ISSN 0250-5193

GUJARAT AGRICULTURAL UNIVERSITIES RESEARCH JOURNAL

S.D.Agricultural University
Sardarkrushinagar

Anand Agricultural University
Anand

Junagadh Agricultural University
Junagadh

Navsari Agricultural University
Navsari

VOLUME : 43 NUMBER : 2

JULY, 2018

GAU RES. J. 43 (2)

PATRONS

Prof. (Dr.) Ashok A. Patel
Vice Chancellor
S.D. Agril. University
Sardarkrushinagar

Dr. N. C. Patel
Vice Chancellor
Anand Agril. University
Anand

Dr. A. R. Pathak
Vice Chancellor
Junagadh Agril.University
Junagadh

Dr. C. J. Dangaria
Vice Chancellor
Navsari Agril.University
Navsari

ADVISORY BOARD

Dr. A. M. Patel, Director of Research & Dean PGS, S. D. Agril. University, Sardarkrushinagar

Dr. K. B. Kathiria, Director of Research & Dean PGS, Anand Agril. University, Anand

Dr. V. P. Chovatia, Director of Research & Dean PGS, Junagadh Agril. University, Junagadh

Dr. S. R. Chaudhary, Director of Research & Dean PGS, Navsari Agril. University, Navsari

Dr. B. K. Sagarka, Dean, College of Agriculture, Junagadh Agril. University, Junagadh

Dr. M. K. Arvadia, Dean, N. M. College of Agriculture, Navsari Agril. University, Navsari

Dr. K. P. Patel, Dean, B. A. College of Agriculture, Ananad Agril. University, Anand

Dr. M. R. Prajapati, Dean, C. P. College of Agriculture, S. D. Agril. University, Sardarkrushinagar

Dr. J. B. Prajapati, Dean, Sheth M. C. College of Dairy Science, Anand Agril. University, Anand

Dr. M. K. Jhala, Associate Director of Research, Anand Agril. University, Anand

Dr. N. K. Gontia, Dean, College of Agril. Engineering & Tech., Junagadh Agril. University, Junagadh

EDITORIAL BOARD

Dr. A. M. Patel (Editor in Chief)

SDAU, Sardarkrushinagar

Sh. B. K. Prajapati, Assistant Research Scientist (Pl. Path.)
Dr. S. I. Patel, Associate Research Scientist (Pl. Path.)
Dr. P. S. Patel, Associate Professor (Entomology)

AAU, Anand

Dr. H. R. Patel, Associate Director of Research (Agri.)
Dr. A. J. Dhami, Professor (Vety.Gyanaecology.& Obstetrics)
Dr. J. P. Prajapati, Associate Professor (Dairy tech.)

JAU, Junagadh

Dr. V. V. Rajani, Associate Director of Research
Dr. P. Mohnot, Associate Director of Research
Dr. G. R. Gohil, Extension Educationist

NAU, Navsari

Dr. K. A. Patel, Associate Director of Research
Dr. G. G. Radadiya, Professor (Entomology)
Dr. T. R. Ahlawat, Associate Professor (Fruit Science)

Vol. 43
Number 2
July 2018

Gujarat Agricultural Universities Research Journal

Contents

Research Papers

Eco-friendly management of black mould rot of onion (*Aspergillus niger* Van Tieghem)	B. K. Prajapati and R. K. Patil	55
Effect of boron application on yield, quality and economics of Potato (*Solanum tuberosum* L.)	S.K. Chongtham, R.N. Patel, J.K. Patel and D.M. Zapadiya	62
Assessment of zinc application on yield, quality, productivity and profitability of Potato (*Solanum Tuberosum* L.)	S.K. Chongtham, R.N. Patel, J.K. Patel and D.M. Zapadiya	66
Response of Isabgol to rates of fertilizer under varying sowing times	M. M. Patel, A. U. Amin	70
Effect of micronutrients on growth and yield of Groundnut (*Arachis hypogaea* L.)	K. V. Rabari, B. K. Prajapati And B. M. Nandre	73
Stability Analysis for Grain Yield and Harvest Index in Bread Wheat (*Triticum aestivum* L.)	J. M. Patel, S. K. Patel, C.R. Patel, A. A. Patel, A. S. Patel, M. S. Patel, D. J. Joshi and B. C. Patel	76
Trend and growth rate of Bajra crop in Gujarat state	A. D. Kalola and R. L. Yadav	81
Identification of prevalent races of black or stem rust of Wheat in North Gujarat	S. I. Patel, Elangbam Premabati Devi and A. A. Patel	87
Screening of Potato (*Solanum Tuberosum* L.) cultivars for resistance against Potato apical leaf curl virus	J. K. Patel, R. N. Patel, S.K. Chongtham and D.M. Zapadiya	90
Bio-efficacy of insecticide imidacloprid 600FS as seed treatment against termite infesting on wheat	A. A. Patel, S. I. Patel, Elangbam Premabati Devi and Davada Adilhusen Y	94

Official Publication of

Gujarat Agricultural Universities, Gujarat State

S.D.Agricultural University
Sardarkrushinagar

Anand Agricultural University
Anand

Junagadh Agricultural University
Junagadh

Navsari Agricultural University
Navsari

New report on leaf spot of Teak (*Tectona grandis* L.F.) caused by *Phomopsis tectonae* from Gujarat, India	B. K. Prajapati, D. J. Patel and R. K. Patil	100
Factors affecting sex ratio in mehsana goat at an organized farm of North gujarat	A. B. Chaudhari, Y. M. Gami, B.S. Rathod, M.P. Patel and H.H. Panchasara	102
Management of early blight of Potato (*Solanum tuberosum* L.) incited by *Alternaria solani* (Ellis & Martin) Jones & Grout through fungicides	R. K. Sharma and D. R. Patel	106
A study on farm mechanization level of farmers of Junagadh taluka	N. S. Vithlani, A. L. Vadher, R. G. Jakasania and T. D. Mehta	112
Short Communication		
Occurence and distributional outline of black point and karnal bunt of Wheat in North Gujarat	Elangbam Premabati Devi , S.I. Patel and A. A. Patel	115

GAU Research Journal **43** (2) : 55-61 (July 2018)

Eco-friendly management of black mould rot of onion (*Aspergillus niger* Van Tieghem)

B. K. PRAJAPATI[1]* AND R. K. PATIL[2]

Directorate of Research,
S. D. Agricultural University, Sardarkrushinagar, Banaskantha-385 506, Gujarat

Received: 18 May, 2018 Accepted: 16 July, 2018

ABSTRACT

Black mould rot of onion incited by *Aspergillus niger* is an economically important post-harvest disease of onion under storage conditions and cause extensive losses. Application of fungicides to manage the disease cause residue problems, as it is directly consumed. Therefore, the study was undertaken to manage the black mould rot disease through application of phytoextracts and salts *in vitro* and *in vivo*. Among all phytoextracts screened, custard apple, neem, ghaneri and amaranthus extracts at 10 per cent concentration completely inhibited the mycelial growth of *A. niger* followed by moringa (97.30 %) over control. The results of *in vivo* study revealed that custard apple, neem, ghaneri and amaranthus leaf extracts (10 %) found most effective in controlling the black mould rot over control on 7th and 14th day after inoculation in pre- and post-inoculation treatments. Among the salts screened, aluminum acetate, sodium benzoate, sodium carbonate, sodium bicarbonate and ammonium phosphate at 0.2 M concentration completely inhibited the mycelial growth of *A. niger* over control on 7th day after inoculation *in vitro*. In pre-inoculation treatment, severity of black mould rot disease was negligible in bulbs treated with aluminum acetate (0.00 & 0.67 %) at 7th and 14th day after inoculation. Similar trend of results was noted in post-inoculation treatments.

Key words : *Aspergillus niger*, black mould rot, onion, phytoextracts, salts

Onion (*Allium cepa* L.) is an important vegetable crop widely cultivated and used in the world. After harvest of the bulbs when they are preserved for longer period, many fungal and bacterial pathogens cause deterioration of bulbs. Black mould rot is the most destructive disease of onion in storage as well as under field conditions (Wani and Nisa, 2011). Quadri *et al.*, (1982) reported that the spoilage caused by *A. niger* was as high as 80 per cent. Onion black mould rot disease can occasionally be seen in the field at harvest; it is primarily a post-harvest disease and can cause extensive losses in storage under tropical conditions (Thamizharasi and Narasimham, 1992). Rajam (1992) reported that among the post-harvest diseases of onion, black mould rot caused by *A. niger* was the predominant one. So far, no any effective management practices have been found suitable to manage black mould rot of onion during storage. The present study was undertaken to manage the black mould rot disease of onion by employing phytoextracts and salts.

[1]Assistant Research Scientist, Directorate of Research, S. D. Agricultural University, Sardarkrushinagar, Banaskantha-385 506, Gujarat [2]Ex. Professor, Department of Plant Pathology, B. A. College of Agriculture, Anand Agricultural University, Anand
*Email : bindesh_prajapati@yahoo.in

MATERIALS AND METHODS

Phytoextracts study:

In vitro: Bio-efficacy of different phytoextracts of plant species were tested *in vitro* by Poisoned Food Technique (Nene and Thapliyal, 1979) against black mould rot pathogen. The list of plant species used for phytoextracts study are given in Table 1. The phytoextracts were tested at 10 per cent concentration. Fresh and healthy plant parts of each species were thoroughly washed with tap water and then with distilled sterilized water. They were macerated separately in grinder by adding 100 ml ethanol. The mixture was filtered through two fold sterilized muslin cloth and the filtrate was centrifuged at 5,000 rpm for 10 min. and the clear supernatant extract was collected in sterilized conical flasks. After evaporating the ethanol from extract, the clear extract was collected and diluted

with 100 ml distilled sterile water to make volume 1:1 (W/V). This was considered as 100 per cent concentration for the study to test the efficacy of phytoextracts (Sinha and Saxena, 1989). Control was maintained for each set where fungal disc were placed on PDA medium without phytoextracts. Each treatment was repeated thrice. The inoculated plates were then incubated at 25 ± 1°C in BOD incubator. The observations on mycelial growth (mm) and per cent growth inhibition of test fungi were recorded after 7 days of incubation. The per cent growth inhibition (PGI) of pathogen in each treatment was calculated by following formula (Asalmol *et al.*, 1990).

$$I = \frac{C - T}{C} \times 100$$

Where,

I = Inhibition per cent

C = Colony diameter (mm) in control plate

T = Colony diameter (mm) in treated plate

In vivo: The phytoextracts which found promising *in vitro*, were further tested to study their efficacy in controlling black mould rot of onion.

Pre- inoculation: Healthy, mature uniform size onion bulbs of cultivar Nasik red variety were collected from Sardar Patel vegetable market, Anand. The bulbs were thoroughly washed in tap water, then surface sterilized by dipping in 1 per cent NaOCl solution for one minute followed by three successive washings with distilled sterile water and then were first dipped in 10 per cent phytoextracts for five minutes separately, air dried and after 12 hrs. treated bulbs were inoculated with black mould rot pathogen (10^6 spores/ml) and then inoculated bulbs were bagged in sterilized polythene bags with sterilized moist absorbent cotton swab. The mouth of the bag was loosely tied with rubber bands and inoculated bulbs were incubated at room temperature.

Table 1 List of phytoextracts used for the study

Sr. No	Botanical Name	Common Name	Family	Plant Part used
1.	*Annona squamosa* L.	Custard apple	Annonaceae	Leaf
2.	*Ocimum sanctum* L.	Tulsi	Labiatae	Leaf
3.	*Aloe barbadensis* Mill.	Aloe vera	Asphodeloideae	Leaf
4.	*Azadirachta indica* A. Juss	Neem	Meliaceae	Leaf
5.	*Lantana camara* L.	Ghaneri	Verbenaceae	Leaf
6.	*Andrographis paniculata* (Burm.f.) wall. Nees	Kalmegh	Acanthaceae	Leaf
7.	*Centelly asiatica* L.	Mandukaparni	Apiaceae	Leaf
8.	*Amaranthus viridis* L.	Amaranthus	Amaranthaceae	Leaf
9.	*Moringa oleifera* Lam.	Moringa	Moringaceae	Leaf

Post- inoculation: Healthy mature onion bulbs were inoculated with test pathogen (10^6 spores/ml) and after 12 hrs., the inoculated bulbs were dipped in phytoextracts separately for five minutes. Observations on percent disease severity were recorded after 7th and 14th days of inoculation with the help of standard assessment key.

Standard key for disease severity assessment: (Wani and Nisa, 2011)

Grade	Extent of rotting	Numerical score (%)
0	No rotting	0
1	Pin head to 10 mm	10
2	Up to 1/4th of the onion bulb	25
3	Up to 1/2 of the onion bulb	50
4	Up to 3/4th of the onion bulb	75
5	More than 3/4th of the onion bulb	100

$$\text{Severity (\%)} = \frac{\text{Area of infected bulbs}}{\text{Total area of blub tissue}} \times 100$$

Salts study:

In vitro: Efficacy of different organic and inorganic salts was tested *in vitro* by "Poisoned food technique" against *A. niger*. The list of salts used for the study is given in Table 2. .

Table 2 List of organic and inorganic salts used for the study

Sr. No.	Salts	Concentration (Molarity)
1.	Aluminum acetate ($C_2H_5O_4Al$)	0.2 M
2.	Aluminum chloride ($AlCl_3 \cdot 6H_2O$)	0.2 M
3.	Calcium chloride ($CaCl_2.H_2O$)	0.2 M
4.	Potassium chloride (KCl)	0.2 M
5.	Sodium benzoate ($C_7H_5O_2Na$)	0.2 M
6.	Sodium bicarbonate ($NaHCO_3$)	0.2 M
7.	Sodium carbonate (Na_2CO_3)	0.2 M
8.	Sodium chloride (NaCl)	0.2 M
9.	Ammonium phosphate {$(NH_4)_3PO4$}	0.2 M

Observations on per cent growth inhibition were recorded after 7 days of incubation.

In vivo: The salts which found promising *in vitro*, were further tested to study their efficacy in controlling black mould rot of onion.

Pre-inoculation: Similar methodology was followed as described in pre-inoculation of phytoextracts.

Post-inoculation: Similar methodology was followed as described in pre-inoculation of phytoextracts. Observations on percent disease severity were recorded after 7th and 14th day of inoculation.

RESULTS AND DISCUSSION

Phytoextracts study:

In vitro: Among the phytoextracts screened, five were found significantly superior in inhibiting the mycelium growth of *A. niger* over control. Custard apple, neem, ghaneri and amaranthus extracts completely inhibited the mycelial growth of *A. niger*. The next best treatment in order of merit was moringa recording 97.30 per cent mycelial growth inhibition over control. Mandukaparni (0.74 %) and Tulsi leaf extract (1.22 %) found least effective in suppressing the mycelial growth of the *A. niger* (Table 3). The results of present study are in agreement with the results obtained by Mushtaq *et al.*, (2012). They reported that chloroform leaves extract of *Amaranthus viridis* and *Malvestrum coromendalianum* (0.2 g/ml) gave effective inhibition of *A. niger* through poisoned food technique *in vitro*. Leaf extract of *Annona squamosa* gave good control over sporulation of *A. niger in vitro* isolated from cow pea, ground nut, maize and melon seeds through poisoned food technique (Onyeani *et al.*, 2012). Gupta *et al.*, (2012) reported that leaf extracts of *Datura stramonium*, *Ocimum sanctum*, *Azadirecta indica*, *Eucalyptus* spp. (5 ml/ 10g seeds) were found most effective against *A. niger* isolated from onion *in vitro* by seed soaking and germination method. Girase *et al.*, (2012) found that petroleum ether extract of *Lantana camara* at 125 and 250 ppm gave 100 per cent mycelial growth inhibition of *A. niger* through agar well diffusion assay method *in vitro*.

Table 3 Evaluation of phytoextracts (10 %) against *A. niger in vitro*

Sr. No.	Treatments	Mycelial growth (mm) 7 DAI*	Per cent growth inhibition (PGI)
1.	Custard apple (*A. squamosa* L.)	00.00	100.00
2.	Tulsi (*O. sanctum* L)	88.90	01.22
3.	Aloevera (*A. barbadensis* Mill)	75.67	15.92
4.	Neem (*A. indica* A. Juss)	00.00	100.00
5.	Ghaneri (*Lantana camara* L.)	00.00	100.00
6.	Kalmegh (*A. paniculata* (Burm.f.) wall. Nees)	66.33	26.30
7.	Mandukaparni (*C. asiatica* L.)	89.33	00.74
8.	Amaranthus (*A. viridis* L.)	00.00	100.00
9.	Moringa (*M. oleifera* Lam.)	02.43	97.30
10.	Control	90.00	-
	S.Em.±	0.708	-
	C.D. at 5%	2.104	-
	C.V.%	2.972	-

*DAI= Days after inoculation

In vivo: Among five phytoextracts screened *in vivo*, all were found significantly superior in reducing the black mould rot severity as compared to control on 7th and 14th day after inoculation both in pre- and post-inoculation treatments at 10 per cent concentration (Table 4).

Pre-inoculation: The results revealed that no black mould rot severity was recorded in bulbs treated with ghaneri, kalmegh, amaranthus, custard apple and neem leaves extracts on 7th and 14th day after inoculation as compared to control (13.67 & 25.33 %).

Post-inoculation: Similar trend of results were also noted in post-inoculation treatment. Leaf extracts of ghaneri, kalmegh, amaranthus, custard apple and neem at 10 per cent concentration completely controlled black mould rot severity on 7th and 14th day after inoculation as compared to control (14.67 & 26.33 %). The results of present findings are quite confirmative with the results reported by Kaur and Verma (2002). They noted that dry neem leaf extracts (5×10^4 µg/ ml) found most effective in pre- (94.44 %) and post inoculation treatments (50.0 %) in controlling green mould rot (*Penicillium digitatum*) of kinnow fruits. Singh and Sumbali (2003) noted that leaf extract of *Azadirachta indica* (10 %) found most effective in controlling the Penicillium rot (*Penicillium expansum*) infecting apple fruits. Damaram (2013) reported that Fusarium fruit rot severity in tomato fruits treated with neem leaf extracts in both pre- and post-inoculation treatments showed lower fruit rot severity (18.33 & 19.33 %) as compared to control (47.33 %) after 8 days of inoculation. Reddy (2012) reported that neem leaf extract gave lower Penicillium fruit rot severity (18.33 & 17.50 %) both in pre- and post-inoculation treatments after 8 days of inoculation in citrus fruits.

Salts study:

In vitro: Among the organic and inorganic salts screened, five salts were found significantly superior revealing complete mycelial growth inhibition of *A. niger* over control. Aluminum acetate, sodium benzoate, sodium carbonate, sodium bicarbonate and ammonium phosphate completely inhibited the mycelial growth of *A. niger* over control on 7th day after inoculation. Calcium chloride (90.00 mm, PGI-00.00), potassium chloride (87.33 mm, PGI- 2.97) and sodium chloride (86.33 mm, PGI- 3.70) found least effective at 0.2 M concentration in restricting the mycelial growth of the *A. niger* (Table 5). The results of present investigation corroborate with the results reported by Nwafor and Ikenebomeh (2009). They reported that sodium benzoate at 0.05 per cent (w/v) conc. showed complete inhibition of *A. niger*.

Table 4 Evaluation of phytoextracts against black mould rot of onion (*A. niger*) *in vivo*

Sr. No.	Treatments	Per cent rot severity			
		Pre-inoculation		Post-inoculation	
		7th DAI*	14th DAI	7th DAI	14th DAI
1.	Ghaneri	0.00	0.00	0.00	0.00
		(0.71)**	(0.71)	(0.71)	(0.71)
2.	Kalmegh	0.00	0.00	0.00	0.00
		(0.71)	(0.71)	(0.71)	(0.71)
3.	Amaranthus	0.00	0.00	0.00	0.00
		(0.71)	(0.71)	(0.71)	(0.71)
4.	Custard apple	0.00	0.00	0.00	0.00
		(0.71)	(0.71)	(0.71)	(0.71)
5.	Neem	0.00	0.00	0.00	0.00
		(0.71)	(0.71)	(0.71)	(0.71)
6.	Control	13.67	25.33	14.67	26.33
		(3.76)	(5.08)	(3.88)	(5.18)
	S.Em.±	0.048	0.058	0.062	0.013
	C.D. at 5%	0.149	0.179	0.192	0.040
	C.V.%	6.881	7.015	8.708	1.562

* DAI= Days after inoculation

**Figures in parentheses are square root transformed ($\sqrt{x + 0.5}$) values

Table 5 Efficacy of organic and inorganic salts against mycelial growth of *A. niger in vitro*

Sr. No.	Treatments	Mycelial growth (mm) 7 DAI*	Per cent growth inhibition (PGI)
1.	Aluminum acetate	00.00	100.00
2.	Aluminum chloride	56.33	37.41
3.	Calcium chloride	90.00	00.00
4.	Potassium chloride	87.33	02.97
5.	Sodium benzoate	00.00	100.00
6.	Sodium bicarbonate	00.00	100.00
7.	Sodium carbonate	00.00	100.00
8.	Sodium chloride	86.33	03.70
9.	Ammonium phosphate	00.00	100.00
10.	Control	90.00	00.00
	S.Em.±	1.633	-
	C.D. at 5%	4.817	-
	C.V.%	6.893	-

*DAI= Days after inoculation

Heydaryinia *et al.*, (2011) reported that sodium benzoate at 0.1 per cent concentration found most inhibitory to mycelial growth of *A. niger* followed by potassium sorbate (0.1 %). Ghadiri *et al.*, (2013) showed that ammonium phosphate gave highest inhibition of the mycelial growth of *F. solani* (92.29%) on PDA medium followed by potassium carbonate (54.92%), potassium bicarbonate (46.14%), sodium carbonate (42.60%) and sodium bicarbonate (42.33%). Pandya (2015) found that aluminum acetate and aluminum chloride salts at 0.2 M concentration completely inhibited the mycelial growth of *Fusarium solani in vitro*.

In vivo: Five salts which were found most effective *in vitro* were further screened to test their efficacy in controlling black mould rot of onion at 0.2 M concentration by following both pre- and post-inoculation methods.

Pre-inoculation: The results presented in Table 6 revealed that the severity of black mould rot disease was negligible in onion bulbs treated with sodium benzoate (0.00 & 0.33 %) and sodium bicarbonate (0.00 & 0.33 %) followed by aluminum acetate (0.00 & 0.67 %) after 7th and 14th day of inoculation. Ammonium phosphate (0.33 & 1.00 %) and sodium carbonate (0.33 & 1.93 %) showed mediocre effect over control (16.67 & 27.67 %).

Post-inoculation: Similar trend of results was noted in post-inoculation treatment. Significantly very low black mould rot severity was recorded in bulbs treated with sodium benzoate (0.00 & 1.06 %) and sodium bicarbonate (0.73 & 1.33 %) followed by aluminum acetate (0.67 & 1.50 %) after 7th and 14th days of inoculation. The next best treatment in order of merit was sodium carbonate (1.10 & 2.47 %) followed by ammonium phosphate (1.77 & 4.37 %). The results of present study are in agreement with the results obtained by Mecteau *et al.*, (2008). They showed that application of aluminum chloride gave 40 per cent decrease in dry rot severity of potato infected with *Fusarium solani* var. *coeruleum* compared with the control. Pandya (2015) reported that severity of Fusarium dry rot was not observed in potato tubers treated with aluminum acetate and aluminum chloride on 4th and 8th day after inoculation in pre- and post-inoculation treatments.

Table 6 Evaluation of organic and inorganic salts in management of black mould rot (*A. niger*) of onion *in vivo*

Sr. No.	Treatments	Per cent rot severity			
		Pre-inoculation		Post-inoculation	
		7th DAI*	14th DAI	7th DAI	14th DAI
1.	Aluminum acetate	0.00	0.67	0.67	1.50
		(0.71)**	(1.05)	(1.05)	(1.41)
2.	Sodium benzoate	0.00	0.33	0.00	1.06
		(0.71)	(0.88)	(0.71)	(1.25)
3.	Sodium bicarbonate	0.00	0.33	0.73	1.33
		(0.71)	(0.88)	(1.08)	(1.35)
4.	Sodium carbonate	0.33	1.93	1.10	2.47
		(0.88)	(1.56)	(1.26)	(1.72)
5.	Ammonium phosphate	0.33	1.00	1.77	4.37
		(0.88)	(1.22)	(1.50)	(2.20)
6.	Control	16.67	27.67	22.33	41.33
		(4.33)	(5.30)	(4.77)	(6.46)
	S.Em.±	0.128	0.135	0.124	0.069
	C.D. at 5%	0.394	0.415	0.381	0.212
	C.V.%	16.200	12.835	12.372	4.957

* DAI= Days after inoculation

**Figures in parentheses are square root transformed ($\sqrt{x + 0.5}$) values

ACKNOWLEDGEMENT

The authors are grateful to the Professor & Head, Department of Plant Pathology and Dean, Faculty of Agriculture, B. A. College of Agriculture, Anand Agricultural University, Anand for providing the necessary facilities during the course of investigation.

REFERENCES

Asalmol, M. N., Sen, B. and Awasthi, J. 1990. Role of temperature and pH in antagonism of *Aspergillus niger* and *Trichoderma viride* against *Fusarium solani*. Proc. *Indian Phyto-Pathol. Soc.* (Western Zone). On Bio-control of Plant Pathogen. M.P.A.U., Pune, 11-13.

Damaram. 2013. Investigation on Fusarium Fruit Rot [*Fusarium pallidoroseum* (Cooke) Sacc.] of Tomato (*Lycopersicon esculentum* Mill.) and its Management. M. Sc. (Agri.) Thesis submitted to Anand Agricultural University, Anand, Gujarat.

Ghadiri, M. R., Dalili, A., Frotan, A., Zaker, M. Bahare, Rahmanifard and Dalili, M. 2013. Study on antifungal activity of some salts on growth and dry rot development of *fusarium solani* (mart.) sacc. *J Agr Env Sci* **13** (5): 668-672.

Girase, M., Bholay, A. D. and Pawar, K. 2012. Antimicrobial potential of *Lantana camara* against phytopathogens. *J Ind Res & Technology.* **2** (2): 67-71.

Gupta, R., Khokhar, M. K. and Ram, Lal. 2012. Management of the black mould disease of onion. *J Plant Pathol. Microbiol.* **3** (5): 3-5.

Heydaryinia, A., Masoud, V. and Ali, S. 2011. A comparative study of the effects of the two preservatives, sodium benzoate and potassium sorbate on *Aspergillus niger* and *Penicillium notatum. Jundishapur J. Microbiol.* **4** (4): 301-307.

Kaur, P. and Verma, K. S. 2002. Prevalence of post-harvest rots of Kinnow in Punjab. *J. Pl. Dis. Res.* **17** (2): 329-331.

Mecteau, M. R., Joseph Arul et Russell J. Tweddell. 2008. Effect of different salts on the development of *Fusarium solani* var. *coeruleum*, a causal agent of potato dry rot. *Phytoprotection* 89 (1): 1-6.

Mustaq, S., Saleem, M. H., Ali, A. Javed, S., Khokhar, I. and Mukhtar, I. 2012. *In vitro* comparative screening of antibacterial and antifungal activities of some common weed extracts. *Pak. J. Weed Sci. Res.* **18** (1): 15-25.

Nene, Y. L. and Thapliyal, P. N. 1979 (Edn). Fungicides in plant disease control. Oxford and IBH Publishing Co., New Delhi, **11**: p. 7-10.

Nwafor, O. E. and Ikenebomeh, M. J. 2009. Effect of sodium benzoate on the growth and enzyme activity of *Aspergillus niger* and *Penicillium citrinum* in Zobo drink during storage at 30 ± 2°C. *Afr. J. Biotechnol.* **8** (12): 2843-2447.

Onyeani, C. A., Osunlaja, S. O., Oworu, O. O. and Joda, A. O. 2012. Evaluation of effect of aqueous plant extract in the control of storage fungi. *Int. J. Sci. Tech. Res.* **1** (6): 76-79.

