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RESEARCH ARTICLE

TOXICITY INDUCED BY PROPHENOPHOS AND CHLOROPYRIPHOS IN *LATHYRUS SATIVUS* L.

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Abstract: Dry seeds (moisture content: 3.22%) of grass pea (*Lathyrus sativus* L.; family: Fabaceae) are treated with different doses of (0.05, 0.1 ,0.2 and .03 percent, 3h) of pesticides namely Prophenophos (common name:Carina50) and Chloropyriphos (Dursban), and attributes like seed germination frequency, seedling length, mitotic index, chromosomal aberrations and total protein and soluble sugar content have been analyzed. The objective of this work is to foresee the extent of biological damages caused by the chemicals, which may enable to administer appropriate doses that cause lesser environmental hazards. Results have been analyzed.

Keywords: Pesticides, Chromosomal aberration, Biological damage, Environmental hazards

INTRODUCTION

Pesticides are used all over the world to protect agricultural products from pests, thereby stepping up the output for satisfying up surging demand of population. However, residues of these chemicals are hazardous to the health of nontarget organisms like domestic animals, human beings etc. (Ali 2007). Most of the pesticides are chromosome damaging as well as mutagenic and carcinogenic (Kihlman, 1966). The pesticides are introduced into the nature through plants and moulds (Ahluwalia, 1985) affecting the ecosystem resulting into environmental hazards. Therefore, careful assessment of such chemicals is of utmost importance. Plant system can be used as test material as it is convenient, easy to use and cost effective.

There is meager information regarding cytogenetic side effects of Prophenophos (common name: Carina50) and Chloropyriphos (common name: Dursban) the widely applied pesticides in West Bengal plains on a large variety of plants to control various types of insects in the fields. The present investigation has been undertaken to assess the toxic effects of these two pesticides on *Lathyrus sativus* L. (family: Fabaceae, common name: grass pea, 2n= 14) with a view to ascertain sub lethal doses, which can be beneficial to control environmental hazards.

MATERIAL AND METHOD

Dry and filled seeds (moisture content: 3.322%) of *Lathyrus sativus* L. (family: Fabaceae) were treated with different doses (0.05, 0.1 ,0.2 and 0.3 for 3h; doses administered were based on doses applied in the field by the farmers) of two pesticides namely Profenophos (common name:Carina50, formula: o-(4 bromo-2 chlorophenyl)-o ethyl 3 hydroxy propyl phosphorothioate, functions: causing stomach toxicity) and Chloropyriphos (common name: Dursban, formula: $C_9H_{11}Cl_3NO_3PS$, functions: on the nervous system of insects by inhibiting acetylcholine esterase) at $25^oC \pm 1^oC$ temperature and 80% relative humidity. The treated seeds were thoroughly washed in running water and were recovered in Knops solution for overnight and dried on blotting paper. Untreated control seeds were soaked in deionized water for overnight. Treated and control seeds were given in petriplates lined with moist filter paper under controlled condition ($25^o \pm 1^oC$). Germination frequency (bursting of seed coat and emergence of radical) and seedling growth were estimated from randomly taken 15 germinating seeds (7 days after sowing). Biological damages like lethality and injury were assessed from germination frequency and seedling growth respectively (Konzak *et al*. 1965).

For cytological studies suitable sized root tips from control and treatments were excised and fixed in acetic acid: ethyl alcohol (1:3) for overnight at room temperature. The fixed roots were then stained in 2% aceto orcein: 1(N) HCl(9:1) mixture and kept for 1hr. The root tips were excised and squashed in 45% acetic acid on a grease free slide and observed under microscope for scoring chromosomal aberrations and determination of mitotic index. Mitotic index (M.I.) was calculated from the following formula:

$$\text{Mitotic Index} = \frac{\text{Total no. of dividing cells}}{\text{Total no. of cells}} \text{X100\%}$$

Quantitative analysis of protein and total soluble sugar were made from seedlings of control and treatments (three replicas in each case) using the method described by Lowry *et al.*(1951) and Sadasivam and Manickam (1992) respectively.

RESULT AND DISCUSSION

Data relating to germination frequency, seedling growth and biological damages are presented in Table1. As compared to control, germination frequency is found to enhance in higher doses of

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Carina50. Among the treatments germination frequency varies from 20.0% to 40.0% (control: 28%). In Dursban, germination frequency shows dose dependent decrease (range:12.0% to 38.0%). Seedling growth has been noted to be 36.7mm + 0.21 in control and it shows significant reduction in treatment of both pesticides (excepting 0.3% carina50). Reduction in germination frequency and seedling growth has been attributed to the nature and extent of chromosome aberrations occurring in the cell (Mukherjee and Basu 1979, Datta and Biswas 1983, Datta *et al*. 1986) and to structural changes (Gray and Read 1950) of the chromosomes. Retardation of growth may primarily be due to the destruction of auxin at meristematic region (Singh 1974). In the present investigation lethality is less; although injury is predominant in treatment.

In the present investigation a total of 7 mitotic aberration types (Table2) is noted in dividing cells and 3 in resting cells. The aberrations types are: clumping and sticky nature of chromosomes (Fig.2) and fragment(s)[Fig.3] at metaphase, bridge(Figs.4-6) with or without accompanying fragment(s),early and late separation(Fig.7) of chromosomes and multipolarity(Fig.8) in anaphase cells. Micronuclei(Fig.9), giant cells and nuclear margination(Fig.10) are also recorded in resting cells. Control cells also reveal occasional occurrence of clumped metaphase, fragments, bridge and giant cell (Table2).Mitotic index is noted to be 19.63% in control; whereas, it ranges between 19.21% and 38.58% in Carina50 and between 18.49% and 41.395 in Dursban treatment. Mitotic index has been found to enhance in treatments of both the pesticides. The cell which is unable to repair the DNA damage has two options at the end of Hayflic limit – the first one is apoptosis by cytolysis second one is anapoptosis (a state of immortality) condition gained by the cell probably causing cancer (Sreedevi and Bindu 2004). Increase of mitotic index in this study, may be the result of anapoptosis condition earned by the cell when exposed in extremely stressed environment. Stickiness of the chromosomes at metaphase is the most common abnormality found in all treatments. Frequency of sticky cells shows dose dependent increase in concentration in both the pesticides. Stickiness may result from breakage and exchange between chromatin fibres on the surface of adjoining chromosomes (Abdelsalam *et al* 1999a). It causes inability of normal movement of chromosomes at anaphase (Sreedevi and Bindu 2004) resulting in nonsynchronus movement of chromosomes (Badr *et al.* 1985). Sticky chromosomes indicate high toxic chemical effects that are usually not reversible and will probably lead to cell death (Ateeq *et al*. 2002, Yuzba Sioglu 2003). Formation of metaphase fragments suggests breakages. Such fragments may be distributed randomly to either pole or may produce micronuclei at telophase (Abdelsalam *et al*. 1993b). Micronucleus and multipolarity are only found in Carina50 treated samples at higher doses. Occurrence of micronuclei has been regarded as reliable parameter for clastogenicity or mutagenicity of an agent (Auerbach 1976). The higher the micronucleus frequency detected in exposed organisms, the higher the potentiality of the agent to cause mutation (Sparrow 1961). Multipolarity is strongly correlated with bridges at anaphase which are due to dysfunctional telomerase produced by abnormal telomerase shortening (Gisselsson *et al.* 2002, Stewenius *et al.* 2007). Nuclear marginationis only found in Dursban treated samples.

Total Protein content (Table3) is found to decrease in lower doses of Carina50 treatment but increase in the applied dose. It indicates that initially gene expression was inhibited but at highest dose the plant tried to cope up with the adverse condition by inducing more proteins (probably stress protein). On the contrary, Dursban treatment shows initial increase in protein content but at higher doses it may be that initially protein (probably stress protein) production was induced to eliminate the stress given to it and ultimately at higher doses protein production decreases due to the lethal action of the chemical on gene expression. In Carina50 treatment total soluble sugar content (Table3) has been found to decrease in lower doses and increases in 0.3% concentration; while, in Dursban it increases in lower doses but abruptly decreases in 0.3% concentration. Increase of soluble sugar may be due to the breakdown of lipid content or may be due to the induction of gluconeogenesis.

Table1. Germination frequency (%), seedling growth and biological damage in petriplates for control and different doses of treatment.

Treatments (%)	No. of seeds given	Germination frequency(%)	Seedling growth(mm)		Biological damage(%)	
			Mean±SE	CV(%)	Lethality	Injury
Control	100	28.0	36.7±0.21	2.18	-	-
Carina50 0.05	100	20.0	18.75***±0.076	6.58	28.57	49.42
0.1	100	26.0	24.0***±0.073	5.59	7.14	33.43
0.2	100	24.0	12.63***±0.09	7.26	14.29	66.02
0.3	100	42.0	34.29±0.06	3.89	-	6.43

Dursban 0.05	100	38.0	28.44*±0.022	5.23	-	22.89
0.1	100	32.0	12.2***±0.02	7.34	-	17.69
0.2	100	22.0	30.42*±0.037	5.01	21.43	48.93
0.3	100	12.0	19.0***±0.15	6.08	57.14	67.008

t value at 28 DF
*- significant at 0.05 probability level, ***- significant at 0.001 probability level

Table 2. Mitotic aberration frequencies(%) and mitotic index(%) in control and in different doses of treatment.

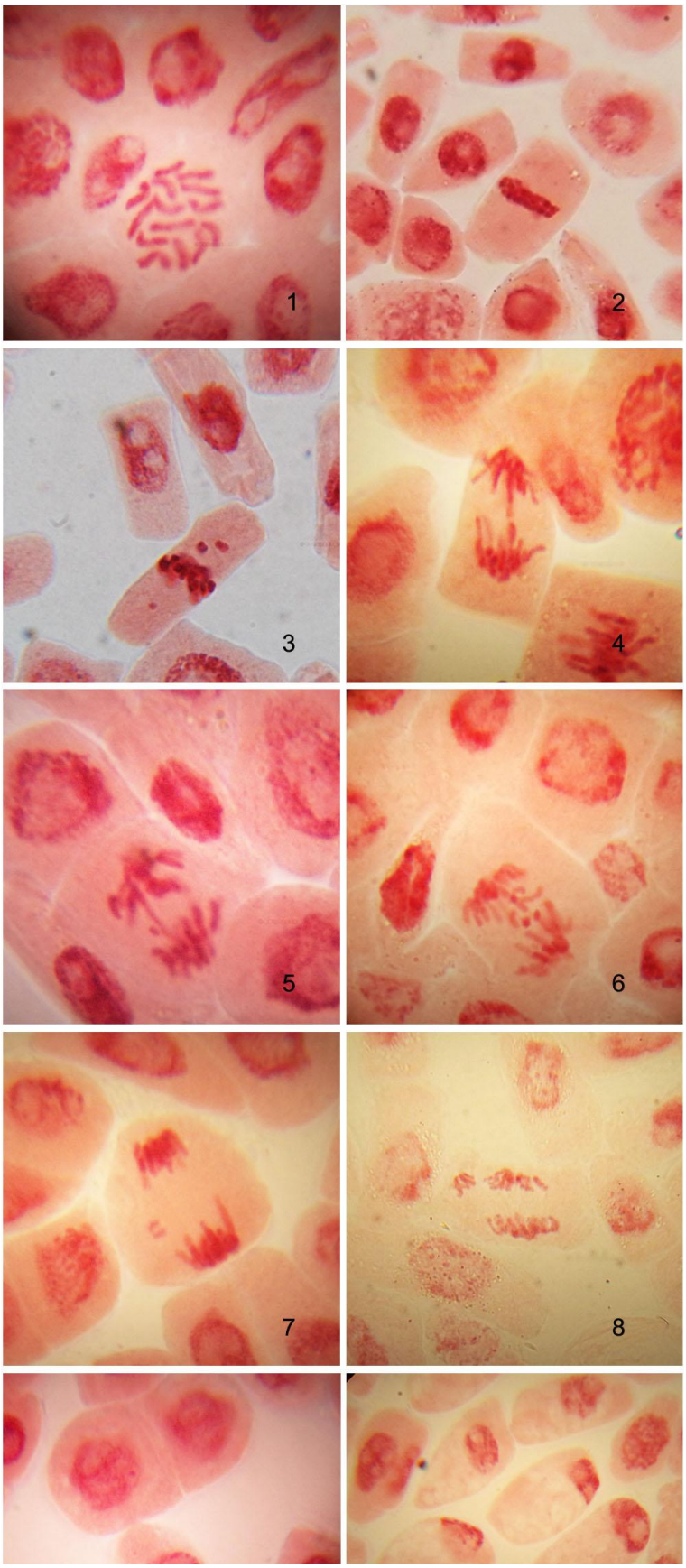
Treatments (%)	Total No. of cells scored	No. of dividing cells	Mitotic Index(%)	Frequency(%) of chromosomal aberrations									
				Dividing cells							Resting cells		
				CM	FM	ES	LS	BF	BWF	MP	MN	GC	NM
Control	1310	333	19.63	2.37	0.07	-	-	-	0.07	-	-	0.31	-
Carina50 0.05	1346	354	26.30	4.75	0.59	3.94	2.53	0.82	-	-	-	0.97	-
0.1	1275	245	19.21	8.16	1.65	2.43	4.78	1.65	1.65	0.78	-	1.02	-
0.2	1287	346	26.89	5.75	2.33	4.89	2.56	0.31	1.32	1.65	0.47	2.09	-
0.3	1174	453	38.58	16.5	3.07	3.49	3.92	3.32	1.96	-	-	2.81	-
Dursban 0.05	1058	438	41.39	10.9	0.47	2.08	2.46	1.13	0.95	-	-	1.61	-
0.1	1261	438	34.74	6.58	1.11	1.11	1.82	1.11	1.35	-	-	1.03	-
0.2	1175	345	29.37	8.42	1.45	1.70	2.64	1.45	1.45	-	-	0.94	0.43
0.3	1352	250	18.49	14.8	1.99	8.80	2.81	3.62	3.62	-	-	2.44	-

CM- Clumped and sticky metaphase, FM- Fragment(s) at metaphase, ES- Early separation, LS- Late separation, BF- Anaphase bridge with Fragment(s), BWF- Anaphase bridge without fragment, MP- Multipolarity, MN- Multinucleus, GC- Giant cell and NM- Nuclear margination,.

Table 3. Quantitative analysis of protein(%) and soluble sugar(%) from seedling of control and different doses of treatments.

Treatments	Protein(%)	Soluble Sugar(%)
Control	14.75	23.968
Carina50 0.05	9.71	12.32
0.1	12.88	20.72
0.2	12.32	19.88
0.3	17.08	40.32
Dursban 0.05	17.54	37.52
0.1	13.82	21.56
0.2	16.43	30.24
0.3	8.86	9.52

Explanations of the figures
Figs.1-10. 1-Normal metaphase, 2-Clumped and sticky metaphase, 3-Fragments at metaphase, 4-Anaphase bridge without fragment, 5- Anaphase bridge with fragment, 6-Broken bridge with fragment,7- Late separation of chromosomes, 8-Multipolarity, 9-Micromuclus and 10-Nuclear margination.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CONCLUSION

In this investigation both the insecticides show severe irreparable cytotoxic effect on *Lathyrus sativus* L., and both of them were found to be clastogenic (showing chromosomal aberration) and turbagenic (affecting the spindle) in nature. The toxicity increases mostly with an increase in concentration of the chemicals. Furthermore, micronucleus formation induced by Carina50 reflects the mutagenic nature of the chemical. The present investigation highlighted the necessity of proper monitoring of appropriate dose level in the pesticides to reduce environmental hazards.

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RESEARCH ARTICLE

EFFECT OF THRIPS POPULATION ON MANAGEMENT OF BUD NECROSIS VIRUS INFECTING TOMATO *LYCOPERSICON ESCULTENTUM* MILL IN ANDHRA PRADESH

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Abstract: The closer the spacing resulted the lower was the thrips incidence. The thrips population was increased from 30 DAP to 50 DAP and then declined from 60 DAP. The thrips population was lowest in early planted crop and highest in late planted crop and medium in normal planted crop in *kharif* and *Rabi* seasons. The thrips population was highest in *kharif* followed by *Rabi* season. The thrips populations has a significant relationship with the stage of the crop.

Keywords: Bud necrosis virus, Tomato, Thrips population, Cultural practices

INTRODUCTION

In Andhra Pradesh, tomato is grown very extensively in Chittoor district followed by Kurnool. Major markets for tomato export are located at Madanapalli and Palamaneru in Chittoor district and Aluru, Aspari, Pyapili and Pattikonda in Kurnool district. The most important tospo virus infecting tomato include tomato spotted wilt virus (TSWV) in USA, Spain, Taiwan and Argentina and peanut bud necrosis virus (GBNV) in India. GBNV seems to be endemic in India and its host range indicates that legumes and other hosts play a major role in disease occurrence (Ghanekar *et al.*, 1979; Singh and Krishna Reddy, 1996). Tomato spotted wilt virus (TSWV) was reported to occur as early as 1919 in Australia. Its occurrence in India was first reported by Todd *et al.*, (1975) from Nilgiris. Of several viral diseases attacking tomato bud necrosis disease caused by Groundnut bud necrosis virus (GBNV) transmitted by *Thrips palmi* (karmy) in a propagative manner was considered to be a major threat and caused chlorotic and necrotic symptoms. The management of the disease emphasizes phytosanitary and agronomic measures that limits potentials sources of virus infection, uses chemical control measures against thrips.(Coutts & Jones, 2005). The disease development , thrips population and yield of tomato were influenced by different cropping systems (Ramkat *et al* 2008).

