GUJARAT AGRICULTURAL UNIVERSITY

RESEARCH JOURNAL

VOLUME : 10 NUMBER : 1 JULY, 1984

GAU RES. J. 10 (1)

Gujarat Agricultural University Research Journal

July, 1984
Vol. 10, No. 1

Editorial Office:
Publication Unit,
Gujarat Agricultural University,
Shahibag, Dafnala,
Ahmedabad
380 004. INDIA

CONTENTS

Short Communications

SUGGESTIONS FOR CONTRIBUTORS

Gujarat Agricultural University Research Journal is published biannually, in January and July.

General Requirements:

Articles must be original reports of research in agricultural science, comprising Agriculture, Dairy, Animal Husbandry and Veterinary, Agricultural Engineering, Home Economics, Basic Sciences and Humanities, Forestry, Fisheries etc., not previously or simultaneously published in any other scientific or technical journal. The papers are to be submitted in duplicate inclusive of illustrations. They must be concise and not unnecessarily elaborate. Papers are accepted subject to the right of minor editorial revision if considered necessary. No reasons will be given in cases of non-acceptance of the articles.

Articles will be accepted only from the author who is the subscriber of the journal.

Short Communication:

Short communication should include title of communication, followed by the names of authors and department of origin. The reporting matter shall be a continuous report with minimum references and it may not exceed two to three typed foolscaps.

Manuscript:

The manuscript must be typed, in double space on standard typewriter with pica lettering on one side of 32 cm x 20 cm paper with 4 cm margin. The lines of type must be numbered on each page in the margin. No overwriting is admissible.

Title page should be separate and have the following : title of paper, authors, department of origin, complete address for mailing and a suggested running title not exceeding 40 letters.

Text should have the following subdivisions: Abstract—not exceeding 125 words in the beginning, Introduction, Materials and Methods, Results and Discussion may then follow. The introduction should not be very elaborate.

Table should be numbered consecutively and typed on separate sheets. The tables should be designed in a manner to fit 14 cm x 19 cm space on printing. Matter which is presented in charts and graphs should not be duplicated.

Foot-notes should be numbered consecutively and typed at the bottom of the pages. The symbols to be used for indicating foot-notes will be: *, †, §, * *, ‡, etc.

Illustrations and Figures:

Photographs for halftone production should be glossy prints with good dark and light contrast. Line drawings and graphs should be prepared in India ink on thick white paper of atleast twice the size of final reproduction. Each illustration should carry the title of the paper, the number of the figure on its reverse. They are to be numbered in Arabic numerals. Legends to individual figures or graphs should be given on separate sheet.

Nomenclature Abbreviations and Unit of Measures etc.:

Unfamiliar or new terms and arbitrary, abbreviations should be defined when first used. Proprietory or the trade names should begin with capital letters. The chemical names should precede the trade name, the first time it occurs. The Latin binomial or trinomial and authority must be shown for all plants, insects and pathogens at first listing. Crop varieties (not experimental lines and strains) should be identified by single quotation mark at first listing only, e.g. 'Ranger'

alfalfa (*Medicago sativa* L.) or *Medicago sativa* L. Ranger; and *Bothriocola ischalmum* var. *songarica* Rupr. Cel. et Harl., King Ranch.

Units of measures must be in metric system. All yield of crops must be reported in units of weights or mass.

Referencing:

References should be arranged according to Harvard system. In the text, the reference to other work should give the surname of author followed by the year of publication. More than one paper in one year being indicated by small letters a, b, c after the year.

The list of reference at the end of the paper should be in the alphabetical order of the surnames of the first author of each paper and should include authors name followed by initials, year of publication, title of article, title of publication abbreviated in accordance with the world list of scientific periodicals, volume number in Arabic numbers underlined with a line to indicate bold type, and then the number of first and last page. For example:

Karper, R. E. and J. C. Stephens, 1936. Floral abnormalities in sorghum, *J. Hered.* **27:** 183-94.

Steel, R. G. D. and J. H. Torrie. 1960. Principles and Procedures of Statistics. Mc. Graw Hill Book Co., Inc., New York. p. 136.

Reprints:

Twentyfive reprints will be supplied free of charge to author(s). Additional reprints may be had on payment.

Copyright:

Rate of Annual Subscription :

Rs. 20/- (in India)
$8 or £ 3.25 (foreign)
Rs. 10/- (for GAU scientists)

The cheque or demand draft issued in favour of "*Gujarat Agricultural University, Ahmedabad*", should be sent to the Publication Unit.

Information for Subscriber:

Correspondence concerning business matters should be addressed to the Publication Unit, Gujarat Agricultural University, Shahibag, Ahmedabad-380 004 (India).

GAU Res. J. 1984, 10 (1) : 1-7

Combining Ability Analysis in Sorghum*

M. H. Patel, K. B. Desai and M. U. Kukadia

Department of Plant Breeding & Genetics, GAU, Navsari

ABSTRACT

Thirty-six hybrids of sorghum (*Sorghum bicolor* (L.) Moench) were grown alongwith 3 female parents (fertile counterparts of male steriles), 12 male parents and GJ 108 and CSH 5 as checks. Additive genetic variance predominantly governed the expression of yield and components in present set of material.

Line 2077 A was a superior female for number of grains and grain yield, whereas SPV 228 and SPV 230 were good combiners for these characters. Specific combination 2219A x SPV 226 appeared most desirable for grain yield.

(Received on 23rd Oct. 1981)

INTRODUCTION

The object of hybridization is to combine in a single genotype desirable genes contained in two or more genotypes. However, the choice of the parents and the choice of cross are the two basic things about which the breeder must have some information. Among several experimental designs, line X tester design enables the geneticist to evaluate large number of genotypes for their suitability as parents for hybridization. Present study reports on this aspect of sorghum.

MATERIALS AND METHODS

The experimental material comprised of 36 F_1 hybrids, derived by crossing 12 diverse varieties to 3 diverse male sterile lines alongwith 15 parents (12 males and 3 fertile counterparts of male sterile lines). The fifty-three genotypes were grown in 1979 *kharif* season at N. M. College of Agriculture, Navsari in a randomized block design with three replications. GJ 108, an improved local variety and CSH 5 a released hybrid were used as check. Plot size comprised of 3 rows 3m long spaced 45 cm apart.

Observations were recorded on 5 competitive plants in each replication on days to 50% bloom, plant height (cm), length of the panicle (cm), panicle circumference (cm), panicle weight (g), number of whorls/panicle, number of primaries/panicle, length of primary branch, number of primaries/ whorl, number of secondary branches/primary branch, number of grains/primary branch, number of grains/panicle, 1000-grain weight (g) and grain yield/plant (g). Data were analysed following Kempthorne (1957) and Rao *et al.* (1968).

RESULTS AND DISCUSSION

Analysis of the data revealed that there were singificant differences among the genotypes for all the attributes in-

*Part of M.Sc. (Agri.) thesis submitted by senior author to the Gujarat Agricultural University.

TABLE 1

Analysis of variance for combining ability for various characters studied in line x tester crosses in sorghum.

Source of variation	*df*	*Mean sum of square*						
		Days to 50% blooming	*Plant height*	*Panicle length*	*Panicle circumference*	*Panicle weight*	*No. of whorls per panicle*	*Number of primaries per panicle*
Replications	2	2.69*	35.03	35.22**	2.52	420.08	11.16**	65.11
Hybrids	35	49.76**	2179.42**	56.81**	12.64**	1404.76**	1.78**	270.52**
Males	11	27.98**	5358.97**	22.00	12.17**	1506.62**	1.74*	407.45**
Females	2	696.33**	4686.03**	798.67**	106.32**	13102.96**	13.51**	1690.42**
M x F	22	1.87**	361.77**	6.77**	4.35**	299.45**	0.74	91.15*
Error	70	0.73	93.92	3.83	1.72	174.05	0.89	24.21
$\hat{6}^2$ gca:		16.01	207.14	17.94	2.44	311.35	0.31	42.57
$\hat{6}^2$ sca:		0.38	89.29	0.96	0.87	41.79	–0.05	22.31
$\hat{6}^2$ gca/6_2 sca:		42.14:1	2.32:1	18.68:1	2.80:1	7.45:1	6.38:1	1.19:1

TABLE 1 (Contd.)

Source of variation	*df*	*Mean sum of squares*						
		Number of primaries/ whorl	*Length of primary branch*	*Number of second arises/ primary*	*Number of grains per primary*	*Number of grains/ panicle*	*1000-grain weight*	*Grain yield/ panicle*
	1	2	3	4	5	6	7	8
Replications	2	0.64*	0.01	6.83**	47.34	261634.77	0.20	232.42
Hybrids	35	1.25**	5.21	0.79**	120.14**	695483.01**	52.88**	718.45**
Males	11	2.57**	0.57	0.75	261.93**	1228991.19**	32.63**	801.25**
Females	2	2.25**	78.72**	3.08**	297.60**	3759379.75**	621.36**	5951.64**
M x F	22	0.5**	0.69	0.60	33.10	150192.85	11.33**	201.31
Error	70	0.19	0.45	0.42	22.55	132376.88	0.41	139.12
$\hat{6}^2$ gca:		0.08	1.73	0.06	10.96	104177.44	14.03	141.12
$\hat{6}^2$ sca:		0.11	0.09	0.06	3.53	5938.82	3.69	13.82
$\hat{6}^2$ gca/6_2 sca :		0.78:1	19.22:1	1.00:1	3.10:1	17.54:1	3.80:1	10.21:1

vestigated (Table 1). Female parents also followed the same trend. Rao *et al.* 1968 also reported that there were no differences among existing females with regards to grain yield. Mean squares for male parents were also significant for all characters except length of primary and number of secondary/primary branches. This finding is, however, contradictory with the findings of Rao *et al.*, (1968). It is possible that the dry spell which prevailed during the later part of the season when experiment was conducted led to non-significant differences among the parental lines. On the other hand, the hybrids differed significantly for all the characters indicating that heterozygotes are more homeostatic. Mean squares for parents *vs.* hybrids were also significant for all the characters which strongly implied heterosis for these attributes.

Almost all the characters under study (Table 1) revealed preponderance of additive genetic variance. Importance of additive genetic variance for grain yield components was also observed by Whitehead (1962), Kambal (1963), Kambal and Webster (1965), Niehaus and Pickett (1966), Beil and Atkins (1967), Rao *et al.*(1968) and Shankargowda *et al.* (1972). On the other hand, several reports are available where non-additive genetic variance was found to be of greater importance for grain yield (Nagur and Murty, 1970; Rao *et al.*, 1970; Goud, 1971; Goud *et al.*, 1973 and Govil and Murty, 1973). It depends on the material used whether additive genetic variance or the non-additive genetic variance is important because the gene frequences and degree of dominance influence the magnitude of the components of genotypic variances.

The estimates of combining ability effects for grain yield and number of grains revealed that 2077A was most desirable female and SPV 228 as well as SPV 230 were most desirable males by virtue of their significant positive gca effects (Tables 2 and 3). On the other hand for 1000-grain weight, 36A appeared to be a good female and SPV 221, SPV 225 and SPV 231 were desirable males.

Since early maturity and medium stature are desirable, parents with negative gca effects would be desirable. It was found that 2219 A was most superior female parent with respect to these traits. However, among male parents, SPV 224 and 221 were found to be desirable for days to flowering, while SPV 230 and 223 were desirable for plant height (Tables 2 and 3).

Two best parents (both female as well as male, best F1s, best general combiners and the best specific cross combinations for different characters were identified (Table 3). The order of best parents selected on the basis of GCA effect and array means was essentially the same. It implies that for practical purpose the selection of the best parents could be made on the basis of array mean and in so doing the use of long and time-consuming statistical computations could be avoided. This finding confirms the earlier reports of Rao *et al.* (1968) and Shankargowda *et al.* (1972).

The best crosses selected on the basis of SCA effects and *per se* performance were not the same for almost all the characters. High SCA need not necessarily mean a high performance by the hybrid. Therefore, the estimation of SCA effects seems rather of limited value. The choice of best cross combinations should be based on *per se* performance. 2077A x SPV 228 and 2077A x SPV 230 were identified as best crosses for yield.

TABLE 2

Estimates of general combining ability effects associated with parents.

Sr. No.	*Character/ parents*	*Days to 50% blooming*	*Plant height*	*Panicle length*	*Panicle circum-ference*	*Panicle weight*	*Number of whorls/ panicle*	*Number of primaries panicle*
1	2	3	4	5	6	7	8	9
1	2077 A	2.11**	12.89**	4.68**	0.16	8.66**	0.34*	3.76**
2	2219 A	–5.05**	–8.81**	0.07	–1.79**	–21.87**	–0.71**	–7.91**
3	36 A	2.94**	–4.08**	–4.75**	1.63**	13.33**	0.37*	4.15**
	S.E. (i)	±0.14	±1.62	±0.33	±0.22	±2.20	±0.16	±0.82
1	SPV 220	–1.92**	–9.81**	–1.61*	–0.64	–6.79	–0.60	–2.43
2	SPV 221	–2.36**	7.64**	0.35	–0.16	–11.66*	–0.07	1.05
3	SPV 223	–1.25**	–20.25**	0.15	–2.27**	–28.10**	0.71*	–3.79*
4	SPV 224	–2.25**	–4.36	1.95**	–0.52	–0.48	0.62	7.21**
5	SPV 225	–0.58*	–1.69	–0.91	–0.41	1.17	–0.29	2.36
6	SPV 226	1.86**	26.42**	–1.35*	0.72	–5.30	–0.20	0.98
7	SPV 227	1.64**	–12.25**	–1.80**	–0.08	–3.34	–0.60	–5.81**
8	SPV 228	1.53**	2.31	–0.20	1.77**	20.10**	0.06	1.14
9	SPV 229	–0.47	–7.92*	1.45*	–1.10*	3.52	–0.12	–16.30**
10	SPV 230	0.19	–32.03**	3.33**	–0.02	14.03**	0.60	1.45
11	SPV 231	2.97**	62.52**	–0.32	1.88**	13.50**	–0.14	4.34*
12	SPV 232	0.64*	–10.58**	–1.04	0.67	3.35	0.03	9.80**
	S.E. (j)	±0.28	±3.23	±0.65	±0.44	±4.40	±0.32	±1.64

TABLE 2 (Contd.)

Sr. No.	*Parents*	*Number of primaries/ whorl*	*Length of primary branch*	*Number of secondaries/ primary*	*Number of grains/ primary*	*Number of grains/ panicle*	*1000-grain weight*	*Grain yield/ panicle*
1	2077 A	0.12	1.49**	0.21	2.97**	367.25**	–1.46**	8.07**
2	2219 A	–0.29**	–0.03	–0.33**	–0.20	–240.83**	–3.23**	–14.83**
3	36 A	0.17*	–1.46**	0.11	–2.76*	–126.42*	4.69**	6.76**
	S.E. (i)	±0.07	±0.11	±0.11	±0.79	±60.64	0.11	±1.97
1	SPV 220	0.11	– 0.11	–0.22	–1.73	–177.66	0.99**	–3.11
2	SPV 221	0.24	–0.03	–0.30	–6.79**	–485.66**	4.00**	–7.76
3	SPV 223	–0.67**	0.02	0.11	–7.57**	–663.88**	–0.17	–21.42**
4	SPV 224	0.24	0.03	0.35	–3.14	–31.56	0.90**	1.53
5	SPV 225	0.32*	–0.12	–0.02	–0.86	17.44	1.33**	4.36
6	SPV 226	0.17	–0.17	0.05	–1.47	–100.11	–1.01**	–6.80
7	SPV 227	–0.17	–0.23	–0.08	2.23	8.11	–2.01**	–3.71
8	SPV 228	0.04	0.04	0.11	5.51**	502.00*	–1.03**	13.58**
9	SPV 229	–1.28**	0.29	0.56*	11.54**	262.22**	–2.59**	1.75
10	SPV 230	–0.17	0.62**	0.14	4.88**	486.44**	–2.35**	9.62*
11	SPV 231	0.41**	0.00	–0.20	0.03	156.33	1.12**	8.95*
12	SPV 232	0.76**	–0.34	–0.50*	–3.03	26.33	0.82**	3.00
	S.E. (j)	±0.15	±0.23	±0.22	±1.58	±121.28	±0.21	±3.93

*Significant at 5% level, **Significant at 1% level.

TABLE 3

Two best parents, best general combiners, best F_{1s} and best specific combinations for each character.

Character	*Best parent*		*Best general combiner*		*Best F_1*	*Best specific combination*
	Female	*Male*	*Female*	*Male*		
Days to 50% blooming	2219B	SPV.221	2219A	SPV.221	2219A x SPV.220	36A x SPV. 223
	2077B	SPV.223	2077A	SPV.224	2219A x SPV.221	36A x SPV.231
Plant height	2219B	SPV.232	2219A	SPV.230	36A x SPV.223	2077A x SPV.226
	36B	SPV.230	36A	SPV.223	2219A x SPV.230	2219A x SPV.225
Panicle length	2077B	SPV.229	2077A	SPV.230	2077A x SPV.229	2219 x SPV.226
	2219B	SPV.224	2219A	SPV.224	2077A x SPV.224	2219A x SPV.225
Panicle circumference	2077B	SPV.232	36A	SPV.231	36A x SPV.231	2077A x SPV.221
	36B	SPV.228	2077A	SPV.228	36A x SPV.228	36A x SPV.225
Panicle weight	2077B	SPV.229	36A	SPV.228	2077A x SPV.228	2077A x SPV.230
	36B	SPV.232	2077A	SPV.230	2077A x SPV.230	2077A x SPV.228
No. of whorls/panicle	2077B	SPV.230	36A	SPV.223	36A x SPV.224	2077A x SPV.227
	36B	SPV.223	2077A	SPV.224	2077A x SPV.223	2219A x SPV.221
No. of primaries/panicle	2077B	SPV.221	36A	SPV.230	36A x SPV.232	2077A x SPV.236
	36B	SPV.224	2077A	SPV.224	36A x SPV.225	2077A x SPV.220
No. of primaries/whorl	2219B	SPV.232	36A	SPV.232	36A x SPV.225	2219A x SPV.229
	2077B	SPV.226	2077A	SPV.231	36A x SPV.232	2219A x SPV.230
Length of primary branch	2077B	SPV.220	2077A	SPV.230	2077A x SPV.229	2219A x SPV.225
	2219B	SPV.223	2219A	SPV.229	2077A x SPV.231	36A x SPV.223
No. of secondaries/primary	2077B	SPV.229	2077A	SPV.229	2077A x SPV.229	2077A x SPV.231
	36B	SPV.223	36A	SPV.224	36A x SPV.223	36A x SPV.223
No. of grains/primary	2077B	SPV.229	2077A	SPV.229	2077A x SPV.229	2219A x SPV.225
	2219B	SPV.220	2219A	SPV.228	2077A x SPV.228	2219A x SPV.232
No. of grains/panicle	2077B	SPV.225	2077A	SPV.228	2077A x SPV.230	2077A x SPV.230
	2219B	SPV.229	36A	SPV.230	2077A x SPV.228	2077A x SPV.228
1000-grain weight	36B	SPV.221	36A	SPV.221	36A x SPV.221	2077A x SPV.221
	2219B	SPV.224	2077A	SPV.225	36A x SPV.225	2077A x SPV.232
Grain yield/panicle	2077B	SPV.229	2077A	SPV.228	2077A x SPV.228	2219A x SPV.226
	36B	SPV.225	36A	SPV.230	2077A x SPV.230	2077A x SPV.230

For grain yield, 2[illegible] A x SPV 226 appeared to be the most superior combination whereas for number of grains, an important component of yield, 2077A x SPV 230 was most superior combination. Bolder grains are desirable. Several specific combinations like 2077A x SPV 221; 2077A x SPV 232, 36A x SPV 224, 2219 x SPV 220, and 2219A x SPV 229 were identified as best specific crosses. For days to 50% blooming, 36A x SPV 223 and 36A x SPV 231 were superior cross combinations since they had highly significant negative sca effects. Significant sca effects in negative direction were also found for 2077A x SPV 226 and 2219A x SPV 225 crosses for plant height.

Unless yield improves, we may not be interested in other panicle charaters and therefore sca effects for other characters are not discussed.

Since variance for grain yield was predominantly additive in nature, deisrable segregants for yield could be expected to be used as varieties from crosses among 2077B, SPV 228 and SPV 230. Superior transgressive segregants could also be fixed. This would exploit highly significant heterosis observed for grain yield when 2077A is crossed with SPV 228 and SPV 230. The use of good general combiners in hybridization programme and selecting desirable segregants from the segergating generations by adopting progeny selection technique for exploiting additive genetic variance would lead to rapid improvement.

REFERENCES

Beil, G. M. and R. E. Atkins. 1967. Estimates of general and specific combining ability in F_1 hybrids for grain yield and its components in grain sorghum. *Sorghum vulgare* Pers. *Crop Sci.* **7** : 225-228.

Goud, J. V. 1971. Combining ability in sorghum. *Indian J. Agric. Sci.* **41** : 924-931.

Goud, J. V.; M. D. Kachapur and M. J. Vasudeva Rao. 1973. Combining ability in kharif season. *Mysore J. Agric. Sci.* **7:** 369-376.

Govil, J. N. and B. R. Murty. 1973. Combining ability for yield and quality characters in grain sorghum. *Indian J. Genet.* **33** : 239-251.

Kambal, A. E. 1963. A study on combining ability in grain sorghum. *Diss. Abstr.* **23** : 63. (Fide 2229. Pl. Breed. Abstr. 34: 275).

Kambal, A. E. and O. J. Webster. 1965. Estimates of general and specific combining ability in sorghum. *Sorghum vulgare* Pers. *Crop. Sci.* **5** : 521-523.

Kempthorne, O. 1957. "An Introduction to Genetic Statistics" John Wiley and Sons. New York.

Nagur, T. and K. N. Murty. 1970. Diallel analysis of heterosis and combining ability in some Indian sorghums. *Indian J. Genet.* **30** : 26-35.

Niehaus, M. H. and R. C. Pickett. 1966. Heterosis and combining ability in a diallel crosses in *Sorghum vulgare* Pers. *Crop Sci.* **6** : 33-36.

Rao, N. G. P.; V. K. S. Rana, and B. D. Tripathi. 1968. Line x tester analysis of combining ability in sorghum. *Indian J. Genet.* **28:** 231-238.

Rao, N. G. P. 1970. Genetic analysis of some exotic x Indian Crosses in sorghum. II. Combining ability and components of genetic variation. *Indian J. Genet.* **30** : 362-376.

Shankaregowda, B. T.; Madhva Rao and S. W. Mensinkai. 1972. Heterosis and line x tester analysis of combining ability in selected lines of sorghum. (*Sorghum vulgare* Pers). II. Combining ability. *Mysore J. Agric. Sci.* **6** : 242-253.

Whitehead, W. L. 1962. The breeding behaviour of phenotypically diverse grain sorghum varieties in hybrid combinations. Ph.D. Thesis. (Unpublished). Purdue University.

