamics of *Chilo partellus* Swinhoe infesting maize was made during 2003 and 2004 in kharif season at Agronomy farm of Anand Agricultural University, Anand. The incidence of the pest begins from 1st week of July and continued up to 2nd week of September with a peak activity in August. Parasite *Apanteles flavipes* showed significant positive correlation with larval population during both the years. The abiotic factors, sunshine hours and rainfall had significantly negative and positive association with *C. partellus* on maize during 2004, respectively.

Keywords : Maize, weather parameters, relative humidity

Introduction

Maize (*Zea mays* Linnaeus) popularly known as 'corn' is one of the most important cereals of the world. In India, maize is cultivated in area of 6.21 million hectares and the production of 13.95 million tonnes of grain with 2246.3 kg/ha productivity (1). Out of these, Gujarat occupies 0.44 million hectares of area and producing 0.88 million tonnes of grain with 1990 kg/ha productivity (2). Maize is attacked by nearly 130 species of insect pests in India (3). Among these maize stem borer (*Chilo partellus* Swinhoe) is one of the most important pest. The loss in yield due to infestation of *C. partellus* was 60 % and stem infestation levels reached 98 % in Nepal (4). In spite of regular occurrence of *C. partellus* on maize crop and causing economic losses, no systematic work has been done on population dynamics of *C. partellus* on maize in Gujarat state. Therefore, an attempt was made to know the population fluctuation of *C. partellus* on maize crop and pinpoint the main period of activity of the pest, which could be utilized in formulating the strategies of Integrated Pest Management.

Materials and methods

Maize (GM 4) cultivar was grown in an area of 500 m² with a distance of 60 X 20 cm at Agronomy farm, B. A. College of Agriculture, Anand Agricultural University, Anand during 4th week of June in kharif season of 2003 and 2004 to record the population fluctuation of

C. partellus. The crop area was divided into five equal quadrates. From each quadrate 20 plants were selected randomly for recording the observations. The stem borer damaged plants were recorded from each quadrate at weekly interval starting from one week of germination till harvest of the crop. To know the larval population in damaged plants, 10 per cent damaged plants were selected from general field of same variety and numbers of larvae were noted by splitting the stem. These larvae were brought to the laboratory and reared till pupation for recording the emergence of parasites, if any. The parasites emerged out from the collected larvae were recorded. The pest population data were correlated with biotic and abiotic factors.

Results and discussion

During 2003, *C. partellus* incidence (Table 1) on maize crop commenced with 0.8 larva/plant from 27th standard week (1st week of July), which cause 7 % damage to the maize plants. The number of larvae per plant increased gradually and reached to a peak level (2.6 larvae/plant) on 34th standard week (4th week of August). During the period crop was damaged 38 %. The parasite activity, minimum and maximum temperature, relative humidity, vapour pressure, bright sunshine, rainfall and wind speed recorded during the peak activity of *C. partellus* were 34.61 %, 24.74 and 31.79 °C, 85.24 %, 23.37 mm, 2.83 hrs, 179.80 mm and 4.81 kmph, respectively (Fig. 1). After 34th

Table 1 : Population dynamics of *C. partellus* in relation to biotic and abiotic factors

Std. Week	Month and Week	Larvae/plant		Damaged Plant (%)		Larval parasitism	
		2003	2004	2003	2004	2003	2004
26	June IV	0.0	0.0	0	0	0.00	0.00
27	July I	0.8	0.4	7	8	12.50	0.00
28	II	1.4	0.7	12	13	7.14	14.28
29	III	1.7	0.9	21	22	23.52	22.22
30	IV	1.8	0.9	27	29	33.33	33.33
31	Aug. I	2.0	1.3	30	32	35.00	30.76
32	II	2.4	0.8	31	32	29.16	12.50
33	III	2.4	0.6	35	33	33.33	16.66
34	IV	2.6	0.3	38	33	34.61	0.00
35	V	1.9	0.3	38	34	21.05	0.00
36	Sept. I	1.1	0.2	39	36	9.09	0.00
37	II	0.3	0.0	39	36	0.00	0.00
38	III	0.0	0.0	39	36	0.00	0.00

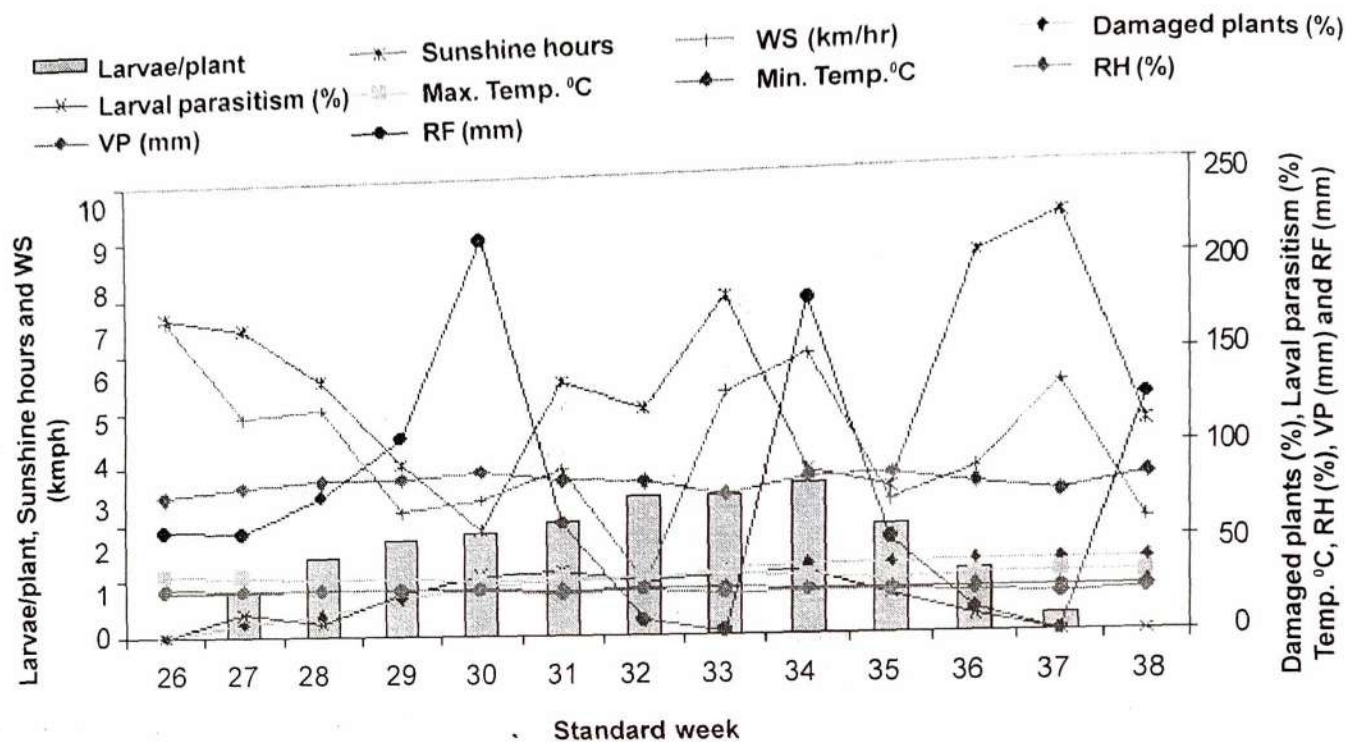
standard week, the larval population was suddenly decreased and found to be 1.9 larvae per plant on 35th standard week (5th week of August). The decreasing trend of the pest was continued from 34th standard week and it disappeared on maize from 38th standard week (3rd week of September). Maximum (39 %) damage was recorded in the month of September during study period.

During 2004, *C. partellus* incidence (0.4 larva/plant) on maize crop commenced from the 27th standard week (1st week of July) with 8 % plant damage (Table 1). The number of larvae per plant increased slowly and reached to a peak (1.3 larvae/plant) on 31st standard week (1st week of August) when the pest caused 32 % damage to maize crop. The larval parasitism, minimum and maximum temperature, relative humidity, vapour pressure, bright sunshine, rainfall and wind speed recorded during the peak activity of *C. partellus* were 30.76 %, 24.60 and 28.14 °C, 92.47 %, 23.83 mm, 0.64 hr, 199 mm and 3.30 kmph, respectively (Fig. 1). After 31st standard week the larval population was decreased suddenly and found to be 0.8 larva per plant on 32nd standard week (2nd week of August). The decreasing trend of the pest was continued from 31st standard week and it was disappeared on maize crop from 37th standard week (2nd week of September).

Looking to the pest activity recorded during both the years, it appeared that the larval population of *C. partellus* commenced during early July when the crop was 15 days old and reached to a peak level in August and it was disappeared from mid September when the crop was 70 days old. Singh and Sharma (5) reported that the peak emergence of adults of *C. partellus* occurred in August but declined gradually in September-October.

The correlation coefficient results (Table 2) revealed that the parasite *Apanteles flavipes* showed significant positive correlation with larval population of *C. partellus* with critical value of 0.910 and 0.904 during first and second year, respectively. Significant positive correlation of biotic agents was observed by Jalali (6), which is in conformity with the present findings. The abiotic factors, sunshine hours ($r = -0.711$) and rainfall ($r = 0.689$) had significantly negative and positive association with *C. partellus* larval population on maize during 2004, respectively. The relationship between *C. partellus* larval population and minimum temperature, relative humidity and vapour pressure were positively correlated, whereas maximum temperature negatively correlated, but non-significant. However, the relationship between *C. partellus* and wind speed was not established during study period.

Kharif 2003



Kharif 2004

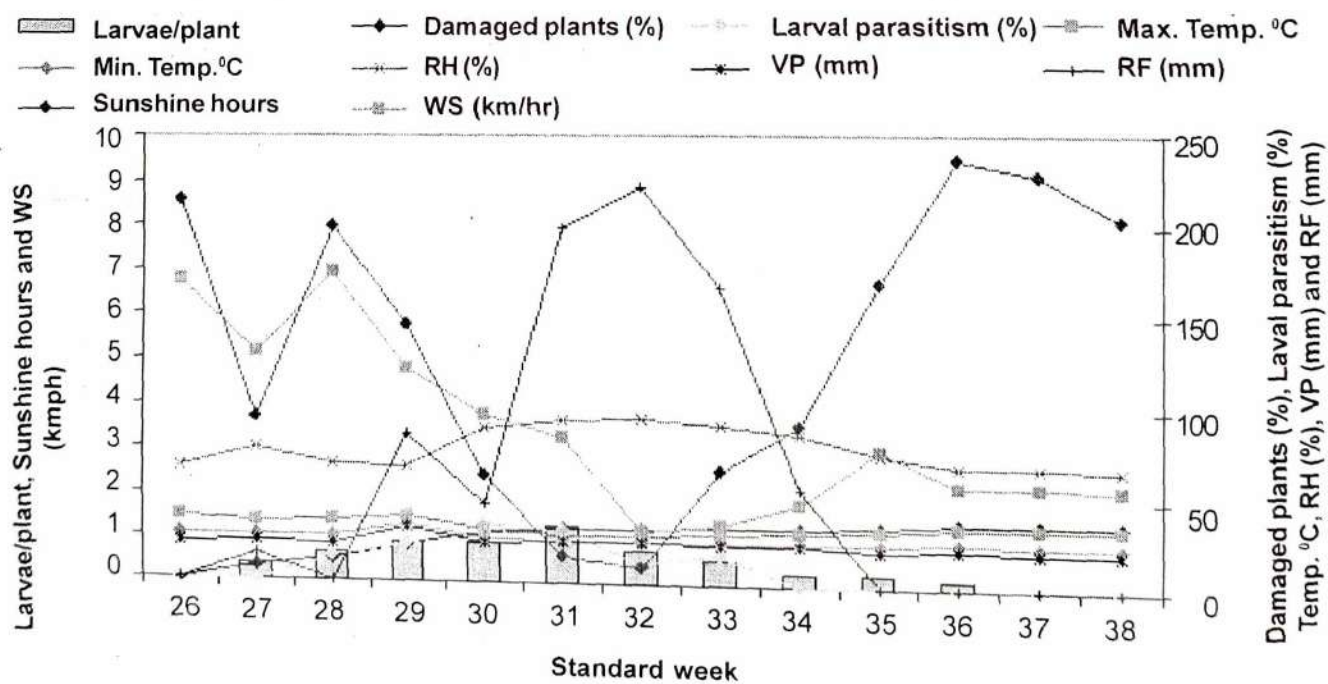


Fig. 1 : Population fluctuation of *C. partellus* larvae in relation to biotic and abiotic factors

Table 2. Correlation coefficient between *C. partellus* and biotic as well as abiotic factors

Year	Stem borer	Larval parasitism	Abiotic factors						
			Temperature °C		Relative humidity (%)	Vapour pressure (mm)	Sunshine hours	Rainfall (mm)	Wind speed (kmph)
			Min.	Max.					
2003	Larval population Damaged plant (%)	0.910 *	0.158	- 0.162	0.257	0.342	- 0.405	0.112	- 0.009
			- 0.761 *	- 0.469	- 0.309	- 0.771 *	0.042	- 0.107	- 0.107
2004	Larval population Damaged plant (%)	0.904 *	0.301	- 0.349	0.552	0.562	- 0.711 *	0.689 *	0.297
			- 0.503	- 0.443	0.222	- 0.309	0.070	0.173	- 0.849 *

* Significant at 5 % level

The damaged plants caused by *C. partellus* were significantly negative correlated with minimum temperature and vapour pressure in 2003 and wind speed in 2004. The minimum and maximum temperature, vapour pressure and wind speed negatively associated, whereas sunshine hours positively correlated with *C. partellus* damage in maize crop during the study period. The relation between damaged plants caused by *C. partellus* and relative humidity as well as rainfall were not established during the year 2003 and 2004.

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Susceptibility of maize varieties/cultivars to stem borer, *Chilo partellus* Swinhoe

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Abstract

Field screening of twenty genotypes/cultivars of maize was conducted to identify the less susceptible genotypes/cultivars against *Chilo partellus* Swinhoe in Gujarat during kharif season of 2003 and 2004. Among the 20 varieties/genotypes screened, Ganga Safed 2, Narmada Moti and GM 3 were found resistant to *C. partellus* and registered higher grain yield.

Key words : Maize, stem borer, stem tunneling

Introduction

Maize is one of the most important cereals, which plays a vital role in the food economy of the world, though the financial value of this crop per unit area is relatively low. In India, maize is cultivated in an area of 6.21 million hectares with the production of 13.95 million tonnes of grain and productivity of 2246.3 kg/ha (1). Of these Gujarat occupies 0.44 million hectares of area and producing 0.88 million tonnes of grain with 1990 kg/ha productivity (2). Maize is attacked by nearly 130 species of insect pests in India (3). Among these maize stem borer (*Chilo partellus* Swinhoe) is one of the most important pest. In spite of regular occurrence of *C. partellus* on maize crop and causing economic losses, no systematic work has been done on evaluation of maize varieties/genotypes against this pest. Hence, the present study was carried out to identify the genotypes/cultivars having less susceptible or tolerant to the pest.

Materials and methods

To screen the available maize varieties/genotypes for their resistance to *C. partellus*, an experiment was conducted in Randomized Block Design with three replications in pesticide free open field condition at Agronomy farm of B. A. College of Agriculture, Anand Agricultural University, Anand during kharif season of 2003 and 2004. Twenty maize varieties/genotypes (Table 1) were chosen for the resistance study and sown in 4th week of June during both the years. The crop was sown at a distance of 60 x 20 cm in plot

size of 5.0 x 1.2 m. The observations on number of damaged and healthy plants were recorded at weekly interval starting from one week of germination till the harvest of the crop. Stem tunnelling was recorded at the time of harvesting. Grain yield was recorded at harvest from net plot area. Data, so obtained were subjected to the appropriate transformation and statistically analyzed for interpretation. Cut off value were worked out for grouping the varieties/genotypes in to susceptible and resistant against the pest by using the following formula suggested by Bapat and Mote (4).

$$\text{Cut off value} = \frac{(\text{Maximum damage} - \text{Minimum damage})}{2} + \text{Minimum damage}$$

Results and discussion

The genotypes/varieties of maize were evaluated against *C. partellus* by recording the damaged plants and stem tunneling.

Damaged plants (%)

Pooled analysis for the two years (Table 1 and Fig. 1) showed that significantly least (7.18 %) damaged plants were observed in Ganga Safed 2 than all the tested varieties/genotypes. The Narmada Moti and GM-3 were next promising varieties, which registered 10.69 and 12.32 % damaged plants, respectively. In contrast to this, maximum (19.27 %) damaged plants were found in GM-4 but it was statistically at par with remaining all the varieties/genotypes exhibiting 17.56 to 19.18 per cent damaged plants.

Table 1. Damage caused by *C. partellus* in different varieties/genotypes of maize and its effect on yield.

Varieties/ Genotypes	Damaged plants (%) [*]				Stem tunneling (%) ^{**}				Yield (q/ha)		
	2003	2004	Pooled	Rank	2003	2004	Pooled	Rank	2003	2004	Pooled
GM 1	4.68 ^a (21.90)	4.01 ^{ab} (16.08)	4.35 ^a (18.92)	R ₁₀	16.79 ^{bcd} (8.34)	16.50 ^a (8.07)	16.65 ^{bc} (8.21)	R ₁₀	23.62 ^{def}	23.91 ^{de}	23.76 ^{defg}
GM 2	4.60 ^a (21.16)	4.05 ^{ab} (16.40)	4.33 ^a (18.75)	S	17.46 ^{bc} (9.00)	16.88 ^a (8.43)	17.18 ^b (8.72)	S	20.90 ^{efgh}	21.14 ^{efgh}	21.02 ^{gh}
GM 3	3.36 ^{bc} (11.29)	3.66 ^c (13.39)	3.51 ^b (12.32)	R ₅	16.84 ^{bcd} (8.39)	15.82 ^a (7.43)	16.34 ^{bcd} (7.91)	R ₅	47.14 ^a	47.53 ^a	47.33 ^a
GM 4	4.61 ^a (21.25)	4.17 ^a (17.38)	4.39 ^a (19.27)	S	20.55 ^a (12.32)	19.57 ^a (11.22)	20.06 ^a (11.76)	S	16.73 ⁱ	17.01 ^h	16.87 ⁱ
GM 6	4.39 ^a (19.27)	4.11 ^{ab} (16.89)	4.25 ^a (18.06)	R ₃	15.10 ^{cd} (6.79)	16.63 ^a (8.19)	15.87 ^{bcd} (7.48)	R ₃	18.62 ^{ghj}	18.90 ^{fgh}	18.76 ^h
Namada Moti	3.75 ^{ab} (14.06)	2.79 ^d (7.78)	3.27 ^b (10.69)	R ₁	14.03 ^d (5.88)	14.31 ^a (6.11)	14.17 ^d (5.99)	R ₁	35.49 ^b	35.77 ^b	35.63 ^b
Farm Sameri	4.36 ^a (19.00)	4.15 ^a (17.22)	4.26 ^a (18.15)	R ₄	15.78 ^{bcd} (7.39)	16.04 ^a (7.63)	15.91 ^{bcd} (7.51)	R ₄	20.95 ^{efgh}	21.25 ^{efgh}	21.10 ^{gh}
Ganga Safed 2	2.68 ^c (7.18)	2.67 ^d (7.13)	2.68 ^c (7.18)	R ₂	14.87 ^{cd} (6.58)	14.09 ^a (5.93)	14.48 ^{cd} (6.25)	R ₂	29.08 ^c	29.72 ^c	29.40 ^c
ZM 421	4.48 ^a (20.07)	4.18 ^a (17.47)	4.33 ^a (18.75)	R ₉	16.55 ^{bcd} (8.11)	16.44 ^a (8.00)	16.50 ^{bc} (8.07)	R ₉	18.11 ^{hij}	18.41 ^{gh}	18.26 ⁱ
Kiran	4.49 ^a (20.16)	4.18 ^a (17.47)	4.33 ^a (18.75)	R ₇	15.83 ^{bcd} (7.44)	16.97 ^a (8.52)	16.41 ^{bcd} (7.98)	R ₇	23.40 ^{def}	23.70 ^{def}	23.55 ^{defg}
Surya	4.69 ^a (21.99)	4.07 ^{ab} (16.56)	4.38 ^a (19.18)	R ₁₁	16.98 ^{bcd} (8.53)	16.75 ^a (8.30)	16.87 ^b (8.42)	R ₁₁	24.94 ^{de}	25.24 ^{cde}	25.09 ^{de}
Mega	4.49 ^a (20.16)	4.17 ^a (17.39)	4.33 ^a (18.75)	R ₁₂	17.09 ^{bc} (8.64)	16.79 ^a (8.34)	16.95 ^b (8.42)	R ₁₂	25.06 ^{cd}	25.37 ^{cde}	25.21 ^d
VL 42	4.41 ^a (19.45)	4.13 ^{ab} (17.06)	4.27 ^a (18.23)	R ₁₄	17.36 ^{bc} (8.90)	16.72 ^a (8.28)	17.04 ^b (8.59)	R ₁₄	25.62 ^{cd}	26.35 ^{cd}	25.98 ^d
Madhuri	4.35 ^a (19.92)	4.10 ^{ab} (16.81)	4.23 ^a (17.89)	R ₆	15.85 ^{bcd} (7.46)	16.88 ^a (8.43)	16.37 ^{bcd} (7.94)	R ₆	21.75 ^{defgh}	22.42 ^{defg}	22.08 ^{fg}
Manokamna	4.38 ^a (19.18)	4.02 ^{ab} (16.16)	4.20 ^a (17.64)	R ₈	15.29 ^{bcd} (6.95)	17.54 ^a (9.08)	16.42 ^{bcd} (7.99)	R ₈	20.72 ^{fghi}	21.28 ^{efgh}	21.00 ^{gh}
Sweta	4.63 ^a (21.44)	4.07 ^{ab} (16.56)	4.35 ^a (18.92)	S	18.28 ^{ab} (9.84)	16.35 ^a (7.92)	17.32 ^b (8.86)	S	20.86 ^{fghi}	21.18 ^{efgh}	21.02 ^{gh}
Chhindwara 9	4.53 ^a (20.52)	4.08 ^{ab} (16.65)	4.30 ^a (18.49)	R ₁₃	17.21 ^{bc} (8.75)	16.74 ^a (8.29)	16.98 ^b (8.53)	R ₁₃	17.70 ⁱ	18.22 ^{gh}	17.96 ⁱ
D 844	4.42 ^a (19.54)	3.97 ^b (15.76)	4.19 ^a (17.56)	S	17.21 ^{bc} (8.75)	18.12 ^a (9.67)	17.67 ^{ab} (9.21)	S	22.31 ^{defg}	22.29 ^{defg}	22.30 ^{abj}
D 822	4.49 ^a (20.16)	4.11 ^{ab} (16.89)	4.30 ^a (18.49)	S	17.58 ^{abc} (9.12)	16.86 ^a (8.41)	17.23 ^b (8.77)	S	21.63 ^{defghi}	21.88 ^{defg}	21.75 ^{fg}
Hy 93 R 1073	4.43 ^a (19.62)	4.18 ^a (17.47)	4.30 ^a (18.49)	S	17.59 ^{abc} (9.13)	16.79 ^a (8.34)	17.19 ^b (8.73)	S	24.13 ^{def}	24.34 ^{de}	24.23 ^{def}
S.E.m. $\pm$	0.30	0.05	0.15		0.89	1.08	0.69		1.19	1.42	0.82
C.V. %	34.64	6.90	26.01		9.24	11.21	10.21		8.64	10.09	9.40

* Figures in parentheses are original values, those outside are $\sqrt{x}$ transformed values.

** Figures in parentheses are original values, those outside are arc sin transformed values.

Treatment means with letter(s) in common are not significant by DNMRT at 5 % level of significance.

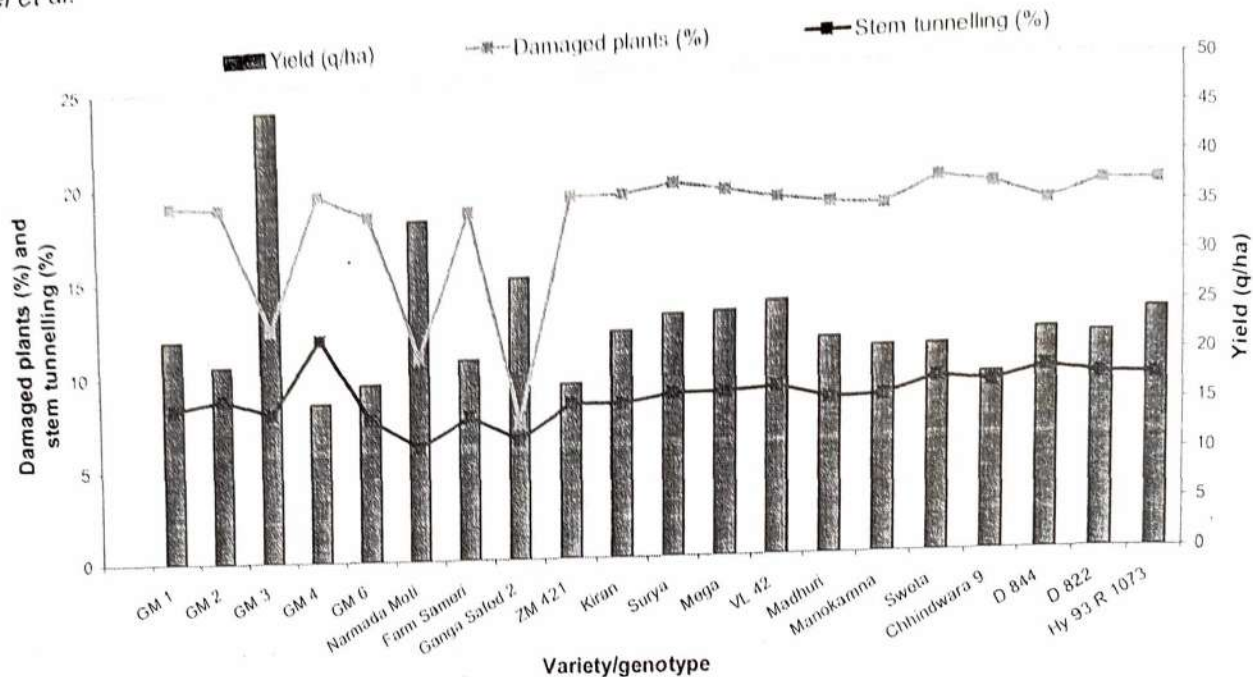


Fig. 1 : Incidence of *C. partellus* in maize varieties/genotypes and its effect on yield

The cut off value calculated on the basis of damaged plants revealed that the varieties Ganga Safed-2, Narmada Moti and GM-3 were found resistant which recorded minimum damaged plants, where as remaining all the varieties/genotypes were found susceptible.