METHODOLOGY

Interaction of time of planting, different spacing levels and different doses of nitrogen fertilizer application as major factors. The most susceptible cultivar Meghana was planted in a plot size of 4.2 x 3.6M and replicated thrice. In 27 combinations are D1: Early planting: June 1 (*kharif*) and September 1 (*rabi*); D2: Normal planting: July 1 (*kharif*) and October 1 (*rabi*); D3: Late planting: August 1 *(kharif*) and November 1 (*rabi*); S1: Closer spacing: 60 x 30cm; S2: Normal spacing: 60 x45cm; S3: Wider spacing: 60 x60cm; N1: Lower dose of N-application: 100kg/ha; N2: Medium dose of N-application: 150kg/ha; N3: Higher dose of N-application: 200kg/ha.

Out of 27 combinations of treatments included in the first phase of experiment, two best combinations were chosen to include in the second phase of experiment along The trail was conducted in two phases during *Kharif* and *Rabi* in a factorial RBD with with barrier crop, seed treatment coupled with spray application. The thrips population was recorded at 30 DAP

RESULT

Phase –I: *Kharif, 2009*

Thrips population

At 30 DAP, in normal planted July 1st crop, the minimum thrips population 12.48, 14.05, 15.75 in closer spacing.with nitrogen levels 100kg/ha, 150kg/ha and 200kg/ha respectively (Table 1). At 30, DAP in late planted August crop the minimum thrips population 15.48, 15.4, 19.3 in close spacing and nitrogen levels 100kg/ha, 150kg/ha and 200kg/ha respectively. Where as it was increased with increase in spacing and nitrogen levels. Evidently the occurrence of thrips population was closely associated with plant density or plant to plants spacing. The lowest thrips population was observed with closer spacing 60x30cm Even at 40 DAP the highest thrips population (18.48) was recorded with wider spacing 60x60cm and high nitrogen dose @200kg/ha in late planted (August) crop. At 50 DAP also, the same result was recorded the lowest thrips population 14.73, was recorded in the closer spacing in early planted (June 1st) crop.

Rabi

Thrips population

At 30 DAP, lowest population of 5.58 thrips was observed at closer spacing 60x30 cm and lower

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nitrogen 100 Kg/ha in early planted September 1st crop. Thrips population significantly increased to 12.55 with wider spacing 60x60 cm and high nitrogen content 200 Kg/ha (Table 2).

Over all data revealed that the factors dates of sowing, spacing levels and nitrogen levels had significant influence on the occurrence of thrips population. The closer the spacing resulted the lower was the thrips incidence. The thrips population was increased from 30 DAP to 50 DAP and then declined from 60 DAP. The thrips population was lowest in early planted crop and highest in late planted crop and medium in normal planted crop in *kharif* and *Rabi* seasons. The thrips population was highest in *kharif* followed by *Rabi* season. The observation clearly indicated the thrips populations were having a significant relationship with the stage of the crop. population was low at 30 DAP and increased progressively up to 50 DAP to reach peack levels.

When the interaction effect studied the thrips population had significant difference between date of planting, spacing levels and nitrogen levels.

Yield Data

In the *kharif* , maximum yield was recorded in the treatment combination D2S2N2 (29.14 t/ha) i.e. normal data of planting (July 1st) + normal spacing (60X45cm) + normal nitrogen level (150kg/ha) followed by D2S2N1 (28.52 t/ha) i.e. Normal data of planting (July 1st) + normal spacing (60X45cm) + low level nitrogen (100kg/ha) in *rabi* 2007, maximum yield was recorded in the same combination D2S2N2 (30.54 t/ha). (Table.3)

Phase –II: *Kharif*

Thrips population

At 30 DAP, the lowest thrips population in spray treatment with S_1-seed treatment with imidacloprid @ 5 g/Kg seed and spray with imidacloprid 0.4 ml/L. of water with barrier crop further there was increase in thrips population up to 50 DAP and declined significantly at 60 DAP (Table 4).

Rabi

Thrips population

At 30 DAP lowest population of thrips (1.91) was observed at spray treatment with S_1-seed treatment with imidacloprid @ 5 g/Kg seed and spray with imidacloprid 0.4 ml/L of water with barrier crop further there was increase in thrips population up to 50 DAP and declined significantly at 60 DAP (Table 5)

Yield Data

Highest yields were recorded in C1B1S1 treatment combination during *kharif* 2010 (28.11 t/ha) and in *rabi* (29.05 t/ha) respectively (Table 6).

Table 1. Thrips population counts on tomato phase -1 *kharif* 2009-2010

	D1(30 DAP)			D1 (40 DAP)			D1 (50DAP)			D1 (60DAP)		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
N1	13.81(21.81)	14.41(22.30)	14.72(22.55)	13.5(25.70)	12.38(22.38)	13.53(21.97)	14.73(22.71)	14.48(23.14)	14.03(22.79)	14.71(22.55)	13.24(21.30)	14.29(22.22)
N2	15.64(23.26)	15.65(23.26)	15.43(23.11)	14.24(23.42)	14.64(22.95)	15.96(21.81)	15.84(23.14)	15.2(24.12)	14.84(23.11)	15.55(23.19)	13.71(21.71)	15.29(23.03)
N3	17.25(24.55)	16.55(24.00)	17.33(24.60)	16.04(23.81)	18.16(23.58)	17.52(24.00)	16.29(23.81)	16(24.95)	16.56(23.81)	16.36(23.81)	14.75(22.55)	16.01(23.58)
	D2 (30 DAP)			D2 (40 DAP)			D2 (50DAP)			D2 (60DAP)		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
N1	12.48(20.70)	13.45(21.50)	12.21(20.44)	12.88(21.30)	14.64(21.89)	14(21.97)	13.24(21.34)	13.85(21.85)	14.01(21.97)	13.17(21.30)	11.75(20.80)	12.11(20.36)
N2	14.05(21.97)	1.4(16.80)	12.83(20.96)	14.24(21.97)	1.6(17.92)	11.88(22.55)	13.99(21.99)	1.9(7.92)	14.73(22.55)	13.88(21.89)	1.17(6.29)	12.93(21.05)
N3	15.75(23.38)	14.04(21.97)	14.91(22.71)	15.52(22.38)	14.96(22.38)	16.16(22.95)	14.55(22.41)	14.5522.41)	15.22(22.95)	14.13(22.06)	21.31(20.53)	13.67(21.72)
	D3 (30DAP)			D3 (40 DAP)			D3 (50DAP)			D3 (60DAP)		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
N1	15.48(23.34)	13.42(23.19)	14.52(22.30)	14.13(23.190	12.56(23.42)	15.64(24.27)	16.26(23.80)	15.84(23.45)	16.89(24.27)	13.26(21.34)	14.28(22.22)	14.69(22.55)
N2	15.4(24.30)	16.88(23.89)	16.96(23.42)	15.76(24.27)	14.16(24.42)	14.96(24.84)	16.87(24.25)	16.26(23.80)	17.65(24.84)	13.89(21.89)	15.05(22.79)	15.29(23.03)
N3	19.3(25.33)	19.32(24.35)	16.4(24.45)	14.72(25.00)	16.72(25.10)	18.48(25.44)	18.01(25.10)	18.03(25.10)	18.46(25.44)	14.73(22.55)	15.85(23.44)	16.16(23.70)
	30 DAP			40 DAP	CRITICAL DIFFERENCE		50 DAP			60 DAP		
FACTORS	SEm	CRITICAL DIFFERENCE	FACTORS	SEm		FACTORS	SEm	CRITICAL DIFFERENCE	FACTORS	SEm	CRITICAL DIFFERENCE	
F1	0.7685	1.5803*	F1	0.8863	1.8222*	F1	0.9232	1.8980*	F1	0.6486	1.3335*	
F2	0.7685	1.5308*	F2	0.8863	1.8222*	F2	0.9232	1.8980*	F2	0.6486	1.3335*	

F3	0.7685	1.5308*	F3	0.8863	1.8222*	F3	0.9232	1.8980*	F3	0.6486	1.3335*	
F1*f2	1.3291	2.7326	F1*f2	1.5332	3.1522*	F1*f2	1.5990	3.2875*	F1*f2	1.1233	2.3095*	
F1*f3	1.3291	2.7326	F1*f3	1.5332	3.1522*	F1*f3	1.5990	3.2875*	F1*f3	1.1233	2.3095*	
F2*f3	1.3291	2.7326	F2*f3	1.5332	3.1522*	F2*f3	1.5990	3.2875*	F2*f3	1.1233	2.3095 NS	
F1*f2*f3	2.3055	4.7401	F1*f2*f3	2.6589	5.4666*	F1*f2*f3	2.7696	5.9429*	F1*f2*f3	1.9458	4.0005 NS	

Figures in parentheses are square root transformed values.

Table 2. Thrips population counts on tomato phase -1 *rabi* 2009 -2010

	D1 (30DAP)			**D1 (40DAP)**			**D1 (50DAP)**			**D1 (60DAP)**		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
N1	5.58(13.66)	6.12(14.32)	9.06(17.51)	9.55(17.99)	10.24(18.65)	11.84(20.12)	20.14(26.65)	24.05(29.35)	24.46(29.63)	3.12(10.17)	4.21 (11.83)	5.24(13.23)
N2	8.25(16.68)	8.84(17.29)	10.27(18.68)	9.84(18.27)	10.55(18.95)	13.44 (21.5)	22.28(28.15)	24.92(29.93)	26.11(30.72)	5.45(13.49)	7.91(16.33)	8.66(17.11)
N3	10.25(18.66)	11.24(19.58)	12.55(20.74)	11.86(20.14)	12.44(20.64)	16.33(23.82)	24.41(29.59)	26.66(31.07)	28.29(32.12)	6.44(14.69)	8.02(16.44)	9.55(17.99)
	D2 (30 DAP)			D2 (40 DAP)			D2 (50DAP)			D2 (60DAP)		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
N1	2.44(8.98)	3.41(10.64)	6.24(14.46)	4.26(11.91)	6.97(15.3)	8.11(16.54)	16.84(24.22)	18.56(25.51)	19.06(25.87)	2.41(8.93)	3.46(10.72)	5.18(13.15)
N2	5.06(12.99)	5.24(13.23)	7.33(15.7)	6.34(14.58)	6.99(15.32)	10.21(18.63)	17.44(24.67)	19.22(25.99)	20.85(27.16)	3.28(10.43)	4.11(11.69)	6.11(14.3)
N3	6.26(14.48)	7.69(16.09)	8.11(16.54)	7.69(16.09)	9.33(17.78)	2.59 (9.26)	18.22(25.26)	21.45(27.58)	23.66(29.09)	5.21(13.19)	5.68(13.78)	7.84(16.25)
	D3 (30 DAP)			D3 (40DAP)			D3 (50DAP)			D3 (60DAP)		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
N1	7.76(16.17)	8.27(16.71)	10.24(18.65)	10.66(19.05)	11.66(19.96)	13.21(21.3)	22.85(28.54)	26.66(31.07)	28.44(32.21)	6.12(14.32)	7.29(15.66)	9.11(17.56)
N2	8.02(16.67)	9.45(17.9)	11.33(19.66)	12.71(20.88)	13.11(21.22)	15.06(22.82)	23.11(28.72)	28.55(32.28)	29.24(32.72)	7.69(16.09)	8.09(16.99)	10.05(17.56)
N3	8.75(17.2)	12.82(20.97)	15.46(23.14)	15.04(22.81)	18.41(25.4)	16.24(23.75)	27.22(31.43)	30.11(33.26)	32.24(34.58)	8.14(16.57)	9.44(17.89)	11.24(19.58)
	30 DAP			40 DAP			50 DAP			60 DAP		
FACTORS	SEm	CRITICAL DIFFERENCE	FACTORS	**SEm**	CRITICAL DIFFERENCE	FACTORS	**SEm**	CRITICAL DIFFERENCE	FACTORS	**SEm**	CRITICAL DIFFERENCE	
F1	0.7638	1.5696*	F1	0.8682	1.7841*	F1	0.9252	1.9022*	F1	0.6954	1.4297*	
F2	0.7638	1.5696*	F2	0.8682	1.7841*	F2	0.9252	1.9022*	F2	0.6954	1.4297*	
F3	0.7638	1.5696*	F3	0.8682	1.7841*	F3	0.9252	1.9022*	F3	0.6954	1.4297*	
F1*f2	1.3236	2.7199*	F1*f2	1.5019	3.0788*	F1*f2	1.6024	3.2945*	F1*f2	1.1827	2.4316*	
F1*f3	1.3236	2.7199*	F1*f3	1.5019	3.0788*	F1*f3	1.6024	3.2945*	F1*f3	1.1827	2.4316*	
F2*f3	1.3236	2.7199*	F2*f3	1.5019	3.0788*	F2*f3	1.6024	3.2945*	F2*f3	1.1827	2.4316*	
F1*f2*f3	2.3831	4.8996NS	F1*f2*f3	2.7010	5.5532NS	F1*f2*f3	2.7756	5.7066NS	F1*f2*f3	2.8620	2.8842 NS	

Figures in parentheses are square root transformed values.

Table 3. Influence of different types of Thrips population practices on fruit yield in tomato during *Kharif* and *Rabi* 2009-10 phase- I

Treatment Combination	Yield t/ha	
	kharif – 09	*Rabi* – 09
D1S1N1	25.35	26.85
D1S1N2	27.48	28.98
D1S1N3	26.64	28.14
D1S2N1	27.98	28.48
D1S2N2	28.14	28.64
D1S2N3	27.25	28.74
D1S3N1	27.04	28.19
D1S3N2	26.22	27.82
D1S3N3	27.56	28.97
D2S1N1	27.75	29.22
D2S1N2	27.68	29.18
D2S1N3	27.05	28.55

D2S2N1	28.52	29.96
D2S2N2	29.14	30.54
D2S2N3	28.05	29.34
D2S3N1	28.02	29.52
D2S3N2	27.66	28.96
D2S3N3	27.95	29.15
D3S1N1	24.66	26.16
D3S1N2	26.94	27.44
D3S1N3	25.12	26.62
D3S2N1	26.29	27.79
D3S2N2	26.14	27.64
D3S2N3	26.02	27.52
D3S3N1	25.06	26.56
D3S3N2	25.95	27.45
D3S3N3	24.65	26.15
Sem	0.09	0.11
CD5%	0.27	0.33
CD1%	0.35	0.43
CV	1.77	2.23

D=Days after sowing, S=Spacing, N=Nitrogen.

Table 4. Thrips population counts on tomato phase-II *Kharif* 2010.

July 1-10 30DAP - (C1)			July 11-20 40DAP- (C1)			July 21-30 50DAP- (C1)			July31-Aug-10 60DAP- (C1)		
	B1	B2		B1	B2		B1	B2		B1	B2
S1	2.20 (4.35)	2.71 (6.85)	S1	2.84 (7.57)	2.95 (8.18)	S1	3.53 (11.99)	3.51 (11.81)	S1	2.02 (3.58)	1.90 (3.11)
S2	2.38 (5.17)	2.98 (8.38)	S2	3.09 (9.05)	3.19 (9.7)	S2	3.58 (12.79)	3.72 (13.34)	S2	2.17 (4.22)	1.75 (2.56)
S3	2.77 (7.20)	3.16 (9.47)	S3	3.40 (11.07)	3.51 (11.84)	S3	3.65 (12.82)	3.89 (14.64)	S3	1.94 (3.25)	1.90 (3.1)
July 1-10 30DAP - (C2)			July 11-20 40DAP- (C2)			July 21-30 50DAP- (C2)			July31-Aug-10 60DAP- (C2)		
	B1	B2		B1	B2		B1	B2		B1	B2
S1	1.90 (3.12)	2.17 (4.21)	S1	2.57 (6.12)	2.79 (7.29)	S1	3.01 (8.56)	3.12 (9.21)	S1	1.74 (2.54)	1.73 (2.5)
S2	2.44 (5.45)	2.90 (7.91)	S2	2.86 (7.69)	3.08 (8.99)	S2	3.15 (9.44)	3.26 (10.12)	S2	2.04 (3.65)	2.21 (4.4)
S3	2.63 (6.44)	2.92 (8.02)	S3	2.94 (8.14)	3.15 (9.44)	S3	3.46 (11.47)	3.56 (12.14)	S3	2.02 (3.59)	1.70 (2.38)

	30 DAP		40 DAP			50 DAP			60DAP		
FACTORS	Sem	CRITICAL DIFFERENCE	FACTORS	Sem	CRITICAL DIFFERENCE	FACTORS	Sem	CRITICAL DIFFERENCE	FACTORS	Sem	CRITICAL DIFFERENCE
F1	0.6954	1.4297	F1	0.7638	1.5896	F1	0.9252	1.9022	F1	0.75682	1.55602
F2	0.6954	1.4297	F2	0.7638	1.5896	F2	0.9252	1.9022	F2	0.75682	1.55602
F3	0.6954	1.4297	F3	0.7638	1.5896	F3	0.9252	1.9022	F3	0.75682	1.55602
F1*F2	1.1827	2.4316	F1*F2	1.3236	2.7199	F1*F2	1.6024	3.29453	F1*F2	1.331081	2.695025
F1*F3	1.1827	2.4316	F1*F3	1.3236	2.7199	F1*F3	1.6024	3.29453	F1*F3	1.331081	2.695025
F2*F3	1.1827	2.4316	F2*F3	1.3236	2.7199	F2*F3	1.6024	3.29453	F2*F3	1.331081	2.695025
F1*F2*F3	2.86200	5.8842	F1*F2*F3	2.3831	4.89960	F1*F2*F3	2.7756	5.70660	F1*F2*F3	2.27046	4.66806

Figures in parenthesis are $\sqrt{n+0.5}$

C1=cultural practice – 1, c2 = cultural practice – II, B1=barrier crop, B2=with out barrier crop;
S1, S2, S3 = three types of sprayings.

Table 5. Thrips population counts on tomato phase-II *Rabi* 2010-11.