GAU Res. J. 1984. 10 (1) : 8-12

Response of Wheat to N, P, K and Zn Application on Farmers' Fields in Kutch District of Gujarat

J. P. Patel, A. S. Patel, G. N. Karelia, N. P. Patel and M. J. Buch

College of Agriculture, GAU, Sardar Krushinagar

ABSTRACT

The experiments were conducted on cultivators' fields to study the response of nitrogen, phosphorus, potash and zinc on the grain yield of wheat in Kutch district during 1977-78 to 1979-80 in *rabi* season. From the results of three years it was revealed that the grain yield increased significantly with increasing rate of nitrogen from N_{40} to N_{120} kg/ha and that of phosphorus from 20 to 60 kg P_2O_5/ha. However, the response of potassium was significant, while no significant response was observed with the application of zinc sulphate. The highest grain yield (36.61 q/ha of J-18 and 39.26 q/ha of J. 24) was obtained with the application of N_{120} P_{60} K_{60} during 1977-78.

(Received on 22nd July, 1981)

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops grown in the world. The responses of applied fertilizers to wheat differ from field to field depending on their native fertility status. It was, therefore, important to study the response of major plant nutrients as well as that of Zn under varied farm conditions in order to formulate fertilizer recommendations for their judicious use by the farmers. With this end in view, the experiments on cultivators' fields were conducted in Kutch district (Gujarat) to study the response of wheat to the application of N, P, K and Zn.

MATERIALS AND METHODS

Tnis investigation was conducted on Wheat (*Triticum aestivum* L.) variety 'J-18' and 'J-24' in different zones on randomly selected blocks, villages, cultivators and fields in Kutch district of the Gujarat State for three years from 1977-78 through 1979-80 in *rabi* season under the All India Co-ordinated Agronomic Research Project (I.C.A.R.). The whole Kutch district was stratified into four agriculturally homogeneous zones by suitably combining contiguous talukas, taking into consideration homogenity in respect of climate, soil, cropping pattern, rainfall, irrigation facilities etc. The soil samples were collected prior to conducting the experiments from 0-15 cm depths from randomly selected fields and analysed for nutrient status. Texturally the soils were sandy. The initial soil pH ranged from 7.3 to 9.0. The status of organic carbon was low to medium. The soils were low to medium in nitrogen, low to medium in phosphorus and low to very high in potash content. The number of experiments conducted during each year and the initial soil fertility status is shown in Table 1. The details of treatment in three years were :

TABLE 1

Zonewise initial fertility status of the soil.

Year	*Zone*	*No. of villages i.e. experiments*	*Range of available nutrients in the soil, kg/ha*		
			N	P_2O_5	K_2O
1977-78	I	10	126-308 (197)*	13-47 (27.6)	100-1000 (496)
1978-79	I	5	112-168 (136)	21-46 (30)	230-460 (352)
	II	5	77-154 (120)	30-107 (62)	80-410 (277)
	III	5	91-189 (147)	15-53 (26)	210-600 (335)
	IV	5	35-168 (101)	10-43 (22)	120-270 (199)
1979-80	I	10	118-392 (228.5)	8-35 (28.5)	200-985 (586)
	III	10	140-221 (177.8)	11-64 (21.7)	400-900 (646.5)
	IV	10	132-224 (191.8)	11-29 (20.1)	215-985 (563.0)

*Figures in the brackets are the means.

1. $N_0P_0K_0$ 5. $N_{40}P_{20}K_0$ 9. $N_{80}P_{40}K_{40}$
2. $N_{40}P_0K_0$ 6. $N_{80}P_{40}K_0$ 10. $N_{120}P_{60}K_{60}$
3. $N_{80}P_0K_0$ 7. $N_{120}P_{60}K_0$ 11. $N_{120}P_{60}K_{40}$
4. $N_{120}P_0K_0$ 8. $N_{40}P_{20}K_{20}$ 12. $N_{120}P_{60}K_{60}$ Zn_{25}

The N, P and K were applied in the form of urea, single/triple superphosphate and muriate of potash, respectively, while Zn was applied as zinc sulphate. All the phosphorus, potash, zinc and half of nitrogen were applied by drilling just before sowing of wheat and rest of the nitrogen was topdressed after about three weeks from sowing at first irrigation.

RESULTS AND DISCUSSION

The results pertaining to the yield response of wheat to the application of different treatments are presented in Table 2.

Response of Nitrogen

The response of nitrogen was significant in all the years. There was significant increase in yield of wheat variety 'J-18' with increase in level of nitrogen from 40 to 120 kg/ha. However, the differences between N_0 and N_{40} were not significant. The variety 'J-24' yielded significantly higher at 40 kg N/ha than no nitrogen. There was no significant difference between N_{40} and N_{80} during 1977-78 for variety 'J-24'. In the presence of N_{40}, N_{80} and N_{120}, the variety 'J-24' yielded 3.46, 5.66 and 8.92 q/ha, respectively, higher than the control. It was found that the variety 'J-24' yielded higher than 'J-18' at the same level of N_{40}. Considering three years average of zones, in Zone-I N_{120} produced an additional grain yield of 6.22 q/ha over the control. However, in Zone-II, the response was very low (1.77 q/ha at N_{120}). Considering the district mean over three years period, the response was 0.81, 3.09 and 5.24 q/ha with the application of N_{40}, N_{80} and N_{120}, repectively. The net incremental cost benefit ratio for N_{120} was 1:1. Increased wheat yield with increasing levels of nitrogen has been also reported by Singh *et al.* (1971) and Borse and Mahajan (1980).

Response of phosphorus over nitrogen

The response of phosphorus was not significant during 1977-78. In 1978-79, the responses to only P_{20} over N_{40} in Zone-I and to P_{20} over N_{40} and P_{40} over N_{80} in Zone-II were significant. In

TABLE 2

Response (q/ha) of wheat grain to different combination levels of N, P, K and Zn.

Varieties	Zone	Nos. of trials	Mean yield of control plot, q/ha	Response to nitrogen at N_{40}	Response to nitrogen at N_{80}	Response to nitrogen at N_{120}	Response to P_2O_5 over N: P_{20} over N_{40}	Response to P_2O_5 over N: P_{40} over N_{80}	Response to P_2O_5 over N: P_{60} over N_{120}	Response to K_2O over N and P: K_{20} over $N_{40}P_{20}$	Response to K_2O over N and P: K_{40} over $N_{80}P_{40}$	Response to K_2O over N and P: K_{60} over $N_{120}P_{60}$	Mean yield at N_{120} P_{60} K_{60}	Mean yield at N_{120} P_{60} K_{40}	Response to Zn So_4 25 kg/ha over N_{120} P_{60} K_{60}	C.D. at 5%
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
								1977-78								
J-18	I	9	21.47	1.28	6.27	8.72	1.49	0.62	2.59	2.90	0.70	3.83	36.61	34.68	–1.02	3.22
J-24	I	9	23.66	3.46	5.66	8.92	–0.44	1.61	2.64	3.41	2.59	4.04	39.26	38.75	–1.16	2.76
								1978-79								
J-18	I	5	20.28	0.92	4.40	6.48	2.96	2.00	0.16	3.32	2.92	3.44	30.36	30.20	0.72	2.61
	II	5	15.06	0.24	1.02	1.77	1.76	2.15	1.01	1.94	1.12	2.69	20.52	20.60	–0.04	1.11
	III	5	16.48	0.76	3.92	5.64	1.96	1.88	0.12	3.64	2.48	3.04	25.28	25.48	0.80	2.61
	IV	5	31.78	–1.94	1.12	8.00	2.60	3.68	–1.56	2.98	–1.38	0.56	38.78	36.08	–3.62	3.93
								1979-80								
J-18	I	10	20.49	0.06	1.34	1.42	2.48	2.00	2.86	–0.40	0.32	1.00	25.77	25.37	0.06	1.81
	III	8	15.79	0.52	2.29	4.35	0.58	1.08	0.49	1.16	0.60	1.90	22.52	21.82	0.48	1.43
	IV	10	19.43	0.62	1.30	2.86	1.46	1.36	0.16	0.60	1.64	3.70	26.15	25.83	0.54	2.05
								Mean								
	I	33	21.59	1.44	4.33	6.22	1.48	1.52	2.32	2.10	1.44	2.97	33.10	33.29	–0.47	
	II	5	15.06	0.24	1.02	1.77	1.76	2.15	1.01	1.94	1.12	2.69	20.52	20.60	–0.04	
	III	13	16.05	0.61	2.92	4.84	1.11	1.38	0.35	2.11	1.32	2.34	23.58	23.23	0.60	
	IV	15	23.55	–0.23	1.24	4.57	1.84	2.13	–0.41	1.39	0.64	2.65	30.36	29.25	–0.85	
District mean of trials		66	20.45	0.81	3.09	5.24	1.53	1.68	1.21	1.93	1.20	2.75	29.65	28.93	–0.31	
NICBR for District mean				1:-0.05	1:0.78	1:1.01	1:2.43	1:0.70	1:-0.09	1:10.0	1:2.43	1:4.20	1:1.04	1:0.98		

1979-80, the responses were significant and identical for all the levels of P_2O_5 in Zone-I. Looking to the arithmetic mean of the district over all the years. There was an increasing trend of response of phosphorus upto P_{40} over N_{80}. Application of only P_{20} over N_{40} with a net incremental cost benefit ratio of 1:2.43 was advantageous. These results correspond to the finding of Malik *et al.* (1972).

Response of potassium over N and P

In 1977-78, the response to K application was singificant for 'J-18' variety only at K_{60} over $N_{120}P_{60}$. However, in the case of variety 'J-24' it was significant at K_{20} over $N_{40}P_{29}$ as well as at K_{60} over $N_{120}P_{60}$. In 1978-79, it was significant and identical at all the levels of K in Zone-I. In Zone-II, the response was significant which was higher at K_{60} over $N_{120}P_{60}$ than K_{40} over $N_{80}P_{40}$ but at par with K_{20} over $N_{40}P_{20}$. In Zone-III, the response was significant and identical at K_{60} and K_{20} over respective NP levels. The response was not significant for Zone-IV. In 1979-80 the response of K_{60} over $N_{120}P_{60}$ only was significant in Zone-III and IV. Looking to the arithmetic mean responses of the zones and the district mean, it was observed that the response was the highest at K_{60} over $N_{120}P_{60}$ (with net incremental cost benefit ratio of 1:4.2) followed by K_{20} over $N_{40}P_{20}$ and K_{40} over $N_{80}P_{40}$.

Response of Zinc

On the whole, the response of zinc was not significant during investigation periods as more number of trials were laid out on the soils having medium or high status of Zn (Table 3). However, when the results were tabulated on the basis of zinc status of different soil groups, the soils having low status of Zn showed 7 per cent increase in response which was 210 kg/ha. However, in 1978-79 there was 6.3 per cent increase in yield by application of $ZnSO_4$ @ 25 kg/ha over $N_{120}P_{60}K_{60}$ with a response of 192 kg/ha. The mean Bray's per cent yield was 100 and 105 during 1977-78

TABLE 3

Response to Zn application of wheat (mean of experiments in each group) low, medium and high.

Year	*Sr. No.*	*No. of villages i.e. expts.*	*Average yield kg/ha*			*Per cent response yield*	*Bray's per cent yield*	*Zn content (ppm)*			*Zn uptake kg/ha*		
			N_0 P_0 K_0	N_{120} P_{60} K_{60}	N_{120} P_{60} K_{60} Zn_{25}			N_0 P_0 K_0	N_{120} P_{60} K_{60}	N_{120} P_{60} K_{60} Zn_{25}	N_0 P_0 K_0	N_{120} P_{60} K_{60}	N_{120} P_{60} K_{60} Zn_{25}
1977-78	1	Low-2	1570	3440	3650	7	95	23	27	29	36	91	104
	2	Medium-3	2140	3180	3207	1	100	29	30	33	63	97	106
	3	High-13	2393	3991	3802	–	105	30	29	33	72	117	127
1978-79	1	Low-8	1930	2928	3120	6.3	94	25	26	31	48	77	96
	2	Medium-6	1427	2083	2017	–	104	25	26	28	37	55	56
	3	High-6	2678	3628	3203	–	112	31	26	30	82	94	96

and 104 and 112 during 1978-79 in medium and high groups, respectively, suggesting negative response to Zn application. In general, the grain yield response was marked in low group of soils. These results corroborate the finding of Agrawala *et al.* (1980).

ACKNOWLEDGEMENT

The authors are thankful to the ICAR for providing funds under All India Co-ordinated Agronomic Research Project and to the Research Scientist, Micronutrient Research Project, Anand, for Zn analysis.

REFERENCES

Agrawala, S. C.; N. K. Mehrotra; S. Ahmad and C. P. Sharma (1980). Crop response to zinc application in some alluvial soils of U.P. *Indian J. Agric. Res.* **14** (3): 131-136.

Borse, C. D. and Mahajan, V. K. (1980). Studies on the effect of sowing depths, seeding rates and nitrogen levels on growth and yield of wheat Var. Sonalika. *Indian J. Agron.* **25** (1): 45-50.

Malik, P. S.; R. C. Pandey; B. S. Chauhan; P. Patil and R. A. Khan, (1972) *Indian J. Agron.* **6** (1): 37-40.

Singh, S. P.; Dilipsingh and S. K. Paliwal (1971). Effect of levels of nitrogen and plant population, yield behaviours of Sonara-64 and Lerma Rojo Varieties of Wheat. *Indian J. Agron.* **16:** 37-39.

GAU Res. J. 1984. 10 (1): 13-17

Studies on Intercrop Cultivation with Sugarcane in South Gujarat Region

K. R. Patel, R. D. Vashi and H. S. Damame
Regional Sugarcane Research Station, GAU, Navsari

ABSTRACT

Field experiments were conducted on heavy black soils during the years 1979-80 and 1980-81 at the Regional Sugarcane Research Station, Navsari, on intercropping with sugarcane. The intercrops tried were onion, garlic, chillies, cabbage, fennugreek, gram and groundnut which did not affect the yield of sugarcane significantly. Among all the treatments, sugarcane with onion gave the highest additional net profit of Rs. 2764/- per hectare followed by sugarcane + chillies Rs. 2606/ha, sugarcane + garlic Rs. 1261/ha and sugarcane + groundnut Rs. 297/ha. Sugarcane with cabbage, gram and fennugreek gave 1943/-, 921/- and 894/- net loss respectively, compared to sugarcane alone. This indicated the suitability of onion, chillies and garlic as suitable intercrops with sugarcane in the heavy black soils of the South Gujarat Region.

(Received on 1st March, 1982)

INTRODUCTION

Sugarcane is an important cash crop gaining more popularity in the irrigated area of South Gujarat Region. The rapid increase in the area under this crop is noticed after perennial irrigation facilities are being made available under Ukai-Kakrapar irrigation project as well as successful development of co-operative sugar factories in the region. This major shift in the area is from food and nonfood crops like jowar, rice and cotton. Irrigated areas are expected to grow both food and nonfood crops, preferably by the way of intercropping with a view to utilize the available space and moisture in the soil for getting additional income or improving the fertility of the land.

Sugarcane is a long duration crop, planted at a wide distance and very slow growth in first 2 to 3 months after planting. It becomes therefore necessary for economic reasons to grow short duration crops during the early phase of the sugarcane crop (Rage and Patwardhan, 1952). Zende and Patil (1973) and Hapse (1978) reviewed the work on intercropping or multiple cropping in sugarcane in Maharashtra. They observed that both vegetables and legumes produced a beneficial effect on cane weight resulting in higher cane yield and CCS. In other studies on intercropping of various crops with sugarcane in Bihar, Sharma and Prasad (1972) noted that potato and coriander were very effective as intercrops in sugarcane. In Hyaryana, potato, onion and garlic proved to be the best suited as intercrops in sugarcane for giving higher economic return (Zende, 1981).

Bawaskar *et al.* (1978) studied the influence of intercropping of oil seeds in

sugarcane on soil properties and cane yield. It was noticed that, only growing of soyabean increased the total nitrogen content of the soil, while groundnut increased the availability of phosphate and potash. However, no oil seed crop had any direct effect in increasing the cane yield. Bhoj *et al.* (1970), Kirtikar *et al.* (1975), Mathur *et al.* (1968) and Sachan *et al.* (1978) studied the effect of intercropping in sugarcane only from the point of view of economics.

Based on these above as well as with a view to assertain the suitability of some intercrops, which can give additional income without adverse effect on the yield and quality of sugarcane, the present investigation was carried out at Regional Sugarcane Research Station, Navsari on heavy black soils during the years 1979-80 and 1980-81.

MATERIALS AND METHODS

Field experiments were conducted by adopting complete randomised design, with four replications and eight treatments during the years 1979-80 and 1980-81. Treatments undertaken were (1) sugarcane + onion, (2) sugarcane + garlic, (3) sugarcane + chillies (4) sugarcane+cabbage (5) sugarcane+fennugreek (6) sugarcane + gram (7) sugarcane + groundnut and (8) sugarcane alone. Sugarcane variety CO-419 was planted at a distance of 90 cm in second week of January in both the years. The ridges were flattened by dragging a light wooden plank over the top. Sowing of intercrops was carried out in two rows on either side of flattened ridges within one week after planting of sugarcane. Onion, chillies and cabbage seedlings were transplanted at 15, 20 and 30 cm apart, respectively. Garlic was planted at a distance of 15 cm. Fennugreek was sown in rows while gram and groundnut were dibbled in a row at a distance of 15 cm.

The crop was fertilized with 250 kg N, 125 kg P_2O_5 and 125 kg K_2O per hectare in addition to 25 tonnes of F.Y.M. Entire dose of P_2O_5 as well as K_2O was applied at the time of planting cane, while nitrogeneous fertilizer was given in four splits. Fifteen per cent at the time of planting and remaining in split doses of 30, 20 and 35 per cent after 6, 12 and 18 weeks of planting, respectively. No additional fertilizer was given to any of the intercrops. The necessary operations like weeding, irrigation and plant protection were carried-out whenever necessary. Intercrops were harvested after 12 to 16 weeks on maturity and sugarcane was harvested at 12 month age. The cabbage crop was uprooted and removed in both the years because of the heavy attack of prodenia (*Spodoptera litura* F.)

RESULTS AND DISCUSSION

The data on yield of sugarcane and intercrops are given in Table-1. The data revealed that in the year 1979-80, except in the treatment of sugarcane + chillies, the yield of sugarcane was low compared to that under the treatment of sugarcane alone, but the reduction in the yield was not significant. In the year 1980-81, the yield of sugarcane was at par, except in the treatment, sugarcane + chillies, which gave significantly higher yield (93.09 t/ha) as compared that under control (75.99 t/ha) i.e. sugarcane alone.

In pooled analysis, the yield difference was found significant. The average yield of 1979-80 and 1980-81 in the treatment sugarcane alone was 91.38 t/ha, while the same in other treatments in which onion, garlic, chillies, cabbage, fennugreek, gram and groundnut were grown as an intercrops were 87.22, 97.85, 92.32, 85.83, 88.63, 79.99

TABLE 1

Mean data on sugarcane and intercrops yields (1979-80 and 1980-81).

Sr. No.	*Treatment*	*Sugarcane yield t/ha*			*intercrops yield qt/ha*		
		79-80	*80-81*	*Average*	*79-80*	*80-81*	*Average*
(1)	Sugarcane alone	106.77	75.99	91.38	—	—	—
(2)	Sugarcane + Onion	100.87	73.56	87.22	113.72	72.92	93.31
(3)	Sugarcane + Garlic	102.60	93.09	97.85	15.75	0.69	8.22
(4)	Sugarcane + Chillies	109.42	75.22	92.32	3.08	23.82	13.45
(5)	Sugarcane + Cabbage	90.80	80.86	85.83	*	*	—
(6)	Sugarcane + Fennugreek	104.69	72.57	88.63	13.45	3.12	11.15
(7)	Sugarcane + Gram	86.20	73.78	79.99	16.80	0.39	8.60
(8)	Sugarcane + Groundnut	96.57	82.08	89.33	—	—	4.98
	Bye-product	—	—	—	—	—	26.10
	S.Em. t/ha	4.948	3.144	2.932	—	—	—
	C.D. at 5% t/ha	14.552	9.247	8.360	—	—	—

*The cabbage crop was uprooted and removed because of the heavy infestation of prodenia.

TABLE 2

Average data on sugarcane yield, yield attributing characters and juice quality (1979-80 and 1980-81).

Sr. No.	*Particulars*	*Treatments*							
		Sugarcane alone	*Sugarcane + Onion*	*Sugarcane + Garlic*	*Sugarcane + Chillies*	*Sugarcane + Cabbage*	*Sugarcane + Fennugreek*	*Sugarcane + Gram*	*Sugarcane + Groundnut*
1	2	3	4	5	6	7	8	9	10
1.	Sugarcane yield t/ha	91.38	87.22	97.85	92.32	85.83	88.63	79.99	89.33
2.	Millable canes/ha in thousand	103.037	98.892	100.303	104.146	95.333	98.719	94.335	94.465
3.	Weight/cane in kg	0.930	0.880	0.980	0.890	0.900	0.890	0.850	0.940
4.	Juice quality								
	(a) Pol. per cent	17.27	17.96	17.97	18.15	17.16	17.40	17.80	18.10
	(b) Pirity per cent	92.62	92.01	93.41	92.20	92.50	92.96	92.49	93.74
	(c) CCS per cent	12.30	12.81	13.34	12.91	12.50	12.55	12.77	13.38
	(d) CCS t/ha	11.30	11.21	12.96	11.95	10.53	11.19	10.21	11.97

TABLE 3

Economics of different intercrops treatments with sugarcane, based on pooled data (1979-80 and 1980-81).

Sr. No.	Item	Treatment							
		Sugarcane alone	*Sugarcane + Onion*	*Sugarcane + Garlic*	*Sugarcane + Chillies*	*Sugarcane + Cabbage*	*Sugarcane + Fennugreek*	*Sugarcane + Gram*	*Sugarcane + Groundnut*
(1)	Sugarcane yield t/ha	91.38	87.22	97.85	92.32	85.83	88.63	79.99	89.33
(2)	Yield of intercrops qt/ha	—	93.31	8.22	13.45	*	3.12	8.60	4.98
	Bye-product qt/ha	—	—	—	—	—	—	—	26.10
(3)	Gross income								
	(a) Sugarcane Rs/ha	22845	21805	24462	23080	21457	22157	19997	22332
	(b) Intercrops Rs/ha	—	4665	1644	3362	—	780	3010	2004
	(c) Total Rs/ha	22845	26470	26106	26442	21457	22937	23007	24336
(4)	Cost of cultivation (Sugarcane + intercrops Rs/ha)	9000	9861	11000	9991	9555	9986	10083	10194
(5)	Net profit Rs/ha	13845	16609	15106	16451	11902	12951	12924	14142
(6)	Net additional profit Rs/ha	—	2764	1261	2606	(–)1943	(–)894	(–)921	297

*Cabbage crop was uprooted and removed because of heavy infestation of prodenia.