Stem tunneling (%)

Results (Table 1 and Fig. 1) revealed that the cultivar Narmada Moti registered minimum (5.99 %) stem tunnelling and it was at par with Ganga Safed-2, GM-6, Farm Sameri, GM-3, Madhuri, Kiran and Manokamna with 6.25 to 7.99 % stem tunneling. Maximum (11.76 %) stem tunneling was observed in GM-4. The D 844 was the next most preferred genotype by *C. partellus* with 9.21 % stem tunneling and it was at par with remaining all the varieties/genotypes with 7.48 to 8.86 per cent stem tunneling, except Narmada Moti and Ganga Safed-2.

The cut off value calculated on the basis of stem tunneling revealed that the varieties/genotypes Narmada Moti, Ganga Safed-2, GM-6, Farm Sameri, GM-3, Madhuri, Kiran, Manokamna, ZM-421, GM-1, Surya, Mega, Chhindwara-9 and VL-42 were found resistant, whereas other varieties/genotypes were categorized in susceptible group.

Highest (47.33 q/ha) grain yield produced from cultivar GM-3 (Table 1) followed by Narmada Moti (35.63 q/ha) and Ganga Safed 2 (29.40 q/ha). The VL-42, Mega, Surya, Hy-93, R-1073, GM-1 and Kiran were found statistically at par with each other

and registered 23.55 to 25.98 q / ha yield of maize (Fig. 1). Among the tested varieties/genotypes, significantly lowest (16.87 q/ha) grain yield was harvested from GM-4 and it was at par with Chhindwara-9 (17.96 q/ha), ZM-421 (18.26 q/ha) and GM6 (18.76 q/ha). The remaining varieties/genotypes registered 21.00 to 22.30 q/ha grain yield of maize.

On the basis of damaged plants and stem tunneling due to *C. partellus* it can be concluded that the varieties GM-3, Narmada Moti and Ganga Safed-2 were found resistant with good yield potentiality, whereas the varieties/genotypes GM-4, Chhindwara-9, ZM-421, GM-6, Manokamna, GM-2 and Sweta were found susceptible with low in yield potentiality.

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Performance of CERES model for maize, wheat and pearl millet crops under sandy loam soils of middle Gujarat agro-climatic zone

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Abstract

Field experiments were conducted during *rabi* and Summer seasons of the year 2004-05 at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural university, Anand to evaluate the performance of CERES model for maize (cv. GM-3 and Ganga Safed-2), wheat (cv. GW-496) and pearl millet (cv. MH-179) crops under sandy loam soils of middle Gujarat agro-climatic zone. The CERES Model for the given crops was individually calibrated with the field experimental data. Results revealed that the simulated and observed phenology and grain yield were very close to the observed values within the range of ± 0.1 % for maize crop. In wheat crop, physiological maturity simulated by model showed deviation of less than 3.0 percent, while under estimation was observed in case of LAI, grain and straw yields. For pearl millet, the phenological events simulated by the model were very close to the observed values with slight under estimation of one or two days. The simulated grain yield was also very close to observed yield. Thus, CERES models can be used to predict the phenological events and grain yields of maize, wheat and pearl millet crops with reasonable accuracy.

Keywords : CERES models, maize, wheat, pearl millet

Introduction

Crop growth simulation models play a vital role in bringing out specific relationship between weather conditions and productivity and provide capabilities for transferring agricultural production technology from sites of origin to new location (1). These dynamic models not only help in understanding the climate-crop interaction and the processes that contribute to crop and yield but also assist in evaluating the potential of various soil and crop management options (2). With the advancement in computing technology by fast computers, it becomes easy to study the various crop models. The Crop Estimation through Environment Resource Synthesis (CERES) is generic name for cereal crop models. These models were developed under IBSNAT (International Benchmark Sites Network for Agrotechnology Transfer) system, wherein, more than 16 crops are included. These models simulate the effect of weather, soil, water, nitrogen dynamics and cultivars on crop growth and yield. CERES wheat (3, 4 and 5), CERES-maize (6) and CERES-pearl millet models required uniform minimum data set on soil, weather and crops. These models have widely been

used to simulate the phenology, growth and yield of crops. Maize, wheat and pearl millet crops are potentially grown by the farmers in Gujarat. However, the lower productivity of these crops is the major concern in some parts of the state. The cultivation of summer pearl millet and *rabi* maize and wheat increased due to increase in irrigation facilities through Narmada Canal. Decision Support System for Agrotechnology Transfer (DSSAT) is a valuable tool for making viable decision on technological options and their transfer to any point in space and time. Hence, an attempt have been made to evaluate the performance of CERES model for maize, wheat and pearl millet crops under sandy loam soils of Middle Gujarat Agro-climatic zone

Materials and methods

Field experiments were conducted during *rabi* and summer seasons of the year 2004-05 at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand to generate the minimum data set required by the models for deriving the genetic coefficients for different cultivars of the crop. The crops selected for the study viz.,

maize (cv. GM-3 and Ganga Safed-2) and wheat (cv. GW-496) were grown during *rabi* season, while pearl millet (cv. MH-179) was grown during summer season in an area of 10 x 10 m² by adopting all the recommended package of practices for the respective crops. The soil of the experimental field was sandy loam in texture having low in available nitrogen, medium in available phosphorous and high in available potassium. For the evaluation of CERES model for different crops, the occurrence of phenological dates mainly flowering and maturity, periodical growth parameters viz., LAI and dry biomass, yield and yield attributes at harvest were noted. Daily weather data on maximum and minimum temperature (°C), solar radiation (MJ m⁻²/day) and rainfall (mm) and experimental soil data of Anand station were used as input.

Using minimum data sets the genetic coefficients for all the three crops were generated through iterative procedure. Calibrated models were used to simulate the phenological dates, biometric parameters, yield and yield attributes. The simulated values were compared with the corresponding observed values obtained from the field experiment for evaluation purpose.

The details of these coefficients and values of derived genetic coefficients are given as under

Results and discussion

CERES-Maize

The simulated and observed number of days to flowering and physiological maturity, LAI, grain and straw yields of maize cultivars GM-3 and Ganga Safed-2 are presented in Table 4 and 5. Results revealed that the observed number of days taken to reach the flowering stage were 73 and 78 days for GM-3 and Ganga Safed-2, respectively. Whereas, those simulated by the model were 75 and 79 days for the two cultivars, respectively. Thus, the deviation from the observed days was -1 to -2 days only. To attain the physiological maturity, GM-3 took 119 days while Ganga Safed-2 took 128 days. The physiological maturity simulated by the model was very closed to the observed values. Thus, the model well predicted the flowering and physiological maturity for both the cultivars.

The maximum LAI simulated by the model for two cultivars were 5.22 and 5.23, respectively while the observed maximum LAI were 3.4 and 3.9 only for GM-3 and Ganga Safed-2, respectively. This showed that model had overestimated the leaf area index in both the cases. The simulated and observed grain yields were 3554 and 3551 kg/ha for GM-3 and 4023 and 3991 kg/ha for Ganga Safed-2, respectively. This

Table 1. Description of parameter and derived genetic coefficients for two cultivar of maize

	Description of parameter Coefficients controlling development aspects	Derived genetic coefficients	
		GM-3	Ganga Safed-2
P1	Thermal time from seedling emergence to the end of the juvenile phase (expressed in degree days above a base temperature of 8°C) during which the plant is not responsive to changes in photoperiod.	331.0	351.0
P2	Extent to which development (expressed as days) is delayed for each hour increase in photoperiod above the longest photoperiod at which development proceeds at a maximum rate (which is considered to be 12.5 hours).	0.3	0.5
P5	Thermal time from silking to physiological maturity (expressed in degree days above a base temperature of 8°C).	530.0	630.0
G2	Maximum possible number of kernels per plant.	635.0	755.0
G3	Kernel filling rate during the linear grain filling stage and under optimum conditions (mg/day).	9.3	8.0
PHINT	Phylochron interval; the interval in thermal time (degree days) between successive leaf tip appearances.	38.9	38.9

Table 2. Description of parameter and derived genetic coefficients for wheat

	Description of parameter Coefficients controlling development aspects	Derived genetic coefficients
PHINT	Phyllochron interval: it describes the thermal time required between emergence of two successive leaves and its value of 95 is used for spring wheat	73.9
P1V	Vernalization coefficient: it describes the relative amount of slowing down the development for each day of unfulfilled vernalization assuming that 50 days of vernalization are sufficient for all cultivars. Its range varies from 0-9.	0.5
P1D	Photoperiodism coefficient: The coefficient governs the relative amount that development is slowed when plants are grown in photoperiod 1 hour shorter than the optimum (which is considered to be 16 hours, Chipanshi <i>et al.</i> 1997).	2.0
P5	Grain filling duration coefficient: It related to thermal time in degree days above a base of 1°C where each unit increase above zero adds 20 degree days to the initial value of 430 degree days.	3.2
G1	Kernel number coefficient: The coefficients accounts for the kernel number per unit weight of stem (less leaf blades and sheaths) plus spike at anthesis (g).	5.4
G2	Kernel weight coefficient: It controls the kernel-filling rate under optimum conditions (mgday ⁻¹).	4.2
G3	Spike number coefficient: It computes the non-stressed dry weight (g) of a single stem (excluding leaf blades and sheaths) and spike when elongation ceases.	5.2

Table 3. Description of parameter and derived genetic coefficients for pearl millet

	Description of parameter Coefficients controlling development aspects	Derived Genetic coefficient
P1	Thermal time from seedling emergence to the end of the juvenile phase (expressed in degree days above a base temperature of 10°C during which the plant is not responsive to changes in photoperiod.	168.00
P20	Critical photoperiod or the longest day length (in hours) at which development occurs at a maximum rate. At values greater than P20, the rate of development is reduced.	12.05
P2R	Extent to which phasic development leading to panicle initiation expressed in degree days) is delayed for each hour increase in photoperiod above P20.	122.00
P5	Thermal time (degree days above a base temperature of 10°C) from beginning of grain filling (3-4 days after flowering) to physiological maturity.	630.00
G1	Scaler for relative leaf size.	2.00
G4	Scaler for partitioning of assimilates to the panicle (head).	0.85
PHINT	Phyllochron interval; the interval in thermal time (degree days) between successive leaf tip appearances.	48.00

Table 4. Model performance and its deviation in terms of various variables for maize cv. GM-3

Variable	Simulated	Observed	Deviation
Flowering date (Day)	75	73	-2.0 (-2.74)
Physiological maturity (Day)	120	119	-1.0 (-0.84)
Maximum LAI	5.22	3.4	-1.8 (-53.53)
Grain yield (kg/ha)	3554	3551	-3.0 (-0.08)
Straw (kg/ha)	12861	7624	-5237.0 (-68.69)

* Values in the parenthesis shows per cent deviation

Table 6. Model performance and its deviation in terms of various variables for wheat cv. GW-496

Variable	Simulated	Observed	Deviation
Flowering date (Day)	70	62	- 8 (-12.90)
Physiological maturity (Day)	114	111	- 3 (-2.70)
Grain yield (kg/ha)	4200	4715	515 (10.92)
Maximum LAI	1.24	2.8	1.56 (55.71)
Straw (kg/ha)	2718	6487	3769 (58.10)

* Values in the parenthesis shows per cent deviation

showed that the model simulated grain yield accurately with deviation of less than 1 per cent for both the cultivars. The simulated and observed straw yields were 12861 and 7624 kg/ha for GM-3 and 13274 and 8941 kg/ha for Ganga Safed-2, respectively. This showed overestimation of straw yield of both cultivars of maize by the model, this may be due to overestimation of LAI. The phenological observation on LAI and dry biomass also indicated over estimation by the model for both the cultivars (Fig. 1 and 2).

CERES-Wheat

The results on simulated and observed number of days for flowering and physiological maturity, LAI, grain and straw yields of wheat cultivars GW-496 are presented in Table 6. Results revealed that the wheat crop (cv. GW-496) took 62 days to reach the flowering stage while the model simulated 70 days. Similarly, the crop took 111 days to attain its physiological maturity while

Table 5. Model performance and its deviation in terms of various variables for maize cv. Ganga Safed-2

Variable	Simulated	Observed	Deviation
Flowering date (Day)	79	78	-1 (-1.28)
Physiological maturity (Day)	128	128	0 (0.0)
Maximum LAI	5.23	3.9	-1 (-34.10)
Grain yield (kg/ha)	4023	3991	-32 (-0.80)
Straw (kg/ha)	13274	8941	-4333 (-48.46)

* Values in the parenthesis shows per cent deviation

Table 7. Model performance and its deviation in terms of various variables for pearl millet cv. MH-179

Variable	Simulated	Observed	Deviation
Flowering date (Day)	54	55	1 (1.81)
Physiological maturity (Day)	96	98	2 (2.04)
Grain yield (kg/ha)	5324	5335	11 (0.21)
Maximum LAI	5.8	5.82	0.02 (0.34)
Straw yield (kg/ha)	10232	11335	1103 (9.73)
Harvest index (%)	34.2	32.0	-2.0 (-6.88)

* Values in the parenthesis shows per cent deviation

the model simulated 114 days for physiological maturity. Thus, the model had overestimated the flowering and physiological maturity days by 8 and 3 days, respectively. The periodical LAI observed and simulated by the model (Fig. 3) revealed that the model underestimated the LAI. The maximum LAI observed and simulated were 2.8 and 1.24, respectively. Thus, the simulated and observed grain yields were 4200 and 4715 kg/ha, respectively with difference of 515 kg/ha. Thus, the model underestimated grain yield by less than 11 per cent. The simulated and observed straw yields were 2718 and 6487 kg/ha, respectively with the difference of 3769 kg/ha. This showed that the model highly underestimated straw yield of wheat. The periodically observed and simulated dry biomass of wheat (Fig. 4) showed that upto 55 DAS the observed dry biomass were slightly lower than the simulated, than after sharp increase in dry biomass was observed while model simulated slower rate of increase in dry biomass.

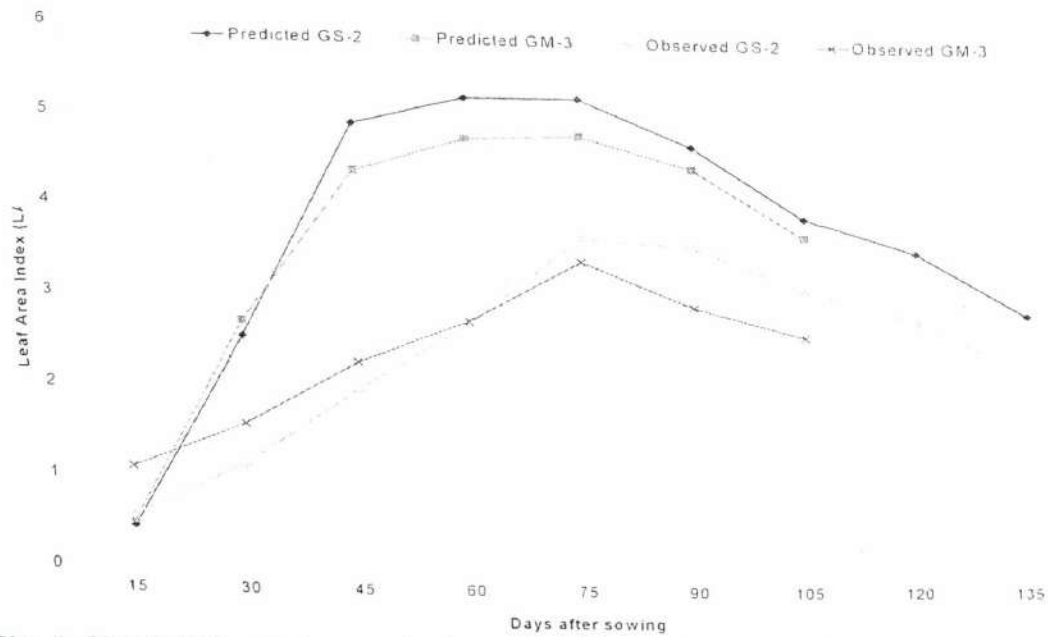


Fig. 1. Simulated and observed values of LAI for maize cultivar GM-3 and Ganga Safed-2

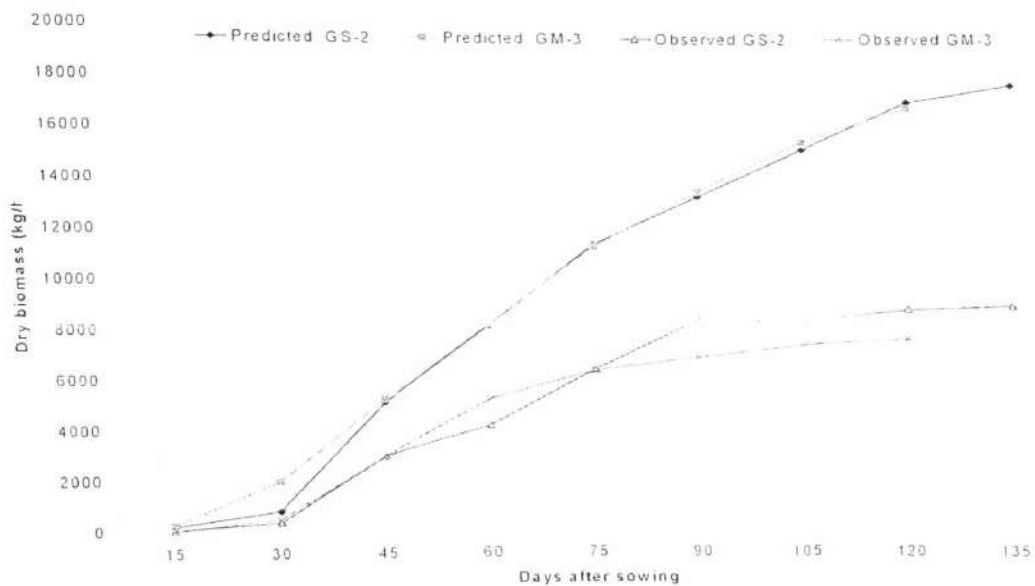


Fig. 2. Simulated and observed values of crop dry biomass for maize cultivar GM-3 and Ganga Safed-2

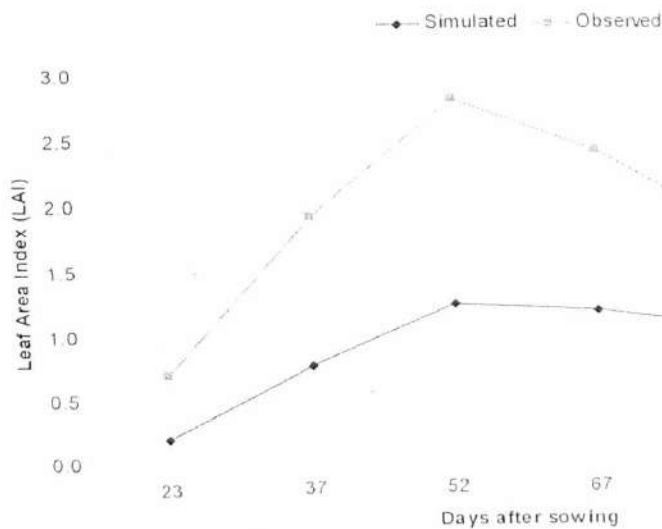


Fig. 3. Simulated and observed values for LAI of wheat cv. GW-496

CERES-Millet

The simulated and observed number of days for flowering and physiological maturity, LAI, grain and straw yields and harvest index of pearlmillet are given in Table 7. Results showed that the Pearlmillet (cv. MH-179) took 55 and 98 days to reach its flowering and physiological maturity, respectively, whereas, the model simulated 54 and 96 days with differences of only 1 and 2 days, respectively. Similarly, the simulated and observed maximum LAI were 5.8 and 5.82, respectively. The simulated and observed grain yields were 5324 and 5335 kg/ha, respectively, while simulated and observed straw yields were 10232 and 11335 kg/ha, respectively. Thus, the simulated grain and straw yields were deviated from observed values by less than 10 per cent. The simulated and observed values for harvest index were 34.2 and 32.0 percent, respectively with a mean

difference of -6.88 per cent. The periodical LAI & observed and simulated were also in good agreement with each other (Fig. 5 & 6). Thus, the CERES-Millet model simulated the phenology, yield and yield attributing characters of peralmillet (cv. MH-179) very well.

The study revealed that CERES-maize model simulated the phenological events and grain yield of two cultivars of maize (GM-3 and Ganga Safed-2) with reasonably good accuracy. However, LAI and straw yields were highly overestimated by the model. CERES-wheat model also performed well in simulating phenology and grain yield, while the straw yield and LAI wee under estimated by the model. CERES-millet model simulated very well the phenological events, yield and yield attributing characters of pearlmillet cultivar MH-179. Thus, these models can be used to predict the phenological events

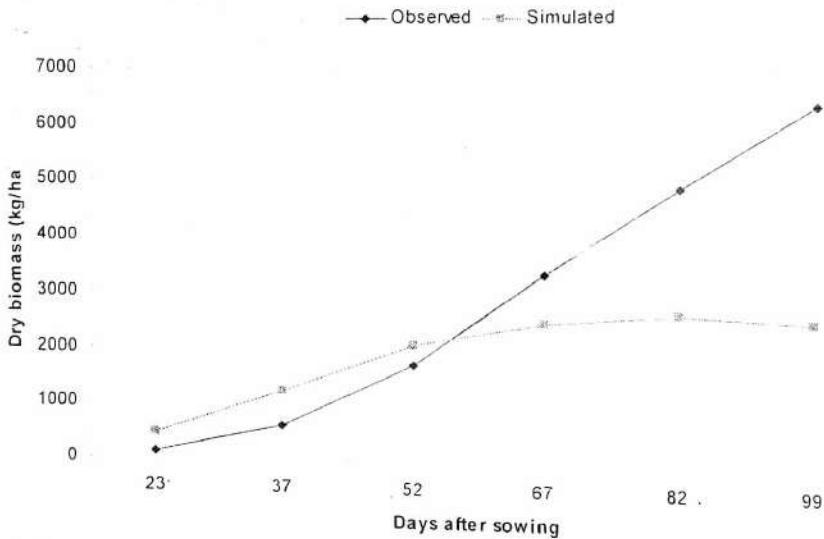


Fig. 4. Simulated and observed values for crop biomass for wheat cultivar GW-496

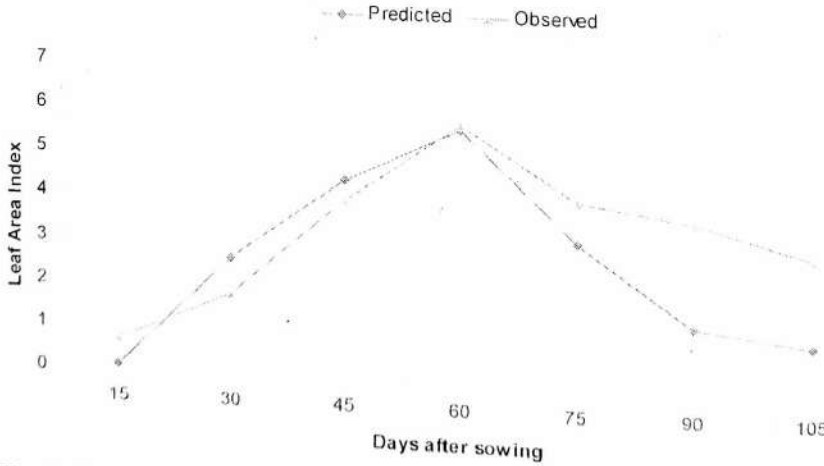


Fig. 5. Simulated and observed values of LAI for pearlmillet cultivar MH-179

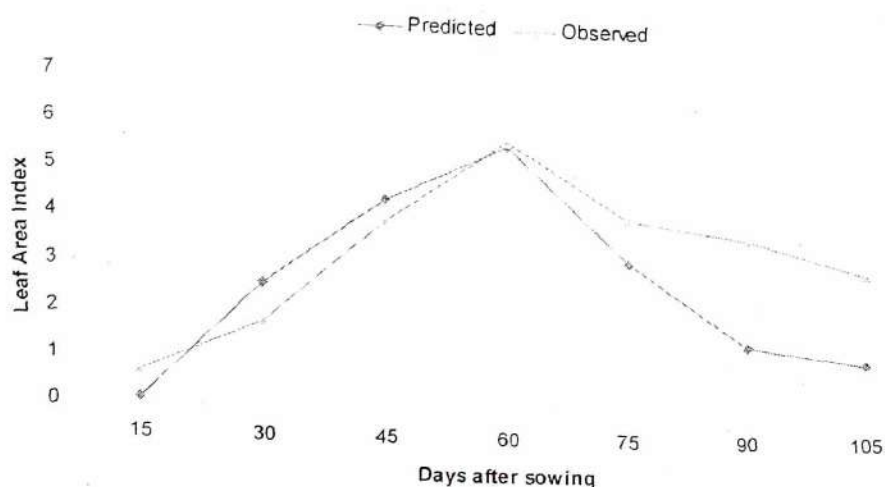


Fig. 5. Simulated and observed values of LAI for pearl millet cultivar MH-179

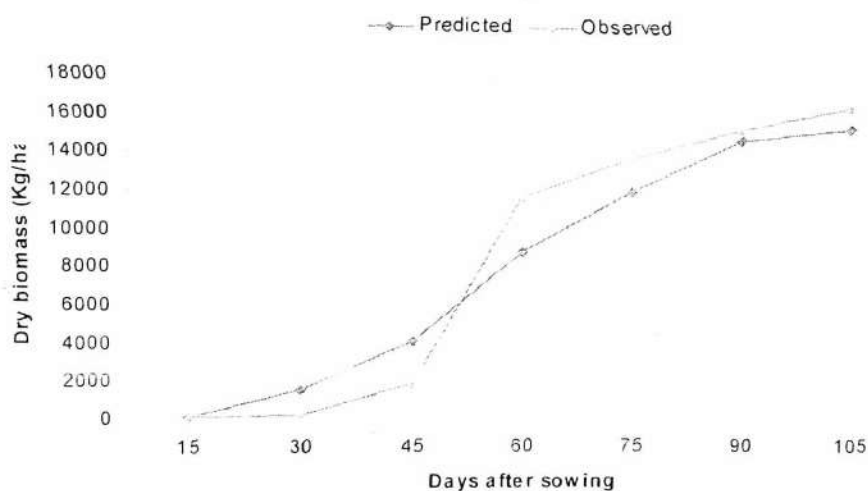


Fig. 6. Simulated and observed values for crop biomass pearl millet cultivar MH-179

and grain yields of maize, wheat and pearl millet crops accurately.