Pandya, J. P. 2015. Molecular characterization of *Fusarium solani* (Mart.) Sacc. causing dry rot of potato tubers (*Solanum tuberosum* L.) and its management. M. Sc. (Agri.) Thesis submitted to Anand Agricultural University, Anand, Gujarat.

Quadri, S. M. H., Srivastava, K. J., Bhonde, S. R., Pandey, U. B. and Bhagchandani, P. M. 1982. Fungicidal bioassay against certain important pathogens of onion (*Allium cepa* L.). *Pesticides.* **16**: 11-16.

Rajam, S. R. 1992. Studies on the post harvest fungal spoilage of onion. M. Sc. (Ag.) Thesis submitted to Tamil Nadu Agricultural University, Coimbatore, India.

Reddy, S. 2012. Studies on Penicillium fruit rot (*Penicillium citrinum*) of citrus (*Citrus aurantifolia* Swingle) and its management. M. Sc. (Agri.) Thesis submitted to Anand Agricultural University, Anand, Gujarat.

Singh, Y. P. and Sumbali, G. 2003. Management of *Penicillium expansum* rot of apple by certain plant extract and essential oils. *J. Mycol. Plant Pathol.* **33** (3): 504.

Sinha, P. and Saxena, S. K. 1989. Effect of treating tomatoes with leaf extracts of certain plant on the development of the fruit rot caused by the *Aspergillus niger* in presence of *Drosophila busekii. J Phytopath. Res.* **2**: 97-101.

Thamizharasi, V. and Narasimham, P. 1992. Growth of *Aspergillus niger* on onion bulbs and its control by heat and sulphur dioxide treatments. *Trop. Sci.* **33**: 45-55.

Wani, A. H. and Taskeen-Un-Nisa. 2011. Management of black mold rot of onion. *Mycopath.* **9** (1): 43-49.

GAU Research Journal **43** (2) : 62-65 (July 2018)

Effect of boron application on yield, quality and economics of Potato (*Solanum tuberosum* L.)

S.K. CHONGTHAM[1*], R.N. PATEL[2], J.K. PATEL[3] and D.M. ZAPADIYA[4]

Potato Research Station,
S. D. Agricultural University, Deesa-385 535 (Gujarat)

Received : 18 June, 2018 Accepted: 06 July, 2018

ABSTRACT

Two years field experiment was conducted at Potato Research Station, S. D. Agricultural University, Deesa during 2014-15 and 2015-16 to study the effect of boron application on yield, quality and economics of potato cv. Kufri Chipsona-3. Results revealed that boron application had no significant influence on tuber yields and number of tubers. Quality parameters like per cent dry matter of tuber and dry matter tuber yield were not significantly influenced by boron application. However, least tuber cracking was recorded under application of recommended dose of fertilizer (NPK) along with foliar application of 0.1% boric acid at 40, 50 and 60 days after planting. In terms of economic remuneration, application of recommended dose of fertilizer (NPK) along with 0.1% boric acid foliar application at 40 and 60 days after planting was the best among all treatments.

Key words : Boron, dry matter, economics, Kufri Chipsona-3, tuber cracking.

Boron is one of the essential micro-nutrients which play a vital role for increasing both yield and quality of potato tubers. It reduces the oxidation of phenols thus preventing discolouration of tubers and improves calcium absorption and stabilizes calcium in cell wall (Singh *et al.*, 2018). About 90% of boron in plants is accumulated in cell walls specifically associated with cell wall formation, functioning and strength (Blevins and Lukaszewski, 1998). Deficiency of boron has been reported to induce cracking in tubers and increasing susceptibility to diseases. Boron deficiency induces the internal breakdown of tubers in sugarbeet, turnip and potatoes (Brown *et al.*, 2002). However, response to boron application varies with the variety and location. So, it is obligatory to find out the suitable dose and method of boron application to achieve potato tubers of high quality. Hence, an experiment was planned to evaluate the effect of boron application on tuber yield, qualities like % tuber dry matter, dry matter yield and cracking in tuber (weight and number) and economics of potato cv. Kufri Chipsona-3.

[1]Assistant Research Scientist (Agronomy), [2]Associate Research Scientist (Plant Breeding), [3]Assistant Research Scientist (Plant Pathology), [4]Agriculture Officer
*Email : sunil.sunil.ch@gmail.com

MATERIALS AND METHODS

A field experiment was conducted at Potato Research Station, SDAU, Deesa (Gujarat) during *Rabi* season of 2014-15 and 2015-16 to study the effect of boron application on yield, qualities and economics of potato variety Kufri Chipsona-3. The soil was loamy sand in texture, low in organic carbon (0.31%), available nitrogen (170.02 kg/ha), medium in available phosphorus (29.92 kg P/ha) and available potassium (297.00 kg K_2O/ha). Five treatments *viz*; recommended dose of NPK (RDF_{NPK}), RDF_{NPK} +2.0 kg B/ha as soil application, RDF_{NPK} + 0.1% boric acid as foliar spray at 40 days after planting (DAP), RDF_{NPK} +0.1% boric acid as foliar spray in two equal splits at 40 and 60 DAP and RDF_{NPK} + 0.1% boric acid as foliar sprays in three times at 40, 50 and 60 DAP were laid out in randomized block design and replicated four times. The RDF_{NPK} of potato was 275:140:275 kg N: P_2O_5: K_2O/ha. Sources of boron for soil and foliar application were solubor and boric acid, respectively. Potato variety Kufri Chipsona-3 was sown on 15th November with seed rate of 3000 kg/ha at a spacing of 50 cm x 20 cm. Recommended package of practices were followed for potato crop

Table.1. Plant emergence, tuber yields and number of tubers of processing potato variety Kufri Chipsona-3 as influenced by different treatments of boron

Treatment	Plant emergence (%)	Grade-wise tuber yield (t/ha)					Number of tubers ('0000/ha)				
		0-40 g	40-100 g	100-150 g	>150 g	Total	0-40 g	40-100 g	100-150 g	>150 g	Total
RDF_{NPK}	91.54	3.38	15.00	23.22	14.42	56.02	16.78	21.33	18.31	6.34	16.78
RDF_{NPK} + 2 kg B/ha soil application	92.04	3.58	16.03	22.51	16.41	58.53	17.89	22.91	17.95	7.20	17.89
RDF_{NPK} + 0.1% boric acid foliar spray at 40 DAP	90.81	3.84	14.26	20.76	18.00	56.86	19.19	20.41	16.60	7.84	19.19
RDF_{NPK} + 0.1% boric acid foliar spray at 40 and 60 DAP	90.81	3.75	14.72	24.72	14.81	58.00	18.70	21.01	19.31	6.70	18.70
RDF_{NPK} + 0.1% boric acid foliar spray at 40, 50 and 60 DAP	91.07	3.76	16.01	21.93	15.58	57.28	18.79	22.83	17.68	7.06	18.79
SEm ±	0.77	0.40	1.11	0.55	0.67	1.25	2.33	2.31	0.97	0.56	3.70
CD (P=0.05)	NS	NS	NS	NS	2.08	NS	NS	NS	NS	NS	NS

Table.2. Quality parameters, tuber dry matter yield and economics of processing potato variety Kufri Chipsona-3 as influenced by different treatments of boron

Treatment	Tuber dry matter (%)	Grade-wise number of cracked tuber/ha					Tuber Dry matter yield (t/ha)	Gross return (₹ x 10^4/ha)	Net return (₹ x (10^4/ha)	BCR
		0-40 g	40-100 g	100-150 g	>150 g	Total				
RDF_{NPK}	11.38	208	2292	2396	938	5833	6.28	30.81	21.71	3.39
RDF_{NPK} + 2 kg B/ha soil application	10.58	0	1458	2708	313	4479	6.37	32.19	22.62	3.36
RDF_{NPK} + 0.1% boric acid foliar spray at 40 DAP	11.23	104	208	3229	1667	5208	6.39	31.27	22.14	3.42
RDF_{NPK} + 0.1% boric acid foliar spray at 40 and 60 DAP	11.29	0	208	2188	1146	3542	6.40	31.90	22.73	3.48
RDF_{NPK} + 0.1% boric acid foliar spray at 40, 50 and 60 DAP	11.31	104	938	729	1042	2813	6.36	31.51	22.30	3.42
SEm ±	0.28						0.16			
CD (P=0.05)	NS						NS			

during the experiment. Plant emergence per cent was recorded at 30 DAP. Total tuber yield at harvest from each net plots of size 3.0 m x 4.0 m was further classified into different grades *i.e:* 0-40 g, 40-100 g, 100-150 g and >150 g and later expressed in t/ha. Dry matter yield was determined by chopping and mixing of tubers into small pieces and drying of 100 gram sample in hot air oven at 80° C for first six hours and then at 65° C till constant weight was obtained (Kumar *et al.*, 2006). Grade-wise number of tubers and cracked tubers per plot were recorded and then expressed in terms of number per ha. Net returns and benefit: cost ratio were calculated by using formula:

Net return (₹/ha) = Gross return (/ha) – Total cost of cultivation (/ha)

Benefit cost ratio (BCR) = Gross return (/ha) / Total cost of cultivation (/ha)

Data were statistically analysed using OPSTAT of CCSHAU, Hisar and interpreted accordingly.

RESULTS AND DISCUSSION

Plant emergence, tuber yield and tuber number

Perusal of the data (Table 1) revealed that plant emergence was not significantly influenced by different treatments. Similarly, grade-wise tuber yield of potato were statistically unaffected by different boron treatments, except for >150 g grade tuber yield. Application of RDF_{NPK} + 0.1% boric acid foliar spray at 40 DAP recorded significantly highest >150 g grade tuber yield, which was at par with RDF_{NPK} + 2 kg B/ha soil application. In case of total tuber yield, there was no significant difference among all treatments. However, total tuber yield was highest under RDF_{NPK} + 2 kg B/ha soil application. Bari *et al.* (2001), Hopkins *et al.* (2007) and Singh *et al.* (2018) had studied the role of boron on yield of potato and reported a non-significant effect of soil or foliar application of boron. According to findings of Choudhary (2017), boron alone did not have direct influence on yield or related attributes of potato, however it played supplementary role when applied with other nutrients like sulphur, zinc etc. The grade-wise and total number of tubers remained statistically unaffected by different treatments. However, highest total number of tuber was registered under RDF_{NPK} + 0.1% boric acid foliar spray at 40 DAP.

Quality parameters and economics

It was evident from Table 2 that tuber dry matter per cent and tuber dry matter yield did not varied significantly due to different treatments. However, highest tuber dry matter per cent and tuber dry matter yield were recorded under RDF_{NPK} (11.38 %) and RDF_{NPK} + 0.1% boric acid foliar spray at 40 and 60 DAP (6.40 t/ha), respectively. Application of RDF_{NPK} + 0.1% boric acid foliar spray at 40, 50 and 60 DAP recorded least total number of cracked tubers, which was followed by RDF_{NPK} + 0.1% boric acid foliar spray at 40 and 60 DAP. Reduction in cracked tubers in these treatments might be due to enhanced availability of boron which further increased calcium absorption and accumulation in cell wall. Consequently, this might have improved formation of cell wall with better functioning and strength while reducing internal breakdown of tubers in potato. Similar findings were reported by Brown *et al.* (2002), Cakmak *et al.* (1995) and Pilbeam and Kirkby (1983).

Highest gross return was recorded under RDF_{NPK} + 2 kg B/ha soil application (32.19 x 10^4) which was followed by RDF_{NPK} + 0.1% boric acid foliar spray at 40 and 60 DAP (31.90 x 10^4). However, application of RDF_{NPK} + 0.1% boric acid foliar spray at 40 and 60 DAP had highest net return (22.73 x 10^4/ha) which was closely followed by RDF_{NPK} + 2 kg B/ha soil application (22.62 x 10^4/ha). Similarly, highest BCR (3.48) was registered under application of RDF_{NPK} + 0.1% boric acid foliar spray at 40 and 60 DAP which was attributed to higher tuber yield with lower number of cracked tubers with lower total cost of cultivation as compared to other treatments.

ACKNOWLEDGEMENT

The authors are highly grateful to ICAR-AICRP (Potato) and SDAU, Sardarkrushinagar for extending financial assistance and support for the project.

REFERENCES

Bari, M. S., Rabbani, M. G., Rahman, M. S., Islam, M. J. and Hoque, A. T. M. R. 2001. Effect of zinc, boron, sulphur and magnesium on the

growth and yield of potato. *Pakistan Journal of Biological Science*. **4**: 1090-1093.

Blevins, D. G. and Lukaszewski, K. M. 1998. Boron in plant structure and function. *Annual Review of Plant Physiology and Plant Molecular Biology*. **49**: 481-500.

Brown, P. H., Bellaloui, N., Wimmer, M. A., Bassil, E. S., Ruiz, J., Hu, H. and Römheld, V. 2002. Boron in plant biology. *Plant Biology*. **4**: 205-223.

Cakmak, I., Kurtz, H. and Marschner, H.1995. Short-term effects of boron, germanium and high light intensity on membrane permeability in boron deficient leaves of sunflower. *Physiologia Plantarum*. **95**: 11–18.

Choudhary, R. S. 2017. Effect of calcium, magnesium, sulphur, zinc and boron on growth and yield of potato (cv. Kufri Jyoti). M.Sc (Horticulture) Thesis, Department of Vegetable and Spice crops, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal.

Hopkins, B. G., Jolley, V. D., Webb, B. L., Ellsworth, J. and Callahan, R. 2007. Boron fertilization in Potato. In : *Western Nutrient Management Conference*. Volume No. 7, March 8-9, 2007, Salt Lake City, Utah p. 215-218.

Kumar, D., Singh, B. P. and Paul Khurana, S. M. 2006. Processing quality of potato hybrid Ht/92-621 during storage at intermediate temperature along with sprout suppressant treatment. *Potato Journal*. **33** (1-2): 90-93.

Pilbeam, D. J., and Kirkby, E. A. 1983. The physiological role of boron in plants. *Journal of Plant Nutrition*. **6** (7): 563-582.

Singh, S. K., Sharma, M., Reddy, K. R. and Venkatesh, T. 2018. Integrated application of boron and sulphur to improve quality and economic yield in potato. *Journal of Environmental Biology* **39**: 204-210. DOI : http://doi.org/10.22438/jeb/39/2/MRN-395.

GAU Research Journal **43** (2) : 66-69 (July 2018)

Assessment of zinc application on yield, quality, productivity and profitability of Potato (*Solanum Tuberosum* L.)

S.K. CHONGTHAM[1*], R.N. PATEL[2], J.K. PATEL[3] and D.M. ZAPADIYA[4]

Potato Research Station, S.D. Agricultural University,
Deesa - 385 535 (Gujarat)

Received : 18 June, 2018 Accepted: 16 July, 2018

ABSTRACT

A field experiment was conducted at Potato Research Station, S.D. Agril. University, Deesa during 2014-15 and 2015-16 to assess the effect of zinc application on yield, quality and profitability of potato cv. Kufri Badshah. Results indicated that various levels of zinc had no significant influence on total tuber yields and its total number of tubers. However, application of recommended dose of fertilizer (275-140-275 kg N-P_2O_5-K_2O/ha) along with 4.5 kg Zn/ha had marked improvement in tuber yields of grade 25-50 g (9.99 t/ha) and 50-75 g (25.68 t/ha). Highest per cent dry matter of tuber was registered with application of recommended dose of fertilizer along with 1.5 kg Zn/ha, but dry matter tuber yield remained statistically unaffected by different levels of zinc. Crop, water and partial nutrient productivity did not varied significantly due to various levels of zinc. In terms of economic profitability, application of recommended dose of fertilizer (NPK) along with 4.5 kg Zn/ha was the best among which was closely

Key words : Dry matter, Kufri Badshah, productivity, profitability, tuber yield

Zinc deficiency is most widely spread in Indian soils, with almost half of the country is poor in zinc. In Gujarat, several districts namely Banaskantha, Ahmedabad, Jamnagar and Bahruch are reported deficient in zinc (Anonymous, 2011). Zn is also vital for protein metabolism, auxin metabolism, pollen formation, maintenance of the integrity of biological membranes and those related to the resistance to infection by certain pathogens (Alloway, 2008). To improve productivity, potato plant requires a balance dose of NPK along with adequate amount of micronutrients like, zinc, boron and manganese (Sati *et al.*, 2017). There are many reports of marked improvement in potato yield and quality due to zinc application (Brahmachari *et al.* 2010; Rahaman *et al.*, 2011). Therefore, it is needed to evaluate the effect of zinc application on yield, quality, productivity and profitability of potato.

[1]Assistant Research Scientist (Agronomy), [2]Associate Research Scientist (Plant Breeding), [3]Assistant Research Scientist (Plant Pathology), [4]Agriculture Officer
*Email : sunil.sunil.ch@gmail.com

MATERIALS AND METHODS

A field experiment was conducted at Potato Research Station, SDAU, Deesa (Gujarat) during *Rabi* seasons of 2014-15 and 2015-16 to study the effect of zinc application on yield, qualities and economics of potato variety Kufri Badshah. The soil was loamy sand in texture, low in organic carbon (0.31%), available nitrogen (170.02 kg/ha), medium in available phosphorus (29.92 kg P/ha) and available potassium (297.00 kg K_2O/ha). Five treatments *viz*; RDF of NPK (RDF_{NPK}), RDF_{NPK} + 1.5kg Zn/ha, RDF_{NPK} + 3.0 kg Zn/ha, RDF_{NPK} + 4.5 kg Zn/ha and RDF_{NPK} + 6.0 kg Zn/ha were laid out in randomized block design and replicated four times. The RDF_{NPK} 275:140:275 kg N: P_2O_5: K_2O/ha was given to potato crop in all treatments. Source of zinc was zinc sulphate heptahydrate and applied in soil at the time of planting. Potato variety Kufri Badshah was sown on November 15, 2014 and 2015 using seed rate of 3000 kg/ha with spacing of 50 cm x 20 cm. Recommended

package of practice was followed for planting potato crop during the experiment. Plant emergence at 30 DAP was recorded. Total tuber yield was harvest from each net plot of size 3.0 m x 4.0 m, which was further grouped into different grades *i.e*; 0-25 g, 25-50 g, 50-75 g and >75 g and then expressed in t/ha. Dry matter content was determined by chopping and mixing of tubers in to small pieces and drying of 100 gram sample in hot air oven at 80° C for first six hours and then at 65° C till constant weight was obtained (Kumar *et al.*, 2006). Grade-wise number of tubers per plot were recorded and then expressed in terms of number in per ha. Crop productivity was calculated by using formula:

$$\text{Crop productivity (kg/ha/day)} = \frac{\text{Total yield (kg/ha)}}{\text{Total crop duration (days)}}$$

The total duration of crop and quantity of irrigation water applied was 125 days and 700 mm, respectively during all the years of experimentation. Water productivity (WP) was calculated by using formula:

$$WP = \frac{\text{Total yield (kg/ha)}}{\text{Total amount of irrigation water applied (mm)}}$$

$$\text{Partial factor productivity (PFP) of N, P and K} = \frac{\text{Total yield in kg/ha (Y)}}{\text{Nutrient applied in kg/ha (N, P, K)}}$$

Net returns and benefit: cost ratio were calculated. Data were statistically analysed using OPSTAT of CCSHAU, Hisar and interpreted accordingly.

RESULTS AND DISCUSSION

Plant emergence, tuber yield and tuber number

Perusal of the data (Table 1) revealed that plant emergence was not significantly influenced by different treatments. In case of grade-wise tuber yields were significantly influenced by different zinc treatments, except 0-25 g and >75 g grade tuber yields. Application of RDF_{NPK} + 4.5 kg Zn/ha recorded highest 25-50 g (9.99 t/ha), which was statistically at par with all other treatments, except RDF_{NPK} + 1.5 kg Zn/ha. In case of 50-75 g, highest tuber yield (25.68 t/ha) was observed under RDF_{NPK} + 4.5 kg Zn/ha, which was statistically higher than other treatments, except RDF_{NPK} and RDF_{NPK} + 1.5 kg Zn/ha. However, total tuber yield did not varied significantly due to different levels of zinc. These results are in accordance with several reports across different regions of India (Anomymous, 2013-14 and 2014-15). Maximum value of total tuber yield was observed under RDF_{NPK} + 4.5 kg Zn/ha (63.41 t/ha). Highest 0-25 g grade number of tuber was recorded under RDF_{NPK} + 3.0 kg Zn/ha, which was statistically better than rest of treatments, except RDF_{NPK} + 1.5 kg Zn/ha and RDF_{NPK} + 6.0 kg Zn/ha. However, remaining grade-wise tuber and total tuber numbers remained statistically unaffected by different treatments.

Quality, productivity and profitability

Highest % dry matter was recorded under RDF_{NPK} + 1.5 kg Zn/ha (11.49 %) which was statistically higher than rest of treatments except, RDF_{NPK} + 6.0 kg Zn/ha (Table 2). However, tuber dry matter yield was not significantly affected by different levels of zinc. Highest tuber dry matter was recorded under RDF_{NPK} + 1.5 kg Zn/ha.

Crop and water productivity did not vary statistically due to different zinc treatments (Table 2). However, highest values of both crop and water productivity were registered under RDF_{NPK} + 4.5 kg Zn/ha. Similar trend was also noted for partial nutrient productivity of NPK. However, highest values of partial nutrient productivity of NPK were recorded under RDF_{NPK} + 4.5 kg Zn/ha. These might be attributed to higher tuber yield under RDF_{NPK} + 4.5 kg Zn/ha.

Highest gross return was recorded under RDF_{NPK} + 4.5 kg Zn/ha (₹ 34.88 x 10^4) which was followed by RDF_{NPK} + 1.5 kg Zn/ha (₹ 34.49 x 10^4). Similarly, application of RDF_{NPK} + 4.5 kg Zn/ha had highest net return (₹ 25.69 x 10^4/ha) which was closely followed by RDF_{NPK} + 1.5 kg Zn/ha (₹ 25.36 x 10^4/ha). Maximum value of BCR (2.79) was registered under application of RDF_{NPK} + 4.5 kg Zn/ha, which was closely followed by RDF_{NPK} + 1.5 kg Zn/ha 2.78). Highest gross, net return and BCR under RDF_{NPK} + 4.5 kg Zn/ha could be attributed to highest tuber yield with lower total cost of cultivation among all treatments. Similar findings were reported by Banerjee *et al.* (2016).

ACKNOWLEDGEMENT

The financial assistance and support extended for the project by ICAR-AICRP (Potato) and SDAU, Sardarkrushinagar are highly acknowledged.

Table1 Plant Emergence, tuber yields and tuber number of potato variety Kufri Badshah as influenced by different levels of zinc

Treatment	Plant Emergence (%)	Grade-wise tuber yield (t/ha)					Number of tubers ('0000/ha)				
		0-25 g	25-50 g	50-75 g	>75 g	Total	0-25 g	25-50 g	50-75 g	>75 g	Total
RDF_{NPK}	91.30	2.85	9.18	23.89	25.53	61.45	21.82	27.59	40.03	26.02	115.47
RDF_{NPK} + 1.5 kg Zn/ha	91.40	3.37	7.14	23.89	28.31	62.71	26.09	22.04	40.00	29.25	117.39
RDF_{NPK} + 3.0 kg Zn/ha	90.81	3.74	9.47	20.01	27.56	60.77	29.07	28.22	34.23	28.03	119.55
RDF_{NPK} + 4.5 kg Zn/ha	90.73	2.80	9.99	25.68	24.94	63.41	21.16	30.06	43.07	25.30	119.59
RDF_{NPK} + 6.0 kg Zn/ha	90.30	3.53	9.97	20.96	24.09	58.56	27.35	29.64	35.70	24.27	116.96
S. Ed ±	1.30	0.45	0.89	1.52	2.65	3.09	1.82	3.69	3.12	2.82	4.18
CD (P=0.05)	NS	NS	1.97	3.34	NS	NS	4.01	NS	NS	NS	NS

Table 2 Quality parameters, productivity, nutrient use efficiencies and economics of potato variety Kufri Badshah as influenced by different levels of zinc

Treatment	Tuber dry matter (%)	Tuber Dry matter yield (t/ha)	Crop) productivity (kg/ha/day	Water productivity (kg/ha/mm)	Partial Nutrient productivity (kg tuber per kg nutrient return applied)			Gross return (₹ x 10^4/ha)	Net (₹ x 10^4/ha)	BCR
					N	P	K			
RDF_{NPK}	10.33	6.40	491.57	87.78	223.44	438.90	223.44	33.80	24.70	2.71
RDF_{NPK} + 1.5 kg Zn/ha	11.49	6.97	501.72	89.59	228.05	447.96	228.05	34.49	25.36	2.78
RDF_{NPK} + 3.0 kg Zn/ha	10.38	6.18	486.19	86.82	221.00	434.10	221.00	33.43	24.26	2.65
RDF_{NPK} + 4.5 kg Zn/ha	10.37	6.27	507.32	90.59	230.60	452.96	230.60	34.88	25.69	2.79
RDF_{NPK} + 6.0 kg Zn/ha	11.11	6.75	468.48	83.66	212.95	418.29	212.95	32.21	22.99	2.49
S. Ed ±	0.26	0.37	24.68	4.41	11.22	22.04	11.22			
CD (P=0.05)	0.57	NS	NS	NS	NS	NS	NS			

REFERENCES

Alloway, B. J. 2008. Zinc in soils and crop nutrition. 2nd ed., International Zinc Association (IZA) and International Fertilizer Association (IFA), Brussels, Belgium and Paris, France. P. 139.

Anonymous (2011). Guidelines for use of micronutrients, soil ameliorants and integrated nutrient management practices in National Food Security Mission States. P. 1-27.

Anonymous (2013-14). Project Coordinator Unit, Central Potato Research Institute, Shimla- 171 0001 (H.P.). P. 342.

Anonymous (2014-15). Compiled Results Database. Project Coordinator Unit, Central Potato Research Institute, Shimla- 171 0001 (H.P.). P. 342.

Banerjee, Hirak, Sarkar, Sukamal, Deb, Prahlad, Dutta, Sudarshan Kumar, Ray, Krishnendu, Rana, Lalita and Majumdar, Kaushik. 2016. Impact of zinc fertilization on potato (*Solanum tuberosum* L.) yield, zinc use efficiency, quality and economics in Entisol of West Bengal. *Journal of the Indian Society of Soil Science.* **64** (2): 176-182.

Brahmachari, K., Rajib, K., Suborna, R., and Sounda, G. 2010. Effects of different methods of application of zinc on productivity and quality of potato under coastal saline soil of West Bengal. *Indian Agriculturist Journal.* **54** (3/4): 143-146.

Kumar, D., Singh, B. P. and Paul Khurana, S. M. 2006. Processing quality of potato hybrid Ht/ 92-621 during storage at intermediate temperature along with sprout suppressant treatment. *Potato Journal.* **33** (1-2): 90-93.

Rahman, M. H., Halder, B. C., and Khan, M. A. 2011.Effects of zinc and manganese on growth and yield of potato. *Journal of Bangladesh Society of Agriculture Science and Technology.* **1**(2):17-22.

Sati, Kailash, Raghav, Manoj, Singh, C. P., Singh, V. K. and Shukla, Alok. 2017. Effect of zinc sulphate application on growth and yield of potato (*Solanum tuberosum* L.). *Research in Environment and Life Sciences.* **10** (8): 685-687.

GAU Research Journal **43** (2) : 70-72 (July 2018)

Response of Isabgol to rates of fertilizer under varying sowing times

M.M.PATEL[2] AND A.U. AMIN[1*]

Agricultural Research Station
S. D. Agricultural University, Kholwada, Ta. Sidhpur, Dist.Patan (Gujarat)

Received : 26 June, 2018 Accepted: 16 July, 2018

ABSTRACT

A field experiment was conducted during *Rabi* seasons of 2014-15 to 2016-17 at Agriculture Research Station, Sardarkrushinagar Dantiwada Agricultural University, Kholwada to study the effect of sowing time and fertilizer management on isabgol (*Plantago ovata*, Forsk.). The five sowing times *viz,* S_1: 2 nd week of November, S_2 : 3rdweek of November,S_3 : 5th week of November,S_4 :2nd week of December, S_5: 4thweek December and three fertilizer rates i.e. F_1 : 50%F_2 : 100% , F_3 : 150% RDF levels were tested under factorial RBD with three replications. Pooled data of three years experimentation indicated thatthe crop sown during the second week of November produced significantly the higher growth and yield attributes which were at par with the treatment S_2 for plant height, number of tillers per plant and seeds per spike. Seed and stover yields of isabgol were reduced with each late in sowing during all the year and in pooled data. Crop sown during second week of November produced significantly higher seed and stover yields during all the years as well as in pooled results. Application of 150 % RDF recorded significantly maximum growth, yield attributes and yield.Maximum swelling percentage (11.0) was recorded with 100 % RDF and was at par with 150 % RDF. Crop sown during second week of November (S_1) secured maximum net realization as well BCR. Similarly, these values were higher when crop was fertilized with 150 % RDF.