N.B.: The price of Sugarcane, Onion, Garlic, Chillies, Fennugreek, Gram, Groundnut and Groudnut bye-product were considered as Rs. 250/- ton, Rs. 50/qt., Rs. 200/qt, Rs. 250/qt (green), Rs. 250/qt, Rs. 250/- qt, Rs. 350/qt and Rs. 10/qt respectively.

and 89.33 tonnes per hectare, respectively. The yield in the treatments sugarcane + onion, sugarcane + garlic, sugarcane + chillies, sugarcane + fennugreek, sugarcane + groundnut and sugarcane + cabbage were at par with control i.e. sugarcane alone. While the same was significantly lower under the treatment sugarcane + gram. This indicated that intercrops i.e. onion, garlic, chillies, fennugreek and groundnut did not affect yield of sugarcane significantly. But gave an additional yields of the said intercrops to the tune of 93.31, 8.22, 13.45, 3.12, 8.60 and 4.98 qts/ha, respectively.

The observations on weight per millable cane, number of millable cane/ha, pole percent, purity per cent C.C.S. per cent and CCS/ha were recorded and are given in Table-2. It is evident from the table that weight per millable cane was higher in the treatments intercropped with garlic and groundnut as compared

to that under sugarcane alone. The CCS per cent in all the treatments were higher than that under sugarcane alone, indicating that there was no adverse effects of intercrops on the quality of cane. The CCS per cent in the treatment sugarcane alone was 12.30, while the same in the treatment sugarcane intercropped with onion, garlic, chillies, cabbage, fennugreek, gram and groundnut were 12.81, 12.34, 12.91, 12.50, 12.55, 12.77 and 13.38 respectively.

The economics of each treatments were calculated. The mean data on this aspect are given in Table-3. The net additional profit i.e., profit realised after deduction of net profit of treatment sugarcane alone showed that the treatment sugarcane intercropped with onion gave the highest net additional profit of Rs. 2764/ha. The same were followed by sugarcane + chillies Rs. 2606/ha, sugarcane + garlic Rs. 1261/ha, and sugarcane + groundnut Rs. 297/ha. The other intercrops i.e. cabbage, gram and fennugreek gave net loss of Rs. 1943, 921 and 894 per hectare, respectively as compared to sugarcane alone. This indicated the suitability of onion, chillies and garlic as suitable intercrops with sugarcane in the heavy black soils of the South Gujarat Region.

REFERENCES

Bawaskar, V. S., S. P. Patil, S. J. Ranadive and G. K. Zende (1978). Studies on the influence of intercropping of oil seeds on Sugarcane. *Indian Sugar* **27** (12): 807-810.

Hapase, D. G. (1978). Lead paper on a seminar on Sugarcane production technology for profit D.S.T.A. Pune.

Bhoj, R. L. and Kapoor, P. L. (1970). Intercropping of maize in spring planted sugarcane given high profit with adequate nitrogen use. *Indian J. Agronomy* **15** (3): 242-246.

Kirtikar, R. S., Dixit and Jai Singh Saroj (1975). Intercropping with autumn planted sugarcane in U.P. *Indian Sugar* **25** (1): 27-30.

Mathur, B. K., Singh, A. and Bhadauria, V. S. (1968). Intercropping of sugarcane. *Indian Sugar* **19** (1) : 43-48.

Rege, R. D. and J. P. Maskarenhas (1952). A review on Intercropping in sugarcane in Maharashtra Proc. D.S.T.A. 9th convention: 76-81.

Sachan, R. S., R. G. Menon and Mangal Singh (1978). Studies on intercropping with sugarcane. *Indian J. Sugar Technol. 1* (1): 29-32.

Sharma, S. C. and R. B. Prasad (1972). Studies on intercropping of various crops with sugarcane, Proc. 38th conven. S.T.-A.I.: 53-62.

Zende, G. K. and Patil, H. S. (1973). Bull. on Multiple cropping. *Indian Soc. Agron.*: 320-321.

Zenda, G. K. (1981). Lead paper on soil management for economic production of sugarcane, 31st Annual conven. D.S.-T.A.: 51-97.

GAU Res. J. 1984. 10 (1): 18-23

Determination of Economic Threshold for Cotton Bollworms (*Earias* spp. and *Heliothis armigera* Hb.) on Hybrid-4 Cotton

N. B. Rote, B. K. Patel, N. P. Mehta and A. H. Shah
Main Cotton Research Station, GAU, Surat

ABSTRACT

An experiment to find out economic threshold levels based on larval units, was conducted during the years 1978-79, 1979-80 and 1980-81 at Main Cotton Research Station, Surat. Four different threshold levels viz. 5, 10, 15 and 20 larval units for spotted bollworms (*Earias* spp) and 3, 7, 12 and 15 larval units for American bollworms (*Heliothis armigera* Hb.), were tested in comparison to recommended schedule for hybrid-4 cotton. From the results it was found that the threshold level of 10 larval units was found most ideal and economical for spotted bollworms on hybrid-4 cotton.

(Received on 20th April, 1983)

INTRODUCTION

Spotted bollworm (*Earias* spp.) an American bollworm (*Heliothis armigera* Hb.) are the major pests of cotton. Indiscriminate use of pesticides for their control causes several side problems. Eradication of insect-pests is practically impossible and hence proper approach is of "Integrated Pest Management". The temporal Schedule based plant protection measures have certain built in inadequacies. During the season of heavy infestation they are inadequate, whereas, during the season of light infestation they are wasteful. Therefore, it becomes necessary to apply proper pesticide when the level of pest reaches "economic threshold". The purpose of pest control according to economic threshold level is to pin-point the timing of control measures in order to obtain optimal results based on need based plant protection. Therefore, it becomes vital to determine the economic threshold levels for bollworms. Economic threshold concept is flexible and the levels may vary from area to area, variety to variety and even time to time (Reynolds, 1972). Mahalle *et al.* (1976) reported that economic injury increases as the cost of control increases and decreases as the price of output increases. In U.S.A. Stern (1965) has worked out the economic threshold of four larvae per plant for bollworm, *Heliothis zea* on cotton. In India attempts were made in past to work out threshold values based on injury caused but so far sound dependable indices are not available. The present approach is based on population density of pest i.e. larval units, reported by Shah and Mehta (1979) and results of the trial conducted in this connection are reported below.

MATERIALS AND METHODS

The trial was conducted at Main Cotton Research Station, Gujarat Agri-

cultural University, Surat during the years 1978-79, 79-80 and 80-81 in Randomized Block Design with four replications. Four different threshold levels for bollworms were compared with time bound plant protection schedule for hybrid-4 cotton (Appendix "A"). During the year 1978-79 the treatments were as below:

Treat No.	*Threshold levels for spotted bollworms in larval Units (LU)*		*Threshold levels for heliothis in larval Units (LU)*
1.	5 (LU)	&	3 (LU)
2.	10 (LU)	&	7 (LU)
3.	15 (LU)	&	12 (LU)
4.	20 (LU)	&	15 (LU)
5.	Schedule for hybrid-4 cotton. (Appendix "A")		

APPENDIX A

Recommended schedule for Hybrid-4 cotton.

Sr. No.	*Period*	*Name of insecticides and concentrations*
1.	August II week	Phosphamidon 0.03% + Streptocyline 0.005% + Copper oxychloride 0.2%
2.	September II week	Endosulfan 0.075%
3.	September IV week	Carbaryl 0.2%
4.	October II week	Phosalone 0.087%
5.	October III week	Endosulfan 0.075% + DDT 0.2% + Copper oxychloride 0.2%
6.	October IV week	Carbaryl 10% dust
7.	November II week	Endosulfan 0.075% + DDT 0.2%
8.	November IV week	Phosalone 0.087% + Stretptocyline 0.005% + Copper oxychloride 0.2%
9.	December II week	Endosulfan 0.075%
10.	December IV week	Phosalone 0.087%
11.	January II week	Carbaryl 10% dust
12.	January IV week	Endosulfan 4% dust

The above threshold levels were based on the 20 plants randomly selected from four replications (5 plants x 4 replications). The plot size was 64.80 sq.m. and spacing was 1.20 x 0.60 m. The observations were recorded twice in a week (Monday and Thursday) from 5 plants randomly selected from each net plot. Total number of spotted and *Heliothis* larvae were counted from whole plant and recorded separately as small, medium and big according to their sizes. The treatment-wise larval units (on the basis of 20 plants) were worked out and as soon as larval units reached equal or above threshold level of the respective treatment the insecticides were applied to control the particular pest. Carbaryl 10% dust and DDT 10% dust were used for the control of spotted bollworm and *Heliothis* respectively. In all 24, 14, 13 and 9 applications were made throughout the season in the treatments 1, 2, 3 and 4 respectively.

Calculation of Larval Units (LU)

I. Spotted bollworm
   1. Small larvae–having the length upto 4 mm. = 1 LU
   2. Medium larvae–having the length of 4 to 8 mm. = ½ LU
   3. Bigger larvae–having the length more than 8 mm. = 0 LU

II. *Heliothis* sp.
   1. Small larvae upto 4 mm. length = 0 LU
   2. Medium larvae from 4 to 12 mm. length = 1 LU
   3. Bigger larvae more than 12 mm. length = 2 LU

The above larval units were fixed on *ad-hoc* basis considering the long experience in pest control and the experimental results.

Combined effects of two bollworms

When both the bollworms were damaging at a time but their individual threshold level could not surpass the threshold levels, the combined effect was worked out. For working out the combined effects, the respective threshold levels were considered equal to 100 per cent for each bollworm and the observed population was converted into the percentages, and as soon as the sum of percentages of the two bollworms reached above 100% the measures were taken to control both the bollworms.

As the infestation of *Heliothis* was not severe during 1978-79, the experiment was repeated for spotted bollworm alone during the years 1979-80 and 1980-81. Monocrotophos @ 0.8 kg. ai/ha. was used for the control of spotted bollworm, whereas, DDT 0.2% was used as a blanket spray, for the control of *Heliothis* whenever necessary.

The observations on bollworm infestation were recorded at each picking on bolls and locules. The data were subjected to Arcsin percentage wherever required before statistical analysis.

RESULTS AND DISCUSSION

1. Bollworm infestation during the year 1978-79

The data are presented in Table-1. It is evident from the results that the lowest bollworm infestation to bolls was recorded in Treatment-1 (5 LU for spotted and 3 LU for *Heliothis*) and it was at par with treatment-2 (10 LU for spotted and 7 LU for *Heliothis*). The other treatments have recorded comparative higher infestation. Treatment-1 (5 LU and 3 LU) has also recorded significantly lower bollworm infestation to locules and it was followed by Treatment-2 (10 LU for spotted and 7 LU for *Heliothis*). Other treatments have recorded higher bollworm infestation.

2. Bollworm infestation during the year 1979-80 and 1980-81

The data are presented in Table-2. From the results of the pooled data of the two years it is revealed that the lowest threshold i.e. 5 larval units for spotted bollworm, has recorded the lowest bollworm infestation to bolls (15.8%) and it was at par with treatment of 10 larval units (18.0%). Other treatments have recorded higher infestation.

From the same Table-1 it is also seen that more or less the same trend was observed in case of bollworm infestation to locules.

3. Yield of seed cotton

The yield data are also presented in Table-1 and 2. During the year 1978-79, Treatment-1 (5 LU for spotted and 3 LU for *Heliothis*) has recorded significantly higher yield (2224 kg/ha). It was followed by Treatment-2 (10 LU for spotted and 7 LU for *Heliothis*) i.e. 1803 kg/ha. which was at par with Treatment-3 (1712 kg/ha). Treatment-4 has recorded significantly lower yield.

During the year 1979-80, the highest yield was obtained in the treatment of 5 larval units for spotted bollworm (3068 kg/ha) and it was followed by the treatments of 10 larval units (2860 kg/ha),

15 larval units, schedule for hybrid-4 and 20 larval units.

During the year 1980-81 also highest yield was obtained in the treatment of 5 larval units (1653 kg/ha) and the other treatments have recorded the same trend as previous year.

From the pooled data it is revealed that the lowest threshold level i.e. 5 larval units has recorded highest yield (2359 kg/ha) and it

TABLE 1

Percentage infestation of bollworms and yield of seed cotton during the year 1978-79.

Sr. No.	*Treatments*	*Av. % infestation to*		*Yield of seed cotton kg/ha.*
		bolls	*Locules*	
1.	5 LU for spotted and 3 LU for Heliothis	46.2 (42.82)	27.1 (31.38)	2224
2.	10 LU for spotted and 7 LU for heliothis	50.2 (45.17)	33.8 (35.53)	1803
3.	15 LU for spotted and 12 LU for heliothis	58.0 (49.60)	37.2 (37.59)	1712
4	20 LU for spotted and 15 LU for heliothis	68.8 (56.03)	42.9 (40.90)	1090
5	Recommended schedule for hybrid-4	61.6 (51.72)	40.4 (39.45)	1451
	S.E.	1.12	1.30	108
	C.D. @ 5%	3.45	4.00	336
	C.V. %	4.61	7.00	18.28

Note: Figures in parenthesis are angular transformed values.

TABLE 2

Percentage infestation and yield of seed cotton during the years 1979-80 and 1980-81.

Sr. No.	*Treatments*	*Av. % infestation to bolls*			*Av.% infestation to locules*			*Yield of seed cotton (kg/ha)*		
		1979-80	*1980-81*	*Pooled Mean*	*1979-80*	*1980-81*	*Pooled Mean*	*1979-80*	*1980-81*	*Pooled Mean*
1.	5 LU for spotted bollworm	17.6 (24.82)	14.0 (22.01)	15.8 (23.41)	10.8 (18.84)	6.8 (15.13)	8.5 (16.98)	3068	1653	2359
2.	10 LU ,, ,,	22.0 (22.99)	14.3 (22.27)	18.0 (25-13)	13.1 (21-22)	7.9 (16-30)	10.3 (18.76)	2860	1623	2241
3.	15 LU ,, ,,	27.4 (31.57)	34.4 (35.92)	30.1 (33.29)	17.5 (24.75)	17.9 (25.01)	17.7 (24.88)	2554	1466	2010
4.	20 LU ,, ,,	33.8 (35.58)	59.6 (50.53)	46.6 (43.05)	21.1 (27.33)	34.4 (34.90)	27.5 (31.61)	2075	123	1099
5.	Recommended schedule for Hybrid-4	33.0 (35.05)	33.8 (35.54)	33.4 (35.29)	17.6 (24.79)	16.2 (23.73)	16.9 (24.25)	2477	1309	1893
	S-E	2.37	5.59	3.14	1.92	2.59	3.75	59	242	136
	C.D. @ 5%	5.15	12.18	6.50	4.19	5.64	7.73	129	525	280
	C.V.%	12.09	23.92	19.66	11.70	15.78	32.17	7.95	27.63	14.78

Note: Figures in parenthesis are angular transformed values.

TABLE 3

Economics of the treatments during the year 1978-79.

Sr. No.	*Treatments*	*Yield (kg/ha)*	*Gross income Rs/ha*	*Cost of treatment Rs/ha*	*Net realisation Rs/ha*	*No. of applications*
1.	5 LU for spotted and 3 LU for Heliothis	2224	13121	6746	6375	24
2.	10 LU for spotted and 7 LU for heliothis	1803	10637	3839	6798	14
3.	15 LU for spotted and 12 LU for heliothis	1712	10100	3450	6650	13
4.	20 LU for spotted and 15 LU for heliothis	1090	6431	2432	3999	9
5.	Recommended schedule for hybrid-4	1451	8560	2101	6459	12

TABLE 4

Economics of the treatments during the years 1979-80 and 1980-81.

Sr. No.	*Treatments*	*Av. yiled of seed cotton kg/ha*	*Gross income Rs/ha*	*Av. cost of treatment Rs/ha*	*Net realisation Rs/ha*	*No. of spraying 1979-80*	*1980-81*
1.	5 LU for spotted bollworm	2359	13042	4177	8865	12	11
2.	10 LU ,, ,,	2241	12424	3499	8925	9	10
3.	15 LU ,, ,,	2010	11149	2806	8343	7	8
4.	20 LU ,, ,,	1099	5587	1580	4007	6	2
5.	Recommended schedule for Hybrid-4	1893	10446	2706	7740	12	12

was at par with 10 larval units (2241 kg/ha). It was followed by 15 larval units, schedule for hybrid-4 and 20 larval units.

4. Economics

The data on economics during the year 1978-79, are presented in Table-3. From this it can be observed that highest net realisation (6798 Rs/ha) was obtained in the treatment-2 (10 LU for spotted and 7 LU for *Heliothis*) and it was followed by treatment-1 (5 LU for spotted and 3 LU for *Heliothis*), treatment-3 and treatment -4.

The data of economics during the years 1979-80 and 1980-81 are presented in Table-4. It is seen from the results that treatment of 10 larval units for spotted bollworm gave highest net realisation (8925 Rs/ha). Though treatment of 5 larval units has recorded highest yield, it has failed to record higher net realisation because of higher incremental cost of the treatment.

Durig the year 1978-79 four threshold levels for spotted bollworms and *Heliothis* as (1) 5 larval units for spotted and 3 larval units for *Heliothis* (2) 10 LU and 7 LU (3) 15 LU and 12 LU, (4) 20 LU and 15 LU were compared with schedule treatment. During that season the threshold levels of 10 larval units for spotted bollworm and 7 larval units for *Heliothis* were found most effective and economical.

During the years 1979-80 and 1980-81, the experiment was carried out only for spotted bollworms and the same threshold levels viz. 5 LU, 10 LU, 15 LU and 20 LU were tested with schedule for hybrid-4 cotton.

From the results of the two years data it was found that the threshold level of 10 larval units was found most ideal and economical for spotted bollworm on hybrid-4 cotton. Maisuria *et al.* (1982) have also reported that the 10 larval units were found as most economical threshold level for spotted bollworm on G. Cot. 11 cotton.

REFERENCES

Mahalle, M. V., Ghodke, R. D. and Saksena, J. S. 1976. Economic injury level of cotton bollworms. *Indian J. Ent.*, **38** (1): 27-32.

Maisuria, I. M., Rote, N. B., Patel, B. K. and Mehta, N. P. 1982. Determination of economic threshold for bollworms (*Earias* spp. & *Heliothis armigera* Hb.) on medium staple cotton G. Cot. 11. Paper read at Seminar on "Focus on development of medium staple cotton with special reference to Gujarat State." December 1982 at Surat.

Reynolds, H. T. 1972. Practical application of suppression methods in pest management. *Implementing practical pest management strategies*, Page 30-6.

Shah, A. H. and Mehta, N. P. 1979. Need based cotton insect pest management utilizing economic threshold in Gujarat. *ISCI Journal, Special issue*, **2** (2): 40-43.

Stern, V. M. 1965. Significance of the economic threshold in integrated pest control. *Proc. F. A. O. symposium, Integrated Pest Control:* 41-56.

GAU Res. J. 1984. 10 (1): 24-28

Influence of Nitrogen and Water Management on Yield and Chemical Composition of Oat (*Avena sativa*, L.) Forage

C. A. Patel, M. S. Patel and G. R. Patel

Agricultural Chemistry and Soil Science Department, Agriculture College, Anand

ABSTRACT

An experiment was conducted on sandy loam soil to study the yield and quality of oat (Kent variety) forage as influenced by nitrogen (0, 40, 80 and 120 kg N/ha) and soil moisture regime (irrigation at 25, 50 and 75 per cent available soil moisture). The yield of dry forage gradually increased from 79 to 99 q/ha with progressive increase in levels of nitrogen from 0 to 120 kg N/ha. The crude protein content increased with successive dose of nitrogen fertilization, while the trend was not consistent for phosphorus, calcium, ash, silica and acid detergent fibre content of oat forage. Frequent irrigation depressed the concentration of crude protein, phosphorus, calcium, ash, silica and acid detergent fibre in the forage.

(Received on 16th Nov. 1982)

INTRODUCTION

The high yielding and cross-bred cows need regular supply of green and nutritious forage throughout the year to maintain their performance in milk production. Oat is grown in winter chiefly to provide green forage to livestock and it is an important forage crop, when there is an acute shortage of cereal green forage in winter.

Water and fertilizer are two important inputs in agricultural production. These two inputs being scant and costly, need to be efficiently used through proper management to get maximum production of good quality oat forage per unit area. Information on water and nitrogen requirement of oat for sandy loam soil of middle Gujarat is lacking. This consideration prompted to undertake the present investigation to find out the optimum dose of nitrogen and proper time of irrigation to get the maximum production of good quality oat forage in winter season.

MATERIALS AND METHODS

An experiment was conducted in sandy loam soil of Anand in rabi season on oat variety kent. There were twelve treatmens consisting of four levels of nitrogen (0, 40, 80 and 120 kg/ha) and three levels of irrigation (irrigation at 25, 50 and 75 per cent available soil moisture level). The treatments were replicated three times. A dose consisting of 30 kg P_2O_5 as superphosphate + 25 kg K_2O as muriate of potash per hectare was ploughed into all the plots. Nitrogen was applied in the form of urea as per treatment to respective plots at the time of preparation of seed bed.

The initial fertility status of the experimental field was total nitrogen-

607 kg/ha, available P_2O_5 –67 kg/ha and available K_2O–363 kg/ha. The field capacity and permanent wilting point of soil were 18.2 and 5.4 per cent respectively. The crop was harvested at about 50 per cent flowering stage. The green forage yield of each plot was recorded. From the moisture per cent of green forage, dry matter yield for each plot was computed. The replication-wise plant samples were analysed for crude Protein, Phosphorus, Calcium, Ash, Silica and A.D.F. as per methods of A.O.A.C. (1970).

RESULTS AND DISCUSSION

Forage yield

The data on dry forage yield of oat as influenced by soil moisture regimes and nitrogen levels are presented in Table-1.

TABLE 1

Dry forage yield (q/ha) of oat as influenced by nitrogen and irrigation levels.

Nitrogen levels	*Soil moisture regimes*			
	I_{25}	I_{50}	I_{75}	*Mean*
N_0	77	79	82	79
N_{40}	83	87	90	87
N_{80}	97	101	93	97
N_{120}	102	103	92	99
Mean	90	92	89	90
		Nitrogen (*N*)	*Soil moisture* (*I*)	*N*×*I*
S.Em. ±		1.29	0.89	2.21
C.D. 5%		3.77	N.S.	6.29

A perusal of the data revealed that the effects of nitrogen levels and N x I interaction on dry forage yield of oat were significant. The yield of dry forage gradually increased from 79 to 99 q/ha with progressive increase in levels of nitrogen from 0 to 120 kg N/ha. However, the yield obtained at higher two levels of nitrogen (80 and 120 kg/ha) were at par. Thus the optimum level of nitrogen was 80 kg/ha for higher production of oat forage. These results are in line with those reported by Patel *et al.* (1972) and Singh *et al.* (1973).

The dry forage yield varied between 89 q/ha under I_{75} and 92 q/ha under I_{50} treatments without significant difference. Therefore, an application of 80 kg. N/ha and irrigation at 25 ASM would be advantageous for optimum forage production of oat.

Forage quality

The data on crude protein, phosphorus, calcium, ash, silica and acid detergent fibre contents of oat forage are presented in Table-2.

