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Mousumi Ghose
Department of Agriculture, Government of West Bengal, and Research scholar, Department of Plant Protection, Palli Siksha Bhavana, Visva-Bharati, Sriniketan

Swarnali Bhattacharya
Assistant Professor(Agricultural Entomology), Department of Plant Protection, Institute of Agriculture (PSB), Viswa-bharati, Shantiniketan

SK Mandal
Depatrment of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal.

Correspondence
Mousumi Ghose
Department of Agriculture, Government of West Bengal, and Research scholar, Department of Plant Protection, Palli Siksha Bhavana, Visva-Bharati, Sriniketan

Effect of date of planting on pest and leaf curl virus incidence on Bell Pepper (*Capsicum annum* var grossum Sendt.) in the Bengal Basin

Mousumi Ghose, Swarnali Bhattacharya and SK Mandal

Abstract
The effect of three dates of planting viz 1st November, 15th November and 30th November on pest and leaf curl virus incidence of bell pepper var Indra was studied in a farmer's field at North 24 Parganas district in West Bengal for two consecutive seasons (2015-16 & 2016-17). The five insects pest namely thrips *(Scirtothrips dorsalis* Hood), aphids (*Aphis gossypii* Glover. and *Myzus persicae* Sulzer), whitefly(*Bemisia tabaci* Gennadius), yellow mite(*Polyphagotarsonemus latus* Banks) and fruit borer (*Helicoverpa armigera* Hubner) were recorded.
Crop planted on 30th November showed highest average population of thrips (1.24/5 leaves), aphids (2.09/5 shoots), whitefly (2.57/5 leaves), fruit borers (0.97/plant) and chilli leaf curl virus incidence (34.58%) but lowest average population of yellow mite (0.42/5 leaves) and damage of plant due to mite(15.59%).Crop planted on 1st November exhibited lowest population of thrips (0.57/5 leaves), aphids (1.20/5 shoots), whitefly (2.17/5 leaves) and fruit borers (0.54/plant) and chilli leaf curl virus incidence(23.76%) except yellow mite (0.77/5 leaves). Pest and leaf curl virus incidence was moderate on 15th November planted crop. Crop planted on 1st November gave highest yield of marketable fruits (18.3t/ha) followed by 15th November (15.2 t/ha) and 30th November (13.3t/ha) planted crop. Planting of bell pepper should be completed within 1st week of November in Southern district of Bengal basin with proper protective measure against yellow mite during seedling and early vegetative growth stage.

Keywords: bell pepper, planting dates, pest incidence, leaf curl virus

Introduction

Capsicum (*Capsicum annum* var *grossum* Sendt.), also known as 'Bell pepper' or 'Sweet pepper', is a highly remunerative vegetable crop grown in most parts of the world. India contributes one fourth of world production of capsicum with an annual production of 0.9 million tons from about 0.885 million hectare area [1]. In India, Karnataka has highest area under capsicum cultivation (3.10 thousand hectares) with a production of 45.80 thousand metric tons [2]. In West Bengal the crop is grown over small areas. Owing to its increasing demand especially by urban consumers, the farmers are showing increased interest in growing the crop in open fields and under protective cover mainly during winter months, and both area and production has increased considerably in recent years. Moreover, it has high potential for export.

About 35 species of insect and mite pests have been reported to infest bell pepper, of which thrips *(Scirtothrips dorsalis* Hood and *Thrips palmi* arny), aphids (*Aphis gossypii* Glover and *Myzus persicae* Sulzer), whitefly (*Bemisia tabaci* Gennadius), capsule borers (*Helicoverpa armigera* Hubner and *Spodoptera litura* Fabr.) and yellow mite (*Polyphagotarsonemus latus* Banks) cause serious damage to the crop in different regions of India [3, 4]. Ahmed.M (2005) [5] has estimated the crop losses up to 34 per cent due to attack of sucking pests. In addition to de-sapping, sucking pests also transmit viral diseases, which become a limiting factor in the cultivation of capsicum [6]. During the past decade, white fly has become a prominent problem worldwide especially in the subtropical agro ecosystems. Millions of dollars have been lost as a result of direct damage, honeydew contamination, and fungal growth and virus diseases caused by white fly -transmitted geminiviruses [7, 8].

As pesticide residues in bell pepper are of great concern from the point of view of exports and domestic consumption as well, nonchemical pest management strategy like adjusting the date of planting for avoiding the pests and leaf curl virus without sacrificing the yield may be a better approach.