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Students' attitude towards veterinary education in Gujarat

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Abstract

Majority (96.48 %) of the students studying in the Veterinary Colleges in Gujarat had favorable attitude towards veterinary education. The mean attitude score was 72.11. The students' academic achievement, family income, family educational status and fathers' social participation was a positively and significantly correlated with his attitude towards veterinary education. However participation in extracurricular activities and number of real brothers and sisters had significant but negative correlation with the students' attitude towards veterinary education.

Keywords : Attitude, veterinary education, attitude scale

Introduction

Education in any form is an important agent of development both in urban and rural areas and is the main instrument effecting change. While imparting education care should be taken that education must meet the requirement of society and the individual involved. Students possess different attitude towards different psychological objects like school, science, scientist, institute, educational system etc. depending upon the extent up to which it is helpful in solving their problems or career development or in achieving the goal which they aspire for in terms of job/service or proper placement. The recent technological discoveries in dairy industry and animal husbandry have considerably enlarged the scope of veterinary graduates and consequently resulted in new job opportunities for degree holders in veterinary science. Looking to this fact, the number of veterinary colleges in the country is increasing steadily. When the institute is for social reform and for betterment of students, the attitude of students involved is of prime importance. By and large the success of it depends upon the favourable attitude of the students by which one can judge to what extent this will contribute towards the well being of the student and also to the society. Keeping this in view an attempt has been made to measure the attitude of veterinary college students towards veterinary education.

Methodology

An attitude is often defined as a tendency to react favourably or unfavourably towards a designated class of stimuli, such as national or social group, a custom or an institution. For the purpose of this study, the definition of the attitude of the veterinary college students' towards veterinary education was taken as an affect or feeling, favourable or unfavourable towards veterinary education which is imparted through veterinary college.

In the present study an attempt has been made to standardize a scale, which can scientifically measure the attitude of the veterinary college students' towards veterinary education. While constructing a scale the investigator applied the methodology suggested by Likert (1) and Edward (2). The method of summated rating was used in this study for scale construction.

Construction of attitudinal statements

The items of the attitude scale are called statements. It requires a large number of monotonous items, that is, item having the characteristic that the more favourable individuals' attitude towards the psychological objects, the higher expected score of the item. Preliminary for preparing the attitude scale items, the researcher resorted to the perusal of published literature dealing

with students' perception towards veterinary education as well as sought the opinion and guidance of the peers and various experts in the field. Thus an internal pool of sixty statements was prepared. Out of sixty statements collected initially, the most relevant thirty statements were selected for scale construction after complete discussion with experts in the field. This included quite a good number of both positive and negative statements.

Item analysis

Eighty slips of these statements in form of questionnaire were handed over to professionals belonging to SAUs, state animal husbandry department, co-operative dairies of the state and SAUs of the other states. In addition, 50 students were randomly selected and were interviewed for item analysis. Out of these experts only 68 judges returned the statements after duly recording their judgments. But 3 judges responded partly and hence the same slips were eliminated. Similarly 46 students returned the statements after duly recording their judgments but 2 students did not respond properly and hence these slips were not considered for final calculation. Thus finally the responses of 65 experts and 44 students were considered for calculation of the scale value.

These judges were asked to respond to each statement in terms of their own agreement or disagreement on a five point rating method, namely strongly agree, agree, undecided, disagree and strongly disagree. For favourable statement, the strongly agree response was given a weight of 4, the agree response a weight of 3, the undecided response a weight of 2, the disagree response a weight of 1 and strongly disagree response a weight of 0. For unfavorable statements the scoring system was reversed. For each judge and student response, a total score was obtained by summing these score for the individual items; frequency distribution of the score of respondents was then prepared. For the purpose of item analysis, 25 subjects with the highest total score and also 25 subjects with the lowest total score (i.e. nearly 25 per cent of each) were selected. These two groups provided the criterion group in terms of which item analysis was conducted. The response of the high and low group to each statement was then analyzed by working out T value.

Validity

While selecting attitude statements, due care was exercised in obtaining a fair degree of content validity.

The validity of the scale was worked out by using calculated 't' value for all the selected statements. The calculated 't' value being significant for all the twenty statements of the scale indicated that the attitude statements of the scale had discriminate values.

Reliability of the scale

The reliability of the scale was worked out by using the test-retest method. The scale was administered to 35 experts twice with 15 days interval. Thus two sets of attitude scores were obtained. The correlation co-efficient, r-value of 0.86, indicated that attitude scale was fairly stable for measurement.

Scoring technique (attitude scale)

There were 25 statements in the final format, which were administered to the respondents. To measure the attitude of individual respondent towards veterinary education, five-point scale was used. The score assigned for the positive statements were, 4 for strongly agree, 3 for agree, 2 for undecided, 1 for disagree and zero for strongly disagree. The score for the negative statement was just the reverse. For ascertaining the nature of attitude the maximum and minimum score of respondents were taken into consideration, which were 100 and zero, respectively. The point between possible maximum and minimum score was 50 i.e. neutral score. Hence, the respondents obtaining more than 50 score, were classified to be possessing favorable attitude and below 50 score, as unfavorable attitude towards veterinary education.

The attitude of the students toward veterinary education is presented in Table-1. Majority (96.48 percent) of the respondents held favourable attitude. 3.17 percent had an unfavourable attitude and a meagre section (0.35 percent) did not express any clear-cut opinion, about veterinary education. The mean attitude score was 72.11. Majority of the respondents were from the families having good literary rate, good economic condition, good occupational status and class status, which would have created a favourable condition for higher education. The students from urban areas would have been influenced by their parents who would have enquired about various courses and been convinced about the high value of veterinary education. Students from rural areas would have known the importance of veterinary education from the local veterinary doctors. Subsequently, on being admitted to veterinary education, they might have learnt the importance of veterinary graduates leading to

develop a favourable attitude towards veterinary education.

Results and discussion

The finding were similar to those of Vernal (3) and Shrivastava and Shrivastava(4). The relationship between the personal, social and economic characteristics of the veterinary college students with their attitude towards veterinary education was determined by computing a correlation coefficient, which is presented in Table-2.

Table 1. Attitude of respondents towards veterinary education.(n=284)

Sr. No.	Attitude	Number	Percentage
1	Favorable (More than 50 score)	274	96.48
2	Unfavorable (below 50 score)	9	3.17
3	Neutral (50 score)	1	0.35
4	MeanScore=72.11		

Table 2. Relationship between characteristics of the respondents and their attitude towards veterinary education.

Sr. No.	Characteristic	Correlation Coefficient
1	Age	-0.0424
2	Birth Order	0.0192
3	Caste	0.0016
4	Academic achievement	0.1464*
5	Participation in extracurricular activities	-0.1878**
6	Number of real brothers and	-0.1197*
7	Fathers education	-0.1082
8	Fathers occupation	0.0562
9	Family educational status	0.1389*
10	Family occupational status	0.0472
11	Family income	0.1212*
12	Family land holding	0.0752
13	Fathers social participation	0.1388*
14	Class status	0.0384

* Significant at 5 per cent level of probability

** Significant at 1 per cent level of probability

It was found that more than half of the students had obtained second class and above, indicating that they had a good academic achievement. The academic

achievement was found to have a positive and significant relation with the attitude toward veterinary education. This may be due to the fact that only those who are positively inclined towards veterinary education could put in more efforts and take an interest in their course work, thus leading them to have a good academic performance. Moreover as their efforts could bear fruit in the form of good results, their interest and attitude towards the course could also become more enthusiastic: the findings were in line with those of Vernal (3).

The family educational status had a significant and positive effect on the attitude of the students towards veterinary education. The importance and value of livestock wealth is well recognized both in the rural and urban areas. An educated person understands the true value and importance of livestock for Indian economy and the contribution of veterinarians towards the livestock industry. This helps him to fully comprehend the scope it would provide for veterinary graduates. Thus, developing a favorable attitude toward veterinary education.

The average family income, of families under study, was good. This indicated that majority of the families belonged to the well-to-do section of the society. Hence, the parents could provide complete facilities and afford higher education for their children leading to aspire for their children to be well educated. This could probably be the reason for family income to show a positive and significant effect on the attitude toward veterinary education. The findings were similar to those of Hazari *et al.* (5).

As the parents' participation in the social organization increased they would come more into contact with extension personnel and experts in various fields. They would also be more exposed to mass media like film shows, television, magazines and newspapers. Scrutiny of the questionnaire revealed that the social participation of the student's father was mainly in milk producer's co-operative society either at village or district level. This increased their contacts with personnel in the veterinary field, helping them to receive correct information about veterinary education. Thus armed with this knowledge they would have influenced their children to follow into veterinary education, with favorable attitude.

Participation in extracurricular activities exhibited a negatively significant impact on the attitude of the student towards veterinary education. The intensive

course work during the semester system leaves little time for the students to take part in extracurricular activities. Those participating in extracurricular activities are left with very less time to study for the internal and external examinations. The dates of these competitions often clash with the examination dates. This leads to an increase in the workload of the students and their attitude towards study becomes discouraging. All the above reasons cumulatively develop a negative feeling among the students participating in extracurricular activities, toward veterinary education.

The coefficient correlation between number of real brothers and sisters and attitude toward veterinary education was negative and significant. This indicates that as members in the family increase, the attitude toward veterinary education becomes negative. Family environment and condition contributes significantly in developing a child's attitude towards any object. With an increase in the members of the family, proper attention and care is not paid to the individual children. Since the environment is affected, the children may develop a negative attitude towards veterinary education. The coefficient correlation was found to be negative but non-significant for the age of the student and father's income. For the other characteristics under study viz., birth order, caste, father's occupation, family occupational status and land holding, and class status, the correlation was positive and non significant.

Conclusion

Majority of the respondents showed favourable

attitude towards veterinary education. Relationship between socio-personal and other characteristics of the respondents and their attitude towards veterinary education indicated that out of the 14 variables tried, four variables viz., academic achievement, family educational status, family income and father's social participation was positively and significantly related. Participation in extracurricular activities and the number of real brothers and sisters were negatively and significantly related to attitude towards veterinary education. The remaining variables did not show any significant relationship.

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Inter-cropping systems under rainfed conditions of Sabarkantha district- a journey through traditional wisdom

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Abstract

The farmers of the rainfed area of Sabarkantha district based on their traditional system of subsistence farming developed alternative innovative farming method i.e. keeping different crop combinations in inter-cropping system, with different row ratio. This technique had an advantage of proper use of land, labour and capital and It also reduces the risk of total crop failure. In order to know the various crop combinations developed by the farmers of Sabarkantha district, a total of 100 farmers were selected from five talukas randomly. Using simple interview schedule, the data were collected. It was revealed that in selecting crop combination, farmers gives priority to cereal crops, fiber crops and pulse crops. It was further observed that as the size of land holding increased the adoption of two crop combination was also found to increase. Among various crop combinations, the combinations of Castor + Maize, Castor + Groundnut and Pigeonpea + Groundnut were commonly followed by maximum number of farmers.

Keywords : Intercropping, livelihood, wisdom

Introduction

Community participation and their initiatives In the framework of bottom up recesses of demand driven developments are being looked upon for sustainable resource management. Management of natural resources by communities is the current paradigm of research and development strategies and therefore, livelihood gatherings by increasing production of bio-mass, productive employment generation and conservation of resources are the most important concerns of watershed development. Considering this fact, it is accepted that farmers' knowledge and wisdom are dynamic to cope up with new paradigms. They have well tested and proven technologies for their specific local situations. Farmers therefore, have their significant role In the decision-making processes for resource management and development of watersheds. It is also a matter of great realization that the process of depletion of natural resources is best understood by local people.

They are the ultimate users of resources and exploit It judiciously with the help of their Indigenous technical knowledge In rural micro-situation. Particularly in rainfed conditions crop production becomes relatively difficult as it mainly depends upon intensity and

frequency of rainfall. The crop production, therefore, in such areas is called as rainfed farming as there is no facility to give any irrigation and even protective or life saving irrigation is not possible. Therefore. Dry land agriculture becomes more serious and complex problem due to frequent drought and scarcity conditions. The current problem is to prevent erosion of top fertile soil and make full utilization of surplus water to boost up the crop yields. Thus, an efficient soil and water conservation will play a vital role in boosting the crop yields. Considering these climatic hazards the cropping patterns of most of the rainfed areas of the country are based on the traditional systems of subsistence farming where farmer tries to grow every thing he needs, though big farmers do produce for the market.

In view of vagaries of rainfall, it is difficult to make rainfed farming profitable and economical Under such conditions farmers of Sabarkantha district in order to avoid risk are practicing alternate innovative farming methods i.e. Keeping different crop combinations in inter cropping systems with different row ratios. This technology proves helpful to the farmers in risk minimizing from climatic adversities particularly drought. The inter crop (s) between two rows of main crop may be treated as catch crop when early

retrenchment of rainfall condition arises. Further, they follow different cropping systems with a view to have proper use of land, labour and capital around the year. They also grow number of crops together as a mixed crop in rows as intercrops.

These age old practices are common in this district for assured crop returns and sustainability against climatic hazards viz., drought, frost, flood etc. All the crops do not fail under adverse climatic conditions, eg. drought kills only monocot plants or shallow rooted crops, frost kills only legumes and flood kills only di-cot plants, thus, farmers get something instead of losing the entire crop in mono cropping system. In addition of these advantages farmers are growing different crops at a time as an intercrop or mixed crop with following objectives.

- (i) These systems improve/maintain the soil fertility.
- (ii) Mixed crop check soil erosion, winds etc.
- (iii) Inter crops use water from various stratum of the soil.
- (iv) Inter crops conserve soil moisture and harvest rain water.
- (v) Attack of insects pests or diseases can not adversely affect all crops.
- (vi) Family members and labour can be employed through out the year.
- (vii) Animals can also be engaged through out the year.
- (viii) The main products of different crops balance their daily dietary need for cereals, pulses and oilseeds.
- (ix) The by-products of the various crops can be utilized for nutritive animal feed and fodder.

Looking to the above facts, this study was carried out in Sabarkantha district. This study tried to understand the groups of crop combination in intercropping systems adopted by the farmers as traditional wisdom. The specific objectives of the study were :

1. To analyse the group of crop combinations in intercropping systems adopted by farmers.
2. To study the number of crop combinations adopted by different categories of farmers.
3. To know the various combinations as adopted by different categories of farmers.

Methodology

The present study was conducted in Sabarkantha district of North-Gujarat Agro-climatic zone, which is an intensive intercropping system adopted area and has 62 per cent of total cultivated area under rainfed conditions.

The Scientists of Gujarat Agricultural University have recommended following package of practices to the farming community during 1991 to 2000 (1).

Sr. No.	Name of Inter cropping crops	Ratio of inter cropping	Center and year of recommendation
1.	Pearlmillet + Green gram or Pigeonpea	2:1	Research Scientist (Pearl millet) Jamnagar (1993)
2.	Maize + Pigeonpea (B.D.N.-2)	1:1	Research Scientist (Pulses) S.K.Nagar (1993)
3.	Pigeonpea + Black gram	1:1	Research Scientist (Pulses) S.K.Nagar (1993)
4.	Sorghum + Pigeonpea	1:1	Research Scientist (Dryfarming) Rajkot (1994)
5.	Pearlmillet + Cluster bean	2:1	Research Scientist (Dryfarming) S.K.Nagar (1994)
6.	Cotton + Soybean or Black gram or Green gram	2:1	Research Scientist (Cotton) Surat (1994)
7.	Cotton + Groundnut	1:2	Research Scientist (Cotton) Surat (1995)
8.	Castor + Groundnut or Green gram	1:1	Research Scientist (Castor) S.K.Nagar (1997)
9.	Pigeonpea + maize	2:1	Research Scientist (N.A.R.P.) Derol (1997)

There are 13 talukas in this district from which 5 talukas have been identified viz., Khedbrahma, Ider, Bhiloda, Modasa and Bayad and a total of five villages were covered from these talukas. The size of sample was kept as 100, by selecting 20 farmers from each village. A field survey by personal contact, the basic method for raw data collection was used. A simple interview schedule was designed for collecting the data, covering the objectives of the study. The farmers were asked open-ended questions to enlist the groups of crop combinations/intercropping systems.

Results and discussion

Crop combination in intercropping systems adopted by the farmers

The major groups of crop combination in intercropping systems adopted by the farmers are classified and presented in Table-1.

The perusal of the information presented reveals that out of 15 groups of crop combinations, 7 groups of crop combination were with cereal crop, 3 groups of crop combination with fiber crop, two with pulse crops, one with vegetable crops and one with mixed crops.

The results indicate that the farmers gave priorities to the food, fodder and fiber crops in intercropping combination. The results also indicate that the combination in inter-cropping were normally deep rooted with shallow rooted crops which have an advantage of reducing risk as well as efficient use of rain water from various soil layer (stratum).

It can be seen from Table-2 that the majority of the respondents (35) were marginal farmers and they adopted single intercrop combination, the remaining respondents were small (25), medium (25) and big farmers (15). Among small farmers only 2 (8.00%) respondents had adopted two intercrop combination and amongst medium farmers only 3 respondents two intercrop combination. It is interesting to note that as the size of land holding increase the adoption of two crop combination was also found to increase.

Various crop combinations as adopted by different categories of farmers :

Adoption in this investigation was considered as the use of intercrops in various combinations by the farmers for obtaining expected benefits in terms of efficient use of rain water, land and human unit for obtaining higher yield and minimizing the risk factors.

Data presented in Table -3 reveals that maximum number of farmers have adopted castor + maize (15),

Table 1. Classification of groups of crop combinations in intercropping systems adopted by the farmers

Sr. No.	Name of the group of crop combination	Name of the crops sown for inter-cropping system	Ratio of crops
1)	Cereal crop along with Non-edible oil crop	I) Maize + Castor Maize + Castor	1:1 1:2
2)	Cereal crop with non-edible oil crop and vegetable crops	i) Maize + Castor + Brinjal + castor II) Maize + Castor + Indian bean + Castor III) Maize+ Castor + Okra + Castor	1:1:1 1:1:1:1 1:1:1:1
3)	Cereal crop along with fiber crop	I) Maize+ cotton + Cotton	1:2
4)	Cereal crop with pulse crops	I) Maize+Arhar II) Maize+Arhar + Black gram + Arhar III) Maize +Cotton + Green gram	1:1 1:1:1:1 1:1:1
5)	Cereal with pulses and edible oil crop	I) Maize + Arhar + Sesame + Arhar	1:1:1:1
6)	Cereal crop with spices crops	I) Maize+Fennel	1:1
7)	Cereal crop with vegetable crop	I) Maize+Okra	1:1
8)	Non-edible with edible oil crops	I) Castor+ soybean II) Castor +Sesame III) Castor + Groundnut +Groundnut	1:1 1:1 1:2
9)	Fiber crop with pulse & edible oil crops	I) Cotton+Green gram + Cotton + Groundnut	1:1:1:1
10)	Fiber crop with pulse crop	I) Cotton+ Greengram	1:1
11)	Fiber crop with cereal and edible oil crops	I) Cotton + Maize + Cotton + Sesame	1:1:1:1
12)	Pulse crop with cereal crop		
13)	Pulse crop with edible oil crops	I) Arhar + Groundnut + Arhar + Sesame	1:1:1:1
14)	Inter crops of vegetable crops	I) Brinjal + Cauliflower	1:1
15)	Mixed cropping	I) Mix cropping of Groundnut and Sesame	

Table 2. Number of crop combination adopted by the farmers according to their land holding (n=100)

Sr. No.	Categories of farmers according to land holding	No. of farmers in each category	No. of farmers adopting single inter-crop combination	No. of farmers adopting two intercrop combination
1)	Marginal (< 1 ha)	35	35(100.00 %)	—
2)	Small (1 to 2 ha)	25	23 (92.00 %)	2 (8.00 %)
3)	Medium (2 to 4 ha)	25	22 (88.00 %)	3 (12.00 %)
4)	Big (> 4 ha)	15	10 (66.67 %)	5 (33.33 %)
	Total	100	90	10

Figures in parentheses indicates the percentage of the respective category.

Table 3. Rank order of the various crop combination as adopted by the different categories of farmers (n=100)

Sr. No.	Combination of inter crops	Marginal (35)	Small (25)	Medium (25)	Big (15)	Total	Rank order of combination
1	Castor + maize	4	1	7	3	15	1.0
2	Castor + groundnut	4	5	5	-	14	2.5
3	Castor + green gram	4	3	1	1	9	5.3
4	Castor + sesame	7	2	3	1	13	4.0
5	Castor + cowpea	4	3	-	2	9	5.3
6	Castor + blackgram	1	-	-	1	2	11.5
7	Cotton + green gram	-	1	-	-	1	13.3
8	Cotton + cowpea	3	3	1	2	9	5.3
9	Cotton + maize	2	2	-	-	4	9.0
10	Cotton + marigold	-	1	1	-	2	11.5
11	Maize + groundnut	-	-	1	-	1	13.3
12	Maize + pigeonpea	1	-	3	3	7	7.0
13	Pearlmillet + pigeonpea	-	-	1	-	1	13.3
14	Pigeonpea + sesame	1	1	1	-	3	10.0
15	Pigeonpea + groundnut	2	4	3	5	14	25.0
16	Sesame + greengram	2	1	1	2	6	8.0
	Total	35	27	28	20	110	1.0

castor + groundnut (14) and pigeonpea + groundnut (14). The crop combination of castor + sesame was adopted by 13 farmers. The crop combination each viz., castor + greengram, castor + cowpea and cotton + cowpea adopted by 9 farmers, seven farmers had adopted maize + pigeonpea combination. While very less farmers had adopted cotton + maize, pigeonpea + sesame, castor + blackgram, cotton + marigold, cotton + greengram, maize + groundnut and pearl millet + pigeonpea group of crops combination in inter-cropping system. From this, it can be concluded that while selecting crop combination, farmers emphasized on cash crops with cereal, pulse

and edible oil crops which secure food as well as fodder requirement. The probable reason behind this might be the farmers give priority for food and fodder security. They also had sown cash crops to earn monetary requirement for maintaining social occasions and entertainment and thereby overall development.

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Technological gaps in *kharif* fennel cultivation by fennel growers of Banaskantha district of Gujarat state

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Abstract

This study was conducted in Banaskantha district of Gujarat state with a view to find out the technological gaps and constraints in adoption of recommended *kharif* fennel production technology. For this purpose, 120 fennel growers of ten villages were interviewed. The maximum technological gap was observed in plant protection measures and nursery raising. The overall technological gap was found 36.80 per cent.

Key words : *Kharif* fennel, production technology, inter culturing

Introduction

Fennel is an important spice crop of Palanpur taluka of Banaskantha district of Gujarat state. Palanpur taluka has been considered as productively potential region of fennel crop due to assured irrigation facilities and favourable soil and climatic conditions. However, there is still a wide gap between the production potential and the actual production realized by the fennel growers. This may be due to partial adoption of recommended package of practices by the fennel growers. Technological gap is a major problem in increasing fennel production in Palanpur taluka. So far, no systematic effort has been made to study the technological gap existing in various components of fennel cultivation. The present study was therefore undertaken to find out the technological gaps in adoption of recommended *kharif* fennel production technology.

The present study was conceived with a general objective of assessing the technological gap in adoption of recommended fennel cultivation technology.

The specific objectives of the study were :

1. To ascertain the knowledge level of the fennel growers pertaining to recommended fennel production technology.
2. To know the extent of adoption of recommended fennel production technology by the fennel growers.

3. To determine the technological gaps among the fennel growers against selected recommended fennel production technology.
4. To study the constraints experienced by the farmers in adopting recommended fennel production technology.

Methodology

The present study was undertaken in Palanpur taluka of Banaskantha district of Gujarat state. There are 40 villages in the taluka where fennel crop is grown by majority of farmers. Ten villages were randomly selected for the present study. From each of the selected village, twelve fennel growers were randomly selected, making a total random sample of 120 fennel growers.

Knowledge level of the respondents about fennel production technology was determined by using the teacher made test based on the scale developed by Jha and Singh (1). Extent of adoption of recommended fennel production technology was measured by using adoption quotient the formula developed by Sengupta (2). Technological gap was determined with the help of the formula developed by Dubey *et al.* (3).

A simple ranking technique was applied to measure the constraints in adoption of fennel production technology. The data were collected with the help of structured interview schedule. The statistical tools used to analyse the data were percentage, mean

score, standard deviation and coefficient of correlation.

Knowledge level of the fennel growers regarding recommended fennel production technology

Knowledge is the cognitive behaviour of an individual. Knowledge plays an important role in covert as well as overt behaviour of an individual. Knowledge was measured with the help of teacher made test developed for the purpose. As discussed earlier, the knowledge index for each farmer was calculated and the respondents were grouped into three categories viz., low, medium and high. Data regarding this aspect are presented in Table 1.

It is evident from the Table 1 that majority (91.67 %) of the respondents had medium level of knowledge, whereas, 6.66 per cent and 1.67 per cent of the respondents had low and high level of knowledge about fennel production technology.

Table 1. Distribution of the respondents according to their level of knowledge regarding fennel production technology

Sr. No.	Level of knowledge	Frequency	Percentage
1.	Low (0 to 33.33 index)	008	006.66
2.	Medium (33.34 to 66.66 index)	110	091.67
3.	High (Above 66.67 to 100.00 index)	002	001.67
Total		120	100.00

From this finding, it can be concluded that majority of the respondents had medium level of knowledge. The probable reason might be that most of the respondents were educated so they could easily understand and acquire skills about fennel production technology. This finding is in conformity with findings of Singh (4) and Sai (5).

Extent of adoption of recommended fennel production technology by the fennel growers

The "adoption process" is the mental process through which an individual passes from first hearing about an innovation to its final adoption. An 'adoption' is a decision to continue full use of an innovation. With a view to find out the extent of adoption of *kharif* fennel production technology, the farmers were asked to give information about package of practices adopted by

them. Data regarding this aspect are presented in Table 2.

Table 2. Distribution of the respondents according to extent of adoption of recommended fennel production technology

Sr. No.	Level of knowledge	Frequency	Percentage
1.	Low (0 to 33.33 index)	22	18.33
2.	Medium (33.34 to 66.66 index)	95	79.17
3.	High (Above 66.67 to 100.00 index)	03	02.50
Total		120	100.00

The data presented in Table 2 reveal that majority (79.17 %) of the respondents were in medium level of adoption followed by only 18.33 per cent in low and only 2.50 per cent respondents were observed having high level of adoption. The probable reason might be their medium to low level of knowledge. These findings are in line with the findings of Patel (6).