Crude protein content of oat forage significantly increased with successive dose of nitrogen fertilization. The increase in crude protein content over control was by 21, 29 and 54 per cent due to application of 40, 80 and 120 kg nitrogen per hectare respectively. The crude protein content was significantly higher under the treatment of soil

moisture regimes varied from 0.53 per cent under N_0 I_{75} to 0.70 per cent under N_{40} I_{25} treatments.

Significant effect on calcium content of oat forage was observed due to nitrogen and soil moisture regimes. Application of nitrogen at the rate of 80 and 120 kg/ha were at par and significantly superior over nitrogen levels N_{40} and N_0. The effect of soil moisture regimes on calcium content of oat forage was significant. It was observed that the calcium content under either wet (I_{75}) or dry (I_{25}) regime of soil moisture was lower than medium regime (I_{50}).

The ash content of oat forage ranged from 9.32 to 9.55 per cent due to variation in nitrogen levels but the difference was not sigificant. The ash content was significantly lower (9.15 per cent) under dry soil moisture regime (I_{25}) than those under medium (I_{50}) and wet regimes (I_{75}). The interaction of soil moisture regime and nitrogen levels had significant effect on ash content of oat forage.

The silica content of oat forage was not significantly influenced either by nitrogen or irrigation levels.

The differences in A.D.F. content due to nitrogen levels and soil moisture regimes as well as their interaction were significant. However the variation in A.D.F. content of oat forage due to different treatments was narrow with an average value of 43.99 per cent.

REFERENCES

A.O.A.C. 1970. Official Methods of Analysis of the Association of Analytical Chemists. 11th Edn. Washington, D.C. 20044.

Bhargava, B. S. and D. P. Motiramani. 1967. Effect of fertilizers on the chemical composition of wheat at different stages of growth. *J. Indian Soc. Soil Sci.*, **15** : 23-27.

Grunes, D. L. and B. A. Krantz. Nitrogen fertilization increases NPK concentration in oats. *Agron. J.*, **50** : 729-732.

Modgal, S. C. and K. C. Das. 1962. Effect of varying soil moisture regimes and nitrogen levels on yield and quality of wheat. *Indian J. Agron.*, **8** : 393-398.

Patel, A. S., T. N. Barevadia and P. S. Vashi. 1972. Comparative performance of certain varieties of forage Oats. *Indian J. Dairy Sci.*, **28** : 260-262.

Singh, L. N., D. C. Katoch and P. K. Verma. 1973. Note on the response of forage oat to different levels of nitrogen and phosphorus in mid-hill of Himachal Pradesh. *Indian J. Agron.* **43** : 426-427.

GAU Res. J. 1984. 10 (1) : 29-37

Comparison of the Fan Design with the Split Plot Design for Spacing Experiments

N. M. Patel and R. M. Patel

Gujarat Agricultural University, Anand Campus, Anand

ABSTRACT

Nelder's design FAN (Systematic design) was compared with the Split Plot design (SPL) for spacing treatments. The field experiments were conducted using cotton IAN 579-188 on the same field. The data on plant height, number of bolls per plant and cotton yield per plant were collected and used to assess bias in the estimate of treatment means. The results revealed that (i) the comparison FAN vs SPL showed an underestimation of the treatments means in FAN when area per plant was 900 sq.cm. and above and (ii) the rectangularity had some impact on the variables studied. Therefore, FAN design can not be used for spacing trial on a crop with monopodial growth habit like cotton IAN 579-188.

(Received on 1st Nov. 1982)

INTRODUCTION

Fan design has been developed by Nelder (1962) for spacing experiments. Design consisted of single row plots for each spacing treatment arranged in much compacted area in a sequence (Systematic pattern). The systematic arrangement gives biased estimates (Tedin, 1931; Fisher, 1935; Barbacki and Fisher, 1936; Greenberg, 1951; Salmon, 1955 and Patel, 1978). Such information, however, is not available for fan design.

The spacing trials need large area under each replication of conventional designs like randomized block design, split plot design etc. for testing a number of spacing treatments. Generally spacing trials are conducted in split plot design to ease agronomical operations. In the present investigation the relative utility of Fan design (FAN) was assessed in relation to Split plot design (SPL). For this purpose investigation on cotton IAN 579-188 was undertaken during the years 1973-74 and 1974-75 at the College Agronomy Farm, Gujarat Agricultural University, Anand Campus, Anand.

Spacing treatments

Keeping in view the growth habit of the cotton IAN 579-188, the different spacings were considered which varied from 0.045 m^2 to 0.270 m^2 per plant in both the layouts. The parameters of FAN were worked out as suggested by Nelder (1962). There were 10 spacing treatments in FAN (Table 1).

For SPL, a set of combinations of 30 cm, 60 cm and 90 cm as inter row spacings (Main plots) and 15 cm, 22.5 cm and 30 cm as intra row spacings (sub plots) was chosen. The smallest and largest spacings in the FAN matched with the smallest and largest spac-

TABLE 1

Spacing details for FAN and SPL.

FAN		*SPL*	
Coded spacing, S_j	*Area per plant sq.cm.*	*Coded spacing,* Sp_j	*Area per plant, sq. cm.*
S_1	450	Sp_1	450
S_2	550	Sp_2	675
S_3	670	Sp_3	900
S_4	820	Sp_4	900
S_5	990	Sp_5	1350
S_6	1220	Sp_6	1800
S_7	1490	Sp_7	1350
S_8	1820	Sp_8	2025
S_9	2220	Sp_9	2700
S_{10}	2700	—	—

ings of the SPL. The net plot size was 3.6 m x 3.6 m. in SPL.

The number of replications during both the years were 12 and 6 for FAN and SPL respectively.

RESULTS AND DISCUSSION

The data on plant height as well as number of bolls per plant of five randomly selected plants and cotton yield per plot were collected from both the layouts to assess relative utility of FAN in relation to SPL. There were eight observations ($P_{1\cdot1}$ through $P_{1\cdot8}$) on plant height during the first year and three observations ($P_{2\cdot1}$, $P_{2\cdot2}$ and $P_{2\cdot3}$) during the second year of the study. The corresponding observations in SPL were used in estimating differences in plant height (FAN vs SPL).

Since the number of treatments (Table 1) were not the same in FAN and SPL and also the area per plant in some of the treatments in FAN and SPL did not match with one another, the difference in spacing treatment means (bias) was judged using graphical method.

Plant height

data for various spacing treatments in each period of observation for FAN and SPL are presented in Tables 2 and 3 respectively and are depicted in Figures 1 (1973-74) and 2 (1974-75).

TABLE 2

Spacingwise plant height, in cm, during each period of observation in FAN.

	1973-74								*1974-75*		
S_j	$P_{1\cdot1}$	$P_{1\cdot2}$	$P_{1\cdot3}$	$P_{1\cdot4}$	$P_{1\cdot5}$	$P_{1\cdot6}$	$P_{1\cdot7}$	$P_{1\cdot8}$	$P_{2\cdot1}$	$P_{2\cdot2}$	$P_{2\cdot3}$
S_1	68.2	76.5	79.1	81.7	81.8	82.7	83.8	86.6	82.5	99.3	104.9
S_2	68.2	75.0	76.7	78.4	79.7	80.8	81.6	84.3	82.3	100.5	108.3
S_3	65.4	74.9	77.5	79.4	81.6	85.2	85.4	86.4	78.7	91.8	97.3
S_4	67.1	76.6	78.1	80.0	82.3	82.3	83.6	86.6	81.6	95.0	101.1
S_5	65.4	75.5	79.7	81.8	83.6	84.7	85.9	89.7	75.2	88.6	96.2
S_6	64.7	76.1	78.3	81.0	83.2	83.8	84.5	87.1	72.5	84.7	92.2
S_7	68.1	79.1	83.4	86.1	88.6	90.1	90.2	94.1	69.3	85.2	91.0
S_8	67.3	79.6	85.0	87.7	90.4	90.7	92.3	95.6	70.1	86.8	94.8
S_9	65.8	81.2	84.7	87.8	91.3	91.5	91.9	97.2	68.5	85.2	92.2
S_{10}	64.3	78.8	84.2	88.1	90.4	91.8	93.0	96.6	63.2	80.3	88.6
Average	66.5	77.3	80.7	83.2	85.3	86.4	87.2	90.4	74.7	89.3	96.7

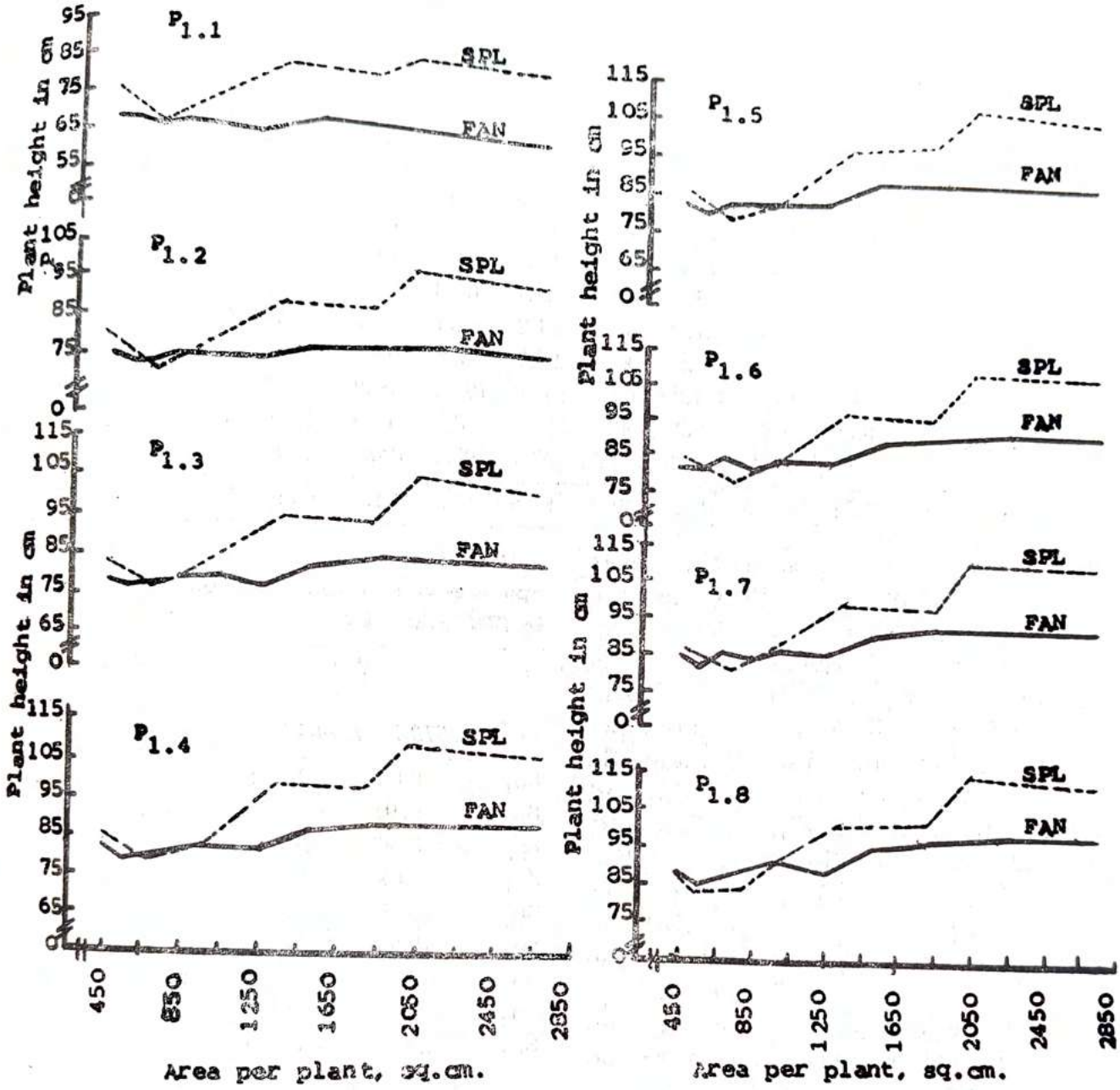


Figure 1: AVERAGE PLANT HEIGHT IN VARIOUS SPACINGS IN SPL AND FAN DURING $P_{1.1}$ THROUGH $P_{1.8}$.

The results presented in Tables 2 and 3 reveal that the spacing treatments with area 900 sq. cm and above had greater plant height in SPL than the height in FAN. The plant height (Table 3) was less in Sp_3 than that in Sp_4, both having the same area (900 sq. cm) per plant but differing in rectangularity (1 : 1 in Sp_3 and 4 : 1 in Sp_4). Likewise Sp_5 had smaller plant height in each period of observation during both the years compared with that in Sp_7, both having same area per plant but differing in rectangularity, 8:3 in Sp_5 and 6:1 in Sp_7. The results, therefore, indicate that the rectangularity i.e. inter and intra row spacing had some impact on the plant height of cotton IAN 579-188. Such information can not be obtained for FAN as it has constant and almost square rectangularity.

The difference in plant height in the corresponding spacing of FAN and SPL are indicative of bias in the estimates.

TABLE 3

Spacingwise plant height, in cm, during each period of observation in SPL.

	19.3-74								*1974-75*	
Sp_j	$P_{1\cdot1}$	$P_{1\cdot2}$	$P_{1\cdot3}$	$P_{1\cdot4}$	$P_{1\cdot5}$	$P_{1\cdot6}$	$P_{1\cdot7}$	$P_{1\cdot8}$	$P_{2\cdot1}$	$P_{2\cdot2}$	$P_{2\cdot3}$
Sp_1	76.6	81.2	82.7	83.9	84.9	85.2	86.2	88.1	71.7	88.6	89.6
Sp_2	67.4	73.8	77.4	78.1	78.8	80.1	80.8	81.1	73.2	91.9	94.2
Sp_3	71.2	76.3	77.8	79.2	80.2	81.3	81.5	84.1	72.4	92.6	93.6
Sp_4	73.6	79.6	81.7	83.2	84.1	84.8	87.9	90.8	82.6	100.5	100.9
Sp_5	75.9	84.4	87.9	89.7	91.2	91.5	93.1	94.7	74.1	94.0	95.8
Sp_6	80.0	90.5	94.5	96.8	99.5	97.3	97.4	101.2	77.0	94.6	94.8
Sp_7	88.5	98.3	101.8	103.4	104.9	105.3	106.2	107.4	86.4	111.0	111.5
Sp_8	85.0	100.3	106.3	108.4	110.2	110.3	111.3	113.9	79.8	102.4	102.7
Sp_9	82.5	97.1	102.8	105.2	107.4	107.4	108.5	110.5	72.4	97.2	98.3
Average	77.9	86.8	90.3	91.7	93.5	93.7	94.8	96.9	76.6	97.0	97.9

The smallest and largest spacings were common in SPL and FAN i.e. Sp_1 matched with S_1 and Sp_9 matched with S_{10}. Two more spacings; Sp_2 with S_3 and Sp_6 with S_8 nearly matched (about 1% difference) in terms of area per plant. The matching pairs Sp_1 and S_1, Sp_2 and S_3, Sp_6 and S_8 and Sp_9 and S_{10} have been coded as S'_1, S'_2, S'_3 and S'_4 respectively. The differences in plant height (FAN vs SPL) in these spacings ranged from —10.92% to 1.78% in S'_1, —0.79% to 4.31% in S'_2, —15.88% to -5.55% in S'_3 and —22.10% to —12.56% in S'_4 during first year. The corresponding difference observed during second year were 12.13% to 17.50% in S'_1, 0.16 to 7.51 % in S'_2, -9.02% to0.5—1% in S'_3 and —17.35% to —9.90% in S'_4. The trend in difference in plant height (FAN vs SPL) in S'_2, S'_3 and S'_4 was consistent in both the years. But S'_1 had inconsistent trend in two years which may be due to seasonal fluctuations.

It is clear from the results that the FAN design gives underestimation of plant height when area per plant was 900 sq.cm and above. This is supported by the results presented in Figures 1 and 2 also.

TABLE 4

Spacing-wise number of bolls per plant in SPL and FAN.

Sp_j	*SPL*		S_j	*FAN*	
	1973-74	*1974-75*		*1973-74*	*1974-75*
Sp_1	8.80	7.16	S_1	6.73	4.82
Sp_2	6.10	6.64	S_2	6.07	4.32
Sp_3	8.66	7.40	S_3	6.33	3.80
Sp_4	9.67	8.04	S_4	7.40	4.37
Sp_5	10.93	8.68	S_5	7.38	4.63
Sp_6	15.36	11.24	S_6	9.53	5.37
Sp_7	15.43	7.72	S_7	12.75	5.80
Sp_8	19.26	9.40	S_8	13.07	7.18
Sp_9	22.46	10.60	S_9	15.40	8.48
—	—	—	S_{10}	18.32	9.95
Average	12.74	8.54	—	9.88	5.67

Number of bolls per plant for various spacings in FAN and SPL are presented in Table 4 and are graphically presented in Figure 3.

The examination of the results (Table 4) reveals that in general, the number of bolls per plant in FAN was less than that in SPL during both the years. Like plant height, rectangularity played a vital role in the performance of the attribute in the spacing trials. The com-

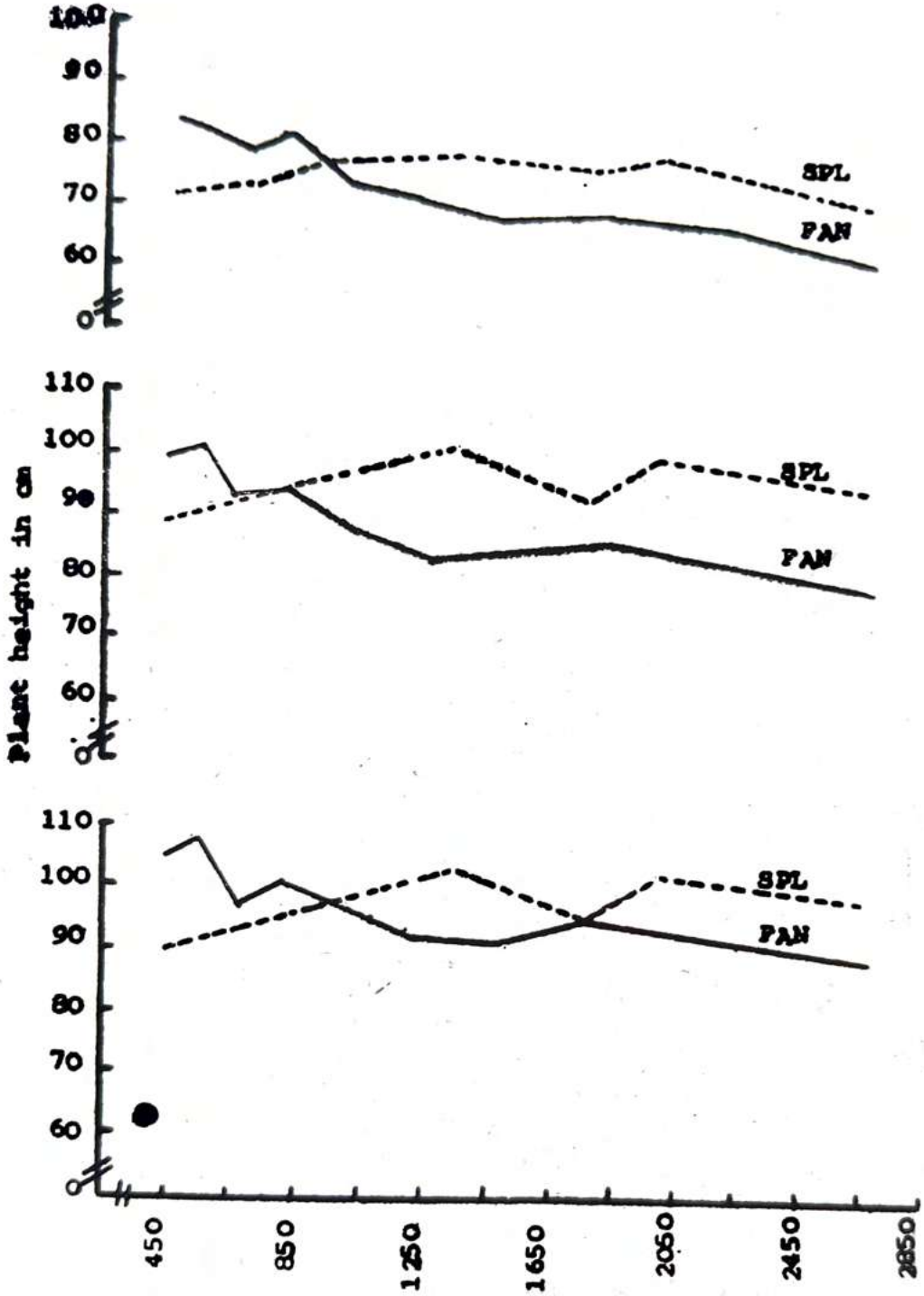


FIGURE 2: AVERAGE PLANT HEIGHT IN VARIOUS SPACINGS IN SPL AND FAN DURING $P_{2.1}$ (UPPER), $P_{2.2}$ (MIDDLE) AND $P_{2.3}$ (LOWER).

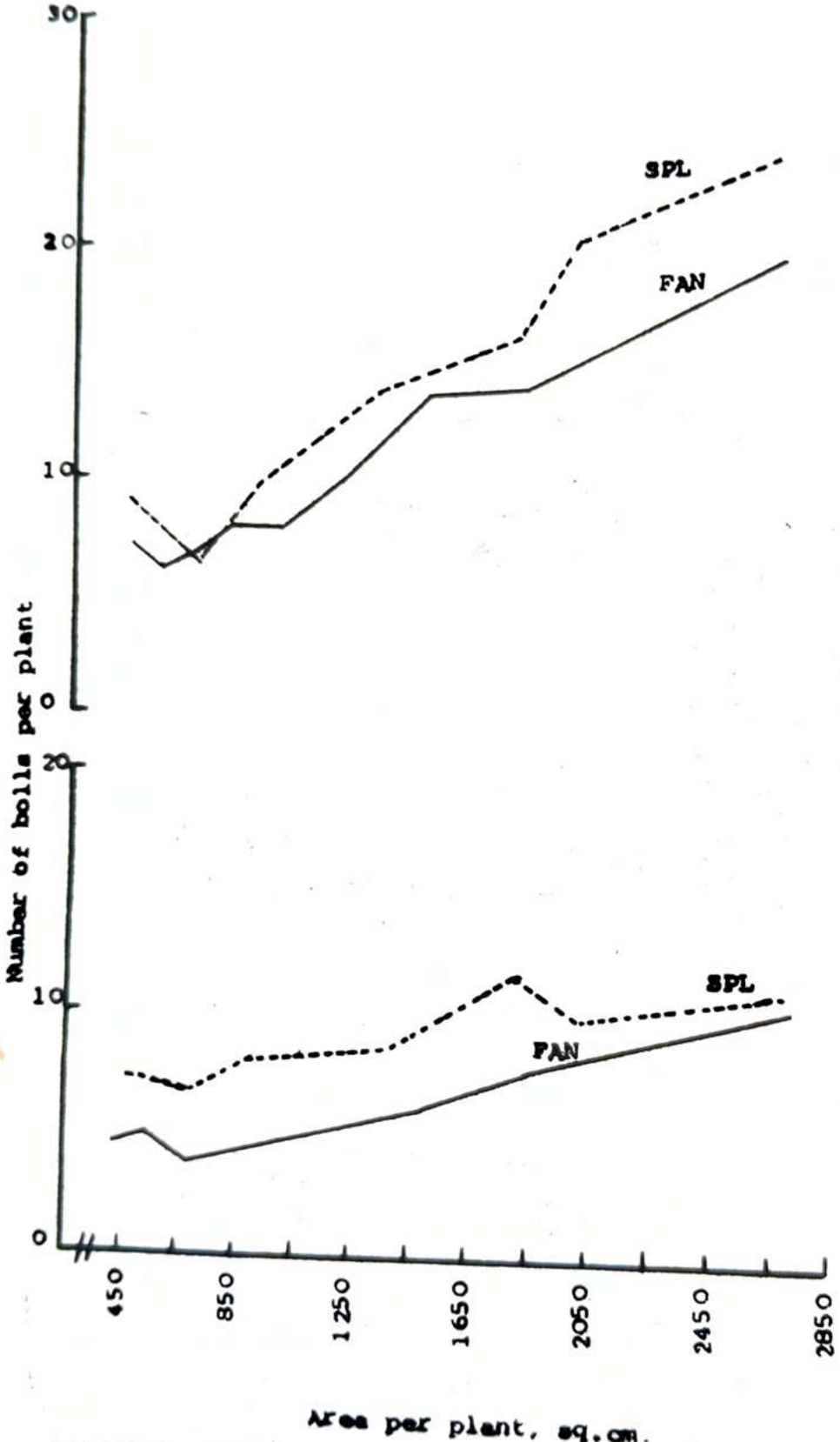


FIGURE 3: AVERAGE NUMBER OF BOLLS PER PLANT IN VARIOUS spacings in SPL and FAN during 1973-74 (UPPER) AND 1974-74 (LOWER).