July 1-10 30DAP - (C1)			July 11-20 40DAP- (C1)			July 21-30 50DAP- (C1)			July31-Aug-10 60DAP- (C1)		
	B1	B2		B1	B2		B1	B2		B1	B2
S1	1.91 (3.14)	2.95 (8.22)	S1	3.32 (10.55)	3.75 (13.59)	S1	4.71 (21.65)	5.73 (32.18)	S1	1.77 (2.64)	2.27 (4.64)
S2	2.41 (5.29)	3.11 (9016)	S2	1.55 (3.89)	4.00 (15.53)	S2	5.09 (25.36)	5.54 (30.14)	S2	1.94 (3.25)	2.42 (5.34)

S3	2.62 (6.34)	3.43 (11.24)	S3	3.67 (12.96)	4.32 (18.13)	S3	4.13 (16.58)	5.37 (28.36)	S3	1.93 (3.22)	2.84 (7.56)
July 1-10 30DAP - (C2)			July 11-20 40DAP- (C2)			July 21-30 50DAP- (C2)			July31-Aug-10 60DAP- (C2)		
	B1	B2		B1	B2		B1	B2		B1	B2
S1	1.96 (3.35)	2.77 (7.15)	S1	2.91 (7.94)	3.57 (12.27)	S1	4.14 (16.6)	4.12 (16.44)	S1	1.83 (2.85)	2.62 (6.34)
S2	2.38 (5.17)	3.04 (8.77)	S2	3.47 (11.5 5)	3.74 (13.5)	S2	4.32 (18.14)	4.34 (18.3)	S2	1.93 (3.24)	2.45 (5.48)
S3	2.73 (6.98)	3.29 (9.35)	S3	3.66 (12.9)	4.00 (15.51)	S3	4.38 (18.69)	4.79 (22.46)	S3	2.42 (5.34)	2.39 (5.23)

30 DAP			40 DAP			50 DAP			60DAP		
FACTORS	Sem	CRITICAL DIFFERENCE	FACTORS	Sem	CRITICAL DIFFERENCE	FACTORS	Sem	CRITICAL DIFFERENCE	FACTORS	Sem	CRITICAL DIFFERENCE
F1	0.6486	1.3354*	F1	0.7685	1.5803*	F1	0.8863	1.2823*	F1	0.8563	1.76137*
F2	0.6486	1.3354*	F2	0.7685	1.5803*	F2	0.8863	1.2823*	F2	0.8563	1.76137*
F3	0.6486	1.3354*	F3	0.7685	1.5803*	F3	0.8863	1.2823*	F3	0.8563	1.76137*
F1*F2	1.1233	2.3095	F1*F2	1.3291	2.7326	F1*F2	1.5332	3.1522	F1*F2	1.4837	3.05069
F1*F3	1.1233	2.3095	F1*F3	1.3291	2.7326	F1*F3	1.5332	3.1522	F1*F3	1.4837	3.05069
F2*F3	1.1233	2.3095	F2*F3	1.3291	2.7326	F2*F3	1.5332	3.1522	F2*F3	1.4837	3.05069
F1*F2*F3	1.94580	4.65050	F1*F2*F3	2.3055	4.74010	F1*F2*F3	2.6589	5.46660	F1*F2*F3	2.57010	4.85145

Figures in parenthesis are $\sqrt{n+0.235}$ transformed

C1=cultural practice – 1, c2 = cultural practice – II, B1=barrier crop, B2=with out barrier crop; S1, S2, S3 = three types of sprayings.

Table 6. Influence of different types of Thrips population practices on fruit yield in tomato during *Kharif* and *Rabi* 2010 phase- II

Treatment Combination	Yield t/ha	
	kharif – 10	*Rabi* – 10
C1B1S1	28.11	29.05
C1B1S2	27.54	28.64
C1B1S3	26.74	27.86
C1B2S1	27.85	28.04
C1B2S2	27.14	27.56
C1B2S3	26.06	27.14
C2B1S1	27.45	27.85
C2B1S2	27.06	27.47
C2B1S3	26.85	27.32
C2B2S1	27.21	27.94
C2B2S2	27.01	27.55
C2B2S3	26.55	27.26
Sem	0.07	0.15
CD5%	0.22	0.44
CD1%	0.30	0.59
CV	1.48	2.88

C1 = cultural practice – 1, C2 = cultural practice – 2,
B1 = Barrier crop (Sorghum), B2 = with out Barrier crop;
S1, S2, S3 – three types of spraying

DISCUSSION

Reddy *et al.* (1978) recorded high incidence of bud necrosis in groundnut crop sown in July which gradually declined in last sowings and reached to a negligible level in the late sowing taken up in December. In contrary to this, the field trail conducted in the present study have clearly indicated that planting of tomato in the first week of July given with a normal spacing of 60 X 45cm and with a nitrogen application of 150 kg / ha has proved as the best agronomic practice in keeping the disease incidence low. Amin (1983); Reddy *et al.* (1983a); Reddy *et al.* (1983); Kennedy *et al.* (1990), Gopal (1998); Tsai *et al.* (1995); Dandnaik *et al.*(1996); Patil (1993); Weeks and Hagan (1992); Su and Chen (1986); Kadamben and Ramanujam (1987) have made management studies in groundnut with cultural

practices such as seed rate and spacing, intercroping, maintenance of barrier crops all around, sprays with chemicals and plant products.

Weeks and Hagan (1992) studied date of planting in relation to TSWV and thrips population. Patil (1993) revealed that groundnut crop sown in first fortnight of June showed lower incidence of GBNV (8.3%) than late sown crop (27.2% GBNV). However, the variation in incidence of bud necrosis and the prevalence of vector population totally dependent on local agro-climatic conditions.

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RESEARCH ARTICLE

SURVEY OF VARIOUS PESTS AND DISEASES OF NIGER (*GUIZOTIA ABYSSINICA* CASS) CROP UNDER TRIBAL BELTS OF SOUTH GUJARAT

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Abstract: Niger (*Guizotia abyssinica* Cass) is an important minor oil seed crop. The Niger crop is found infested by number of diseases & pests, which causes harsh damage to the crop. The survey for Niger diseases was conducted during the *Kharif*, 2013 in different villages of Vansda taluka of Navsari district, Kaprada taluka of Valsad district and similarly, in Dang district of Gujarat. The two major diseases *viz*., *Alternaria* and *Cercospora* leaf spot were noticed in the scale of 1.0 to 4.0 and 1.0 to 3.0 grades respectively. However, the incidence of powdery mildew disease was not observed but the infestation of *Cuscuta* was observed as a minor problem during the survey of Niger crop. Apart from this, in pest incidence hairy caterpillar was observed in scattered as well as in uniform population while, the population of aphids and white flies was not noticed in the field during the survey.

Keywords: Survey, Niger, Crop, Tribal

INTRODUCTION

Niger (*Guizotia abyssinica* Cass) is an important minor oil seed crop grown in countries like India, Ethiopia, East Africa, West Indies and Zimbabwe. In India, it is mainly cultivated in tribal belts of Gujarat, M.P., Orissa, Maharashtra, Bihar, Karnataka and Andhara Pradesh. Niger is a crop of dry areas grown mostly grown by tribal and interior places as life line of tribal segment. Niger is commonly known with different names as *ramtil*, *jagni* or *jatangi* (Hindi), *ramtal* (Gujarati), *karale* or *khurasani* (Marathi), *uhechellu* (Kannada), *payellu* (Tamil), *verrinuvvulu* (Telgu), *alashi* (Oriya), *sarguza* (Bengali), *ramtil* (Punjab) and *sorguja* (Assamese) in various parts of the country (Rao and Ranganatha, 1989). Niger is an important oilseed crop in Ethiopia where it provides about 50-60 per cent oil for domestic consumption (Riley and Belayneh, 1989) with the fatty acid composition of 75-80 % linoleic acid, 7-8 % palmitic acid and stearic acid and 5-8 % oleic acid (Getinet and Teklewold, 1995). It is also used as oilseed crop in India, where it provides about 3 per cent of the edible oil requirement of the country (Getinet and Sharma, 1996). The Niger seed contains 33.3 % protein, 34.2-39.7 % total carbohydrates and 13.5 % fiber. Niger oil is slow drying so used in food, paint, soap and as an illuminant. The oil is used as cooking as a ghee substitute. The oil is used in cooking and also used to treat burns and in the treatment of scabies. The seed is eaten fried, used as condiments or dried, powdered and mixed with flour to make sweet cakes. The seeds are used in chutney preparation with curd. The press cake from oil extraction is used for livestock feed. The oil is considered good for health (Pandey *et al*., 2014). The Niger crop is found infested by number of diseases & pests, which causes harsh damage to the crop. Further, the accidental rain at flowering stage leads the expansion of *Alternaria* and *Cercospora* leaf spot incidence and results in the poor seed set and seed yield. The crop is affected by number of fungal diseases. The important diseases of Niger are Alternaria blight (*Alternaria porii* & *A. alternata*), leaf spot (*Cercospora guizoticola*), Seedling blight (*Alternaria tenuis*), seed rot (*Rhizotonia bataticola*), rust (*Puccinia guizotiae*), powdery mildew (*Sphaetheca* sp.), root rot (*Macrophomina phaseolina*) and cuscuta as *Phanerogamic* parasite (Rajpurohit, 2004 and Rajpurohit & Dubal, 2009). *Cercospora* and *Alternaria* diseases cause heavy damage to this crop and reduce its seed yields, which harm the status of the farmers. Currently studies pertaining to the use of fungicides in management of diseases are highly emphasized (Kolte, 1985 and Sandipan *et al.*, 2014).
Looking on importance in terms of oil extraction, which having high medicinal values but knowledge of the diseases of this Niger crop merits attention, Niger is a crop of dry areas grown mostly by tribal in interior places due to which desired attention has not been given on the biotic and abiotic stresses. Now the crop is gaining importance and studies are being made on disease aspects (Rajpurohit, 2011). Therefore, this study was planned to record the pest and diseases of Niger crop plant so, that preventive measures can be taken well in advance to avoid any crop damage. Keeping in view the destructive nature and economic loss, the present investigation was undertaken to evaluate the respective scenario of the pests and diseases. Considering the economic losses this present investigation, attempts were therefore made to ascertain the spectrum of fungal pests and diseases of Niger crop under tribal region of South Gujarat.

*Corresponding Author

MATERIAL AND METHOD

Observation on score (grade) on Niger plant by observing top, middle and bottom leaves of the plant. And the scored by using the Disease Rating scale of (0 to 5) as developed by Mayee and Datar, 1986, Townsend and Heuberger, 1943.

Disease Score

Score	Description	PDI/ Incidence
0	No infection	Immune
1	1-10 % leaf area infected	Resistant
2	11-25 % leaf area infected	Moderately Resistant
3	26-50 % leaf area infected	Tolerant
4	51-70 % leaf area infected	Moderately Tolerant
5	71-100 % leaf area infected	Susceptible

RESULT AND DISCUSSION

The survey for Niger diseases was conducted during the *Kharif*, 2013 in different villages of Vansda taluka of Navsari district, Kaprada taluka of Valsad district and similarly, in Dang district of Gujarat. The two major diseases *viz*., *Alternaria* and *Cercospora* leaf spot were noticed in the scale of 1.0 to 4.0 and 1.0 to 3.0 grade respectively (Table: 1 and Graph: 1 & 2). However, the incidence of powdery mildew disease was not observed but the infestation of *Cuscuta* was observed as a minor problem during the survey.

Apart from this, in pest incidence hairy caterpillar was observed in scattered as well as in uniform population while the population of aphids and white flies was not noticed in the field during the survey. Similar, findings were found by Jagtap *et al*., 2014.

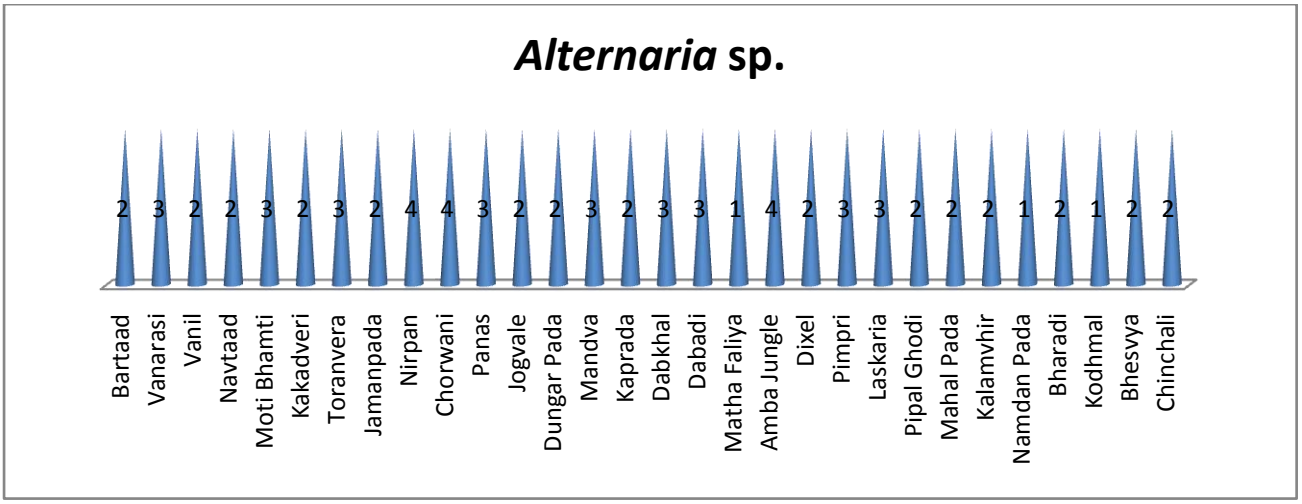
Table 1. Score of *Alternaria* (*Alternaria* sp.) and *Cercospora* (*Cercospora guizoticola*) leaf spot disease of Niger crop.

Vansda Taluka of Navsari district			
Sr. No.	**Villages**	***Alternaria* grade**	***Cercospora* grade**
1	Bartaad	02	01
2	Vanarasi	03	01
3	Vanil	02	01
4	Navtaad	02	02
5	Moti Bhamti	03	02
6	Kakadveri	02	03
7	Toranvera	03	02
8	Jamanpada	02	02
9	Nirpan	04	03
10	Chorwani	04	03
Kaprada taluka of Valsad district			
1	Panas	03	02
2	Jogvale	02	01
3	Dungar Pada	02	03
4	Mandva	03	02
5	Kaprada	02	01
6	Dabkhal	03	02
7	Dabadi	03	02
8	Matha Faliya	01	01
9	Amba Jungle	04	02
10	Dixel	02	02
Dang District			
1	Pimpri	03	02
2	Laskaria	03	02
3	Pipal Ghodi	02	01
4	Mahal Pada	02	01
5	Kalamvhir	02	02
6	Namdan Pada	01	02
7	Bharadi	02	02

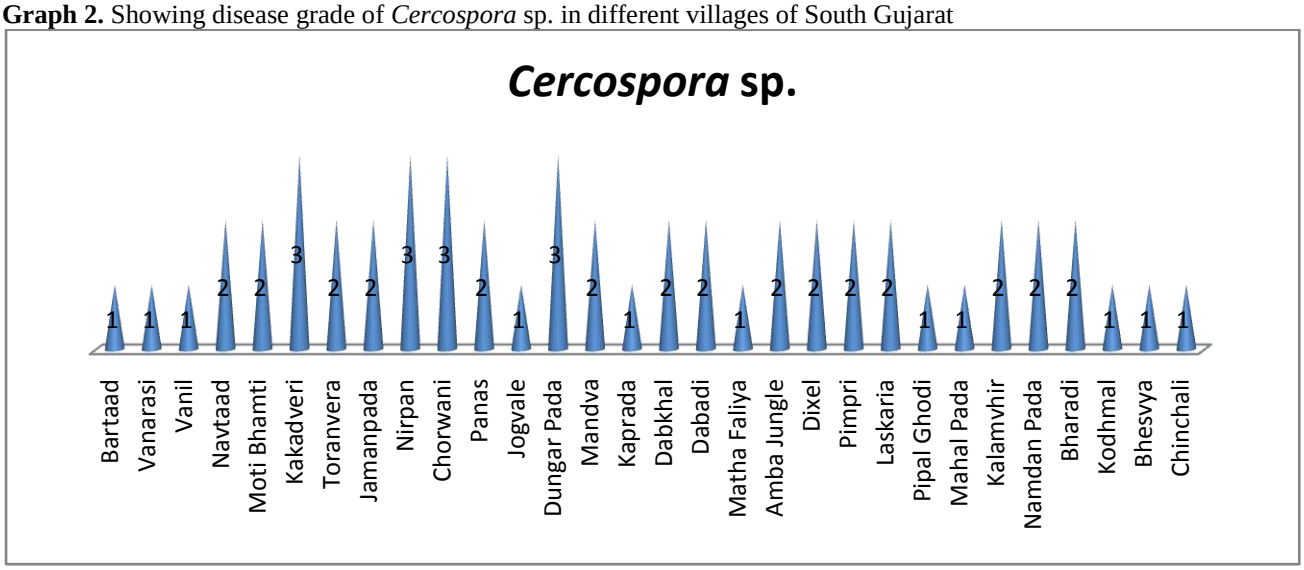
8	Kodhmal	01	01
9	Bhesvya	02	01
10	Chinchali	02	01

Note: Powdery mildew and Root rot disease was not observed during the *Kharif*, 2013 survey.

Graph 1. Showing disease grade of *Alternaria* sp. in different villages of South Gujarat



Graph 2. Showing disease grade of *Cercospora* sp. in different villages of South Gujarat



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OSMOTIC STRESS RESPONSE INDUCED ON EXPOSURE TOENDOSULFAN AND MALATHION IN *LYCOPERSICON ESCULENTUM* MILL.