Technological gaps in adoption of fennel production technology

The technological gap refers to the difference between technology adopted by the farmers and technology recommended by the scientists. It was felt that agricultural technology is not generally adopted by the farmers completely in all respects. As a result, technological gap appears and poor yield is obtained. Keeping this in view, technological gap has been studied.

The average technological gap in adoption of different component of fennel production technology among the fennel growers are summarized in Table 3.

It could be seen from Table 3 that the average technological gap was found varied from component to component. The average technological gap among the fennel growers was ranged from 2.5 per cent to 76.03 per cent.

It could be further inferred that there was a higher (above 66.00 %) technological gap in plant protection measures (76.03 %) of nursery raising (68.65 %). The medium (34.00 to 66.00 %) technological gap was observed in recommended variety (60.83 %) irrigation schedule (59.06 %), chemical fertilizer (49.58 %) and

harvesting (33.89 %). The low (up to 33.00 %) technological gap was found in transplanting (24.31 %), hand weeding (14.17 %), farm yard manure (9.17 %), interculturing, earthing up (6.67 %) and gap filling (2.5 %).

Table 3. Average technological gaps in different components of fennel production technology (N = 120)

Sr. No.	Different component of fennel production technology	Adoption (%)	Technological gap (%)	Rank
1.	Recommended variety	39.17	60.83	III
2.	Nursery raising	31.35	68.65	II
3.	Transplanting	75.69	24.31	VII
4.	Farm yard manure	90.83	09.17	IX
5.	Chemical fertilizer	50.42	49.58	V
6.	Irrigation schedule	40.94	59.06	IV
7.	Gap filling	97.50	02.50	XI
8.	Interculturing and earthing up	93.33	6.67	X
9.	Hand weeding	85.83	14.17	VIII
10.	Plant protection measures	23.97	76.02	I
11.	Harvesting	66.11	33.89	VI
Average		63.20	36.80	

The overall technological gap combining all the listed 11 practices together was 36.80 per cent. Thus, it could be inferred that 63.20 per cent adoption of recommendation of fennel crop by the fennel growers.

These findings are supported by the earlier findings of Prajapati (7).

Constraints experienced by the fennel growers in adoption of recommended fennel production technology :

The respondents were requested to express the constraints faced by them in adopting recommended fennel production technology. According to the number of respondents rank was given and data in this regard are presented in Table 4.

Table 4. Constraints experienced by fennel growers in adoption of recommended fennel production technology (N = 120)

Sr. No.	Constraints	No. of respondents	Per cent	Rank
1.	Lack of technical guidance	59	49.17	I
2.	More problem of disease and insect	58	48.33	II
3.	Non-getting remunerative price of the produce	57	47.50	III
4.	Long duration crop	52	43.33	IV
5.	High charge and irregular supply of electricity	47	39.17	V
6.	Unavailability of certified seeds	23	19.17	VI

As seen from Table 4 that major constraints faced by the farmers were "Lack of Technical Guidance" (49.17 %). More problems of disease and insects (48.33 %), non-getting remunerative price of the produce (47.50 %), Long duration crop (43.33 %), high charge and irregular supply of electricity (39.17 %).

Conclusion

Majority of the fennel growers had medium level of knowledge regarding the recommended fennel production technology. Majority of the fennel growers were found to have medium extent of adoption. The maximum technological gap was observed in plant protection measures, nursery raising. The overall technological gap was found 36.80 per cent. Major constraints perceived by the fennel growers were lack of technical guidance, more problem of disease and insect, non-getting remunerative price of the produce and long duration crop.

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Assessment of motivational factors behind the shift towards organic farming

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Abstract

A study was conducted in four districts of North Gujarat to know the motivational factors behind the shift towards organic farming. For this purpose 90 organic farmers were selected purposively and interviewed personally. They were found motivated by variety of motivational factors viz., improvement in soil health and maintaining soil fertility, high cost of conventional inputs, get poison free food and antipathy to chemicals. They were also found motivated through the farm literature and activities of NGOs. Therefore the media should focus on such issues and give more coverage so that more number of farmers get motivated.

Keywords : Motivational factor, organic farming, soil health

Introduction

Motivation is the process of maintaining a conscious and purposeful action. A motive means an urge or a combination of urges to induce conscious or purposeful action. The adoption of any idea or technology depends upon people's motives to accept it. People usually do things for a number of reasons or motivations and this is no less true for farmers. During the last decade, organic farming has gained international recognition as a viable substitute to conventional farming. The organic farming movement is spreading gradually in all most all states of the country.

In answering the question considering why farmers shift to organic farming, one should know that there is whole range of motivational issues to be considered. In this study it is assumed that there may be several motives behind the paradigm of shift to organic farming, which pulled them towards adopting it with a difference. Many farmers in the state and country have accepted the organic farming. However, no such study has been carried out in the state so far. Hence, the present research study was undertaken with an objective to know different motivational factors behind the shift from conventional to organic farming. The reviewed past studies indicated that organic farmers were motivated not only by economic motives but by several sociological, environmental and psychological or ideological motives as reported by Anandkumar (1) and Verma(2).

James (3), John Fair weather (4), Neiberg and Offerman (5), Pederson (6) reported that the powerful motives behind shift were the price premium of organic products and subsidies / support provided by government.

Methodology

The study was conducted in North Gujarat. The districts in which at least ten farmers engaged in organic farming were selected for the study and such four districts viz., Sabarkantha, Gandhinagar, Mahesana and Banaskantha were selected purposively. From these four district 15 talukas were selected purposively. Total 36 such villages were identified from these talukas where organic farming was practiced by more or less number of farmers. All the farmers in the selected villages who were practicing organic farming since last three years were selected as respondents for the study. Total 90 organic farmers were finally selected.

The structured schedule was prepared and farmers' replies were recorded in form of Yes or No. Finally the responses were tabulated and analyzed on the basis of frequency, percentage and rank.

Results and discussion

In the present study attempt has been made to know the motives behind shift towards organic farming. The results are presented in Table 1.

Environment and health concern motives

Among environment and health concern motives half or more respondents reported the motives viz., maintaining soil fertility (86.66 %) was ranked first followed by improving soil health (75.55 %), eco-friendly organic practices (66.66 %), minimizing residue in food and feed (57.77 %) and protecting human health (50.00 %) were the motives reported by majority of the farmers and were ranked second, third, fourth and fifth, respectively.

Hence, it can be said that farmers found more cautious about maintaining soil fertility, improving soil health i.e. production oriented motives. Secondly, they considered general motives like eco-friendly organic practices, minimizing residue in food and feed and improving human health.

Economic concern motives

With respect to economic motives, costly conventional inputs (72.22 %) was ranked first followed by more net return in organic farming (61.61 %), low credit requirement (55.55 %) and were ranked second and third respectively. Premium prices (40.00 %), and export opportunities (20.00 %) were the other motivational factors behind shift towards organic farming.

It can be concluded from the above results that majority organic farmers attracted towards organic farming due to high cost of conventional inputs (i.e. fertilizers, insecticides, pesticides, weedicides etc.), more net return and less credit requirement in organic farming. Moreover, it is surprising to note that premium prices and export opportunities motives had not attracted the majority farmers. Therefore, it is inferred that farmers want to reduce the cost of production by adopting organic agriculture and thereby want to increase net return.

Quality concern motives

As regards the quality concern motives, a great majority (80.00 %) of the farmers were found interested to adopt organic farming due to motive that organic food would be free from toxic chemicals was ranked first followed by better in taste (56.66 %) and good storage quality (52.22 %) and were ranked second and third, respectively. Organic products have attractive colour and high nutritional value were the other motives reported by small number of farmers.

Hence, it can be concluded that majority organic farmers shifted towards organic farming with the reason of producing poison free food and such food have better taste and good keeping quality. The results indicated that organic farmers were conscious

about residue of chemicals in food and its other quality parameters like good taste and storage quality.

Personal belief and value concerns

Every individual has his own unique set of beliefs and values. The behaviour of an individual is affected to some extent by these personal beliefs and values. In case of organic farmers, it might be true that certain beliefs and values possessed by them might have affected their decision to shift towards organic farming.

The data in Table 1 reveal that antipathy to chemicals (74.44 %), dissatisfaction in conventional farming (66.66 %), less dependency for external inputs (60.00 %) and do not disturb nature (52.22 %) were the important beliefs and value motives as reported by majority of the farmers and were ranked first, second, third and fourth, respectively.

From the foregoing discussion, it can be concluded that majority organic farmers possess antipathy to chemicals used in agriculture, and hence they got dissatisfaction in conventional farming. Moreover, organic farming makes them less dependent for external inputs as it is based on local and on-farm inputs. They also believed that the nature should not be disturbed.

It is quite obvious that all the organic farmers might be the progressive conventional farmers in their early days but they got tired of the problems of conventional farming and therefore, might have shifted to the organic farming.

Media concerns

Media play an important role to aware the people about technology. In present study the important media source, which have motivated the farmers towards organic farming were also identified. The information regarding this was presented in Table 1.

The data showed that majority (63.33 %) organic farmers were motivated through farm literature only. Television got second position (27.77 %) and books got third position (8.88 %) to motivate the farmers towards organic farming. The data further showed that only two farmers were motivated by internet information and none by radio.

It is clear from the above discussion that farm literature was the single source that had motivated the majority of the farmers towards organic farming. It might be due to the fact that many local farm magazine, viz., Gram Jatan, Lok Sarvani, and News papers daily etc. give due coverage to articles on

Table 1. Motivational factors behind shift towards organic farming (n =90)

S.No.	Motivational factors	No.	Per cent	Rank
A	Environmental and health concerns			
1.	Environmental balance	20	22.22	VII
2.	Maintaining soil fertility	78	86.66	I
3.	Protecting bio-diversity	28	31.11	VI
4.	Improving human health	45	50.00	V
5.	Minimizing residue in food and feed	52	57.77	IV
6.	Improving soil health	68	75.55	II
7.	Eco- friendly organic practices	60	66.66	III
B	Economic concerns			
1.	Costly conventional inputs	65	72.22	I
2.	More net return in organic farming	55	61.61	II
3.	Premium prices	36	40.00	IV
4.	Export opportunities	18	20.00	V
5.	Low credit requirement	50	55.55	III
C	Quality concerns			
1.	Better in taste	51	56.66	II
2.	Attractive in colour	12	13.33	V
3.	Highly nutritious	22	24.44	IV
4.	Free from toxic chemicals	72	80.00	I
5.	Good storage quality	47	32.22	III
D	Personal belief and value concerns			
1.	Do not disturb nature	47	52.22	IV
2.	Antipathy to chemicals	67	74.44	I
3.	Dissatisfaction in conventional farming	60	66.66	II
4.	Moral duty towards society	21	23.33	VII
5.	Less dependency for external inputs	54	60.00	III
6.	Less risky for farmers	27	30.00	VI
7.	Honest way of farming	36	40.00	V
E	Media concerns			
1.	Television			
2.	Radio	25	27.77	IV
3.	Book	00	00.00	-
4.	Farm literature	08	08.88	III
5.	Internet	57	63.33	I
		02	2.22	IV
F	Personal and Institution concerns			
1.	Family members & friends			
2.	Neighbours and relatives	10	11.11	VIII
3.	Intension workers	26	28.80	V
4.	Learned personality	37	41.41	IV
5.	Progressive/other organic farmers	09	10.00	X
6.	Motivational fairs	45	50.00	III
7.	Organic farmers meet	15	16.66	VI
8.	Exhibition and fairs	67	74.44	II
9.	Success stories	12	13.33	VII
10.	NGOs	10	11.11	VIII
		72	80.00	I

organic farming. More over, all the farmers were educated and hence they preferred the farm literature to read which is easily available and cheap source of getting information.

Individual and institution concerns

Institutions and agencies with whom he works or come in to contact affect an individual. These all more or less affect the decision making process. With this idea in mind, farmers were asked to name the person(s) or institution, which led them to shift towards organic fanning. The information regarding this is depicted in Table 1.

The data presented in Table 1 portray that NGOs (80.00 %) was the important source of motivation for shift towards organic farming and was ranked first followed by organic farmers' meet (74.44 %), other organic farmers (50.00 %) and were ranked second and third motivational source, respectively.

Conclusion

Results related to environmental and health concern motivational factors indicated that more than 50.00 per cent of the farmers reported the factors like, maintaining soil fertility improving soil health were personal motives and eco friendly organic practices, reducing residue in food and feed and improving human health as general motives behind their shift towards organic farming.

With respect to economic motives, majority of farmers were attracted towards organic farming due to high cost of conventional more return in organic farming and low credit requirement. It is surprising that export opportunities and premium prices had not considered as motives by the organic farmers.

Among quality concern motives, majority organic farmers reported that poison free food, having good taste and more keeping quality were the important quality concern motives, which inspired them to shift towards organic farming.

Majority of organic farmers possessed antipathy to chemicals, dissatisfaction in conventional farming, less dependency for inputs and nature, should not be disturbed are the important personal value oriented motives behind the shift towards organic farming.

As regards the motives related to media, farm literature was the only source that motivated majority farmers towards organic fanning. The institutional and individual motives like NGOs Organic Farmers Meet and other organic farmers were the important factors of motivation towards organic farming. Based on above

findings following implications can be drawn to motivate more number of farmers towards organic farming in the state.

1. The mass media has to promote the concept of organic farming as environmentally safe and economically viable option to chemical based farming. The consumers also need to be aware of the ill effects of contaminated food produced conventionally. They have to pay some more to get chemical free, safe, tastier and healthy food, vegetables and fruits.
2. In addition series of workshops, seminars and lectures of eminent workers and scientists may be organized to create awareness among students, extension functionaries and general public.
3. Many NGOs, farmer groups and individual have proved that the organic farming is capable of generating more return with healthy food for consumer than conventional farming. The problem however is of inadequate reporting and coverage of such successful attempts, which are found mostly in far-flung remote places. Therefore, media coverage should be extended to those remote places and their efforts should be duly recognized.

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Optimum size and shape of plot for field experiments on potato (*Solanum tuberosum* L.)

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Abstract

An uniformity trial on potato (*Solanum tuberosum* L.) was carried out at the Potato Research Station, S.D. Agricultural University, Deesa to determine optimum size and shape of plot for field experiments using maximum curvature method and fair field Smith's variance method. The variability as judged by coefficient of variation per unit area (C.V.) decreased with the increase in plot size. A plot of 8 sq. m having 2 m. width x 4 m. length (i.e. 4 rows each of 4m length) a rectangular shape of plot (net) was considered as optimum size and shape of plot for field experiments on potato on sandy loam soil of North Gujarat.

Keywords : Coefficient of variation, potato, plot size, plot shape, field experiments, experimental error.

Introduction

Research work on agricultural science is mainly concerned with the field experimentation. Efficient planning of any field experiment depends on the magnitude of experimental error. Choice of optimum size and shape of plot is one of the important factors for reduction of experimental error. The size of plot can be said to be optimum when experimental error is at minimum for a fixed cost (1) and it depends on the nature of experimental material, soil variability, kind of crop, choice of design of experiment, number of treatments per block and cost of conducting experiment. The knowledge of field soil variability which could be evaluated through uniformity trial helps in determining optimum size and shape of plot.

The potato (*Solanum tuberosum* L.) is the most popular vegetable crop grown through out the world. In Gujarat, a half of the potato produced only from Banaskantha district with the highest productivity. Optimum plot size for field experiments on potato crop has been reported (Table 1) by various scientists at different locations varies from 4.39 to 40.00 sq. m (2,3,4,5,6). However, such information is not available for potato crop grown on sandy loam soils of North Gujarat. Therefore, an uniformity trial on potato (variety *Kufri Badshah*) was carried out at the Potato Research Station, S.D. Agricultural University, Deesa,

District Banaskantha in North Gujarat Agro-climatic zone to determine optimum size and shape of plot for field experiments on potato.

Author (s)	Year	Optimum plot size (sq.m.)	Location
Sardana <i>et al.</i>	1967	8.40	Jalandhar, Punjab
Bist <i>et al.</i>	1975	4.39 to 3.58	Mukteshvar (Kumaon hills)
Premajayantha and Ganasekara	1982	25.0 to 40.0	Sita Eliya, Srilanka
Oliveira and Esefanel	1995	16.0	Santa Mariya Brazil
Bhatt <i>et al.</i>	1998	7.20	Anand, Middle Gujarat

Material and methods

An uniformity trial was conducted at the Potato Research Station, Deesa during *rabi* season in the year 2002-03 on potato with 50 cm spacing between rows and 20 cm spacing within row. The net experimental area had a dimension of 36 m x 36 m (i.e. 72 rows each having 36 m length). The crop cultivation practices in vogue on the research station were followed. The potato tuber yield data was recorded for 1296 basic units. Two rows each of 1 m length i.e.

1m x 1m was considered as a basic unit. Two methods viz., maximum curvature method (7) and Fairfield Smith's method (8) were used to determine optimum plot size for field experiments on potato.

Results and discussion

Size of plot

The results presented in Table 2 revealed that maximum coefficient of variation (21.63 %) was observed in the smallest sized plot i.e. one unit (1 sq.m) and it decreased with the increase in plot size up to 648 basic units plot size. Similar trend was also reported by Sardana *et al.* (2) Bist *et al.* (3) Premajayantha and Ganasekara (4) and Bhatt *et al.* (6). However, slight increase in C.V. per cent was observed for 9, 27 and 54 basic units plot sizes (i.e. 10.74, 8.04 and 6.60 % respectively) as compared to 8, 24, and 48 basic units plot sizes 10.67, 8.03 and 6.51 % respectively). A further look into the data clearly indicated that the reduction in C.V. was more rapid in the beginning i.e. up to 6 basic units

Table 2. Coefficient of variation (in per cent) and its decrease per unit plot size.

Plot size in basic units (X)	Coefficient of variation (%) C.V.	Decrease in C.V.	Per unit decrease in C.V.
1	21.63	-	-
2	16.65	4.98	4.98
3	14.84	1.81	1.81
4	13.35	1.49	1.49
6	11.90	1.45	0.72
8	10.67	1.23	0.61
9	10.74	-0.07	-0.07
12	9.75	0.99	0.33
16	8.82	0.93	0.23
18	8.71	0.11	0.06
24	8.03	0.68	0.11
27	8.04	-0.02	-0.01
36	6.98	1.06	0.12
48	6.51	0.47	0.04
54	6.60	-0.08	-0.01
72	5.60	1.00	0.06
108	5.13	0.47	0.01
144	4.08	1.05	0.02
216	4.03	0.05	0.00
324	3.60	0.43	0.00
648	1.89	1.71	0.01

The trend in C.V. expressed in equation form using original data was as under

$$C.V. = 17.33 - 0.6697X + 0.0098X^2 \dots\dots (R^2 = 0.81)$$

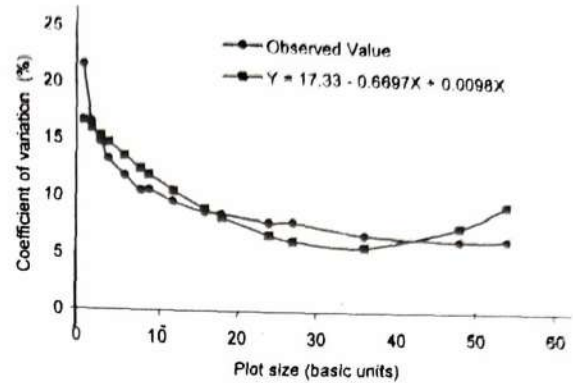


Fig. 1 Coefficient of variation in per cent for different sized plots

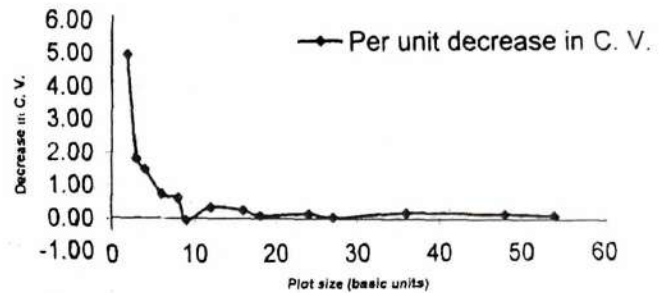


Fig.2 Per unit decrease in coefficient of variation for different sized plots

plot size and then it decreased marginally. Thus, the decrease in C.V. per cent was not proportional when plot size increased beyond 6 basic units. The results graphically presented in Fig. 1 and Fig. 2 showed the curvature more clearly. Therefore 6 basic units plot size could be taken as point of maximum curvature (7) and 8 basic units plot size i.e. just adjacent to 6 basic units plot size appeared to be optimum plot (net) size for field experiments on potato crop.

The quadratic prediction equation of C.V. on plot size (X) based on original data accounted for 81 per cent of variation. In the varying cost ratio K_1/K_2 i.e. the ratio of cost proportional to the number of plots required per treatment to the cost proportional to the total area per treatment and soil heterogeneity index b' were considered for estimating optimum size of the plot (Table 3).

The potato yield data recorded in the present study gave $b' = 0.64$. The results presented in Table 3 revealed that the plot size increased with the increase in the cost ratio i.e. K_1/K_2 . For $b' = 0.64$ the plot size varies from 1.19 to 4.15 basic units for the K_2 ranging from 30 to 60 per cent. Generally, K_2 varies from 30 to 60 per cent. Similar trend was observed for $b' = 0.79$. It was further observed that for a given cost K_2 , plot size increased with the increase in soil heterogeneity index b' . These results are akin to those reported by Bist *et al.* (3), Sharma (9) and Bhatt *et al.* (6)

Table 3. Optimum plot size in basic units under varying cost consideration

Soil heterogeneity index (b')	K_2 ratio	30 %	40 %	50 %	60 %
		2.33	1.50	1.00	0.67
0.30		1.00	0.64	0.43	0.29
0.40		1.56	1.00	0.67	0.53
0.50		2.33	1.50	1.00	0.66
0.60		3.50	2.25	1.50	1.00
0.64*		4.15	2.67	1.78	1.19
0.70		5.44	3.50	2.33	1.56
0.79**		8.78	5.64	3.76	2.51

* As per Smith's general model (average b' value)** As per Smith's two dimensional model (largest b' value)**Table 4.** Coefficient of variation per basic unit in per cent for various plot shapes and sizes.

Width in basic units	Length in basic units								
	1	2	3	4	6	9	12	18	36
1	21.63	16.45	14.37	12.73	11.28	10.11	8.72	7.77	5.83
2	16.86	13.14	11.40	10.09	9.22	8.45	7.10	6.67	5.16
3	15.31	11.96	10.65	9.31	8.54	7.87	6.47	6.17	4.89
4	14.17	11.25	10.16	8.82	8.25	7.79	6.30	6.15	4.73
6	12.95	10.19	9.23	7.98	7.55	6.88	5.43	5.18	4.36
9	11.46	9.29	8.22	7.41	6.95	6.68	4.99	4.87	4.22
12	10.90	8.78	7.61	6.72	6.22	5.92	4.30	4.46	3.83
18	8.96	7.31	6.39	5.75	5.64	5.53	3.55	3.39	2.98
36	6.15	4.90	4.19	3.22	3.75	3.18	1.16	0.79	-

Shape of plot

Dimension wise C.V. is presented in Table 4 indicated that the rate of reduction in C.V. was higher with the increase in length of plot (*i.e.* length of rows) rather than that of width of plot (*i.e.* number of rows). The results thus revealed that long and narrow plot (rectangular) having higher length of row rather than number of rows *i.e.* width of plot should be preferred for field experiments. In order to judge the optimum shape of plot for 8 basic units plot size, it was observed that a plot of 2m width x 4m length gave lower C.V. (10.09 %) than a plot of 4m width x 2m length (11.25 %). These results are in agreement with those reported by Sardana *et al.* (2), Bist *et al.* (3), Oliveira and Stefanel (9) and Bhatt *et al.* (7). Keeping in view the above results, a plot of 8 basic units having dimension 2m width x 4m length (*i.e.* 4 rows each of 4m length) a rectangular shape of plot was considered as optimum size and shape of plot (net) for field experiments on potato.

Conclusion

The optimum plot size obtained by the Smith's variance method is very small and inconvenient for carrying out various agronomical operations in the field experiments. Therefore, a rectangular plot of size 8 sq. m. as obtained from Maximum Curvature method having 2 m width x 4 m length (*i.e.* 4 rows each of 4 m length) is considered as optimum (net) plot size for field experiments on potato crop.

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Studies on body weight and measurement traits of goat in farmers flock

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Abstract

Data for growth and body measurement traits were collected on 2644 Mehsana, 464 Kutchi and 424 Sirohi goats from farmers flocks in North Gujarat under ICAR - NBAGR Network Project on Mehsana goat. The overall least square means in male animals for body weight at 0-3, 4-6, 7-9, 10-12 months and above 12 months (adult) age groups were observed to be 9.48 ± 0.30 , 19.72 ± 0.33 , 20.31 ± 0.53 , 23.54 ± 0.46 and 44.15 ± 1.76 kg., respectively. The corresponding estimates in females were found to be 10.04 ± 0.26 , 18.91 ± 0.14 , 21.09 ± 0.16 , 23.42 ± 0.15 and 35.30 ± 0.72 kg., respectively. These findings revealed better growth in female kids (0-3 months) as compared to males, but significantly ($P \leq 0.01$) higher body weights were observed in adult males. The breed wise least square means for body weights revealed that Sirohi goats had significantly higher growth up to six months age as compared to Mehsana and Kutchi breeds, while Mehsana goat differed significantly at twelve months (23.88 ± 0.16 kg). Breed wise least squares means in adult goats were significantly higher in Kutchi (42.90 ± 0.92 kg), followed by Sirohi (41.99 ± 1.31 kg) and Mehsana goat (38.35 ± 0.84 kg). The effect of sex was observed significant for body measurement traits in adult animals and all the body measurement traits were significantly higher in adult males. Breed wise least squares means for body length was significantly higher in Kutchi goat (78.05 ± 1.05 cm) as compared to Sirohi (71.23 ± 1.63 cm) and Mehsana (69.95 ± 1.0 cm).