Hence, an attempt was made to study the impact of different dates of planting of capsicum on pest and chilly leaf curl virus incidence keeping in mind the cropping sequence of the concerned area.

Materials and Methods

A Field experiment of capsicum var Indra was conducted in farmers' field in Pakdah and Sonatikary village of Barasat II Block, North 24 Parganas during Rabi 2015 and 2016. The area falls in the new alluvial zone of West Bengal and lies between 23˚15' to 22˚11' N latitude and 89˚50' to 88˚20' E longitude with mean annual rainfall of 1579 mm, maximum temperature around 41^0 C during May and minimum temperature around 10^0 C during January. The relative humidity of the area lies between 50% in March and 90% in July.

The capsicum variety Indra was grown in 21 plots (3 treatments and 7 replications) each measuring 5.4 sq m following RBD. Thirty days old seeding was planted at spacing of 60cm X 45 cm. on three different dates, i.e., 1st November, 15th November and 30th November each year. Ten ton organic manure, N: P_2O_5: K_2O @ 100:80:80 kg /ha and micronutrient mixture of cupper, zinc, boron @ 15kg /ha applied into soil at the time of transplanting. After that 10 kg/ha molybdenum and sulphur mixture was applied in soil at the time of earthing up. Apart from this capsicum crop was sprayed with water soluble fertilizer like N: P_2O_5:K_2O: 19:19:19 at every three weeks interval after 2 months of transplanting @ 3g/lit of water. Weeding up was done before earthing up. Then earthing up was completed after 20 days of transplanting followed by first irrigation. After that the crop was irrigated 8 to 10 days interval through out crop period. Fungicides were applied in the experimental plots as per requirement. The seeds were treated with *Trichoderma viridi* @ 4 g/kg of seed before sowing. The crop was raised / grown as per the recommended package of practices except insecticides and acaricide measure.

All the observations were recorded during morning hours between 6:30 AM to 8:30 AM with the help of a hand lens (10X). The pest incidence was recorded from five fixed plants/plot, selected randomly for this purpose, at 10 days interval starting from 15 days after planting. The population of whiteflies (nymphs and adults) was recorded from five leaves one each from the upper, middle and lower position from each plant. Thrips population was recorded from five twigs of each plant by shaking over a piece of wet white coloured cloth. The population of aphids was recorded from five numbers of 10 cm terminal shoot from each plant. Mite count was recorded from five terminal leaves on each plant. Population of lepidopteron larvae of the fruit borer was recorded on the whole plant basis. More over the damage index by mites and leaf curl virus was recorded in 1 – 5 scale following (Table – 1) [9].. The percentage of fruits damaged by fruit borer, and fruit yield were recorded at harvest. Data obtained were subjected to analysis of variance after suitable transformation. In case of percentage observations Pooled data analysis was obtained after angular transformation.

Table 1: Scoring procedure for sucking pests (mites and thrips) and fruit borer (*Spodoptera litura*) damage.

Score	Symptoms
0.	No symptoms
1	1 to 25% leaves per plant showing curling or damage
2	26 to 50% leaves per plant showing curling moderately damage
3	51 to 75% leaves per plant showing curling, heavily damaged, malformation of growing points, and reduction in plant height.
4	>75% leaves per plant showing curling, severe and complete destruction of growing points, drastic reduction in plant height, defoliation and severe malformation

Result and Discussion

During the course of study, five pest species *viz.* thrips, aphid, whitefly, fruit borer and yellow mite were detected causing damage bell pepper at various growth stages of the crop.