Key word: Isabgol, Seed yield, Stover yield, Net return, Benefit: Cost Ratio.

Isabgol (*Plantago ovata*, Forsk.)is a medicinal crop, locally known as 'Ghodajiru" grown in *Rabi* season. Isabgol husk is used against constipation, irritation of digestive tract due to good sources of soluble fiber.Husk, gola, lali and khakho are separated from seed during processing.

In India, Isabgolis widely grown in semi arid to arid regions of Rajasthan and Gujarat. India ranks first in Isabgol production (around 1 lakh tones) in world than Pakistan. Gujarat grows 24199 hectares and produces about 26092 M.T. with a productivity of about 1078 kg/ha. The major area (95%) falls in Banaskantha, Kutch, Patan and Mehsana districts of North Gujarat. The share of Gujarat in an area and production in the country is about 30 to 35 per cent. About 90 % of the country's production is exported, therefor it is termed as dollar earning crop.

Time of sowing is known as non –monetary input and exerts a distinguish effect on growth and development as well as disease of crop, consequently on yield. The time of sowing varies with cultivars, irrigation facilities and agroclimatic conditions.

Productivity of isabgol is poor of these regions due to light in texture soils which are poor in fertility and water holding capacity. Scientific information on these aspects is scanty, hence, present experiment was planned.

[1]Research Scientist, [2]Assistant Research Scientist
*Email : rsspices@sdau.edu.in

MATERIALS AND METHODS

A field experiment was conducted during *Rabi* season of 2014-15 to 2016-17 to study the effect of sowing times and fertilizer levels on isabgol at Agriculture Research Station, SDAU., Kholwada, Ta.Sidhpur, Dist. Patan.

The soil of experimental field was loamy sand in texture, neutral in reaction (pH 7.6), low in organic carbon (0.39%) and available nitrogen (150.8 kg ha^{-1}), mediumin phosphorus (37.6.0 kg P2O5 ha^{-1}), and potassium (150.5 kg K_2O ha^{-1}). The treatment consisting of five sowing times *viz.* S_1:2 nd week of

November, S_2 : 3rdweek of November,S_3 : 5th week of November,S_4:2nd week of December, S_5: 4th week December and ,three fertilizer rates *viz,* F_1 : 50% F_2 : 100% , F_3 : 150% recommended dose of fertilizer (RDF) levels were treated in FRBD with three replications. The RDF for isabgol is 40:20:0, N-P-K, kg/ha. The crop variety 'GI-3' was sown at 30 cm row spacing, with uniform seed rate of 4.00 kg/ha. Half nitrogen and full dose of phosphorus in forms of urea and super phosphate was applied as basal dose and remaining N was applied in two equal splits at 30 and 50 days after sowing.Five random plants were selected from each plot to record yield attributes. As per need of crop under different sowing times all the recommended cultural practices were applied.

RESULTS AND DISCUSSION

Effect of sowing time

Crop sown at 2nd and 3rd week of November (S_1 and S_2) were at par and recorded significantly higher growth , yield attributes and yield than rest of the treatments except spikes per plant, 1000 seed weight and seed yield. (Table1)

Seed yield of isabgol was reduced with each delay in sowing. Favorable climatic condition at initial growth stage and long crop duration due to early sowing might be increased growth and yield attributes ultimately higher yield. High temperature at reproductive phase in late sown condition and short crop duration which ultimately reduce the crop yield. Crop sown during second week of November (S_1) produced significantly the highest seed yield 784 kgha^{-1} over the rest of the sowing times, except treatment crop sown during third week of November (S_2). Early sowing i.e. Crop sown during second week of November (S_1) produced significantly the highest stover yield (4335 kgha^{-1}.) These findings are in conformity with Ram Chandra *et al.* (2006) andAhirwar*et al.*, (2014).

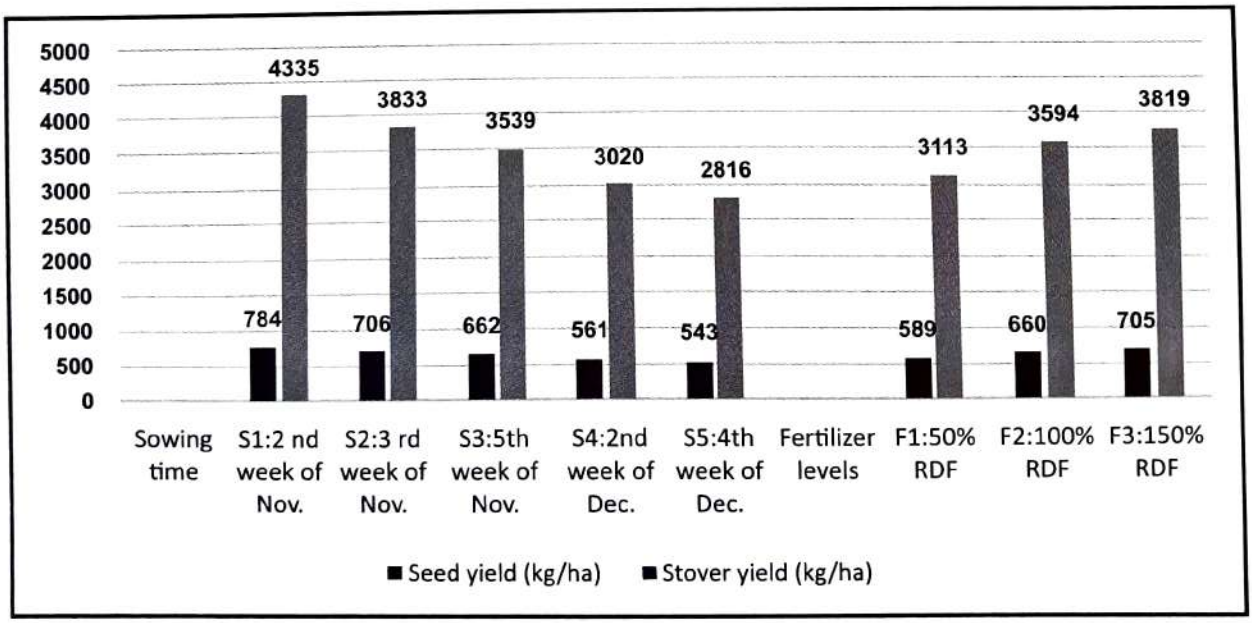
Effect of Fertilizer levels

Application of 150 % RDF recorded significantly the maximum growth and yield attributes except,spike length (4.47 cm) and test weight (1.39 gm) were recorded with application of 150 % RDF except of spike length (4.07 cm) seeds per spike (54.5) and 1000 seed weight. (Table 1).

The results indicated that, seed yield of isabgol increased significantly with each successive increase in fertilizer levels from 50 % RDF to 150 % RDF. Application of 150 % RDF to crop produced significantly the highest seed yield (705 kgha$^{-1)}$and stover yield (3819kgha^{-1}). The favorable effect of nitrogen on growth and yield attributes and ultimately on seed yield could be attributed to the fact that nitrogen and phosphorus the most dispensable plant nutrients for improving growth and development. These findings are in accordance with Patel (2002), Utgikar*al.* (2003), Patel (2006), Ram Chandra *et al.* (2006), Arunjyothi (2007) and Ahirwar et *al.* (2014).

Economics:

Crop sown during second week of November (S_1) secured the maximum net realization as well as BCR (3.16). Similarly these values were higher when crop was fertilized with 150 % RDF (Table 1). Crop sown



during Second to third week of November and applied with 150% RDF recorded higher seed and stover yield which turned to higherBCR. These findings are in line of work withPatel (2002), Patel 2006, Ram Chandra *et al.* (2006), Arunjyothi (2007) and Ahirwar, *et al.* (2014).

Table 1: Growth and yield attributes, yield and economics of isabgol as influenced by different sowing time and fertilizer levels (Pooled data of three years)

Treatments	Plant height (cm)	No of tillers/ plant	No of spikes/ plant	Spike length (cm)	No of seeds /spike	1000 seed weigh	Swelling factor	Stover yield (kg/ha)	Seed yield (kg/ha)	Net return (Rs/ha)	Benefit:cost ratio
A Sowing time											
S_1: 2 nd week of Nov.	33.7	6.32	26.73	4.75	58.1	1.48	11.4	4335	784	40767	3.16
S_2 : 3 rdweek of Nov.	32.5	5.44	23.00	4.59	57.3	1.40	10.9	3833	706	34817	2.84
S_3 : 5 thweek of Nov.	31.2	4.93	19.45	4.10	53.7	1.36	10.9	3539	662	31458	2.66
S_4 : 2 nd week of Dec.	28.0	4.27	15.83	3.71	52.2	1.28	10.4	3020	561	23779	2.26
S_5 : 4th week of Dec.	25.9	3.81	13.92	3.41	50.3	1.27	10.2	2816	543	22388	2.18
S.Em. ±	0.6	0.42	1.03	0.14	0.60	0.01	0.11	74	25	40767	3.16
C.D at 5%	1.8	1.37	3..70	0.45	1.69	0.05	0.30	209	82	34817	2.84
B Fertilizer levels											
F_1 : 50% RDF	29.1	4.53	17.55	3.84	53.2	1.32	10.5	3113	589	25138	2.28
F_2 : 100% RDF	30.3	4.99	19.90	4.07	54.5	1.35	11.0	3594	660	29800	2.46
F_3 : 150% RDF	31.3	5.35	21.42	4.47	55.2	1.39	10.8	3819	705	32459	2.53
S.Em. ±	0.3	0.10	0.42	0.16	0.46	0.02	0.08	57	11		
C.D at 5%	0.8	0.29	1.18	0.45	1.31	0.05	0.23	162	31		
Interaction											
S X F	NS	NS	s	NS	NS	NS	NS	NS	NS		
Y X S	S	S	NS	S	NS	S	NS	NS	S		
S.Em. ±									25		
C.D at 5%									69		
Y X F	NS	NS	NS	NS	NS	NS	NS	NS	NS		
Y X S X F	NS	NS	NS	NS	NS	NS	NS	NS	NS		
CV %	6.36	13.76	14.32	11.50	5.73	8.16	5.10	10.98	11.34		

Thus, the crop sown during 2ndto 3rdweekof November and fertilized with 60+30 kg N, P/ ha (30 Kg N/ha+30 kg P/ha, as basal and remaining 30 Kg N/ha to be applied in two equal splits at 30 and 50 DAS) for obtaining higher yield and net return.

REFERENCES

Ahirwar, S. K.; Aruna Devi and Agrawal, K. K. 2014. Impact of sowing date and fertility levels on growth parameters of isabgol. Plant Archives **14** (1) pp. 249-252.

Arunjyothi,A. 2007. Effectof date of sowing and nitrogen on growth and yield of isabgol (*Plantago ovata* Forsk.).M.Sc. (Agri.)Thesis submitted to Acharya N.G.Rranga Agricultural University, Rajendranagar, Hyderabad – 500 030.

Ram Chandra; Dinesh Kumar;Jha, B.K.; Gajbhiye,N.A. and Aishwath, O.P. 2006. Influence of sowing time on growth and yield of isabgol. (*Plantago ovata* Forsk.) under middle Gujarat. Indian J. Hort. **63** (4): 424-427.

Patel M.M. 2006. Response of ajwain (*Trachyspermum ammi* L.) to vaying levels of FYM and nitrogen under different dates of sowing. M.Sc. (Agri.)Thesis submitted to Gujarat Agricultural University, Sardarkrushinagar.

Patel V. S. 2002. Response of dillseed (*Anethum graveolens* L.) to different sowing dates under varying levels of nitrogen and phosphorus . M.Sc. (Agri.)Thesis submitted to Gujarat Agricultural University, Sardarkrushinagar.

Utgikar Swarupa; Sadawarte K. J; Wankhade S.G. 2003. Growth and yield of isabgol (*Plantago ovata* Forsk.) as influenced by nitrogen and phosphorus levels. Agric. Sci. Digest **23** (1) : 77-78.

GAU Research Journal **43** (2) : 73-75 (July 2018)

Effect of micronutrients on growth and yield of Groundnut (*Arachis hypogaea* L.)

K. V. RABARI[1], B. K. PRAJAPATI[2] AND B. M. NANDRE[4]

Agricultural Research Station,
S. D. Agricurural University, Aseda, Deesa-385 535 (Gujarat)

Received : 29 June, 2018 Accepted: 16 July, 2018

ABSTRACT

The field experiment carried out during *Kharif* season of 2017 at Agricultural Research Station, S.D. Agricultural University, Aseda, Gujarat to study the effect of soil and foliar application of micronutrient. Application of $ZnSO_4$ @ 8 kg/ha + Foliar spray of $FeSO_4$ @ 1 % recorded higher pod yield (4078 kg/ha) and remained at par with treatment T_3, T_4, T_5, T_6, T_7, and T_{10}. Haulm yield was recorded higher (5700 kg/ha) in the treatment T_3 ($ZnSO_4$ @ 8 kg/ha) and remained statistically at par with the treatment T_9, T_7, T_{10} and T_6.

Key word: Micronutrient, Groundnut, Pod yield

Groundnut (*Arachishypogaea* L) is important oilseed crop. India is one of the largest producers of groundnut in the world. Among the oilseed crops, Groundnut (Arachishypogaea L.), the king of oilseeds, is the world's fourth most important source of edible oil and third most important source of vegetable protein. The special variety peanut of this area (Saurastra, Gujarat) is world famous in its flavor, taste and aroma. Groundnut contains more protein then meat, two and half more than eggs and more than any other vegetable food. It also contains phosphorous, thiamin and niacin that help in building resistance against all infections, such as hepatitis and tuberculosis. Zinc (Zn) and iron (Fe) deficiency is a well- documented problem in food crops, causing decreased crop yield and nutritional quality. Generally, the regions in the world with Zn and Fe deficient soils are also characterized by widespread Zn and Fe deficiencies in humans. Zinc plays significant role in various enzymatic and physiological activities of the plant. Zinc catalyses the process of oxidation in plant cells and is vital for transformation of carbohydrates, regulates the consumption of sugar, increases source of energy for the production of chlorophyll, aids in the formation of auxins which produce more plant cells and more dry matter, that in turn will be stored in seed as a sink and promotes absorption of water. Fe plays an important role in a series of metabolic activities involving respiratory enzymes and various photosynthetic reactions. Iron also plays an important role in legumes for nodulation and nitrogen fixation. Fe application also found to improve the protein content in groundnut kernels.

Application of micronutrients successfully prevented occurrence of chlorosis and increased chlorophyll content, pod yield and micronutrient uptake (Singh. 2001). Groundnut is one of the most important and economical oilseeds in Gujarat. Now a days yellowing of groundnut is common occurrence resulted in poor yield. It is might be due to deficiency of the iron and zinc in the soil. In order to correct deficiency of iron and zinc, field experiment was conducted with the objective to find out effectiveness of soil as well as foliar feeding of iron and Zn to groundnut crop for better growth and higher yield under North Gujarat conditions.

MATERIALS AND METHODS

The present experiment was conducted at Agricultural Research Station, Sardarkrushinagar Dantiwada Agricultural University, Aseda, Gujarat during *kharif* seasonof 2017. The soil of experimental site was loamy sand in texture with 7.64 pH, low in organic carbon (0.41 %), medium in available P_2O_5 (32.68 kg/ha) and higher in available K_2O (336 kg/ha). Groundnut variety Gujarat Groundnut -20 (GG 20) was sown at

[1,2] Assistant Research Scientist, Directorate of Research, [3]Assistant Research Scientist, Agricultural Research Station, S. D. Agricultural University, Aseda -385 535, Gujarat
Email : kiranrabari26@gmail.com

Table 1 Effect of micronutrient on plant population of groundnut.

Treatment	Plant population	
	20 DAS	At Harvest
T_1 – Water spray	5.73	5.13
T_2 – $FeSO_4$ @ 15 kg/ha	5.80	5.40
T_3 – $ZnSO_4$ @ 8 kg/ha	6.26	5.73
T_4 – Foliar spray of $FeSO_4$ @ 1 %	6.20	5.73
T_5 – Foliar spray of $ZnSO_4$ @ 0.5 %	6.00	5.63
T_6 – Foliar spray of $FeSO_4$ @ 1 % + Foliar spray of $ZnSO_4$ @ 0.5 %	6.33	5.80
T_7 – $FeSO_4$ @ 15 kg/ha + $ZnSO_4$ @ 8 kg/ha	5.26	4.73
T_8 – $FeSO_4$ @ 15 kg/ha + Foliar spray of $ZnSO_4$ @ 0.5 %	5.86	5.06
T_9 – $ZnSO_4$ @ 8 kg/ha + Foliar spray of $FeSO_4$ @ 1 %	6.60	5.40
T_{10} - Grade IV Multi micronutrient spray @ 1 %	6.33	5.60
SEm±	0.27	0.28
C.D. (P = 0.05)	0.80	0.84
C.V. (%)	7.71	9.00

Table 2 Effect of micronutrient on plant height (cm) of groundnut.

Treatment	Plant Height (cm)		
	60 DAS	90 DAS	At harvest
T_1 – Water spray	50.27	54.73	62.93
T_2 – FeSO4 @ 15 kg/ha	50.53	54.60	67.13
T_3 – ZnSO4 @ 8 kg/ha	55.20	59.20	83.40
T_4 – Foliar spray of FeSO4 @ 1 %	50.00	52.67	65.20
T_5 – Foliar spray of ZnSO4 @ 0.5 %	51.13	55.07	67.60
T_6 – Foliar spray of FeSO4 @ 1 % + Foliar spray of ZnSO4 @ 0.5 %	51.13	55.13	67.67
T_7 – FeSO4 @ 15 kg/ha + ZnSO4 @ 8 kg/ha	52.93	57.47	70.00
T_8 – FeSO4 @ 15 kg/ha + Foliar spray of ZnSO4 @ 0.5 %	49.20	53.20	62.73
T_9 – ZnSO4 @ 8 kg/ha + Foliar spray of FeSO4 @ 1 %	53.73	58.40	79.90
T_{10} - Grade IV Multi micronutrient spray @ 1 %	55.00	58.73	70.93
SEm±	4.32	3.94	4.07
C.D. (P = 0.05)	NS	NS	12.09
C.V. (%)	14.42	12.19	10.11

secondfortnight of Junewith line sowing method in randomized block design with nine treatments and three replications. The experimentconsist of ten treatments viz., T_1: Water spray, T_2: $FeSO_4$ @ 15 kg/ha, T_3:$ZnSO_4$ @ 8 kg/ha, T_4:Foliar Spray of $FeSO_4$ @ 1 %, T_5:Foliar spray of $ZnSO_4$ @ 0.5 %, T_6:Foliar spray of $FeSO_4$ @ 1 % + Foliar spray of $ZnSO_4$ @ 0.5 %, T_7:$FeSO_4$ @ 15 kg/ha + $ZnSO_4$ @ 8 kg/ha, T_8:$FeSO_4$ @ 15 kg/ha + Foliar spray of $ZnSO_4$ @ 0.5 %, T_9 – $ZnSO_4$ @ 8 kg/ha + Foliar spray of $FeSO_4$ @ 1 % and T_{10}- Grade IV Multi micronutrient Spray @ 1 %. Pre emergence herbicide (Pendimethalin @ 1 kg a.i / ha) was applied at next day after sowing (DAS) with knapsack sprayer fitted withflat-fan nozzle using 500 liter water/ha. The Recommended dose for groundnut was 25-50-00 NPK kg/ha. The half dose of N and full dose of P were applied through urea and diammonium

Table 3 Effect of micronutrient on pod yield (kg/ha) and haulm yield (kg/ha) of groundnut.

Treatment	Pod Yield (kg/ha)	Haulm yield (kg/ha)
T_1 – Water spray	2500	3856
T_2 – $FeSO_4$ @ 15 kg/ha	2678	4300
T_3 – $ZnSO_4$ @ 8 kg/ha	3878	5700
T_4 – Foliar spray of $FeSO_4$ @ 1 %	3567	4528
T_5 – Foliar spray of $ZnSO_4$ @ 0.5 %	3444	4089
T_6 – Foliar spray of $FeSO_4$ @ 1 % + Foliar spray of $ZnSO_4$ @ 0.5 %	3672	4989
T_7 – $FeSO_4$ @ 15 kg/ha + $ZnSO_4$ @ 8 kg/ha	3839	5406
T_8 – $FeSO_4$ @ 15 kg/ha + Foliar spray of $ZnSO_4$ @ 0.5 %	2989	3722
T_9 – $ZnSO_4$ @ 8 kg/ha + Foliar spray of $FeSO_4$ @ 1 %	4078	5489
T_{10} - Grade IV Multi micronutrient spray @ 1 %	3711	5072
SEm±	268.82	388.42
C.D. (P = 0.05)	798.58	1153.88
C.V. (%)	13.55	14.27

phosphate as basal at the time of sowing and remaining N was top dressed at 30 DAS.

RESULTS AND DISCUSSION

The result shown in table 1 indicates that effect of micronutrient on plant population at 20 DAS and at harvest was foundnon-significant.

Significantly higher plant height was observed under treatment T_3($ZnSO_4$ @ 8 kg/ha) (83.40 cm) and it was statistically at par with the treatment T_9 ($ZnSO_4$ @ 8 kg/ha + Foliar spray of $FeSO_4$ @ 1 %) (79.90 cm) at harvest. Whereas, at 60 and 90 DAS result reveals non-significant.Improvement in the growth attributes of groundnutwere observed by Sankar*et al* (1998) andRahevar*et al* (2015).

The result in above table indicated that effect of micronutrient on pod yield of groundnut found significant. Application of $ZnSO_4$ @ 8 kg/ha + Foliar spray of $FeSO_4$ @ 1 % recorded higher pod yield (4078 kg/ha) and remained at par with treatment T_3, T_4, T_5, T_6, T_7, and T_{10}. Haulm yield was recorded higher (5700 kg/ha) in the treatment T_3 ($ZnSO_4$ @ 8 kg/ha) and remained statistically at par with the treatment T_9, T_7, $T_{10}$and T_6.It might be due to improvement innutrient uptake particularly iron and zinc that increased transformation of photosyntheticactivity towards growing plant parts. Similar findingswere also observed by Rahevar*et al* (2015), Elayaraja D. (2014) and Gowthami andAnanda (2017).

REFERENCES

Elaraja D. (2014). Response of groundnut to zinc, boron and organics on the yield and nutrient availability in coastal sandy soil. *Inter. J. Chem.* **5**:16-23.

Rahevar, H.D., Patel, P.P., Patel, B.T., Joshi S.K. and Vaghela, S.J. (2015). Effect of FYM, iron and zinc on growth and yield of summer groundnut (*Arachishypogaea* L) under north gujaraty Agro climatic conditions. *Indian J.Agric.Res.* **49** (3): 294-296

Gowthami, S. S. and Ananda, N. (2017). Effect of zinc and iron fertilzers – fortification on growth, pod yield and zinc uptake of groundnut (Arachishypogaea L) genotypes. International Journal of Agriculture, Environment and Biotechnology. **10** (5): 575-580.

Sanker, RK., Chakraborty. A., and Bala, B. (1998). Analysis of growth and productivity of groundnut (*Arachishypogaea* L) in relation to micronutrient application. *Indian. J Pl Physio.* **3** (3): 234-236.

Singh, A.L. (2001). Yield losses in groundnut due to micronutrient deficiencies in calcareous soils of India. *Plant Nutrition*.838-839.

GAU Research Journal **43** (2) : 76-80 (July 2018)

Stability Analysis for Grain Yield and Harvest Index in Bread Wheat (*Triticum aestivum* L.)

J M PATEL[1*], S K PATEL[2], C.R.PATEL[3], A.A.PATEL[4], A.S.PATEL[5], M.S.PATEL[6], D. J. JOSHI[7] AND B.C.PATEL[8]

Wheat Research Station,
S. D. Agricultural University, Vijapur-382 870 (Gujarat)

Received : 30 June, 2018

Accepted: 17 July, 2018

ABSTRACT

Present study was conducted to assess the genetic diversity and stability for grain yield (GY) and harvest index under three varied environmental locations using 26 diverse wheat genotypes (including five checks i.e., GW 496,GW 322,GW 366,GW 451 and HI 1544) during *Rabi* 2016-2017. Pooled analysis of variance revealed highly significant variance due to environments for both the traits studied indicating differential response of the genotypes. The variance due to Genotype x environment was found highly significant only for harvest index. Genotype VA 2015-34 showed stable performance for harvest index across the environment whereas, VA 2005-26, VA 2015-45 and VA 2015-19 were found suitable for unfavorable environment for harvest index. VA 2015-34 may be further assessed for their genetic distance and diverse parents could be utilized in future wheat hybridization programme as well as a donor parents in multiple traits breeding programme to improve harvest index in wheat.

Key words: Bread wheat, Genotype-environment interactions, Multi-location testing, Harvest index

Wheat (*Triticum aestivum* L.) is the world's most important staple food crop as well as most consumed cereal. It is known as "king of cereals" as its cultivation is easier, ecologically suitable and contain high amount of nutrients. It compares well with other cereals in nutritive value. In India, it is the staple diet in the northern and central regions. It is cultivated on 15.4% of the arable land in the world in almost all countries, except the humid and high-temperature areas in the tropics and high-latitude environments. Accounting for a fifth of humanity's food, wheat is the second only to rice which provides 21% of the food calories and 20% of the protein for more than 4.5 billion people in 94 developing countries (Braun *et al.*, 2010).The harvest index (HI) was defined as ratio of economic yield to total aboveground biomas yield. Donald (1962). This "trait" was chosen because it represents plant efficiency in translocating nutritive matter from vegetative to generative plant part that can serve as useful indicator of productivity. Harvest index has been recommended as selection criterion for increasing yield of cereals (Dalal *et al.*, 1995). One of the possibilities in increasing of grain yield production can be to increase HI up to 0.50 or more at the level of biomass already produced by semidwarf wheat cultivars. When biological yield is more or less constant economic yield is proportional to HI and economic yield is in correlation with biomass yield, while biomass yield and HI are uncorrelated. Cultivars with improved harvest index expressed increase in physiological efficiency of nutrient re-utilisation, capacity to mobilize photosynthates and efficiency of their translocation from leaves and stem into grains . Some genotypes frequently show fluctuations in yield performance in different environments as a result of genotype-environment interactions (GxE).Thus, GxE interactions are of major consequence to the breeders in the process of evaluation of improving genotypes when genotypes are grown at multi-locations for testing their performance. However, their relative rankings do not remain the same; this could cause difficulties in demonstrating significant superiority of any genotype. The information about phenotypic stability could be useful for the selection of desirable genotypes for yield and quality traits as well as for

[1&6]Associate Research Scientist, [2&5]Assistant Research Scientist, [3&7]Agriculture Officer, [4]Research Scientist, S. D. Agricutural University, [8]Associate Research Scientist, Anand Agricutural University, Anand
*Email : dr.jmpatel63@gmail.com

breeding programme. A number of techniques have been used to interpret data from multi-environment trials (Eberhart and Russel, 1966), including GGE bi-plot analysis for effectively identifying mega-environments. Therefore, we need to have research programme which primarily focus to develop cultivars with high yield potential and consistent performance across the environments. Thus, the assessment of the nature and extent of GxE interaction and identification of phenotypically stable genotypes, showing low GxE interaction, becomes important. Therefore, the present study was conducted to identify stable wheat genotype for grain yield and harvest index.