Keywords : Body weight, measurement traits, goat breed

Introduction

Goat production is a major source of livelihood security for landless labourers, small and marginal farmers in semi-arid and arid region of North Gujarat. Goat rearing is still characterized by traditional extensive production system under zero / low inputs. Mehsana goats are generally better adapted to harsh climatic conditions in its breeding tract i.e. North Gujarat. The Sirohi and Kutchi goats are also preferred by the goat keepers in the area and leads interbreeding between Mehsana, Sirohi and Kutchi goats and reduced genetic purity of goat genetic resources. The growth performance evaluation of these breeds is almost scanty. Therefore, the present investigation has been planned to study the comparative growth performance and body measurement traits of goat resources under semi-arid and arid conditions of North Gujarat.

Materials and methods

The goat genetic resources in North Gujarat and Kachchh region were surveyed for comparative evaluation under ICAR-NBAGR Network Project on Mehsana Goat (April-2004 to March-2006). The information was collected in farmers flocks maintained under traditional extensive production system from Banaskantha, Mehsana, Patan and Kachchh districts on 2644 Mehsana, 464 Kutchi and 424 Sirohi goats. The data on body weight and measurement traits (body length, heart girth and height at withers) at 0-3, 4-6, 7-9, 10-12 and above 12 months (adult) age groups were collected and classified according to breeds and sex of the animal. The data were analyzed by least squares analysis of variance to ascertain the effects of sex of animal and genetic group (breeds).

Results and discussion

The least squares means for body weight, body length, heart girth and height at withers according to sex and breed in different age groups are presented in table 1, 2, 3 and 4, respectively.

Body weight (kg)

The overall least squares means for body weights at 0-3, 4-6, 7-9, 10-12 and above 12 months age groups were observed to be 9.82 ± 0.20 , 19.06 ± 0.13 , 21.02 ± 0.16 , 23.44 ± 0.14 and 39.44 ± 1.05 kg., respectively (table 1). The least square analysis revealed non significant effect of sex for body weight

up to 12 months age, but in adult animals males had significantly ($P \leq 0.01$) higher body weight (44.15 ± 1.76 kg) than the females (35.30 ± 0.72 kg). Breed wise body weight revealed that Sirohi goat had significantly higher body weight up to six months age, Mehsana goat at 12 months (23.88 ± 0.16 kg.) and in adult animals significantly higher body weight was observed in Kutchi goat (42.85 ± 0.92 kg.). Present findings fairly agreed with the reports of Arun Kumar *et.al.* (1) for Kutchi kids body weight at three months and Acharya (2) for body weight in adult Kutchi and Mehsana goats. But comparatively lower estimates were reported by Roy and Rout (3) in adult Kutchi and Sirohi goat. These findings revealed that Mehsana goat attained maximum growth at an early age (12 months) as compared to Kutchi and Sirohi goats.

Table 1. Least square means for body weight (kg) of goats in different age groups

Sex / Breed	Age groups in months				
	0 - 3	4 - 6	7 - 9	10 - 12	Adults
Sex:					
Male	9.48 ± 0.30 (253)	19.72 ± 0.33 (153)	20.31 ± 0.53 (54)	23.54 ± 0.46 (94)	44.15 ± 1.76^a (31)
Female	10.04 ± 0.26 (287)	18.91 ± 0.14 (679)	21.09 ± 0.16 (502)	23.42 ± 0.15 (601)	35.30 ± 0.72^b (866)
Breed:					
Mehsana	9.60 ± 0.22^a (462)	18.89 ± 0.17 (471)	21.01 ± 0.18 (457)	23.88 ± 0.16^a (533)	38.35 ± 0.84^a (721)
Kutchi	9.40 ± 0.34^a (99)	18.16 ± 0.28 (116)	21.12 ± 0.45 (50)	22.90 ± 0.47^a (85)	42.85 ± 0.92^b (114)
Sirohi	11.77 ± 0.89^b (73)	20.05 ± 0.25 (216)	21.02 ± 0.49 (49)	20.86 ± 0.42^b (44)	41.99 ± 1.31^b (42)
Overall mean	9.82 ± 0.20 (641)	19.06 ± 0.13 (832)	21.08 ± 0.16 (556)	23.44 ± 0.14 (662)	39.44 ± 1.05 (877)

Table 2. Least square means for heart girth (cm) of goats in different age groups

Sex / Breed	Age groups in months				
	0 - 3	4 - 6	7 - 9	10 - 12	Adults
Sex:					
Male	46.45 ± 0.43 (253)	61.39 ± 0.40 (153)	61.12 ± 0.58 (54)	67.51 ± 0.58 (94)	81.53 ± 1.42 (31)
Female	46.31 ± 0.38 (287)	60.83 ± 0.17 (679)	61.80 ± 0.19 (502)	67.10 ± 0.26 (601)	77.54 ± 0.62 (866)
Breed:					
Mehsana	45.90 ± 0.34^a (462)	60.84 ± 0.21 (471)	61.69 ± 0.20 (457)	67.80 ± 0.27^a (533)	77.48 ± 0.69^a (721)
Kutchi	46.23 ± 0.54^a (99)	60.27 ± 0.43 (116)	61.38 ± 0.74 (50)	64.95 ± 0.73^b (85)	79.13 ± 0.73^{ab} (114)
Sirohi	49.53 ± 0.84^b (73)	61.68 ± 0.31 (216)	62.51 ± 0.64 (49)	65.02 ± 0.85^b (44)	80.64 ± 1.13^b (42)
Overall mean	46.36 ± 0.28 (641)	60.94 ± 0.16 (832)	61.73 ± 0.18 (556)	67.15 ± 0.24 (662)	78.71 ± 0.88 (877)

* Note : Means with similar superscript did not differ significantly.

Heart Girth (cm.)

The overall least squares means with their standard errors for heart girth at 0-3, 4-6, 7-9, 10-12 and above 12 months age groups in males were observed to be 46.45 ± 0.43 , 61.39 ± 0.40 , 61.12 ± 0.58 , 67.51 ± 0.58 and 81.53 ± 1.42 cm., respectively. The corresponding estimates in females were 46.31 ± 0.38 , 60.83 ± 0.17 , 61.80 ± 0.19 , 67.10 ± 0.26 and 77.54 ± 0.62 cm, respectively. The effect of sex was non significant for heart girth in all the age groups except adult animals, where males (81.53 ± 1.42 cm) had significantly ($P \leq 0.01$) higher estimates as compared to females (77.54 ± 0.62 cm). The breed wise least square means were observed significantly higher in Sirohi kids (49.53 ± 0.84 cm) and adult goat

(80.64 ± 1.13 cm), whereas, breed effect was observed non-significant in other age groups (Table 2). The findings under study are lower to that reported by Mishra et al. (4) in Sirohi kids, but higher estimates were observed for heart girths in adult does.

Body Length (cm.)

The least squares means for body length in different breeds and sex are presented in table 3. Least squares analysis revealed significant effect of sex on body length in young stock (4-6 and 7-9 months) and adult group. The body length in adult male and female were observed to be 83.39 ± 1.58 and 76.87 ± 0.68 cm, respectively. The breed wise least squares means were observed significantly higher in adult Kutchi goat

Table 3. Least square means for body length (cm) of goats in different age groups

Sex / Breed	Age groups in months				
	0 - 3	4 - 6	7 - 9	10 - 12	Adults
Sex:					
Male	42.59 ± 0.46 (253)	58.19 ± 0.42^a (153)	58.12 ± 0.82^a (54)	58.91 ± 0.55 (94)	75.57 ± 2.07^a (31)
Female	41.21 ± 0.39 (287)	55.97 ± 0.19^b (679)	55.95 ± 0.23^b (502)	59.03 ± 0.23 (601)	68.92 ± 0.90^c (866)
Breed:					
Mehsana	41.69 ± 0.36 (462)	56.58 ± 0.23 (471)	55.62 ± 0.24^a (457)	59.63 ± 0.24^a (533)	69.95 ± 1.00^a (721)
Kutchi	41.29 ± 0.69 (99)	56.71 ± 0.45 (116)	58.74 ± 0.77^b (50)	57.21 ± 0.68^{ab} (85)	78.05 ± 1.05^b (114)
Sirohi	42.83 ± 0.86 (73)	55.95 ± 0.38 (216)	58.22 ± 0.74^b (49)	56.75 ± 0.77^b (44)	71.23 ± 1.63^c (42)
Overall mean	41.75 ± 0.30 (641)	56.38 ± 0.18 (832)	56.17 ± 0.22 (556)	59.01 ± 0.22 (662)	72.13 ± 1.23 (877)

Note : Means with similar superscript did not differ significantly.

Table 4. Least square means for height at withers (cm) of goats in different age groups

Sex / Breed	Age groups in months				
	0 - 3	4 - 6	7 - 9	10 - 12	Adults
Sex:					
Male	48.69 ± 0.45 (253)	62.35 ± 0.43 (153)	63.00 ± 0.64 (54)	68.92 ± 0.55 (94)	83.39 ± 1.58^a (31)
Female	48.31 ± 0.36 (287)	61.06 ± 0.20 (679)	63.62 ± 0.25 (502)	68.90 ± 0.23 (601)	76.87 ± 0.68^b (866)
Breed:					
Mehsana	48.17 ± 0.34^a (462)	61.24 ± 0.22 (471)	63.27 ± 0.26^a (457)	69.61 ± 0.24^a (533)	77.19 ± 0.76^a (721)
Kutchi	48.08 ± 0.62^a (99)	60.96 ± 0.50 (116)	63.68 ± 0.84^a (50)	66.35 ± 0.56^b (85)	81.56 ± 0.80^b (114)
Sirohi	51.05 ± 0.80^b (73)	61.97 ± 0.42 (216)	65.63 ± 0.67^b (49)	67.00 ± 0.79^{ab} (44)	80.91 ± 1.24^b (42)
Overall mean	48.46 ± 0.28 (641)	61.30 ± 0.18 (832)	63.56 ± 0.23 (556)	68.90 ± 0.21 (662)	79.59 ± 0.97 (877)

Note : Means with similar superscript did not differ significantly.

(78.05 ± 1.05 cm) as compared to Sirohi (71.23 ± 1.63 cm) and Mehsana (69.95 ± 1.00 cm). The present findings on body length in kids and adult does are higher than the report of Mishra *et al.* (4) and Taneja *et al.* (5) for Sirohi and Marwari goats, respectively.

Height at Withers (cm.)

Table 4 revealed that overall least squares means for height at withers in 0-3, 4-6, 7-9, 10-12 and above 12 months age groups were 48.46 ± 0.28 , 61.30 ± 0.18 , 63.56 ± 0.23 , 68.90 ± 0.21 and 79.59 ± 0.97 cm, respectively. The effects of sex and breed were non-significant on height at withers. But comparatively higher means for adult age group were observed in Kutchi (81.56 ± 0.80 cm) followed by Sirohi (80.91 ± 1.24 cm) and Mehsana goats (77.19 ± 0.76 cm). Mishra *et al.* (4) and Singh *et al.* (6) observed lower estimates for kids and adult does in Sirohi and Marwari breed.

Present findings revealed that the least squares means for growth traits at 4-6 and 7-9 months age groups were almost similar. This might be due to the scarcity of water, feed and fodder in summer season, because majority of kidding occurs in October–November months and as kids reach to 6–9 months age, summer season adversely affect the growth of the animals. Further, these findings concluded that body length was more in Kutchi goat than Mehsana and Sirohi breeds.

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Antibiotic sensitivity profile of oral microflora from clinical cases of stomatitis in dogs

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Abstract

Cultural examination of oral swabs collected aseptically from 72 dogs with stomatitis resulted in recovery of bacterial isolates from 50 cases (69.44 %). Of these, majority was from catarrhal stomatitis (56.00 %) followed by ulcerative and allergic type. Out of the 50 positive bacterial cultures, the frequency of isolates was *Staphylococcus* spp. 30, *Escherichia coli* 20, *Pseudomonas* spp. 20, *Streptococcus* spp. 14, *Proteus* spp. 8, mixed culture 6 and *Corynebacterium* spp. 2 per cent. Maximum isolates were sensitive to enrofloxacin (94 %) followed by tetracycline (44 %), gentamicin (34 %), cephadroxil (32 %) and ciprofloxacin (26 %). Some isolates (22 to 68 %) were found intermediately sensitivity to these antibiotics, whereas 68 and 70 % isolates were resistant to erythromycin and amoxicillin, respectively, and ampicillin was ineffective *in vitro* on 84 % isolates. Sensitivity to co-trimoxazole and doxycycline was of moderate type. Mixed culture was found 100 % resistant to all these drugs. The details organism wise drug sensitivity is presented.

Keywords : Antibigram, canine stomatitis, cultural examination.

Introduction

As *Staphylococcus* strains, from the normal microflora of the saliva, play an important role in dog bite inflicted wounds and in diseases of the oropharyngeal mucosa of the animal, the acquisition of knowledge of the different species of the genus and their role in the normal microflora of the dog is fundamental. Also looking to the antibiotic resistance pattern of these strains, a full antimicrobial investigation should be considered when providing antibiotic therapy. Reports on cultural examinations of oral swabs from the cases of canine stomatitis and their antibiograms are meager particularly from Indian subcontinents. The present investigation aims to explore the same in dogs, so that a sound therapeutic approach can be planned and executed effectively.

Materials and methods

This study was carried out over a period of one year (June, 2004 to May, 2005) on 72 oral swabs of dogs with stomatitis. The dogs with stomatitis were also randomly selected from the Government Veterinary Polyclinics and NGO's (Animal helpline) hospitals at Ahmedabad and Vadodara.

For isolation of bacteria, sterile cotton swabs (Hi-Media Lab., Mumbai) were used for collection of saliva samples from oral cavity of all dogs with stomatitis. Various sampling techniques were employed as described by Nesbitt (1) to obtain a representative sample from different types of bacterial lesions. Oral swabs were streaked aseptically on the nutrient agar plates after enrichment and the plates were incubated at 37°C at least for 24 hours. Following incubation, the plates were examined for different types of organisms based on bacterial growth, colony characteristics, staining characteristics (Gram's stain), microscopic morphology and for other primary and secondary tests (2).

All bacterial isolates were subjected to *in-vitro* antibacterial sensitivity testing by disc-diffusion method (3). The standard discs (Hi-Media Lab) of various antibacterials used to examine the zones of inhibition produced by them against the tested isolate were Ampicillin (A-10 µg), Tetracycline (T-10 µg), Amoxicillin (Am-25 µg), Gentamicin (G-10 µg), Cephadroxil (Cq-30 µg), Enrofloxacin (Ex-5 µg), Doxycycline (Do- 30 µg), Cotrimexazole (Co-5 µg), Ciprofloxacin (Cf-30 µg) and Erythromycin (E-10 µg). The organisms were categorised as susceptible,

intermediate and resistant depending upon the diameter of zone of inhibition (mm) as specified by the manufacturer for each disc.

Results and discussion

Cultural Examination of Oral Swabs

Of the 72 oral swabs cultured from the cases of stomatitis bacterial isolates could be recovered from 50 cases (69.44 %), while 22 (30.56 %) swabs did not yield any bacterial isolate. Of the positive swabs, majority was from catarrhal stomatitis (56.00 %) followed by ulcerative and allergic stomatitis. Bacterial isolates were detected in the range of 50 to 100 % in different types of stomatitis. Ulcerative, necrotic and allergic stomatitis yielded more bacterial isolates (75.00 to 87.50 % cases), whereas papular and vesicular stomatitis though only one case each yielded bacterial isolates on culture (Table 1).

Table 1. Frequency of stomatitis cases found positive on cultural examination (n = 72)

Type of Stomatitis	Total cases	Culture +ve cases	Per cent
Catarrhal	44	28	63.64
Ulcerative	8	7	87.50
Necrotic	4	3	75.00
Allergic	9	7	77.78
Gangrenous	3	2	66.67
Granulomatous	2	1	50.00
Papular	1	1	100.00
Vesicular	1	1	100.00
Total	72	50	69.44

The frequency of *Staphylococcus* isolates was found to be 15 (30 %), *Escherichia coli* 10 (20 %), *Pseudomonas* spp. 10 (20 %), *Streptococcus* spp. 7 (14 %), *Proteus* spp. 4 (8 %), mixed culture 3 (6 %) and *Corynebacterium* spp. 1 (2 %) (Table 2). Catarrhal stomatitis was one, which yielded maximum bacterial isolates compared to other types of stomatitis. Among the catarrhal stomatitis, maximum isolates (28.6 %) were of *Staphylococcus* followed by *E. coli* (21.4 %), *Streptococcus* (17.9 %), *Proteus* (14.3 %), *Pseudomonas* (10.7 %) and the lowest of *Corynebacterium* and mixed type (9.6 % each). Ulcerative stomatitis yielded more of *Staphylococcus* and *Pseudomonas* spp. (each 42.9 %) organisms. Allergic stomatitis also showed more isolates of *Staphylococcus* spp. (42.9 %) followed by *Pseudomonas* spp. (28.6 %).

Table 2. Frequency of bacterial isolates obtained from cases of canine stomatitis (n = 50)

Sr. No.	Name of the isolate	Frequency	Per cent
1	<i>Staphylococcus</i> spp.	15	30.00
2	<i>Streptococcus</i> spp.	7	14.00
3	<i>Corynebacterium</i> spp.	1	2.00
4	<i>E. coli</i>	10	20.00
5	<i>Pseudomonas</i> spp.	10	20.00
6	<i>Proteus</i> spp.	4	8.00
7	Mixed culture	3	6.00
	Total	50	100.00

Several bacterial genera, such as *Corynebacterium*, *Bacillus*, *Escherichia*, *Pasteurella* and *Neisseria* have already been reported from the gingival flora of dogs (4). *Staphylococcus aureus*, haemolytic *Streptococci*, *Pseudomonas* and *Pasteurella multocida* have been cultured from infected tissue affected by necrotizing ulcerative stomatitis (5). Nieves *et al.* (6) reported that dogs with only mild gingivitis became bacteraemic with gram-negative bacilli and hence 60-90 per cent bacterial genera isolated from blood and dental plaque were identical and mostly included *Pasteurella* spp., *Pseudomonas* spp. and *E. coli*, whereas among gram-positive isolates 40 per cent each were *Staphylococcus* spp., *Actinobacillus* spp. Ilgazz and Birgel (7) diagnosed different oral pathological lesions in dogs fed with home-made food. A wide scale of oral flora was observed, with the amount of gram-positive and gram-negative bacteria being equal. More *Staphylococcus* spp. were found in dogs suffering from the first stage of periodontitis. Mihakjevic and Klein (8) isolated *Streptococci* from gum swabs from 13 of 16 healthy dogs and 34 of 37 dogs with periodontal disease. Ossiprandi *et al.* (9) isolated 64 *Streptococcal* strains from 43 of 105 dogs with different gingival conditions. Kro *et al.* (10) identified a total of 91 aerobic bacterial isolates from the throats of 35 health dogs, as well as 15 dogs with pharyngitis. Gram-negative microorganisms (*Pasteurella* sp. and *Moraxella* sp.) constituted the most abundant portion of pharyngeal microbiota in healthy dogs. Among the gram-positive bacteria, *Staphylococcus intermedius*, *Streptococcus mitis* and *Streptococcus sanguis* were the most frequent isolates.

Antibiogram of Bacterial Isolates from Stomatitis

The overall and isolate-wise drug sensitivity of various organisms obtained from dogs suffering from stomatitis has been presented in Tables 3 and 4.

The *in vitro* drug sensitivity study revealed that 94 per cent isolates were sensitive to enrofloxacin followed by tetracycline, gentamicin, cephadroxil, ciprofloxacin, doxycycline, erythromycin, amoxicillin, and co-trimoxazole and ampicillin. Some isolates were found intermediately sensitive to co-trimoxazole, doxycycline, gentamicin, tetracycline, cephadroxil, ciprofloxacin and amoxicillin. Moreover, 68.00 and 70.00 per cent isolates were resistant to erythromycin and amoxicillin, respectively, while ampicillin was ineffective *in vitro* on 84.00 per cent isolates (Table 3).

Among the different isolates, *Staphylococcus* showed highest susceptibility to enrofloxacin (100 %), followed by cephadroxil (60.03%), tetracycline (46.69%), doxycycline (46.69%), amoxicillin (26.68%) and erythromycin (20.01%), while they were totally

resistant to gentamicin, co-trimoxazole, ampicillin and ciprofloxacin (Table 5). Love *et al.* (11) isolated 40 strains of *Staphylococci* from infections of dogs and cats and stated that 12.5 per cent organisms were resistant to tetracycline antibiotic.

Streptococcus isolates showed maximum sensitivity to enrofloxacin and tetracycline (100.00 % each), followed by cephadroxil (57.18 %), erythromycin (42.84 %), gentamicin (28.59 %) and doxycycline (28.59 %), while they were 100 per cent resistant to amoxicillin, co-trimoxazole, ampicillin and ciprofloxacin. *Corynebacterium* spp. was most sensitive to enrofloxacin and tetracycline (100.00 % each). *Escherichia coli* showed maximum sensitivity to enrofloxacin (100.00 %), gentamicin (100.00 %), ciprofloxacin (90.00 %), tetracycline (30.00 %),

Table 3. Antibigram of microbial isolates emanating from the canine stomatitis (n = 50)

Sr. No.	Drugs	Sensitive		Intermediate		Resistant	
		No.	%	No.	%	No.	%
1.	Amoxicillin (Am)	4	8.0	11	22.0	35	70.0
2.	Ampicillin (A)	1	2.0	7	14.0	42	84.0
3.	Cephadroxil (Cq)	16	32.0	18	36.0	16	32.0
4.	Ciprofloxacin (Cf)	13	26.0	16	32.0	21	42.0
5.	Co-trimoxazole (Co)	1	2.0	34	68.0	15	30.0
6.	Doxycycline (Do)	9	18.0	29	58.0	12	24.0
7.	Enrofloxacin (Ex)	47	94.0	1	2.0	2	4.0
8.	Erythromycin (E)	7	14.0	9	18.0	34	68.0
9.	Gentamicin (G)	17	34.0	28	56.0	5	10.0
10.	Tetracycline (T)	22	44.0	25	50.0	3	6.0

Table 4. Isolate-wise antibiotics sensitivity profile of oral microflora from cases of stomatitis

Sr. No.	Name of the isolate	Am	A	Cq	Cf	Co	Do	Ex	E	G	T	Total
1.	<i>Staphylococcus</i> spp.	4/15 (26.68)	0/15 (0.00)	9/15 (60.03)	0/15 (0.00)	0/15 (0.00)	7/15 (46.69)	15/15 (100.0)	3/15 (20.01)	0/15 (0.00)	7/15 (46.69)	45
2.	<i>Streptococcus</i> spp.	0/7 (0.00)	0/7 (0.00)	4/7 (57.18)	0/7 (0.00)	0/7 (0.00)	2/7 (28.59)	7/7 (100.0)	3/7 (42.84)	2/7 (28.59)	7/7 (100.0)	25
3.	<i>Corynebacterium</i> spp.	0/1 (0.00)	0/1 (0.00)	0/1 (0.00)	0/1 (0.00)	0/1 (0.00)	0/1 (0.00)	1/1 (100.0)	0/1 (0.00)	0/1 (0.00)	1/1 (100.0)	2
4.	<i>E.coli</i>	0/10 (0.00)	1/10 (10.00)	3/10 (30.00)	9/10 (90.00)	1/10 (10.00)	0/10 (0.00)	10/10 (100.0)	1/10 (10.00)	10/10 (100.0)	3/10 (30.00)	38
5.	<i>Pseudomonas</i> spp.	0/10 (0.00)	0/10 (0.00)	0/10 (0.00)	0/10 (0.00)	0/10 (0.00)	0/10 (0.00)	10/10 (100.0)	0/10 (0.00)	1/10 (10.00)	4/10 (40.00)	15
6.	<i>Proteus</i> spp.	0/4 (0.00)	0/4 (0.00)	0/4 (0.00)	4/4 (100.0)	0/4 (0.00)	0/4 (0.00)	4/4 (100.0)	0/4 (0.00)	4/4 (100.0)	0/4 (0.00)	12
7.	Mixed culture	0/3 (0.00)	0/3 (0.00)	0/3 (0.00)	0/3 (0.00)	0/3 (0.00)	0/3 (0.00)	0/3 (0.00)	0/3 (0.00)	0/3 (0.00)	0/3 (0.00)	0

cephadroxil (30.00 %), followed by erythromycin, co-trimoxazole and ampicillin (10.00 %) each, while they were resistant to doxycycline and amoxicillin (Table 4).

Antibiogram of *Pseudomonas* spp. revealed maximum susceptibility to enrofloxacin (100.00 %), followed by tetracycline (40.00 %), but were resistant to ciprofloxacin, cephadroxil, erythromycin, co-trimoxazole, ampicillin, doxycycline and amoxicillin. *Proteus* spp. was 100 % sensitive to enrofloxacin, gentamicin and ciprofloxacin. Mixed culture was found 100 % resistant to all these drugs.

Harvey *et al.* (12) cultured and identified aerobic and anaerobic subgingival bacteria from 49 dogs and 40 cats with spontaneous gingivitis. Amoxicillin-clavulanic acid (Clavamox, Pfizer Animal Health) had the highest *in-vitro* susceptibility against all isolates (96 %); 94 per cent aerobes and 100 per cent anaerobes tested. For gram-negative aerobes, enrofloxacin (Baytrill, Bayer Corp.) had the highest *in-vitro* susceptibility. For bacteria associated with gingivitis, the antimicrobial of choice for clinical use based on these susceptibility tests was amoxicillin – clavulanic acid. Krol *et al.* (10) concluded that the bacterial strains obtained from dogs with pharyngitis were most susceptible to enrofloxacin and gentamicin.

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Seroprevalence of Bluetongue virus in aborted ruminants in Gujarat

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Abstract

This communication is to report the prevalence of antibodies to bluetongue virus in aborted ruminants in Gujarat. A total of 149 sera from aborted ruminant, which included sheep (20), goats (55), cattle (24), buffaloes (39) and camels (11) were collected at random with history of abortion. Of 149 sera screened, 74 (49.66 %) and 102 (68.46 %) were found to be positive for BTV group specific antibodies by BT-AGID and c-ELISA respectively. Species wise seroprevalence recorded was 40.00, 58.18, 45.83, 48.72 and 36.36 percent by BT-AGID and 70.00, 78.18, 62.50, 61.54 and 54.54 percent by c-ELISA in sheep, goats, cattle, buffaloes and camels respectively.