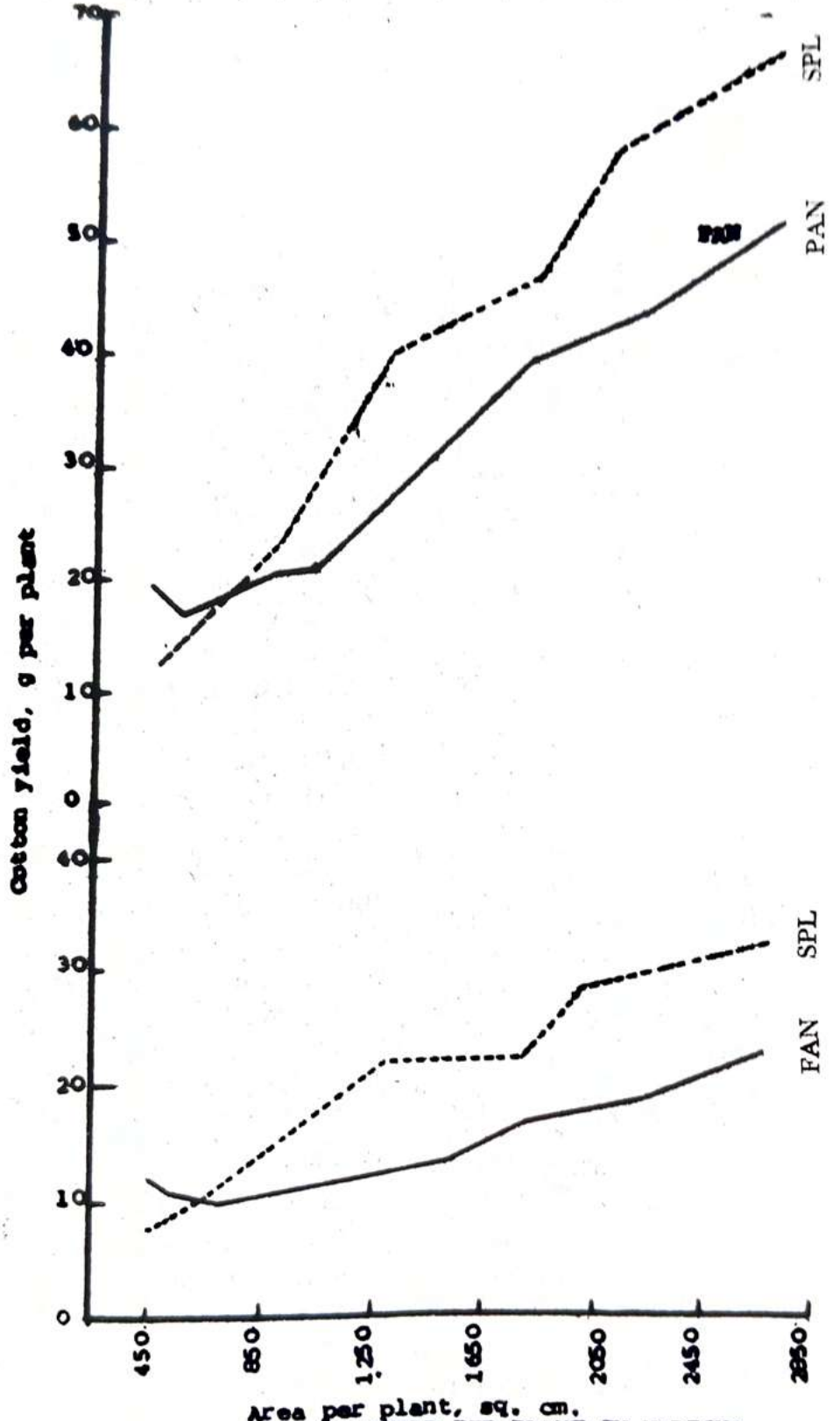


FIGURE 4. AVERAGE COTTON YIELD PER PLANT IN VARIOUS SPACINGS IN SPL AND FAN DURING 1973-74 (UPPER) AND 1974-74 (Lower)

parison of common spacing treatments (FAN vs SPL) over seasons showed that the S'_1, S'_2, S'_3 and S'_4 had negative differences in the number of bolls per plant. It is also clear from Figure 3 that, except for one spacing S_3 in FAN, all other spacings in SPL had greater number of bolls per plant than the corresponding spacing in FAN. On the basis of two season's data it can be concluded that the estimates of the average number of bolls per plant in FAN are biased.

Cotton yield per plant for various spacing treatments in FAN and SPL are presented in Table 5 and are depicted in Figure 4.

TABLE 5

Spacingwise cotton yield, g per plant in SPL and FAN.

Sp_j	SPL		S_j	FAN	
	1973-74	1974-75		1973-74	1974-75
Sp_1	11.52	7.87	S_1	19.11	12.09
Sp_2	18.45	10.37	S_2	16.77	10.58
Sp_3	22.58	13.77	S_3	18.25	9.78
Sp_4	24.63	15.04	S_4	20.18	10.30
Sp_5	37.49	20.04	S_5	20.84	11.32
Sp_6	47.4i	22.15	S_6	26.83	12.30
Sp_7	43.31	23.80	S_7	34.34	12.98
Sp_8	59.13	28.54	S_8	40.63	16.28
Sp_9	69.06	32.23	S_9	45.06	18.28
—	—	—	S_{10}	53.42	22.89
Average	37.06	19.63	—	29.54	13.68

The results presented in Table 5 reveal that the average cotton yield per plant in SPL was more than that in FAN. The cotton yield per plant increased with the increase in area per plant in SPL during both the years of study. In case of FAN the cotton yield per plant decreased from 19.11 in S_1 to 16.77 in S_2 during first year and from 12.09 in S_1 to 9.78 in S_3 during second year and thereafter it increased with the increase in spacing. The spacings Sp_3 and Sp_4 (having same area of 900 sq.cm) and Sp_5 and Sp_7 (having same area of 1350 sq.cm) in SPL showed deviation in cotton yield per plant which may be attributed to rectangularity.

The differences in cotton yield per plant in the corresponding spacings of FAN and SPL are indicative of bias in the estimates. These differences for S'_1, S'_2, S'_3 and S'_4 were compared and found that the average cotton yield in S'_1 in FAN was more than that for the corresponding spacing in SPL in both the years. In case of S'_2, S'_3 and S'_4 the average cotton yield per plant in SPL was more than in FAN. It is evident from the Figure 4 that the cotton yield per plant was more in SPL than that in FAN when the area per plant is 900 sq.cm and above. The results thus lead to the conclusion that the estimates of average cotton yield per plant in FAN are biased.

The results presented in Tables 2 through 5 revealed that the FAN, in general, gives underestimation of plant height, number of bolls per plant and cotton yield per plant. Tedin (1931), Barbacki and Fisher (1936), Yates (1939), Greenberg (1951) and Salmon (1955) had also reported bias in systematic arrangements.

The adjacent plots of FAN may have a border (marginal) effect on each other which is not possible to evaluate directly. Hence the alternative layouts were simulated and studied for obtaining estimates of border effect, if any. It was observed that there was no border effect and the FAN can be used for spacing experiments on crops with monopodical type of growth habit such as cotton IAN 579-188 (Patel, 1978).

The bias observed in treatment means in FAN was due to systematic arrangements

of single row plots. Therefore, a method for adjustment of bias need to be developed particularly for FAN design. The ractangularity plays vtal role in crop geometry and therefore, it should be given due consideration in planning of the spacing experiments.

REFERENCES

Barbacki, S., and R. A. Fisher. 1936. A test of the supposed precision of systematic arrangements. Eugenics. **7** : 189-193.

Fisher, R. A. 1935. The design of experiments. Oliver and Boyd. London.

Greenberg, B. G. 1951. Why randomize? Biometrics **7** : 309-322.

Nelder, J. A. 1962. New Kinds of systematic designs for spacing experiments. Biometrics **18** : 283-307.

Patel, N. M. 1978. Comparison of the Fan design with the conventional designs for spacing experiments—An empirical study. Unpublished Ph.D. thesis, Gujarat Agricultural University, Sardar Krushinagar.

Salmon, S. C. 1955. Random versus systematic arrangements in non-latin square field experiments. *Agron. J.* **47** : 289-294.

Tedin, O. 1931. The influence of systematic plot arrangement upon the estimate of error in field experiments. *J. Agric Sci.* **21**: 191-208.

Yates, F. 1939. The comparative advantages of systematic and randomized arrangements in the design of agricultural and biological experiments. *Biometrika* **30** : 440-466.

GAU Res. J. 1984. 10(1) : 38-42

Effect of Sheltering During Summer on Serum PBI Content of Kankrej and Kankrej x Jersey (F_1) Cattle

J. P. Patel, R. Borah, A. D. Dave and J. M. Patel

Department of Livestock Production, College of Veterinary Science and Animal Husbandry, Anand Campus, Anand

ABSTRACT

Experiment was conducted to study the effect of sheltering during summer on serum PBI content in order to assess the thyroid activity in Kankrej and Kankrej Jersey (F_1) cattle. Serum PBI content in sheltered group was higher by 14.56 and 11.24 per cent than that of the exposed group in Kankrej and Kankrej x Jersey (F_1) respectively. The difference in PBI content for two groups was highly significant ($P < 0.01$) in Kankrej and significant ($P < 0.05$) in Kankrej x Jersey (F_1). Week to week variation in PBI content was highly significant ($P < 0.01$) in both the breeds for sheltered as well as exposed group.

Findings revealed that under summer stress thyroid activity is significantly suppressed in indigenous as well as crossbred animals and sheltering definitely helps in maintaining higher thyroid activity.

(Receiveed on 11th Aug. 1981)

INTRODUCTION

Thyroid hormones play an intricate role in nutrient metabolism, promotion of growth and milk production (Turner, 1966). Serum protein bound iodine (PBI) content is an important indicator to assess the level of circulating thyroid hormones. Depression in thyroid activity during hot environment has been documented (Thomson *et al.* 1963; Kapoor and Mahadevan, 1971; Kapoor *et al.* 1974). Investigations discussing effect of sheltering (especially during summer stress) on thyroid activity in indigenous and crossbred cattle under tropical/sub-tropical climate could not be traced. Therefore, in the present paper an attempt has been made to furnish some information on this aspect in Kankrej and Kankrej × Jersey (F_1) crossbred cattle.

MATERIALS AND METHODS

An experiment was conducted at Veterinary Science College, Anand during intense summer (March, 28 to June, 28, 1978). Twelve Kankrej heifers (16-37 months) and 12 Kankrej × Jersey (F_1) crossbred male calves (10-15 months) were the experimentala nimals. Two groups, each of 6 animals were made on the basis of age and body weight of the animals for both respective breeds. One group from each breed was kept in an open yard, completely exposed to sun and the other was sheltered in a shed with a dom shape roof.

Blood samples of all the experimental animals were collected once in a week and separated serum was used for PBI estimation. Serum PBI was esti-

mated as per the method of Acland (1957). Statistical analysis of the data was carried out after Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Protein Bound Iodine (PBI)

(a) *Kankrej heifers:* Average serum PBI content of Kankrej heifers of sheltered and exposed group for different weeks under study is presented in Table 1 alongwith ANOVA.

It can be seen from the presented data that the average PBI content in serum of sheltered and exposed heifers was 5.90 and 5.15 μg/100 ml respectively. The sheltered group had 14.56 per cent higher PBI concentration than the exposed group. This defference of PBI content was highly significant ($P < 0.01$). It can further be noticed that the week to week variation in serum PBI concentration was also highly significant ($P < 0.01$) in both exposed as well as sheltered group.

TABLE 1

Average serum protein bound iodine content of Kankrej heifers. (ug per 100 ml).

Weeks	*Shed group*	*Exposed group*	*Average*
1	4.48	3.58	4.03
2	4.48	3.92	4.20
3	3.93	3.20	3.57
4	7.46	6.53	7.00
5	4.15	4.29	4.22
6	8.25	7.79	8.02
7	7.32	6.85	7.09
8	7.32	5.35	6.34
9	5.65	4.64	5.15
10	5.73	4.66	5.20
11	5.55	5.15	5.35
12	6.03	5.19	5.61
13	6.35	5.85	6.10
Average	5.90	5.15	5.53

ANOVA

Sources of variation	*d.f.*	*S.S.*	*M.S.*	*Cal. F.*	*Table value of F*	
					5%	*1%*
Weeks	12	43.27	3.61	29.87**	2.69	4.16
Treatment	1	3.62	3.62	29.98**	4.75	9.33
Error	12	1.45	0.12	—	—	—

Effect	S.Em.	C.D. at 5%	C.D. at 1%	C.V.%
Weeks	0.25	0.76	1.08	6.30
Treatment	0.10	0.31	0.43	

**Significant at $P < 0.01$.

It ranged from 3.93 to 8.25 µg/100 ml for the sheltered group and 3.20 to 7.79 µg/100 ml for the exposed group.

(b) *Cross bred males:* The average serum PBI content of castrated crossbred males of exposed and sheltered group for different weeks under study is presented in Table 2 along with ANOVA.

Data presented in Table 2 showed that the average serum PBI content of sheltered and exposed group was 5.54 and 4.96 µg/100 ml respectively. The males housed in the shed had 11.24 per cent higher PBI content than those kept in the open. This difference in PBI content was statistically significant ($P < 0.05$).

TABLE 2

Average serum protein bound iodine content of castrated crossbred males. (ug per 100 ml).

Weeks	*Shed group*	*Exposed group*	*Average*
1	4.11	2.45	3.28
2	3.76	4.49	4.13
3	5.54	5.71	5.63
4	7.16	6.46	6.81
5	4.48	4.88	4.68
6	7.14	6.52	6.83
7	6.67	5.45	6.06
8	5.69	4.45	5.07
9	5.66	3.93	4.80
10	6.69	6.41	6.55
11	5.67	4.63	5.15
12	4.66	4.65	4.66
13	4.83	4.48	4.66
Average	5.54	4.96	5.25

ANOVA

Sources of variation	*d.f.*	*S.S.*	*M.S.*	*Cal. F.*	*Table value of F* 5%	1%
					5%	*1%*
Weeks	12	27.69	2.31	7.62**	2.69	4.16
Treatment	1	2.19	2.19	7.24*	4.75	9.33
Error	12	3.63	0.30	—	—	—

Effect	S.Em.	C.D. at 5%	C.D. at 1%	C.V. %
Weeks	0.39	1.20	1.68	10.50
Treatment	0.15	0.46	N.S.	

*Significant at $P < 0.05$

**Significant at $P < 0.01$

Analysis of the data further revealed that the week to week variation in serum PBI concentration was highly significant ($P < 0.01$) for both the groups. PBI content varied from 3.76 to 7.76 µg/100 ml for the exposed group. The range of serum PBI concentration for sheltered group in the present study is higher than that reported by Singh *et al.* (1970) for Sahiwal x Holstein crosses.

Analysis of variance showing the influence of week, shelter, breed and various interactions on serum PBI concentration are shown in Table 3.

TABLE 3

Analysis of variance of experimental data.

Source	*d.f.*	*S.S.*	*MSS*	*F*	*SEM*	*CD 0.05*
Breed group (G)	1	0.98	0.98	4.62^{NS}	0.09	—
Weeks (W)	12	57.81	4.82	22.73**	0.23	0.71
Shelter (S)	1	5.72	5.72	26.98**	0.09	0.28
W x G	12	13.145	1.095	5.16**	0.33	1.07
W x S	12	2.54	0.29	1.37^{NS}	—	—
S x G	1	0.90	0.090	0.42^{NS}	—	—
W x S x G	12	2.5445	0.212	—	—	—

**Significant at 1% level.

It is evident from the results that week and shelter both had significant influence ($P < 0.01$) on serum PBI content. Influence of breed was observed to be non-significant. Among interactions, week x breed interaction was found to exert a significant influence. It is difficult to give the precise explanation for the same. However, significantly lower values of serum PBI of exposed group in comparison to sheltered one clearly suggest that under summer stress thyroid activity of the animals is suppressed considerably and sheltering is definitely beneficial for maintaining high thyroid activity (serum PBI level) both in indigenous as well as crossbred cattle.

(c) *Climatic elements and Serum PBI Concentration:* In order to find out all possible relationships between various climatic elements and PBI content of serum, correlation coefficients were worked out. The results are presented in Table 4.

TABLE 4

Correlation coefficient between serum protein bound iodine and climatic elements.

Climatic elements	*Crossbred males*		*Kankrej heifers*	
	Shed group	*Exposed group*	*Shed group*	*Exposed group*
Average ambient temperature	0.41	0.27	0.19	0.22
Maximum temperature	0.31	0.21	0.06	0.05
Minimum temperature	0.30	0.19	0.37	0.33
Mean temperature	0.50	0.33	0.36	0.32
Diurnal difference	–0.02	0.00	–0.21	–0.19
Average vapour pressure	0.37	0.34	0.43	0.38
Average relative humidity	0.06	0.15	0.20	0.16
Duration of sunshine	0.12	0.09	0.05	0.14

Results showed that the average ambient temperature, maximum temperature, minimum temperature, average vapour pressure and average relative humidity had non-significant but positive association with serum PBI concentration in both the breeds, for those housed in shed as well as kept in open. The diurnal difference had negative association with serum PBI in both the breeds for both the groups.

REFERENCES

Acland, J. D. 1957. The estimation of serum protein bound iodine by alkaline incineration. *Bio. Chem. J.* **66** : 177-188.

Kapoor, P. D., D. P. Sharma and O. P. Nangia. 1974. A note on seasonal variation in PBI in Murrah buffalo bulls. *Indian J. Anim. Sci.* **44** : 133-134.

Kapoor, U. R. and V. Mahadevan. 1971. Interrelationship between caeruloplasmin, PBI and atmospheric temperature in cattle. *Indian Vet. J.* **48** : 272-278.

Singh, A., M. S. Sefia, V. P. Dixit and V. K. Aggrawal. 1970. Estimation of thyroid secretion rate and the related parameters in buffalo (*Bos bubalis*) and Sahiwal x Holstein (F_1) crossbred calves using I 131 labelled L – thyroxine. *Indian J. Anim. Sci.* **40** : 579-586.

Snedecor, G. W. and W. G. Cochran (1967). Statistical methods. 6th Ed. Oxford and IBH Pub. Co. Calcutta.

Thompson, R. D., J. E. Johnston, C. P. Breidenstein, A. J. Guidry, M. R. Benerjee and W. T. Burnett. 1963. Effect of hot conditions on adrenal cortical, thyroid and other metabolic responses of dairy heifers. *J. Dairy Sci.* **46** : 227-231.

Turner, C. D. 1966. General Endocrinology. 4th Ed. W. B. Saunders Company, Philadelphia, London.

GAU Res. J. 1984. 10 (1): 43-50

Comparison of Vat Performance of Meito, Rennilase and Calf Rennet During Cheddar Cheese Making from Buffalo Milk

K. G. Upadhyay, S. H. Vyas, H. K. Desai, A. J. Pandya and J. N. Patel

Department of Dairy Technology, Sheth M. C. College of Dairy Science, GAU, Anand Campus, Anand 388 110

ABSTRACT

Fungal rennets, namely, Meito and Rennilase were compared with calf rennet for manufacture of buffalo milk cheddar cheese, using them alone or as 50:50 mixtures of their own and with calf rennet. The rennets and their combinations had statistically identical cheese vat performance to calf rennet with regard to curd characteristics, acid development, milk solids losses in whey, yield of cheese and gross composition of fresh buffalo cheddar cheese and therefore modifications in the existing procedure for manufacture of buffalo milk cheddar cheese using calf rennet were not required. It is concluded that these coagulants can be successfully used as calf rennet substitutes provided that they also compare favourably during ripening.

(*Received on 26th Sept. 1984*)

INTRODUCTION

In recent years, for cheese-making, milk coagulants derived from Mucor species, viz. *Mucor pusillus Lindt* and *Mucor miehei* have found greater acceptance as calf rennet substitutes Green (1977). Successful cheddar cheese-making trials, using these fungal rennets have been reported by many workers (Phelan, 1973; Robertson and Gilles, 1969; Wigley, 1947). However, all these reports are on the cheddar cheese made from cow milk and information on technological suitability of Mucor rennets for manufacture of cheddar cheese from buffalo milk is lacking.

In view of this, two commercial preparations, namely, Meito (derived from *M. pusillus Lindt*) and Rennilase (dervied from *M. miehei*) were selected and compared with part (50%) or full replacement of calf rennet for manufacture of buffalo milk cheddar cheese. In this paper we report the performance of the above rennets and the combinations, during cheese-making with respect to (i) curd characteristics (ii) influence on acid production (iii) milk solids losses in cheese whey (iv) yield of cheese and (v) composition of fresh cheese.

MATERIALS AND METHODS

Calf rennet (activity: 100000 units/g; Chr. Hansen's), Meito rennet (activity: 300000 units/g; Meito Sangyo Co. Ltd., Japan) and Rennilase (activity: 150000 units/ml.; Novo Industries, Denmark) were used as coagulants for

cheese-making in the following combinations.