Table 2 represented that, during the first date planting (1st November), the thrips population was ranged from 0.32 to 0.35 per 5 leaves with a calculated pooled value of 0.57 per 5 leaves. The aphid population was varied from 1.05 to 1.95 per 5 shoots with calculated pooled population of 1.20 per 5 shoots. The white fly population was ranged from 4.03 to 5.41 per 5 leaves with calculated pooled value of 2.17 per 5 leaves. The yellow mite population was recorded from 0.65 to 0.54 per 5 leaves with calculated pooled value 0.77 per 5 leaves. Finally, fruit borer population was ranged from 0.21 to 0.40 per plant with pooled data 0.54 per plant though out the crop growth period. The similar result was found by Pathipati VL. (2015) [10] who reported that the population and damage levels, per cent yield loss of bell pepper due to insect pests and insecticide usage pattern were recorded in open field and poly house conditions in and around Hyderabad. The insect pests, viz., thrips, mite, cut worm, blossom midge, and fruit borer, *S. litura* incidence were recorded, whereas, in poly house in addition to the above pests, aphids and whiteflies incidence were also recorded. The present survey is in line with the findings of Sunitha (2007) [3] who took a fixed plot survey to record the natural incidence of insect pests of capsicum in major growing areas in and around Dharwad and Belgaum, Karnataka. The survey revealed the occurrence of cutworm, *Agrotis ipsilon* (Hufn.) (30 to 40 %), aphids, *M. persicae* (0.00 to1.6nymphs and adults/ 3leaves), thrips, *S. dorsalis* (0.00 to 2.00 nymphs and adults/ leaves) and fruit borer, *Helicoverpa armigera* (Hub.)(20.68 to 26.16 % damage), respectively.

In second date planting (15th November), it was observed that thrips population ranged from 0.67 to 0.51 per 5 leaves with pooled data 0.76 per 5 leaves, aphid population varied from 1.36 to 2.96 per 5 shoots with pooled population 1.44 per 5 shoots, white fly from 4.70 to 6.23 per 5 leaves with pooled data 2.33 per 5 leaves, yellow mites from 0.45 to 0.57 per 5 leaves with pooled data 0.71 per 5 leaves and fruit borer ranged from 0.44 to 0.63 per plant with pooled data 0.73 per plant though out the growth period. Similar results were also obtained by Meena *et.al.* (2013) [11] who observed that the incidence of thrips, whiteflies, aphids and mites were appeared on the chilli crop soon after transplanting, while the aphid appeared little late during both the years.

In case of 30th November plated crop, it was noted that thrips population ranged from 1.81 to 1.96/5 leaves with pooled data 1.24 /5 leaves, aphid population varied from 3.46 to 5.45/5 shoots with pooled data 2.09/ five no of shoot, white fly from 5.67 to 7.65/5 leaves with pooled data 2.57 /5 leaves, yellow mites from 0.15 to 0.22/5 leaves with pooled data 0.42/5 leaves and fruit borer ranged from 0.91 to 1.01 /plant with pooled data 0.97 /plant though out the growth period. Similar

results were also obtained by Nandini *et al*. (2010) [12] who conducted survey on capsicum pests under field condition at Dharwad area. Sucking pests *viz*., thrips (0.60 to 2.30 thrips/ leaves), mites (0.60 to 1.20 mites/3 leaves) and aphids (1.20 to 1.60 aphids/ 3leaves) were observed during vegetative to reproductive stage.

The pooled data obtained from yellow mite population gave an idea about opposite trend with the other insect like thrips, aphid, white fly and fruit borer. The population of yellow mite was positively co-related with the date of sowing. 1st November planted crop differ significantly from other two date but 15th November and 30th November were statistically at par. The findings were confirmed with the results obtained by Kethran *et al*. (2014) [13] conducted an experiment on effect on different sowing date on insect pest of chilli at Kunri, Mirpur Khas Sindh during 2014. He observed that early sowing (January15th or January 30th) resulted in lower incidence of aphids, thrips, whitefly and fruit borer except mites. Such low level of insect pest caused a less crop injury which resulted in enhancing the green pod yield of chilli. Anon (2004) [14] also showed that late planting, as it is known in many crops, attracts greater intensity of pests and subsequent plant damage.

The percentage plant damage due to mite, percentage incidence of leaf curl virus and the marketable production of semi ripe green fruits are presented in table 3. The crops when planted in 1st November (18.3 t/ha) significantly increased the marketable production of fruits as compared to the 15th November (15.2 t/ha) and 30th November (13.3 t/ha) planted crops. It is justified by the findings of Kumar (1995) [15]. He told that the yield losses range from 50-90 per cent due to insect pests of chilli.The damage due to mites and thrips together had been estimated to the tune of 50 per cent [16] and fruit borers is to an extent of 90 per cent [17].