Keywords : Ruminants, reagents, buffalo, goat, sheep, camel

Introduction

Bluetongue (BT) is an infectious, non-contagious, arthropod borne viral infection of domestic and wild ruminants and has been reported from most of the tropical and subtropical regions of the globe (1). In India, first outbreak of BT was reported by Sapre (2) in sheep and goats in Maharashtra. Since, then several outbreaks of BT have been recorded and many workers have confirmed its existence in various parts of the country (3, 4). Out of 24 known serotypes of BT, 22 have been reported from India (5, 6).

There is wide spread prevalence of Bluetongue in India, literature reveals a paucity of information regarding the prevalence of Bluetongue in aborted animals. The object of this communication is to report the prevalence of antibodies to Bluetongue Virus in aborted ruminants in Gujarat.

Material and methods

Test samples

A total of 149 sera from aborted ruminants, which included sheep (20), goats (55), cattle (24), buffaloes (39) and camels (11) were collected, with history of abortion. The separated serum samples were placed in screw – capped vials and heat inactivated at 56° C for 30 minutes and stored at -20° C until tested.

Reference reagents

The Bluetongue virus (BTV) antibody test kits and c-ELISA kits were made available by courtesy of Dr. M. M. Jochim, Veterinary Diagnostic Technology Incorporation, USA.

The protocol of AGID test was followed as per Pearson and Jochim (7). Six ml of molten gel was poured in each petridish and allowed to solidify on a horizontal plane. A pattern consisting of a centre well surrounded by six peripheral wells was made using an immunodiffusion template. Each well had a diameter of four mm and the centre to centre distance between wells was 6.4 mm. The central well was charged with known BTV soluble antigen and the peripheral wells with the test sera. Each serum sample was placed next to the well containing reference BTV antiserum so as to ascertain the specificity of the lines developed. The charged petridishes were incubated at room temperature under humid condition for 72 hours pronouncing the sample as negative or positive. In BT-AGID test, clear positive sera showed sharp precipitating lines were in continuity with those given by the reference antiserum against BTV.

Competitive Enzyme linked Immunosorbent Assay (c-ELISA)

The test was performed as per the protocol of (8) and

Table 1. Seroprevalence of antibodies to Bluetongue virus in aborted ruminants

Species	Number tested	Number positive by			
		BT-AGID	Percent Positive	c-ELISA	Percent Positive
Sheep	20	8	40.00	14	70.00
Goats	55	32	58.18	43	78.18
Cattle	24	11	45.83	15	62.50
Buffaloes	39	19	48.72	24	61.54
Camels	11	4	36.36	06	54.54
Total	149	74	49.66	102	68.46

as per the manufacturer's instructions (Veterinary Diagnostic Technology Inc., USA).

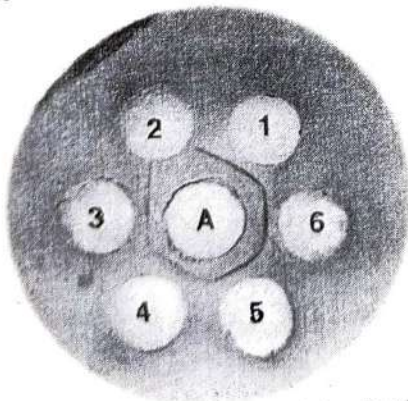
To calculate the result, the average OD value was determined for all the negative, weak positive and strong positive duplicate wells. The average OD value of the diluent wells represented the back ground OD and was subtracted from the average OD values of the control and test sera to yield their adjusted OD values. Then positive/negative ratios were calculated by dividing the adjusted OD values of the positive control and the test sera by adjusted OD values of the negative control serum. These ratios were multiplied by 100 to express them as a percentage of the negative control and this was subtracted from 100 to calculate the percentage inhibition (PI). The samples were considered to be positive for BTV antibody if the PI value was above 50 per cent.

Result and discussion

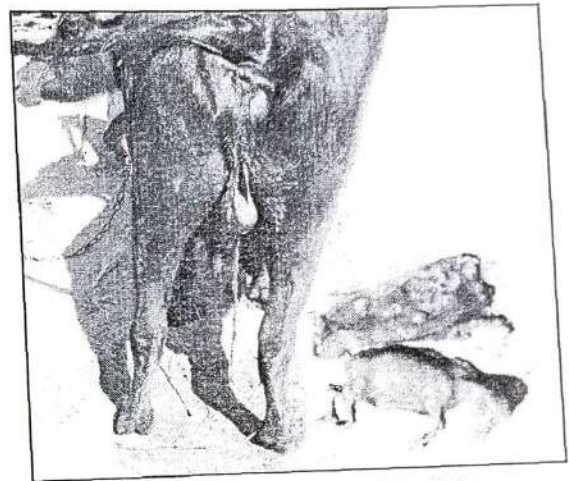
Of 149 sera screened, 74 (49.66 %) and 102 (68.46%) were found to be positive for BTV group specific

Agar gel immunodiffusion pattern of the positive and negative serum samples

Placement of reagents
 A : BTV reference antigen
 1,3,5 : BTV reference antiserum
 2,4,6 : Test serum samples



2 is negative, 4 & 6 are positive test sera



A seropositive aborted buffalo

antibodies by BT -AGID and c-ELISA respectively. Species wise seroprevalence is shown in Table 1.

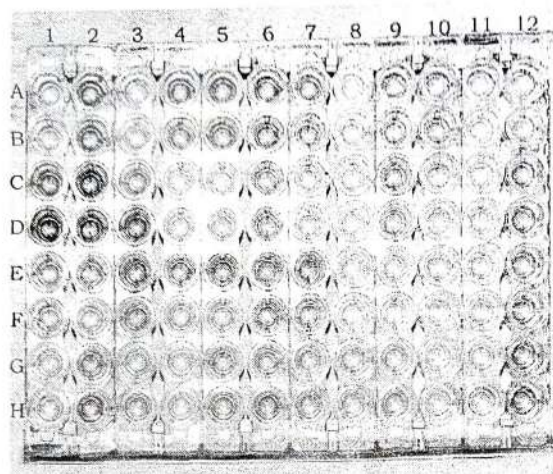
A very high rate of seroprevalence (86.2 %) in aborted exotic ewes compared to 17.2 % in indigenous sheep has also been reported by Prasad *et al.* (9).

In the present study, aborted goats showed higher rate of seroprevalence (58.18, and 78.18 %) which is in accordance with the observations of Chandel *et al.* (10), who observed higher rate of seroprevalence in aborted goats than apparently healthy goats.

Although, clinical form of BT in cattle has not been reported in this country. Research in South Africa, showed that cattle in Bluetongue epidemic areas have a high prevalence of infection without exhibiting overt disease (11), and cattle are considered asymptomatic reservoir hosts (12).

Overt, clinical signs have been reported in cattle from which BTV has been isolated, abortions and foetal malformations have been attributed to BTV (13, 14). Though, Subsequent analysis of such reports showed that there was no consensus (15). opined that,

Microtitre ELISA plate showing results of c-ELISA



A₁ & B₁ : Diluent controls,
 C₁ & D₁ : Negative controls
 E₁ & F₁ : Weak positive controls
 G₁ & H₁ : Positive controls
 A₂, B₂ G₁₂ H₁₂ : Field sera

Bluetongue infection was no longer considered to cause overt clinical disease in cattle, although infection during early pregnancy may possibly cause reproductive wastage.

The present findings in aborted buffaloes collaborate with the findings of Chandel *et al.* (10), whereas Tongaonkar *et al.* (16) reported lower prevalence of 15.85 per cent in aborted and apparently healthy buffaloes.

In the present study 11 camels, aborted were also tested for BTV antibodies by BT-AGID and c-ELISA and out of 11, 4 (36.36 %) and 6 (54.54 %) were positive by both the tests, respectively. A higher rate of positive reactors to BTV in aborted camels was similar to aborted sheep, goat, cattle and buffalo during the present study corroborates with the work done by several other workers (16, 9 and 10).

Seropositivity cases among aborted animals needs further study to associate the role of Bluetongue virus in abortion.

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Isolation and typing of *Escherichia coli* from mutton and their public health significance

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Abstract

Escherichia coli (*E.coli*) was isolated and identified from different retail market mutton samples as well as from butchers' hand and their instruments. Analysis of 150 samples comprising of liver, lymph nodes, muscle, swab from hands, knife and log (25 samples each) from five different retail mutton shops of Anand, Gujarat which revealed 100 (66.66%) *E.coli* isolates. The highest prevalence of *E.coli* was recovered from muscle (88.00%) followed by liver (84.00%), lymph nodes (68.00%), knife swab (60.00%), log swab (52.00%) and the least from butchers' hand (48.00%). All 100 *E.coli* isolates were studied for serotyping, and the public health significance of isolates especially their role in human diseases were discussed. On the basis of serotyping 80 typable isolates were distributed into 35 different serogroups (08, 01, 0101, 02, 09, 051, 05, 013, 032, 036, 039, 088, 015, 060, 078, 0153, 06, 011, 023, 025, 027, 029, 050, 058, 061, 068, 076, 081, 086, 0109, 0123, 0133, 0158, 0168 and 0172 in descending order of frequency) along with 10 rough and 10 untypable strains. The public health significance of different *E.coli* serotypes is discussed.

Keywords : *E. Coli*, isolation, public health, mutton

Introduction

Developments in the livestock management practices and food processing industries, along with changes in people's food habits have invited the emergence of pathogenic diseases. *Escherichia coli* (*E.coli*) is one of such important food borne zoonotic pathogens. Animals and their products are the major source of such infection for human beings. Among the meat of various animals, the mutton is a major non-vegetarian diet in the country indicated by the consistent increase in mutton production and consumption over last two decades.

The intestinal tract of ruminants, in particular sheep and cattle is the major reservoir of *E. coli*. Moreover, during slaughtering, dressing and processing, meat surface invariably comes in contact with contaminated tools as well as equipments and gets contaminated. Therefore, keeping in view the above facts and magnitude of the problem the present study was conducted to isolate and identify *E.coli* from sheep carcass (muscle, liver and lymph nodes) sold in retail outlets and swabs from butcher's hands, log and knife were taken to know the possible cross contamination

as well as to study their properties in relation to serotypes, and their public health significance.

Materials and methods

150 different meat samples of sheep carcass (muscle, liver and lymph nodes) sold in retail market (25 samples each) as well as swabs from butchers' hand, knife and cutting log (25 samples each) were collected from randomly selected five mutton shops from Anand, Gujarat State under aseptic conditions. Meat samples and swabs were collected hygienically in sterilized polyethylene bags and plastic tubes, respectively. The collected samples were marked as A (liver sample), B (lymph node), C (muscle), D (swab of butcher's hand), E (knife swab) and F (log swab). Similarly, shops were also numbered (1 to 5). For example, 15B₄ indicates fifteenth number of the isolate obtained from lymph node sample of shop number four. Isolation of *E.coli* was attempted from different samples of meat and swabs according to standard methods described by Edwards and Ewing (1), Cruickshank *et al.* (2) and Quinn *et al.* (3) by using Mac Conkey agar (MCA) and Eosin Methylene Blue (EMB) agar as selective media.

Identification of the isolates was done according to the procedures described by Edwards and Ewings (1), Cruickshank *et al.* (2) and Kreig and Holt (4). Cultures identified as *E. coli* were serotyped at National Salmonella and Escherichia Centre, Central Research Institute (CRI), Kasauli (Himachal Pradesh), India.

Results and discussion

Examination of 150 samples yielded *E. coli* isolates from 100 (66.66%) samples (Table 1). The highest prevalence of *E. coli* was observed in muscle (88.00 %) followed by liver (84.00 %), lymph node (68.00 %), knife swab (60.00 %), log swab (52.00 %) and from butchers' hands (48.00 %). The higher percentage of isolation of *E. coli* from different meat samples of sheep carcass was also recorded earlier (5, 6, 7). In contrast to the present findings Erganis *et al.* (8), revealed 7.00 per cent occurrence in lymph nodes of sheep slaughtered at abattoir. Shah *et al.* (9), reported 16.13 per cent *E. coli* and in the same year Singh and co-workers revealed 20.00 per cent prevalence of *E. coli* in the muscle and lymph node samples from healthy sheep. Similar findings were also reported by Pattnaik *et al.* (10) and Ramasastry *et al.* (11). Presence of *E. coli* in the swab samples collected from different slaughter house points such as knives (60.00%), logs (52.00%) and workers' hands (48.00 %) may be considered as potential source of *E. coli* contamination to the meat surface.

Out of 100 *E. coli* isolates, 80 isolates could be typed which were distributed into 35 different serogroups whereas 10 isolates did not react with the available O group sera (untypable) and 10 were found to be rough. On the basis of serotyping 80 typable isolates were distributed into 35 different serogroups (08, 01, 0101, 02, 09, 051, 05, 013, 032, 036, 039, 088, 015, 060, 078, 0153, 06, 011, 023, 025, 027, 029, 050, 058, 061, 068, 076, 081, 086, 0109, 0123, 0133, 0158, 0168 and 0172 in descending order of frequency) along with 10 rough and 10 untypable strains. Our finding supports that a wide range of serotypes isolated from samples of different mutton shops could be transmitted to human population and hence in view of its transmissibility, they appear to be of great public health significance as many of them are reported from human infections. There are many serotypes reported to be responsible for various foodborne outbreaks as well as various pathological conditions like haemorrhagic colitis and haemolytic uremic syndrome in man as well as animals (12).

E. coli is considered to be responsible for more than 70.00 per cent urinary tract infection (13), haemorrhagic enteritis (14) and vaginal infection (15). Bell and Kyriakides (16) and Willshaw *et al.* (17) classified the *E. coli* on the basis of their virulence and pathogenicity in six different groups such as EPEC (enteropathogenic *E. coli*), ETEC (enterotoxigenic *E. coli*), VTEC (Vero-cytotoxigenic *E. coli* or EHEC (entero-haemorrhagic *E. coli*), EIEC (enteroinvasive *E. coli*), EAaggEC (Enterotoxigenic aggregative *E. coli*) and DAEC (Diffusely adherent *E. coli*). Classifying the results of the present study in above mentioned groups revealed 2 (086 and 0158) isolates as EPEC. Moreover, 9 isolates of serogroup 6 (1, 15 (2), 25 (1), 27 (1), 78 (2) and 0153 (2) as ETEC and 15 isolates of VTEC which belong to sero group 02 (5), 05 (3), 06 (1), 015 (2), 023 (1), 0153 (2) and 0168 (1). Similarly, one isolate of serogroup 029 as EIEC and 5 isolates which belong to sero group 0151 (4) and 086 (1) as EAaggEC. A total of 12 isolates of serogroup 01 (7) and 02 (5) categorized as DAEC in the present study. In a detailed study, McGeachie (18) recorded 01 and 06 commonest serotypes in Urinary tract infection (UTI). The total prevalence of serogroup 01, 02 and 06 was 13 per cent in present study which suggests the possible source to human infection as reports of human disease including diarrhoea in Germany (19), bloody diarrhoea and HUS in the US (20).

There are reports of sero types 06, 08, 09, 011, 013, 023 and 086 from cases of human infection. Sero type 06 has been isolated from human diarrhoea in Belgium (21). Serotypes 06, 08, 020, 013, 018, 026, 055, 069, 085 and 011 have been recovered from cases of UTI in various parts of India, viz., Amritsar (22), Visakhapatnam (23), Rohtak (24), Delhi (25) and Bareilly (26). Sero type 09 has earlier been isolated from human peritoneum, human urine, urinary tract infection (27). Sero type 09 was found highly enterotoxigenic and produce enterotoxin (28 and 29). Sero types 06, 08, 011, 013, 023 and 086 have been recovered from cases of urinary tract infections in India (30). In the present study altogether prevalence of serogroup 06, 08, 09, 011, 013, 023 and 086 was 19.00 per cent.

Yasuoka *et al.* (15) obtained vaginal *E. coli* (VEC) from Japanese women. The common serotypes 01, 04, 06, 018, 025 and 075 were identified in three or more isolates. In present findings, serotypes 01, 02, 025 and 039 altogether have contributed to be 16 per cent of the total isolates. The similar serotypes have also been reported earlier from market meat samples by Bachhil (5).

Table 1. Prevalance and distribution of *E.coli* Serotypes in different samples

Type of samples	Total No. of isolates recovered	Prevalence percentage	Total No. of serotypes	Different serotypes detected
Liver (A)	21	84.00	14	08 (3), 039, 051, 0153 (two each) 02, 06, 050, 061, 068, 081, 088 and 0123 (one each) Rough (three) and untypable (one)
Lymph node (B)	17	68.00	13	0101 (three) 01, 02, 09, 025, 029, 032, 036, 039, 076, 088 (one each) Rough (three) and untypable (one)
Muscles (C)	22	88.00	17	0101 (three) 01 and 08 (two) 05, 09, 011, 013, 015, 023, 032, 051, 0109, 0158, 0168 and 0172 (one each) Rough (two) and untypable (one)
Hand swab (D)	12	48.00	9	01 (3) 09, 015, 036, 078, 088 and 0109 (each one) Rough (one) and untypable (two)
Knife swab (E)	15	60.00	10	02 and 05 (2 each) 06, 09, 051, 058, 078 and 0101 (one each) Rough (one) and untypable (four)
Log swab (F)	13	52.00	9	08 (3) 013 and 060 (two each) 027, 032, 036, 086 and 0133 (one each) Untypable (one)

*Number of samples examined 25 in each group

During present investigation, sero group 05 was recovered at rate of 3 per cent. Similar result was reported from sheep meat in New Zealand (7). Of the most recent isolation from healthy sheep in US (20), in Australia (12), Canada (31) and India (32). Serotype 08 and 09 were recovered at the rate of 8.00 and 4.00 per cent, respectively in the present study.

Other reports of serogroups 08 included that from sheep (32), calf diarrhoea (33) and from meat, either

beef (30), pork (34) or mutton (7). Similarly Anitakumari *et al.* (27) obtained sero type 09 (12.50 %) from buffalo meat.

A few numbers of untypable isolates (10 isolates) were recovered in present study. The importance of these untypable isolates is not known and should be considered alongwith the predominant sero groups when formulating future control measures.

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Effect of Extender-additives on sperm and acrosome abnormalities during cryopreservation of triplebred (HF x J x K) Bulls' semen

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Abstract

Thirty-six semen ejaculates of 4 mature triplebred (HF 25% x J 25% X Kankrej 50%) bulls were used to study the effect of extender-additives, viz. cysteine HCl (0.1 %) and EDTA (0.1 %) in Tris fructose yolk glycerol diluent using split-sample technique (1:10 dilution) on sperm and acrosome abnormalities during cryopreservation. The data analyzed using 3-factors' factorial RBD revealed that there were significant ($P < 0.01$) differences in percentages of sperm and acrosome abnormalities, overall and of different types, between bulls, between stages and between additives. Further, only bull x stage and/or stage x additive interaction was found significant ($P < 0.05$) for some of these defects. The mean percentages of total sperm abnormalities at initial, prefreeze and post-thaw stages were 7.44 ± 0.16 , 9.07 ± 0.17 and 13.57 ± 0.20 ($P < 0.01$), respectively. The overall mean percentages of sperms with head, midpiece and tail abnormalities in fresh semen were 2.33 ± 0.06 , 1.37 ± 0.06 and 3.78 ± 0.12 , respectively. The corresponding values at prefreeze and post-thaw stages were 2.94 ± 0.10 , 2.11 ± 0.08 , 4.10 ± 0.14 , and 4.35 ± 0.13 , 2.78 ± 0.09 , 6.45 ± 0.18 , respectively. The mean percentages of sperms with damaged acrosome at initial, prefreeze and post-thaw stages were 7.67 ± 0.19 , 10.13 ± 0.24 and 16.30 ± 0.28 ($P < 0.01$), respectively. The values of swollen, ruffled, denuded and detached acrosome in fresh semen were 2.25 ± 0.06 , 2.03 ± 0.08 , 2.00 ± 0.09 and 2.55 ± 0.10 %, respectively. The corresponding prefreeze values were 2.73 ± 0.09 , 2.43 ± 0.09 , 2.22 ± 0.09 and 3.17 ± 0.12 %, and post-thaw values 3.69 ± 0.12 , 3.79 ± 0.13 , 3.63 ± 0.12 and 5.32 ± 0.16 %, respectively. The trend observed for the effect of freezing steps and additives was identical in the semen of all 4 bulls for both sperm and acrosome abnormalities. In general, the values of all traits were significantly ($P < 0.01$) lower both at prefreeze and post-thaw stages in the presence of EDTA and cysteine hydrochloride (EDTA being superior than cysteine) as compared to those in control Tris diluent, indicating beneficial effect of both the additives towards sperm protection against cryo-damage.

Keywords : Triplebred bulls' semen, cryopreservation, extender-additives, sperm morphology, acrosome abnormalities,

Introduction

The success of crossbreeding programme launched in India depends on post-thaw quality of semen, as frozen semen is being used universally for artificial insemination. The freezing process causes damage to spermatozoa leading to deterioration in semen quality. Various studies have shown that crossbred bull semen is poor initially and is more vulnerable to cryodamage in comparison to that of purebred exotic cattle (1 and 2). Freezability of crossbred bulls' semen has also been poor with the discard rate of

more than 45 per cent ejaculates (3 and 4). To reduce cryodamage and to improve post-thaw quality and fertility of bovine semen several extender-additives in the form of organic acids, vitamins, enzymes, hormones, chelating agents, membrane stabilizers etc have been tried by different laboratories with varying success rate (5, 6, 7 and 8). The information on the freezability in terms of sperm and acrosome abnormalities of semen of HJK triplebred bulls developed in Gujarat and the effect of additives cysteine and EDTA their on is lacking, hence, this study was attempted on semen of triplebred bulls.

Materials and methods

This study was conducted on semen of 4 mature healthy triplebred (HF 25% x J 25% x Kankrej 50%) bulls, aged 4-6 years, stationed and maintained identically at LRS, Veterinary College, Anand during autumn. Semen was collected from each bull in the artificial vagina over a female partner in oestrus of the same species as the bulls were under natural service. In all, 36 good quality semen ejaculates (9 per bull) were studied. Soon after collection and evaluation, the ejaculates were diluted 1:10 at 32°C temperature with standard Tris-fructose-yolk-glycerol (TFYG) dilutor (9) without or with EDTA disodium salt and Cysteine HCl (each 0.1% separately) as additives. The diluted aliquots were filled in French medium straws of different colours. The straws were sealed with PVA powder, gradually cooled to 5°C in refrigerator and then frozen in the liquid nitrogen vapour using thermocol-freezing unit after 4 hrs of equilibration (5). The frozen straws were thawed at 37°C for 15 sec on the next day of freezing. The percentages of sperm (head, midpiece, tail & total) and acrosome (swollen, ruffled, denuded, detached and total) abnormalities were determined at the initial, prefreezing and post-thaw stages using eosin-nigrosin (10) and Giemsa stain (11), respectively. The data were analysed statistically using 3 factors factorial CRD to see the effect of bulls, stages, additives and their interactions on the spermatozoal traits evaluated (12).

Results and discussion

The findings on the influence of addition of cysteine

HCl (0.1%) and EDTA (0.1%) in standard TFGY diluent on sperm and acrosome abnormalities observed during cryopreservation of triplebred bulls' semen including analysis of variance are presented in Tables 1 to 6, and are also depicted in Figures 1 to 3. Statistically, there were significant ($P < 0.01$) differences in percentages of total abnormal sperms and damaged acrosome between bulls (except ruffled and detached acrosome), between additives (except head and midpiece abnormalities) and between stages. Further, except bull x stage interaction for abnormal sperm and bull x stage and/or stage x additive interaction for acrosome abnormalities, all the two- and three-way interactions of bulls, stages and additives studied, were found non-significant for both sperm and acrosome abnormalities (Tables 3 and 6).

Total sperm abnormalities

The overall mean percentages of total sperm abnormalities found at initial, prefreeze and post-thaw stages were 7.44 ± 0.16 , 9.07 ± 0.17 and 13.57 ± 0.20 ($P < 0.01$), respectively. The pooled mean percentage of total abnormal sperms in semen extended in Tris diluent with EDTA (9.69 ± 0.29 %) was significantly ($P < 0.01$) lower as compared to control diluent (10.31 ± 0.30 %), and the value for cysteine added diluent (10.10 ± 0.32 %) was of intermediate level. The mean percentages of total sperm abnormalities recorded at pre-freeze and post-thaw stage in control Tris diluent were 9.56 ± 0.27 and 13.92 ± 0.26 , respectively; in presence of EDTA 8.58 ± 0.27 and 13.03 ± 0.32 , and cysteine 9.08 ± 0.32 and 13.78 ± 0.41 , respectively. The same trend was observed for the effect of freezing stages and

Table 1. Mean ($\pm$ SE) percentages of total sperm abnormalities in triplebred bulls' semen at different stages of cryo-freezing in TFGY diluent with and without additives

Freezing Stage	Diluent Additives	Bull Number				Overall
		TP 28-01	TP 10-01	TP 19-03	TP 16-01	
Initial	-	7.89 ± 0.56	7.56 ± 0.34	7.22 ± 0.72	7.11 ± 0.59	7.44 ± 0.16^a
	Control	10.11 ± 0.42	9.00 ± 0.37	9.89 ± 0.59	9.22 ± 0.70	9.56 ± 0.27
	EDTA	8.67 ± 0.33	8.44 ± 0.48	9.11 ± 0.74	8.11 ± 0.61	8.58 ± 0.27
Prefreeze	Cysteine	9.78 ± 0.66	9.33 ± 0.50	9.78 ± 0.49	7.44 ± 0.58	9.08 ± 0.32
	Average	9.52 ± 0.30	8.93 ± 0.26	9.59 ± 0.35	8.26 ± 0.38	9.07 ± 0.17^b
	Control	13.22 ± 0.36	13.67 ± 0.47	15.44 ± 0.48	13.33 ± 0.44	13.92 ± 0.26
Post-thaw	EDTA	12.67 ± 0.60	12.56 ± 0.67	14.11 ± 0.54	12.78 ± 0.72	13.03 ± 0.32
	Cysteine	13.33 ± 0.87	13.11 ± 0.61	15.11 ± 1.02	13.56 ± 0.63	13.78 ± 0.41
	Average	13.07 ± 0.36	13.11 ± 0.34	14.89 ± 0.42	13.22 ± 0.34	13.57 ± 0.20^c
Overall	Control	10.41 ± 0.50	10.07 ± 0.56	10.85 ± 0.75	9.89 ± 0.60	10.31 ± 0.30^b
	EDTA	9.74 ± 0.50	9.52 ± 0.51	10.15 ± 0.68	9.33 ± 0.60	9.69 ± 0.29^a
	Cysteine	10.33 ± 0.59	10.00 ± 0.53	10.70 ± 0.78	9.37 ± 0.67	10.10 ± 0.32^{ab}
	Average	10.16 ± 0.31^{vw}	9.86 ± 0.31^{xy}	10.57 ± 0.42^z	9.53 ± 0.36^x	10.03 ± 0.18

Bull-wise/Stage-wise and Additive-wise means bearing common superscript do not differ significantly ($P > 0.05$) among themselves.

additives in the semen of individual bulls. The abnormal sperm, overall and at different stages of freezing, were significantly lower in TP bull Gangesh 16-01 and highest in Bhavesh 19-03 as compared to other two bulls, which were at par (Table 1).