(1) Calf rennet (C)....Control
(2) Meito rennet (M)....alone
(3) Rennilase (R)....alone
(4) Calf + Meito (CM)....1 : 1 (w/w)
(5) Calf + Rennilase (CR)....1 : 1(w/v)
(6) Meito + Rennilase (MR)
....1 : 1 (w/v)

The above rennets and the combinations were added in quantities sufficient to give a setting time of 30-35 min at 32° C.

Cheddar cheese culture No. 1288 (Wiesby Lab; West Germany) was used as starter culture throughout the study. Ninety kg. of fresh, pooled, standardised (casein to fat ratio 0.686), pasteurized (72° C for 15-16 sec.) buffalo milk having 4.57% fat and 3.135% casein was used for cheese-making.

In all, eighteen batches of cheese, three for each rennet and rennet combination, were prepared as per the method of Van Slyke and Price (1952), as outlined for cow milk cheddar cheese, with the following modifications: higher rate of starter addition (1.5%), slightly higher temperature of setting (32° C), cooking at low temperature (36° C) for a shorter time ($\leq$60 min) and early as well as high piling during cheddaring.

The cheese whey obtained was analysed for titratable acidity. (Is: 1479, Part I, 1961) fat. (Is: 1224, Part, I, 1977) total solids and total protein. (Is: 1479, Part II, 1961). The non protein-nitrogen (NPN), soluble in 12% TCA was determined by Kjeldahl method.

The representative samples of fresh cheeses were analysed for moisture (IS: 1479, Part II, 1961) fat (IS: 2785, 1964) salt and total protein Kosikowski (1970).

The data obtained were subjected to statistical analysis as per Steel and Torrie (1960).

RESULTS AND DISCUSSION

Manufacture of cheddar cheese from buffalo milk:

The details of comparative performance of various rennets during cheddar cheese-making from buffalo milk are depicted in Table 1. The data show that all the rennets gave almost identical setting time, ranging from 33 to 35 min. The vats set with C, M, R and CM rennets had same setting time of 35 min, whereas the vats set with CR and MR showed a slightly shorter setting time of 33 min. The little shorter setting time observed with CR and MR rennets could be attributed to somewhat higher setting acidity (0.18%) of milk set with these rennets.

The measurement of NPN liberated at cutting showed identical values for different rennets and their combinations, ranging fiom 0.034 to 0.035%. This is in agreement with the results of Kikuchi *et al.* (1968) who observed similar trend of release of NPN at cutting while manufacturing cheddar cheese from cow milk using calf rennet, *Mucor pusillus Lindt* rennet and their combinations.

The influence of the milk coagulants on acid development at different stages of cheddar cheese-making revealed similar pattern. The final acidity at milling for C, M, R, CM, CR and MR rennets was 0.466, 0.469, 0.468, 0.470, 0.475 and 0.473% respectively, showing that starter activity during cheese-making was neither stimulated nor inhibited by any of the rennet or rennet combination tested. Similar results have been reported by Nelson (1969) for

TABLE 1

Comparative performance of various rennets during cheddar cheese-making from buffalo milk.

Manufacturing stage	*Unit*	*Rennet used*					
		C	*M*	*R*	*CM*	*CR*	*MR*
Ripening of milk:							
Acidity of milk at ripening	% L.A.	0.165	0.165	0.165	0.168	0.171	0.171
Rate of addition of starter	% (w/w)	1.5	1.5	1.5	1.5	1.5	1.5
Temperature of milk	°C	30	30	30	30	30	30
Time spent for acid development	Min	45	45	45	45	45	45
Milk acidity at renneting	% L.A.	0.174	0.174	0.174	0.177	0.180	0.180
Setting or Renneting:							
Rate of rennet addition	g or ml*/ 100 L	3.75	1.75	2.0*	1.25+1.25*	1.25+1.25*	1.0+1.0*
Temperature of milk	°C	32	32	32	32	32	32
Time taken for setting	Min	35	35	35	35	33	33
Cutting:							
Whey acidity	% L.A.	0.09	0.09	0.09	0.10	0.10	0.10
NPN of whey at cutting	%	0.035	0.035	0.034	0.034	0.034	0.034
Cooking :							
Final temperature of cooking	°C	36	36	36	36	36	36
Period	Min	60	60	60	60	60	60
Final acidity of whey	% L.A.	0.127	0.127	0.127	0.133	0.133	0.133
Cheddaring:							
Initial acidity of whey	% L.A.	0.167	0.170	0.163	0.170	0.170	0.170
Final acidity of whey	% L.A.	0.444	0.450	0.453	0.456	0.447	0.458
Period	Hr. Min.	2.30	2.32	2.30	2.38	2.35	2.35
Milling:							
Time after addition of rennet	Hr. Min.	4.50	4.52	4.50	4.58	4.53	4.53
Acidity at milling	% L.A.	0.466	0.469	0.468	0.470	0.475	0.473
Salting:							
Amount of salt	g/100 L	400	400	400	400	400	400
Pressing:							
Period	Hour	18	18	18	18	18	18
Yield after pressing	Kg	11.750	11.500	11.420	11.500	11.420	11.330

Average of 3 trials

*Rennilase added on volume basis.

cheddar cheese-making from cow milk using calf rennet, *M. pusillus Lindt* rennet and their mixture.

The quality of curd, its characteristics and behaviour at different stages of cheese-making did not show any appreciable differences for the various rennets and their mixtures. The total time for cheese-making also was almost similar for all the vats set with different rennets.

The weight of cheese obtained with different rennets varied from 11.33 kg for MR rennet cheese to 11.75 kg for C rennet cheese. However, the differences in yield were non-significant.

Composition of cheese whey

Table-2 contains the data on fat, protein and solids contents of cheddar cheese whey obtained by using different coagulants and collected upto the end of cheddaring. The mean values for fat content were identical (0.27%) in all whey except in case of whey from rennet C which was little lower than other coagulants (0.25%). The average values for protein content ranged between 0.999 and 1.018%. The lowest value was observed in case of rennet C and the highest in case of rennet CM. The average solids content of whey ranged from 6.48% for CM rennet to 6.68% for rennet R. The whey from cheese made with other rennets showed intermediate values.

TABLE 2

Composition of cheese whey obtained with different rennets.

	constituent (%)		
Rennet	*Fat*	*Total protein*	*Total solids*
C	0.25	0.999	6.57
	(0.20-0.30)	(0.960-1.040)	(6.25-6.69)
M	0.27	1.011	6.52
	(0.20-0.30)	(0.98-1.050)	(6.32-6.65)
R	0.27	1.011	6.68
	(0.20-0.35)	(0.940-1.052)	(6.34-7.00)
CM	0.27	1.018	6.48
	(0.20-0.30)	(1.00-1.04)	(6.16-6.84)
CR	0.27	1.007	6.66
	(0.20-0.30)	(0.97-1.04)	(6.43-6.84)
MR	0.27	1.017	6.65
	(0.20-0.30)	(0.98-1.04)	(6.48-6.77)

Figures in the parentheses indicate range.

The differences in the values of fat, protein and solids contents of whey from different rennets were statistically non-significant and were well within the limits normally and practically observed with cheese-making from buffalo milk. Thus, all the milk coagulants studied proved equal to rennet C, used as control.

The trend of losses of fat, protein and solids observed in the whey obtained from buffalo milk in the present study is supported by the findings of Robertson and Gilles (1969) for protein, Labuschagne and Jaarsma (1970) for

solids content in cheddar cheese whey obtained from cow milk using calf and Mucor rennets. On the other hand, some workers (Green and Stackpoole 1975; Labuschagne and Jaarsma, 1970; Richardson, *et al.* 1967) have reported higher fat losses in cheese whey obtained from Mucor rennets. Reps *et al.* (1974 a, b, c) and Poznanski *et al.* (1974) reported higher N looses in whey obtained with Meito rennet. The higher losses of fat and protein were attributed to softness of curd with these Mucor rennets.

Composition of cheese

The data in Table 3 represent average composition of fresh cheddar cheese made from buffalo milk using different rennets. The ranges of mean values for moisture, fat, protein and salt for cheeses made with different rennets were 36.78 – 37.35, 32.28 – 32.58, 24.50 – 25.01 and 1.48 – 1.56% respectively. The highest values for moisture, fat, protein and salts were observed in cheeses made with MR, M, CR and MR and CM respectively, whereas the lowest values for these constituents were noted in R, C, C and M cheeses respectively.

TABLE 3

Average composition of cheddar cheese made with different rennets.

Rennet used	*Constituent* (%)				
	Moisture	*Total solids*	*Fat*	*Protein*	*Salt*
C	36.92	63.08	32.28	24.50	1.52
	(35.58-38.22)	(61.78-64.20)	(31.48-33.18)	(23.31-25.11)	(1.49-1.56)
M	37.12	62.88	32.58	24.78	1.48
	(36.45-37.56)	(62.44-63.57)	(31.59-33.22)	(24.59-25.04)	(1.36-1.62)
R	36.78	63 22	32.40	24.89	1.53
	(36.08-37.59)	(62.41-63.92)	(32.00-32.80)	(24.45-25.33)	(1.44-1.65)
CM	37.20	62.80	32.43	24.75	1.56
	(36.24-37.81)	(62.19-63.76)	(32.20-32.56)	(24.40-25.06)	(1.53-1.58)
CR	37.05	62.95	32.30	25.01	1.53
	(36.35-37.60)	(62.40-63.55)	(32.01-32.79)	(24.72-25.30)	(1.44-1.64)
MR	37.35	62.65	32.40	25.01	1.54
	(36.95-37.89)	(62.11-63.05)	(31.49-32.86)	(24.63-25.46)	(1.47-1.63)

Figures in the parentheses indicate range.

The variations observed in the values of these components were well within the limits experienced with normal cheddar cheese-making. Compositionally, cheeses made from buffalo milk using Mucor rennets and their mixtures were comparable to C rennet used as control.

The above findings are in agreement with those of Wong *et al.* (1976) and others (Green and Stackpoole, 1975; Labuschagne and Jaarsma) 1970; Nelson, 1969; Robertson and Gilles, 1969) who obtained comparable results for calf rennet and Mucor rennets for cheddar cheese made from cow milk.

Published data on proximate composition of buffalo milk cheddar cheese made with fungal rennets are not available for comparison. However, the values observed in the present study, for cheeses made with calf rennet, Mucor rennets and their mixtures, for moisture, fat and protein are almost comparable to those obtained by Czulak (1964) for moisture, Neogi and Jude

TABLE 4

Average yield of cheese and recovery of fat, protein and total milk solids in cheese.

Rennet used	*Yield %*	*Per cent recovery*		
		Fat	*Protein*	*Total milk solids*
C	12.86 (12.59-13.14)	92.32 (87.43-96.18)	78.74 (74.79-80.84)	56.69 (54.40-59.31)
M	12.59 (12.59)	91.15 (89.70-92.27)	77.97 (75.87-79.28)	55.39 (54.93-56.17)
R	12.50 (12.04-12.86)	90.00 (86.91-93.09)	77.75 (73.56-81.27)	55.24 (53.05-57.67)
CM	12.59 (12.32-13.14)	90.69 (88.31-93.33)	77.83 (71.11-78.56)	55.24 (53.58-57.57)
CR	12.50 (12.04-13.14)	89.75 (85.05-95.05)	78.09 (75.87-81.45)	54.99 (52.40-58.56)
MR	12.41 (12.04-12.86)	89.40 (83.67-93.26)	77.52 (75.78-78.59)	54.55 (53.07-56.65)

Figures in parentheses indicate range.

(1978) for fat and Bhattacharya *et al.* (1970) for protein in cheddar cheese made from buffalo milk using calf rennet as coagulant.

Yield of cheese and recovery of milk constituents

The data reported in Table-4, on per cent yield of cheese (kg of cheese per 100 kg milk), exhibited highest yield of 12.86% with rennet C and lowest of 12.41% with MR rennet. The other coagulants showed yield values within this range.

The ranges for mean values for recovery of fat, protein and milk solids were found to be 92.32-89.40, 78.74-77.52 and 56.69-54.55% respectively for buffalo milk cheddar cheese made with different rennets. The highest recovery of these components was observed with rennet C followed by rennet M except for protein recovery, in which rennet CR was little superior to rennet M. Least recoveries for all the three components were observed with MR rennet. This could be attributed to higher moisture content of the cheese. The observed differences in the yield and recovery of fat, protein and milk solids in cheddar cheese made with different rennets, however, were statistically non-significant and therefore the various coagulants studied could be considered equally satisfactory from yield and recovery points of view as compared to rennet C used as control.

The above observations on yield of cheddar cheese made from buffalo milk with calf rennet, Mucor rennets and the mixtures are supported by similar findings of Robertson and Gilles (1969) and others (Nelson, 1969, 1975; Phelan, 1973) for cheddar cheese made from cow milk using calf and Mucor rennet. As against this, Kikuchi *et al.* (1968) and Wigley (1974) reported lower cheese yields with Mucor rennets as compared to calf rennet used as control in cow milk. Labuschagne and Jaarsma (1970) reported lower recovery of fat in cow cheddar cheese made with Mucor rennets compared

to calf rennet, owing to higher fat losses in whey.

The comparative data on yield and recovery of milk constituents in cheddar cheese made from buffalo milk using Mucor rennets are lacking. However, the values of yield end recovery of fat and milk solids noted in the present study are comparable to those obtained by Bhattacharya *et al.* (1970) for cheddar cheese made from buffalo milk using calf rennet as tne coagulant.

REFERENCES

Bhattacharya, D. C., Mathur, O. N., Srinivasan M. R. and Samlik, O. 1970. Studies on the manufacture of quick curing cheddar type cheese. *Ind. J. Dairy Sci.* **23** (3): 133-139.

Czulak, J. 1964. Manufacture of gouda and cheddar type cheese from buffalo's milk. *Aust. J. Dairy Tech.* **19** (4): 166-169.

Green, M. L. and Stackpoole, A. J. 1975. The preparation and assessement of a suitable *Mucor pussilus Lindt* proteinase swine pepsin mixture for cheddar cheese-making. *J. Dairy Res.* **42** (2): 297-312.

Green, M. L. 1977. Review of progress of Dairy Science: Milk coagulants. *J. Dairy Res.* **44** (1): 159-188.

IS: 1479 (Part I) 1961. Methods of test for dairy industry. Rapid examination of milk. Indian Standards Institution. New Delhi.

IS: 1479 (Part II) 1961. Methods of test for dairy industry. Chemical analysis of milk. Indian Standards Institution. New Delhi.

IS: 2785. 1964. Specification for hard cheese, processed cheese and processed cheese spread. Indian Standards Institution. New Delhi.

IS: 1224 (Part I). 1977. Determination of fat by the Gerber method. Indian Standards Institution. New Delhi.

Kikuchi, T., Toyoda, S., Ahiko, K. and Suzuki, Y. 1968. Studies on microbial rennet. III. Practical application of microbial rennet in cheese-making Rep. Res. Lab. Snow Brand Milk, Prod., Co. Tokyo. **70** : 13-22, 33-37.

Kosikowski, F. V. 1970. Cheese and fermented milk foods. Edwards Bros. Inc. Ann. Abror. Michigan.

Labuschagne, J. H. and Jaarsma, J. 1970. Studies on cheese manufactured with microbial rennet. *S. Afr. J. Dairy Tech.* **2** (4): 253-259.

Nelson J. H. 1969. Commercial scale cheese-making trials with a milk clotting enzyme produced by *Mucor pusillus Lindt. J. Dairy Sci.* **52** (6): 889.

Nelson J. H. 1975. Symposium: Application of enzyme technology to dairy manufacturing. Impact of new milk clotting enzyme on cheese technology. *J. Dairy Sci.* **58** (11): 1739-1750.

Neogi, S. B. and Jude, T. V. R. 1978. Effect of homogenization of buffalo milk on the chemical quality of cheddar cheese. XX Int. Dairy Cong. 810.

Phelan, J. A. 1973. Laboratory and field tests on new milk coagulants. *Dairy Ind.* **38** (9): 418-19, 422-23.

Poznanski, S., Reps, A., Kowalewska, J., Maszewsk, J. R. and Jedryochowski, L. 1974. Proteolytic activity of coagulating preparations of microbial origin depending on a kind of substrate. *Milchwissenschaft.* **29** (12): 742-746.

Reps, A., Poznanski, S., Rymaszewski, J., Jakubowski, J., Smietana, Z., Kowalewska, J., Bednarski, W. and Chojnowski, W. 1974 a. The characteristics of different milk coagulating enzymes. XIX Int. Dairy Cong. **1E:** 323-324.

Reps, A., Poznanski, S., Kaszycka, A. and Wasilewski, R. 1974 b. Milk coagulation by microbial rennet substitutes. *Dairy Sci. Abstr.* **37** : 4412.

Reps, A., Poznanski, S., Rymaszewski, J., Jarosz, M. and Jedrychowski, L. 1974 c. Proteolytic activity of microbial rennet substitutes. *Dairy Sci. Abstr.* **37** : 4413.

Richardson, G. H., Nelson, J. H., Lubnow, R. E. and Schwarberg, R. L. 1967. Rennin like enzyme from *Mucor pusillus* for cheese manufacture. *J. Dairy Sci.* **50** (7): 1066-1072.

Robertson, P. S. and Gilles, J. 1969. Commercial cheese-making with a Japanese microbial rennet. *N.Z.J. Dairy Sci. Tech.* **4** (3): 128-132.

Steel, R. G. D. and Torrie, J. H. 1960. Principles and procedures of statistics. McGraw Hill Book Co. Inc., New York.

Van Slyke, L. L. and Price, W. V. 1952. Cheese, Orange Judd Pub. Co. Inc., New York.

Wigley, R. C. 1974. The use of microbial rennet substitutes in the production of cheddar cheese XIX Int. Dairy Cong. **1E:** 687.

Wong, N. P., Lacroix, D. E., Vestal, J. H. and Alford, J. A. 1976. Composition of cheddar cheese made from different milk clotting enzymes. *Dairy Sci. Abstr.* **39**: 1693.

GAU Res. J. 1984. 10 (1): 51-55

Check Basin Size for Irrigating Chick-pea in Heavy Black Soils

M. Mallik, S. D. Patel and R. S. Joshi

Main Irrigation Research Centre, GAU, Navsari Campus, Navsari

ABSTRACT

An experiment was carried out to find the proper size of check basin and corresponding optimal flow rate for irrigating chick-pea (Cicer arientinum, cv. 'Dahod yellow') in black cotton soil of South Gujarat at the Main Irrigation Research Centre, Navsari during November to March 1979-80 and 1980-81. The study was conducted on four sizes of check basins (50 m^2, 72 m^2, 98 m^2 and 128 m^2) and three inflow rates (3.0 1/sec, 4.5 1/sec and 6.0 1/sec). The statistical analysis of the data indicated that the check basin of 50m^2 size with 3.0 1/sec inflow rate was suitable for irrigating chick-pea.

(Received on 30th Aug. 1982)

INTRODUCTION

The check basin method of irrigation is by far the most common method of irrigation in India and many parts of the world. This method of irrigation is well suited for a wide variety of crops and soils. The pattern of irrigation and sizes of check basins, however differ considerably from place to place depending upon the local conventional practice followed by the farmers, who generally do not possess sufficient knowledge regarding the proper sizes of check basins and inflow rates for various crops and soils. For the given soil characteristics of a region, with a suitable combinations of plot size and inflow rate, it is possible to apply required amount of water uniformly throughout the basin.

Information to recommend the optimum size of check basin for efficient use of water is scanty. Ram *et al.* (1976) reported that the highest wheat yield was obtained in the check basin of 5m x 5m on sandy soil. Yadav (1973-75) reported that maximum wheat yield (25.47 q/ha) and water use efficiency (109 kg/ha/cm) were obtained in check basin of 250 m^2 size and non-erosive inflow rate on sandy loam soils. Slabbers (1971) carried out study at the Marvedasht pilot project at Iran and found that a rectangular basin size of 25m x 10m was best for growing sugar beet in sandy loam soils. Wayse *et al.* (1980) reported that in clayey soils, check basins of 8.33m$\times$ 6m size with 8 1/sec inflow rate was suitable for irrigating wheat crops. It was further reported that rectangular shape was superior to other shapes. Hence the soil type, crop and flow rates are the major factors affecting the check basin size considerably.

Chick-pea, which is one of the major pulse crops in India, is normally grown under unirrigated conditions. However, recent studies (Joshi *et al.*,

1979) have indicated that giving three irrigations the yield can be increased substantially. Since the normal practice of growing pulse crops in this country is by adopting check basin system, it follows that a properly designed check basin under irrigated condition will improve the water application efficiency and the production of chick-pea.

MATERIALS AND METHODS

The experiment was conducted at the Main Irrigation Research Centre, Navsari, India during November to March of 1979-80 and 1980-81 in levelled heavy black soils having pH 7.95, EC 0.37 millimohs/cm field capacity 32.44%, permanent wilting point 17.20%, clay content 62% and bulk density 1.42 g/cm^3. Chick-pea (cv. Dahod yellow) with 30 cm x 15 cm spacing was sown on 28th November and 21st November in the year 1979 and 1980 respectively. The experiment was laid out in split plot design with four sizes of rectangular (2 : 1 length breadth ratio) check basins, namely, 50m^2, 72m^2, 98m^2 and 128m^2 and three flow rates, namely 3.0, 4.5 and 6.0 l/sec replicated three times. Width of the irrigation channels and the peripheral bunds of the check basins were 60 cm and 30 cm respectively. Infiltration rate was measured by concentric cylinder infiltrometer. Water discharge was measured by Parshall measing flume. Soil moisture was determined gravimetrically just before and after 24 hours of irrigation at 0-15 cm, 15-30 cm, 30-45 cm, 45-60 cm and 60-75 cm soil depths to estimate different irrigation efficiencies. A light irrigation of 4 cm was applied for germination just after sowing. Three more irrigations each of 7.5 cm were applied at branching (30-35 days), flowering (55-60 days) and pod formation (70-75 days) stages of chick-pea as per recommendation of this centre. During the year 1981-82, a large scale trial was taken on a plot of 71 m x 90 m with the recommended check basin size and flow rate for testing the applicability of result in farmer's field.

RESULTS AND DISCUSSION

Infiltration rate

The cumulative infiltration rate equation was developed as $d=1.01\ t^{0.38}$ where d is cumulative depth of infiltration in cm and t is elapsed time in minutes. The fit was found to be good. The instantaneous rate $I=0.38\ t^{-0.62}$ can be obtained from the above equation.

Water application, storage and distribution efficiency

The values of efficiencies for different check basin sizes and inflow rates are given in Table-1.

TABLE 1

Water application, storage and distribution efficiencies of chick-pea as influenced by check basin sizes and inflow rates.