MATERIALS AND METHODS

An experiment was conducted at three locations Wheat research station Vijapur and Sardarkrushinagar representing North Gujarat Agro climatic zone IV and Regional research station Anand representing middle Gujarat Agro climatic zone in rabi crop season 2016-17 using Randomised Complete Block Design with three replications. The material used in the present experiment comprises of twenty one advanced breeding lines along with five standard checks Recommended cultural practices were adopted to raise a good crop. Data were recorded for grain yield and harvest index according to standard procedures. Yield was taken from 4 m^2 plot (5.0 m length and 0.8 m width).

Statistical analysis: The mean values from each replication were subjected to statistical analysis using SAS computer software. The analysis of variance was carried out as per Panse and Sukhatme (1985). Stability parameters, were computed as per Eberhart and Russell (1966), (Singh and Chaudhary ,1985). Estimates of mean performance ($\bar{X}$), regression coefficient (bi) and deviations from regression (S^2di) were used to draw inferences on stability of genotypes.

RESULTS AND DISCUSSION

The location wise analysis of variance (Table 1) was significant for both the traits in all the locations (Vijapur,Sardarkrushinagar and Anand), suggesting sufficient variability in the present set of materials. The pooled analysis of variance concerning both the traits is presented in (Table 2). The variances due to genotypes were significant for grain yield per hectare, and harvest index indicated differential response of the genotypes selected for the present study. The variance due to environment was significant for both the traits indicated the distinct and differential effects of different environmental conditions. Similar results were also reported by Kumar *et al.*, (2014) for grain yield in wheat. The variance due to genotype x environment interaction was found significant at 5% level of significance for harvest index only sowing differential response of the varieties with different environments, so stability analysis was performed for harvest index only. Similar results were reported earlier by Krupal S. M. *et. al.*, (2018) for harvest index. The mean squares due to environment + (genotype x environment) interaction were significant for harvest index only which showed that genotypes were interacted considerably with environmental conditions that existed over different locations. The significant linear component of GxE interaction was also recorded for harvest index indicating differential response of the genotypes with in different environments (locations). Hence, it would be possible to predict the performance of genotypes over wide range of environments (multilocation) for harvest index only. Charan singh *et al.*, (2018) and Krupal S. M. *et. al.*, (2018) reported similar results for grain yield and harvest index respectively.

Stability analysis and identification of stable genotypes over locations: Eberhart and Russell (1966) emphasized the need of considering both linear (bi) and non-linear regression coefficient, i.e. deviation from regression (S^2di) components of G x E interactions to measure the stability of genotypes. The genotypes with lowest deviation around regression line (S^2di) were considered to be stable and vice-versa. Along with above measures, the highest mean performance was also considered as a requirement for identifying high grain yield and stability of genotypes. Thus, in the present investigation three measures, viz. higher mean performance, regression coefficient (bi=1) and deviation from regression ($S^2di=0$) were used to identify superior and stable genotypes. The stability analysis showed a wide range of adaptation and resilient performance of genotypes. The mean performance and estimates of stability parameters for both the traits are presented (Table 3). The mean harvest index ranged from 0.42 to 0.37 across the locations (environments). Considering high mean performance than population mean with stability parameters together, only one genotype VA-2015-34 was found desirable and exhibited stable performance across the locations for harvest index. Similar finding was reported by Kumar *et al.*, (2014).

Furthermore, the genotypes VA-2015-11, VA-2015-38 and VA 2015-41 were having higher mean grain yield than population mean and regression coefficient lesser than unity (b<1), hence this genotypes are specifically adapted to poor environmental location. The genotypes VA 2015-26, VA 2015-45 and VA 2015-19 having lower mean grain yield than the population mean also than all the three checks with unit regression (b=1), hence, this genotype are poorly adapted to all the environmental locations. The sensitivity of HI under environmental variation was noticed by Bedak *et al.,* (1999). Eberhart and Russell (1966), Lillimo *et al.* (2004) and Kumar *et al.* (2014) they also emphasized that genotypes with high mean performance and regression coefficient near to unity with non-significant deviations are desirable and gave stable performance across the environments. Based on the mean performance, regression coefficient (bi) values and deviation from regression values, some of the genotypes have been identified to suit with stability of performance under unfavorable environments in respect of harvest index. However, breeders must keep in mind that the assessments of stability depend on the sets of genotypes and environments studied.

Table 1 Location wise analysis of variance (ANOVA) for grain yield and harvest index in bread wheat

Source of variation	DF	Grain yield(Kg/ha)	Harvest Index
		A Location Vijapur	
Replication	2	308791.66	0.001
Treatment	25	577711.53*	0.003**
Error	50	196425.0	0.001
Total	77		
		B Location Sardarkrushinagar	
Replication	2	9075729.16	0.0
Treatment	25	1394132.051*	0.001**
Error	50	348054.16	0.0
Total	77		
		C Location Anand	
Replication	2	144531.54	0.001
Treatment	25	1052377.82*	0.004*
Error	50	348054.16	0.002
Total	77		

* and ** indicates 5 % and 1 % level of significance respectively

Table 2 Pooled analysis of variance (ANOVA) for grain yield and harvest index

Source of variation	D F	Grain yield (Kg/ha)	Harvest Index (%)
Genotypes	25	599047.70*	0.001*
Environments	2	22964874.4**	0.063*
G x E	50	204513.049 NS	0.001*
E+ (G x E)	52	1079911.56	0.004*
Environments(linear)	1	45929748.94**	0.126*
G x E (linear)	25	172574.53 NS	0.001
Pooled deviation	26	227356.966	0.001
Pooled error	150	341006.45	0.001
Total	77		

* and ** indicates 5 % and 1 % level of significance respectively

Table 3 Stability analysis for harvest index in wheat

Sr. No.	Genotype	$\bar{X}$	bi	S^2di
1	VA 2015-09	0.40	-0.02	0.007
2	VA 2015-11	0.41	0.82	0.001
3	VA 2015-14	0.40	0.41	0.002
4	VA 2015-18	0.40	1.60	0.002
5	VA 2015-21	0.41	0.54	0.002
6	VA 2015-25	0.39	1.61	-0.000
7	VA 2015-26	0.40	1.07	-0.000
8	VA 2015-30	0.40	0.94	0.002
9	VA 2015-34	0.42	1.11	-0.000
10	VA 2015-38	0.42	0.67	0.001
11	VA 2015-41	0.41	0.67	0.002
12	VA 2015-43	0.41	0.60	-0.000
13	VA 2015-45	0.38	0.91	0.000
14	VA 2015-46	0.39	0.72	0.000
15	J 15-06	0.38	1.45	0.001
16	J 15-22	0.41	0.68	0.001
17	J 15-27	0.37	1.47	0.002
18	J 15-31	0.39	1.29	0.000
19	J 15-29	0.38	1.03	0.001
20	J 15-45	0.40	1.14	0.002
21	LOK-73	0.40	1.56	0.003
22	GW 496©	0.38	0.90	0.002
23	GW 322©	0.42	1.24	-0.000
24	GW 366 ©	0.38	1.15	-0.000
25	GW 451 ©	0.41	1.02	-0.000
26	HI 1544©	0.40	1.33	-0.000

Pooled Mean = 0.40, S.E of Mean= 0.03, Mean of B=1.00 S.E. of b= 0.55

REFERENCES

Bedak, N., Yildrim, Z., Yildrim, M.B. 1999. Agronomic performance of tall and semi dwarf genotypes of durum wheat. *Turkish Journal for Field Crops*, **4** (1): 16-20.

Braun, HJ, Atlin G, Payne T. 2010. Multi-location testing as a tool to identify plant response to global climate change. In: Reynolds, CRP (ed) Climate change and crop production, CABI, London, UK.Charan Singh, Puja Srivastava, Achla Sharma, Pradeep Kumar, Praveen Chhunej,

V.S. Sohu and N.S. Bains 2018. Stability analysis for grain yield and some quality traits in bread wheat (Triticum aestivum L.) *Journal of Applied and Natural Science* **10** (1): 466 – 474.

Dalal, S. K., Yunus, M., Singh, S. 1995. Comparison of some selection criteria in two spring wheat crosses. *Indian Journal Genetics & Plant Breeding*. **55**. 90-93.

Donald, C.M. (1962): In search of yield. *Australian Journal Agriculture Research*. **28**. 171-178.

Eberhart, S.A. and Russell, R.A. 1966. Stability parameters for comparing varieties. *Crop Science*. **6** :36-40.

Kumar, V., Tyagi, B.S., Verma, A. and Sharma, I. 2014. Stability analysis for grain yield and its components under different moisture regimes in bread wheat (Triticum aestivum). *Indian Journal of Agricultural Sciences*, **84** (8): 931-6.

Krupal S. M., Rathod S. T. and Kamble B. G 2018. Stability analysis for yield and quality traits in wheat (Triticum aestivum L.) *Electronic Journal of Plant Breeding*, **9** (1) : 160 - 168

Lillimo, M., Ginkel, M., Trethowan, R.M., Hernandez, E. and Rajaram, S. (2004). Associations among international CIMMYT bread wheat yield testing locations inhigh rainfall areas and their implications for wheat breeding. *Crop Science*, **44**: 1163-9.

Panse, V.C. and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers.Indian Council of Agricultural Research, New Delhi.

Singh, R.K. and Chaudhary, B.D. 1985. Biometrical Methods in Quantitative Genetics Analysis, P 318.Kalyani Publishers, Ludhiana.

GAU Research Journal **43** (2) : 81-86 (July 2018)

Trend and growth rate of Bajra crop in Gujarat state

A. D. KALOLA[1*] AND R.L. YADAV[2]

Department of Agricultural Statistics, B. A. College of Agriculture,
Anand Agricultural University, Anand- 388110 (Gujarat)

Received : 08 August, 2017 Accepted: 18 July, 2018

ABSTRACT

The trend of area, production and productivity for bajra important factor for successful planning and decision making for the policy makers. Forecasting also plays a crucial role in agricultural, business, industrial, government and institutional planning because many important decisions depend on the anticipated future values of certain variables. The time-series data from 1960-61 to 2012-13 on area, production and productivity of bajra crop for Gujarat were collected from Directorate of Agriculture, Gujarat state, Gandhinagar. The present study was made through fitting of different linear, non-linear and time series models viz., Linear, Quadratic, Cubic, Exponential, Gompertz and Autoregressive Integrated Moving Average (ARIMA), along with their instability index.

The results revealed that among different polynomial models for area, productivity of bajra, maximum adjusted R^2 value of 56.00 per cent and 72.61 per cent was observed in case of the exponential model and third degree polynomial model respectively, in case of ARIMA models, ARIMA (1,1,0), ARIMA (2,1,0)and ARIMA (3,1,0) as the candidate models and based on R^2 and RMSE values, ARIMA (3,1,0) is the best among ARIMA tested models in area and productivity of bajra crop. The compound growth rates for area, production and productivity were -3.62, 1.86 and 5.44 % annually in bajra crop, respectively. The instability indices area, production and productivity were observed 26.02, 27.63 and 22.34 in bajra crop, respectively. The coefficient of variation for area, production and productivity were observed 39.22, 29.35 and 39.57% in bajra crop, respectively.

Key words: ARIMA, polynomial models, compound growth rates, instability indices, trend

Bajra is the second most important millet which is used as food in drier part of the country. It is also widely used as fodder as its stalks are fed to cattle. In India, agriculture and other allied activities contribute significantly to the Gross Domestic Product (GDP). Last four decades have been an era of revolution in agriculture, especially in the field of crop production, which has brought a spectacular change in the existing cropping systems. The population of country is growing at an enormous speed and therefore, it is of paramount importance to achieve an enhanced rate of productivity of crops in order to keep pace with the population growth through better planning for optimum utilization of scare inputs such as land, capital, human mechanization and other natural resources. Since, agriculture is a vital sector of economy, even among highly industrialized countries, much care and expenditure are devoted to compilation of agricultural statistics.

In the year 2012-13, in Gujarat state production of bajra was 10.4 lakh tonnes and the productivity was 1743 kg/ha (Anon, 2012-13). Crop is severely affected with abiotic factors e.g. rainfall, humidity and other environmental factors and biotic stresses such as diseases and pest infestation which also indirectly depends upon environment. The observation on these time series variables are varying in some pattern due to the existence of artificial and natural forces. The policymakers, while formulating policies have to keep in mind the shifting pattern and stability of crops for formulating the strategic all round developmental plan for zone, state or a country. The present investigation was therefore undertaken, to study the fluctuation in area, production and productivity for bajra crop through different models viz., Linear, Quadratic, Cubic, Exponential, Gompertz and Autoregressive Integrated Moving Average (ARIMA), along with their instability index.

[1]Associate Professor, [2]Post-Graduate Student
*Email : adkalola@aau.in

MATERIALS AND METHODS

The time series data on area, production and productivity had some missing observations. Therefore, the simple moving average concept was utilized to find out missing observations. Three year simple moving averaging technique was found best for missing values during model development stage (Boken, 2000). There was a severe drought caused by the failure of south-west monsoon over major parts of India during the year 1987 (Anon., 1990). Therefore, the observations of area, production and productivity of the year 1987-88 for bajra the crop, were excluded from analysis of trends and compound growth rates. The following models were fitted for area, production and productivity of bajra crop for the purpose.

Model No.	Model	Name of the Model
I.	$Y=A+B*X$	Linear equation
II.	$Y=A+B*X+C*X^2$	Second degree polynomial
III.	$Y=A+B*X+C*X^2+D*X^3$	Third degree polynomial
IV.	$Y=A*\exp(B*X)$	Exponential model
V.	$Y=A*\exp(-\exp(B-C*X))$	Gompertz model

Where, Y is the area, production and productivity and X is the time points.

Among linear and non-linear models, the model having highest adjusted R^2 with significant F value, which satisfies test for goodness of fit was selected. In the case of time-series models at first the conditions of stationarity was checked and then different ARIMA models were tried. Among the ARIMA models, the model having less Akaike's Information Criterion (AIC) and Bayesian Information Criterions (BIC) as well as the significant values of estimated parameters was considered as the best fitted model. The selected model was further tested for randomness and normality of error terms. In case of more than one model having the good fit for the data, the best model was selected having lower values of Mean Absolute Error (MAE) and Root Mean Square Error (RMSE).

The compound growth rate (CGR) was calculated by fitting the exponential function given below.

$$Y = a*b^X \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, Y = Area, Production and Productivity

a=Constant,

b = Regression coefficient,

X= Time variable

Thus natural log on both the sides of equation (1) was taken to convert it in to linear form.

$$\text{Log } Y = \log a + X \log b \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

CGR (%) was worked out by using following formula.

$$\text{CGR } (\%) = (\text{Anti log of } b - 1) * 100 \quad \ldots\ldots\ldots (3)$$

The simple coefficient of variation (CV %) often contains the trend component and thus over estimates the level of instability in time series data characterized by long-term trends. To overcome this problem, this study used the Cuddy Della Valle index which corrects the CV by:

$$\text{Instability Index} = (\text{CV } \%)\sqrt{(1 - R^2)} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Where, CV% = Coefficient of variation

R^2 = Coefficient of determination from a time trend regression adjusted by the number of degrees of freedom.

RESULTS AND DISCUSSION

Trends in area, production and productivity of bajra crop

Different linear, non-linear and time-series models were fitted to the area, production and productivity data of bajra crop for Gujarat as a whole. The characteristics of different fitted linear, non-linear (Table 1) and time-series (Table 2) models are presented. The findings are discussed in sequence as under.

Trends in area based on linear and non-linear models

The results presented in Table 1 for area under cultivation of bajra crop revealed that among the five fitted linear and non-linear models, the exponential model have maximum adjusted R^2 value of 56.00 per cent. The Shapiro-Wilks test (test for normality) was significant for all the model indicating that the residuals were not normally distributed. The run test (test for randomness) was significant for all the models, indicating that the residuals were correlated. Hence based on R^2 value, exponential model was found suitable to fit the trends in area under the bajra crop. Gompertz non-linear model could not be fitted due to the fact that the parameters were found to be non-

convergent in area, production and productivity of bajra.

Trends in area based on time-series models

Autocorrelation up to fourteen lags were worked out for fitting the ARIMA models. Since the computed autocorrelations gk values did not tail off towards zero, the original series was found to be non-stationary. The non-stationarity was also confirmed by examining the realization visually. It was found that the mean and variance were changing over the time. However, the stationarity was achieved by differencing one time i.e., d=1. The pattern of autocorrelations k showed damped sine-wave and significant partial autocorrelations fkk at first and second lags. This suggested consideration of ARIMA (1,1,0), ARIMA (2,1,0) and ARIMA (3,1,0) as the candidate models and the results are given in Table 2. The Shapiro-Wilks test (test for normality) was significant for all the ARIMA models indicating that the residuals were not normally distributed. Therefore, based on R^2 and RMSE values, ARIMA (3,1,0) is the best among ARIMA tested models.

Trends in production based on linear and non-linear models

The data presented in Table 1 for production of the bajra crop revealed that the third degree polynomial model have showed maximum adjusted R^2 value of 19.43 per cent.

Trends in production based on time-series models

For fitting the ARIMA time-series models the autocorrelation up to fourteen lags were worked out. Since the computed autocorrelations k values did not tail off towards zero, the original series was found to be non-stationary. The non-stationarity was also confirmed by examining the realization visually. It was observed that the mean and variance were changing over the time. However, the stationarity was achieved by differencing one time i.e., d=1. The pattern of autocorrelations gk showed damped sine-wave and significant partial autocorrelations fkk at second and third lags. This suggested consideration of ARIMA (1,1,0), ARIMA (2,1,0) and ARIMA (3,1,0) as the candidate models and the results are given in Table 2. Since all the suggested ARIMA model have very low R^2 values, hence none of the ARIMA model was found suitable to fit the trends in production of bajra crop.

Trends in productivity based on linear and non-linear models

Productivity data of bajra crop presented in the Table 1 (Fig. 1) revealed that among the five fitted models, the maximum adjusted R^2 value of 72.60 per cent was observed in case of third degree polynomial model. The third degree polynomial model also showed comparatively lower values of root mean square (186.137) and mean absolute (149.934) error values in comparison to that of in other linear and non-linear models. The Shapiro-Wilks test (test for normality) was not significant for all the models indicating that the residuals were normally distributed. The run test was also not significant for third degree polynomial model indicating that the residuals were not correlated. Since all the partial regression coefficient was significant, and not significant S-W and run test, the third degree polynomial model was found suitable to fit the trends in productivity of the bajra crop.

$Y=252.741^{**}+59.915^{**}X-2.097^{*}X^2+0.028^{**}X^3$

($R^2= 72.60^{**}$ %)

Vaishnav and Dixit (1998) used polynomial models to study trends of crop productivity in long term experiment.

Trends in productivity based on time-series models

In ARIMA time-series methodology the autocorrelation up to fourteen lags were worked out. Since the computed autocorrelations gk values did not tail off towards zero, the original series was found to be non-stationary. The non-stationarity was also confirmed by examining the realization visually. It was found that the mean and variance were changing over the time. However, the stationarity was achieved by differencing one time i.e., d=1. The pattern of autocorrelations gk showed damped sine-wave and significant partial autocorrelations fkk at second and third lags. This suggested consideration of ARIMA (1,1,0), ARIMA (2,1,0) and ARIMA (3,1,0) as the candidate models and the results are given in Table 2. Since the AIC (704.082) and BIC (711.809) in ARIMA (3,1,0) were found smaller than that of in other two ARIMA models. The assumptions of residuals i.e. normality and independence of residuals were tested by Shapiro-Wilks test and Box-Ljung (BLQ) test indicated that ARIMA (3,1,0) model satisfied the assumption of normality and independence of residuals. Thus, the ARIMA (3,1,0) model was found suitable to fit the trends in productivity of the bajra crop for Gujarat as a whole with 62.92 per cent R^2 value. Sridhar *et al.* (1994) developed ARIMA model using 35 years district wise yield data of wheat for seven districts in Madhya Pradesh. They observed that forecasts were 15.8, 10.0 and 6.0% lower than post-harvest estimates of

Table 1: Characteristics of fitted linear and non-linear models for area, production and productivity of bajra crop in Gujarat

Aspects	Model	Regression constant	Partial regression coefficient			Goodness of fit				
		a	b	c	d	Adj. R^2 (%)	S-W Test	Run Test (|Z|)	RMSE	MAE
Area	Linear	18290.403**	-193.062**	-	-	30.70**	0.468**	3.361**	4218.073	1880.864
	Quadratic	15838.723**	79.347	-5.140	-	33.54**	0.487**	4.762**	4089.137	2012.654
	Cubic	14092.120**	456.940	-22.782	0.222	33.56**	0.488**	2.521*	4046.617	1836.143
	Exponential	18987.937**	-0.016**	-	-	56.00**	0.492**	3.361**	4326.101	1885.647
	Gompertz	-	-	-	-	-	-	-	-	-
Production	Linear	9253.414**	66.783*	-	-	7.97*	0.948*	1.120	3043.756	2628.080
	Quadratic	7232.986**	291.275*	-4.236*	-	13.47**	0.966	0.840	2921.819	2447.792
	Cubic	4661.136*	847.276**	-30.214*	0.327*	19.43**	0.972	1.120	2790.513	2371.142
	Exponential	8610.451*	0.008**	-	-	11.41**	0.948*	1.120	3097.410	2606.423
	Gompertz	-	-	-	-	-	-	-	-	-
Productivity	Linear	397.242**	20.308**	-	-	68.51**	0.987	0.840	203.651	164.196
	Quadratic	476.875**	11.460	0.167	-	68.75**	0.984	0.280	200.857	166.362
	Cubic	252.741*	59.915**	-2.097*	0.028**	72.60**	0.977	1.120	186.137	149.934
	Exponential	465.609**	0.023**	-	-	68.14**	0.982	0.280	200.775	168.970
	Gompertz	-	-	-	-	-	-	-	-	-

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

Table 2: Characteristics of fitted time-series models for area, production and productivity of bajra crop in Gujarat

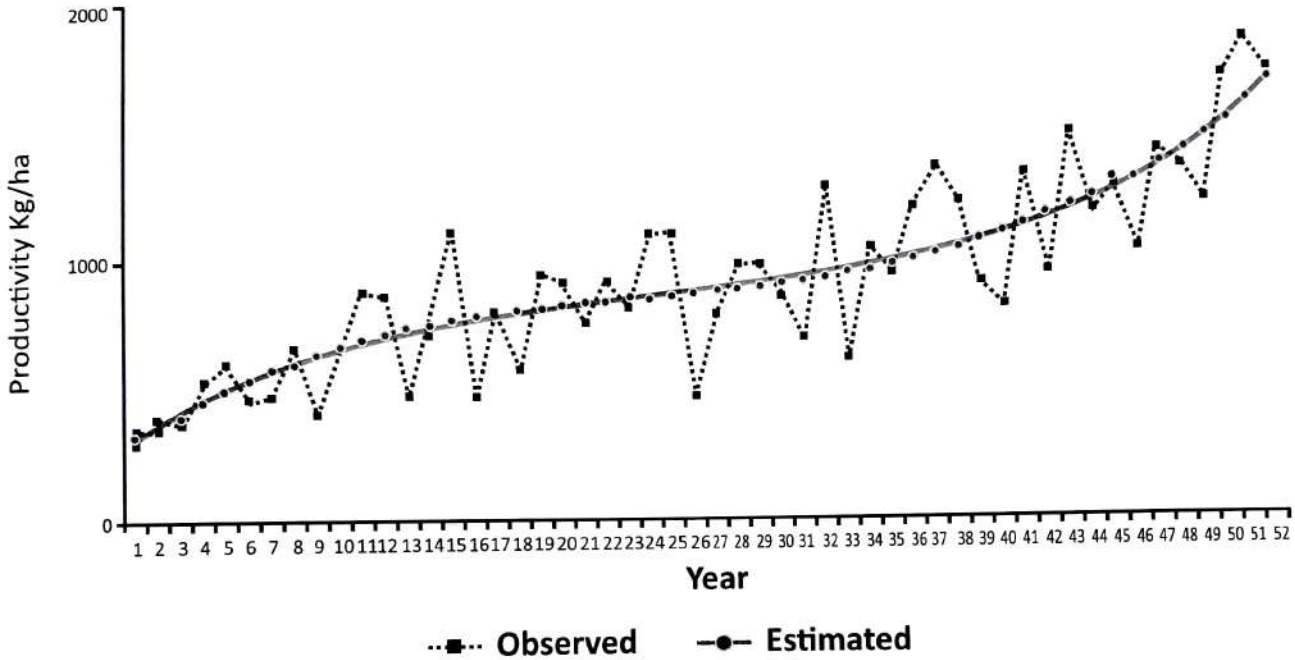
Aspects	ARIMA p,d,q	Constant	AR (ϕ) ϕ_1	ϕ_2	ϕ_3	ϕ_4 / ϕ_5	MA ( ) θ_1	AIC Test	BIC Test	S-W Test	BLQ	RMSE	R^2(%)
Area	(1,1,0)	191.263	-0.449**	-	-	-	-	1017.32	1021.18	0.526**	8.558	5125.48	7.30
	(2,1,0)	188.153	-0.576**	-0.272	-	-	-	1015.38	1021.17	0.544**	6.762	4969.73	14.66
	(3,1,0)	196.384	-0.642**	-0.40*	-0.228	-	-	1014.72	1022.44	0.525**	5.177	4876.50	19.58
Production	(1,1,0)	462.294	-0.469**	-	-	-	-	986.498	990.362	0.981	38.014**	3784.46	0.00
	(2,1,0)	428.351	-0.650**	-0.375**	-	-	-	980.911	986.707	0.980	32.313**	3534.66	0.00
	(3,1,0)	425.967	-0.780**	-0.617**	-0.373*	-	-	975.996	983.723	0.980	16.586	3310.77	0.00
Productivity	(1,1,0)	11.251	-0.533**	-	-	-	-	711.314	715.177	0.987	30.711*	254.849	52.89
	(2,1,0)	10.352	-0.713**	-0.326*	-	-	-	707.612	713.407	0.971	25.364	242.467	58.25
	(3,1,0)	10.961	-0.823**	-0.570**	-0.332*	-	-	704.082	711.809	0.972	19.727	230.961	62.92

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

Table 3 Compound growth rates and instability indices of area, production and productivity of bajra in Gujarat state

Characters	CGR (% p.a.)	Instability Index	CV%	R^2
Area	-3.62*	26.02	39.22	0.5600
Production	1.86*	27.63	29.35	0.1141
Productivity	5.44*	22.34	39.57	0.6814

Fig.1 Trends in productivity of bajra crop for Gujarat based on cubic regression model



production, acreage and yield, respectively. Rajarathinam and Dixit (2007) used time-series model to study the trend in groundnut yield in long-term fertilizer experiment. Among the families' of ARIMA models, ARIMA (1,1,0) model was found to be best fitted trend equation. Padhan (2012) fitted ARIMA models for productivity of different crops in India for the data from 1950 to 2010. He fitted ARIMA (1,1,0) with Adjusted R^2 0.16 for wheat crop.

Compound growth rates and Instability indices

The compound growth rates and instability indices were calculated and are given in Table 3.The results revealed that the area of bajra crop decreased with as an annual rate of -3.62% per annum with medium instability index. During the study period the rate of increase in production was 1.86% per annum as a result of improvement in bajra productivity at an average rate of 5.44% per annum with in the category of positive and significant growth rates with medium instability index. The instability indices area, production and productivity were observed 26.02, 27.63 and 22.34 in bajra crop, respectively. The coefficient of variation for area, production and productivity were observed 39.22, 29.35 and 39.57% in bajra crop, respectively.

Kalola *et al.* (1995) studied trends and variability in area, production and productivity of tobacco in Gujarat. Hasija *et al.* (2004) analysed trends in area, production and productivity of wheat in Haryana. The results showed that in eastern zone, the area increased at an average annual growth rate of 6.23, 2.42 and 0.28 per cent, under period I, II and III, respectively, while in western zone, the area had increased with an annual growth rate of 5.94, 3.22 and 2.21 per cent respectively under the three periods. The highest increase in production growth was under period I in

eastern zone (10.04%) followed by period I in western zone (8.00%).