Significantly lower total abnormal sperm count observed on cryopreservation of TP bull semen in EDTA containing diluent than that with cysteine or control Tris diluent agreed to the earlier reports (7,13), wherein significantly lower percentages of abnormal spermatozoa in presence of cysteine and EDTA as compared to ascorbic acid, chlorpromazine, chloroquine or hyaluronidase added or control Tris diluent at all stages of cryopreservation of buffalo semen has been noted. Misra *et al.* (8) reported insignificant effect of EDTA and glutathione in citrate diluent on percentage of total abnormal spermatozoa in crossbred bulls' semen. Moreover, the values of total sperm abnormalities reported by Virani (6) and Singh *et al.* (14) were relatively lower at different stages of cryopreservation than the present findings, while others (15,16) reported higher total sperm abnormalities during initial and post-thaw stage than the present ones.

Segment-wise sperm abnormalities

The overall mean percentages of sperms with head, midpiece and tail abnormalities recorded initially in fresh semen of triplebred bulls were 2.33 ± 0.06 , 1.37 ± 0.06 and 3.78 ± 0.12 , respectively. The corresponding values after equilibration (prefreeze)

and freezing thawing were 2.94 ± 0.10 , 2.11 ± 0.08 , 4.10 ± 0.14 , and 4.35 ± 0.13 , 2.78 ± 0.09 , 6.45 ± 0.18 , respectively (Table 2, Figs. 1 & 3). The differences due to bulls and freezing stages were significant ($P < 0.01$) for all the three traits. However, there was no significant effect of diluent-additives on sperm head and midpiece defects (Table 3), but the tail abnormalities were significantly lower with EDTA than cysteine added or control Tris diluent. In brief, the trend of variations observed in head, midpiece and tail abnormalities of spermatozoa due to freezing steps closely followed the trend of total sperm abnormalities, overall and in different bulls too.

These findings of segment-wise sperm abnormalities of fresh semen (initial) corroborated well with the values reported earlier (17,18). However, other researchers (16, 19, 20, 21) reported relatively high incidence of these abnormalities. Not only this but the effect of freezing on such abnormalities also coincided well with the reports of Vyas *et al.* (20) and Rana and Dharni (16), although the values reported by them were much higher than the present findings. However, it was difficult to find comparable report in the literature wherein the effect of additives on segment-wise sperm abnormalities was studied before and after freezing of bovine semen. Although, Dharni *et al.* (7) recorded significantly higher motility and fertility with lower enzyme leakage in semen of HF and Murrah bulls by adding cysteine (0.1%) and EDTA (0.1%) in Tris diluent as compared to raffinose (0.1%) added and control Tris diluent.

Table 2. Mean ($\pm$ SE) percentages of sperm head, midpiece and tail abnormalities in triplebred bulls' semen at different stages of cryofreezing in TFYG diluent with and without additives

Freezing Stage	Diluent Additives	Segment-wise sperm abnormalities		
		Head	Midpiece	Tail
Initial	-	2.33 ± 0.06^A	1.37 ± 0.06^A	3.78 ± 0.12^A
Prefreeze	Control	2.97 ± 0.19	2.11 ± 0.11	4.44 ± 0.21
	EDTA	3.11 ± 0.16	1.91 ± 0.12	3.64 ± 0.23
	Cysteine	2.72 ± 0.17	2.32 ± 0.18	4.22 ± 0.28
	Average	2.94 ± 0.10^B	2.11 ± 0.08^B	4.10 ± 0.14^A
Post-thaw	Control	4.47 ± 0.18	2.94 ± 0.16	6.50 ± 0.23
	EDTA	4.31 ± 0.25	2.80 ± 0.16	6.00 ± 0.30
	Cysteine	4.28 ± 0.23	2.58 ± 0.16	6.86 ± 0.36
	Average	4.35 ± 0.13^C	2.78 ± 0.09^C	6.45 ± 0.18^B
Overall	Control	3.26 ± 0.13	2.15 ± 0.10	4.91 ± 0.17^b
	EDTA	3.25 ± 0.13	2.03 ± 0.10	4.47 ± 0.18^a
	Cysteine	3.11 ± 0.13	2.09 ± 0.10	4.95 ± 0.21^b
	Average	3.21 ± 0.07	2.09 ± 0.06	4.78 ± 0.11

Means bearing common superscript within the column do not differ significantly ($P > 0.05$).

Table 3. ANOVA showing the effect of bulls, stages of freezing, diluent-additives and their interactions on total and different types of sperm abnormalities in triplebred bulls' semen

Sources of variance	D F	Mean Sum of Squares and Statistical Significance			
		Total Sperm Abnormalities	Head Abnormalities	Midpiece ties Abnormalities	Tail Abnormalities
Bulls (B)	3	15.74**	3.91*	3.17*	4.34 NS
Stages (S)	2	1088.61**	115.99**	54.36**	230.34**
Additives (A)	2	10.80*	0.74 NS	1.01 NS	7.62*
B x S	6	9.41*	2.65*	1.66*	2.87 NS
B x A	6	0.53	0.32 NS	0.40 NS	0.19 NS
S x A	4	2.97	0.53 NS	0.52 NS	2.67 NS
B x S x A	12	1.20	1.17 NS	0.81 NS	0.56 NS
Error	288	3.13	1.03 NS	0.74 NS	2.40 NS
Total	323	-	-	-	-

* $P < 0.05$ ** $P < 0.01$ NS - Non Significant

For rapid forward progression of sperms normal morphology especially of tail is important. Since the apparatus for contractility are located in the tail and midpiece, any abnormalities or damage would adversely affect the motility and thereby fertility of that sample/bull (16,21). Similarly normal morphology of sperm head is also essential for propagation and penetration into the oocyte membrane during fertilization. The findings of the present study in general suggest that the semen donated by all 4 triplebred bulls was of normal type with good freezability without seriously affecting the sperm morphology.

Damaged acrosome

The overall mean percentages of spermatozoa with

damaged acrosome observed immediately after dilution, after equilibration and after freezing-thawing of semen were 7.67 ± 0.19 , 10.13 ± 0.24 and 16.30 ± 0.28 ($P < 0.01$), respectively. The pooled mean percentages of sperms with damaged acrosome in Tris diluent with EDTA (10.45 ± 0.37 %), cysteine (11.07 ± 0.38 %) and non-added control diluent (12.57 ± 0.49 %) differed significantly ($P < 0.01$) from one another, being lowest in presence of EDTA. The mean percentages of damaged acrosome recorded at pre-freeze and post-thaw stages in control Tris diluent were 11.65 ± 0.45 and 18.58 ± 0.44 , respectively. The corresponding values with EDTA were 8.78 ± 0.38 and 14.92 ± 0.39 , and with cysteine 9.97 ± 0.39 and 15.56 ± 0.35 , respectively. The damaged acrosome per cent, overall and at different stages of freezing, were significantly

Table 4. Mean ($\pm$ SE) percentages of sperms with damaged acrosome in triplebred bulls' semen at different stages of cryo-freezing in TFYG diluent with and without additives

Freezing Stage	Diluent Additives	Bull Number				Overall
		TP 28-01	TP 10-01	TP 19-03	TP 16-01	
Initial	-	7.56 ± 0.29	9.00 ± 0.53	7.78 ± 0.70	6.33 ± 0.75	7.67 ± 0.19^a
Prefreeze	Control	12.56 ± 0.34	11.56 ± 0.73	12.00 ± 0.69	10.44 ± 0.87	11.65 ± 0.45
	EDTA	9.56 ± 0.56	9.56 ± 0.65	8.89 ± 0.59	7.11 ± 1.01	8.78 ± 0.38
	Cysteine	10.33 ± 0.82	9.33 ± 0.67	10.67 ± 0.58	9.56 ± 1.04	9.97 ± 0.39
	Average	10.82 ± 0.42	10.15 ± 0.43	10.52 ± 0.43	9.04 ± 0.61	10.13 ± 0.24^b
Post-thaw	Control	19.67 ± 0.78	17.33 ± 1.30	17.67 ± 0.55	19.00 ± 1.11	18.58 ± 0.44
	EDTA	15.33 ± 0.82	15.00 ± 0.82	14.22 ± 0.52	15.11 ± 1.01	14.92 ± 0.39
	Cysteine	15.11 ± 0.59	14.78 ± 0.47	16.56 ± 0.69	15.78 ± 0.91	15.56 ± 0.35
	Average	16.70 ± 0.58	15.70 ± 0.56	16.15 ± 0.43	16.63 ± 0.65	16.30 ± 0.28^c
Overall	Control	13.26 ± 1.02	12.63 ± 0.85	12.48 ± 0.87	11.93 ± 1.15	12.57 ± 0.49^d
	EDTA	10.82 ± 0.73	11.19 ± 0.65	10.30 ± 0.65	9.52 ± 0.93	10.45 ± 0.37^a
	Cysteine	11.00 ± 0.70	11.04 ± 0.61	11.67 ± 0.80	10.56 ± 0.92	11.07 ± 0.38^b
	Average	11.69 ± 0.49^e	11.62 ± 0.41^e	11.48 ± 0.46^e	10.67 ± 0.59^e	11.36 ± 0.25

Bull-wise / Stage-wise and Additive-wise means bearing common superscript do not differ significantly ($P > 0.05$) among themselves.

lower in TP bull Gangesh 16-01 as compared to other bulls, which were at par, and the semen of all the 4 bulls behaved identically for the effect of freezing stages and additives as far as acrosomal abnormalities was concerned (Table 4).

Several researchers (15, 22-24) reported relatively higher incidence of damaged acrosome during initial (18 - 25 %) and post-thaw (38 - 45 %) stages than the present findings in crossbred bulls. The present findings on effect of additives on acrosomal damage during freezing of semen agreed well with those of Verma *et al.* (2) and Kumar *et al.* (25), who also reported significantly lower incidence of damaged acrosome in post-thawed semen with addition of

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chlorpromazine and cysteine in Tris diluent, respectively, as compared to control Tris diluent. The differences observed in the damaged acrosome between the present and earlier reports could be mainly the staining technique and the subject (viewer) effect, apart from the breed, age and health of bulls, freezing medium used etc.

Different forms of acrosomal abnormalities

The overall mean percentages of sperms with swollen, ruffled, denuded and detached acrosome recorded in fresh semen of triplebred bulls were 2.25 ± 0.06 , 2.03 ± 0.08 , 2.00 ± 0.09 and 2.55 ± 0.10 , respectively. The values after equilibration were

Table 5. Mean ($\pm$ SE) percentages of sperms with different types of acrosomal abnormalities in triplebred bulls' semen at different stages of cryo-freezing in TFYG diluent with and without additives

Freezing Stage	Diluent Additives	Types of acrosomal abnormalities			
		Swollen	Ruffled	Denuded	Detached
Initial	-	2.25 ± 0.06^A	2.03 ± 0.08^A	2.00 ± 0.09^A	2.55 ± 0.10^A
Prefreeze	Control	2.53 ± 0.14	2.81 ± 0.18	2.53 ± 0.15	3.86 ± 0.21
	EDTA	2.86 ± 0.16	2.06 ± 0.12	1.83 ± 0.17	2.67 ± 0.18
	Cysteine	2.81 ± 0.16	2.40 ± 0.14	2.24 ± 0.16	2.91 ± 0.15
	Average	2.73 ± 0.09^B	2.43 ± 0.09^B	2.22 ± 0.09^B	3.17 ± 0.12^B
Post-thaw	Control	4.39 ± 0.22	4.08 ± 0.27	3.92 ± 0.22	5.81 ± 0.21
	EDTA	3.19 ± 0.21	3.53 ± 0.21	2.94 ± 0.23	5.25 ± 0.30
	Cysteine	3.50 ± 0.14	3.77 ± 0.20	3.22 ± 0.17	4.92 ± 0.31
	Average	3.69 ± 0.12^C	3.79 ± 0.13^C	3.36 ± 0.12^C	5.32 ± 0.16^C
Overall	Control	3.06 ± 0.13^b	2.97 ± 0.14^b	2.97 ± 0.14^b	4.15 ± 0.18^b
	EDTA	2.77 ± 0.10^a	2.54 ± 0.11^a	2.34 ± 0.13^a	3.56 ± 0.18^a
	Cysteine	2.85 ± 0.09^a	2.73 ± 0.12^{ab}	2.58 ± 0.11^a	3.52 ± 0.17^a
	Average	2.89 ± 0.06	2.75 ± 0.07	2.64 ± 0.07	3.74 ± 0.10

Means bearing common superscript within the column do not differ significantly ($P > 0.05$).

Table 6. ANOVA showing the effect of bulls, stages of freezing, diluent-additives and their interactions on percentages of sperms with total and different acrosome abnormalities in triplebred bulls' semen

Sources of variance	D F	MSS and significance for Acrosome abnormalities				
		Swollen	Ruffled	Denuded	Detached	Total defects
Bulls (B)	3	3.07*	0.14 NS	6.03**	1.17 NS	18.13*
Stages (S)	2	58.93**	90.45**	139.19**	284.21**	2134.16**
Additives (A)	2	2.75*	5.73**	10.73**	15.78**	128.65**
B x S	6	0.88 NS	2.89*	2.77*	2.52 NS	18.14*
B x A	6	0.37 NS	0.67 NS	1.43 NS	0.76 NS	4.85NS
S x A	4	5.98**	1.59 NS	3.02*	5.74**	35.38*
B x S x A	12	1.00 NS	0.49 NS	1.21 NS	0.83 NS	2.37NS
Error	288	0.87	1.18	1.23	2.02	4.76
Total	323	-	-	-	-	-

* $P < 0.05$ ** $P < 0.01$

NS Non-significant.

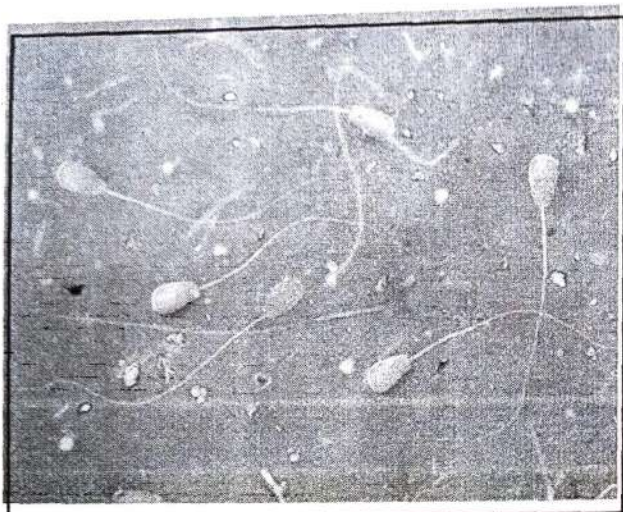


Plate : 1. Photograph showing differential staining for detection of live/dead and abnormal spermatozoa

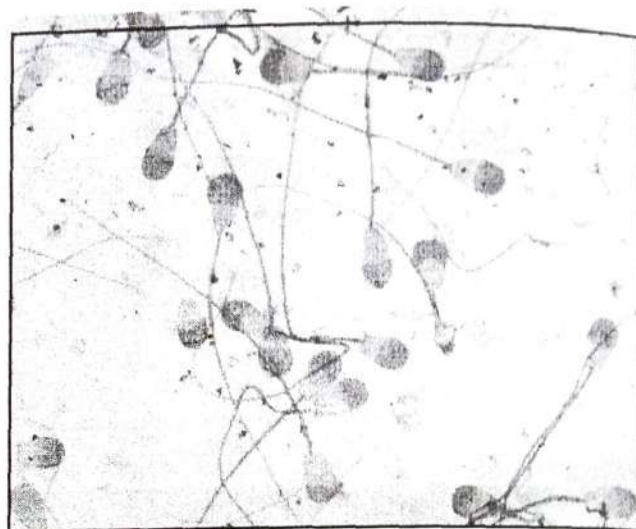


Plate : 2. Photograph showing acrosomal defects in Giemsa stained smears of triplebred bull semen

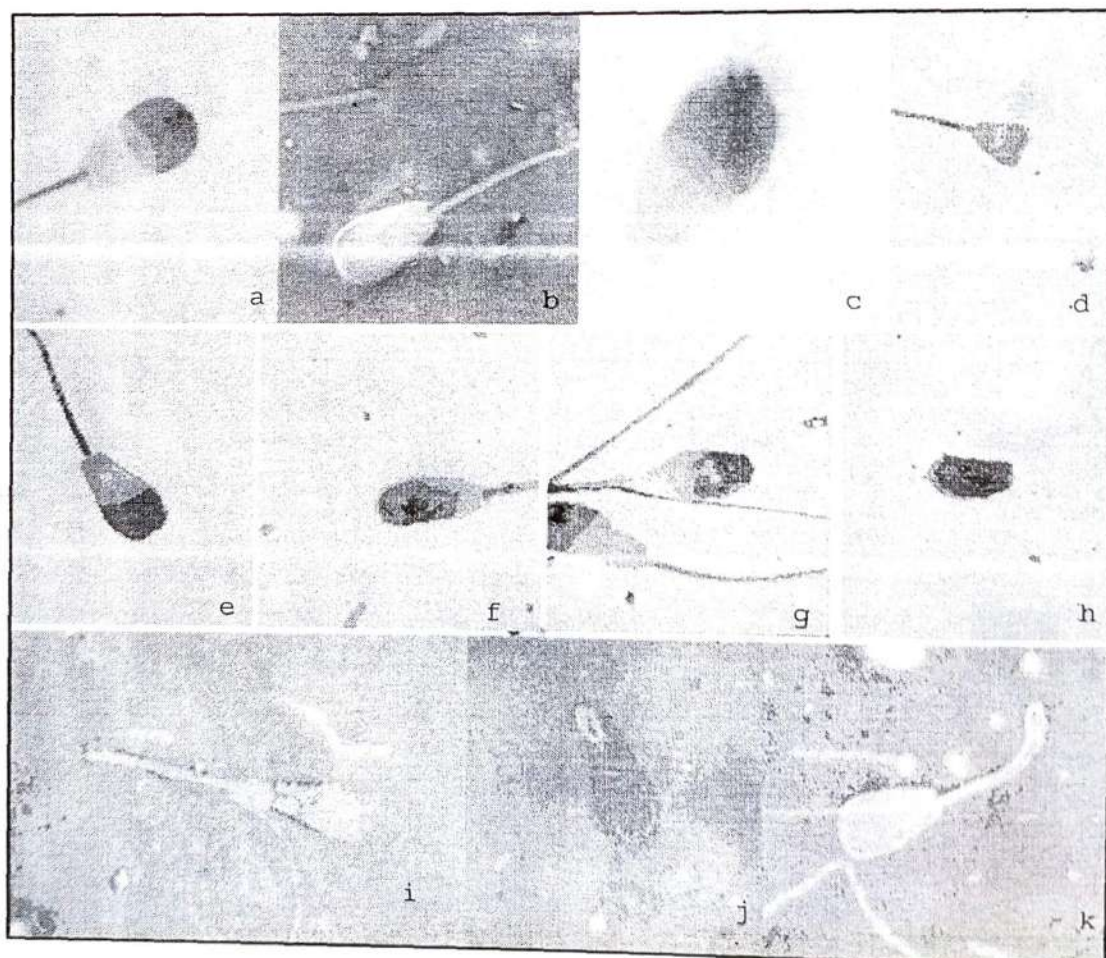


Plate : 3 Photograph showing different forms of sperm/acrosomal abnormalities in semen of triplebred bulls.
 (a) Intact acrosome (b) Live and dead sperms (c) Swollen acrosome (d) Loss of acrosome (e) Ruffled acrosome (f) Disintegrated acrosome (g) Knobbed acrosome (h) Detached gelia capitis (i) Proximal protoplasmic droplet (j) Dag defect (k) Bent tail

2.73 ± 0.09, 2.43 ± 0.09, 2.22 ± 0.09 and 3.17 ± 0.12 %, and at post-thaw stage 3.69 ± 0.12, 3.79 ± 0.13, 3.63 ± 0.12 and 5.32 ± 0.16 %, respectively (Table 5, Figs. 2 & 3). The differences due to bulls, freezing stages and additives were significant ($P < 0.01$) for all four defects (Table 6). The incidence of different abnormalities increased significantly in post-thawed semen than the prefreeze or fresh semen. The values of all the defects were also significantly lower in diluent containing EDTA and/or cysteine as compared to control (Table 5). In general, the trend of variations observed in incidence of swollen, ruffled, denuded and detached acrosome due to freezing steps closely followed the trend of total damaged acrosome, overall and in different bulls.

The incidence of different forms of acrosomal abnormalities observed in the present study coincided well with the previous reports (4,24). Moreover in fresh bull semen, Saacke *et al.* (26) recorded the incidence of knobbed, incomplete and ruffled acrosomes as 5, 20 and 8 %, respectively. Chenoweth *et al.* (27) concluded that Giemsa stain method of Watson (11) proved reliable only for depiction of damaged and abnormal acrosomes, but not for the intact, loosened and lost acrosomes. In one of the earlier studies, the mean post-thaw acrosomal abnormalities, viz. ruffled, swollen, incomplete, damaged and knobbed acrosomes have been reported as 0.23 ± 0.06, 3.29 ± 0.67, 5.35 ± 0.94, 11.34 ± 1.82 and 0.52 ± 0.10 %, respectively, in crossbred bulls' semen (28), while in another study (22) the percentage of intact acrosome in fresh and post-thawed semen of HF x J x Haryana bulls was reported as 74.05 ± 1.15 and 69.40 ± 1.29, respectively, along with the incidence of knobbed, swollen, denuded, incomplete and ruffled acrosomes. However, it was difficult to find comparable report as we studied in the literature wherein the effect of additives on acrosomal abnormalities was studied before and after freezing of bovine semen.

From the findings, it was concluded that sperm and acrosome abnormalities were significantly lower at all stages of cryopreservation of TP bulls semen in the presence of EDTA and cysteine HCl, suggesting that either of the two additives can be routinely added in the semen extenders with the beneficial results while freezing crossbred bulls' semen for use in artificial insemination.

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Use of ultrasound in diagnosis of abdominal and pelvic disorders in dogs

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Abstract

A study on use of ultrasound in diagnosis of abdominal and pelvic disorders in dogs was conducted in 16 adult dogs of either sex. The objective of the study was to be familiar with diagnostic ultrasound and to study and selectively record the images of normal and abnormal organs. Eleven clinical cases were scanned for the purpose, amongst which, three bitches were presented for pregnancy diagnosis, a full term bitch was scanned and five live fetii were observed. The other two bitches were brought for confirmation of fetus in the uterus postpartum. Two more bitches were subjected to USG for confirmation of pyometra. Other abdominal organs like kidney, liver and the organs of urinary system were scanned in rest of the cases. Imaging and recording the changes in the kidneys and location of altered anatomical pattern could confirm renal failure cases. During the course of study, a case of urinary incontinence showed presence of bladder calculus accompanied with cystitis. Ultrasonographic features were found useful to correlate associated etiological factors in the cases having ascites. The ultrasonography was found to be an effective additional confirmative diagnostic tool and should be used in day-to-day veterinary clinical practice.

Key words: Ultrasound, dog, pelvic disorder

Introduction

Ultrasound is like ordinary sound except it has a frequency higher than humans can hear. The sound waves are reflected from the internal structures. These returning echoes are then received by the transducer and converted by an electronic instrument into an image on a monitor (1). Ultrasonography is used in the needle-guided biopsy of internal organ (2). In its two-dimensional form, ultrasonography is used extensively for abdominal and thoracic examinations (3). It is useful in animals to diagnose pregnancy, as the fetal heartbeat cannot be found early in pregnancy (4). The present report describes the use of ultrasonography for diagnosis of pregnancy and other abdominal as well as pelvic disorders in dogs.

Materials and methods

The present study on use of diagnostic ultrasound for abdominal and pelvic disorders in dogs was carried out on five clinically healthy and eleven sick dogs

registered at Veterinary College Hospital, Anand. This included: Pregnancy diagnosis in 3, Pyometra in 2, Ascites in 3, Renal failure in 2 and Anuria/ Urolithiasis in a dog. ALOKA SSD-500 model with two convex probes of 3.5 and 5 MHz was used for ultrasonography. For abdominal scanning, the animal was positioned on the table in dorsal recumbency, specifically, with its head away from the sonographer.

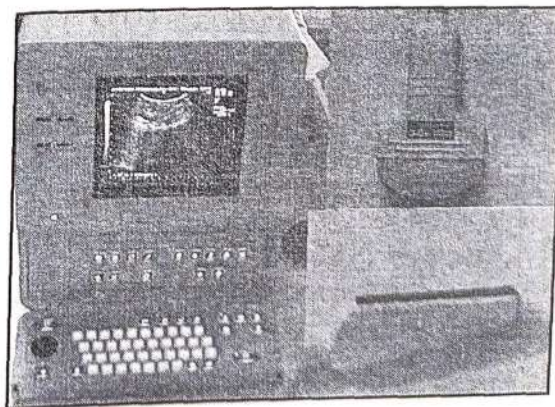


Plate-1 : Ultrasonic Instrument with probes

For liver procedures, the scan head was placed directly under the sternum with firm but gentle pressure application at the level of 11th and 12th intercostals space. The left kidney was easier to locate sonographically by direct placement of the scan head in the sublumbar region on left side. As the canine right kidney is present more cranially attempts of scanning the right kidney at the level of 11th –12th intercostals space were made. The urinary bladder was located by placing the scan head mid-abdominal and it was gradually moved caudally for imaging of the bladder neck and urethra. In females, locating uterus was easy by taking urinary bladder as acoustic window, as uterus lies immediately dorsal to the bladder. The uterus was scanned close to the midline ventrally first, then according to the bladder where it was displaced.

