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Original Research Article

Influence of Spacing and Intercropping on Attack of Falls Armyworm Infestation in Sweet Corn under Konkan Agro Climatic Conditions

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A B S T R A C T

The field experiment was carried out at College of Horticulture, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli (MS), for investigating the effects of different spacing levels and intercrops leafy vegetables on the number of plants affected per block in sweet corn by falls armyworm infestation. The experiment was laid out in spilt plot design during *rabi-summer* season of the year 2019 to 2020 by considering the objective of commercial importance of sweet corn and leafy vegetables to maximize the production of farmer through intercropping. The falls armyworm (*Spodoptera frugiperda*) is a major problem in sweet corn, it is the major host and yield losses of upto 34 %. The interaction effect of spacing and intercrop on the number of plants affected by falls armyworm attack on sweet corn showed significant variation during both the years of experimentation. The pooled data revealed that the highest number of plants per block affected (46.70) was recorded in (S_1I_6) i.e. coriander + sweet corn intercropping with the spacing 60 × 20 cm, while the lowest (14.03) was recorded when mustard intercropped with sweet corn at the spacing 60 × 40 cm i.e. S_3I_4, which was significantly superior over rest of the treatment combinations. Considering overall performance of the different intercrops leafy vegetables with spacings, it is concluded that the mustard plus sweet corn intercropping at the spacing 60 × 40 cm was found to be best and performed better in terms of the lowest number of plant affected in sweet corn by FAW attack under Konkan agro-climatic conditions of Maharashtra state.

Keywords

Sweet corn, spacings, intercrops and falls armyworm

Introduction

Sweet corn (*Zea mays var. saccharata*) belongs to the family Graminae. It is also called as 'Sugar corn'. It is the recent form of grain vegetable maize, which has prime importance in diversification, revenue generation and value addition as well as in the processing industry, due to its wide adaptability in the globe(Okviche *et al.*, 2013). It is the third most important crop in the India after rice and wheat. It is a hybridized variety of maize (*Zea mays*) specially bred to improve the sugar content.

While considering suitable agro-climatic conditions of the Konkan region of Maharashtra; sweet corn can be a promising cash crop in this region. It can be well fitted in vegetable-based cropping system; as it is a short duration crop, maturing in 85 to 95 days. During initial days more than two cycles of leafy vegetables are taken as intercrop. Keeping in mind the commercial demand for leafy vegetables and sweet corn; its productivity needs to be increased by following economic intercropping to achieve intensive cultivation and monitory returns.

As consequence, the sweet corn is badly affected by the attack of falls armyworm (*Spodoptera frugiperda*), the green ear and corn grain yield losses up to 34 % (Lima *et al.,* 2010). Falls armyworm is a polyphagous insect, with more than 100 host plants in 27 families, (Goergen *et al.*, 2016; Roger *et al.*, 2017, *Anon.,* 2019). It is a crucial pest in the United States as well as in the world, which causes severe damage to economically important crops, likes maize, sorghum, rice, cotton and groundnut (Sparks, 1979). Crop diversification with various temporal and geographical arrangements reduces pest incidence while increasing the population of beneficial arthropods (Altieri and Liebman, 1986; OgengaLatigo *et al.,* 1992; Girma *et al.,* 2000; Girma, 2006; Seran and Brintha, 2010) and this has been reported as one management option for FAW control (Altieri, 1980). Another way to control falls armyworm is intercropping. Nowadays, small and marginal farmers are motivated towards intercropping. Different short duration leafy vegetables or other leguminous crops are intercropped with sweet corn was also provided a significance reduction in falls armyworm as compared to sole cropping, especially during the early growth phases of the sweet corn up to the tasseling stage. Hence, in view of these facts, the present study was done to determine the effect of spacing and intercrops leafy vegetable on the number of plants affected per block in sweet corn as well as to find out which cropping system with spacing is best to reduce infestation by FAW.

Materials and Methods

The field experiment was laid out in split plot design and replicated thrice. Main block treatments consist three spacings levels *viz.*, S_1 (60 cm × 20 cm), S_2 (60 cm × 30 cm) and S_3 (60 cm × 40 cm) and seven intercropping combination (leafy vegetables including control) *viz.*, I_1 (sweet corn + amaranth), I_2 (sweet corn + radish), I_3 (sweet corn + palak), I_4 (sweet corn + mustard), I_5 (sweet corn + coriander), I_6 (sweet corn + fenugreek) and I_7 (sole sweet corn) i.e. without intercrops as sub plot treatments. The field experiment was conducted during the *rabi* season from January to April, 2019 for first field trial and second trial more or less same to the first field trial. Number of plants per block was recorded by counting all the infected plants from each treatment by falls armyworm during the experimental period. The data were analyzed statistically as per the method suggested by Panse and Sukhatme (1995) using SPD and valid conclusions were drawn only on significant differences between treatment mean at 0.05% level of significance.

