Comparative susceptibility of commercial cultivars of bell pepper (*Capsicum annuum* var *grossum* Sendt) to major insect pests in West Bengal

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ABSTRACT

A field experiment was conducted at Barasat II Block, North 24 Parganas, West Bengal in two consecutive rabi seasons of 2017 and 2018 to study the relative susceptibility of different commercial cultivars of bell pepper to major insect pests infesting it. Ten recommended commercial cultivars of bell pepper viz Indra, Asha, Biotara, KSP 1070, Fiza, Lakshmi, Arya, Super Gold, Ayesha and Mahabharath were planted on 15 November each year to know their relative susceptibility to the major insect pests namely thrips (*Scirtothrips dorsalis* Hood), aphid (*Aphis gossypii* Glover, *Myzus persicae* Sulzer), whitefly (*Bemisia tabaci* Gennadius), fruit borer (*Helicoverpa armigera* Hubner) and chilli mite (*Polyphagotarsonemus latus* Banks). Pest population studies revealed that the varieties Indra, Asha, Biotara and Fiza were relatively less susceptible to all the major pests of bell pepper, whereas, Super Gold, Mahabharath, Ayesha and Arya were relatively more susceptible. The variety Indra resulted in less damage score (0.82) after 120 days of planting which resulted in enhancement of yield (15.97 tonnes/ha) and benefit-cost ratio (0.60). Coloured varieties of bell pepper were more vulnerable to pest infestation.

Keywords: Bell pepper; cultivars; major insect pests; susceptibility

INTRODUCTION

Capsicum (*Capsicum annum* var *grossum* Sendt) or bell pepper or sweet pepper is cultivated in most parts of the world including India as a highly remunerative vegetable crop. Over 35 species of insect and mite pests are reported on the crop which include thrips, aphids, whiteflies, fruit borers, cutworms, plant bugs, mites and other minor pests (Ghosh et al 2009). Among different pests reported on sweet pepper, thrips, *Scirtothrips dorsalis* is the dominant one causing 50 to 90 per cent yield loss. Among the non-insect pests, yellow mite (*Polyphagotarsonemus latus* Banks) is a major pest causing yield loss up to 96.4 per cent in north Karnataka (Borah 1987) and 25 per cent in West Bengal (Ahmed et al 1987) under open field conditions. Thrips, *S dorsalis* Hood, yellow mite, *P latus* Banks and fruit borer, *Helicoverpa armigera* Hubner caused economic loss every year especially in the southern districts of West Bengal and became a major threat to chilli growers (Sarkar et al 2005, Ghose et al 2018). To overcome the pest damage, farmers rely on using excess amounts of pesticides to minimize the incidence of these pests on the crop. Use of insecticides for the control of major pests of chilli pepper has not always been successful (Rao and Ahmed 1986). Moreover, the ill-effects of excessive pesticide usage in bell pepper are of serious concern both from export point of view and domestic consumption. With a view to reducing pesticide use in bell pepper production, host plant resistance to insect pests merits attention and resistant/ tolerant cultivars could be a foundation stone to an integrated pest management programme. Keeping this perspective in mind, an experiment was conducted to evaluate the relative susceptibility of ten recommended cultivars of bell pepper (Indra, Asha, Biotara, KSP

1070, Fiza, Lakshmi, Arya, Super Gold, Ayesha and Mahabharath) to major insect pests viz thrips (*S dorsalis* Hood), aphid (*Aphis gossypii* Glover and *Myzus persicae* Sulzer), whitefly (*Bemisia tabaci* Gennadius), fruit borer (*H armigera* Hubner) and chilli mite (*P latus* Banks) infesting it so as to recommend a resistant/tolerant variety to the farmers for safe cultivation.

MATERIAL and METHODS

The experiment to study the comparative susceptibility of ten bell pepper cultivars to thrips, aphid, whitefly, fruit borer and chilli mite was conducted in a farmer's field located at Barasat II Block, North 24 Parganas, West Bengal in two consecutive rabi seasons of 2017 and 2018. Ten recommended commercial cultivars viz Indra, Asha, Biotara, KSP 1070, Fiza, Lakshmi, Arya, Super Gold, Ayesha and Mahabharath were planted on 15 November each year. The fruits of Indra, Asha, Biotara, KSP 1070, Fiza and Mahabharath are green, Lakshmi and Ayesha are red and Arya and Super Gold are yellow in colour.