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Abstract: A study was conducted in the field of Department of Botany, D.N. College, Meerut using two crop varieties of Tomato, viz. Pusa Ruby and Pusa Early Dwarf. The plants were exposed to three different concentrations of pesticides namely Malathion and Endosulfan. Proline was estimated for osmotic stress response. It was observed that there was a high accumulation of proline which was concentration dependent. The increase in the values of proline were found to be more in Pusa Ruby than Pusa Early Dwarf which suggests that Pusa Ruby is comparatively a resistant variety. The enhanced accumulation of proline may be supportive to the tomato plants exposed to high concentration of pesticide. It might have helped the test crops under xenobiotic stress, to maintain membrane stability, water relations, and nitrogen and energy metabolism. It might also have helped to maintain the growth and yield of the pesticide treated plants. Proline acts as osmoprotectant under stress conditions. The free radicals are constantly generated under stress conditions that are quenched by an efficient antioxidant network in the plant body which acts as a supportive system in plant defense.

Keywords: Endosulfan, Malathion, Xenobiotic Stress and Osmolytes

INTRODUCTION

With the ever-increasing population and escalating demand for food, scientists are toiling hard to enhance the production level through the introduction of new high yielding cultivars, effective cultural practices and adopting advanced technologies. Pesticides are one of the most essential inputs in modern agriculture for insuring food security particularly in the developing countries where population growth for exceed the agricultural growth. Among the various strategies adopted to combat pest of Tomato, insecticides from the first line of defense. But the indiscriminate use of pesticides, in modern agriculture has led to various negative impacts on the environment. Some of the pesticides remain persistent (Recalcitrant) and more into the environment (Nasrabdi and Dhumal, 2014).

Among pesticides of synthetic origin, Organochlorine and Organophosphate insecticides play an important role in controlling insect pests in agriculture but the farmers usually go for excess application of these pesticides to protect the susceptible vegetables (Nasrabdi and Dhumal, 2014). Previous studies have demonstrated that dimethoate causes a reduction in plant growth, photosynthetic pigments of *Glycine max* L. (Pandurang*aet al.*, 2005) and *Vignaunguiculata* L. (Mishra *et al.*, 2008). The blocked growth might have resulted from the inhibition of normal cell division or elongation. Besides, insecticides triggered oxidative stress by producing reactive oxygen species (ROS), e.g. superoxide radical (O_2^-) and H_2O_2 (Mishra *et al.*, 2008). Insecticide induced oxidative stress was shown to alter the cellular redox balance by altering ascorbate glutathione (ASC-Glu) cycle or damaging other antioxidant defense systems (Bashir *et al.*, 2007).

Plants have multiple strategies to confer their tolerance to insecticide induced toxicity, and prevention of oxidative and osmotic damage to cells has been suggested as one the mechanisms of stress tolerance (Safar and Sood, 2002; Prasad *et al.*, 2005). In most cases, toxic organic compounds can give rise to the increased activities of antioxidant enzymes such as SOD, POD or ascorbate peroxidase (APX), which reflect not only the degree of toxicity but the ability to tolerate the stress as well (Wu and Von Tiedemann 2002; Pelxoto*et al.*, 2006; Song *et al.*, 2007).

Although a number of studies have demonstrated the effect of insecticides on various plants, but surprisingly, little work has been done to find out the effect of widely used insecticides such as Endosulfan and Malathion on different developmental stages of vegetable crop tomato. To the best of our knowledge, there is not much information available so far about the effect of Malathion and Endosulfan on osmotic and antioxidant system of Tomato plant. In this context, present study will explain and elucidate the effects of Malathion and Endosulfan induced osmotic stress in plant cells of Tomato.

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MATERIAL AND METHOD

For experimentation, seeds were procured from certified seed center of Meerut. Simple randomized block design was followed for growing the crops. For each variety, the field was divided into six plots each being 1×1 meter^2 for different pesticide concentrations (0.05%, 0.15% and 0.25%) of both pesticides. For control, 1 plot for each variety of 1×1 m^2 size was selected apart from the treatment plot. The three concentrations of pesticides were prepared with double distilled water using Pearson's Square method (Wagner and Stanton, 2006). Tap water was used as control. The plants were treated with different pesticide solutions of different concentration on 15th day of transplantation of seedlings. The pesticide treatments were given with the help of a sprayer. Samples were collected on 30th day after treatment to analyze the effect of Malathion and Enodosulfan treatment on proline contents of both tested varieties of Tomato.

Estimation of Proline (Bates *et al.*, 1973)

100mg of fresh leaves were homogenized in 5ml of 3% sulphosalicylic acid. Filter the homogenate through Whatman no. 2 filter paper, 2 ml of filtrate was mixed with 2ml glacial acetic acid and 2 ml of acid ninhydrin and mixture was allowed to heat on water bath for 1 hour. Reaction was then terminated by cooling it in ice. 4 ml of toluene was added to the reaction mixture and mixed vigorously with a test tube stirrer for 12-20 seconds. Then it was transferred into the separating funnel and mixed well. Two layers were formed and out of these two layers, toluene layer was separated. Then OD was taken at 520 nm. Pure proline was used to make calibration curve. Amount of proline was estimated in mg g^{-1}f.wt.

RESULT AND DISCUSSION

An attempt was made to study the effect of various concentrations of Malathion and Endosulfan on *Lycopersiconesculentum* (Mill.). Final results are represented in the figures 1 and 2. Insecticide exposure can lead to various physiological and biochemical changes within the plant cells causing numerous changes in the cell structure and function.

With the onset of chemical stress caused by the pesticide, plant initially tried to mitigate the effect of chemical exposure by optimal resources utilization, nutrient management, alterations in biomass allocation, etc. The complex network of adaptive mechanisms in plants cause changes in the synthesis and accumulation of various osmolytes and antioxidants which provide stress tolerance to the plants. Pesticide treatment affected the accumulation of foliar proline traits in both varieties and caused them to alter to a great extent (Figure 1 and 2). It is clear from the data that in both varieties, a progressive enhancement in foliar proline level were recorded with increased concentration of pesticide. In Pusa Ruby percent increase in Proline content content at 0.25% concentration of endosulfan was 25.21 where as the corresponding value for Pusa Early Dwarf was 19.70. Enhancement in Proline content of Pusa Ruby was more than that of Pusa Early Dwarf with reference of both pesticides.

It has been well known, that small metabolite like proline accumulate to a high level in plants when they are under stress (Kovacik*et al.*, 2009). Over-generation of ROS is a rapid and sensitive response of plants to environmental stresses. Amongst ROS, $O_2^-$and H_2O_2 was used to illustrate the degree of oxidative injury to cells (Elhami*et al.*, 2015). The aromatic amino acid proline acts as a free radical scavenger to overcome the oxidative stress by preventing the membrane damage and protein denaturation (Reddy *et al.*, 2004). In this way it would be responsible to maintain the osmotic balance. Enhanced proline content has been reported under insecticide stress (Bashir *et al.*, 2007) in *Glycine. max* L., suggesting that it might prevent chlorophyrifos-induced production of ROS and protect plants from the oxidation damage. These biochemical results can be interpreted as internal tolerance mechanisms and may allow us to develop strategies for reducing the risks of the insecticide contamination in the crop production. The increase in the values of proline were found to be more in Pusa Ruby than Pusa Early Dwarf which suggests that Pusa Ruby is comparatively a resistant variety. The enhanced accumulation of proline may be supportive to the tomato plants exposed to high concentration of pesticide. It might have helped the test crops under xenobiotic stress, to maintain membrane stability, water relations, and nitrogen and energy metabolism.

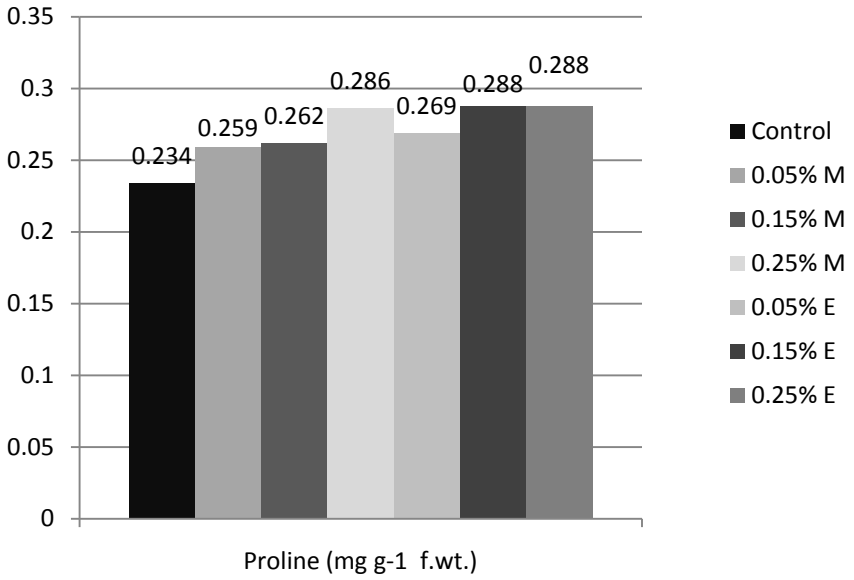

Fig. 1. Effect of Malathion and Endosulfan on Proline content of leaves of *Lycopersiconesculentum* var. Pusa Ruby at the age of 30 days

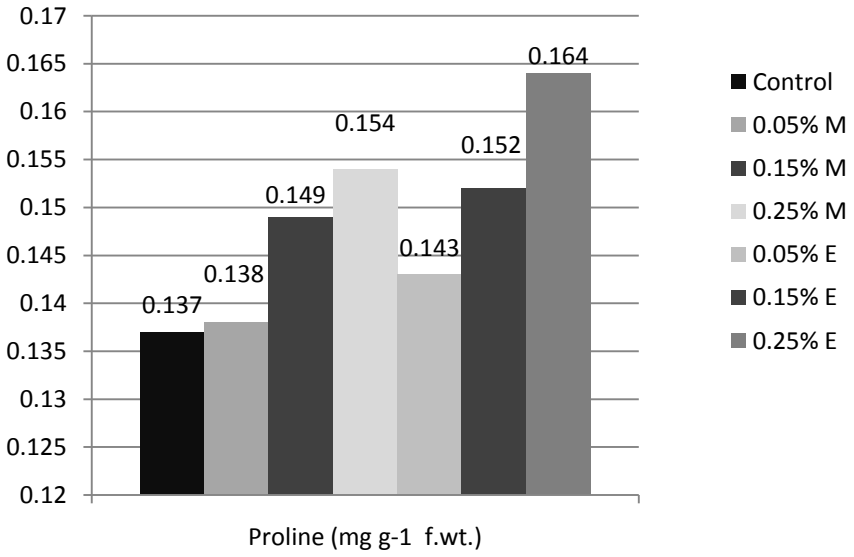

Fig. 2. Effect of Malathion and Endosulfan on Proline content of leaves of *Lycopersiconesculentum* var. Pusa Early Dwarf at the age of 30 days

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RESEARCH ARTICLE

STUDIES ON BIO AND MODERN PESTICIDES FOR THE MANAGEMENT OF DIAMOND BACK MOTH, *PLUTELLA XYLOSTELLA* (LINN.) ON CAULIFLOWER

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Abstract: The present study was undertaken the most effective as well as economical viable insecticide for the control of diamond-back moth *Plutella xylostella* L. on cauliflower. One bio-pesticide i.e. *Bacillus thuringiensis* (WP) and six modern insecticides i.e. Imidacloprid (17.8% SL), Acetamiprid (20% SP), Thiomethoxam (25% WG,) Fipronil (5% SC), Cartap hydrochlorid (50% SP) and PII-0111 (20% WDG) with an adjuvant "Chipco" were tested against the diamond back moth under natural field condition. In all two sprays were applied in morning hours when the pest attained a desired level of larval population. The result indicated that all the treatments were superior to the control in reducing the larval population of DBM after both applications of the sprays. After the first and second sprays fipronil proved to be the most effective and also gave significantly higher yield as compared with other treatments. The next effective treatment was cartap hydrochloride, which also gave significant reduction in the larval population after first and second sprayings. It also gave better yield and higher per cent increase in yield over control. Other treatments, i.e., PII-0111, thiomethoxam, acetamiprid, imidacloprid and *Bacillus thuringiensis*, were least effective.

Keywords: Cauliflower, Pesticides, Management, Population

INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis*) is one of the most important cole crops of India. It occupies an important place in human diet. Cauliflower has high quality protein and is peculiar in stability of vitamin "C" after cooking. It is rich in minerals such as potassium, sodium, iron, phosphorus, calcium and magnesium. Cauliflower requires a cool and moist growing season and does not endure as much as cabbage does as it is more seriously affected by unfavorable conditions. Rich, heavy loam soils with good drainage and liberal supplies of moisture are ideal for cauliflower growing.

India is the world's second largest producer of vegetables, next to China. The total production of vegetable in India is 98.50 million tones and the total area is about 6.2 million/ha (Anonymous, 2002). In India, cauliflower is more widely grown as compared with cabbage. It is generally grown throughout India during winter season. In summer season it is grown in parts of Bihar, Madhya Pradesh, Himachal Pradesh, Maharashtra and Nilgiri Hills in Chennai.

The insect pest complex is a major menace in cauliflower production. Diamond back moth, *Plutella xylostella* (Linn.) is the major pest of cruciferous vegetables crop like cauliflower, cabbage and rapeseed and enjoys worldwide distribution (Chelliah and Srinivasan, 1986). The DBM is a serious pest of crucifer vegetables throughout Asia (NRI, 1991; Zhang, 1994) and it is a regular pest of cauliflower (Singh, 1980). In India, it was first recorded in 1914 on crucifer vegetable (Fletcher, 1914). Economic significance and remunerative nature of the cole crops in short span have compelled the growers to adopt intensive vegetable cultivation. It has been estimated that the insect pests are responsible for reducing more than 40 per cent yield in vegetables. Among these the diamond back moth is the most devastating and cosmopolitan pest of crucifer vegetables (CIE, 1967).

The pest is found to be active from July to April with two peak periods, one during September when up to 38 per cent cauliflower plants are infested and the other during December to February when 23 to36.9 per cent cauliflower, 27 to 49 per cent cabbage and 27 to 29 per cent radish plants are infested (Choudhary and Rawat, 1967).

Diamond back moth has developed resistance to nearly all classes of insecticides used in South- East Asian countries (Lim, 1996). In 1980s high level of resistance to synthetic pyrethroids, cypermethrin, fenvalerate and deltamethrin were reported from different parts of the country (Mehrotra, 1993). Management of the pest poses serious concern due to development of insecticide resistance to organophosphate (Noppun *et al.*, 1986), carbamates (Sun *et al.*, 1978) and synthetic pyrethroids (Liu *et al.*, 1981).

Vegetable farming in different agro-climatic zones of Madhya Pradesh experiences heavy losses due to insect pests. Chemicals are resorted to by majority of farmers of the state to get rid of the pest problems. Keeping in view the present investigation on studies on bio and modern pesticides in the management of diamond back moth, *Plutella xylostella* (L.) on cauliflower" was undertaken.

*Corresponding Author

MATERIAL AND METHOD

The present investigation studies on bio and modern pesticides in the management of diamond back moth, *Plutella xylostella* (L.) on cauliflower was conducted during the rabi season. The recommended package of practices for growing the cauliflower crop was followed.

Experimental details

A field of 603.5 sq m was divided into 24 plots, the size of each sub-plot being 20 sq m. The experiment was conducted in a randomized block design. The experimental details are given in Table 1.The crop was cauliflower variety Madhuri Replicated three times eight treatments (including untreated control) and Plot size were 5m x 4m Distance between replication 1m Spacing, plant to plant 35 cm Spacing, row to row 45 cm No. of plants/plot 9 x 14 126 Total plant populations were 3024. Previous crop was cauliflower and Seed treatment was done with IPRODION-carbendazym and the number of insecticidal sprays were two times.

Details of insecticidal treatments

Eight treatments (six chemicals, one biopesticide and one untreated control) were tested in the field experiment against the diamond-back moth on cauliflower.

Table 1. Details of insecticides, their formulation, dose and source

Insecticides	Formulation	Dose/ha	Source
Imidacloprid	17.8% SL	100 ml	Bayer (India) Ltd., Mumbai
Acetamiprid	20% SP	50 g	DE-NOCIL Crop Protection Ltd., Mumbai
Thiomethoxam	25% WG	100 g	Syngenta (India) Ltd., Mumbai
Fipronil	5% SC	500 ml	Aventis Crop Science Ltd., Mumbai
Cartap hydrochloride	50% SP	1000 g	Dhanuka Pesticides Ltd., Haryana
PII-0111	20% WDG	100 g	PI-Industries Ltd., Rajasthan
Bacillus thuringiensis	WP	1000 g	Wockhardt Ltd., Mumbai
Untreated control	-	-	-

Method of application of insecticides

For spraying on individual plot the measured quantity of spray material of particular concentration was taken in a hand operated knapsack sprayer to which a fine single nozzle was attached. Due to waxy layer present on cauliflower leaf a sticking agent "Chipco" @ 5 ml lit^{-1} of the spray fluid was used with insecticide for better dispersion and adhesion of spray material. Before and after the preparation of material and spraying of individual insecticides, the sprayer and measuring cylinder were thoroughly washed with clean water. The first application of insecticides was given on 26/02/2003, just after population build up of the pest and the second spray was repeated after 15 day on 13/03/2003 in accordance with the treatments at the morning hours. While spraying the bacterial insecticide *Bacillus thuringiensis*, it was important to maintain the pH of the spray fluid at neutrality. Hence, the performance of this bacterial insecticide had been enhanced by adding spray additives as molasses.

Methods of observations

Sampling Technique – Random sampling

Field trials were conducted to evaluate insecticides to find out the effective control measure for diamond back moth. Pretreatment population of DBM larvae were recorded before each spraying from 10 randomly selected plants from each plot. Post treatment larval population was recorded one, two, three, seven and ten days after spraying to assess the efficacy of the insecticidal treatments.