Results and Discussion

The number of plants affected in sweet corn by falls armyworm attack as influenced by the spacing of main crop and intercrops leafy vegetables under Konkan agro-climatic condition of Maharashtra State has been studied and the results of these findings have been presented in this paper.

The interaction effect of spacing and intercrop on the number of plants affected by falls armyworm was significant at all growth stages of sweet corn during both the years of

experimentation as well as in pooled data and are presented in table 1-4. During the year 2019, the highest number of plants affected (5.33) was recorded in S_1I_7 i.e. sweet corn grown as a sole crop with spacing 60 × 20 cm, while the lowest number of plants affected (1.93) were observed when mustard intercropped with sweet corn at the spacing 60 × 40 cm i.e. S_3I_4 and it was found significantly superior over rest of the treatment combinations at 30 DAS (Table 1). Similar, results were obtained at 60, 90 and at harvest. The minimum number of corn plants affected (4.67, 8.46 and 12.93) were observed in S_3I_4. Whereas maximum numbers of corn plants were affected (19.87, 34.00 and 45.67) in S_1I_7 respectively (Table 2-4).

During second field trail 2020, the highest number of plants (6.27) affected per block were recorded in (S_1I_7). While, the lowest number of plants affected (2.73) was noticed in S_3I_4, which was significantly superior over other intercropping combination sat 30 DAS(Table 1). At 60, 90 DAS and at harvest the lowest number (5.57, 9.80 and 15.13) of corn plants damaged was in S_3I_4. The highest number (20.37 and 32.00) of corn plants affected was registered in S_1I_7 at 60 and 90 DAS respectively. At harvest, the highest number of plants affected (48.13) in sweet corn was found in S_1I_6(fenugreek intercrops with sweet corn at the spacing 60 × 20 cm)(Table 2 to 4).

With regards to pooled data, Significantly S_3I_4 recorded the lowest number (2.33, 5.12, 9.13 and 14.03) of corn plants were affected at 30, 60, 90 DAS and at harvest whereas, the highest number (5.80, 20.12 and 33.00) of plants were affected in S_1I_7 at 30, 60 and 90 DAS (Table 1 to 3). At harvest, the highest number of affected(46.70) corn plants was observed in S_1I_6(Table 4).

The spacing had a significant effect on the number of plants affected per block in sweet corn. The highest number of plants affected was observed in closer spacing, while the lowest in wider spacing. The lowest number of plants affected at wider spacing might be due to the lower plant population were also reported by Clovis *et al.,* (2020) in maize and Lima *et al.*, (2010) in sweet corn.

During the present investigation; it was seen that intercropping had a significant effect on the number of plants affected per block. The highest number of plants affected was recorded in sole sweet corn (without intercrops) and it was followed by (sweet corn + fenugreek), (sweet corn + palak), (sweet corn + amaranth), (sweet corn + coriander) and (sweet corn + radish).

The lowest number of plants affected was noticed in (sweet corn + mustard) intercropping system might be attributed to allelopathic effects and odorous smell release form the intercrops mustard plants that repelled the falls armyworm larvae away from the sweet corn plants. Similar reports were given by Clovis *et al.*, (2020) in maize, Fenta and Dereje (2019) in maize + bean and Girma *et al.*, (2018) in maize + groundnut. They registered that the lowest number of plants affected in sweet corn was recorded mustard plus sweet corn intercropping at wider spacing.

From the present investigation, it can be concluded that the intercropping combination S_3I_4 (mustard intercropped with sweet corn at the spacing 60 × 40 cm) recorded the lowest number of affected per block in corn plants at 30, 60, 90 DAS and at the harvest which helps for increasing yield of sweet corn as well as intercrop, hence it was found to be best as compared to other intercropping combinations and sweet corn grown as a sole crop.