Thirty days old seedlings of each cultivar were planted in two rows containing 15 plants in each row with a spacing of 60 cm × 45 cm following standard package of practices to make available favourable stages of the crop to the pests over prolonged period. FYM @ 10 tonnes/ha and N_2:P_2O_5:K_2O @ 100:80:80 kg/ha were applied to the crop. The entire amount of phosphatic and potassic fertilizers was applied at the final tillage while half of the nitrogenous fertilizer at final tillage and rest half in two equal splits at first and second earthing up. In addition, micronutrient mixture of copper, zinc and boron (Agromin Soil Plus of Aries Agro Ltd) @ 15 kg/ha was applied to soil during final tillage. Magnesium sulphate (Mag Mix of Aries Agro Ltd) was applied in soil @ 10 kg/ha at the time of first earthing up (21 days after planting) and water soluble fertilizer, N_2:P_2O_5:K_2O (19:19:19) @ 3 g/l of water was sprayed on foliage two times at three weeks interval starting from 60 days after planting. First earthing up was done 21 days after planting and second 12 days after the first. Hand weeding was done thrice at fortnightly interval starting from 15 days after planting. Irrigation was given as and when required. The crop was sprayed with clorothalonil 75 WP (Kavach), a mixture of azoxystrobin 18.2 per cent + difenoconazole 11.4 per cent w/w SC (Amistar Top) and carbendazim 12 per cent + mancozeb 63 per cent WP (SAAF) at fortnightly interval starting from 15 days after planting as prophylactic measure to save the crop from different fungal diseases like damping off, powdery mildew, *Cercospora* leaf spot, *Phytophthora* blight (chilli wilt) and anthracnose (fruit rot) etc.

The plots were inspected on regular basis for the incidence of pests appearing on the crop. Insect pest populations were recorded from five randomly selected tagged plants of each cultivar at 10 days interval starting from 15 days after planting. The population of whitefly (adults), thrips (larvae and adults) and motile stages of chilli mite (larvae, nymphs and adults) were recorded from five tender leaves from each plant. The population of aphids was recorded from five 10 cm terminal shoots from each plant. Population of fruit borer larvae was recorded on whole plant basis from the selected plants. All the observations were recorded during morning hours between 6:30 to 8:30 am with the help of a hand lens (10X).

Yield of marketable fruits and damaged fruits was recorded at each harvest. Damage index due to mite and leaf curl virus was recorded in 0-5 scale as given by Niles (1980) (Table 1):

$$\text{Damage score} = \frac{\text{Score obtained from damage index}}{\text{Total number of plants}}$$

Table 1. Damage index due to mite and leaf curl virus in 0-5 scale

Score	Extent of damage
0	No infestation/infection
1	Less than 10% plants infested/infected with slight curling/crumpling of leaves
2	Less than 25% plants infested with moderate curling/crumpling of leaves
3	Less than 50% plants infested with heavy curling/crumpling of leaves
4	More than 75% plants infested with severe curling/crumpling of leaves coupled with reduction in size and slight tip burning, aborted flowers and deformed fruits
5	Almost all the plants infested; severe tip burning

From the observed data, average pest population present on the crop during the season was calculated and analyzed for test of significance following randomized block design (RBD) to assess the comparative susceptibility of the cultivars based on two seasons' data. The pooled data after suitable transformation were analyzed following statistical package for the social sciences (SPSS package). Ranking of cultivars was done based on the average mid-value of pooled data of all cultivars indicated to judge the susceptibility to different pests on bell pepper.

RESULTS and DISCUSSION

Ten recommended commercial cultivars of bell pepper viz Indra, Asha, Biotara, KSP 1070, Fiza, Lakshmi, Arya, Super Gold, Ayesha and Mahabharath planted on 15th November each year showed varied responses to pest infestation as represented in Table 2. The fruits of Indra, Asha, Biotara, KSP 1070, Fiza and Mahabharath were green, Lakshmi and Ayesha were red and Arya and Super Gold were yellow in colour.

The average of the two years data (2015-16 and 2016-17) as well as the pooled data show that Indra was the least susceptible cultivar to major insect pests of bell pepper viz thrips, aphid, whitefly, chilli mite and fruit borer followed by Asha, Biotara and Fiza whereas Super Gold, Mahabharath, Ayesha and Arya were relatively more susceptible to the major pests. KSP 1070 exhibited relatively less susceptibility to thrips, aphid, whitefly and chilli mite but exhibited more susceptibility to fruit borer.