In all treatments the percentage plant damage due to mite showed that, the 30th November planted crop (15.59%) was the best performing than the others two date of planting(21.77% and 18.45%) but the percentage incidence of leaf curl virus was low in 1st November (23.76%) than the 15th November (26.70%) and 30th November (34.58%) planted crops. The present study is justified with the conclusion by Bugti (2016) [18] who told that the highest pest population of Whitefly was recorded in capsicum spp. followed by Jassid, Thrips, Aphid, Mealy bug & Fruit borer. However Venkatesh *et al.* (1998) [19] reported that chilli leaf curl complex was caused by leaf curl geminivirus (CLCV) transmitted by chilli mite (*Polyphagotarsonemus latus*), whitefly (*Bemisia tabaci*) and thrips *(Scirtothrips dorsalis*). The number of *B. tabaci* transmitted plant viruses has escalated and the total yield loss of important food and industrial crops has also increased [20].

The table 4 represented that the damage score in a different growth stage of plants in different date of planting. In three dates of planting viz 1st November, 15th November and 30th November, the highest damage score was obtained in 120th DAP (1.35 to 1.46) and lowest obtained in 60th DAT (0.68 to 0.85). The present findings confirmed with the results obtained by Alatawi *et al*. (2007) [21] who reported that older plants exhibited greater damage than younger plants.

Conclusion

It is inferred that 1st November planted crop reveals in lower incidence of aphids, thrips, whitefly and fruit borer and leaf curl virus except mites. Such low level of insect pest caused a less crop injury which resulted in enhancing the yield of bell pepper. Pest and leaf curl virus incidence was moderate on 15th November planted crop. Therefore planting of bell pepper should be completed within 1st week of November in Southern district of Bengal basin with proper protective measure against yellow mite during seedling and early vegetative growth stage.

Table 2: Population of bell pepper pests on different date of planting (Rabi, 2015-16 and 2016-17).

Date of planting	Thrips /5 leaves			Aphid/5 shoots (10 cm terminal portion			White fly/5 leaves			Yellow mites/ 5 leaves			Larvae/plant		
	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
1st November	0.32 (0.57)	0.35 (0.59)	0.57	1.05 (1.02)	1.95 (1.40)	1.20	4.03 (2.01)	5.41 (2.33)	2.17	0.65 (0.80)	0.54 (0.73)	0.77	0.21 (0.46)	0.40 (0.63)	0.54
15th November	0.67 (0.82)	0.51 (0.72)	0.76	1.36 (1.17)	2.96 (1.72)	1.44	4.70 (2.17)	6.23 (2.50)	2.33	0.57 (0.76)	0.45 (0.67)	0.71	0.4 (0.67)	0.63 (0.80)	0.73
30th November	1.81 (1.34)	1.96 (1.40)	1.24	3.46 (1.86)	5.45 (2.34)	2.09	5.67 (2.38)	7.65 (2.77)	2.57	0.15 (0.39)	0.22 (0.47)	0.42	0.91 (0.95)	1.01 (1.00)	0.97
C.D. (0.05)	0.06	0.04		0.08	0.10		0.09	0.07		0.06	0.04		0.04	0.04	

*Values in parenthesis are square root transformed.

Table 3: Percent plant damage and the marketable production of bell pepper fruits in different date of planting. (Rabi, 2015-16 and 2016-17)

Date of planting	% damage of plant due to mite			% incidence of leaf curl virus			Marketable Production(t/ha)		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	aAverage
1st November	15.71(23.57)	12.14(20.39)	21.77	10.71(19.09)	22.86(28.56)	23.76	19.63	16.95	18.29
15 th November	12.14(20.39)	8.57(17.02)	18.45	12.86(21.01)	29.29(32.76)	26.70	16.20	14.17	15.19
30 th November	7.86(16.28)	7.14(15.45)	15.59	25.71(30.46)	39.29(38.81)	34.58	14.25	12.42	13.34
C.D.(0.05)	4.20	3.02		4.28	5.45		30.02	15.44	

*Values in parenthesis are angular transformed (% data only)

Table 4: Damage score of bell pepper plant in different date of planting (Rabi, 2015-16 and 2016-17).

Days after planting	Damage score at 1st November planting			Damage score at 15th November planting			Damage score at 30th November planting		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
60th day	0.60	0.83	0.71	0.51	0.85	0.68	0.73	0.97	0.85
90th day	1.19	1.20	1.20	1.15	1.26	1.21	1.40	1.41	1.40
120th day	1.51	1.41	1.46	1.59	1.11	1.35	1.48	1.36	1.42
C.D.	0.24	0.20		0.17	0.19		0.21	0.28	
SE(m)	0.08	0.06		0.06	0.06		0.07	0.09	

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