Table.1 Effect of main crop spacing and intercrops on number of plants affected per block in sweet corn by falls armyworm attack (at 30 DAS)

Number of plants affectedper block (at 30 DAS)												
Intercrop	**Year 2019**				**Year 2020**				**Pooled**			
	Spacing											
	S_1	**S_2**	**S_3**	**MEAN**	**S_1**	**S_2**	**S_3**	**MEAN**	**S_1**	**S_2**	**S_3**	**MEAN**
I_1	4.20	3.57	3.50	**3.76**	5.00	4.50	4.30	**4.60**	4.60	4.03	3.90	**4.18**
I_2	3.40	2.47	2.33	**2.73**	4.47	3.47	3.13	**3.69**	3.93	2.97	2.73	**3.21**
I_3	4.40	3.73	3.47	**3.87**	5.33	4.53	4.27	**4.71**	4.87	4.13	3.87	**4.29**
I_4	2.80	2.37	1.93	**2.37**	3.60	3.17	2.73	**3.17**	3.20	2.77	2.33	**2.77**
I_5	3.60	2.87	2.80	**3.09**	4.40	3.67	3.60	**3.89**	4.00	3.27	3.20	**3.49**
I_6	4.93	3.93	3.53	**4.13**	5.73	4.73	4.33	**4.93**	5.33	4.33	3.93	**4.53**
I_7	5.33	4.13	3.63	**4.37**	6.27	4.93	4.43	**5.21**	5.80	4.53	4.03	**4.79**
MEAN	**4.10**	**3.30**	**3.03**		**4.97**	**4.14**	**3.83**		**4.53**	**3.72**	**3.43**	

	S	**I**	**S x I**	**S**	**I**	**S x I**	**S**	**I**	**S x I**
F test	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG
S.Em.±	0.01	0.03	0.08	0.01	0.03	0.08	0.01	0.03	0.08
CD @ 5%	0.03	0.09	0.24	0.03	0.08	0.24	0.03	0.08	0.23

Treatment details:-	**Spacing of sweet corn** (main crop)		**Intercrop**	
	S_1:-	60 × 20 cm	**I_1**:- Amaranth	**I_4**:- Mustard
	S_2:-	60 × 30 cm	**I_2**:- Radish	**I_5**:- Coriander
	S_3:-	60 × 40 cm	**I_3**:- Palak	**I_6**:- Fenugreek
			I_7:- Control (no intercropping)	

Table.2 Effect of main crop spacing and intercrops on number of plants affected per block in sweet corn by falls armyworm attack (at 60 DAS)

Number of plants affected per block(at 60 DAS)												
	Year 2019				**Year 2020**				**Pooled**			
Intercrop	**Spacing**											
	S_1	**S_2**	**S_3**	**MEAN**	**S_1**	**S_2**	**S_3**	**MEAN**	**S_1**	**S_2**	**S_3**	**MEAN**
I_1	14.27	7.93	5.40	**9.20**	14.43	8.53	6.30	**9.76**	14.35	8.23	5.85	**9.48**
I_2	13.67	7.27	5.07	**8.67**	14.17	8.07	5.97	**9.40**	13.92	7.67	5.52	**9.03**
I_3	15.27	8.67	5.93	**9.96**	15.77	9.47	6.83	**10.69**	15.52	9.07	6.38	**10.32**
I_4	13.20	7.00	4.67	**8.29**	13.37	7.80	5.57	**8.91**	13.28	7.40	5.12	**8.60**
I_5	14.07	7.87	5.67	**9.20**	14.57	8.67	6.57	**9.93**	14.32	8.27	6.12	**9.57**
I_6	15.53	9.93	6.60	**10.69**	16.03	10.73	7.50	**11.42**	15.78	10.33	7.05	**11.06**
I_7	19.87	10.40	6.73	**12.33**	20.37	11.20	7.63	**13.07**	20.12	10.80	7.18	**12.70**
MEAN	**15.12**	**8.44**	**5.72**		**15.53**	**9.21**	**6.62**		**15.33**	**8.82**	**6.17**	

	S	**I**	**S x I**	**S**	**I**	**S x I**	**S**	**I**	**S x I**
F test	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG
S.Em.±	0.01	0.02	0.06	0.02	0.04	0.12	0.01	0.03	0.08
CD @ 5%	0.03	0.06	0.18	0.06	0.12	0.36	0.03	0.09	0.24

Treatment details:-	**Spacing of sweet corn** (main crop)		**Intercrop**	
	S_1:-	60 × 20 cm	**I_1**:- Amaranth	**I_4**:- Mustard
	S_2:-	60 × 30 cm	**I_2**:- Radish	**I_5**:- Coriander
	S_3:-	60 × 40 cm	**I_3**:- Palak	**I_6**:- Fenugreek
			I_7:- Control (no intercropping)	

Table.3 Effect of main crop spacing and intercrops on number of plants affected per block in sweet corn by falls armyworm attack (at 90 DAS)