Results and discussion

Five normal dogs were initially scanned to be familiar with equipment and to study normal anatomic configuration of important abdominal and pelvic organs. Early diagnosis of pregnancy has become a concern in veterinary practice. As stated by Cartee and Rowles (4) ultrasound has been used to detect pregnancy in the bitch as early as 10 days post breeding. During the present study, 3 bitches were presented for pregnancy diagnosis. In one full term bitch, USG revealed 5 live fetii: 3 in one horn and 2 in another. Fetal movements and heartbeats of all the 5 fetii could easily be seen on the monitor. And other two bitches were brought for confirmation of presence of any fetus still present in the uterus after whelping. Both the bitches were subjected to clinical examination, and then confirmed by ultrasonography, which showed uterine enlargement by more echogenic image than normal due the presence of fluid and fetal as well as maternal membranes. The sites of placentation were found to be enlarging than the interplacental uterus. On longitudinal scan, the placental sites looked oval shaped (5).

Two cases were subjected to scanning of uterus for confirmative diagnosis of pyometra. USG of one bitch revealed enlargement of right uterine horn as compared with the left and the hyperechogenicity of the horn indicating presence of material in the uterus. Additionally there was thickening of the uterine wall as compared to normal. USG image of the second bitch showed increased thickness of both the uterine horns and wall. Hyperechogenic material that showed swirling movements was also evident (6).

A total of six dogs having problem related to urinary system were scanned. This included, three cases of ascites, two cases of renal failure and one case of urinary incontinence.

Three cases of ascites were evaluated by USG to know the related features, if any. One of the ascitic dogs, upon USG did not demonstrate any changes in kidneys but showed enlargement of liver which has been reported to be very rare by Henley *et al.* (7). USG of left kidney revealed hypoechogenicity of pelvis than right kidney in another case with clinical evidence of ascites. The 3rd case actually brought for pregnancy diagnosis as the owner observed abdominal enlargement with unknown history of matting. On palpation, no fetus could be felt however, fluid thrill was indicative of ascites. Hemato-biochemical evaluation carried out latter revealed increased BUN and serum creatinine levels. On USG there was neither uterine enlargement nor the presence of any fetus. Left kidney was normal but the right kidney was enlarged in size with renal pelvis dilatation indicative of hydronephrosis. (Plate 2).



Plate-2 : Hyperechoic renal pelvis with dilatation of medulla

Upon USG, a dog suspected for renal failure based on clinical and clinicopathological findings, showed extensive hyperechoic region of renal pelvis in sagittal view suggestive of renal pelvis dilatation. The entire right kidney was too large to be included on the ultrasound scan as has also been stated by Cartee *et al.* (8). Another suspected case with increased BUN and serum creatinine values and decreased total plasma proteins, showed pelvis dilatation of the left kidney, which was exhibited by increased hypoechoic medullary region than normal. The bladder did not depict changes except presence of little amount of urine. Large visible calculi was observed in the bladder (Plate 3).

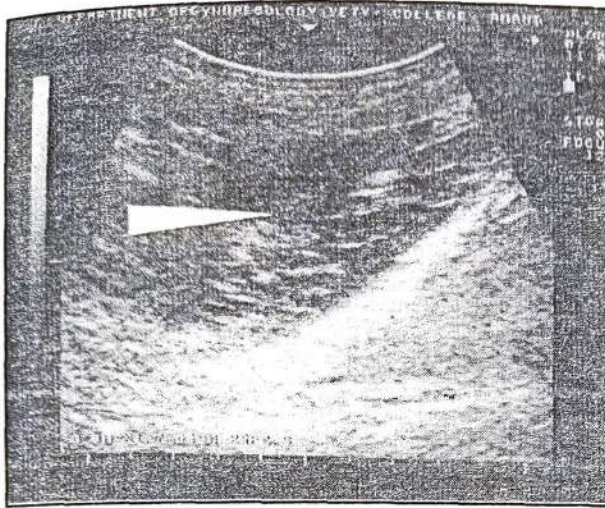


Plate-3 : Calculi in Urinary bladder

A case of urinary incontinence was studied, in which ultrasonographic picture revealed cystitis with increase in urinary bladder thickness to 4 mm and presence of bladder calculi accompanied by hydronephrosis.

Summary

Ultrasonography was used as a diagnostic modality in five normal and eleven unhealthy adult dogs of either sex for diagnosis of abdominal and pelvic disorders. Five normal dogs were scanned to be familiar with the USG machine and to know ultrasonographic features of normal organs. A full term bitch was scanned in which five live fetii were observed. The two other bitches were brought for confirmation of fetus in the uterus postpartum, which on USG examination were confirmed as non-gravid with postpartum uterine changes. Two more bitches were subjected to USG for confirmation of pyometra revealed a case of unilateral closed pyometra and a confirmative diagnosis of bilateral open pyometra. Other abdominal organs like kidney, liver and the organs of urinary system were scanned in rest of the cases. Imaging and recording the changes in the kidneys and location of altered anatomical pattern could confirm two renal failure cases. Three cases of ascites were scanned; in which associated factors were correlated.

A case of urinary incontinence showed cystitis accompanied with presence of calculi in the bladder. It was concluded that the ultrasonography was found to be an effective additional confirmative diagnostic tool and should be used in day-to-day veterinary clinical practice.

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Heterosis for seed yield, its components and wilt resistance in castor (*Ricinus communis* L.)

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Castor, *Ricinus communis* L. ($2n = 20$) is an important non-edible oil seed crop of arid and semi-arid regions of India, which belongs to the genus *Ricinus* of Euphorbiaceae family. The phenomenon of heterosis has proved to be the most important genetic tool in enhancing the yield of self-pollinated as well as cross-pollinated species. With the availability of pistillate lines in castor, exploitation of heterosis or hybrid vigour on commercial scale has become commercially feasible and economical (1). In Gujarat, real break through in castor production has come with development and release of hybrids for commercial cultivation. In genetic improvement, selection of suitable parent is important for development of better hybrid. For this, it is always essential to evaluate available promising lines in hybrid combinations for yield and yield contributing characters (2). Some idea may be obtained from their *per se* performance, however, proper information on magnitude of heterosis for yield and its components would also be more helpful in selecting most suitable parents and desirable cross combinations for commercial exploitation of hybrid vigour. The present study was, therefore, undertaken to determine the extent of heterosis in castor to identify some superior hybrids.

The experimental material involving 10 parents viz., RG-392, RG-390, RG-611, 48-1, RG-724, JI-258, SKI-80, JI-244, DCS-9 and JI-35 and their 45 hybrids made through diallel mating design, were evaluated in a randomized block design with three replications in normal plot and in one replication in wilt-sick plot at the Main Castor-Mustard Research Station, Gujarat Agricultural University, Sardarkrushinagar during Kharif-2002. Each entry was planted in a single row of twelve dibbles keeping row-to-row distance of 90 cm and plant-to-plant distance of 60 cm. All the recommended agronomic practices and plant protection measures were adopted for raising normal crop (3). The observation were recorded on five randomly selected plants for each treatment in each replication for days to 50 per cent flowering, number

of capsules on main raceme, number of effective branches per plant, length of main raceme (cm), number of nodes upto main raceme, capsule cover weight (g), test weight (g), plant height (cm), seed yield per plant (g), oil content (%) and wilt incidence (%). Each character was analysed separately using analysis of variance techniques suggested by Panse and Sukhatme (4) and heterosis was calculated as per cent increase (+) or decrease (-) in the value of F_1 hybrids over mid-parent, better parent and standard check, GCH-5.

The analysis of variance for experimental design revealed considerable genetic variation among parents and hybrids for all the traits under study, which indicated that the experimental material was appropriate for the present study. Comparison of mean squares due to parents vs. hybrids were found to be highly significant for all the characters, which suggested that parental group as a whole was quite different from their F_1 's indicating the presence of mean heterosis for all the characters under study.

The number of crosses exhibited significant heterosis over mid-parent, better parent and standard check in desired direction for all the characters are presented in Table 1. With respect to seed yield, 28, 19 and only 1 hybrids manifested significant and positive heterosis over mid-parent, better parent and standard check, GCH-5, respectively. The results also showed that low to medium heterosis was observed for most of the important yield contributing characters. These results are in close conformity with earlier reporters (5, 6, and 7).

A comparative study of most of the standard heterotic crosses for seed yield per plant with heterobeltiosis for yield components (Table 2) revealed that hybrid, RG-392 x JI-258 expressing higher standard heterosis (11.21%) for seed yield per plant also manifested high Heterobeltiosis (41.96%) for seed yield. It also possessed the high heterosis for yield components viz., number of effective branches per

Table 1. Number of crosses exhibited significant heterosis over mid-parent, better parent and standard check for different characters in castor.

Characters	No. of crosses exhibiting significant heterosis over		
	Mid-parent	Better parent	Standard check
Days to 50 per cent flowering	27	33	20
Number of capsules on main raceme	35	25	03
Number of effective branches per plant	24	18	16
Length of main raceme (cm)	19	11	07
Number of nodes up to main raceme	13	04	00
Capsule cover weight (g)	27	16	04
Test weight (g)	30	20	07
Plant height (cm)	23	09	45
Seed yield per plant (g)	28	19	01
Oil content (%)	24	15	00
Wilt incidence (%)	19	23	00

Table 2. Heterotic crosses and their performance for seed yield per plant and its component characters.

Best heterotic hybrids	Heterobeltiotic effect								
	Seed yield per plant (g)	Days to 50 % flowering	Number of capsules on main raceme	Number of effective branches per plant	Length of main raceme (cm)	Test weight (g)	Plant height (cm)	Oil content (%)	Wilt incidence (%)
RG-392 x JI-258	41.96** (294.33)	-10.40** (51.67)	42.84** (74.47)	12.92* (9.03)	10.76** (73.10)	1.39 (34.47)	-14.06** (62.73)	-4.62** 44.73	-72.50** (4.05)
RG-392 x RG-390	41.96** (294.33)	-13.59** (53.00)	14.67** (57.33)	11.67** (8.93)	-21.11** (52.07)	-1.48* (33.50)	-18.78** (69.20)	-3.30** (45.38)	-77.50** (4.05)
RG-392 x JI-35	22.03** (253.00)	-21.16** (49.67)	30.40** (65.20)	-23.33** (6.13)	-14.85** (56.20)	-9.36** (30.82)	-18.15** (87.20)	4.94** (48.81)	-0.41 (45.27)
RG-390 x RG-611	15.99** (239.33)	-9.24** (55.67)	6.03 (45.93)	2.86 (7.20)	39.43** (65.53)	10.44** (34.24)	6.67* (90.67)	-8.84** (42.78)	-83.44** (4.05)

Where

• * & ** indicates significant at $p = 0.05$ and $p = 0.01$ levels, respectively.

• The figures in the parenthesis shows mean performance for respective character.

plant, length of main raceme, number of capsules on main raceme and wilt incidence. Similar trend was observed in other heterobeltiotic hybrids, RG-392 x RG-390, RG-392 x JI-35 and RG-390 x RG-611. These results substantiated the findings of Mehta *et al.* (8). The expression of such heterosis arises from the combinations of favourable yield components.

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Nutrient removal by weeds in summer soybean [*Glycine max* (L.) Merrill.]

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Soybean is highly infested by weeds due to initial slow growth rate causing considerable yield losses ranging from 27 to 71 per cent (1). About 30 to 40 per cent of applied nutrients can be utilized by weeds for their growth and development, if weeds are not managed in time (2). A field experiment was conducted at the Gujarat Agricultural University, Navsari during the summer season of 1999. The soil was clayey in texture and neutral in reaction with poor in total nitrogen, medium in available phosphorus and fairly high in available potash. Fourteen treatments (Table 1) were compared in a randomized block design with three replications. Soybean variety Gujarat Soybean 2 was sown on 3rd February, 1999. The herbicides were applied as aqueous solution @ 600 liters ha⁻¹ as per treatments.

Seed and straw yields

Pre-sowing application of fluchloralin @ 1.0 kg ha⁻¹ supplemented with hoeing and HW at 30 DAS recorded higher seed and straw yields and was at par with pre-emergence application of pendimethalin @ 1.0 kg ha⁻¹ with hoeing and HW at 30 DAS, but both these treatments were significantly superior to rest of the treatments. The improvement in yield under these treatments was might be due to reduction in weed competition by effective weed control which increased availability of nutrients to crop (Table 1). The weed competition throughout the growing season resulted in 55 % and 49 % reduction in seed and straw yields, respectively. These findings are in agreement with those of Ahmed *et al.* (3).

Among the different herbicides, in general, pre-sowing application of fluchloralin @ 1.5 kg ha⁻¹ alone recorded the highest seed and straw yields of soybean and followed by pendimethalin @ 1.5 kg ha⁻¹ as pre-emergence. Thus, integration of physical and chemical methods of weed control reduces the herbicide requirement and increased yield and uptake of nutrients by crop.

Nutrient uptake by crop

The highest nitrogen and phosphorus uptake by soybean crop was recorded with the application of fluchloralin @ 1.0 kg ha⁻¹ + hoeing followed by HW at 30 DAS but did not differed significantly with pendimethalin @ 1.0 kg ha⁻¹ + hoeing followed by HW at 30 DAS treatment (Table 1). Higher amount of nitrogen and phosphorus removed by the crop under these treatments might be due to lower crop weed competition owing to higher crop canopy in terms of plants spread and branches. The lowest nitrogen and phosphorus uptake by seed, straw and crop were recorded under unweeded control and was at par with hoeing + HW at 30 DAS but these both the treatments were significantly inferior to rest of the treatments. Among the different herbicides, pre-sowing application of fluchloralin @ 1.5 kg ha⁻¹ recorded the highest nitrogen and phosphorus uptake by the crop. These results are in agreement with those of Gediya *et al.* (4).

Nutrient removal by weed

Nitrogen and phosphorus removal by weed were significantly influenced due to different weed management practices (Table 1). The lowest uptake of nitrogen by weeds was noticed with the application of fluchloralin @ 1.0 kg ha⁻¹ pre-sowing with hoeing and HW at 30 DAS, and was at par with pendimethalin @ 1.0 kg ha⁻¹ as pre-emergence with hoeing and HW at 30 DAS but both these treatments were significantly inferior to rest of the treatments. Similarly, in both the integrated weed management treatments, removal of phosphorus by weeds was minimum. Application of these herbicides checked the weed growth from initial stage, whereas, hand weeding and hoeing at 30 DAS were effectively controlled weed which emerged later on resulting in considerably lower weed biomass production ultimately reduced the removal of nitrogen and phosphorus by weeds. The weeds of unweeded control treatment has

Table 1. Effect of weed management treatments on seed yield, straw yield and nutrient uptake

Sr. No.	Treatments	Yield (kg ha ⁻¹)		Uptake by soybean (kg ha ⁻¹)						Uptake by weeds (kg ha ⁻¹)	
				N Uptake			P Uptake			N Uptake	P Uptake
		Seed	Straw	Seed	Straw	Total	Seed	Straw	Total		
T ₁	Fluchloralin 1.5 kg ha ⁻¹ pre-sowing	993	1,595	62.49	36.88	99.37	5.09	3.03	8.12	6.42	0.57
T ₂	Fluchloralin 1.0 kg ha ⁻¹ pre-sowing	931	1,377	57.44	31.59	89.03	4.28	2.39	6.67	6.71	0.60
T ₃	Pendimethalin 1.5 kg ha ⁻¹ pre-emergence	987	1,410	61.21	31.99	93.20	4.93	2.48	7.40	6.65	0.55
T ₄	Pendimethalin 1.0 kg ha ⁻¹ pre-emergence	852	1,265	52.20	28.40	80.60	3.94	2.27	6.21	7.66	0.70
T ₅	Alachlor 2.0 kg ha ⁻¹ pre-emergence	840	1,235	51.32	27.31	78.63	4.27	2.01	6.27	7.88	0.61
T ₆	Alachlor 1.5 kg ha ⁻¹ pre-emergence	803	1,194	48.92	26.12	75.04	3.61	1.86	5.47	8.62	0.68
T ₇	Oxyfluorfen 0.25 kg ha ⁻¹ pre-emergence	881	1,350	53.93	29.82	83.75	4.37	2.24	6.61	8.01	0.67
T ₈	Oxyfluorfen 0.20 kg ha ⁻¹ pre-emergence	834	1,209	50.85	26.35	77.20	3.75	1.90	5.65	9.44	0.69
T ₉	Fluchloralin 1.0 kg ha ⁻¹ pre-sowing + Hoeing and hand weeding at 30 DAS	1,271	1,906	81.79	48.78	130.78	7.00	4.05	11.05	3.17	0.30
T ₁₀	Pendimethalin 1.0 kg ha ⁻¹ pre-emergence + Hoeing and hand weeding at 30 DAS	1,204	1,800	76.53	43.52	120.05	6.48	3.59	10.07	4.40	0.38
T ₁₁	Alachlor 1.5 kg ha ⁻¹ pre-emergence + Hoeing and hand weeding at 30 DAS	1,005	1,641	63.40	37.96	101.36	5.34	3.13	8.34	6.19	0.50
T ₁₂	Oxyfluorfen 0.20 kg ha ⁻¹ pre-emergence + Hoeing and hand weeding at 30 DAS	993	1,543	61.71	34.25	95.96	5.16	2.76	7.92	6.78	0.57
T ₁₃	Hoeing followed by hand weeding at 30 DAS	685	1,037	41.02	18.02	59.04	3.16	1.58	4.74	14.10	0.99
T ₁₄	Unweeded control	578	968	32.40	16.23	49.03	2.38	1.28	3.66	43.08	2.48
	CD at 5 %	141	193	9.86	7.41	10.79	1.11	0.52	1.37	2.11	0.13

depleted significantly the highest nitrogen and phosphorus per hectare. Similar results were also reported by Gediya *et al.* (4). Among the different herbicidal treatments, pre-sowing application of fluchloralin @ 1.5 kg ha⁻¹ recorded the lowest nitrogen uptake by weeds whereas, removal of phosphorus was the minimum under application of pendimethalin @ 1.5 kg ha⁻¹ as pre-emergence.

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Histomorphological studies on rosettee of furstenberg of the Surti heifers

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The rosette of furstenberg is one of the components of the secretory apparatus of mammary glands as well as it is also playing a key role in leucocytic phagocytosis of the infective pathogens (1). This area is grossly recognized by the convergence of the longitudinal mucosal folds of teat canal near teat orifice. The detailed microstructure and its prepubertal development of this structure in buffalo heifers is lacking in the literature. Hence, an attempt is made to study the histomorphology of the rosette of furstenberg.

The mammary glands of prepubertal buffalo heifers were procured from the local abattoirs of Anand town. The glands were studied under the seven age groups comprised of six animals in each. The age groups described were 3 months, 6 months, 1 year, 1.5 years, 2 years, 2.5 years and 3 years (considered as prepubertal age). The right fore quarters (# 6) were collected from each specimen under the group for the study. The tissue pieces of 0.5 cubic cms from a teat near its apex were collected and processed for the paraffin section cutting method. The cross sections and longitudinal sections at 6-8 μ m thickness was obtained on rotary microtome. The micro-thin sections were stained with the following staining techniques:

- H. & E. Staining method for routine observations of the tissue (2)
- Hart's staining method to differentiate the connective tissue fibers and muscles (2)
- Alcian blue-PAS staining method to study the distributions of mucopolysaccharides (3)
- Succinic dehydrogenase activity (4)

The mucosa of the rosette of furstenberg was highly folded and lined by double-layered epithelium. The mucosal folds were 5-8 at 3 months, 6-8 at 6 months and increased up to 8-10 at 1 year onwards up to 3 years. The cross section of rosette showed stellate

shaped lumen with primary and secondary folds at 3 months and 6 months (Fig. 1). The tertiary folds appeared from 1 year onwards (Fig. 2). The lumen was completely obliterated by the mucosal folds. The lining epithelium of the rosette was made up of superficial tall columnar cells and basal cuboidal cells. The sub epithelial lining presented collagen fibers, elastic fibers, fibroblasts and blood capillaries in the tunica propria. There were also present leucocytes, plasma cells and lymphocytes at the age of 2 years onwards in the tunica propria. The wall of rosette below the tunica propria presented circularly arranged smooth muscles layers supposed to be continued from sphincter the in wall of the streak canal. The V.G. stain differentiated the alternate arrangement of collage and smooth muscle fibers. The elastic fibers were also noticed in the loose connective tissue of tunica propria and blood capillaries. External to this layer there appeared the irregularly arranged dense connective tissue of the dermis and the cell layers of the epidermis of the teat skin. The outer skin was non hairy and no glandular structure. Nickerson and Pankey (5) reported in adult bovines that there were 6-10 mucosal folds in the rosette of furstenberg. The lymphocytes and monocytes were commonly observed in the epithelial lining. However, the underlining connective tissue contained lymphoid cells and neutrophils in comparison to teat cistern in adult cows. They also reported that the plasma cells were the most prevalent cells in the sub epithelial stroma of the rosette and were also observed in the epithelial lining. The present study also revealed the connective tissue cells like lymphocytes, plasma calls and leucocytes but to a much lesser extent in the sub epithelial connective tissue areas. The succinic dehydrogenase and the PAS staining methods revealed moderate activity of the enzyme and the neutral mucopolysaccharides in the tissue. It indicated the slow developmental stage of the tissue structures.



Fig. 1. Photomicrograph of rosette of Furstenberg (c.s.) showing the mucosal folds and circularly arranged muscles around the tunica propria at 6 months aged heifer. Moderate activity of the succinic dehydrogenase activity of the enzyme is also noticed (Succinic dehydrogenase, Nuchlas 1957, X 225).

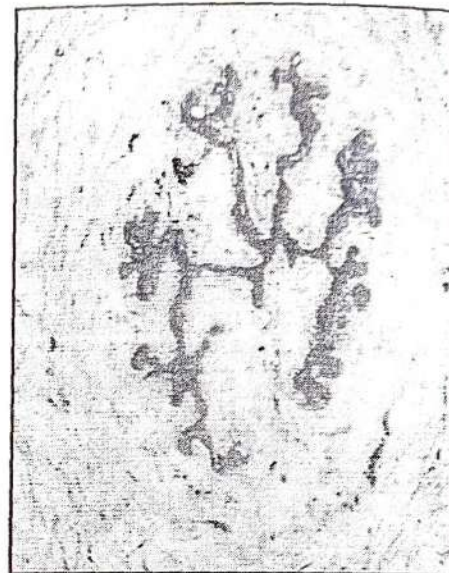


Fig. 2. Photomicrograph of rosette of Furstenberg (c.s.) showing the mucosal folds and circularly arranged muscles around the tunica propria at 2.5 years aged heifer. Note the tertiary mucosal folds appeared in the mucosa (H. & E. stain, X 225).

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A case study of equine ringworm and its treatment

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Ringworm is a fungal skin disorder caused by dermatophytic fungi. The *Microsporum* and *Tricophyton* are etiological agents in most of the domestic animals. Equines are usually less commonly affected by ringworm and superficial lesions are more common; lesions usually appear on trunk, over the rump and may spread to head, neck and limbs. In the present study, a clinical case of ring worm in a mare caused by *Microsporum gypseum* is presented which was treated with topical application of Whitefield ointment twice a day for seven days.

A Bay Indian mare aged about three years was admitted to the College hospital with a history of pruritic skin lesions for the last 21 days. Clinical examination revealed multiple, discrete, small, bare crusted patches on the neck and withers. At places, few of them coalesced to form larger, circumscribed and inflammatory lesions with raised margins. The affected part was cleaned with 70 % alcohol and allowed to dry, with help of sterile blunt scalpel, margins of the lesions was scrapped and the scraping was collected in sterile petridish. The material was first examined under 10% KOH and then inoculated in to slant of Sabouraud-cycloheximide-chloramphenicol media and was incubated at room temperature. Macro and micromorphological studies were made on the 10th and 14th days respectively as per the methods of Ajello *et al.* (1). Direct examination revealed fungal elements. In the slants, the growth was rapid and on the 10th day, a regular circular colony with coarser granular structure-texture reached the diameter of 16 mm. The surface colour was creamy white. The microscopic examination in diluted Albert's solution-I (2) showed profused spindle shaped 3-6 celled macroconidia with thin shells and rough surface which indicated the *Microsporum gypseum* fungi.

Ringworm is a fungal skin disorder caused by *Microsporum* and *Tricophyton* in most of the domestic animals. Equines are usually less commonly affected by ringworm and superficial lesions are more

common (3). Typical symptoms of equine ring worms are dry, raised, scaling lesions with circumscribed bare patches on any part of animal, but usually around neck, saddle and hind quarters (4) but in the present case the lesions were moist, crusted and inflammatory which seems atypical type indicating the . This fungi is geophilic dermatophyte the change in habit is usual with increase virulence.

Different type of topical treatments like washes and sprays of medicine in horse have been documented (3). In the present case, the lesions were thoroughly washed with luke warm water and the crusts were removed. Whitefield ointment was applied over the affected part and was gently rubbed. The application was continued daily for seven days. The lesions become dry and inflammation was reduced after third application and on seventh day complete healing was noticed followed by regeneration of hairs with in ten days and the patches were covered. The scraping then further tested in laboratory revealed no lesions. The course in equine ring worm is about eight weeks and there is current opinion that topical treatment does not influence the course of infection though it may reduce the amount of infection (4).

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NOTIFICATION

The SDAU Germplasm Identification Committee vide its meeting held on August 31, 2007 considered different genetically diverse materials for identification for registration at NBPGR and identified following *sui-generis* genetically diverse material of pigeonpea for registration.

Sr. No.	A (CGMS) lines/ B (maintainer) lines
1	CMS GT 87A/GT 87B
2	CMS GT 289A/GT 289B
3	CMS GT 301A/GT 301B
4	CMS GT 302A/GT 302B
5	CMS GT 303A/GT 303B
6	CMS GT 304A/GT 304B
7	CMS GT 305A/GT 305B
8	CMS GT 306A/GT 306B
9	CMS GT 307A/GT 307B
10	CMS GT 308A/GT 308B
11	CMS GT 309A/GT 309B
12	CMS GT 310A/GT 310B
13	CMS GT 311A/GT 311B
14	CMS GT 401A/GT 401B
15	CMS GT 402A/GT 402B
16	CMS GT 403A/GT 403B
17	CMS GT 404A/GT 404B
18	CMS GT 405A/GT 405B
19	CMS GT 406A/GT 406B
20	CMS GT 501A/GT 501B
21	CMS GT 502A/GT 502B
22	CMS GT 503A/GT 503B
23	CMS GT 504A/GT 504B
24	CMS GT 505A/GT 505B

Sr. No.	R (Restorer) lines
1	GTR 7
2	GTR 9
3	GTR 35
4	GTR 39
5	GTR 42
6	GTR 43
7	GTR 51
8	GTR 52
9	GTR 54
10	GTR 55