REFERENCES

Anonymous (1990). The drought of 1987, Response and management. Department of Agriculture and Co- operation, ministry of Agriculture, GOI, New Delhi. 1990, **1**.

Anonymous (2012-13). District-wise area, production and yield of important food and non-food crops in Gujarat state. Directorate of Agriculture, Gujarat state, Gandhinagar.

Boken, V. K. (2000). Forecasting spring wheat using time series analysis: A case study for the Canadian prairies. *Agronomy Journal*, **92** (6) : 1047-1053.

Hasija, R. C. ; Kausik, L. S.; Suhag, K. S.and Aneja, D. R. (2004). Growth and trend in area, production and productivity of wheat in Hariyana. *Agriculture Science Digest.* **24** (2) : 91-94.

Kalola, A. D.; Patel, J. S. and Lakshminarayana, R. (1995). Trends and variability in area, production and productivity of tobacco in Gujarat. *Tobacco Development Journal.* **3** (4) : 37-43.

Padhan, P. C. (2012). Applications of ARIMA model for forecasting agricultural productivity in India. *Journal of Agriculture and Social Science.* **8** : 50-56.

Rajarathinam, A. and Dixit, S.K. (2007). Fitting of groundnut yield trends in long term fertilizer experiment. *Crop Res.,* **34** (1, 2 & 3): 92-96.

Sridhar, V. N. ; Dadhwal, V. K.; Chaudhari, K. N.; Sharma, R.; Bairagi, G.D. and Sharma A.K. (1994). Wheat production forecasting for a predominantly unirrigated region in Madhya Pradesh (India). *Int. J. of Remote Sensin.*, **15** (6): 1307-1316.

Vaishnav, P. R. and Dixit, S. K. (1998). Trend of groundnut productivity in long term experiment. *GAU Res. J.* , **24** (1): 73-82.

GAU Research Journal **43** (2) : 87-89 (July 2018)

Identification of prevalent races of black or stem rust of Wheat in North Gujarat

S. I. PATEL[1], ELANGBAM PREMABATI DEVI[2] AND A. A. PATEL[3]

Wheat Research Station,
S. D. Agricultural University, Vijapur-382 870 (Gujarat)

Received : 30 June, 2018 Accepted: 18 July, 2018

ABSTRACT

Emergence of new highly virulent races of wheat rust due to mutation inside pathogen has rendered many resistant varieties of wheat into susceptible one with passing of time. Earlier report for the breakdown of stripe rust resistance against *Yr9*, virulence of *Sr24, Sr25* and *Sr31* for black or stem rust has posed a serious challenge while combating rust pathogens. The pattern of dynamism of black or stem rust races during the last six years (2011-12 to 2016-17) has revealed that two races i.e. 11 and 40A were predominantly well established in climatic conditions of North Gujarat while another two races i.e. 40-1 and 40-3 were detected only during 2013-14.

Key words: Black or stem rust, Race, Ug99, Virulence

Black or stem rust of wheat incited by *Puccinia graminis* f.sp.*tritici* Eriks. and E. Henn. is most important disease in Central and Peninsular Southern parts of India where the warmer temperature prevails during growing season of wheat. Generally new races in wheat rusts evolved through sexual reproduction in the presence of alternate hosts. However, in absence of functional alternate hosts in India, new virulent forms mostly arise through mutation only. But in some cases, somatic hybridization is also responsible to give rise to new races (Bhardwaj *et al.*, 2006). Due to their air borne nature of spore dispersal mechanism and its ability to rapid multiplication of inoculum, local races can migrate to other areas and quickly become regionally and often globally predominant races with advancement of time (Saleem *et al.*, 2015). Races 79G31 virulent on *Sr5, Sr11* in 1962, 16G2 with virulence on *Sr8b* in 1959, 73G7 with virulence for *Sr28* and *Sr30* in 1954, 7G11 in 1952, 36G2 in 1961 and 7G43 in 1962 were identified. Cultivation of CIMMYT wheat like Chhoti Lerma in Nilgiri hills led to selection of races such as 62G29 (Bhardwaj *et al.*, 1990). Race 62G29-1 with virulence for *Sr24* was detected in 1989, much ahead of release of variety HW 2004 (*Sr24*) in 1995 (Bhardwaj *et al.*, 1990). Recently *Sr25* has also become susceptible to black or stem rust of wheat (Jain *et al.*, 2009). Break down of yellow rust resistance *Yr9* in 1986 in Western Asia and subsequently in other parts of the world was a serious challenge to combat rust pathogen. The widespread cultivation of varieties with 1B/1R translocations led to develop another races designated as 46S119 with virulence for *Yr9* in 1996 and on *Yr9* and *Yr27* in 2001 (Prashar *et al.*, 2007) which have been rendered susceptible in India. Another report of virulence on *Sr31* designated as Ug99 was identified from Uganda (Pretorius *et al.*, 2000). Due to evolution and dispersal of highly virulent races of black rust under Ug99 group has once again become a threat to global wheat production. This gene was known to confer black or stem rust resistance in wheat materials covering more than 40% area world over. Fortunately, so far *Sr31* types of virulence have not been reported in India suggesting that it may not be a threat for the Western Asia (Nagarajan, 2012) but occurrence of independent mutation for *Sr31* locally in the much prone areas of Peninsular and Central zone of India can not be ruled out (Bhardwaj *et al.*, 2014). Many useful resistance genes like *Lr26, Lr9, Lr19* and *Lr28* have been rendered susceptible over the years (Nayar *et al.*, 1991, 2003; Bhardwaj *et al.*, 2005, 2010). Though the new races evolved through the gain in virulence, however, recently loss of virulence has been recorded on *Lr20, Lr2a* and *Lr2c* (Bhardwaj *et al.*, 2010; Bhardwaj, 2013). In recent surveys, 37

[1]Associate Research Scientist, [2]Assistant Research Scientist, [3]Research Scientist
*Email : sipatel@sdau.edu.in

races have been reported to occur in *Puccinia triticina* during 2009-2013 (Bhardwaj *et al.*, 2016). Thus, there is a need for proper investigation for the distributional pattern of races of black or stem rust which will be helpful for mitigating the disease outbreak well in time. Hence, the present study was conducted to identify the predominant races prevalent in North Gujarat conditions and also to detect any emergence of new race of black or stem rust of wheat.

MATERIALS AND METHODS

Pathogen of black rust is dynamic in nature and evinces innumerable oddities. So, the pathogen is known to have many races of various degree of virulence and emergence of new race by mutation generally renders resistant variety to become susceptible. Hence, dynamism of races has tangible repercussions. Every year the rust inoculum comprising four races of black rust i.e. 11, 40-A, 40-1 and 40-3 were procured from Regional Station, Indian Institute of Wheat and Barley Research, Flowerdale, Shimla for the creation of artificial epiphytotic condition in screening programme of different nursery against black or stem rust of wheat under pathological trials at Wheat Research station, SDAU, Vijapur. The inoculum were multiplied in infectors which were sown in all the borders of pathological trials for screening programme. In order to monitor the variability in rust races and their distribution as well as to countercheck the emergence of new race periodic rust samples were randomly collected through mobile surveys depending upon location and transportation facility. The samples were collected from regular crop as well as from off-type plants in regular crops as they also serve as source of inoculum. The samples showing typical rust symptoms of black or stem rust collected from different locations were brought to the laboratory. Samples of those entries showing more than 40 per cent severity of black or stem rust from screening programme of different nurseries against rust of wheat under pathological trials under artificially created epiphytotic conditions were also collected and brought to the laboratory. Then, small bits of each black rust infected sample were dried overnight at room temperature followed by wrapping in paper envelope and information *viz.*, name of person who collected the sample, type of rust, date and place of collection, details of host/variety, *etc.* were mentioned on each sample. Later on samples were sent to Regional Station, Indian Institute of Wheat and Barley Research, Flowerdale, Shimla for race analysis.

RESULTS AND DISCUSSION

Out of ninety six samples analyzed in last six years for black or stem rust, primarily four races were identified, but majority of them were identified as races 11 and 40-A. This suggested that these two races i.e. 11(79G31) and 40-A (62G29) had developed and well established in climatic conditions of North Gujarat. While two races 40-1 (62G29-1) and 40-3 (127G29) were detected only during 2013-14. This clearly indicated that these two races could not be able to establish in climatic conditions of North Gujarat. But fortunately so far, no any new virulent race of black rust had been reported from Gujarat including Ug99 which is a great concern of threat in global wheat production (Table 1). Similar findings were also reported by Prasad *et al.* (2017) where they observed population differentiation of brown rust of wheat in South Asia and suggested that races 12-1, 12-3, 12-6, 12-7, and 12-8 shared more than 80 per cent similarity. Likewise races 77-2, 77-3, 77-6, 77-A and 77-A-1 shared more than 70 per cent similarity, which indicated that they might have evolved from genetically similar ancestors as reported by Bhardwaj (2012) and concluded that high diversity among the races might be due to evolution and mutation in the pathogens along with long term continuous cultivation of same wheat varieties in different wheat growing zones of the country. Moreover, three brown rust races 12-2, 77-5 and 104-2 were identified in more than 86 per cent out of total 622 samples analysed from fourteen states of the country (Bhardwaj *et al.*, 2006).

ACKNOWLEDGEMENT

The authors are thankful to Regional Station, IIWBR, Flowerdale, Shimla for their administrative support and co-operation for race analysis of black or stem rust.

REFERENCES

Bhardwaj, S. C. 2012. Wheat rust pathotypes in Indian subcontinent then and now. In Wheat-Productivity enhancement under changing climate (eds Singh, S. S. *et al.*), Narosa Publishing House, New Delhi, India,pp.227-238.

Bhardwaj, S. C. 2013. *Puccinia Triticum* interaction: An update. *Indian Phytopathology*. **66**:14-19.

Table 1 Status of black or stem rust races distribution in Gujarat during last six years

S.N.	Year	No. of isolate analyzed	Races identified			
			11 (79G31)	40A (62G29)	40-1 (62G29-1)	40-3 (127G29)
1.	2011-12	8	—	8	—	—
2.	2012-13	15	15	—	—	—
3.	2013-14	8	1	5	1	1
4.	2014-15	26	24	2	—	—
5.	2015-16	17	17	—	—	—
6.	2016-17	22	22			
Total	96	78	15	1	1	

Bhardwaj, S.C., Prashar, M., Jain, S.K., Kumar, S., Sharma, Y.P., Sivasamy, M. and Kalappanvar, I.K. 2010. Virulence on *Lr28* in wheat and its relation to prevalent pathotypes in India. *Cereal Research Communications*. **38**:83-89.

Bhardwaj, S.C., Prashar, M., Kumar, S. and Datta, D. 2006. Virulence and diversity of *Puccinia triticina* on wheat in India during 2002-04. *Indian Journal of Agricultural Sci*ence. **76**:302-306.

Bhardwaj, S.C., Nayar, S.K., Prashar, M., Kumar, J., Menon, M.K. and Singh, S.B. 1990. A pathotype of *Puccinia graminis* f.sp. *tritici* on *Sr24* in India. *Cereal Rusts and Powdery Mildews Bulletin*. **18**:35-38.

Bhardwaj, S.C., Prashar, M., Kumar, S., Jain, S.K. and Datta, D. 2005. *Lr19* resistance in wheat becomes susceptible to *Puccinia triticina* in India. *Plant Disease*. **89**:1360.

Bhardwaj, S.C., Prashar, M., Kumar, S., Gangwar, O.P., Gupta, N., Prasad, P. and Khan, H. 2016. Patterns of physiologic diversity of *Puccinia triticina* on wheat in Indian subcontinent during 2008-2013. *Indian Journal of Agricultural Sci*ence. **86**:55-64.

Bhardwaj, S.C., Prashar, M. and Prasad, P. 2014. Ug99 future challenges. In: A. Goyal and Manoharachary C (eds.), Future challenges in crop protection against fungal pathogens, fungal biology. Springer Science and Business Media, New York, pp. 231-248.

Jain, S.K., Prashar, M., Bhardwaj, S.C., Singh, S.B. and Sharma, Y. P. 2009. Emergence of virulence to *Sr25* of *Puccinia graminis tritici* on wheat in India. *Plant Disease*. **93**:840.

Nagarajan, S. 2012. Is *Puccinia graminis* f.sp. *tritici* virulence Ug99 a threat to wheat production in North Western Plain Zone of India. *Indian Phytopathplogy*. **65**:219-226.

Nayar, S.K., Bhardwaj, S.C. and Prashar, M. 2003. Slow rusting in wheat. *Annual Review of Plant Pathology*. **2**:271-286.

Nayar, S.K., Prashar, M., Kumar, J., Bhardwaj, S.C. and Bhatnagar, R. 1991. Pathotypes of *Puccinia recondita* f.sp. *tritici* virulent on *Lr26* (1BL.1RS translocation) in India. *Cereal Research Communications*. **19**:327-331.

Prasad, P., Bhardwaj, S. C., Gangwar, O. P. and Kumar, S., Khan, H., Kumar, S., Rawal, H. C. and Sharma, T. R. 2017. Population differentiation of wheat leaf rust fungus *Puccinia triticina* in South Asia. *Current Science*. **112** (10):2073-2084.

Prashar, M., Bhardwaj, S.C., Jain, S.K. and Datta, D. 2007. Pathotypic evolution in *Puccinia striiformis* in India during 1995-2004. *Australian Journal of Agricultural Research*. **58**:602-604.

Pretorius, Z.A., Singh, R.P., Wagoire, W.W. and Payne, T.S. 2000. Detection of virulence to wheat stem rust resistance gene *Sr31* in *Puccinia graminis* f. sp. *tritici* in Uganda. *Plant Disease*. **84**:203.

Saleem, K., Hafiz, M., Arshad, I., Shokat, S. and Manzoor Atta, B. 2015. Appraisal of wheat germplasm for adult plant resistance against stripe rust. *Journal of Plant Protection Research*. **55** (4):405-414.

GAU Research Journal **43** (2) : 90-93 (July 2018)

Screening of Potato (*Solanum Tuberosum* L.) cultivars for resistance against Potato apical leaf curl virus

J.K. PATEL[1]*, R.N. PATEL[2], S.K. CHONGTHAM[3] AND D.M. ZAPADIYA[4]

Potato Research Station,
S.D. Agricultural University, Deesa - 385 535 (Gujarat)

Received : 30 June, 2018 Accepted: 20 July, 2018

ABSTRACT

A field experiment was conducted at Potato Research Station, S. D. Agricultural University, Deesa during 2012-13, 2013-14 and 2014-15 to assess thirteen potato cultivars for resistance against potato apical leaf curl virus. The potato cultivars *viz.* Kufri Badshah, K. Pukhraj, K. Chipsona-3, K. Bahar, K. Anand, K. Sadabahar, K. Himsona, K. Surya, K. Khyati, K. Sutlej, K. Pushkar, K. Jyoti and K. Laukar were planted in randomized block design in the second week of November keeping inter and intra row spacing of 50 cm and 20 cm, respectively in three replication. The observations on per cent disease incidence, population of white fly and total tuber yield were recorded. All the varieties were affected by the apical leaf curl virus. However minimum incidence 2.64 per cent was recorded in K. Badshah followed by K. Anand (7.90%), K. sutlej (8.23%) and K. khyati (9.63%). On the other hand highest disease incidence (25.33%) was observed in K. Bahar. The numbers of whiteflies were also found lowest in K. Badshah at 60 days after planting (DAP).

Key words: Potato, Apical leaf curl virus, Screening, Resistance

Potato (*Solanum tuberosum* L.) belongs to family *Solanaceae* and is one of the most important vegetable crops grown in all climatic zones of the world and is next only to wheat, rice and corn in terms of total food production. On the basis of potato production, India stands second in the world after china. In India, the area under potato cultivation is 2179 thousand ha with average production of 22.31 tonnes per hectares while Gujarat produce 3797816 MT potatoes from the cultivated area and occupy first rank in productivity (31.00 tonnes/ha) in India (Anonymous, 2018).

Potato is suffering from many viral diseases among them potato apical leaf curl virus disease (PALCVD) is an important disease in early planted potato crop. It is transmitted through whitefly (*Bemisia tabaci*) in a persistent manner. Potato apical leaf curl virus showed chlorotic blotching, crinkling, mosaic, apical leaf curling and stunting symptoms (Grag *et. al.*, 2001). Annual loss due to potato viruses with an average of 30-40 per cent incidence is about 25- 30 per cent yield reduction (Khurana, 1999). Lakra, (2002) reported more than 50 per cent loss in yield in early planted potato cultivar Kufri Ashoka. The most deleterious effect observed was reduction in leaf area, chlorophyll content, plant height, number of tubers per plant and weight of tubers per plant (Lakra, 2003). The disease incidence has positive correlation with whitefly population and whitefly infestation period (Baswaraj *et. al.*, 2015).

The genetic resistance is more safe, stable and economical in comparison to pesticides use. The pre-requisite for the development of disease resistant varieties is the availability of efficient and reliable screening techniques and the identification of resistant sources.

MATERIALS AND METHODS

A field experiment was conducted at Potato Research Station, SDAU, Deesa (Gujarat) during *Rabi* season of 2012-13, 2013-14 and 2014-15 to evaluate thirteen different potato varieties released by the Central Potato Research Institute, Shimla (Himachal Pradesh) against potato apical leaf curl virus. The potato varieties *viz.* Kufri Badshah, K. Pukhraj, K. Chipsona-3, K. Bahar, K. Anand, K. Sadabahar, K. Himsona, K. Surya, K. Khyati, K. Sutlej, K. Pushkar, K. Jyoti and K. Laukar were planted in randomized block design

[1&3]Assitant Research Scientist, [2]Associate Research Scientist, [4]Agriculture Officer
*Email : jkpatel2489@gmail.com

Table 1 Field screening of potato varieties against Potato Apical Leaf Curl Virus (Pooled Data of Three years)

S.N.	Variety	PDI	No. of Whiteflies 40 DAP	No. of Whiteflies 50 DAP	No. of Whiteflies 60 DAP	Yield (t/ha)
1.	Kufri Badshah	2.64 (9.63)*	4.89 (2.26)**	5.22 (2.36)**	6.11 (2.53)**	38.62
2.	Kufri Pukhraj	13.01 (20.37)	4.22 (2.13)	5.67 (2.44)	7.56 (2.81)	37.35
3.	Kufri Chipsona 3	12.88 (21.08)	4.44 (2.22)	5.22 (2.37)	7.89 (2.85)	32.92
4.	Kufri Bahar	25.33 (29.75)	6.78 (2.67)	8.89 (3.03)	11.56 (3.44)	30.27
5.	Kufri Anand	5.71 (14.27)	5.56 (2.38)	7.00 (2.68)	9.00 (2.99)	28.75
6.	Kufri Sadabahar	16.36 (23.68)	5.44 (2.41)	6.33 (2.60)	7.89 (2.88)	30.54
7.	Kufri Himsona	11.34 (19.70)	6.11 (2.45)	6.00 (2.49)	7.78 (2.82)	33.30
8.	Kufri Surya	11.21 (19.72)	7.44 (2.78)	8.11 (2.91)	10.33 (3.27)	34.35
9.	Kufri Khyati	9.63 (17.97)	7.89 (2.87)	9.56 (3.12)	10.67 (3.28)	39.76
10.	Kufri Sutlej	8.23 (15.35)	6.33 (2.58)	7.89 (2.86)	9.33 (3.09)	31.80
11.	Kufri Pushkar	12.31 (20.37)	4.44 (2.21)	5.67 (2.47)	6.78 (2.66)	28.53
12.	Kufri Jyoti	22.98 (28.51)	4.33 (2.18)	6.89 (2.70)	10.00 (3.19)	19.07
13.	Kufri Laukar	21.19 (27.40)	6.89 (2.71)	7.78 (2.87)	11.44 (3.42)	24.30
	S.EM	2.90	0.147	0.163	0.271	4.19
	CD	8.48	0.43	0.48	NS	NS
	CV	25.30	13.77	11.26	12.09	22.02

Data in parentheses are arc sine transformed values, **Data in parentheses are square root transformed values

Table 2 Resistant reaction of potato varieties against potato apical leaf curl virus

Reaction	Name of Varieties
Resistant	K. Khyati, K. Badshah, K. Anand, and K. Sutlej
Moderately Resistant	K. Pukhraj, K. Chipsona-3, K. Sadabahar, K. Himsona, K. Surya and K. Pushkar
Moderately Susceptible	K. Bahar, K. Jyoti and K. Laukar
Susceptible	-
Highly Susceptible	-

in the second week of November by keeping inter and intra row spacing of 50 cm and 20 cm, respectively in three replications. The observations on per cent disease incidence, population of white fly and total tuber yield were recorded. The population of whitefly was recorded from 3 plants per replication at 40, 50 and 60 DAP. Number of whitefly was counted on three compound leaves at different positions, *i.e.*, bottom, middle and top of the plant and then worked out whitefly per plant. Counting of whitefly was carried out early morning hours, as they are comparatively less active before sunrise. Number of plants showing apical leaf curl symptoms were counted in each replication/variety at 60 DAP and percent disease incidence was calculated as followed by Maan *et. al.*, 2017.

$$\text{Percent disease Incidence} = \frac{\text{Total number of disease plant}}{\text{Total number of plants observed}} \times 100$$

Scale used for screening of resistance (Kumar *et. al.*, 2015):

Disease Reaction	Disease Incidence (%)
Resistant	<10
Moderately Resistant	10.1-20
Moderately Susceptible	20.1-40
Susceptible	40.1-60
Highly Susceptible	>60

RESULTS AND DISCUSSION

The pooled data of three years of per cent disease incidence, population of whiteflies at 40, 50 and 60 DAP and total tuber yield are presented in Table 1. The lowest percent disease incidence was recorded in K. Badshah (2.64%) followed by K. Anand (5.71%), K. Sutlej (8.23%) and K. Khyati (9.63%) which showed resistant reaction according to Kumar *et. al.*, 2015 resistance scale whereas the more disease incidence was recorded in K. Bahar (25.33%), K. Jyoti (22.98%) and K. Laukar (21.19%) which showed moderately susceptible reaction against potato apical leaf curl virus disease in north Gujarat conditions. The result found was contradicting with the result of Lakra (2008) and Baswana *et. al.*, (2009). Lakra evaluated 266 germplasm lines and 15 cultivars at Hisar and found that K. Bahar and CP 1246 were resistant to potato apical leaf curl virus. In north Gujarat condition K. Bahar found moderately susceptible which may be due environmental conditions. The results found were similar cum contradicting with Mann *et. al.*, (2017). Mann *et. al.*, (2017) screened 20 varieties/ genotypes at *Haryana Agricultural University, Hisar* and found lowest percent disease incidence of potato leaf curl virus in K. Badshah (6.66%) and K. Pushkar (6.66%), while in case of contradicting they found zero per cent disease incidence in K. Bahar.

The data on number of whiteflies (Table 1) revealed that number of whiteflies were lower at 40 DAP and which were accumulate with crop maturity. The number of whiteflies were recorded lowest in K. Badshah *i.e.* 6.1, while highest number of whiteflies were recorded in K. Bahar (11.56). Whitefly population at 60 DAP had positive correlation with per cent disease incidence of potato leaf curl virus. Mann *et. al.*, (2017) also found that whitefly population had significantly positive correlation with per cent disease incidence of potato leaf curl virus. The statistically highest tuber yield was recorded in K. Khyati (39.76 tonnes/ha) as it has shown resistance reaction against potato apical leaf curl virus and also have high yielding and early bulking attributes. Kufri Badshah and Kufri Pukhraj recorded tuber yield 38.62 and 37.50 tonnes/ ha respectively.

ACKNOWLEDGEMENT

The financial assistance and support extended for the project by ICAR-AICRP (Potato) and SDAU, Sardarkrushinagar are highly acknowledged.

REFERENCES

Anonymous. 2018. Monthly report potato (May, 2018), Horticulture statistics division, Department of Agriculture, Cooperation & Farmers welfare, Ministry of Agriculture & Farmers welfare, Government of India, New Delhi. P.1-8.

Baswana, K. S., Bhatia, A. K. and Gupta, A. 2009. Biennial Progress Report of AICRP (potato) Hisar for the year 2007-09. Department of Vegetable Science, CCS HAU, Hisar, Haryana. P. 28.

Baswaraj, R., Jeevalatha and Kumar, R. 2015. A manual on diseases and pests of potato. Tech Bull. No. 101), CPRI, Shimla, P. 41.

Grag, I. D., Kumar, S., Khurana, S. M. P. and Lakra, B. S. 2001. Association of geminivirus with potato apical leaf curl virus in India and its immune-electron microscopic detection.

Journal Indian Potato Association. **28** (2-4): 227-232.

Khurana, S. M. P. 1999. Potato viruses and viral diseases. Tech Bull. 35(revised), CPRI, Shimla, P. 94.

Kumar, M., Gupta, A., singh, J. and singh, f. 2015. Screening of germplasm lines against potato apical leaf curl virus disease in potato crop. *International Journal of Tropical Agricultural*. **33** (2) : 1283.

Lakra, B. S. 2003. Potato apical leaf curl begomovirus-symptom, appraisal of a scale and losses in potato crop. *Journal of Indian Potato Association*. **30** (1-2): 119-120.

Lakra, B. S. 2002. Leaf-curl: A threat to potato crop in Haryana. *Journal of Mycology and Plant Pathology*. **32**: 367.

Lakra, B. S. 2008. Field evaluation of potato cultivars and germplasms against potato apical leaf curl virus disease. In: proc. 95th Indian Science Congress, Section of Agriculture and Forestry Sciences, January 3-7, 2008 Visakhpatnam. P. 81-82.

Maan, D. S., Bhatia, A. K. and Rathee, M. 2017. Screening and evaluation of potato (*Solanum tuberosum*) genotypes to identify the sources of resistance to potato apical leaf-curl disease. *International Journal of Pure Applied Biosciences*. **5** (3): 53-61.

GAU Research Journal **43** (2) : 94-99 (July 2018)

Bio-efficacy of insecticide imidacloprid 600FS as seed treatment against termite infesting on wheat

A. A. PATEL[1], S. I. PATEL[2], ELANGBAM PREMABATI DEVI*[3] AND DAVADA ADILHUSEN Y[4]

Wheat Research Station,
S. D. Agricultural University, Vijapur-382 870 (Gujarat)

Received : 30 June, 2018

Accepted: 20 July, 2018

ABSTRACT

Field experiments were conducted for testing the bio-efficacy of imidacloprid 600FS as seed treatment against termite infesting on wheat. The result showed none of the insecticidal treatments under study affect seed germination and plant stand. Seed treatment of imidacloprid 600FS @ 8.4 g a.i./ kg was highly effective against termite followed by treatment with lower dose of imidacloprid 600FS @ 4.2 g a.i./kg. The result of pooled data for per cent damaged effective tiller/m row showed that imidacloprid 600FS @ 8.4 g a.i./kg was have lowest per cent damage as compared to untreated check and it was at par with treatment with imidacloprid 600FS @ 4.2 g a.i./kg. Pooled data on grain yield indicated that higher yield was recorded in all above treatments of imidacloprid 600FS. The phytotoxicity study indicated no adverse effect of insecticides on any foliar part of wheat.