Number of plants affectedper block (at 90 DAS)												
Intercrop	**Year 2019**				**Year 2020**				**Pooled**			
	Spacing											
	S_1	**S_2**	**S_3**	**MEAN**	**S_1**	**S_2**	**S_3**	**MEAN**	**S_1**	**S_2**	**S_3**	**MEAN**
I_1	29.67	16.93	10.89	**19.16**	28.33	26.60	12.67	**22.53**	29.00	22.10	11.78	**20.96**
I_2	27.53	15.13	10.87	**17.84**	26.87	24.47	10.40	**20.58**	27.20	19.80	10.63	**19.21**
I_3	30.13	18.80	11.47	**20.13**	29.47	27.47	13.33	**23.42**	29.80	23.13	12.40	**21.78**
I_4	26.80	14.73	8.46	**16.66**	25.47	23.40	9.80	**19.56**	26.13	19.07	9.13	**18.11**
I_5	28.40	16.40	12.20	**19.00**	28.07	25.40	11.33	**21.60**	28.23	20.90	11.77	**20.30**
I_6	31.27	18.40	11.67	**20.44**	30.60	28.27	14.00	**24.29**	30.93	23.33	12.83	**22.37**
I_7	34.00	18.80	12.67	**21.82**	32.00	29.53	15.67	**25.73**	33.00	24.17	14.17	**23.78**
MEAN	**29.69**	**17.03**	**11.17**		**28.69**	**26.45**	**12.46**		**29.19**	**21.79**	**11.82**	

	S	**I**	**S x I**	**S**	**I**	**S x I**	**S**	**I**	**S x I**
F test	SIG	SIG	SIG	SIG	SIG	NS	SIG	SIG	SIG
S.Em.±	0.02	0.12	0.37	0.01	0.04	0.13	0.02	0.06	0.19
CD @ 5%	0.06	0.36	1.07	0.03	0.12	--	0.06	0.18	0.57

Treatment details:-	**Spacing of sweet corn** (main crop)		**Intercrop**	
	S_1:-	60 × 20 cm	**I_1**:- Amaranth	**I_4**:- Mustard
	S_2:-	60 × 30 cm	**I_2**:- Radish	**I_5**:- Coriander
	S_3:-	60 × 40 cm	**I_3**:- Palak	**I_6**:- Fenugreek
			I_7:- Control (no intercropping)	

Table.4 Effect of main crop spacing and intercrops on number of plants affected per block in sweet corn by falls armyworm attack (at harvest)

Number of plants affected per block(at harvest)												
	Year 2019				**Year 2020**				**Pooled**			
Intercrop	**Spacing**											
	S_1	**S_2**	**S_3**	**MEAN**	**S_1**	**S_2**	**S_3**	**MEAN**	**S_1**	**S_2**	**S_3**	**MEAN**
I_1	42.67	27.93	17.93	**29.51**	45.20	30.87	20.13	**32.07**	43.93	29.40	19.03	**30.79**
I_2	42.00	24.80	16.60	**27.80**	44.53	27.00	18.80	**30.11**	43.27	25.90	17.70	**28.96**
I_3	44.80	27.80	19.40	**30.67**	47.00	30.00	20.93	**32.64**	45.90	28.90	20.17	**31.66**
I_4	40.93	23.73	12.93	**25.87**	43.47	25.93	15.13	**28.18**	42.20	24.83	14.03	**27.02**
I_5	42.07	25.73	18.73	**28.84**	44.60	27.27	20.27	**30.71**	43.33	26.50	19.50	**29.78**
I_6	45.27	28.93	19.80	**31.33**	48.13	31.13	21.33	**33.53**	46.70	30.03	20.57	**32.43**
I_7	45.67	29.87	19.60	**31.71**	47.20	32.07	21.47	**33.58**	46.43	30.97	20.53	**32.64**
MEAN	**43.34**	**26.97**	**17.86**		**45.73**	**29.18**	**19.72**		**44.54**	**28.08**	**18.79**	

	S	**I**	**S x I**	**S**	**I**	**S x I**	**S**	**I**	**S x I**
F test	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG
S.Em.±	0.25	0.10	0.31	0.26	0.11	0.34	0.25	0.10	0.29
CD @ 5%	0.75	0.30	0.93	0.78	0.33	1.02	0.75	0.30	0.87

Treatment details:-	**Spacing of sweet corn** (main crop)		**Intercrop**	
	S_1:-	60 × 20 cm	**I_1**:- Amaranth	**I_4**:- Mustard
	S_2:-	60 × 30 cm	**I_2**:- Radish	**I_5**:- Coriander
	S_3:-	60 × 40 cm	**I_3**:- Palak	**I_6**:- Fenugreek
			I_7:- Control (no intercropping)	

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