Lakshmi though found to be relatively low susceptible to fruit borer, yet exhibited more susceptibility to all other pests. Mahabharath was most susceptible cultivar to thrips and chilli mite; Ayesha was most susceptible cultivar to whitefly and fruit borer and Arya was most susceptible to aphids.

Damage score at 120 days after planting and yield of different cultivars of bell pepper

The average of two years data as well as the pooled data show that the lowest damage score (0.82) at 120 days after planting was observed in the variety Indra (Table 2). It was followed by Asha (1.63). Though Biotara (1.82) performed significantly higher than Asha but showed low damage score than Fiza (2.10) which was at par with KSP 1070 (2.12). Similarly, Mahabharath (2.31) showed higher damage score than KSP 1070 but exhibited significantly lower damage score than Super Gold (2.57) which showed similar trend with Lakshmi (2.62), Ayesha (2.69) and Arya (2.74).

The two years pooled data explain that the fruit yield of Indra (15.97 tonnes/ha) and Asha (15.17 tonnes/ha) was statistically at par and higher than all other varieties. Biotara (8.73 tonnes/ha) and Fiza (7.36 tonnes/ha), which were at par with each other were found to be the next best cultivars while Fiza was statistically at par with KSP 1070 (6.86 tonnes/ha). On the other hand, KSP 1070 was at par with Mahabharath (5.26 tonnes/ha). Lakshmi (4.13 tonnes/ha), Ayesha (3.80 tonnes/ha), Arya (3.92 tonnes/ha) and Super Gold (3.95 tonnes/ha) were at par with Mahabharath.

Ranking of cultivars on the basis of susceptibility to different insect pests of bell pepper

Considering the average mid-value of pooled data of all the cultivars as a parameter to judge the susceptibility, Indra, Asha, Biotara, KSP 1070 and Fiza were selected as less susceptible, whereas, Lakshmi, Arya, Super Gold, Ayesha and Mahabharath as more susceptible cultivars to thrips, aphid, whitefly and chilli mite. But in case of fruit borer, the average mid-value of pooled data of all the cultivars revealed that Indra, Asha, Biotara, Lakshmi and Fiza were less susceptible whereas KSP 1070, Super Gold, Mahabharath, Ayesha and Arya were more susceptible (Table 3).

Benefit-cost ratio of cultivation of different cultivars of bell pepper

The benefit-cost ratio (Tables 4, 5) was highest in Indra (0.60) followed by Asha (0.52) and lowest in Mahabharath (–0.47). The next best ratio was found in the cultivar Biotara (–0.13) which was followed by Fiza (–0.26) and KSP 1070 (–0.31). The benefit-cost ratio of coloured varieties namely Lakshmi, Super Gold, Arya and Ayesha were –0.31, –0.34, –0.35 and –0.37 respectively.

The literature on relative susceptibility of bell pepper cultivars commonly grown in India to different pests is relatively scarce. However, Saha et al (2007) conducted an experiment under field conditions to find out the resistant source of diseases and insects of bell pepper. Out of 12 genotypes, SP011 was greatly resistant whereas SP002, SP006, SP010 and SP012 were resistant to thrips. In case of mite, none of the