RESULT

To find the most effective as well as economical and viable insecticides for the control of diamond back moth, a field trial was conducted using biological and chemical insecticides.

Larval populations were recorded on 10 random plants per plot before insecticidal sprays and one, two, three, seven and ten days after spraying. The reductions in larval population were computed using the above data.

First foliar spray

Pretreatment population

The pretreatment mean larval population varied between 4.33 to 5.47 larvae/plant with non-significant difference among the treatments (table 2).

After one day

The data recorded after one day of spraying indicated that the mean population of insect varied between 2.26 to 4.16 larvae/plant. The two insecticides, namely fipronil and catap hydrochloride, were found superior treatments over the remaining treatments with 2.26 and 2.80 larvae/plant respectively. The untreated control recorded the maximum population (4.16 larvae/plant), which remained at par with PII-0111.

After two days

Fipronil and catap hydrochloride (with 1.76 and 1.95 larvae/plant respectively) were significantly superior treatments to the untreated control (4.17 larvae/plant), as evident from table 1. The rest of the

treatments could not perform well and remained statistically at par with each other, except the untreated control.

After three days

The larval population after three days of first spraying showed significant differences among the treatments. The mean population ranged from 1.50 to 4.23 larvae/plant. The minimum mean populations were recorded from the treatments fipronil and cartap hydrochloride (1.50 to 1.87 larvae/plant), both being were at par but superior to others. Cartap hydrochloride, PII-0111 and imidacloprid (1.87, 2.06 and 2.36 larvae/plant) remained statistically at par with acetamiprid (2.60 larvae/plant) and thiomethoxam (2.63 larvae/plant). Higher mean populations were recorded from the plots of *Bacillus thuringiensis* and untreated control, having 3.03 and 4.23 larvae/plant respectively.

After seven days

On the seventh day after first application of insecticide the minimum mean larval population as found in fipronil and cartap hydrochloride (1.23 and 1.40 larvae/plant) and the highest in the untreated control (4.30 larvae/plant). All the treatments proved significantly superior to the untreated control. Fipronil and cartap hydrochloride proved the best and significantly superior to all other treatments. Acetamiprid and PII-0111 (1.86 and1.90 larvae/plant) were at par and next better treatments which were significantly superior to the remaining treatments.

After ten days

Observation on larval population in different treatments after ten days of first spraying showed that all the treatments were significantly superior to the untreated control, reducing the larval population of *P. xylostella*. Fipronil and cartap hydrochloride (i.e. 1.90 and 2.10 larvae/plant) emerged to be superior to all other treatments. Acetamiprid, PII-0111, thiomethoxam and imidacloprid (2.53, 2.70, 2.93 and 3.20 larvae/plant respectively) were at par with each other and the next best treatments. The least effective treatment was *Bacillus thuingiensis* (3.66 larvae/plant).

Table 2. Evaluation of bio and modern pesticides against DBM (first spray)

Treatment	Dose/ha	Pre-treatment larval population/plant	Mean of three replication					Overall mean
			Mean larval population of DBM per plant at days after first spray					
			1	2	3	7	10	
Imidacloprid (17.8%SL)	100 ml	4.47	3.06	2.77	2.36	2.46	3.20	2.77
Acetamiprid (20%SP)	50 g	5.03	3.36	2.50	2.60	1.86	2.53	2.57
Thiomethoxam (25%WG)	100 g	4.80	3.30	2.57	2.63	2.13	2.93	2.71
Fipronil (5% SC)	500 ml	4.33	2.26	1.76	1.50	1.23	1.90	1.73
Cartap hydrochlorid (50% SP)	1000 g	5.47	2.80	1.95	1.87	1.40	2.10	2.02
Bacillus thuringiensis (WP)	1000 g	4.37	3.26	3.07	3.03	2.90	3.66	3.18
PII-0111 (20% WDG)	100 g	4.70	3.76	2.47	2.06	1.90	2.70	2.58
Untreated control	-	4.93	4.16	4.17	4.23	4.30	4.57	4.28
S. Em. ±		N.S.	0.36	0.36	0.25	0.28	0.35	0.20
CD at 5% level			0.77	0.77	0.53	0.60	0.75	0.42

Overall efficacy after first spray

The overall mean larval population after first spraying showed significant differences among the treatments. The population ranged from 1.73 larvae/plant in fipronil to 4.28 larvae/plant in the untreated control. The minimum larval population was recorded from fipronil (1.73 larvae/plant), which was significantly superior to rest of the treatments, except cartap hydrochloride (2.02 larvae/plant). The maximum larval population was recorded in the treatment of *Bacillus thuringiensis* and untreated control (3.18 and4.28 larvae/plant). Acetamiprid, PII-0111, Thiomethoxam and imidacloprid (with 2.57, 2.58, 2.71 and 2.77 larvae/plant) were the next best treatments and significantly superior to rest of the treatments.

The toxicity of different insecticides against DBM in descending order of efficacy were Fipronil > Cartap hydrochloride > Acetamiprid > PII-0111 > Thiomethoxam > Imidacloprid > and *Bacillus thuringiensis.*

Second foliar spray

Pretreatment population before second spraying

The pretreatment larval population of DBM before the second spraying showed non-significant differences among the treatments (table 3).

After one day

The larval population after one day of second spraying depicted significant differences among the treatments. Only fipronil (with 1.83 larvae/plant) performed as a superior treatment over the remaining treatments. The next best treatments were cartap hydrochloride, PII-0111 and thiomethoxam (2.33, 2.36 and 2.70 larvae/plant respectively), which were at par with each other. Rests of the treatments were the least effective.

After two days
Significant differences were observed among the treatments for population after two days of second spraying. The minimum populations were recorded from fipronil, cartap hydrochloride and imidacloprid (1.60, 1.66 and 2.16 larvae/plant), which were at par with each other. Acetamiprid, thiomethoxam and PII-0111 (2.43, 2.46 and 2.53 larvae/plant) were intermediate. Rests of the treatments were the least effective against *P. xylostella.*

After three days
After three days of second spraying all the treatments were significantly superior to the untreated control. Fipronil maintained superiority, followed by cartap hydrochloride, PII-0111 and thiomethoxam, which were at par with each other. The next best treatments were imidacloprid, acetamiprid and *Bacillus thuringiensis* which were at par with each other.

After seven days
After seven days of second spraying all the treatments were found significantly superior to the untreated control in reducing the larval population of *P. xylostella.* Fipronil, cartap hydrochloride and thiomethoxam (1.00, 1.16 and 1.50 larvae/plant) were superior to all other treatments, followed by PII-0111 and acetamiprid (1.97 and 2.26 larvae/plant) which were statistically at par with the former. The least effective treatments were imidacloprid and *Bacillus thuringiensis* (2.53 and 3.03 larvae/plant).

After ten days
Significant differences among the treatments as far as larval population is concerned after ten days of second spraying were observed. Fipronil (1.70 larvae/plant) performed as a superior over the remaining treatments, followed by cartap hydrochloride and PII-0111, which were statistically at par with the former. Thiomethoxam and acetamiprid were the next best treatments and were at par with each other. The least effective treatments were imidacloprid and *Bacillus thuringiensis* (3.06 and 3.36 larvae/plant). The population of the untreated control (6.06larvae/plant) was significantly higher than rest of the treatments.

Overall mean population of second spray
The efficacy of the treatments indicated that the overall mean population reduction of *P. xylostella* larvae ranged between 1.47 to 5.34 larvae/plant. The minimum larval population was recorded from fipronil and cartap hydrochloride with 1.47 and 1.72 larvae/plant respectively, which were significantly superior to rest of the treatments. PII-0111 and thiomethoxam (2.17 and 2.19 larvae/plant) were intermediate. Imidacloprid and acetamiprid were the next best treatment and significantly superior to rest of the treatments. *Bacillus thuringiensis*, however the least effective in reducing the pest population.

Table 3. Evaluation of bio and modern pesticides against DBM (second spray)

Treatment	Dose/ha	Pre-treatment larval population/plant	Mean of three replication					Overall mean
			Mean larval population of DBM per plant at days after second spray					
			1	2	3	7	10	
Imidacloprid (17.8%SL)	100 ml	3.73	2.90	2.16	2.13	2.53	3.06	2.56
Acetamiprid (20%SP)	50 g	3.26	3.07	2.43	2.23	2.26	2.83	2.57
Thiomethoxam (25%WG)	100 g	3.16	2.70	2.46	1.96	1.50	2.33	2.19
Fipronil (5% SC)	500 ml	3.36	1.83	1.60	1.23	1.00	1.70	1.47
Cartap hydrochlorid (50% SP)	1000 g	3.23	2.33	1.66	1.40	1.16	2.03	1.72
Bacillus thuringiensis (WP)	1000 g	4.10	3.10	3.13	2.43	3.03	3.36	3.10
PII-0111 (20% WDG)	100 g	3.40	2.36	2.53	1.90	1.97	2.10	2.17
Untreated control	-	4.56	4.73	4.96	5.36	5.56	6.06	5.34
S. Em. ±		N.S.	0.23	0.33	0.38	0.40	0.38	0.18
CD at 5% level			0.49	0.70	0.81	0.85	0.81	0.38

The toxicity of different insecticides of *P. xylostella* in descending order of efficacy was as under.
Fipronil > Cartap hydrochloride > PII-0111 > Thiomethoxam > Imidacloprid > Acetamiprid > *Bacillus thuringiensis.*

Impact of insecticidal treatments on cauliflower yield
The yield of cauliflower (curds with half cutting of leaves) was recorded in various insecticidal sprays (Table 4). The cumulative yield was expressed as weight of harvested cauliflower curds per plot as well as total weight of all two pickings from each plot.
The yield of crop ranged between 92.75 kg/plot and 122.16 kg/plot (i.e. 46.37 to 61.08 t/ha). The maximum yield was recorded from the plots treated with fipronil as 122.16 kg/plot (61.08 t/ha), which was significantly superior over rest of the treatments. The next in order of effectiveness were the cartap hydrochloride and PII-0111 with the yield of 115.33 kg/plot (57.66 t/ha) and 112.50 kg/plot (56.25 t/ha) respectively. The next in order of comparative effectiveness were the thiomethoxam and acetamiprid with the yield of 109.33 kg/plot (54.66

t/ha) and 105.41 kg/plot (52.70 t/ha) which were at par with each other.

The lowest yield was recorded from the untreated control plot with the yield of 92.75 kg/plot (46.37 t/ha), which was at par with Bt and imidacloprid with the yield of 97.66 and 98.58 kg/plot (48.83 and 49.29 t/ha), respectively.

Table 4. Impact of insecticidal treatments on cauliflower yield (t/ha)

Treatment	Dose/ha	Overall mean of total yield (kg/plot)	Overall mean of total yield (t/ha)	Percentage increase in yield over control	Percentage avoidable loss
Imidacloprid (17.8%SL)	100 ml	98.58	49.29	6.29	19.30
Acetamiprid (20%SP)	50 g	105.41	52.70	13.65	13.71
Thiomethoxam (25%WG)	100 g	109.33	54.66	17.87	10.51
Fipronil (5% SC)	500 ml	122.16	64.08	31.72	-
Cartap hydrochlorid (50% SP)	1000 g	115.33	57.66	24.34	5.59
Bacillus thuringiensis (WP)	1000 g	97.66	48.83	5.30	20.05
PII-0111 (20% WDG)	100 g	112.50	56.25	21.30	7.90
Untreated control	-	92.75	46.37	-	24.08
S. Em. ± CD at 5% level		3.69 7.91	1.84 3.94		

The per cent increase in overall yield due to insecticidal treatments was computed from the overall yield of various treatments (Table 4). Fipronil gave 31.72 per cent increase in yield over the untreated control, which was maximum as compared with other treatments. The second in order of effectiveness were cartap hydrochloride and PII-0111, where the per cent increase in yield was recorded as 24.34 and 21.30 respectively. The next in order of effectiveness were thiomethoxam and acetamiprid where the per cent increased yield was estimated as17.87 and 13.65 respectively. The minimum yield increase was recorded from imidacloprid and *Bacillus thurigiensis* as 6.29 and 5.30 per cent respectively.

The per cent avoidable loss was computed and it revealed that in the untreated control 24.08 per cent avoidable loss was recorded as compared with the best treatment, i.e., fipronil. In case of *Bacillu thuringiensis* and imidacloprid the avoidable losses were 20.05 and 19.30 per cent respectively. The comparatively lower avoidable losses were recorded fro cartap hydrochloride, PII-0111, thiomethoxam and acetamiprid, i.e. 5.59, 7.90, 10.50 and 13.71 per cent, respectively.

The overall perusal of data on the total cauliflower yield as affected by different insecticidal treatments against DBM in clearly indicated that fipronil was the most effective treatment amongst all the treatments. The per cent increase in yield over the untreated control was also maximum in fipronil. Cartap hydrochloride and PII-0111 were found the next best treatments in efficacy against DBM. The rest of the treatments, i.e. *Bacillus thuringiensis*, imidacloprid, acetamiprid and thiomethoxam were intermittent, through they proved better than the untreated control.

DISCUSSION

The results of seven pesticides tested against DBM under field condition has shown (Table 2 & 3) that all the treatments were significantly superior to the untreated control. The modern insecticide fipronil proved the most effective treatment as it gave maximum reduction in larval population, followed by cartap hydrochloride, while other treatment s were intermediate, after one, two and three days of first and second sprayings. After seven days of the first and second sprayings, all the treatments were superior to control in reducing the larval population of *P. xylostella*. Fipronil was again superior overall the treatments, followed by cartap hydrochloride. After ten days of the first and second sprayings, fipronil maintained its superiority. The next best treatment was cartap hydrochloride, which was significantly superior to rest of the treatments. The least effective treatment was *Bacillus thuringiensis.*

In view of overall efficacy after first and second sprayings it was concluded that fipronil was significantly superior to rest of the treatment and the next best treatment was cartap hydrochloride. The other treatments viz., PII-0111, thiomethoxam, acetamiprid and imidacloprid were intermittent and at par with each other. The least effective treatment was *Bacillus thuringiensis.* The inherent toxicity of these insecticides against DBM could be arranged in the decreasing order as follows.

Fipronil > Cartap hydrochloride > PII-0111 > Thiomethoxam > Acetamiprid > Imidacloprid > *Bacillus thuringiensis.*

The findings of the present investigation was in accordance with that of Panda *et al.* (1999) who recorded the foliar application of fipronil 5 % SC @50g ai/ha reduced the incidence of DBM (*P. xylostella* L.) on cabbage and was more effective

than cartap hydrochloride and endosulfan during 1996-97 in Orissa. In the present investigation fipronil 5% SC @ 500 ml/ha was also found to be more effective than cartap hydrochloride against DBM on cauliflower and Ridland and Endersby (2011) who also recorded the reduced susceptibility to fipronil against diamond back moth on *Brassica* vegetables in Australia. Nagesh and Verma (1997) who found that cartap hydrochloride was the most effective treatment in controlling the diamond back moth among various insecticides tested, while cartap hydrochloride @ 100 g ai/ha was not found effective when sprayed twice on cabbage to control DBM as reported by Rajavel and Babu (1989). However, in the present investigation cartap hydrochloride 50 % SP @1000 g/ha, when sprayed twice was found effective, next to the best treatment, i.e. fipronil 5% SC @500 mi/ha, as for as the control of *P. xylostella* on cauliflower is concerned. Takahashi *et al.* (1999) they reported the acetamiprid (2 %) granules suitable for the control of diamond back moth on cabbage, whereas in the present experiment it was intermediate in efficacy and significantly superior to imidacloprid and *Bacillus thuringiensis*. Joia *et al.* (1994) reported the DBM resistance to quinalphos at 170 fold. They also found that a new insecticide cartap hydrochloride was successful in controlling the multi resistant population of *P. xylostella*, as found in the present studies. Joshi and Jhala (1999) also found the cartap hydrochloride, spark, deltamethrin and *Bacillus thuringiensis* were the most effective treatment and recorded significantly lower larval population and per cent infested capsules with higher seed yield of cress (*Lipidium sativam* L.) crop against DBM. Sharma *et al*. (2000) tested three formulations of *Bacillus thuringiensis* subsp *kurstaki* (bioasp and biolep each at 10, 1.5 and 2.0 kg/ha and halt at 1.0 kg/ha) against DBM on cauliflower and found that biosp and biolep at 2 kg/ha gave the highest larval mortality. In the present findings *Bacillus thuringiensis* (halt, 1.0 kg/ha) was not effective in both the sprays, which contradicted earlier results. The inefficacy of *B. thuringiensis* in the present studies did not support Ravendra *et al.* (1995) who found that, fenvalerate, monocrotophos, chlorpyriphos and *Bacillus thuringiensis* were equally effective against the DBM larvae in Tamil Nadu. Nowrocka (1986) found that dipel (*B. thuringiensis*) and thuricide HP (*B. thuringiensis*) i.e. bactospeine and entobacterin against DBM in Poland. In the current findings halt (*B. thuringiensis*) was not effective in reducing the DBM population.