Key words: *Odontotermes abesus*, Microtermes obesi, bio efficacy, imidacloprid

Termite is the major pest of agricultural crops in tropical and sub-tropical regions of the world along with South Asia (Geddes and Iles, 1991; Kishor *et al.*, 2017). *Odontotermes obesus* (Rambur) and *Microtermes obesi* are the most destructive predominant species of termite infecting in wheat mainly in loamy and sandy loam soils (Chhillar *et al.*, 2006; Peterson *et al.*, 2006 and Potter, 2011). But, Gadhiya *et al.* (2012) reported that *Odontotermes obesus* (Rambur) was found as the dominant species of termite infesting in wheat. Presence of sandy loam soil moisture regime in Rajasthan provides more favorable condition for termite infestation as reported by Parihar, 1981. Termite damage was around 20 to 40 per cent in wheat crop was reported mostly in rainfed field condition (Misra *et al.*, 2003). The yield losses ranged from 43 to 80 per cent due to termite infestation in wheat as reported by Roonwal, 1979; Sattar and Salihah, 2001; Chhillar *et al.*, 2006 and Kakde *et al.*, 2006. Since, termites are extremely difficult to manage chemical pesticides are the only means for their management (Rathour *et al.*, 2014). Chemicals insecticides like chlorpyrifos, endosulfan, cypermethrin, imidacloprid, carbosulfan and triazophos were being recommended for control of termite (Kumawat, 2001 and Rana *et al.*, 2001). The efficacy of insecticide like imidacloprid showed nonsignificant difference in soil types of sandy loam and silty clay loam, but termiticide quantity increased with depth from injection point (Davis and Kamble, 2008) while in loamy soil, the higher application rates of insecticides like imidacloprid, fipronil and bifenthrin has resulted with greater efficiency of these insecticides against termite (Saran and Kamble, 2008). Thus, considering the importance of management of this pest, the present investigation was carried out to evaluate for bio-efficacy of imidacloprid 600FS as seed treatment against termite of wheat in field condition.

[1]Research Scientist, [2]Associate Research Scientist, [3]Assistant Research Scientist, [4]Technical Assistant
*Email : eprembati35@gmail.com

MATERIALS AND METHODS

Field experiments were conducted during *Rabi* seasons of 2015-16 and 2016-17 for evaluating the bio-efficacy of imidacloprid 600FS as seed treatment against termite of wheat on cv. GW 496 at Wheat Research Station, S.D. Agricultural University, Vijapur, Gujarat. Experiments were laid out in Randomized Block Design (RBD) in three replications. The net plot size was 1.6m x 4m with row to row spacing of 20 cm. Eight treatments including different doses of imidacloprid @ 1.5, 1.8, 2.1, 4.2, 8.4 g a.i./kg,

thiamethoxam 30%FS @ 0.99 g a.i./kg, chlorpyrifos 20%EC @ 0.8 g a.i./kg and untreated control were evaluated against termite of wheat in field condition (Table 1). Germination percentage and number of plant population in all the treatment was recorded at 25 days after sowing along with seedling health and vigour of plants were also recorded during both the years of study. Observations of termite affected plants per plot at 25, 35, 45 days after sowing and at maturity were recorded and per cent damaged effective tiller/m row was calculated by using the formula given below.

$$\text{Per cent plant damage} = \frac{\text{No. of plant damage per meter row}}{\text{Total no. of plants per meter row}} \times 100$$

All the percentage data in all the treatments were subjected to angular transformations and analyzed statistically. The critical difference and standard error mean were calculated for the comparison of treatments and control. Moreover, observations for development of any adverse effects of phytotoxicity with different higher dosages of imidacloprid 600FS on wheat were recorded at 1, 3, 5, 7 and 15 days after germination by using scale given below.

0	No Phytotoxicity
1-10%	Phytotoxicity = 1 Scale
11-20	Phytotoxicity = 2 Scale
21-30	Phytotoxicity = 3 Scale
31-40	Phytotoxicity = 4 Scale
41-50	Phytotoxicity = 5 Scale
51-60	Phytotoxicity = 6 Scale
61-70	Phytotoxicity = 7 Scale
71-80	Phytotoxicity = 8 Scale
81-90	Phytotoxicity = 9 Scale
91-100	Phytotoxicity = 10 Scale

RESULTS AND DISCUSSION

During 2015-16 crop seasons, plant population per meter row counts made after 3 weeks of sowing revealed nonsignificant differences among all the treatments. Similarly, in confirmative test on germination, the results showed nonsignificant differences so none of the insecticidal treatments under study affected seed germination. Likewise, there were nonsignificant differences amongst all the insecticidal treatments in plant height and root length (Table 1). The data on per cent damaged effective tillers per meter row showed nonsignificant differences amongst the treatments. However, minimum damage (3.20 and 3.68) was observed in imidacloprid 600FS @ 2.1 g a.i./kg and imidacloprid 600FS @ 1.8 g a.i./kg. On the basis of number of damaged effective tillers/ha, the highest damage (4030) was recorded in untreated check. While, the lowest damage (3458) was recorded in imidacloprid 600FS @ 8.4 g a.i./kg followed by treatments of imidacloprid 600FS @ 2.1 g a.i./kg and imidacloprid 600FS @ 4.2 g a.i./kg (Table 2).

During 2016-17 crop seasons, similar result for germination, plant stand as mentioned above were observed (Table 1). The data on per cent damaged effective tillers per meter row showed significant differences among the treatments. No termite damage (0.00) was observed in treatments of imidacloprid 600FS @ 8.4 g a.i./kg and it was at par with imidacloprid 600FS @ 4.2 g a.i./kg. While, on the basis of number of damaged effective tillers/ha, there were no damage recorded in imidacloprid 600FS @ 8.4 g a.i./kg and it was at par with lower doses of imidacloprid 600FS @ 4.2 g a.i./kg (Table 2).

The result based on the pooled data on per cent damaged effective tillers/m row showed that minimum damage (2.01) was observed in treatment of imidacloprid 600FS @ 8.4 g a.i./kg followed by imidacloprid 600FS @ 4.2 g a.i./kg as compared to untreated control where highest damage (22.28) was recorded. Similarly, the pooled data on number of effective tillers/ha showed that treatment imidacloprid 600FS @ 8.4 g a.i./kg was found with minimum damage (1856) of termite in the field condition and it was at par with treatment of imidacloprid 600FS @ 4.2 g a.i./kg (Table 2).

The grain yield on the basis of gram per meter row and q per ha recorded during 2015-16 crop season revealed that the highest yield (51 g/m and 23.65 q/ha) was recorded in treatments of imidacloprid 600FS @ 8.4 g a.i./kg and it was at par with imidacloprid 600FS @ 4.2 g a.i./kg followed by imidacloprid 600FS @ 2.1 g a.i./kg. Similarly, the grain yield recorded in gram per meter and q per ha during 2016-17 crop seasons revealed that the highest yield (52 g/m and 27.08 q/ha) was noticed in treatment of imidacloprid 600FS @ 8.4 g a.i./kg and it was at par with imidacloprid 600FS @ 4.2 g a.i./kg followed by imidacloprid 600FS @ 2.1 g a.i./kg. In the same way, pooled data on grain yield on both gram per meter row and q per ha indicated that higher yield was recorded in the all treatments of imidacloprid 600FS as compared to rest of treatments (Table 2).

During the both the experimental years of study, the observations on phytotoxicity recorded at 1, 3, 5, 7 and 15 days after germination showed that there were no visible development of phytotoxicity symptoms on foliar part of wheat in all the insecticidal treatments

Table 1 Effect of insecticidal treatments on germination and plant stand recorded at 25 days after sowing

SN	Treatments	Dose (g a.i. /kg)	Germination %			Plant stand			Seedling health and vigour					
			2015 -16	2016 -17	Pooled	2015 -16	2016 -17	Pooled	2015-16		2016-17		Pooled	
									PH	RL	PH	RL	PH	RL
1	Untreated control	-	85.67	81.00	83.34	39.00	39.00	39.00	22.20	5.13	22.58	5.23	22.39	5.18
2	Imidacloprid 600 FS	1.50	84.33	87.00	85.67	36.00	36.00	36.00	21.40	4.87	21.76	4.80	21.58	4.84
3	Imidacloprid 600 FS	1.80	84.33	86.33	85.33	36.00	37.00	36.50	21.86	4.77	23.54	5.07	22.70	4.92
4	Imidacloprid 600 FS	2.10	83.67	88.00	85.84	38.00	39.00	38.50	22.18	5.70	22.14	5.73	22.16	5.72
5	Thiamethoxam 30% FS	0.99	83.00	84.33	83.67	38.00	38.00	38.00	20.89	5.27	22.56	5.27	21.73	5.27
6	Chlorpyrifos 20% EC	0.80	83.33	87.67	85.50	40.00	40.00	40.00	21.85	4.93	21.87	5.13	21.86	5.03
7	Imidacloprid 600 FS	4.20	85.00	87.00	86.00	40.00	41.00	40.50	22.69	4.63	22.62	4.70	22.66	4.67
8	Imidacloprid 600 FS	8.40	82.67	85.67	84.17	35.00	35.00	35.00	22.47	5.70	21.58	5.30	22.03	5.50
	S.Em ± T		2.79	3.11	0.49	2.34	2.56	0.89	0.98	0.30	0.76	0.69	0.87	0.50
	Y × T		-	-	0.75	-	-	1.30	-	-	-	-	0.40	0.23
	C.D. at 5% T		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Y × T		-	-	NS	-	-	NS	-	-	-	-	NS	NS

• PH= Plant height, RL= Root length

Table 2 Effect of insecticidal treatments on damage and yield against termite of wheat

S N	Treatments	Dose (g a.i. /kg)	% damaged effective tillers/m row			No. of damaged effective tillers/ha			Grains yield g/m row			Grains yield q/ha		
			2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
1	Untreated control	-	15.52*** (12.18)	29.03*e (23.55)**	22.28*g (17.86)**	4030^{+}c (592543)$^{++}$	2963^{+}e (123061)$^{++}$	3497^{+}g	22e (357802)$^{++}$	27d	25d	15.35	18.33	16.84
2	Imidacloprid 600 FS	1.50	5.02	6.13c (0.82)	5.58de (1.14)	3774bc (0.98)	1927bcd (406743)	2851de (26719)	32cd (216731)	43abc	38bc	20.99	21.77	21.38
3	Imidacloprid 600 FS	1.80	3.68	5.41c (0.45)	4.55cd (0.89)	3654ab (0.67)	1752bc (340816)	2703c (20655)	39bc (180735)	45ab	42bc	22.14	23.39	22.76
4	Imidacloprid 600 FS	2.10	3.20	4.55bc (0.31)	3.88c (0.63)	3577ab (0.47)	1529b (304103)	2553b (14884)	44ab (159493)	47ab	46ab	22.50	24.06	23.28
5	Thiamethoxam 30% FS	0.99	4.17	9.46d (0.53)	6.82e (2.70)	3612ab (1.61)	2247cd (320125)	2930ef (42827)	36bcd (362952)	30cd	33cd	21.65	21.65	21.65
6	Chlorpyrifos 20% EC	0.80	4.24	14.80 (0.55)	9.52f (6.52)	3643ab (3.53)	2422de (335290)	3033f (55452)	27de (195371)	35b	31d	18.85	20.31	19.58
7	Imidacloprid 600 FS	4.20	4.83	1.61ab (0.78)	3.22bc (0.79)	3711ab (0.78)	470a (370442)	1964a (3125)	49a (129144)	50a	50ab	23.59	25.99	24.79
8	Imidacloprid 600 FS	8.40	4.02	0.00a (0.49)	2.01a (0.00)	3458a (0.24)	000a (255164)	1856a (0000)	51a (185221)	52a	52a	23.65	27.08	25.36
	S.Em. ± T		3.97	0.99	0.53	86.00	189.00	45	3.00	3.13	3.06	1.77	1.58	0.48
	Y × T		-	-	0.7	-	-	67	-	-	1.50	-	-	1.8
	C.D. at 5% T		NS	3.01	1.51	261.00	574.00	129	9.00	9.48	9.24	NS	4.79	1.72
	Y × T		-	-	NS	-	-	NS	-	-	NS	-	-	5.31
	C.V.%		123.50	19.38	65.00	4.05	19.71	9.23	14.4	13.17	12.77	14.49	12.00	2.40

Table 3 Pooled data of 2015-16 and 2016-17 crop seasons for phytotoxicity of higher dose of imidacloprid 600FS

S.N.	Treatments	Dose (g a.i./kg)	Phytotoxicity (%)					
			Leaf injury	Chlorosis	Necrosis	Wilting	Epinasty	Hyponasty
1.	Untreated check	-	0	0	0	0	0	0
2.	Imidacloprid 600FS	2.10	0	0	0	0	0	0
3.	Imidacloprid 600FS	4.20	0	0	0	0	0	0
4.	Imidacloprid 600FS	8.40	0	0	0	0	0	0

which indicated that seed treatment of imidacloprid 600FS was safe for controlling termite of wheat (Table 3).

Similar results were reported by Mishra *et al.* (2007) where maximum plant stand (77.7 plant/m^2), minimum damaged tillers (5 tillers/plot) and maximum grain yield (42.2 q/ha) were obtained with seed treatment of imidacloprid @ 2 ml/kg seed followed by chlorpyrifos @ 5 ml/kg seed against termite of wheat. The above finding also supported by Kishor *et al.* (2017) where significant control of termite in wheat was observed in treatment of imidacloprid 600FS @ 1.5 lit/ha. The data are closely related with the results recorded by Singh *et al.* (2015) where the minimum damaged number of effective tillers/ha were recorded in seed treatment of fipronil followed by imidacloprid and thiamethoxam as well as the reported grain yield in both g/m row and q/ha were significantly higher in treatment of fipronil followed by imidacloprid and thiamethoxam against termite of wheat. Moreover, the effectiveness of imidacloprid as seed treatment against internal feeders of sorghum and pest complex of pearl millet has also been reported (Kishore and Barman, 2003; Katole *et al.*, 2003; Noor, 2003). Likewise, seed treatment with imidacloprid 70WS @ 10 g/kg seed and imidacloprid 600FS @ 8 ml/kg seed were reported as effective against termite of pearl millet (Ameta *et al.*, 2006).

REFERENCES

Ameta, O.P., Joshi, A. and Hussain, I. 2006. Management of termites in pearl millet with imidacloprid seed treatment. *Annals of Arid Zone.* **45** (2).223-225.

Chhillar, B.S., Saini, R.K. and Roshanlal, K. 2006. Emerging trends in economic entomology. CCSHAU Press, Hissar.pp.191-192.

Gadhiya, V. C., Borad, P. K. and Bhut, G. D. 2012. Survey and identification of termites in wheat crop. *Agres-An International e Journal.***1** (2).173-180.

Geddes, A. M. W. and Iles, M. 1991. The relative importance of crop pests in South Asia. *Natural Research Institute Bulletin.*39.

Davis, R.W. and Kamble, S.T. 2008. Effect of rod tips and soil types on the distribution of imidacloprid and a water soluble dye following subsoil rodding application for subterranean termite control (Isoptera: Rhinotermitidae). *Sociobiology.***51**.437-460.

Kakde, T.D., Siddhabhatti, P.M., Panchbhai, P.R. and Wadaskar, R.M. 2006. Comparative efficacy of candidate termiticides against worker termites, *Odontotermes obesus* (Rambur). *Resistant Pest Management Newsletter.***16** (1).8-10.

Katole, S.R., Kudale, N.V. and Thakare, S.M. 2003. New systemic insecticides against internal feeders of sorghum. In *Proceedings of the National Symposium on Frontier Areas of Entomological Research,* IARI, New Delhi.pp.26-27,

Kishore, P. and Barman, A.K. 2003. Towards development of IPM module against pearl millet pest complex. In *Proceedings of the National Symposium on Frontier Areas of Entomological Research,* IARI, New Delhi.pp.32-33.

Kishor, K., Kumar, J., Vikrant, S.K., Dotasara and Sharma, S. 2017. Wheat crop damaged by termite and co-related of different doses of insecticidal treatment compared with yield in standing crop. *International Journal of Current Microbiology and Applied Sciences.* **6** (12).449-454.

Kumawat, K.C., 2001. Evaluation of some insecticides against field termites, *Odontotermes obesus* and *Microtermes obesi* in wheat, *Triticum aestivum. Annals of Plant Protection and Sciences.***9**.51-3.

Mishra, D.N., Yadav, V. and Chandrapal. 2007. Effect of seed treatment with different insecticides against field termites *Odontotermes obesus* Rampur and *Microtermes obesi* Holmgren damage in wheat (*Triticum aestivum*) under Mid-Western Plain zone of UP. *Environment and Ecology.***25** (4).943-944.

Mishra, R.D., Sharma, R.K., Singh, K.P., Parsohan, P.A., Tiwari, A.N., Verna, R.S. and Jaiswal. 2003. Wheat Research Pantnagar, Research Bulletin No. 132, Directorate of Experiment Station, GBPUA&T, Pantnagar,Uttarakhand.47-49.

Noor, A. 2003. Management of termite and foliage pests of pearl millet with seed and foliar treatments in arid areas. In *Proceedings of the National Symposium on Frontier Areas of Entomological Research.* IARI, New Delhi.pp.34-35.

Parihar, D.R. 1981. Termite pest of vegetation in Rajasthan and their management, CAZRI, *Monograph.* **16**:31.

Peterson, C., Wagner, T.L., Mulrooney, J.E. and Shelton, T.G. 2006. Subterranean termites-their prevention and control in buildings. USDA Home and Garden Bulletin.p64.

Potter, M.F. 2011. Termites: In handbook of pest control: the behaviour, life history, and control of household pests, 10th ed. A. Mallis, S.A. Hedges & D. Moreland (Eds). Cleveland: GIE Media Inc.

Rana, J.S., Ombir. and Dahiya, K.K. 2001. Management of termite, *Microtermes obesi* (Holmgren) in wheat, *Triticum aestivum* through seed treatment. *Annals of Biology*.**17**.207-209.

Rathour, K.S., Ganguly, A.S., Das, T.K., Singh, P., Kumar, A. and Somvanshi, V.S. 2014. Biological management of subterranean termites (*Odontotermes obesus*) infesting wheat and pearl millet crops by entomopathogenic nematodes. *Indian Journal of Nematology*.**44** (1).97-100.

Roonwal, M.L. 1979. Termite injuring crops, plantations and fruit and forest trees and their control. In termite life and termite control. Published by Scientific Publication, Jodhpur.p.24.

Saran, R.K. and Kamble, S.T. 2008. Concentration dependent degradation of three termiticides in soil under laboratory conditions and their bioavailability to eastern subterranean termites (Isoptera: Rhinotermitidae). *Journal of Economic Entomology*.**101**.1373-1383.

Sattar, A. and Salihah, Z. 2001. Detection and control of subterranean termites. Technologies for sustainable agriculture. Proceeding National Workshop September 24-26 NIAB, Faisalabad, Pakistan. p.195-198.

Singh, N.V., Kumar, J. and Singh. D. K. 2015. Efficacy of different insecticidal seed treatment against termite in wheat (*Triticum aestivum L.*) Crop Research in Environment and Life Sciences. **8** (2).243-244.

GAU Research Journal **43** (2) : 100-101 (July 2018)

New report on leaf spot of Teak (*Tectona grandis* L.F.) caused by *Phomopsis tectonae* from Gujarat, India

B. K. PRAJAPATI[1*], D. J. PATEL[2] AND R. K. PATIL[3]

Directorate of Research,
S. D. Agricultural University, Sardarkrushinagar-385 506 (Gujarat)

Received: 19 July, 2018 Accepted: 02 August, 2018

ABSTRACT

Teak (*Tectona grandis* L.f.) is an important forest tree which is used for several furniture and other wood products. Teak plant seedlings infected with leaf spot disease has been observed in Anand, Gujarat. It causes leaf drying starting from the tips of leaves which resulting into complete defoliation. It is a serious nursery disease which leads up to 95 per cent loss in the seedlings. The pathogen was identified as *Phomopsis tectonae* through cultural and microscopic characteristics and pathogenicity was proved following standard Koch's postulates. A perusal of literature revealed that this is the first report on occurrence of Phomopsis leaf tip blight disease of Teak (*T. grandis* L.f.) seedlings from Gujarat.

Key words: Teak, Leaf spot, *Phomopsis tectonae*.

Teak is a tropical hardwood tree of species *Tectona grandis*. The species is placed in the family Lamiaceae. *T. grandis* is a large, deciduous tree that is dominant in mixed hardwood forests. It has small, fragrant white flowers and papery leaves that are often hairy on the lower surface. Teak timber is particularly valued for its durability and water resistance and is used for boat building, exterior construction, veneer, furniture, carvings, turnings, and other small wood projects. Teak is native to South and Southeast Asia mainly India, Indonesia, Malaysia, Thailand and Burma but is naturalized and cultivated in many countries in Africa and the Caribbean. It is a yellowish brown timber with good grain and texture. Teak's high oil content, high tensile strength and tight grain make it particularly suitable for outdoor furniture applications. Teak leaf spot causes leaf drying starting from the tips of leaves which results into complete defoliation of seedling. It is a serious nursery disease which leads up to 95 per cent loss in the seedlings (Balasundaran *et al.*, 1995).

MATERIALS AND METHODS

Sample collection, identification and pathogenicity test

During visit in the nursery of forest trees near Anand, Gujarat, we found some Teak plant seedlings raised in polyhouse by Forest department, Gujarat were infected with leaf spot disease. Further, the pathogen was isolated on PDA medium through tissue isolation method and pure culture of the pathogen was maintained at 27 ± 1°C in BOD incubator. The fungus was then identified as *Phompsis tectonae* based on cultural and microscopic characteristics as well as by referring earlier reported literatures. The pathogenicity was proved by following Koch's postulates on Teak plant seedlings.

RESULTS AND DISCUSSION

Symptomatology and Identification of pathogen

The typical symptoms observed were the development of light brown necrosis on margin of the leaves which gradually advanced towards midrib. The disease spreaded to the upper leaves, petiole and ultimately to the terminal bud and stem tip resulting into drying of upper portion of stem. Later on, the affected seedlings died quickly. Leaves severely affected by this leaf spot got dried up and defoliated. If timely control measures are not taken, the disease spread to the entire nursery, reducing number of healthy seedlings available for planting.

Tiwari *et al.*, (1981) reported that some Teak plants were infected by leaf spotting fungi and further

[1]Assistant Research Scientist, Directorate of Research S. D. Agricultural University, [2]Ex-Principal, [3]Ex-Professor, B. A. College of Agricutural, Anand Agricutural University, Anand
*Email : bindesh_prajapati@yahoo.in

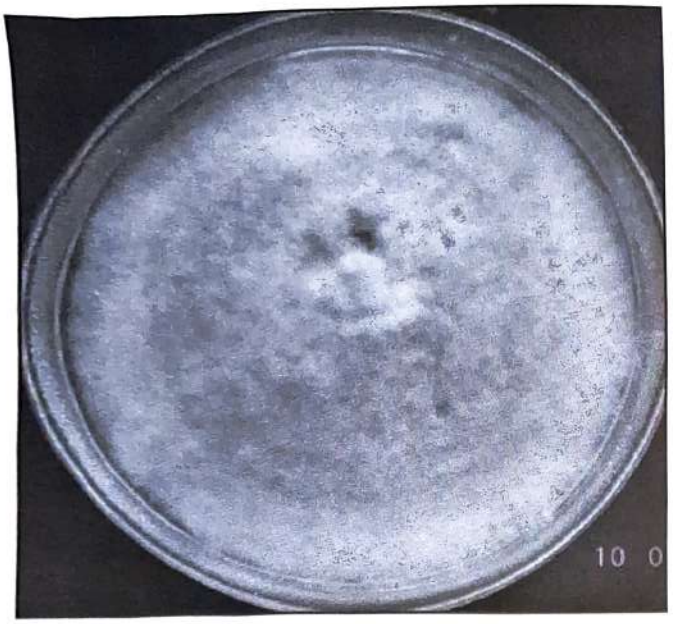


Figure 1: Pure culture of isolated fungi (*Phomopsis tectonae*)

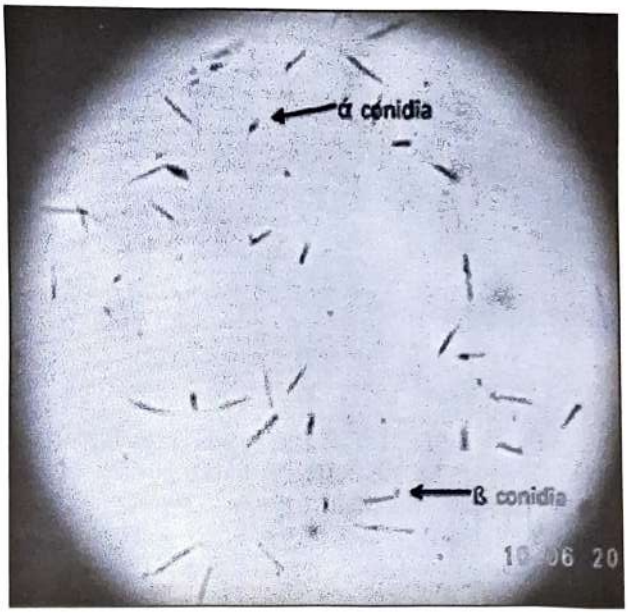


Figure 2: Conidia (α and ß) of *Phomopsis tectonae* (40X)

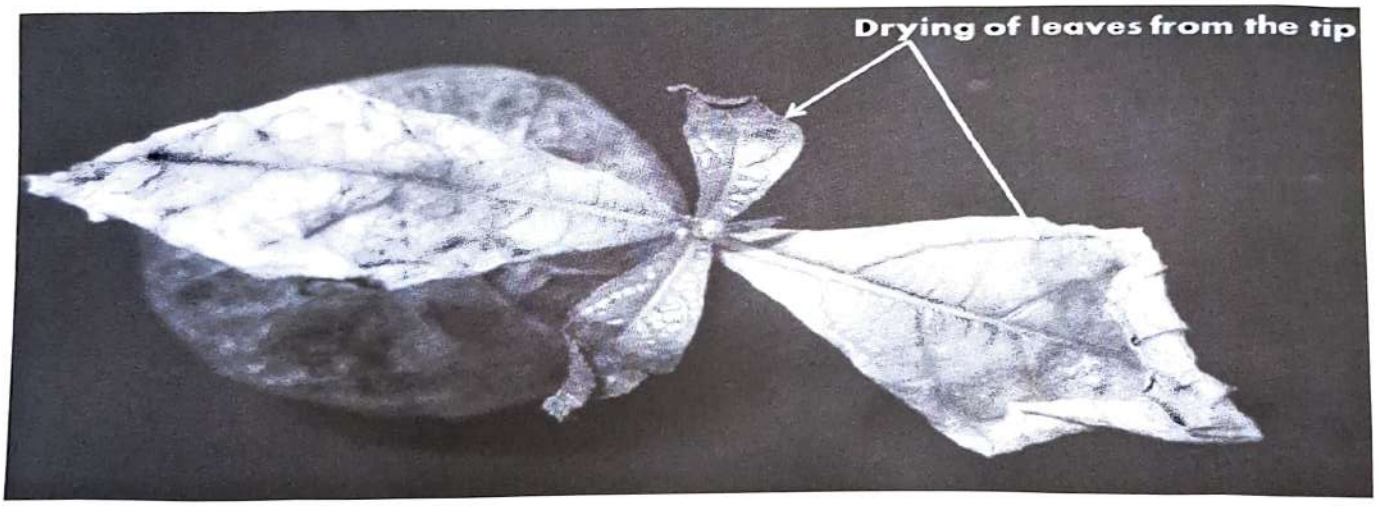


Figure 3: Leaf spot symptoms on leaves of Teak seedling

confirmed it as *Phomopsis tectonae* at Jabalpur, India. Similarly, Balasundaran *et al.*, (1995) reported that, 95 per cent of the nurseries were infected with leaf infection of *Phomopsis* sp., or *Phomopsis* sp. in combination with *C. gloeosporioides*, in Kerala.

REFERENCES

Balasundaran M, Sharma JK, Florence, Maria EJ and Mohanan C. 1995. Leaf Spot Diseases of Teak and Their Impact on Seedling Production in Nurseries. http://www.metla.fi/iufro/iufro95abs/d2pap88.htm

Tiwari DP, Rajak RC and Nikhra M. 1981. A new species of Phomopsis causing leaf spot disease of *Tectona grandis* L. *Current Science* **50** (22): 1002.

GAU Research Journal **43** (2) : 102-105 (July 2018)

Factors affecting sex ratio in mehsana goat at an organized farm of North gujarat

A.B. CHAUDHARI[1*], Y.M. GAMI[2], B.S. RATHOD[3], M.P. PATEL[4] AND H.H. PANCHASARA[5]

Livestock Research Station, S. D. Agricultural University,
Sardarkrushinagar – 385 506 (Gujarat)

Received: 04 July, 2018 Accepted: 03 August, 2018

ABSTRACT

Study on factors affecting sex ratio in Mehsana goat was carried out by retrieving data on birth of 375 kids for the period of 7 years from 2011 to 2017 were analyzed to study the factors affecting the sex ratio in Mehsana goats. The male to female sex ratio was 50.22:49.78 %. The percentage of males was higher in the months of June, April, September, February, March and May whereas it was higher in female in the months of July, November, December, October, January, February and March. The sex of kid was significantly affected by the season.