Table 2. Population of important insect pests on bell pepper cultivars

Variety	Number of thrips/leaf			Number of aphids/leaf (10 cm terminal shoot)			Number of whiteflies/5 leaves			Number of chilli mites/leaf			Number of fruit borer larvae/plant			Damage score at 120 days			Yield (tonnes/ha)		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Mahabharath	5.05 (2.24)	6.09 (2.47)	5.57 (2.35)	7.07 (2.35)	8.29 (2.56)	7.68 (2.45)	7.04 (2.53)	9.71 (2.98)	8.37 (2.76)	5.13 (2.26)	6.16 (2.48)	5.64 (2.37)	3.22 (1.79)	3.87 (1.56)	3.55 (1.48)	2.05 (1.43)	2.56 (1.60)	2.31 (1.51)	5.31	5.22	5.26
Asha	2.47 (1.57)	3.04 (1.74)	2.75 (1.65)	4.18 (1.74)	5.02 (1.86)	4.60 (1.80)	6.18 (2.41)	7.04 (2.51)	6.61 (2.46)	2.22 (1.49)	2.93 (1.71)	2.57 (1.60)	1.45 (1.20)	1.85 (0.95)	1.65 (0.84)	1.50 (1.22)	1.76 (1.33)	1.63 (1.27)	16.06	14.27	15.17
Lakshmi	4.04 (2.00)	4.76 (2.18)	4.40 (2.09)	6.05 (2.18)	7.58 (2.43)	6.82 (2.31)	7.58 (2.60)	8.89 (2.81)	8.24 (2.71)	4.02 (2.00)	4.60 (2.14)	4.31 (2.07)	2.05 (1.43)	2.31 (1.14)	2.18 (1.10)	2.41 (1.55)	2.82 (1.68)	2.62 (1.62)	4.53	3.74	4.13
Super Gold	4.42 (2.09)	5.29 (2.30)	4.85 (2.20)	6.24 (2.23)	7.33 (2.34)	6.78 (2.28)	7.95 (2.67)	8.76 (2.81)	8.35 (2.74)	4.49 (2.12)	5.11 (2.26)	4.80 (2.19)	3.13 (1.77)	3.82 (1.54)	3.47 (1.46)	2.39 (1.55)	2.74 (1.65)	2.57 (1.60)	4.80	3.10	3.95
Fiza	3.69 (1.92)	4.33 (2.08)	4.01 (2.00)	5.00 (1.97)	6.16 (2.24)	5.58 (2.10)	6.95 (2.50)	7.80 (2.64)	7.37 (2.57)	3.24 (1.80)	3.69 (1.92)	3.46 (1.86)	2.55 (1.59)	2.25 (1.15)	2.40 (1.18)	1.92 (1.38)	2.27 (1.51)	2.10 (1.45)	7.48	7.25	7.36
Indra	2.05 (1.43)	2.69 (1.63)	2.37 (1.53)	2.84 (1.38)	3.09 (1.41)	2.96 (1.40)	4.66 (2.02)	5.81 (2.28)	5.23 (2.15)	1.87 (1.37)	2.25 (1.50)	2.06 (1.43)	1.22 (1.09)	1.40 (0.74)	1.31 (0.70)	0.47 (0.68)	1.16 (1.08)	0.82 (0.88)	16.76	15.17	15.97
Arya	4.62 (2.14)	5.02 (2.24)	4.82 (2.19)	7.64 (2.47)	8.58 (2.64)	8.11 (2.55)	7.80 (2.68)	9.07 (2.88)	8.44 (2.78)	4.67 (2.16)	5.64 (2.37)	5.16 (2.27)	3.36 (1.83)	3.95 (1.58)	3.65 (1.51)	2.62 (1.62)	2.86 (1.69)	2.74 (1.65)	3.81	4.04	3.92
Biotara	3.05 (1.74)	3.05 (1.74)	3.05 (1.74)	4.38 (1.77)	5.71 (2.12)	5.05 (1.94)	6.53 (2.40)	7.73 (2.60)	7.13 (2.50)	2.45 (1.57)	3.20 (1.79)	2.83 (1.68)	1.73 (1.31)	1.95 (0.99)	1.84 (0.92)	1.69 (1.30)	1.94 (1.39)	1.82 (1.35)	9.69	7.77	8.73
KSP 1070	3.67 (1.91)	4.09 (2.02)	3.88 (1.97)	5.31 (2.00)	6.27 (2.23)	5.79 (2.12)	7.02 (2.48)	8.16 (2.69)	7.59 (2.58)	3.02 (1.74)	3.65 (1.91)	3.34 (1.82)	2.49 (1.58)	2.73 (1.30)	2.61 (1.25)	1.94 (1.39)	2.30 (1.52)	2.12 (1.45)	7.44	6.28	6.86
Ayesha	5.02 (2.24)	5.04 (2.24)	5.03 (2.24)	7.76 (2.52)	8.22 (2.54)	7.99 (2.53)	7.95 (2.67)	8.96 (2.83)	8.45 (2.75)	4.87 (2.21)	6.24 (2.50)	5.55 (2.35)	3.91 (1.98)	4.42 (1.68)	4.16 (1.62)	2.54 (1.59)	2.83 (1.68)	2.69 (1.64)	3.99	3.61	3.80
SE(m)	0.05	0.05	0.04	0.05	0.05	0.04	0.05	0.04	0.04	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.02	0.02	0.76	0.67	0.55
$CD_{0.05}$	0.14	0.13	0.11	0.14	0.15	0.12	0.14	0.13	0.12	0.11	0.10	0.10	0.11	0.09	0.09	0.10	0.06	0.05	2.44	2.14	1.74
CV (%)	25.23	22.32	27.88	16.87	17.49	20.07	14.23	11.99	16.50	17.97	14.31	20.14	23.58	19.41	27.17	4.61	2.96	3.10	21.37	21.20	22.91