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RESEARCH ARTICLE

CUMULATIVE AND RESIDUAL EFFECT OF YIELD AND NUTRIENT UPTAKE BY RICE UNDER GERANIUM (*PELARGONIUM GRAVEOLENS*) –RICE (*ORYZA SATIVA*) CROPPING SEQUENCE AS INFLUENCED BY LEVELS OF PHOSPHORUS AND ZINC

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Abstract : A field experiment was conduced at Central Institute of Medicinal and Aromatic Plant, Lucknow to influence the cumulative and residual effects of phosphorus and zinc source of nutrient uptake by rice under geranium-rice cropping sequence. The 18 treatment combination consisted of 3 cropping system viz. geranium paired sole (40/80cm.) garlic sole (20×10cm.), geranium paired + garlic (1:4), three levels of phosphorus (0, 30 & 60 Kg. P_2O_5 ha^{-1}) and 2 levels of zinc (0 and 25kg. Zn SO_4 ha^{-1}) were evaluated in a factorial RBD design with three replication. Higher uptake of P by rice in grain in the plots of 80kg P_20_5 ha^{-1} supplied to geranium clearly indicate that there is a residual effect of P on the P uptake by succeeding crop. Hence, there is a net saving of 30kg P_20_5 ha^{-1} to achieve similar yield level to that of 30kg P_20_5 ha^{-1} applied in the plots of geranium received 40kg P_20_5 ha^{-1}. P uptake by rice in grain was also enhanced upto 25kg $ZnSO_4$ ha^{-1} applied over 30kg $ZnSO_4$ ha^{-1} supplied to geranium crop. Residual effect of Zn on uptake of P fallowed the same trend to that of P – uptake under cumulative effect. Zn uptake by rice in grain increased significantly upto 30kg P_20_5 ha^{-1} in the cumulative treatment, However, under the residual treatment the uptake of Zn by rice in grain increased upto 80kg P_20_5 ha^{-1} applied to previous crop. Clearly indicate that higher doses of P may decrease the uptake of Zn by rice in grain. The net profit of rice after geranium paired system (Rs. 13,224.1 ha^{-1}) it was at par with rice after garlic sole (Rs. 13,758.1 ha^{-1}) system. Thus Geranium – rice sequence proved economical.

Keywords: Rice, Medicinal & Aromatic plants, Phosphorus, Zinc

INTRODUCTION

Geranium (*Pelargonium graveolens*) is a native of dry rockey slopes of cape province (South Africa) and has spread to different parts of world. At present china is the major producer. The crop was introduced in India during early part of 20th century and its cultivation gained commercial importance in high altitude of Palney, Shevroy and Nilgiri hills of Tamilnadu. Geranium is a crop of high value perfumery oil widely used in soaps, cosmetics and perfumery industries. Due to developmental activities in traditional areas of its cultivation, production of geranium oil has gone down from 20t to less than 2t per year. Thus there is an urgent need to increase the domestic production of geranium oil not only to meet our own needs but also save precious foreign exchange involved in its procurement. To achieve this, of late, geranium has successfully been introduced in northern plains of India as an annual crop. In an attempt to increase the production of geranium oil, successful efforts have been made to develop appropriate agro-technologies for its commercial cultivation, in the north Indian plains.

Phosphorus and zinc fertilizers have a carry over effects on the succeeding crops. The utilization efficiency of applied phosphatic fertilizers seldom exceeds 15% by the first crop, but a substantial amount of them is left as residue for the next crop (Roy *et al.*, 1978 and Mahala *et al.*, 2006). Geranium - rice is one of the important cropping systems in northern Indian plains, where the poor tribal farming community is not using phosphorus. Hence it become necessary to findout some low-priced indigenous alternative. Further more, in the north Indian plains, rice is grown as a major food crop during Kharif season. In the rice growing belt of the north Indian plains, geranium and upland rice can be grown in sequential cropping system. The recommendation for phosphorus and zinc are made crop based. Such recommendation do not take into account the carry over effect of quantity of nutrient applied to the preceding crop. Hence, rice though in sequence after the geranium cropping is fertilized with full dose of P and Zn. It is, therefore, imperative to study the residual effect of P and Zn on the grain yield of succeeding rice crop and also to workout, the requirement of nutrient for this crop when grown in sequential cropping system. So for, no research work has been carried out to study the nutritional requirement of the geranium – rice based cropping systems, Hence, the aim of the present study was to stabilized the production of geranium and garlic in intercropping system and also the succeeding upland rice crop of the geranium based cropping systems.

In the present investigation an attempt has been made to determine the yield and nutrient uptake of rice and levels of P and Zn application to achieve higher yield of rice with geranium – rice cropping sequence.

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MATERIAL AND METHOD

The experiment was conducted during 1998-1999 at Central Institute of Medicinal and Aromatic Plants Lucknow. The soil was sandy loam in texture and alkaline (pH 8.3) in reaction. The nutrients in the 0-15 cm soil layer were; Low (168.9 kg ha-^{1}) in N (Subbiah and Asija, 1956), Medium (21.6 kg ha^{-1}) in P_2O_5 (Olsen *et al.*, 1954) and K_2O 82.7 kg ha^{-1} (Jackson, 1967). The available Zn was 0.4 ppm, estimated by DTPA $CaCl_2$ TEA method. Three cropping systems (geranium paired sole, garlic sole and geranium paired + garlic), three levels of P (0, 40 and 80 kg P_2O_5 ha^{-1}) and two levels of zinc (0 and 30 kg Zn SO_4 ha^{-1}) were evaluate in experiment No. 2 during rabi season. The same layout was used to observe the residual and cumulative effects of the treatment on succeeding rice crop. A uniform dose of 120 kg. N and 60 kg. K_2O ha^{-1} was applied to the paddy crop. Phosphorus and Zinc fertilizers were applied basally as per the treatment at the time of planting. The potassium fertilizer was also applied basally at the time of planting. Nitrogen was top dressed in three equal proportion at 20, 40 and 60 days after planting. The cumulative effect was examined over the direct application of P (0, 30 and 60 kg P_2O_5 ha^{-1}) and Zn (0 and 25 kg $ZnSO_4$ ha^{-1}) were evaluated in a factorial randomized block design with three applications. The seeds of the variety pant – 12 were obtained from G.B. Pant University of Agriculture and technology Pantnagar. 25 days old seedlings were transplanted at a spacing of 20 × 10 cm using 2-3 seedlings per hill on 2 July 1999 and harvested at 100 days after transplanting. Observation on yield attribute and yield were recorded. Observation on dry matter content (%) and dry matter yield in rice was recorded. The 100 gm fresh plants samples were kept in oven for drying at 50-60^{0} for 48 hours. After proper drying, the plant samples weight was recorded and expressed as dry matter content (%). The dry matter content (%) was multiplied by biomass yield to obtain dry matter yield and expressed as quintals per hectare.

Phosphorus and zinc contents in Plant tissue were estimated in geranium and garlic at harvests. Samples were digested in di-acid and reading for P and Zn were recorded on Kletts colorimeter (Jackson, 1962 and AOAC, 1965) and atomic absorption spectro photometer (Lindsay and Norvell, 1978) respectively.

Nutrient uptake was calculated by multiplying the dry matter yield with nutrient content and expressed in kg ha^{-1}

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%) in dry matter} \times \text{yield of dry matter (kgha}^{-1}\text{)}}{100}$$

RESULT AND DISCUSSION

Cumulative and residual effect of P and Zn in rice

Effect of P on yield attributes and yield in rice

Rice crop grown in the field plots after the harvest of geranium sole as well as intercropped geranium did not differ significantly in yield attributing characters. However, the application of P at 30(40) kg P_20_5 ha^{-1} and Zinc at 25(30) kg $ZnS0_4$ ha^{-1} showed an improvement both in development of panicles and grain. In the cumulative effect, the P levels were added both to geranium and rice crops. The significant differences in the yield attributes of rice at lower doses of P were mainly because of the residual effect of P applied (40 Kg P_20_5 ha^{-1}) to previous crop of geranium.

But higher doses of P applied to rice directly did not contribute significantly with respect to yield attributes. It is interesting to note that the grain weight per panicle of rice was observed significant at 60(80) kg P_20_5 ha^{-1} which was applied to rice crop directly in the plots of previous crop fertilized with 80 kg P_20_5 ha^{-1} (Table-1).As a result, the grain yield was found to be significant in the residual fertility soil status. This implies that the added fertilizer to the preceding geranium crop continued to have marginal residual effects in the succeeding rice crop. Present findings are supported by the observation made by other workers in food crops (Dev and Mistry, 1979, Wichmann, 1979, Mahala *et al.*, 2006 and Singh and singh 2006). Dang *et al* (1989) observed the residual effect of P in wheat - rice system and they found that P at 26.4 kg P_20_5 ha"^{1} in wheat increase the yield of wheat (674 kg ha^{-1}) as well as the yield of succeeding rice (712 kg ha^{-1}). P at the rate of 26.4 Kgha'^{1} used in rice also increased the yield of when the preceding wheat receiving no application, but up to 13.2 kg P ha^{-1} only when the preceding wheat received only 13.2 kg P ha^{-1}. Rathi and Yadav (1992) also reported that residual effect of P applied to pigeon pea crop was positive on grain yield of wheat. It is clear from the findings that the yield of rice grains under residual fertility status of P at 80 kg P_20_5 ha^{-1} supplied to geranium was almost equal to the yield of rice grain recorded with 30 kg P_20_5 ha^{-1} applied in the plot of 40 kg P_20_5 ha^{-1} received by previous crop of geranium. Therefore, it follows from the results that geranium crop followed by rice, 40 kg P_20_5 ha^{-1} is desirable particularly in Rabi crop season. But to grow rice after geranium 30 kg P_20_5 ha^{-1} is suggested (Table-2). On the other hand we can say that neither the higher doses of P (80 kg P_20_5 ha^{-1}) are required to geranium nor to rice (60 kg P_2O_5 ha^{-1})

Effect of Zn on yield attributes and yield in rice

Application of 25Kg $ZnS0_4$ ha^{-1} influenced significantly the yield attributing characters and grain yield on cumulative and residual soil fertility status. The requirement of Zinc for rabi crop of geranium is 30 Kg $ZnS0_4$ ha^{-1} and the rice crop grown in sequence after geranium is 25Kg $ZnS0_4$ ha^{-1}. It has been observed that soil application of $ZnS0_4$ at 20 Kg ha^{-1} to rice improve the grain yield in wheat (Prasad and Umar, 1993). Higher levels of P with Zinc may decrease the availability of Zn to the plants. Several workers have reported the P induced zinc deficiency in agricultural crop (Takkar 1989).

Cumulative and residual effects on uptake of P and Zn in the grain of succeeding rice crop:

Cumulative effect of P uptake by rice in grain reveled that there was a significant and progressive increase in P uptake by rice in grain with successive increase in P level from control to 60 kg P_2O_5 ha^{-1}. P uptake by rice grain up to 80 kg P_2O_5 ha^{-1} also increased on the residual fertility status of the soil. This might be due to residual effect of applied P to geranium. Sinha and Rai (1984) also noticed significant response of direct applied P to wheat grown on varied residual fertility. Thus, the P requirement of rice, especially where geranium in the preceding crop, could be reduced to 30 Kg P_2O_5 ha^{-1} in the cumulative effect of the treatment. Higher uptake of P by rice in grain in the plots of 80 kg P_2O_5 ha^{-1} supplied to geranium clearly indicate that there is a residual effect of P on the P uptake by succeeding crop. Hence, there is a net saving of 30 kg P_2O_5 ha^{-1} to achieve similar yield level to that of 30 kg P_2O_5 ha^{-1} applied in the plot of geranium received 40 kg P_2O_5 ha^{-1}. P uptake by rice in grain was also enhance up to 25 kg $ZnSO_4$ ha^{-1} applied over 30 kg $ZnSO_4$ ha^{-1} supplied to geranium crop. Residual effect of Zn on uptake of P followed the same trend to that of P – uptake under cumulative effect (Table-3). Zn uptake by rice in grain increased significantly up to 30 kg P_2O_5 ha^{-1} in the cumulative treatment. However, under the residual treatment the uptake of Zn by rice in grain increased up to 80 kg P_2O_5 ha^{-1} applied to previous crop. This clearly indicate that higher doses of P may decreased the uptake of Zn by rice in grain. Balanced supply of P up to 30 kg P_2O_5 ha^{-1} in the soil might have favored the efficient use of Zn by the rice crop. Prasad and Umar (1993) have also reported the similar results in rice-wheat rotation.

Gross return and net profit of rice cropping

Cumulative effect of the cost of production of rice was uniform under different cropping systems (Rs. 17380.4 ha^{-1}). But after the harvest of garlic sole crop, the higher net profit (Rs. 18,274.6) showed by rice crop indicated that there was a possibility of utilization of more nutrients and water by rice crop as compare to rice crop taken after the harvest of geranium sole and geranium + garlic intercrop. Residual effect of the cost of production rice was uniform under different cropping systems (Rs. 16,210.4 ha^{-1}). But in terms of net profit of rice after geranium paired system (Rs. 13,224.1 ha^{-1}). It was at par with rice after garlic sole (Rs. 13758.1 ha^{-1}) system. However, the net profit slightly decreased under rice grown after geranium paired + garlic combination.

Table 1. Fresh biomass and oil yields of geranium as influenced by different cropping systems and rates of phosphorus and zinc

Treatment	Biomass yield (q ha^{-1}) at			Oil yield (kg ha^{-1}) at		
	Ist harvest	IInd harvest	Total	Ist harvest	IInd harvest	Total
Cropping System						
Geranium paired sole (40/80 cm)	236.92	152.50	389.92	48.72	32.98	81.73
Garlic sole (20×10cm)	-	-	-	-	-	-
Geranium paired (40/80 cm) + Garlic	217.77	140.40	358.15	44.98	30.37	75.35
SEm	5.98	4.30	9.72	1.19	0.82	2.02
CD at 5%	17.54	NS	28.50	3.49	2.40	5.92
Phosphorus levels (Kg P_2O_5 ha^{-1})						
0	194.57	123.05	317.62	40.33	27.05	67.38
40	237.81	153.18	391.00	49.05	33.7	82.75
80	249.66	163.08	412.75	51.17	34.28	85.5
SEm	7.32	5.28	11.90	1.46	1.00	2.47
CD at 5%	21.48	15.48	34.92	4.28	2.94	7.25
Zinc levels (kg $ZnSO_4$ ha^{-1})						

0	214.23	137.42	351.65	44.30	29.72	74.00
30	2.40.46	155.45	395.90	49.40	33.63	83.08
SEm	5.98	4.31	9.72	1.19	0.82	2.02
CD at 5%	17.54	12.64	28.51	3.49	2.40	5.92

NS= Non significant

Table 2. Yield attributes & Bulb yield of garlic at harvest as influenced by different cropping systems and rates of phosphorus and zinc

Treatment	Diameter/bulb (cm)	No. of Cloves/bulb	Weight/bulb (gram)	Bulb yield (q ha^{-1})
Cropping System				
Geranium paired sole (40/80 cm)	4.55	15.82	32.11	122.24
Garlic sole (20×10cm)	-	-	-	-
Geranium paired (40/80 cm)+ Garlic	3.79	15.50	26.00	56.27
SEm	0.11	0.46	0.80	2.56
CD at 5%	0.33	NS	2.34	7.27
Phosphorus levels (kg P_2O_5 ha^{-1})				
0	3.90	12.97	22.17	80.02
40	4.19	16.18	29.5	90.78
80	4.42	17.83	35.50	96.96
SEm	0.14	0.57	0.98	3.14
CD at 5%	0.40	1.66	2.86	8.91
Zinc levels (kg $ZnSO_4$ ha^{-1})				
0	4.06	14.61	26.61	85.45
30	4.28	16.71	31.50	93.05
SEm	0.11	0.46	0.80	2.56
CD at 5%	NS	1.35	2.34	7.27

NS= Non significant

Table 3. P uptake (kg ha^{-1}) of rice as influenced by cumulative and residual effect of P and Zn under different cropping systems

Treatment	P uptake (kg ha^{-1}) at harvest			
	Cumulative		Residual	
	Grain	Straw	Grain	Straw
Cropping System				
Geranium paired sole (40/80 cm)	36.72	13.62	31.40	12.23
Garlic Sole (20×10 cm)	41.03	13.90	32.08	12.57
Geranium paired (40/80 cm) + Garlic	35.07	13.50	30.13	11.52
SEm	1.00	0.37	0.81	0.35
CD at 5%	2.89	NS	NS	0.99
Phosphorus levels (kg P_2O_5 ha^{-1})				
0 (0)	26.00	11.73	23.48	10.33
30 (40)	41.33	15.07	32.40	12.62
60 (80)	45.48	14.22	37.73	13.37
SEm	1.00	0.37	0.81	0. 35
CD at 5%	2.89	1.05	2.32	0.99

Zinc levels (kg $ZnSO_4$ ha^{-1})				
0 (0)	33.49	12.96	28.87	11.82
25 (30)	41.72	14.39	33.53	12.39
SEm	0.82	0.30	0.66	0.28
CD at 5%	2.36	0.86	1.89	NS

Table 4. Zn uptake (kg ha^{-1}) of rice as influenced by cumulative and residual effect of P and Zn under different cropping systems

Treatment	Zn uptake (kg ha^{-1}) at harvest			
	Cumulative		Residual	
	Grain	Straw	Grain	Straw
Cropping System				
Geranium paired sole (40/80 cm)	0.149	0.188	0.112	0.147
Garlic Sole (20×10 cm)	0.166	0.214	0.123	0.152
Geranium paired (40/80 cm) + Garlic	0.141	0.185	0.107	0.139
SEm	0.005	0.005	0.002	0.004
CD at 5%	0.013	0.14	0.007	0.012
Phosphorus levels (kg P_2O_5 ha^{-1})				
0 (0)	0.125	0.184	0.099	0.141
30 (40)	0.162	0.206	0.114	0.146
60 (80)	0.169	0.196	0.129	0.150
SEm	0.005	0.005	0.002	0.004
CD at 5%	0.013	0.014	0.007	NS
Zinc levels (kg $ZnSO_4$ ha^{-1})				
0 (0)	0.089	0.140	0.080	0.128
25 (30)	0.215	0.252	0.147	0.163
SEm	0.004	0.004	0.002	0.003
CD at 5%	0.011	0.012	0.005	0.009

Table 5. Effect of different cropping systems on gross return (Rs. ha^{-1}) and net profit (Rs. ha^{-1}) of rice crop

Treatment	Grain yield of rice (q ha^{-1})		Straw yield of rice (q ha^{-1})		Gross return (Rs. ha^{-1})		Cost of production (Rs. ha^{-1})		Net profit (Rs. ha^{-1})	
	C	R	C	R	C	R	C	R	C	R
Cropping System										
Geranium paired sole (40/80 cm) – Rice	49.09	44.32	60.87	56.85	32,497.50	29,434.50	17,380.40	16,210.40	15,117.10	13,224.10
Garlic Sole (20×10 cm) – Rice	53.88	45.10	66.54	58.17	35,655.00	29,968.50	17,380.40	16,210.40	18,274.60	13,758.10
Geranium paired (40/80 cm) + Garlic – Rice	47.14	41.88	59.52	53.72	31,260.00	27,814.00	17,380.40	16,210.40	13,879.60	11,603.60

C = Cumulative
R = Residual
N – Rs. 9.87 kg^{-1}, P – Rs. 19.50 kg^{-1}, K – Rs. 7.10 kg^{-1}, Rice Grain – Rs. 600.00 q^{-1}, Straw yield – Rs.50.00q^{-1}

CONCLUSION

It may be conducted that the result of cummulative & Residual effect of uptake of nutricians of rice under geranium – rice cropping sequence. Uptake of P&Zn is more in 30 Kg P_2O_5 & Zn 25 Kg ha^{-1} Over 60 Kg P_2O_5 & 30 Kg $ZnSO_4$ ha^{-1}. The net profit of rice after geranium paired system (Rs. 13,224.1 ha^{-1}) it was at par with rice after garlic sole (Rs. 13,758.1 ha^{-1}) system. Thus Geranium – rice sequence proved economical.