Key words: Mehsana goat, North Gujarat, Sex ratio

INTRODUCTION

The goat-a minicow, is multipurpose animal to provide milk, meat (chevon), hide, hair and manure for soil. In rural area goat farming plays a vital role to solve unemployment. The economic returns from keeping goats are high compared to other farming enterprises. Goat has been described as a poor man's cow because of their immense contribution to the poor people's economy. Mehsana goat is dual purpose breed and found in the Mehsana, Banaskantha, Patan, Gandhinagar and Ahmedabad district of Gujarat. Mehsana is a large size breed. The color of the coat is black with white spots at the base of the ear. The flock size of this goat breed vary from 15 – 300, even very smaller flocks of 2 – 5 goats are also found. Sex ratio in breeding population helps in maximizing genetic gain by enhancing the intensity of selection. It is generally established that the sex ratio do not deviate significantly from 50%. Still there are some factors, which might influence on the deviation of the sex ratio. The kidding percentage and twinning ability are the most important parameters to investigate reproductive efficiency. It is measure of production and profit point of view in organized and unorganized sector of goat farming.

[1,2,3,4]Assistant Research Scientist, [5]Research Scientist
*Email : arthchaudharitanuvas@yahoo.com

MATERIALS AND METHODS

Data on 375 births of Mehsana kids for the period of 7 years from 2011 to 2017 were analyzed for this study. All goats were maintained under same feeding and management practices followed by strict prophylactic measures. The year was divided into three seasons (summer = March to June; Monsoon= July to October; winter= November to February). Type of birth was classified as single and twins. The variation in the sex ratio due to year, season, month and type of birth were analyzed statistically (Snedecor and Cochran, 1967) by using appropriate statistical tools.

RESULTS AND DISCUSSION

Year-wise male and female births are presented in Table 1. The result revealed that the differences between the years were non-significant (P>0.05). Out of 375 total birth recorded, 183 (50.22%) and 192 (49.78%) were males and females respectively.

This was similar findings of nearly equal ratio of male:female by Deokar *et al.* (2000) (50.61:49.39%) in Osmanabadi goats, Barbind *et al.* (2004) in Beetal x Osmanabadi goats (49.16:50.48%), Soundararajan and Sivkumar (2006b) in Tellicherry goats

Table 1 Year wise sex ratio in Mehsana goats

Sr. No.	Year	No. of does	Total birth	No. of male	%	No. of female	%
	2011	83	96	42	43.75	54	56.25
1	2012	53	54	30	55.56	24	44.44
2	2013	40	42	21	50	21	50
3	2014	33	39	20	51.28	19	48.72
4	2015	26	30	18	60	12	40
5	2016	42	54	23	42.59	31	57.41
6	2017	42	60	29	48.33	31	51.67
7	Total	319	375	183	50.22	192	49.78

Calculated chi-square value = 7.63^{NS}
Non significant at P>0.05; NS= non significant

Table 2 Season wise sex ratio of Mehsana goats

Sr. No.	Season	No. of does kidded	Birth	% of total birth	No. of male	%	No. of female	%
1	Winter	61	77	20.53	35	45.45	42	54.55
2	Summer	25	30	8.00	18	60.00	12	40.00
3	Monsoon	233	268	71.47	130	48.51	138	51.49
	Total	319	375		183		192	

Calculated chi-square value = 6.76*; Significant at P<0.05

Table 3 Influence of type of birth on sex ratio in Mehsana goats

Sr. No.	Sex	Single	%	Twin	%	Total
1	Male	130	71.04	53	28.96	183
2	Female	133	69.27	59	30.73	192
	Total	263	70.16	112	29.84	375

Calculated chi-square value = 3.44^{NS}
*Significant at P<0.05; NS= non significant

(51.81:48.19%) and Thiruvenkadan *et al.* (2008) in Tellicherry goats (51.1:48.9%). On the contrary, some workers recorded unequal ratio of male female by Kale and Tomar (1997) reported (54.56:45.55%) in Alpine x Beetal goats, Soundrarajan and Sivakumar (2006a) in Kanni Goats (57.71:42.29%), Sivakumar and Soundararajan (2007) in nondescript goats (55.43:44.57%) and Kharkar *et al.* (2017) in Osmanabadi goats (56.59:43.41%).

Kidding percentage is important parameter which reflects the reproductive efficiency and having low heritability (0 to 0.15). However management plays an important role in increasing reproductive efficiency. The higher kidding percentage indicated that the Mehsana goat have potential to show better reproductive efficiency which could be optimized by providing excellent managerial practices.

Total 375 Mehsana kids were born during 2011 to 2017, out of that 71.47% (268) were born during monsoon followed by 20.53% (77) by winter and 8.00% (30) during summer season (Table 2). Influence of season was found to be significant. The kidding percentage of male was higher in the season of summer and in female was higher in the season of winter.

This is on the contrary with that of Deokar *et al.* (2002) they have observed more births (49.19) during winter months in Osmanabadi goats, Soundrarajan

Table 4 Month wise sex ratio in Mehsana Goats

Sr. No.	Year	No. of does kidded	Total Birth	No. of Male	%	No. of female	%
1	January	16	23	11	47.83	12	52.17
2	February	7	8	4	50.00	4	50.00
3	March	2	4	2	50.00	2	50.00
4	April	14	17	10	58.82	7	41.18
5	May	1	1	1	100.00	0	0
6	June	8	8	5	62.50	3	37.50
7	July	7	10	2	20.00	8	80.00
8	August	2	2	1	50.00	1	50.00
9	September	107	113	60	53.10	53	46.90
10	October	119	147	69	46.94	78	53.06
11	November	6	9	3	33.33	6	66.67
12	December	30	33	15	45.45	18	54.55
	Total	319	375	183		192	

Calculated chi-square value=13.72^{NS}

*Significant at P<0.05; NS= non significant

and Sivakumar (2006a) reported more births (40.97%) during winter season in Kanni goats and Kharkar *et al.* (2017) observed that more births (75.82%) during winter season in Osmanabadi goats. The percentage of male was higher in monsoon and winter seasons with a maximum of 60.00% during summer season.

The percentage of female was higher in twinning (30.73%) but the effect was not significant (Table 3).

The non significant effect on type of birth was also reported by Poonia *et al.* (2009) in Beetal goats. The percentage of single kidding (70.16%) was higher than twinning (29.84%) in Mehsana goat. The higher percentage of single kidding was also reported by Soundararajan and Sivakumar (2006a) in Kanni goats and Kharkar *et al.* (2017) in Osmanabadi goat. However, Sahare *et al.* (2009) reported 10.52% twinning in Osmanabadi goats.

The kidding percentage of male was higher in the month of April, June, September, February, March, May months 58.82 %, 62.50 %, 53.10 %, 50.00 %, 50.00 % and 100% (single record) respectively.

However kidding percentage in female was higher in July, November, December and October with 80.00 %, 66.67 %, 54.55 % and 53.06%, respectively (Table 4).

REFERENCES

Barbind, R.P., Bobde, S.D., Dandewar, B.I. and Kamble, V.I. 2004. Factors affecting sex ratio in Beetal x Osmanabadi goats. *Indian Journal of Small Ruminants.* **10** (1): 84-85.

Deokar, D.K., Koratkar, D.P. and Bhoite, U.Y. 2000. Factors affecting sex ratio in Osmanabadi goats. *Journal of Maharashtra Agriculture University.* **25** (1): 112-113.

Kale, M.M. and Tomar, O.S. 1997. Study on type of kidding, birth and sex ratio in crossbred dairy goats under stall fed conditions. *Indian Journal of Small Ruminants.* **3**: 58-65.

Kharkar, K.P., Rghuwanshi, D.S., Khati, B.M. and Lende, S.R. 2017. Factors affecting sex ratio in Osmanabadi Goat in Vidarbha Climatic condition. *International Research Journal of Natural and Applied Sciences.* **4** (1): 143-149.

Poonia, J.S., Malik, B and Khanna, A.S. 2009. Factors affecting sex ratio in Beetal goats, *Indian Journal of Small Ruminants.* **15** (2): 268-270.

Sahare, M.G., Sawaimul, A.D., Ali, S.Z. and Kolte, B.R. 2009. Kidding percentage and twinning ability in Osmanabadi goat in Vidarbha climatic condition. *Veterinary World.* **2** (2): 60-61.

Sivakumar, T. and Soundararajan, C. 2007. Factors affecting sex ratio in non-descript goats. *Tamilnadu Journal of Veterinary and Animal Sciences.* **3**: 98.

Snedecor, W.G. and Cochran, W.G. 1967. Statistical methods, Oxford Publishing Co., New Delhi.

Soundararajan C. and Sivakumar T. 2006a. Factors affecting sex ratio in Kanni goats. *Indian Journal of Small Ruminants*. **12** (2): 230-232.

Soundararajan, C. and Sivakumar, T. 2006b. Factors affecting sex ratio in Tellichery goats. *Indian Journal of Small Ruminants*. **12** (2): 227-229.

Thiruvenkadan, A.K., Chinnamani, K., Muralidharan, J. and Karunanithi, K. 2008. Factors affecting birth weight of Tellicherry kids. *Indian Journal of Small Ruminants*. **14** (2): 255-258.

GAU Research Journal **43** (2) : 106-111 (July 2018)

Management of early blight of Potato (*Solanum tuberosum* L.) incited by *Alternaria solani* (Ellis & Martin) Jones & Grout through fungicides

R. K. SHARMA[1*] AND D. R. PATEL[2]

Agricultural Research Station
S. D., Agricultural University, Ladol, Mehsana-382 840 (Gujarat)

Received: 05 July, 2018 Accepted: 03 August, 2018

ABSTRACT

The efficacy of some combination fungicides like fenamidone 10% + mancozeb 50% WDG, metiram 55% + pyraclostrobin 5% WG and cymoxanil 8% + mancozeb 64% WP along with commonly used fungicides *viz.*, dimethomorph 50% WP, fosetyl Al 80% WP, mancozeb 75 WP, metalaxyl 8% + mancozeb 64% WP, captan 70% + hexaconazole% WP and carbendazim 25% + mancozeb 50% WS were tested against early blight of potato *cv.* Kufri Pukhraj at Agricultural Research Station, Ladol, Gujarat. A variant with no application of fungicide was used as a control. All the treatments reduced the disease intensity significantly as compared to untreated check. The data on PDI of early blight of potato was recorded periodically at 40, 50, 60 and 70 days after sowing with consecutive three spray of fungicides at 15 days interval and was found low to moderate in range (12.94–20.64%). The lowest per cent disease intensity (PDI) 12.94 was observed in case of fenamidone 10% + mancozeb 50% WDG @ 0.2% treatment (2.5 gm/l) and it was at par with the treatment of metiram 55% + pyraclostrobin 5% WG @ 0.2% (2 gm/l) and cymoxanil 8% + mancozeb 64% WP @ 0.25% (2.5 gm/l) with its PDI per cent 14.04 and 14.94, respectively. It significantly reduced the early blight as compared to control. Similarly, the highest yield of potato tubers was recorded in fenamidone 10% + mancozeb 50% WDG @ 0.2% (2.5 gm/litre) against early blight with 60574 kg/ha followed by metiram 55% + pyraclostrobin 5% WG @ 0.2% (2.0 gm/litre) and cymoxanil 8% + mancozeb 64% WP @ 0.2% (2.5 gm/litre) with its yield 56778 and 50352 kg/ha, respectively. Thus, it can be said that combination of protective fungicides effectively suppressed pre- as well as post-infection activity and inhibited sporulation and/or restricted lesion expansion of early blight pathogen. Also found increase in the yield of potato as well.

Key words: Potato, Early Blight, *Alternaria solani*, Fungicides, Fenamidone, Mancozeb, Per cent Disease Intensity, management.

Potato (*Solanum tuberosum* L.) is one of the most important food and cash crop belonging to the family solanaceae. The major potato producing states are Uttar Pradesh, Bihar, Gujarat Karnataka, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh, and West Bengal. In India, potato is grown in all the states producing 493 lakh tonnes from total area of 1.5 million ha. The crop has the potential to increase agricultural production in our region. In Gujarat, it is grown in area of 81.27 thousands ha producing 38.35 lakh tonnes which is contribute near about 8 per cent share of potato production with 30758 kg/ha average productivity at national level (Anonymous, 2018). The major potato growing districts of Gujarat are Banaskantha, Sabarkantha, Mehsana, Patan, Gandhinagar, Surat, Valsad, Vadodara, Navasari and Dang (Anonymous. 2009). India ranked second in the potato production worldwide (Anonymous, 2017). Potato is commonly affected by numerous fungal diseases *viz.*, Early blight [*Alternaria solani* (Ellis and Mart.)], Leaf blight [*Alternaria alternata* Fries (Keissler)], Late blight [*Phytophthora infestans* (Mont.) de Bary], Anthracnose [*Colletotrichum phomoides* (Sacc.) Chester], Fusarium wilt [*Fusarium*

[1&2]Assistant Research Scientist
*Email : arsladol@sdau.edu.in

oxysporum f. sp. *lycopersici* (Sacc.) Snyder and Hansen], etc. Among them, early blight of potato caused by *Alternaria solani* is one of the common and wide spread diseases. In every year, it appears in devastating form in major potato growing areas of Gujarat. The disease mainly infects leaves and tubers. Initially the symptoms occur on the lower and older leaves in the form of small (1-2 mm) circular to oval brown spots. These lesions have the tendency to become large and angular at later stage. Mature lesions on foliage look dry and papery, and often have the concentric rings, looking like bulls eye. The symptoms on the tuber comprise of brown, circular to irregular and depressed lesions with underneath flesh turning dry, brown and corky. Lesions tend to enlarge during storage and affected tubers later become shriveled. The various factors limiting yield of potato include lack of high yielding varieties, inadequate supply of healthy seed tubers and high intensity of diseases and pests. Among the fungal diseases early blight of potato incited by *Alternaria solani* (Ellis & Martin) Jones & Grout is the most destructive disease. In Gujarat, the disease occurs every year in not epidemic form but contributing to yield loss up to 30 per cent in unsprayed crop (Patel, 2007). Among the new fungicides, fenamidone 10% + mancozeb 50% WDG and metiram 55% + pyraclostrobin 5% WG have been evaluated as highly effective against *A. solani*. Both the combination of fungicides has already been used in different parts of the country for management of early and late blight of potato. However, it is quite essential to evaluate their efficacy against the disease for a particular climatic condition. Therefore, an experiment has been carried out to investigate the performance of some fungicides *viz.*, fenamidone 10% + mancozeb 50% WDG, cymoxanil 8% + mancozed 64% WP, dimethomorph 50% WP, fosetyl Al 80% WP, mancozeb 75 WP, metalaxyl 8% + mancozeb 64% WP, captan 70% + hexaconazole 5% WP, metiram 55% + pyraclostrobin 5% WG and carbendazim 25% + mancozeb 50% WS under North Gujarat agro climatic conditions.

MATERIALS AND METHODS

The experiment was conducted at Agricultural Research Station, S. D. Agricultural University, Ladol, Gujarat during the year 2015-16 in *Rabi* season using *cv.* Kufri Pukhraj for the management of early blight of potato caused by *Alternaria solani* (Ell. & Mart.) Jones and Grout. The soil of the experimental field was sandy loam. The experiment was laid out in a randomized block design with three replications. All recommended agronomic practices were followed. The potato tubers were sown in the last week of November at a distance of 50 cm X 20 cm spacing by using 20-25 q seed tubers ha^{-1} with the gross area of 6.0 m X 3.0 m = 18.0 m^2. Efficacies of nine fungicides with their prefixed concentrations (Table 1) were compared with untreated control.

Table 1 Treatment details with their dose.

Treatment No.	Treatments	Spray Conc. (gm/lit)
T_1	Fenamidone 10% + Mancozeb 50% WDG	2.5
T_2	Cymoxanil 8% + Mancozeb 64% WP	2.5
T_3	Dimethomorph 50% WP	1.0
T_4	Fosetyl Al 80% WP	2.0
T_5	Mancozeb 75 WP	2.5
T_6	Metalaxyl 8% + Mancozeb 64% WP	2.0
T_7	Captan 70% + Hexaconazole 5% WP	1.0
T_8	Metiram 55% + Pyraclostrobin 5% WG	2.0
T_9	Carbendazim 25% + Mancozeb 50% WS	1.5
T_{10}	Untreated Control	-

Three sprays of each fungicide with their prefixed concentration were applied at an interval of 15 days when the disease initiation was started. The per cent disease intensity was recorded as per three consecutive sprays of fungicides at 40, 50, 60 and 70 days after sowing. On the basis of symptoms (Figure A and Figure B) and microscopic studies, the fungus was identified as *Alternaria solani,* causative agent of

early blight of potato (Ellis and Martin, 1882). The observations on the intensity of early blight disease of potato were recorded from randomly selected 5 plants from each plot using 0-5 scale as mentioned below.

Disease Score		Disease Intensity
0	:	Leaves free from infection.
1	:	Small irregular spots covering < 5% leaf area.
2	:	Small irregular brown spots with concentric rings covering 5.1-10% leaf area.
3	:	Lesions enlarging, irregular brown with concentric rings covering 10.1-25% leaf area.
4	:	Lesions coalease to form irregular and appears as a typical blight symptom covering 25.1-50% leaf area.

Per cent Disease Intensity (PDI) was calculated by using the following formula given by Chestar, 1959 and Weeler, 1969.

$$PDI = \frac{\text{Sum of all disease ratings}}{\text{Total no. of observations (sample) X Maximal disease rating grade}} \times 100$$

Based on these observations, per cent disease intensity (PDI) of early blight of potato was recorded. The per cent disease intensity data was arcsine transformed before analysis of variance (ANOVA). Statistical analysis was done with using the standard procedure described by Gomez and Gomez (1986).

RESULTS AND DISCUSSION

The experiment was conducted successfully at ARS, SDAU, Ladol farm with susceptible variety kufri pukhraj. We visually observed only one major disease infestation in the experiment. It was early blight disease caused by *Alternaria solani* (Ellis & Martin) Jones & Grout. There was no tuber infection found at the time of harvesting. The data on PDI of early blight of potato was recorded periodically at 40, 50, 60 and 70 days after sowing with consecutive three spray of fungicides at 15 days interval and was found low to moderate in range (12.94 – 20.64 per cent). It has also been found that in all treatments PDI increased with the age of the plants. The data on disease intensity revealed that all fungicides tested reduced the disease intensity significantly as compared to control. Table 2 revealed that the minimum PDI 12.94 per cent was recorded in case of T_1 *i.e.* spraying of fenamidone 10% + mancozeb 50% WDG @ 0.2% (2.5 gm/l) and it was at par with the treatment T_8 *i.e.* spraying of metiram 55% + pyraclostrobin 5% WG @ 0.2% (2 gm/l) and treatment T_2 *i.e.* spraying of cymoxanil 8% + mancozeb 64% WP @ 0.25% (2.5 gm/l) with its PDI per cent 14.04 and 14.94, respectively. It was significantly reduced the early blight as compared to control. The data showed that the best PDI reduction was observed with ranged from 12.94 to 14.94 as well as increase in yield ranged from 50352 to 60574 kg/ha. Most effective treatment with highest yield (60574 kg/ha) was T_1 (fenamidone + mancozeb) with minimum PDI 12.94 per cent followed by T_8 (metiram + pyraclostrobin) resulting yield of 56778 kg/ha with 14.04 PDI. Control plot was recorded the lowest tuber yield of 41926 kg ha^{-1}.

Result of the present study showed that among the nine different fungicide treatments, two combination fungicides *viz.*, T_1 (fenamidone 10% + mancozeb 50% WDG) @ 0.2% (2.5 gm/litre) and T_8 (metiram 55% + pyraclostrobin 5% WG) @ 0.2% (2.0 gm/litre) were found significantly superior for the management of early blight of potato disease as compared to others. These fungicides acted as the best fungicides when applied as prophylactic as well as curative measures. Other fungicides such as T_2 (cymoxanil 8% + mancozeb 64% WP) @ 0.2% (2.5 gm/l), T_9 (carbendazim 25% + mancozeb 50% WS) @ 0.2% (2.0 gm/l) and T_5 (mancozeb 75 WP) @ 0.2% (2.7 gm/litre) were also found effective against *A. solani* after T_1 & T_8 treatments. Similar results were obtained by Asit, *et. al.*, 2017, they tested sequential spraying of fenamidone 10% + mancozeb 50% WDG (0.25%) two to three times from 45 day after transplanting at 10 days intervals for better management of early blight of tomato, enhancement of fruit yield and assurance of high economic return. They found minimum disease incidence (10.61%) in case of involving fungicides (Fenamidone 10% + Mancozeb 50% WDG) having both systemic and contact action gave better reduction of early blight disease over other treatment combinations in tomato. Preventive fungicides inhibit

the spore germination and penetration but pathogen can derive resistance against fungicide application so repeated application of fungicides at proper dose and interval of time is mandatory (Hossain and Hossain, 2009). Best disease control with highest yields and fruit quality was reported in combination product of pyraclostrobin + metiram effective against both early blight and late blight has reported by Capriotti *et al.* (2005). Ganeshan and Chethna, (2009) also found pyraclostrobin 25% EC significantly reduced disease and resulted in increased yield as compared to captan, mancozeb and control. Arunakumara *et al.*, 2010; Horsfield *et al.*, 2010 and Sahu *et al.*, 2013 also tested the efficacies of some newer fungicides in field conditions for the management of early blight of tomato and they found pyraclostrobin, azoxystrobin and carbendazim + mancozeb were highly effective for the management of early blight. All the treatments showed significantly better foliage controlled as well as tuber yield over non- treated control. The results of this study were consistent with previous studies and indicated that the application of protective fungicides could reduce foliar early blight to acceptable levels. Thus, in the present study, it can be said that combination of protective fungicides may be effectively had suppression of pre as well as post-infection activity and inhibited sporulation and/or restricted lesion expansion of early blight pathogen. Also found not only to manage early blight but increase in the yield of potato as well (Table 2).

Table 2 Efficacy of fungicides tested as foliar spray on intensity of early blight disease and their impact on yield on potato.

Sr. No.	Name of Treatment	Per cent Disease Intensity (PDI)				Yield (kg/ha.)
		40 (DAS)	50 (DAS)	60 (DAS)	70 (DAS)	
T_1	Fenamidone 10% + Mancozeb 50% WDG	6.96 (1.48)	8.83 (2.37)	10.62 (3.40)	12.94 (5.03)	60574.00
T_2	Cymoxanil 8% + Mancozeb 64% WP	8.53 (2.22)	10.38 (3.26)	11.30 (3.85)	14.94 (6.66)	50352.00
T_3	Dimethomorph 50% WP	11.49 (4.00)	13.31 (5.33)	16.71 (8.29)	19.45 (11.11)	44444.00
T_4	Fosetyl Al 80% WP	13.31 (5.33)	14.93 (6.66)	17.89 (9.48)	20.38 (12.15)	44296.00
T_5	Mancozeb 75 WP	9.11 (2.51)	10.62 (3.40)	14.59 (6.37)	16.09 (7.70)	45648.00
T_6	Metalaxyl 8% + Mancozeb 64% WP	11.71 (4.14)	13.31 (5.33)	16.72 (8.29)	18.20 (9.77)	44537.00
T_7	Captan 70% + Hexaconazole 5% WP	9.62 (2.81)	11.74 (4.15)	15.09 (6.81)	16.71 (8.29)	45500.00
T_8	Metiram 55% + Pyraclostrobin 5% WG	8.25 (2.07)	10.38 (3.26)	11.95 (4.29)	14.04 (5.92)	56778.00
T_9	Carbendazim 25%+ Mancozeb 50% WS	8.25 (2.07)	10.81 (3.55)	12.55 (4.74)	15.76 (7.41)	49648.00
T_{10}	Control (Water spray)	14.25 (6.07)	15.25 (6.96)	18.05 (9.63)	20.64 (12.44)	41926.00
	SE(m) ±	0.34	0.33	0.43	0.47	2793.00
	C.D. at 5 %	1.01	0.99	1.29	1.42	8297.00
	C.V. %	5.80	4.78	5.13	4.86	10.00

Figure A: Concentric ridges forms on infected leaves

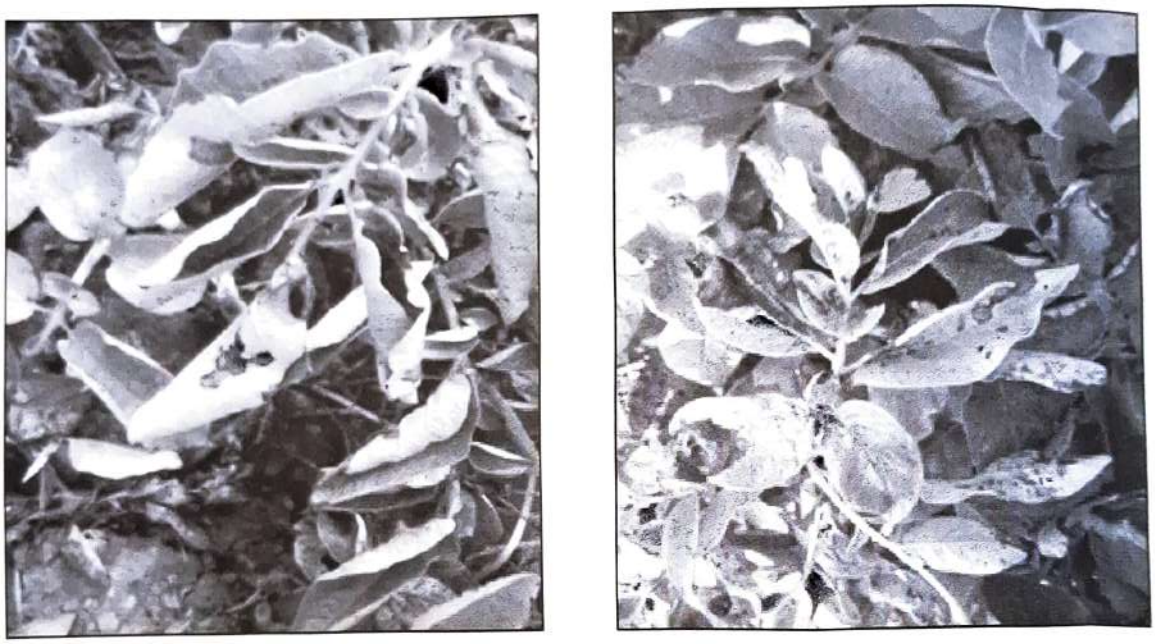


Figure B: Concentric ridges forms on infected leaves

REFERENCES

Anonymous. 2009. Indian Horticulture Database 2009. http://nhb.gov.in/database.2009.

Anonymous. 2017. Source: FAOSTAT. http://www.fao.org/

Anonymous. 2018. Monthly report potato (January 2018). Horticultural Statistics Division, Dept. of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India. p. 9.

Arunkumara, K. T., Kulkarni, M. S., Thammaiah, N. and Hedge, Y. 2010. Fungicidal management of early blight of tomato. *Indian Phytopathol.* **63** (1): 96-97.

Asit, K. M., Praveen, K. M., Subrata, D. and Arup, C. 2017. Effective management of major tomato diseases in the gangetic plains of eastern India through integrated approach. *Agri. Res. & Tech.* **10** (5): 555796.

Capriotti, M., Marchi, A., Coatti, M. and Manaresi, M. 2005. Cabriotop. The broad spectrum fungicide for the control of the main grapevine and tomato diseases. *Informatore Fitopatologico.* **55**: 38- 45.

Chester, K. S. 1959. How sick is the plant? In "Plant Pathology an Advance Traits" (Eds J. G. Horsfall and A. E. Diamond) Vol.1, Academic Press, New York. pp. 199-242.