Check basin area (m^2)	*Water application efficiency in percentage for flow rates*			*Water storage efficiency in percentage for flow rates*			*Water distribution efficiency in percentage for flow rates*		
	3.0	4.5 (*l/sec*)	6.0	3.0	4.5 (*l/sec*)	6.0	3.0	4.5 (*l/sec*)	6.0
50	87	88	82	70	67	42	96	93	94
72	86	87	84	71	68	70	93	91	90
98	83	87	86	66	69	69	90	94	95
128	84	87	83	68	67	67	92	94	95

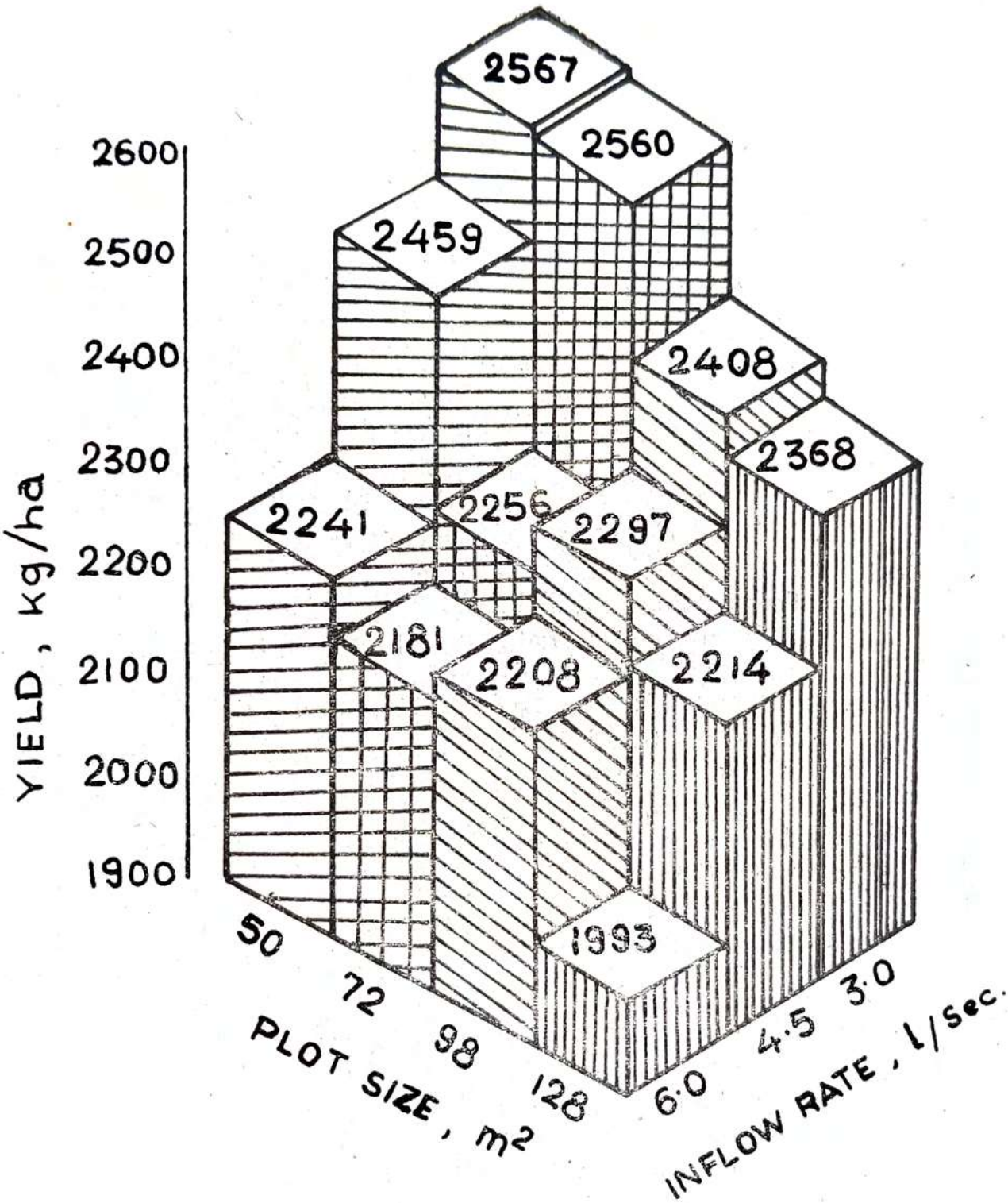


FIG: I EFFECT OF DIFFERENT PLOT SIZES AND INFLOW RATES ON YIELD OF CHICK-PEA

The efficiencies of water application were 87% and 88% for the 50 m² plot size with 3.0 1/sec and 4.5 1/sec flow rates respectively and were significantly superior over other treatments. The efficiencies of water storage of 70% and 71% for plot sizes of 50 m² and 72 m² with 3.0 1/sec flow rate were found better compared to other treatments. The highest distribution efficiency of 96% was obtained for the treatment combination of 50 m² check basin size and 3.0 1/sec inflow rate.

Yield

The average yield for two years for different treatments combinations of plot sizes and inflow rates are given in Fig. 1. An analysis of pooled data (Table 2) on yield of the crop revealed that yield for all the three discharge rates were significantly different from each other. The highest yield was obtained from 3.0 1/sec discharge rate. As far as plot size is concerned, it falls in three contrasting groups viz. (i) 50 m² (ii) 72 m² and 98 m² and (iii) 128m². The highest yield was obtained from 50m² plot size. Analysis of variance for pooled data indicated no interaction between inflow rate and check basin size. Thus check basin size of 50 m² rate would give highest yield.

TABLE 2

Yield of chick-pea (q/ha) as influenced by check basin sizes and inflow rates.

Check basin area (m^2)	*Grain yield for inflow rates of*			*Mean yield*
	3.0	*4.5*	*6.0*	
		(l/sec)		
50	25.67	24.59	22.41	24.22
72	25.60	22.56	21.81	22.32
98	24.08	22.97	22.08	23.04
128	23.68	22.14	19.93	21.92
Mean yield	24.76	23.07	21.56	—
		S.Em±	*C.D.*	*C.V.*
		(q/ha)	*at 5%*	*(%)*
Inflow rate		0.27	0.88	5.72
Check basin size		0.24	0.69	4.92
Interaction		0.42	N.S.	

The large scale trial (1981-82) of 50 m² check basin size and 3.0 1/sec inflow rate gave average net plot yield of 30.88 q/ha and gross yield of 27.21 q/ha. It was higher than the highest yield obtained from the experimental trial. It indicated that the recommended treatment combination would sustain higher yield in farmers field.

In heavy black soils operation of levelling within plot for irrigation is tedious and it is more labour intensive so as the size of check basin increases. In this paper, study shows that the treatment of 50 m² check basin size with 3.0 1/sec inflow rate gave the highest yield. With regard to other irrigation parameters namely water application, storage and distribution efficiencies, the same above mentioned traetment was superior to other treatments. Hence, the treatment of 50m² check basin size and 3.0 1/sec inflow rate is suitable for growing chick-pea in irrigated condition under similar agro-climatic conditions of South Gujarat.

ACKNOWLEDGEMENT

The authors are thankful to Dr. A. K. Bhattacharya and Dr. T. J. Khatri, Professor and Head of Agricultural Engineering and Associate Professor of Statistics respectively for their valuable suggestions. Thanks are also due to the Indian Council of Agricultural Research, New Delhi for financing the project on Water Management under which the work was carried out.

REFERENCES

Joshi, R. S., Desai, N. D. and Panchal, G. N., 1979. Maximising production of gram through proper irrigation. Guj. Asso. Agril. Sci., June, '79: 151-156.

Ram, R. S., Jain, T. C. and Jain, K. C., 1976. Evaluation of check basin method of irrigation for wheat crop in light soils. *Indian J. Agric. Sci.*, **46** (2): 81-87.

Slabbers, P. J., 1971. Design criteria for basin irrigation systems. F.A.O. Irri. and Drain. Paper No. 3 : 15.

Yadav, J. S. P., 1973-75. Annual Progress report of I.C.A.R. scheme on Water Management and Soil Salinity.

Wayse, U. S., Gore, K. P. and Singh, J. K., 1980. Check basin size for irrigating wheat crop in clayey soils. *J. Instt. Engg.* (India), 6 I (ND1): 27-29.

GAU Res. J. 1984. 10 (1): 56-58

Short Communications

Host Range Studies of *Myrothecium roridum* Causing Leaf Spot of Bitter Gourd

A. M. Parakhia and M. U. Vaishnav

Department of Plant Pathology, GAU, Junagadh Campus, Junagadh

The leaf spot of bitter gourd (*Momordica charantia* L.) caused by *Myrothecium roridum* Tode ex Fr. has been observed causing considerable damage to crops during last few years in Junagadh area. The disease is of considerable economic imprtoance because it occurs on a variety of economic crops and does great damage to the foliage and other plant parts resulting in loss of the production.

It appears as small circular, pinhead size, tan coloured spots with violet to brown margin surrounded by a zone of translucent area on bitter gourd. Under favourable conditions of moist atmosphere and cloudy weather these spots enlarge upto 8 mm. in a week, may coalesce and then the entire leaf dries up. Fruiting structures are formed on both the sides of the leaves. The fungus also causes fruit rot of bitter gourd.

The inciting fungus was isolated on potato dextrose agar (PDA) and the pathogenisity test on bitter gourd was successfully conducted. The plants of other crops listed in Table-1 were also inoculated with the fungus to know whether it causes the disease on these plants or not.

Twenty plants of each of the crop were raised in a sterilized soil in 9" size pots keeping one plant in each. When the plants attained the age of 30 days, ten plants of each of the test crops were inoculated by spraying the spore suspension and ten were sprayed with only distilled sterile water to serve as a check. All pots were kept under moist chamber. The observations of disease incidence were recorded upto fifteen days after inoculation.

Observations of disease incidence on these plants (Table-1) revealed that out of twentytwo plant species belonging to different families viz. Cucurbitaceae, Leguminosae, Malvaceae, Solanaceae, Compositae, Tiliaceae and Euphorbiaceae, all test plants including bitter gourd but except groundnut were found to be infected with the fungus. These hosts except *Coccina indica*, *Cajanus cajan*, *Helianthus annus* and *Capsicum annum* were previously reported in the literature as the hosts of the fungus (Mc Intosh, 1949, Thirumala-char and

TABLE 1

List of hosts tested for leaf spot disease caused by *M. roridum* in the host range studies.

Name of the plant		*No. of plants inoculated*	*No. of plants infected*
1		2	3
Cucurbitaceae			
Bitter gourd	(*Momordica charantia* L.)	10	10
Ridge gourd	(*Luffa acutangula* L.)	10	10
Smooth gourd	(*Luffa cylindrica* L.)	10	10
Small gourd	(*Coccinia indica* W & A.)	10	10
Bottle gourd	(*Legenaria siceraria* Standl.)	10	10
Cucumber	(*Cucumis sativus* L.)	10	10
Leguminosae			
Cluster bean	(*Cyamopsis tetragonoloba* L.)	10	10
Bean	(*Dolichos lablab* L.)	10	10
Sosybean	(*Glycine Max* Merr.)	10	10
Mung	(*Phaseolus aureas* Roxo.)	10	10
Urid	(*Phaseolus mungo*)	10	10
Cowpea	(*Vigna sinensis* Endl.)	10	10
Tur (Arhar)	(*Cajanus cajan* (L) Millsp.)	10	10
Groundnut	(*Arachis hypogaea* L.)	10	No infection on any plant.
Malvaceae			
Cotton H4	(*Gossypium hirsutum* L.)	10	10
Cotton Co2	(*Gossypium hirsutum* L.)	10	10
Lady's finger (Bhindi)	(*Hibiscus esculentus* L.)	10	10
Solanaceae			
Tomato	(*Lycopersicum esculentum* L.)	10	10
Brinjal	(*Solanum melongena*)	10	10
Chilli	(*Capsicum annum* L.)	10	10
Compositae			
Sunflower	(*Helianthus annus* L.)	10	10
Tiliaceae			
Jute	(*Corchorus copsulentus* L.)	10	10
Euphorbeaceae			
Castor	(*Ricinus communis* L.)	10	10
Check (All hots)		10 (of each host)	Not infected

Misra, 1953; Munjal, 1960; Ramnath *et al.* 1966; Chauhan and Suryanarayan, 1972). These four crops are hitherto added in the list of the hosts of *M. roridum*.

(*Received on 6th Dec. 1982*)

REFERENCES

Chauhan, M. S. and Suryanarayana, D. (1972). Host range studies of *Myrothecium roridum* the causal organism of Myrothecium leaf spot disease of cotton in Haryana State. *Indian Phytopath.* **25** (1): 127-128.

Mc Intosh, A. E. S. (1949). Annual Report of the Department of Agriculture, Malaya, pp. 87.

Munjal, R. L. (1960). A commonly occurring leaf spot disease caused by *Myrothecium roridum* Tode ex Fr. *Indian Phytopath.* **13** (2): 50-55.

Ram Nath, Seth, M. L. and Raychaudhuri, S. P. (1966). A new blight disease of brinjal caused by *Myrothecium roridum* Tode ex Fr. *Indian Phytopath.* **19** (2): 224-225.

Thirumalachar, M. J. and Mishra, J. M. (1953). Some diseases of economic plants in Bihar, India, *F.A.O. Pl. Prot. Bull. J.* **10:** 145-146.

GAU Res. J. 1984. 10 (1): 59-61

Studies on Preference of *Tribolium castaneum* Herbst (Tenebrionidae : Coleoptera) for Flour of Different Sorghum Varieties

R. C. Jhala, C. B. Patel and A. H. Shah

Department of Entomology, GAU, Navsari

Rust red flour beetle, *Tribolium castaneum* Herbst is one of the important and destructive pests of sorghum flour and its products under storage. The beetle has been reported damaging large number of cereals, but all the varieties are not preferred and damaged equally. This is due to differential response of the beetle to different hosts. Krishnamurthy *et al.* (1969) reported CSH-5 as fairly resistant against *T. castaneum*, *Sitophilus oryzae* L. and *Rizophertha dominica* Fab. They have also reported that CSH-4 had the largest population of *T. castaneum* followed by CSH-1 and CSH-2, whereas seed of CSH-3, CSH-5 and M-35-1 had lower population. Doraiswamy *et al.* (1971) also studied the varietal preference in sorghum by *Sitophilus oryzae* L. However, no information is available on preference of *T. castaneum* for flour of different varieties of sorghum. Trials were therefore conducted to screen various genotypes of sorghum to determine preference of *T. castaneum* to some of the high yielding hybrids and varieties as well as locals.

The culture of *T. castaneum* was raised in the laboratory under controlled conditions. Thirteen varieties and hybrids viz. CSV-1, CSV-2, CSV-3, CSV-4, CSV-5, CSV-6, CSV-7R, CSH-8R, CSH-1, CSH-5, CSH-6, Surat-1 and Sona-108 were obtained from Sorghum Research Centre, All India Co-ordinated Research Project on Sorghum, Gujarat Agricultural University, Navsari. Flour of each variety was prepared in the laboratory with grinder and 25 g. flour of each sorghum variety was kept in heaps separately in an enamelled tray (Size–45 cm x 38 cm x 5 cm) in a circular fashion equidistantly from the centre. Three such replicates were maintained. One hundred adults of *T. castaneum* of about the same age were released in the centre of the tray to choose their food freely. The place of each sorghum variety was changed randomly every third day and the observation for number of adults in each variety was recorded daily up to 30 days. The study was carried out at room temperature from 16th June to 17th July, 1980. The assessment of the food preference was made on the basis of percentage of insects found daily in each sorghum variety. The insects showing no preference or those escaped from the tray were ignored while calculating the percentage insects for food preference. The data obtained were statistically analysed after square root transformation (Split–plot design) and are presented in Table 1.

It can be seen from Table-1 that though the differences between the va-

TABLE 1

Preference of *Tribolium castaneum* Herbst for flour of different sorghum varieties.

Sorghum variety	*Average percentage of Insects/Day*			
	Replication			*Mean*
	I	*II*	*III*	
1 CSV-2	2.24	2.28	2.39	2.30 (5.30)*
2 CSV-4	2.35	2.50	2.32	2.39 (5.71)
3 CSH-6	2.51	2.59	2.24	2.45 (5.98)
4 CSH.5	2.53	2.35	2.58	2.48 (6.17)
5 CSV-5	2.45	2.50	2.63	2.53 (6.39)
6 CSV-1	2.72	2.49	2.48	2.56 (6.57)
7 CSH-8R	2.69	2.48	2.58	2.58 (6.67)
8 CSV-6	2.66	2.88	2.66	2.73 (7.46)
9 CSH-1	2.80	2.82	2.83	2.82 (7.93)
10 Surat-1	2.89	2.91	2.81	2.87 (8.24)
11 CSV-3	2.73	3.12	2.85	2.90 (8.41)
12 CSV-7R	2.95	2.91	2.96	2.94 (8.65)
13 Sona-108	3.82	3.41	3.61	3.62 (13.07)
S. Em. ±				0.082
C.D. at 5% level				0.215
C. V. %				25.081

*Figures in parentheses are retransformed values.

rieties are only marginal, they were statistically significant. Variety CSV-2 was least preferred by the *T. castaneum* having 2.30 as mean percentage of insects per day. However, it was at par with the varieties CSV-4, CSH-6 and CSH-5. Varieties CSV-4, CSH-6, CSH-5 were at par with varieties CSV-5, CSV-1 and CSH-8R and less preferred than the rest of the varieties. Variety Sona-108 having 3.62 as mean percentage insects per day was the most preferred variety and was significantly different from all the other varieties. Varieties CSV-6, CSH-1, Surat-1, CSV-3 and CSV-7R were at par and next to Sona–108 in preference. The cause of preference may be due to the difference in bio-chemical constitution of different varieties which is open for further research.

It was also observed during the study that all the varieties were not preferred in a simlar fashion on different days by the beetle, however the effect of days over varieties could not be worked out as it was of random nature.

(Received on 12th April, 1982)

REFERENCES

Doraiswamy, V.; T. R. Subramanium and A. Dakshinamurthy. 1976. Varietal preference in sorghum for the weevil *Sitophilus oryzae* L. *Bull. Grain Technology*, **41** (2): 107-110.

Krishnamurthy, K.; G. Raghunatha; B. G. Rajashekaran and T. M. M. Ali. 1976. Differential Resistance of sorghum Genotypes to stored Insect pests. *Bull. Grain Technology*, **14** (3): 206-210.

GAU Res. J. 1984. 10 (1): 62-63

Afidentula minima Gorham (Coccinellidae: Coleoptera), a New Pest of Fingermillet and Its Intensity of Damage in South Gujarat

A. H. Shah, M. S. Purohit, G. M. Patel and C. B. Patel

GAU, Navsari Campus, Navsari

Fingermillet is main staple crop of the tribal areas of South Gujarat. Eventhough considered hardiest crop being grown under dryland condition without any serious insect pest problem, last year during August-September 1981, severe incidence of a new insect pest in beetle form has been seen in the fields of fingermillet crop of Dharampur and Vansda Taluka of Gujarat State. The beetles were collected and identified as *Afidentula minima* Gorham. Review of literature revealed that this beetle has not been recorded as a pest of any crop at any place in India uptil now. Thus it is the first record of this pest on fingermillet crop in Gujarat as well as in India.

Further no information is available in literature about the *Afidentula minima* except record of genera *Afidentula* by Pang and Mao (1977) in Tibet Autonomus Region.

Since the occurrence of this insect is newer one, a survey was undertaken to know its infestation level as pest in field condition during Sept., 1981 in Dharampur and Vansda Taluka of Bulsar District. Fingermillet fields infested by this beetle were examined during survey and the intensity of infestation was worked out on plant basis as well as on leaf basis. For this purpose ten plants each at forty spots of the selected field were observed for damage and number of plants damaged by beetles were recorded at different locations. Similarly five plants infested by beetles from each location were randomly observed and number of infested leaves as well as total number of leaves per plant were recorded. The percentage infestation on plants basis and on leaf basis are worked out and shown in Table 1.

TABLE 1

Percentage infestation of *Afidentula minima* Gorham on fingermillet in Dharampur and Vansda Taluka of Bulsar District of Gujarat State during September, 1981.

Village	*Infestation on plant basis*				*Infestation on leaf basis*			
	Plot No.	*Number of plants damaged out of 400 plants*	*Per cent infested plants*	*Average per cent of infested plants*	*Plant No.*	*Number of leaves damaged out of total leaves*	*Per cent infested leaf*	*Average per cent of infested leaves*
Lakadamar (Ta. Dharampur)	1	330	82.5		1	16/18	88.88	
	2	370	92.5	88.33	2	7/11	63.63	

TABLE 1 (Contd.)

1	2	3	4	5	6	7	8	9
	3	360	90.0		3	8/12	66.66	73.68
					4	9/13	69.23	
					5	12/15	80.00	
Naninahiyal	1	340	85.0	88.73	1	8/12	66.66	
(Ta. Dharam-	2	370	92.5		2	6/10	60.00	
pur)					3	10/16	62.50	56.16
					4	7/14	50.00	
					5	5/12	41.66	
Panas	1	40	10.0		1	2/10	20.00	
(Ta. Dharam-	2	10	2.5	5.0	2	3/12	25.00	
(pur)								
	3	10	2.5		3	1/16	16.66	19.69
					4	2/13	15.38	
					5	3/14	21.42	
Karanjveli	1	350	87.5		1	7/12	58.33	
(Ta. Dharam-	2	340	85.0	86.25	2	6/11	54.54	
pur)								
					3	8/15	53.33	55.24
					4	7/14	50.00	
					5	6/10	60.00	
Bartad	1	50	12.5		1	2/10	20.00	
(Ta. Vansda)	2	60	15.0	13.33	2	3/14	21.42	
	3	50	12.5		3	1/7	14.28	19.17
					4	4/17	23.52	
					5	2/12	16.66	
Mahuvach	1	180	45.0		1	2/7	28.57	
(Ta. Vansda)	2	170	42.5	43.75	2	5/12	41.66	
					3	3/9	33.33	38.37
					4	6/14	42.85	
					5	5/11	45.45	

From the Table 1 it can be seen that the fingermillet crop is severely damaged by the Coccinellid beetle. The average infestation varies from 5 per cent to 88.75 per cent on plant basis and 19.17 per cent to 73.68 per cent on leaf basis.

Thus it seems that *Afidentula minima* Gorham causes severe damage to the fingermillet which may ultimately results in reduction of the yield.

Authors are thankful to Dr. T. G. Vazirani, Taxonomist, Commonwealth Institute of Entomology, London for identification and the District Agriculculture Officer, District Panchayat, Bulsar for providing necessary facilities for survey work.

(*Received on 9th Dec. 1982*)

REFERENCE

Pang, X. F. and J. L. Mao (1977). Notes on the Epilachninae, Tibet Autonomus Region (Coleoptera: Cochcinellidae) Acta Entomologica Sinica **20** (3): 323-328.

GAU Res. J. 1984. 10 (1): 64-65

Seasonal Incidence of *Tetranychus neocaledonicus* Andre in Gujarat State

R. K. Bharodia and G. M. Talati

Department of Entomology, College of Agriculture, GAU, Junagadh Campus

The red spider mite, *T. neocaledonicus* has been recorded for the first time in Gujarat State as a pest of cotton, *Gossypium hirsutum* L. It was active during October to February on cotton, after which the activity retarded (Bharodia, 1974). A survey was, therefore, carried out to know the seasonal incidence of mite on various host plants during the year 1973-74. Intensity of attack on different host plants was studied by counting adult mites from one square inch area of the leaf surface of ten randomly selected host plants. Mite counts were taken from nine leaves, three each at top, middle and bottom portions of the randomly selected plants at various periods. The survey was started from July, 1973 and completed in March, 1974. The results obtained are presented in Table 1.