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RESEARCH ARTICLE

POPULATION FLUCTUATION OF YELLOW STEM BORER AND LEAF FOLDER ON BASMATI RICE IN RELATION TO CLIMATIC CONDITIONS OF WESTERN UTTAR PRADESH, INDIA

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Abstract : Population fluctuations of yellow stem borer, *Scirpophaga incertulus* (Walker) and leaf folder, *Cnaphalocrocis medinalis* (Guenee) were assessed in basmati rice during *Kharif* 2014 at Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. The first infestation of yellow stem borer was recorded on first week of August and reached its peak during middle of October when average temperature, relative humidity and rainfall ranged from 27.10 to 30.51 ^{0}C, 69.60 to 84.04 % and 0.30 to 7.56 mm, respectively. The population of leaf folder was first recorded in last week of July and reached at maximum level during end of September to start of October when mean temperature, relative humidity were 28.89 ^{0}C and 76.95 %, respectively. The population of yellow stem borer and leaf folder showed negative correlation with maximum and minimum temperatures, evening relative humidity and rainfall while morning relative humidity showed the positive correlation.

Keywords: Population fluctuation, Yellow stem borer, Leaf folder, Climatic factors

INTRODUCTION

Rice is grown in about 155 million hectare area on approximately 11% of the world's crop lands. India ranks second in the world rice production and 3.5 million tonns are exported (APEDA, 2014). Rice is essentially a crop of warm, humid environment which is conducive to survival and proliferation of lepidopteron insect pests like stem borer and leaf folder (Sarao and Kaur, 2014). Weather conditions are the major regulating causes for the insect pest populations under field circumstances. Certain factors support and other disfavor their multiplication and movement. Therefore, it results in serious out breaks of different insect pests (Hyslops, 1941). Therefore, it is requisite to have a through perception on population fluctuation and its relation with climatic conditions. The present investigation was carried out to assess the population fluctuation of yellow stem borer and leaf folder in western Uttar Pradesh.

MATERIAL AND MATHOD

The field experiment was conduct during *Kharif* 2014, at Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, in a randomized block design with three replications. Transplanting to experimental field was done with 25 days old seedling of Pusa Basmati-1 at 5x4 m^2 plot size. Assessment on population fluctuation of yellow stem borer and leaf folder was determined on ten randomly selected hills from untreated trials. These plants were observed regularly at weekly interval. Dead heart and folded or whitish leaves were counted per hill starting from the transplanting till the harvest of the crop.

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RESULT AND DISCUSSION

Population fluctuation of yellow stem borer, *Scirpophaga incertulus* (Walker)

Data showed that the infestation of *S. incertulas* appeared first on first week of August i.e. 31st standard week and continued till first week of November i.e. 44th standard week (Table 1). The infestation of stem borer recorded as dead hearts/white ear heads ranged from 0.60 to 7.85 per cent during the crop season *Kharif* 2014. The pest population increased from second week of August and reached its peak (7.85 per cent) during 41th standard week i.e. middle of October. During this period the weather parameters like temperature, relative humidity and rainfall ranged from 27.10 to 30.51 ^{0}C, 69.60 to 84.04 per cent and 0.30 to 7.56 mm, respectively. The stem borer infestation suddenly decreased after middle of October i.e. 42th and 43th standard week and this might be due to the no emergence of new leaves. These observations are in agreement with the earlier finding of Kumar and Sudhakar (2001), Pujari *et al*. (2007) who reported the peak activity of stem borer in the month of September - October during *Kharif*. While Joshi *et al.* (2009) reported the maximum number of eggs and pupae in the first week of October, indicating that population of borers builds up late in season.

The correlation studies between infestation of yellow stem borer, *Scirpophaga incertulas* (walker.) with weather parameter are given in Table 1. The correlation matrix indicate that there is a positive correlation with morning relative humidity, (0.37) and a negative correlation with maximum and minimum temperature, minimum relative humidity and rainfall, with the dead heart and white ear head

caused by yellow stem borer. Earlier Hugar *et al*. (2009) also reported the negative correlated with maximum temperature, morning relative humidity and rain fall and had significant positive correlation with sunshine hours. Joshi *et al.* (2009) reported that the maximum temperature, minimum temperature and evening relative humidity exhibited a negative relationship with total number of larvae.

Population fluctuation of leaf folder, *Cnaphalocrocis medinalis* (Guenee)

The infestation of *C. medinalis* on basmati rice was recorded from second fortnight of July (31th standard week) and continued till harvest of the crop during the year 2014. The infestation was low from last week of July to third week of August. The infestation increased from end of August and reached at a maximum level (9.80%) during 40th standard week, when mean temperature and relative humidity was 28.89 ^{0}C and 76.95 % respectively. There after the infestation was declined. These are similar as the earlier finding of Kumar (1996) and Mange Ram (2012), who reported the maximum infestation of leaf folder during second fortnight of September. Nigam (2009) reported that the maximum infestation of *C. medinalis* occurred at 41st standard weak.

The leaf folder infestation showed negative correlation with maximum and minimum temperature, evening relative humidity and rain fall but morning relative humidity showed the positive correlation. The present findings are similar to the finding of Rai *et al*. (2000) who reported that temperature, relative humidity and rainfall were negatively correlated with the infestation of *C. Medinalis*. Padhi and Sanjoy (2004) reported that the maximum temperature, rainfall and relative humidity were negatively correlated, while minimum temperature was positively correlated to the moth population.

Table 1. Population fluctuation of yellow stem borer and leaf folder in relation to climatic factors

S. W	Date	Per cent Dead Heart / white ear head	Per cent leaf damage	Temperature (^{0}C)			Relative Humidity (%)			Rainfall (mm)
				Maxi.	Mini.	Mean	Morning	Evening	Mean	
25	June, 16-22	0.00	0.00	39.70	25.30	32.50	72.30	50.06	61.18	0.00
26	June, 23-29	0.00	0.00	37.51	24.96	31.24	75.90	48.91	62.41	0.76
27	June,30 – July,6	0.00	0.00	35.09	25.26	30.18	89.07	59.37	74.22	3.63
28	July, 7-13	0.00	0.00	38.04	26.56	32.30	88.89	55.91	72.40	0.00
29	July, 14-20	0.00	0.00	33.79	25.79	29.79	93.70	80.91	87.31	7.17
30	July, 21-27	0.00	0.00	32.93	25.63	29.28	89.46	73.97	81.72	0.79
31	July28,- Aug,3	0.60	1.40	34.14	25.47	29.81	94.14	71.37	82.76	2.20
32	Aug,4 -10	0.85	2.15	34.00	25.43	29.72	91.84	71.89	81.87	0.97
33	Aug, 11-17	1.40	3.20	34.53	25.03	29.78	92.89	64.94	78.92	0.30
34	Aug,18- 24	2.65	4.10	35.67	25.34	30.51	84.50	56.87	70.69	0.00
35	Aug, 25-31	3.20	4.60	35.07	25.63	30.35	88.16	65.06	76.61	2.41
36	Sep, 1-7	4.80	5.75	32.89	24.50	28.70	92.93	69.99	81.46	7.56
37	Sep, 8-14	5.30	6.10	32.86	25.09	28.98	95.53	72.60	84.07	0.04
38	Sep, 15-21	5.90	6.70	34.50	23.94	29.22	94.30	59.99	77.15	0.00
39	Sep,22-28	6.35	8.50	34.11	23.01	28.56	90.41	52.47	71.44	0.00
40	Sep,29-Oct,5	7.10	9.80	34.61	23.17	28.89	95.53	58.36	76.95	0.00
41	Oct,6-12	7.85	6.40	33.61	20.59	27.10	88.76	50.44	69.60	0.30
42	Oct, 13-19	4.10	4.60	30.03	15.46	22.75	88.30	49.87	69.09	0.00
43	Oct, 20-26	2.20	3.30	31.36	16.64	24.00	92.23	52.84	72.54	0.00
44	Oct,27 - Nov, 2	1.80	2.70	29.93	15.64	22.79	91.37	55.20	73.29	0.00
Correlation coefficient with per cent dead heart/ white ear head				-0.31	-0.30	-0.33	0.37	-0.22	0.01	-0.18
Correlation coefficient with per cent leaf damage				-0.32	-0.26	-0.31	0.44	-0.16	0.02	-0.20

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RESEARCH ARTICLE

GENETIC STUDIES OF GENOTYPES FOR FRUIT YIELD AND ITS COMPONENT CHARACTERS IN TOMATO (*SOLANUM LYCOPERSICUM* L.)

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Abstract: The present investigation was conducted with twenty four hybrids along with their 10 parents (6 lines and 4 testers) were subjected to study the genetic variability indicated that genetic material in the present investigation possessed variability which provides sufficient basis for selection by breeder. The accessions revealed wide variability for characters evaluated. High estimates of PCV and GCV were obtained for number of secondary branches per plant, number of clusters per plant, number of fruits per cluster, number of fruits per plant, average fruit weight, pericarp thickness and total fruit yield per plot indicated a good deal of variability in those characters signifying the effectiveness of selection of desirable types for improvement. Phenotypic variances were higher than their respective genotypic variances thus revealing the role of environmental factors. High heritability assisted with high genetic advance as per cent of mean was observed for number of secondary branches per plant, number of fruits per plant, number of clusters per plant, average fruit weight (kg), pericarp thickness (mm), total fruit yield per plot (kg). Hence, simple selection based on phenotypic performance of these traits would be more effective.

Keywords: Genetic variability, Heritability, Genetic advance, F1 generation, Tomato

INTRODUCTION

Tomato (*Solanum lycopersicum* L.), 2n=24, is one of the most popular and widely grown vegetables in the world because of its wider adaptability, high yielding potential and suitability for variety of uses. Ripe tomato fruit is consumed fresh as salad and utilized in the preparation of range of processed products such as powder, puree, ketchup, sauce, soup, canned fruit. Unripe green fruits are used for preparation of pickles and chutney. Tomatoes are important source of lycopene (antioxidant) vitamin A, vitamin C and minerals. Exploring natural diversity as a source of desirable alleles for crop improvement (Fernie *et al*.,2006). The role of genetic variability in a crop is of paramount importance in selecting the best genotypes for making rapid improvement in yield and related characters as well as to select most potential parents for making the hybridization programme successful. The success of breeding programme depends on the availability of genetic variability present in the available germplasm (Prasad et al. 2012). Tomato is a distinctive vegetable crop, which is very responsive to genetic improvement due to its high degree of homogeneousness (Pradeepkumar, *et al.,* 2001).

The study of biological parameters is often considered to be useful step in the study of genotypic variability. Genetic parameters such as Genotypic, Phenotypic coefficient of variation (PCV and GCV) are useful in detecting the amount of variability present in the available genotypes. Genotypic and phenotypic coefficients of variability help to access the divergence of the characters (Uniyal *et al*., 2013). Partitioning of observed variability into heritable and non-heritable components is essential to get a true indication of the genetic variation of the trait Heritability and genetic advance help in determining the influence of environment in expression of the characters and the extent to which improvement is possible after selection. Heritable variation can be effectively studied in conjunction with genetic advance. High heritability alone is not enough to make efficient selection in segregation, unless the information is accompanied for substantial amount of genetic advance. Selection would be more meaningful for characters which exhibit high variability and heritability along with moderate to high genetic gain. Realizing the importance of the crop, there is urgent need to isolate such breeding lines having desirable horticultural trails, better quality coupled with high yield potential by analysing the genetic components of variability for desirable traits.

MATERIAL AND METHOD

The present investigation was undertaken during *Rabi*, 2014 at AICRP on Vegetable Crops, IGKV, Raipur (C.G.). The experimental material consisted of 24 F1 hybrids, 10 parents (6 lines and 4 testers) and a commercial check (Arka Vikas). The crop was grown in randomized block design with three replications at spacing of 60 x 45 cm. All recommended agronomic package of practices were followed to grow a healthy crop. Observations of quantitative characters were recorded from 5

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sampled plants in each replication for each genotype. The analysis of variance for testing the variance among treatments was carried out as per the method suggested by Panse and Sukhatme (1967). The data obtained from selected plants were subjected to analysis of genetic variability, heritability and genetic advance (Gomez and Gomez, 1983).

RESULT AND DISCUSSION

Table 1. Analysis of variance for Line X Tester analysis for fruit yield and its component characters in tomato

S. No.	Character	Replications	Treatment	Error
	df	02	33	66
1.	Plant height (cm)	6.20	525.41	4.98
2.	Number of Primary branches per plant	3.13	10.71	0.350
3.	Number of Secondary branches per plant	1.82	66.54	0.52
4.	Days to first flowering	8.11	137.84	2.78
5.	Days to 50% flowering	2.12	148.17	1.85
6.	Number of flowers per cluster	0.05	2.74	0.11
7.	Number of clusters per plant	0.51	12.95	0.69
8.	Number of Fruits per cluster	0.05	3.58	0.37
9.	Number of Fruits per plant	7.17	1,532.18	3.68
10.	Fruit Length (cm)	0.02	3.42	0.07
11.	Fruit Girth (cm)	0.04	2.46	0.03
12.	Days to first harvest	2.70	178.15	6.45
13.	Days to last harvest	18.43	106.75	3.28
14.	Average Fruit Weight (kg)	0.01	0.54	0.01
15.	Pericarp Thickness	0.003	0.06	0.09
16.	Number of locules per fruit	0.02	3.477	0.06
17.	Total fruit yield per plot (kg)	0.82	398.06	1.69

* Significant at P = 0.05 level

The ANOVA and mean performance of different genotypes are presented in the Table 1 and 2 respectively. Highly significant differences among the genotypes for all the characters indicating sufficient variability existed in the present material selected for the study and indicating the scope for selection of suitable initial breeding material for crop improvement. This indicates the presence of much more variability among the genotypes used in present study. Parthasarathy *et al.,* (1976), Nandpuri *et al.,* (1977), Reddy and Reddy (1992) also reported significant difference among tomato genotypes for different characters. A high degree of variability for fruit weight has also been reported by Dhaduk et al., (2004), Borgohain and Swargiary (2008) and Hedau *et al.,* (2008) in tomato. Mean values of all the characters showed wide variations for the plant height (54.19 -89.46 cm), number of primary branches per plant (12.67-4.53), number of secondary branches per plant (6.32-11.28), days to first flowering (22.99-29.06), days to 50 % flowering (33.96-40.47), number of flowers per cluster (4.66-6.20), number of clusters per plant(4.16-7.36), number of fruits per cluster (3.06-4.90), number of fruits per plant (22.43-32.52), Fruit length (4.00-5.95 cm), fruit girth (4.51-5.85 cm), days to first harvest (78.00-90.72), days to last harvest (103.36-117.61), average fruit weight (0.75-1.65 kg), pericarp thickness (0.38-0.57 mm), number of locules per fruit (2.73-4.44) and fruit yield per plant (24.84-38.63 kg).