Ellis, J. B. and Martin, G. B. 1882. Macrosporium solani E&M. *Amer. Nat.* **16**: 1003.

Ganeshan, G. and Chethana, B. S. 2009. Bioefficacy of pyraclostrobin 25% EC against early blight of tomato. *World Appl. Sci. J.* **7** (2): 227-229.

Gomez, K. A. and Gomez, A. A. 1986. Statistical procedures for agriculture research. 2nd edition, John Wiley and Sons. pp. 680.

Horsfield, A., Wicks, T., Davies, C. K., Wilson, D. and Paton, S. 2010. Effect of fungicide use strategies on the control of early blight (*Alternaria solani*) and potato yield. *Australas. Plant Pathol.* **39**: 368–375.

Hossain, M. S. and Hossain, M. M. 2009. Efficacy of foliar fungicides in controlling early blight of tomato. *Bangladesh J. Pl. Pathol.* **25** (1/2): pp. 55.

Patel, H. V. 2007. Studies on early blight of tomato caused by *Alternaria solani* (Ellis and Mart.) under north Gujarat conditions. M.Sc. (Agri.) Thesis, Submitted to Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. pp. 68.

Sahu, D. K., Khare, C. P., Singh, H. K. and Thakur, M. P. 2013. Evalution of newer fungicide for management of early blight of tomato in Chattisgarh. *The Bioscan.* **8**(4): 1255-1259.

Weeler, B. E. J. 1969. An Introduction to Plant Disease. John Willey and Sons Limited, London. pp 301.

GAU Research Journal **43** (2) : 112-114 (July 2018)

A study on farm mechanization level of farmers of Junagadh taluka

N. S. VITHLANI[1*], A. L. VADHER[2], R. G. JAKASANIA[3] AND T. D. MEHTA[3]

Centre of Excellence on Soil and Water Management,
RTTC, Junagadh Agricultural University, Junagadh

Received: 05 July, 2018 Accepted: 03 August, 2018

ABSTRACT

In modern usage, "agricultural mechanization" has come to mean the use of engines, especially tractors, for farm operations, but the word as used in this paper is in its fuller meaning to include all tools, implements and machines which can help the farmer or agricultural practitioner to use his muscles and mind to better advantage. The role of mechanization in enhancing agricultural productivity is well recognized. This paper reveals the status of agricultural mechanization in Junagadh Taluka. To study the available mechanization inputs and utilization questionnaires that were carefully designed to obtain information on the type power source available and their levels of utilization by the farmer of Junagadh taluka. It was revealed from the results of the data. As a result of these, the farm mechanization Level of farm mechanization horse power per unit cultivated land in Junagadh taluka from all sources is 3.30 hp/ha.

Key words: Agricultural mechanization, farm implements, technology, tractor, thresher, Crop, Irrigation

In the past three decades, agricultural output in India increased rapidly mainly through the introduction of high yielding varieties, increase in irrigated areas and increased use of fertilizers and pesticides. Along with the increase in food production, the use of from machinery in agriculture also increased. Many researchers have discussed the benefits of mechanization of agriculture in this region. A similar increase in the level of mechanization of the cultivation of paddy and other crops did not occur in the India.

Patel (1981) studied farm mechanization in India. He observed that per unit cost of operation declined sharply under mechanization and there was time saving in tillage operation. He also reported that mechanized farms had more labour hour use than the non-mechanized farms. Dash et al. (1988) studied constraints in the use of agricultural implements and machinery in the state of Orissa. They observed that mechanization in agriculture was not up to mark because of problems which were mostly social, economic and technical in nature. Mittal et al. (1989) reported that the production and availability of food crops can be increased by about 40 per cent in the Punjab state through the farm mechanization of sowing, intensive cropping, plant protection, post-harvest practices and reclamation of cultural wastes. Srivastava (1985) reported on the energy required for different field operations using animal and tractor power and availability of power and work output for crop production. The KW work done by using animal power was about 4.75 times that of tractor power. Thus, in terms of work output, the contribution of animals as compared to tractor power was much more.

Several reasons can be attributed to the slow progress of agricultural mechanization in state. The small sized fields make it difficult for the use of heavy mobile machinery. Small and fragmented land holdings, high capital investment, low purchasing power of the farmers, traditional methods of farming, abundance of unemployed labour and lack of clear government policies are some other factors hindering the pace of agricultural mechanization in the state. So, there is great need to know the level of mechanize farming. Therefore a study was conducted in selected villages of Junagadh taluka to make an assessment of the level of mechanization practised presently by the farmers and to determine the scope for further mechanization in that region. This paper should help researchers, Agro-industries and government

[1]Research Associate, [2]Assistant Professor, [3]Ph.D. Scholar
*Email : vithlaninipa@gmail.com

organizers to make log-term strategies on the mechanization for overall development of the farmers.

MATERIALS AND METHODS

The study was carried out in Junagadh taluka. It is located between 20º 44' to 21º 40' north latitude and 69º 40' to 71º 05' east longitude. The major crops grown in this region are Groundnut, sugarcane, and cotton.

For this study Dervan, Khalilpur, Majewadi, Choki, Makhiyada, Kathrota, Vadal, Bamangam, Ivnagar, Jamka, Dungerpur, Bela, Navagam, Toraniya, Semrala, Plaswa, Vijapur, Khadiya, Bilkha and Bagdu, total 20 sample villages were selected randomly from the 52 villages of the Junagadh taluka. Sarpanch and

Fig. 1 Map of Junagadh taluka

talatimantri were interviewed using a structured questionnaire in every sample village. Additional information on agricultural mechanization practised by the farmers were also gathered. The specific information asked in the questionnaires were: 1. Total agricultural Land (ha); 2. Irrigation source; 3. Use of tractors and implements; 4. Labour utilization and requirement; 5. No. of bullock.

The assessment of mechanization was done on energy basis. Irrigation sources, human, animal and tractor power were determined from the gathered information and calculate the farm mechanization level of Junagadh taluka with help of bellow equation.

Totalfarmpower (hp) = (0.1 × no. of labour) + (1 × no. of pair of bullock) + (30 × no. of tractor) + (5 × no. of electrical pump) + (7.5 × no. of dieselEngine)

$$\text{Level of farm mechanization} = \frac{\text{Total farm power (hp)}}{\text{Total cultivated land (ha)}}$$

RESULTS AND DISCUSSION

This analysis representation of experimental data collected during investigation.

Availability of Tractor and Cultivated Land in Junagadh Taluka

The purpose of this study, information regarding availability of various power sources in the Junagadh taluka were collected and presented in Table 1. In Junagadh taluka more tractor available in range of 35-45 hp and less tractor available in range of 20-25 hp. Now a day's demand of mini tractor is increased. In Junagadh taluka, land holding capacity of farmers is less, therefor more than 45hp tractors are not utilized by farmers. Use of 35-45hp tractor is more because we can use it in every operation and operating cost also preferable. Trend of tractors population increasing day by day.

Availability of Bullock in Junagadh Taluka

Table 1 shows that more bullock in Majewadi and less bullock in Dungerpur. Bullock has been traditionally the major farm power source in Indian agriculture. Energy from animal power is not only inadequate for modernization of agriculture but also slow. To ensure timeliness in field operation it would be require higher energy input to be supplemented by mechanical power. It was revealed in a study that, use of bullock power is declining due to introduction of mechanical power sources. The study also revealed that animal power use declined mainly in those villages where use of tractor is more.

Table 1. Analysis of Variance

Sr. No.	Name of Village	Land (ha)	No. of Labour	No. of Bullock	No. of tractor	No. of electrical	No. of diesel pump	Farm Power engine	hp/ha (hp)
1	Dervan	93	70	80	16	135	4	1272	13.67
2	Khalilpur	448	321	90	25	163	4	1717	3.83
3	Majewadi	1946	1153	436	56	987	5	7203	3.70
4	Choki	1500	638	300	61	260	38	3778	2.51
5	Makhiyada	331	438	135	27	327	2	2638	7.97
6	Kathrota	369	234	220	15	117	4	1308	3.54
7	Vadal	1946	185	272	55	732	3	5623	2.88
8	Bamangam	369	20	50	16	146	5	1299	3.52
9	Ivnagar	506	1800	100	31	150	15	2072	4.09
10	Jamka	330	131	160	32	171	7	2040	6.18
11	Dungerpur	10	10	0	12	2	0	371	37.10
12	Bela	455	46	104	8	70	10	773	1.70
13	Navagam	298	300	50	19	82	1	1067	3.58
14	Toraniya	80	1080	60	10	7	0	503	6.28
15	Semrala	205	120	135	25	140	3	1619	7.90
16	Plaswa	570	500	140	15	215	3	1737	3.04
17	Vijapur	565	290	56	15	100	2	1050	1.85
18	Khadiya	1200	700	100	35	80	2	1635	1..36
19	Bilkha	984	3000	300	15	264	200	3870	3.93
20	Bagdu	1000	650	80	30	200	5	2082	2.08
	Average	660	584	143	25	217	15	2183	3.30

Availability of Farm Labour in Junagadh Taluka

In Junagadh taluka more labour in Bilkha and less labour in Dungerpur. In most of the villages, labours come from the outside of the Junagadh taluka like Godhara, Madhya Pradesh etc. at harvesting time. They are usually employed for field operation inter culture, sowing, weeding, harvesting etc. In hilly areas even land preparation is usually done manually.

Over the last 50 years on farm mechanization has increased resulting in a decrease in the employed farm labour forces. This was caused to a certain extent by increases in wage payments.

Availability of Electrical Pump and Diesel Engine in Junagadh Taluka

Availability of electrical pump is more as compare to diesel engine which shows in table 1. Electrical pump need minimum maintenance and repairing as compare to diesel engine. Diesel is more costly as compare to electricity, So Electrical pump is more used by the farmer as compare to diesel engine. The government policies: encouraged the farmers to have their own assured irrigation facilities by providing subsidy and credit for drilling of tube-wells and purchase of pumping system.

REFERENCES

Dash, S. K. and S. C. Pradhan. 1988. Agricultural mechanization in orissa, India. AMA **19** (1): 69-72.

Mittal, V. K., B. S. Bhatia, and A. M. Chauhan. 1989. Food security through farm mechanization. The Punjab science. Farm Power and Machinery, ASAE, Jan. 5-7: 88- 95.

Patel, A. R. 1981. Farm mechanization in India. Agricultural Engineering Today. December, 12.

Srivastava, N. S. L. 1985. Status of Draught Animal Power in India and its Utilization in Rural Sector: A key note address. Silver Jubilee Convention, Indian Society of Agricultural Engineers, Central institute of Agricultural Engineering, Bhopal.

GAU Research Journal **43** (2) : 115-119 (July 2018) **Short Communication**

Occurence and distributional outline of black point and karnal bunt of Wheat in North Gujarat

ELANGBAM PREMABATI DEVI[1]*, S.I. PATEL[2] AND A.A. PATEL[3]

Wheat Research Station,
S.D. Agricultural University, Vijapur-382 870 (Gujarat)

Received: 05 July, 2018 Accepted: 03 August, 2018

ABSTRACT

Examination of wheat grain samples for the infection of black point and karnal bunt of wheat during 2011-12 to 2016-17 in various marketing yards and farmer's field of various talukas of North Gujarat has resulted that the overall per cent severity of black point of wheat was higher during the year 2012-13 and 2013-14. While during the remaining of study, the severity of black point were in the range of 21 to 23 per cent. The maximum range of infection of black point of wheat in the infected grain samples was observed during 2011-12 whereas it was under the range of 5.6 to 9.5 during the years 2012-13 to 2016-17. All the grain samples collected from the various talukas of North Gujarat were free from the infection of karnal bunt during all the study years which suggested that the climatic condition of North Gujarat doesn't favour the development of karnal bunt of wheat.

Key words: *Alternaria alternata*, black point, discolouration, market price, karnal bunt

Alternaria alternata is considered as primary causal organism for black point of wheat (Adlakha and Joshi, 1974; Srivastava *et al.*, 2014). Black Point of wheat is the major limiting factor for milling and baking property of chapatti and bread making since it lead to quality deterioration of wheat in India (Singh *et al.*, 2018). The diagnostic symptom of black point of wheat is the presence of conspicuous brownish to black discolouration mainly at embryonic end of wheat seed. It also strikes on endosperm tissues and ventral crease of seeds imparting brownish to black discoloration along with the shrivelling of seed. Sometime, in a very extreme condition, microscopic observations of pericarp tissues verified the presence of typical fungal growth within. These discolourations on various parts of seeds affect grain quality which ultimately leads to reduction in market price of wheat. The infection of black point of wheat reduces quality appearance of grain mainly the colour and luster which reduces the market price of wheat in the range of 3.71 to 12.49 per cent in Gujarat (Solanki *et al.*, 2006; Mishra and Srivastava, 2015). Grain losses due to the black point ranged from 24 to 27 per cent in very susceptible cultivars due to the loss in number of kernels and dry weight of kernel (Bhandari *et al.*, 2003). The infection invariably causes deprivation of seed and grain quality coupled with diminution of nutritive value (Vuckovic *et al.*, 2012). Defective agronomical practices coupled with favourable meteorological conditions endorse the growth of pathogen which in turn causes development of symptoms in grains (Patel and Manipara, 2015). Moreover, delayed application of irrigation in field to utilise the residual soil moisture also facilitates the infection and symptom expression of black point of wheat (Srivastava *et al.*, 2014). The infection becomes severe when prolonged wet weather prevails during grain filling period stage of crop. When seed moisture content exceeds 20 per cent, coupled with the presence of high relative humidity of above 90 per cent, then the amount of infection of black point increases significantly (Toklu *et al.*, 2008). Reduction in germination, seedling emergence, plant stand, root and shoot growth, tillering and grain yield were directly related with the severity of black point of wheat (Stoyanova *et al.*, 1997; Ozer, 2005).

Karnal bunt of wheat, caused by *Neovossia indica* is a limiting factor in wheat export since the pathogen is reported as quarantine pest in India and its seed borne nature also threaten trading of wheat between countries and seed certification point of view (Kumar *et al.*, 2008; Tan *et al.*, 2009). Thus, the present investigation was carried out to know the occurence

[1]Assistant Research Scientist [2]Associate Research Scientist, [3]Research Scientist
*Email : epremabati35@gmail.com

Table1 List of places from where samples were collected in North Gujarat.

Places of sample collection					
2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Mansa	Mansa	Mansa	Mansa	Mansa	Mansa
Dehgam	Dehgam	Dehgam	Dehgam	Dehgam	Dehgam
Rakhiyal	Talod	Talod	Talod	Talod	Prantij
Talod	Khedbramha	Khedbramha	Prantij	Prantij	Talod
Prantij	Idar	Idar	Khedbramha	Idar	Kalol
Mehsana	Vadali	Vadali	Vadali	Kadi	Khedbramha
Visnagar	Bhiloda	Bhiloda	Visnagar	Kalol	Idar
Vijapur	Himmatnagar	Himmatnagar	Mehsana	Khedbramha	Vadali
Farmer's field	Kukarvada	Kukarvada	Kukarvada	Vadali	Dhansura
	Gogaria	Gogaria	Vijapur	Salal	Mehsana
	Mehsana	Mehsana	Farmer's field	Mehsana	Visnagar
	Visnagar	Visnagar		Visnagar	Vijapur
	Vijapur	Vijapur		Kukarvada	Farmer's field
	Farmer's field	Farmer's field		Vijapur	
				Farmer's field	

Table 2 Status of black point infection of wheat during 2011-12 to 2016-17.

Place	Years of sample examined	Total sample examined	No. of infected sample	Average per cent of infection	Average range of infection
Mansa	2011-12 to 2016-17	212	61	30.51	5.7
Dehgam	2011-12 to 2016-17	190	71	35.62	6.1
Rakhiyal	2011-12	13	03	15.40	5.9
Talod	2011-12 to 2016-17	200	46	27.20	5.1
Prantij	2011-12 and 2014-15 to 2016-17	126	24	16.85	3.6
Kadi	2015-16	45	10	22.20	4.7
Kalol	2015-16 to 2016-17	43	20	23.80	4.2
Khedbramha	2012-13 to 2016-17	168	56	35.58	4.7
Idar	2012-13 to 2016-17	187	70	36.40	6.6
Vadali	2012-13 to 2016-17	186	63	34.22	5.3
Bhiloda	2012-13 to 2013-14	62	29	46.66	7.9
Salal	2015-16	20	04	20.00	4.4
Dhansura	2016-17	30	06	20.00	3.2
Himmatnagar	2012-13 to 2013-14	45	20	45.53	5.8
Kukarvada	2012-13 to 2015-16	162	58	35.85	5.2
Gogaria	2012-13 to 2013-14	49	22	44.53	6.0
Mehsana	2011-12 to 2016-17	261	80	33.36	6.8
Visnagar	2011-12 to 2016-17	249	76	31.50	6.8
Vijapur	2011-12 to 2016-17	318	84	28.34	6.9
Farmer's field	2011-12 to 2016-17	345	85	31.36	5.7

Table 3 Year wise severity of black point and karnal bunt of wheat in North Gujarat.

SN	Year	No. of sample	Per cent severity examined	Per cent severity of black point of karnal bunt
1.	2011-12	251	21.50	0
2.	2012-13	380	49.85	0
3.	2013-14	485	47.24	0
4.	2014-15	536	21.80	0
5.	2015-16	629	23.20	0
6.	2016-17	673	22.60	0

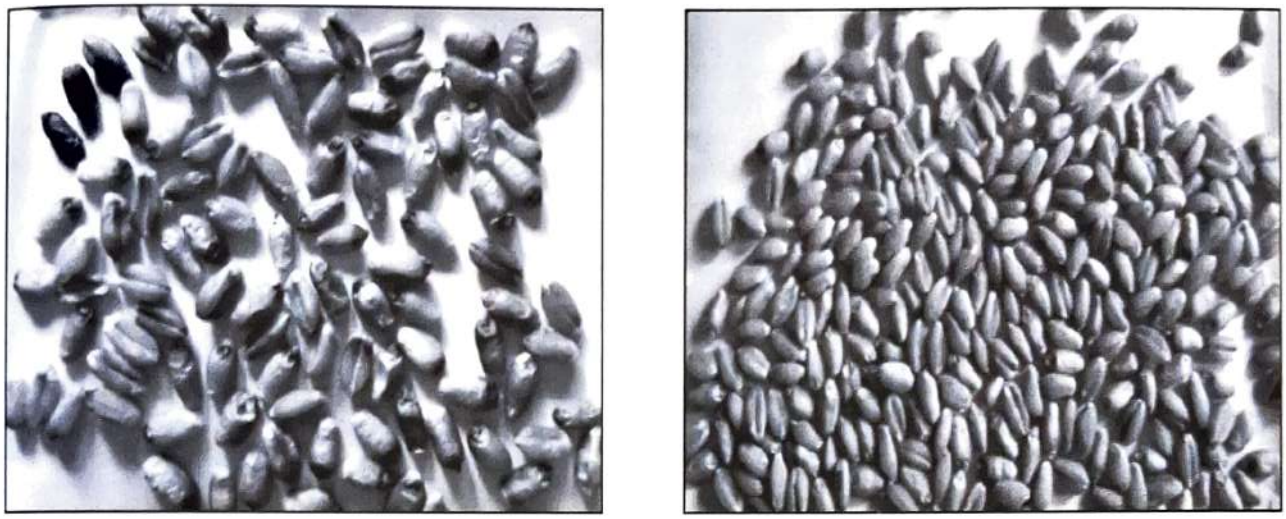


Fig 1. Black point infected grains and healthy grains of wheat

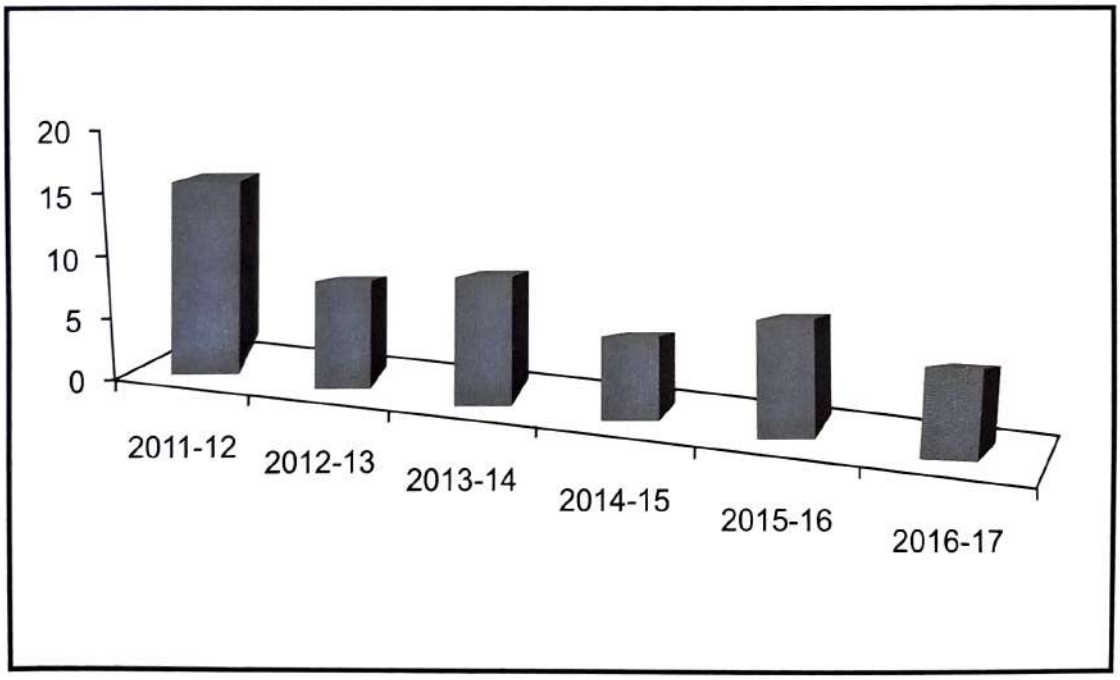


Fig 2. Range of infection of black point in infected grain samples of wheat

and distributional status of black point and karnal bunt of wheat in various marketing yards and farmer's field under different talukas of North Gujarat.

MATERIALS AND METHODS

Mobile survey in local grain marketing yards and farmer's fields under various talukas of North Gujarat were conducted after harvest of crop for the collection and examination of grain samples during 2011-12 to 2016-17. Various talukas of North Gujarat were visited as provided in table 1 and samples were collected for examination of disease. Proper examination of grains for characteristic symptoms of black point and karnal bunt of wheat were conducted by visual observation and later on per cent grain samples infected with the disease were calculated as follows:

Per cent grain sample infected =

$$\frac{\text{No. of samples infected}}{\text{Total no. of samples examined}} \times 100$$

Then, per cent range of infection of black point was determined by collecting 1000 grains from the mixed seed lot and they were examined critically in a ten sub samples of 100 grains each and calculated as follows:

Per cent range of infection =

$$\frac{\text{No. of grains infected with black point}}{\text{Total no. of grains examined}} \times 100$$

RESULTS AND DISCUSSION

Area wise distributional status of black point of wheat is presented in table 2. The overall per cent severity of black point and karnal bunt of wheat under different talukas of North Gujarat during 2011-12 to 2016-17 is presented in Table 3 and overall their range of infection is presented in Fig. 2. During the year, 2012-13 and 2013-14 the overall per cent severity of black point of wheat were higher i.e. 49.85 and 47.24 respectively (Table 3). While during the years of study i.e. 2011-12, 2014-15, 2015-16 and 2016-17 the overall severity of black point infection were in the range of 21 to 23 per cent. But, during all the years of study, infection of karnal bunt of wheat was not reported in all the grain samples collected from various talukas of North Gujarat which suggested that climatic condition of North Gujarat doesn't favour the development of karnal bunt. Examination on the overall range of infection of black point of wheat has indicated that during 2011-12 it was higher i.e. 15.6 while during the years of study i.e. 2012-13 to 2016-17 the overall range of infection of black point of wheat were in the range of 5.6 to 9.5 (Fig. 2).

Visual observation of wheat grains after harvest has indicated that the incidence of black point increased with the increase in exposure period of the spikes due to the airborne inocula of the primary pathogen associated with black point of wheat (Malaker and Mian, 2010). Similar result also reported that the infection of black point of wheat was invariably present in all wheat growing region of North Gujarat with certain degree of its infection in 6664 wheat grain samples of various surveyed areas of marketing yards and farmer field during 2001-02 to 2009-2010 as well as suggested that the occurence of karnal bunt of wheat was free form the state which support the findings of present investigation (Patel and Solanki, 2012). The result of Singh *et al.* (2018) has indicated that infection of black point of wheat was prevalent during 2012-13 to 2014-15 in states of North Western Plain Zone (NWPZ) from where samples were analyzed but there was difference in the disease incidence in different states of India which suggested that the weather factors prevailing in different states at vulnerable stage of the crop affect the disease outbreak.

REFERENCES

Adlakha, K. L. and Joshi, L. M. 1974. Black point of wheat. *Indian Phytopathology*. **27**:41-44.

Bhandari, D., Bhatta, M. R., Duveiller, E., Shrestha, S. M. 2003. Foliar blight of wheat in Nepal: resistance breeding, epidemiology and disease management. In: Proceedings of fourth International wheat tan spot and spot blotch workshop, Bemidji, Minnesota, USA, pp.34-41.

Kumar, A., Singh, U. S., Kumar, J. and Garg, G. K. 2008. Application of molecular and immune diagnostic tools for detection, surveillance and quarantine regulation of Karnal bunt (*T. indica*) of wheat. *Food and Agricultural Immunology*. **19**:293-311.

Malaker, P. K. and Mian, I. H. 2010. Population dynamics of mycoflora and incidence of black point disease in wheat grains. *Bangladesh Journal of Agricultural Research*. **35** (1):1-10.

Mishra, L. P. and Srivastava, J. P. 2015. Studies on black point disease of wheat (*Triticum aestivum* L.). *Research in Environmental Life Science*. **8** (3):459-462.

Ozer, N. 2005. Determination of the fungi responsible for black point in bread wheat and effects of the disease on emergence and seedling viguor. *Trak University Journal of Science*. **6** (1):35-40.

Patel, D. J. and Minipara, D. B. 2015. Symptomatology of black point infected wheat (*Triticum aestivum* L.) seeds. *International Journal of Agriculture Sciences*. **7** (6): 533-535.

Patel, S. I. and Solanki, V. A. 2012. Status of karnal bunt and black point of wheat in north Gujarat. *Environment and Ecology*. **30** (3):552-553.

Singh, P. K., Singh, S., Saharan, M. S., Singh, D. P. and Pandey, G. C. 2018. Distribution of wheat disease black point (Kernel Smudge) in India. *Journal of Pharmacognosy and Phytochemistry*. SP **1**:1821-1824.

Srivastava, J. P., Kushwaha, G. D., Shukla, D. N. 2014. Black point disease of wheat and its implications on seed quality. *Crop Research*. **47**:21-23.

Solanki, V. A., Augustine, N. and Patel, A. A. 2006. Impact of black point on wheat trade and its management. *Indian Phytopathology*. **59** :44-47.

Stoyanova, S. D., Phyliopov, C., Dachev, Z., Vassilev, V. I. 1997. Black point of grain in bread winter wheat, 3 and effect on seed viability. *Annual Wheat Newsletter*. **43**:68-70.

Tan, M. K., Ghalayini, A., Sharma, I., Yi, J., Shivas, R., Priest, M. and Wright, D. 2009. A one-tube fluorescent assay for the quarantine detection and identification of T. indica and other grass bunts in wheat. *Australasian Plant Pathology*. **38**:101-109.

Toklu, F., Akgul, D. S., Bicici, M., Karakoy, T. 2008. The relationship between black point and fungi species and effects of black point on seed germination properties in bread wheat. *Turkish Journal of Agriculture*. **32**:267-272.

Vuckovic, J. N., Brkljaca, J. S., Bodroza-Solarov, M. I., Bagi, F. F., Stojsin, V. B., Culafic, J. N. and Acimovic, M. G. 2012. *Alternaria spp.* on small grains. *Food Feed Res*earch. **39**:79-88.