Figures in parentheses are square root transformed values

Table 3. Ranking of bell pepper cultivars based on susceptibility to different insect pests

Pest	More susceptible cultivars	Less susceptible cultivars
Thrips	Lakshmi, Arya, Super Gold, Ayesha, Mahabharath	Indra, Asha, Biotara, KSP 1070, Fiza
Aphid	Lakshmi, Arya, Super Gold, Ayesha, Mahabharath	Indra, Asha, Biotara, Fiza, KSP 1070
Whitefly	Lakshmi, Arya, Super Gold, Ayesha, Mahabharath	Indra, Asha, Biotara, Fiza, KSP 1070
Mite	Lakshmi, Arya, Super Gold, Ayesha, Mahabharath	Indra, Asha, Biotara, Fiza, KSP 1070
Fruit borer	Arya, Super Gold, Ayesha, Mahabharath, KSP 1070	Indra, Asha, Biotara, Fiza, Lakshmi

Table 4. Benefit-cost ratio of cultivation of different cultivars of bell pepper (green colour fruits)

Variety	Cost of cultivation/ha (Rs) 1	Total yield (q/ha) 2	Gross return @ Rs 1,500/q 3	Net return (Rs) 4 (3-1)	B-C ratio 5 (4/1)
Mahabharath	1,50,000	52.60	78,900	–71,100	–0.47
Asha	1,50,000	151.70	2,27,550	77,550	0.52
Fiza	1,50,000	73.60	1,10,400	–39,600	–0.26
Indra	1,50,000	159.70	2,39,550	89,550	0.60
Biotara	1,50,000	87.30	1,30,950	–19,050	–0.13
KSP 1070	1,50,000	68.60	1,02,900	–47,100	–0.31

Table 5. Benefit-cost ratio of cultivation of different cultivars of bell pepper (coloured fruits)

Variety	Cost of cultivation/ha (Rs) 1	Total yield (q/ha) 2	Gross return @ Rs 2,500/q 3	Net return (Rs) 4 (3-1)	B-C ratio 5 (4/1)
Lakshmi	1,50,000	41.3	1,03,250	–46,750	–0.31
Super Gold	1,50,000	39.5	98,750	–51,250	–0.34
Arya	1,50,000	39.2	98,000	–52,000	–0.35
Ayesha	1,50,000	38.0	95,000	–55,000	–0.37

genotypes was highly resistant but SP002, SP006, SP007 and SP011 were classified as resistant. At the time of scoring when aphid infestation was considered, all the genotypes were found to be free from infestation. Similarly, Shivaramu and Kulkarni (2008) reported that bell pepper variety California Wonder was highly susceptible to fruit borer, *H armigera*. Roopa (2013) observed that the variety NS-281 was susceptibile to fruit borer and thrips. In contrary, Indra and Aditi exhibited susceptibility to thrips. In case of fruit borer, Orobelli and NS-280 were moderately resistant, whereas, Inspiration, Angel, Bachata, Bombay, Aditi and Indra were found moderately susceptible.

CONCLUSION

The present study revealed that the cultivars Indra, Asha, Biotara and Fiza were less susceptible to major pests (viz thrips, aphid, whitefly, chilli mite and fruit borer) of bell pepper cultivation under open field, whereas, Super Gold, Mahabharath, Ayesha and Arya were relatively more susceptible. The variety KSP 1070 exhibited relatively less susceptibility to thrips, aphid, whitefly and chilli mite but exhibited more susceptibility to fruit borer. Lakshmi though found to be relatively low in susceptibility to fruit borer yet exhibited more susceptibility to all other pests.

The maximum yield and highest benefit-cost ratio were obtained in the variety Indra. Asha was found to be the next best cultivar. Therefore, Indra, Asha, Biotara and Fiza cultivars may be recommended for cultivation to the farmers in southern districts of West Bengal. Coloured varieties were more preferred by insect

pests, therefore, these varieties may be recommended to be cultivated under protected conditions.

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