Table 2. Mean performance of F_1 tomato genotypes

	Hybrids	Characters																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	**ITOM-11-1 x Pusa Ruby**	75.27	6.83	8.08	24.11	34.10	6.90	4.63	5.83	26.23	5.28	4.81	88.67	126.23	1.63	0.58	3.07	29.37
2.	**ITOM-11-1 x Kashi Anupam**	57.63	5.30	7.11	29.97	33.96	7.60	4.97	6.10	23.90	6.90	7.00	90.81	121.53	1.60	0.56	4.27	48.43
3.	**ITOM-11-1 x Pant T-3**	79.63	8.97	8.45	24.68	39.03	6.93	8.70	6.07	31.73	5.58	5.67	86.07	122.43	1.82	0.52	4.17	35.53
4.	**ITOM-11-1 x Cherry Tomato-1**	69.90	9.47	9.78	23.20	37.30	7.83	9.73	6.53	36.67	6.06	5.36	92.94	113.87	1.13	0.38	5.33	24.85
5.	**ITOM-11-3 x Pusa Ruby**	67.37	4.53	17.33	32.50	50.60	6.13	6.60	4.73	37.47	7.63	5.13	87.67	114.07	1.66	0.61	3.03	34.27
6.	**ITOM-11-3 x Kashi Anupam**	58.47	7.57	9.08	24.47	36.03	5.53	5.27	4.07	22.80	7.13	7.25	90.95	114.87	2.39	0.53	5.47	60.67

	Hybrids	Characters																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
7.	**ITOM-11-3 x Pant T-3**	64.57	7.83	8.29	33.90	48.60	7.10	5.90	6.20	23.63	7.85	6.25	81.91	110.37	1.95	0.58	4.33	30.02
8.	**ITOM-11-3 x Cherry Tomato-1**	72.53	7.03	13.38	28.83	39.60	6.02	8.00	4.90	40.30	7.06	5.23	78.00	112.10	1.15	0.48	5.73	28.90
9.	**ITOM-11-6 x Pusa Ruby**	58.60	9.82	10.86	32.90	44.73	6.10	5.53	5.60	29.30	5.64	5.64	95.98	121.50	1.41	0.70	3.17	28.67
10.	**ITOM-11-6 x Kashi Anupam**	59.37	6.35	9.07	36.60	41.07	5.30	5.80	4.43	25.10	6.52	6.08	84.44	115.53	1.64	0.80	4.43	53.80
11.	**ITOM-11-6 x Pant T-3**	65.83	7.20	8.84	35.00	44.50	6.36	9.73	5.33	36.93	4.81	6.21	82.53	117.43	1.82	0.51	3.77	30.59
12.	**ITOM-11-6 x Cherry Tomato-1**	61.10	6.23	12.59	29.67	44.97	7.11	7.57	6.13	38.33	6.38	4.52	90.56	116.60	0.77	0.38	5.30	25.11
13.	**ITOM-11-11 x Pusa Ruby**	70.70	6.33	15.77	33.30	50.70	5.03	8.17	3.83	32.70	5.43	5.71	101.17	126.80	1.68	0.91	4.53	34.83
14.	**ITOM-11-11 x Kashi Anupam**	63.30	7.57	7.60	24.63	37.17	4.87	4.17	4.10	24.97	6.41	7.48	87.30	117.50	2.31	0.85	5.57	64.44
15.	**ITOM-11-11 x Pant T-3**	76.48	7.67	9.24	36.80	51.90	6.07	8.97	3.87	37.00	4.66	6.49	104.20	122.30	1.48	0.47	4.41	44.60
16.	**ITOM-11-11 x Cherry Tomato-1**	87.00	5.97	19.05	24.66	36.87	5.70	11.50	3.53	35.00	5.44	5.54	101.23	124.10	0.76	0.49	4.57	31.36
17.	**ITOM-11-12 x Pusa Ruby**	58.23	7.48	13.35	27.57	38.80	5.50	7.77	3.07	33.13	5.32	5.77	108.02	124.50	2.10	0.52	2.73	36.53
18.	**ITOM-11-12 x Kashi Anupam**	54.19	5.53	7.59	27.47	34.70	4.67	7.33	3.50	22.43	6.04	7.22	89.91	111.50	1.81	0.48	5.37	59.40
19.	**ITOM-11-12 x Pant T-3**	62.01	8.50	8.85	22.99	34.37	5.75	7.27	3.57	35.17	5.23	6.06	83.23	117.17	2.07	0.51	3.57	37.00
20.	**ITOM-11-12 x Cherry Tomato-1**	65.82	11.00	17.71	27.07	35.57	5.87	8.83	4.77	52.97	5.09	5.81	78.43	103.37	1.28	0.44	5.52	31.51
21.	**ITOM-11-14 x Pusa Ruby**	62.87	6.16	15.66	36.57	46.07	7.33	5.47	6.27	27.97	7.38	4.68	91.40	119.87	1.90	0.63	4.39	40.50
22.	**ITOM-11-14 x Kashi Anupam**	89.47	6.35	6.33	26.20	38.07	5.27	5.07	3.97	23.43	6.31	5.26	88.80	114.27	2.20	0.73	5.10	34.87
23.	**ITOM-11-14 x Pant T-3**	70.53	8.08	7.71	27.00	38.67	7.73	8.27	6.73	35.30	4.68	5.61	95.47	119.57	1.72	0.57	4.11	43.72
24.	**ITOM-11-14 x Cherry Tomato-1**	59.47	7.13	19.21	26.79	34.07	6.13	11.43	4.53	48.23	4.01	5.64	80.93	115.33	1.38	0.48	4.80	38.33
	CD at 5 %	4.5	1.16	1.32	3.21	2.72	0.60	1.39	1.10	3.74	0.43	0.26	4.74	2.79	0.22	0.05	0.42	2.21
	CV%	3.91	9.35	6.81	6.46	3.91	5.71	11.06	13.08	6.72	4.28	2.66	3.07	1.38	8.09	5.84	5.50	3.33

1. Plant Height (cm)
2. No. of primary branches/ plant
3. No. of secondary branches/ plant
4. Days to first flowering
5. Days to 50% flowering
6. No. of flowers/cluster
7. No. of clusters/plant
8. No. of fruits/cluster
9. No. of fruits/plant
10. Fruit Length (cm)
11. Fruit Girth (cm)
12. Days to first harvest
13. Days to last harvest
14. Average fruit weight (kg)
15. Pericarp Thickness
16. No. of locules/fruit
17. Total fruit yield /plot (kg)

However, the absolute variability in different characters does not permit identification of the characters showing the highest degree of variability. Therefore, PCV and GCV values were estimated. The coefficient of variation whether it is genotypic or phenotypic, both are useful in studying the extent of variability in different characters as it measures the range of variability. The PCV values were slightly higher than the respective GCV for all the characters denoting little influence of environmental factors on their expression. The difference between values of PCV and GCV were less for all traits except for number of primary branches per plant and number of fruits per cluster in present investigation. It means that these traits were less influenced by environment and hence, they could be improved by following different phenotypic selections like directional, disruptive and stabilized selections. The PCV and GCV values were very high particularly for number of secondary branches per plant, total fruit yield per plot (kg), number of clusters per plant, average fruit weight (kg), pericarp thickness, number of fruits per cluster, number of fruits per plant due to very high variability available in these traits (Table 3). This moderate to low variability indicates the need for improvement of base population through intercrossing in F2 generation followed by recurrent selection to increase the gene flow and to fix favourable alleles. High values of GCV and heritability estimates appended with better genetic gains also exposed role of additive gene effects regulating the inheritance of such traits (Narayan *et al.*, 1996).

Heritability is an index of transmissibility of characters from a parent to off-spring. Perusal of

results on heritability and genetic advance as per cent of mean (GAM) revealed that heritability estimates were high for all the characters studied. This suggested the greater effectiveness of selection due to less influence of environment and improvement to be expected for these characters in future breeding programme. Johnson *et al*. (1955) suggested that high heritability coupled with high genetic advance as percentage of mean (GAM) were more useful than heritability alone in predicting the resultant effect during selection of best individual genotype. Genetic advance is the measure of genetic gain under selection and expression in percentage of mean. In the present experiment high heritability was recorded for plant height , number of secondary branches per plant, days to 50% flowering, number of fruits per plant, fruit length, fruit girth, days to last harvest, average fruit weight (kg), number of locules per fruit , pericarp thickness , total fruit yield per plot (kg) indicating predominance of additive gene action for these characters. Simple selection based on phenotypic performance of these characters would be more effective. Haydar et al., (2007), Chadha and Bhushan (2013) have also reported this estimate of heritability for different traits in tomato.

Table 3. **Genetic parameters of variation for fruit yield and its components in tomato**

S. No.	Parameters / Characters	Mean ↓	Range		Coefficient of variation (%)		h^2(b) (%)	Genetic Advance	Genetic advance as per cent of mean
			Minimum	Maximum	GCV	PCV			
1.	Plant Height (cm)	67.09	54.19	89.46	13.62	14.17	92.38	18.09	26.96
2.	No. of Primary Branches Per Plant	11	12.67	4.53	19.95	22.04	81.98	2.71	37.22
3.	No. of Secondary Branches Per Plant	11.28	6.32	19.21	36.18	36.81	96.56	8.26	73.24
4.	Days to First Flowering	29.06	22.99	36.8	15.10	16.47	83.99	8.28	28.50
5.	Days to 50% Flowering	40.47	33.96	51.9	14.18	14.71	92.90	11.39	28.15
6.	No. of Flower Per Cluster	6.20	4.66	7.83	14.55	15.63	86.64	1.73	27.90
7.	No. of Cluster Per Plant	7.36	4.16	11.5	27.40	29.55	85.99	3.85	52.30
8.	No. of Fruits Per Cluster	4.90	3.06	6.73	21.71	25.35	73.37	1.87	38.32
9.	No. of Fruits Per Plant	32.52	22.43	52.96	24.32	25.24	92.91	15.71	48.31
10.	Fruit Length (cm)	5.95	4.00	7.84	17.01	17.54	94.02	2.02	33.98
11.	Fruit Girth (cm)	5.85	4.51	7.47	13.54	13.80	96.28	1.60	27.37
12.	Days to First Harvest	90.72	78.00	108.01	8.53	9.04	89.02	15.04	16.58
13.	Days to Last Harvest	117.61	103.36	126.8	4.66	4.86	91.90	10.83	9.20
14.	Average Fruit Weight (kg)	1.65	0.75	2.39	25.71	26.96	90.99	0.83	50.53
15.	Pericarp Thickness	0.57	0.38	0.91	23.97	24.67	94.38	0.27	47.97
16.	No. of Locules Per Fruit	4.44	2.73	5.73	19.63	20.39	92.70	1.73	38.93
17.	Total Fruit Yield Per Plot (kg)	38.63	24.84	64.43	29.16	29.35	98.70	23.06	59.69

The high value of genetic advance in percent of mean was recorded for plant height, number of primary branches per plant, number of secondary branches per plant, days to first flowering, days to 50% flowering, number of flowers/cluster, number of clusters/plant, number of fruits per cluster, number of fruits per plant, fruit length, fruit girth, average fruit weight (kg), number of locules per fruit , pericarp thickness , total fruit yield per plot (kg). Nair and Thamburaj (1995) and Bora *et al*., (1993) has also reported these estimates of genetic advance for different traits in tomato.

Heritability alone does not provide full evidence regarding the amount of genetic progress which could be possible through selection. In the present investigations, high heritability with high genetic advances in percent of mean was recorded for number of secondary branches per plant, number of fruits per plant, number of clusters per plant, average fruit weight (kg), pericarp thickness (mm), total fruit yield per plot (kg).These findings are in accordance with the results of Singh and Narayan, 2004 in tomato. These traits could be exploited through manifestation of dominance and epistatic components through heterosis.

CONCLUSION

The high amount of genetic variability in the material indicated there is a good scope for a breeder to adopt suitable breeding methodology to utilize both additive and non-additive gene effects simultaneously, since varietal and hybrid development will go a long way in the breeding programmes especially in case of tomato.

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RESEARCH COMMUNICATION

PATH ANALYSIS FOR YIELD AND YIELD COMPONENTS IN RICE (*ORYZA SATIVA* L.)

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Abstract: Seventy rice genotypes were studied for estimating the direct and indirect influence on grain yield. Path analysis revealed that the characters kernel length followed by days to maturity, number of effective tillers per plant, plant height, number of grains per panicle and 1000-grain weight were directly influencing the grain yield per plant. Hence, these characters need to be considered while designing a selection strategy for yield improvement of rice.

Keywords: Rice, Path analysis, Yield and Yield attributing traits

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important food crops in the world, both in terms of area (151.0 million hectares) and production (597.8 million tonnes). It is consumed by more than half of the world's population living in the developing countries. About 90% of the world's rice is grown and consumed in Asia. In India rice is cultivated in an area of 42.9499 million ha with an average production of 105.23 million tonnes and productivity of 2.462 tonnes ha^{-1}. In Andhra Pradesh, rice is cultivated in an area of 3.234 million ha with a production of 11.51 million tonnes and productivity of 3.126 tonnes ha^{-1} (http://www.indiastat.com/searchresult.aspx, 2012-2013). Due to various socio-economic constraints, a chance of bringing more area under rice cultivation is very remote. Hence to achieve the target of increased rice production, it requires raising the production per unit area. Attempts are being made worldwide, to break the yield barrier in rice breeding strategies. As the grain yield is a complex trait dependent on many component traits and as it responds poorly to the direct selection, the knowledge on yield and its component traits, their direct and indirect effects on grain yield will be useful for the improvement of grain yield. The objective of present study was to study the direct and indirect influence of some yield components on grain yield in rice.

MATERIAL AND METHOD

The experimental material comprised of seventy genotypes of rice which was raised in a randomized block design with three replications at College farm, Agricultural college, Naira, Srikakulam, during *Kharif* 2012. Each genotype planted with a spacing of 20 cm between the rows and 15 cm with in the row. Ten plants of each genotype in each replication were selected at random and mean of the plant observations were recorded for yield attributing characters. The characters studied were days to fifty per cent flowering, days to maturity, number of effective tillers per plant, plant height, panicle length, number of grains per panicle, 1000-grain weight, grain yield per plant, kernel length, kernel breadth and L/B ratio. The mean values were used for the analysis of variance. Path analysis was carried out following the methods of Singh and Chaudhary (1979) and Dewey and Lu (1959), respectively.

RESULT AND DISCUSSION

Path coefficient analysis (Table 1) showed that the genotypic values were in general higher than the phenotypic values which indicated the effect of environment on these traits. Maximum positive direct effect of kernel length followed by number of ear bearing tillers per plant, number of grains per panicle, 1000- grain weight, days to maturity and plant height was noticed in the present study on grain yield per plant, which were similar to the findings of Gyanendra Pal *et al*. (2011), Yadav *et al*. (2011), Bagheri *et al*. (2011) and Haider *et al*. (2012). Days to fifty per cent flowering had also recorded positive direct effects on grain yield per plant (Kole *et al*. 2008). Negative direct effects on grain yield per plant were recorded by kernel breadth, L/B ratio and panicle length (Kole *et al*. 2008 and Satish Chandra *et al*. 2009). High indirect effects of days to fifty per cent flowering, panicle length, 1000-grain weight

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and L/B ratio were observed through kernel breadth, while number of grains per panicle was noticed to exert high indirect effect through number of ear bearing tillers per plant and 1000-grain weight. Similarly, the indirect effect of L/B ratio on grain yield was noticed to be through kernel length and kernel breadth. Thus, the characters kernel length, days to maturity, number of productive tillers per plant, plant height, number of grains per panicle and 1000-grain weight could be considered as the most important characters for selection in order to improve the grain yield.

Table 1. Genotypic and phenotypic path coefficients for yield, yield components and quality traits in rice

Character		Days to 50% flowering	Days to maturity	Number of ear bearing tillers/plant	Plant height	Panicle length	Number of grains per panicle	1000 grain weight	Kernel length	Kernel breadth	Length breadth ratio	Correlation with grain yield per plant
Days to 50% flowering	G	**-0.0592**	0.1788	0.1125	0.0699	-0.1041	-0.074	-0.0222	-0.0143	0.3964	-0.3751	0.1088
	P	**0.047**	0.0634	0.0403	0.05	-0.0602	-0.0362	-0.0109	-0.0047	0.1518	-0.1368	0.1039
Days to maturity	G	-0.0369	**0.2872**	-0.052	0.1206	-0.0592	-0.0102	0.0034	-0.2344	0.3581	-0.1954	0.1811**
	P	0.0236	**0.1264**	-0.021	0.0778	-0.0368	-0.0064	0.0025	-0.0855	0.1188	-0.0611	0.1383*
Number. of ear bearing tillers/plant	G	-0.0119	-0.0267	**0.5595**	-0.0495	0.0728	-0.0842	-0.1511	-0.0832	0.1933	-0.223	0.1958**
	P	0.0072	-0.01	**0.2651**	-0.0284	0.0404	-0.0377	-0.0481	-0.0314	0.0659	-0.0759	0.1469*
Plant height	G	-0.0148	0.1238	-0.0989	**0.2797**	-0.1408	-0.0034	0.0819	0.1181	-0.0036	-0.1541	0.1878**
	P	0.0107	0.045	-0.0345	**0.2186**	-0.0935	-0.002	0.0337	0.0518	-0.0092	-0.0514	0.1693*
Panicle length	G	-0.0208	0.0573	-0.1372	0.1326	**-0.2968**	0.0223	0.0425	0.3783	-0.2374	-0.0886	-0.1478**
	P	0.0126	0.0206	-0.0475	0.0907	**-0.2253**	0.0073	0.02	0.1503	-0.0925	-0.023	-0.0869
No. of grains per panicle	G	0.0103	-0.0069	-0.1104	-0.0023	-0.0155	**0.427**	-0.1913	-0.0358	-0.0772	0.0977	0.0955
	P	-0.0074	-0.0475	-0.0434	-0.0019	-0.0072	**0.2307**	-0.0701	-0.0149	-0.0331	0.04	0.0893
1000 grain weight	G	0.0033	0.0025	-0.2104	0.057	-0.0314	-0.2032	**0.402**	0.0884	-0.766	0.6975	0.0396
	P	-0.003	-0.0434	-0.0748	0.0432	-0.0264	-0.0947	**0.1707**	0.0439	-0.318	0.2831	0.0258
Kernel length	G	0.0005	-0.0384	-0.0265	0.0188	-0.064	-0.0087	0.0203	**1.7544**	0.7618	-2.2717	0.1464**
	P	-0.0003	-0.0748	-0.0101	0.0137	-0.0409	-0.0042	0.009	**0.828**	0.3324	-0.9732	0.1415*
Kernel breadth	G	0.01	-0.0439	-0.0461	0.0004	-0.0301	0.0141	0.1314	-0.5704	**-2.3431**	2.7898	-0.0879
	P	-0.0069	-0.0101	-0.0168	0.0019	0.0201	0.0073	0.0522	-0.2647	**-1.0397**	1.2103	-0.0908
Length breadth ratio	G	-0.007	0.0178	0.0395	0.0136	-0.0083	-0.0132	-0.0887	1.2608	2.0679	**-3.1611**	0.1213
	P	0.0047	-0.0168	0.0147	0.0082	-0.0038	-0.0067	-0.0353	0.588	0.9182	**-1.3704**	0.1232

Bold: Direct effects *Significant at 5% level **Significant at 1% level

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