TABLE 1

Seasonal incidence of *T. neocaledonicus* Andre on different host plants (given as total counts from 10 plants taken on one square inch basis per leaf for nine leaves on each plant).

Sr. No.	Name of host	Months								
		July 73	Aug. 73	Sept. 73	Oct. 73	Nov. 73	Dec. 73	Jan. 74	Feb. 74	March 74
1	*Phaseolus mungo*	0.0	0.0	530.33	938.33	*	–	–	–	–
2	*Gossypium hirsutum*	0.0	0.0	0.0	27.0	143.0	59.5	61.5	19.5	0.0
3	*Solanum melongena*	0.0	0.0	0.0	60.0	309.25	108.25	0.0	0.0	0.0
4	*Ipomaea palmata*	0.0	0.0	0.0	248.33	132.5	0.0	0.0	0.0	0.0
5	*Hibiscus mutabilis*	0.0	0.0	0.0	92.67	439.5	91.5	82.0	–	–
6	*Abutilon indicum*	0.0	0.0	0.0	92.67	272.0	56.0	0.0	0.0	0.0
7	*Phaseolus trilobus*	0.0	0.0	0.0	129.33	138.0	–	–	–	–
8	*Ipomaea purpurea*	0.0	0.0	0.0	70.0	128.0	–	–	–	–

*(–) Indicate that crops/plants were not available.

The data presented in Table-1 indicate that the mite infestation was observed from the month of September on black gram (*Phaseolus mungo*), while this mite was available on cotton (*Gossypium hirsutum*), brinjal (*Solanum melongena*), railway creeper (*Ipomaea palmata*), *Jungli bhinda* (*Hibiscus mutabilis*), *kaski* (*Abution indicum*), three lobed kidney bean (*Phaseolus trilobus*) and morning glory (*Ipomaea purpurea*) from October onwards till the crops were

either overmatured or the plants dried up. The highest population was recorded during the month of November on almost all the host plants surveyed. Rahman and Sapra (1946) reported this pest to be causing considerable damage to a number of host plants including important crops like cotton and brinjal in Lyallpur, Gujranwal, Montogomery, Lahore and Sargodha district of the Punjab. Similar trend has also been observed by Khot and Patel (1956) in Poona region.

(*Received on 9th Dec. 1982*)

REFERENCES

Bharodia, R. K. 1974. Some studies on bionomics and control of a phytophagous mite of Deviraj (170-CO2) cotton in Junagadh area (*Tetranychus neocaledonicus* Andre). M.Sc. (Agri) Thesis submitted to the Gujarat Agricultural University.

Khot, N. S. and G. A. Patel, 1956. Life history of the gladiolus mite *Tetranychus equatorius* McGr *Indian J. Ent.* **18** (2) 149-160.

Rahman, K. A. and A. N. Sapra, 1946. On the biology of the vegetable mite (*Tetranychus cucurbitae* Rahman and Sapra; Fam. Tetranychidae) *Indian J. Agric. Sci.* **15** (3): 124-130.

GAU Res. J. 1984. 10 (1): 66-67

Use of Yield Prediction Model in Locating Critical Stages of Growth in Groundnut

T. J. Khatri, R. M. Patel & P. D. Mistry

Gujarat Agricultural University, Anand Campus, Anand 388 110

The precipitation at different stages of crop growth has significant contribution in prediction of rice yield (Das and Sajnani, 1970). Das and Ramchandran (1971), while forecasting of bajra yield for Ahmedabad district of Gujarat State, located the period in which rainfall had some significant correlation with yields. The influence of rainfall on wheat production in Madhya Pradesh was studied by Bhargava *et al.* (1974). They found that 56 to 89 per cent of variation in wheat was due to rainfall. The effect of rainfall distribution on yield of groundnut at Amreli was studied by Joshi and Kabaria (1972), and accounted for 64 per cent of the total variation in yield.

An attempt has been made to utilize the yield prediction model in locating critical stages of crop growth. The critical stage being the one where occurrence or otherwise of rainfall has significant influence on groundnut yield for Ahmedabad district of the Gujarat State.

The data on average yield per hectare of groundnut in Ahmedabad district of Gujarat State for the past 24 years viz. 1953-54 to 1977-78 were collected from the season and crop reports, while the data on daily rain fall at Ahmedabad for the corresponding period were collected from the Directorate of Agriculture, Gujarat State, Ahmedabad. Weekly totals of rainfall for the standard meteorological weeks during the groundnut growing season, covering the period from 22nd week to 43rd week, were carried out to utilize them as 22 rainfall variables. Stepwise regression analysis (Efroymson, 1962) was carried out utilizing average yield as dependent and 22 rainfall variables during the crop growing season as independent variables for the purpose of developing the yield prediction model.

The estimates of regression coefficient, their standard errors, R^2 and error of forecasting for the selected rainfall variables in step-wise regression analysis of groundnut yield data of Ahmedabad district are presented in Table 1.

TABLE 1

Estimates of regression coefficients, their standard errors, R^2 and error of forecast for the selected rainfall variables in step wise regression analysis of groundnut yield data of Ahmedabad district.

Selected rainfall variables	*Regression Coefficient*	*S.E.*
X_4	2.1101	1.1516
X_6	0.9191*	0.4327
X_{12}	1.7017*	0.7111
X_{14}	1.0516*	0.4640
X_{18}	2.7193	1.5600
R^2	0.6217**	
Error of forecast	6.36%	

* and ** denotes significance at 5% and 1% levels.

The analysis has helped in predicting the groundnut yield by selecting five variables out of 22 rainfall variables and accounted for 62 per cent of the total variation in yield. The forecast for the groundnut yield can be given earliest by the end of September utilizing the following prediction model.

$$Y = 235.12 + 2.1101\ X_4 + 0.9191\ X_6 + 1.7017\ X_{12} + 1.0516\ X_{14} + 2.7193\ X_{18}$$

The results further reveal that the variables X_4 and X_6 are the values of the rainfall during germination to vegetative development stage, whereas X_{12} and X_{14} are the value of the rainfall during full pegging to pod development stage. All the four variables have positive significant contribution iny ield prediction. This suggests that these two are the critical stages of crop growth, when rainfall has significant influence on groundnut yield.

Sheshadri (1962) reported that hair on the peg and pods of groundnut helps in taking up little moisture thus preventing the pod from excessively drying up and helping it in its proper development. The physiology of water absorption in groundnut indirectly justifies that the rains during this stage help in proper development of pods and hence the higher yield.

The results of this study at Ahmedabad are in confirmation with the results obtained by Joshi and Kabaria (1972), who have reported positive correlation of groundnut yield with rainfall during full pegging to pod development stage. Under the semi-arid condition at Hissar, Singh *et al.* (1971) observed that two irrigations, one at flowering and other at peg formation stage, increased the yield of groundnut. The area of Gujarat comprising Ahmedabad and surrounding districts falls under semi-arid conditions. The results of this study indirectly support the positive effect of rainfall during pod development with the yield of groundnut.

Thus the critical stages of crop growth obtained as the by-product of the regression analysis of yield and rainfall data of the past 24 years of Ahmedabad district suggest the guidlines in scheduling irrigation for cultivation of irrigated groundnut crop or to suggest a supplemental irrigation in absence of rainfall during critical stage of the crop in Ahmedabad district.

(*Received on 19th March, 1982*)

REFERENCES

Bhargava, P. N., Asha Pradhan and Das, M. N. (1974). Influence of rainfall on crop production. *J.N.K.V. Res. J.* **8** (1): 22-29.

Das, J. C. and Ramchandran, G. (1971). Forecasting yield of bajra on the basis of weather parameters of Ahmedabad district. I.M.D. Sci. Rep. No. 141.

———and Sajnani, P.P. (1970). Locating critical period when weather elements have significant influence on crop yield. I.M.D. Sci. Rep. No. 130.

Efroymson, M. A. (1962). "Multiple Regression Analysis" in "Mathematical method for Digital Computers" pp. 191-203. John Wiley and Sons, New York.

Joshi, S. N. and Kabaria, M. M. (1972). Effect of rainfall distribution on yield of groundnut in Saurashtra. *Indian J. Agric. Sc.* **42** (8): 681-85.

Seshadri, C. R. (1962). Groundnut. Indian Central Oilseeds Committee, Hydrabad: 82.

Singh, B. P., Singh Kanwar and Yadava, T. P. (1971). Effect of irrigation and fertility level on the yield and quality of groundnut. *H.A.U. Res. J.* **1** (2): 11-14.

GAU Res. J. 1984. 10 (1): 68-69

A Note on Hydrocyanic Acid (HCN) Content in New Varieties of Fodder *Sorghum vulgare* Pers. (*Jowar*)

Z. N. Patel, H. B. Desai, M. C. Desai and P. C. Shukla

Animal Nutrition Department, GAU, Anand Campus, Anand-388 110

Hyrocyanic acid is most toxic and is rapidly liberated under the actions of ruminal micro organisms (Coop and Blakely 1948-49). Ruminants are more susceptible to poisoning by cyanogenetic plants than horses and pigs, since the enzymes concerned in the release of HCN are destroyed by gastric hydrochloric acid (Clarke and Clarke, 1977). Generally the hybrids of Johnson grass (*Sorghum halepense*), Sudan grass (*S. sudanese*) and Sorghum (*S. vulgare*) are more toxic than the pure species (Blood and Henderson 1963).

Four samples of each of the fodder varieties of *Sorghum vulgare* Pers. (*jowar*) I.S. 3306, I.S. 5026, J-S-3, C-10-2 and S-1049 under trial were received from Plant Breeding Research Station, Anand Centre. These were tested quantitatively for HCN content by the method described by Randhir Singh and Pradhan (1976) at seedling (one month after sowing) and at flowering stage. For the expression of HCN values on dry matter basis the dry matter contents in all the samples were also determined. Average HCN content (mg/100 g dry matter) for all the varieties at seedling and flowering stages of harvest are presented in Table-1.

TABLE 1

HCN content in different varieties of *jowar* (fodder samples). @

Jowar Variety	*HCN content (mg/100g on D.M. Basis)*	
	10-10-80	*13-11-80*
	One month stage (morning cut)	*Flowering strage (morning cut)*
I-S-3306	30.49	10.30
I-S-5026	71.00	63.33 (12.28)*
J-S-3	75.86	23.54
C-10-2	30.59	20.65
S-1049	5.28	5.17

@Average of 4 samples.

* Flowering was late and hence values were determined on 29-11-80.

From the results given in Table-1 it is apparent that the HCN content ranged from 5.28 (S-1049) to 75.86 (J-S-3) mg/100 g on dry matter basis when harvested at one month stage. The values are potentially dangerous in all the varieties except S-1049. At flowering stage, the values ranged from 5.17 to 23.54 mg/100 g. on dry matter basis. The plant material containing HCN 20 mg/100 g or above is potentially toxic and dangerous to animal (Blood and Henderson, 1963). Therefore, varieties J-S-3 and C-10-2 are above the threshold. Thus *S. vulgare* (*jowar*) fodder varieties should be checked quantitatively for HCN content.

(*Received on 9th March, 1982*)

REFERENCES

Blood, D. C. and Henderson, J. A. 1963. Veterinary Medicine, 2nd Edn. Bailliere. Tindall and Cox. London, p. 1049.

Clarke, E. G. C. and Clarke Myra, L. 1977. Veterinary Toxicology, The English language book Society and Bailliere Tindall, New York, 250-255.

Coop, I. E. and Blakley, R. L. 1948-49. N.Z.J. Sci. Technol. Sect. A. **31,** 44 (c.f. Clarke and Clarke, 1977).

Randhir Singh and Pradhan, K. 1976. Determination of HCN. In Laboratory Techniques for forage quality evaluation, Dept. of Animal Nutrition, H.A.U., Hissar, pp. 151-152.

GAU Res. J. 1984 10 (1): 70-71

A Note on Chemical Composition and Nutritive Value of *Avicennia officinalis* (*cher*) Leaves

P. C. Shukla* and P. C. Shukla

Animal Nutrition Department, Anand Campus, Anand 388110

Avicennia officinalis (*cher*) is a large, ever green shrub or tree. Its English name is white mangrove. Its height may vary from 6 to 9 meters and as high as 18 meters is found in "Sundarban". It grows densely near river delta and thrives well there utilizing sea water. *Cher* forest is found in littoral regions throughout tropics. It is also found on coastal regions of Gujarat, Saurashtra and Kutch.. "Alia bet" an island situated where river Narmada meets Arabian sea has plenty of *cher*. People of coastal region especially Bharuch, Hansot, Bhavnagar and Kutch side are feeding *cher* to their animals. It is said that it increases the milk yield and fat content (Bambhadai, 1951). It is used as fodder for cattle in Australia (Paranjpye, 1920). Our country has 5700 kilometres of coastal region and Gujarat has 28 per cent of it i.e. 1600 kilometres. So availability of *cher* leaves is quite high and hence its vital role in cattle feed industries should not be over looked. On reviewing the literature it was seen that composition and digestibility of *cher* leaves has not been worked out. Hence an attempt has been made to assess its nutritional value as fodder by feeding to buffalo bulls.

Air dried *cher* leaves along with twigs were procured in bulk from Jamnagar (Gujarat) area. Digestibility trial was conducted on four Surti buffalo bulls at Animal Nutrition Station, Anand. Buffalo bulls were offered only dried *cher* leaves along with twigs. After preliminary feeding, digestibility and balance trial was conducted for seven days collection period as per conventional methods. Samples of feed, feces and urine were analysed by A.O.-A.C. (1975) methods. The chemical composition of *cher* leaves used during the digestibility trial was 10.81% c. protein; 4.24% ether extract; 11.05% c. fibre; 58.72% N.F.E.; 15.18% ash; 0.72% silica; 0.17% phosphorus and 0.77% calcium.

The data on average dry matter consumption indicated that the animals were consuming on an average 5.48 kg of *cher* leaves which comes to 1.80 kg of dry matter per 100 kg of body weight.

The digestibility data revealed that it has got lower digestibility of all nutrients. The average digestibility coefficients for c. protein, ether extract, c. fibre, N.F.E. and organic matter were 41.39 ± 1.66, 42.60 ± 2.85, 52.50 ± 3.30, 36.78 ± 2.65 and 39.72 ± 2.34 respectively. From the average digestibility coefficients the nutritive value of *cher* leaves was calculated. It was found

*Poultry Feed Testing Laboratory, Anand 388 001.

to have 4.47 and 35.93 kg of D.C.P. and T.D.N. per 100 kg of dry matter respectively

Balance of Nitrogen and Minerals: The balance of nitrogen, phosphorus and calcium are found to be positive, average of which are + 5.91 ± 3.15, + 0.16 ± 0.95 and + 9.71 ± 1.74 respectively. These results suggest that *cher* leaves have definite use in famine condition and can be used as a filler material by cattle feed factories located near coastal region.

(*Received on 8th June, 1982*)

REFERENCES

A.O.A.C. 1975. Official Methods of Analysis of Association of Official Analytical Chemists. 12th Edn. Washington, D.C.

Bambhadai, G. K. 1951. *Vanaspati srushti*, Charutar Vidya Mandal, Vallabh Vidyanagar, Anand.

Paranjpye, H. P. 1920. The use of some salt water plants as fodder. *Agriculture Journal of India* **15** : 350.

GAU Res. J. 1984. 10 (1): 72-74

Proteolytic Activity of Different Rennets on Cow and Buffalo Milk

K. G. Upadhyay, S. H. Vyas, A. J. Pandya, J. N. Patel, and H. K. Desai

Department of Dairy Technology, Sheth M.C. College of Dairy Science, GAU, Anand Campus, Anand

In recent years the enzymes derived from *Mucor pusillus Lindt* and *Mucor miehei* have found widespread application for cheese-making. In the previous publication (Upadhyay *et al.* in press) the commercial fungal rennets, namely, Rnnilase and Meito rennet derived from *Mucor miehei* and *Mucor pusillus Lindt* respectively, were compared with calf rennet using them alone or as their mixtures for their influence on clotting time, curd characteristics and optimum dosage for Cheddar cheese-making from buffalo milk. In this paper the same fungal rennets and their mixtures are compared for their proteolytic activity on buffalo and cow skim milks using calf rennet as control.

Fresh cow and buffalo milks (pH adjusted to 6.7) were used as substrate. The rennet solutions were stanadrdized to same coagulation power by suitably diluting the rennets with distilled water. One millilitre of such diluted rennet solution coagulated 50 ml of fresh buffalo skim milk in 10 min at 32° C. The proteolytic activity was measured in terms of increase in non-protein-nitrogen (NPN) soluble in 12% trichloroacetic acid (TCA) at different time intervals.

Fifty millilitres of buffalo skim milk were transferred to 5 conical flasks for each rennet solution and placed in a water bath at 32° ± 0.1° C. When the temperature was attained, 1 ml of each of the diluted rennet solution was added and mixed well. After 0, 30, 60, 90 and 120 min of incubation, 51 ml of 24% TCA were added to each flask, mixed well and the contents were filtered through Whatman No. 42 filter paper. The sample at time zero was obtained by adding 1 ml of denatured rennet solution to 50 ml skim milk. The denaturation was carried out by heating the diluted rennet solutions at 95° C for 10 min. The NPN of the filterate was determined in duplicate by the Kjeldahl method and expressed as milligram per cent increase over the initial at zero time. Identical set of experiment was run using cow skim milk as substrate.

The results of the proteolytic activity of different rennets carried over a period of 120 min are presented in Table-1. It is observed that in both milks the increase in NPN for all coagulants, except for rennet C and CR, showed a sharp rise upto 60 min of the enzyme action followed by gradual rise upto the end of incubation time. In case of C rennet, after an initial rise in the first 60 min, the level of NPN remained constant until 120 min in both milks. Against this, CR rennet

TABLE 1

Proteolytic activity of different rennets on buffalo and cow skim milk at 32° C.

Milk	*Treatment in minutes*	*Increase in NPN, mg/100 ml*					
		C	*M*	*R*	*CM*	*CR*	*MR*
Buffalo	0	–	–	–	–	–	–
(pH 6.7)	30	1.68	2.24	2.24	2.24	2.24	2.24
	60	2.80	2.80	2.80	2.80	2.80	2.80
	90	2.80	2.80	3.36	2.80	2.80	3.36
	120	2.80	3.36	3.36	3.36	2.80	3.36
Cow	0	–	–	–	–	–	–
(pH 6.7)	30	3.92	5.60	5.04	6.16	5.60	5.60
	60	5.60	6.72	5.60	6.72	5.60	6.16
	90	5.60	6.72	6.16	6.72	5.60	6.72
	120	5.60	7.28	7.28	7.28	6.16	7.28

Average of 3 trials.

C : Calf Rennet CM : Calf + Meito (1 : 1, w/w)
M : Meito CR : Calf + Rennilase (1 : 1, w/v)
R : Rannilase MR : Meito + Rennilase (1 : 1, w/v)

showed slightly different pattern of release of NPN after 90 min incubation time in cow skim milk, showing some increase in NPN. In buffalo milk, it behaved alike calf rennet.

The data further revealed that the increase in NPN was slower in buffalo skim milk compared to cow milk, irrespective of the type of rennet used. This is in agreement with the results of Ganguli *et al.* (1964), Gupta and Ganguli (1965), Angelo (1976) and Abdou *et al.* (1976), who reported that irrespective of the type of rennet, proteolytic activity is faster and more with cow milk than with buffalo milk. Among the various rennets used, C rennet showed the least proteolytic activity both in cow milk (3.92 mg NPN increase) and buffalo milk (1.68 mg NPN increase).

On the other hand, Mucor rennets, namely M and R when used alone showed higher proteolytic activity than calf rennet in both the milks over a period of 120 min. The CM an MR combinations were also equally proteolytic in both milks at 120 min., showing that the CM and MR combinations are compitable. However, CR combiation had lower proteolytic activity than R alone in both the milks over a period of 120 min. This could possibly be due to incompatibility of C and R enzymes in association. Such incompatibility—one enzyme affecting the stability of another enzyme in association—has been reported by Richardson *et al.* (1967).

The above findings of the study reveal that fungal rennets and their mixtures, except CR combination are more proteolytic than calf rennet. This is in agreement with the results of Richardson *et al.* (1967) and Philippos and Christ (1976) who found these Mucor rennets, namely, *M. pussilus Lindt* and *M. miehei* to be more proteolytic than calf rennet in cow milk.

(Received on 20th March, 1982)

REFERENCES

Abdou, S. M., Ghita, I. I. and Dawood, A. E. (1976). Digestibility of cows', buffaloes' and ewes' milk, cited in *Dairy Sci. Abstr.* **41,** 2091.

Angelo, I. A. (1976). Proteolysis of casein by rennet from fistulated cow, buffalo and goat. *J. Fd. Sci. & Tech.* **13,** 337-39.

Ganguli, N. C., Sud, S. K. and Bhalerao, V. R. (1964). The N-terminal amino acids of buffalo milk caseins. *Ind. J. Dairy Sci.* **17**, 119.

Gupta, S. K. and Ganguli, N. C. (1965). Sialic acid content of casein preparation from cow and buffalo milk. *Milchwissenschaft.* **20**, 10.

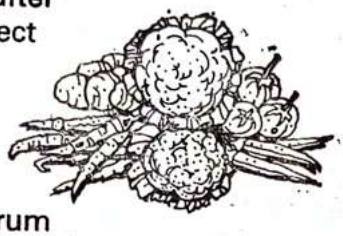
Philippos, S. G. and Christ, W. (1976). Studies on some microbial milk-clotting enzyme for cheese-making and their effect on cows' milk casein. I. Action of milk-clotting enzymes on cows' milk casein. *Milchwissenschaft* **31,** 349-54.

Richardson, G. H., Nelson, J. H., Lubnow, R. E. and Schwarberg, R. L. (1967). Rennin-like enzyme from Mucor pusillus for cheese manufacture. *J. Dairy Sci.* **50**, 1066-72.

Upadhyay, K. G., Vyas, S. H., Pandya, A. J., Patel, J. N. and Desai, H. K. Determination of optimum dosage of milk coagulants for Cheddar cheese-making *G.A.U. Res. J.* (in press)

Sandoz averts the danger again ...and again ...and again

Yes, crop after crop, year after year, Sandoz prevents insect pests and weeds from completely destroying your crops.



Ekalux EC 25, a wide spectrum contact insecticide, proves deadly to chewing pests.

Ekatin and Anthio are systemic insecticides that destroy a variety of sucking pests.

Dosanex is a powerful, post emergent selective weedicide for wheat.

These are all products of Sandoz research. Research that is backed by sophisticated technology from Basle, Switzerland. And field tested and recommended around the world. In fact, in India, Sandoz products have been extensively tested by various agricultural universities, research institutions and scientists.

Sandoz — in the service of the Indian farmer.

Crop perfection, Sandoz protection

SANDOZ

For further details, write to: