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Analysis of Various IPM Modules Against Pea Leaf Miner (*P. horticola* G.) Infesting Pea (*Pisum sativum* L.)

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Abstract

The evaluation of IPM modules under field trial was conducted at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during *Rabi* season of 2016-17 and 2017-18. Experiment was conducted by using high yielding cultivar HUDP- 15, with five IPM modules and three replication in randomized block design, the study revealed that the population of pea leaf miner persisted in the field from 2nd to 11th standard week. When the overall mean of the per cent leaf infestation by *P. horticola* was considered together, the minimum per cent infestation (13.72%) was observed in module 2 followed by module 4 (19.22%), and the highest infestation were observed in module 3 (54.54%) over the untreated control (40.41%) during 2016-17. Similarly, in the year 2017-18, the minimum per cent leaf infestation was found in module 2 (11.20%) followed by module 1 (15.70%) and the highest infestation were observed in module 3 (17.20%) over the untreated control (module 5). The highest cost: benefit ratio found in module 1 (1:7.3) followed by module 4 (1:5.9) and lowest in module 2(1:3.2) during the year 2016-17. Similarly during the year 2017–18 the highest C:B ratio was found in module 1 (1:8.5) followed by module module 4 (1:4.5) and least in module 2 (1:3.9), module 1 is both effective as well as economical, and hence it can be recommended to farmers.

Keywords: Pea, Pea leaf miner, IPM, Percent infestation, Cost: Benefit ratio

1. Introduction

The important factors responsible for the low yield potential of pea might be a heavy infestation of pests and diseases and untimely application of fertilizer,irrigation,and plant protection. Invasion of an array of insect pests at different stages seriously felt as one of the major constraints in realizing the potential yield and in India. Dhamdhere et al.(1970) reported that the crop is devasted by 17 insect pests which are lowering down they yield of the crop both qualitatively and quantitatively of which leaf miner, pea aphid, gram pod borer, pea semi looper, pea stem fly and pea thrips could be considered of major significance. Over the years there has been a steady increase in its acreage and production of pea crop but at the same time the crop became susceptible to a wide array of insect pests like pea leaf miner, *P. horticola* (Goureau) (Sharma et al., 2014). Pea leaf miner is a serious, polyphagous pest of regular occurrence worldwide and the larvae disrupt the process of photosynthesis by construct mines in leaves and consume leaf tissues (Fathi, 2011). Its severe infestation can cause crop damage up to 90% by restricting its flowering and pod formation (Tariq et al., 1991). Sharma et al. (2014) reported that pea leaf miner, *Chromatomyia horticola* is a potential pest of pea crop. In a plant a maximum of 249 mines, leaf infestation up to 89.60% and a maximum of 16.83 maggots were recorded. Farmers apply insecticides resorting to 5-6 sprays to control these serious pests in pea crop which enhances their cost of production as well as also results in excessive and injudicious use of pesticides causing ill effects to the produce as well as the ecosystem. Integrated pest management is an ecosystem-based strategy that focuses on the long-term prevention of crop pests and diseases through a variety of techniques that include biological control, the use of resistant varieties, habitat management, modification of cultural practices and, when needed, judicious and timely use of chemical controls (Flint and Van den Bosch, 2012). So keeping in view the economic importance of the crop, status of insect pests attack the present investigation was carried out with five IPM modules.

2. Materials and Methods

Moderately high yielding HUDP 15 cultivar of pea was sown in plots of 7 rows of 4-meters length and row to row distance of 30 cm and pant to the spacing of 10 cm in *Rabi* season of 2016-17 and 2017-18. The crop was grown in Randomized Block Design following normal agronomic practices with three replications and five treatments. The details of IPM modules

are given in Table 1.

Table 1: Details of IPM module evaluated against

S. No.	IPM Module Details
M_1	Installation of pheromone traps at early vegetative stage of crop. Spray of NSKE 5% at flowering stage followed by spray of Imidacloprid @17.8 SL @ 0.25 ml l^{-1} at 15 days interval.
M_2	Mustard is grown as intercrop in the ratio of 1:5. Pheromone trap was installed in vegetative stage. Two sprays of insecticides were made. First spray of Imidacloprid 17.8 SL@ 0.25 ml l^{-1} at early flowering stage and second spray of indoxacarb 15.8 EC @ 73g a.i/ha at pod formation stage.
M_3	Mustard grown as intercrop with pea at 1:5 ratio. First spray of Dimethoate 30EC@600 g a.i ha^{-1} followed by Indoxacarb @ 15.8 EC @73 g a.i ha^{-1} at 15 days interval in flowering and podding stage of crop.
M_4	Spray of Dimethoate 30EC@ 600 g.a.i ha^{-1} and NSKE 5% at 15 days interval in flowering and podding stage of crop.
M_5	Untreated (Control)

2.1. Pods and leaves damage assessment

Leaf damage observation was done by counting a total number of affected leaves out of total leaves taken for observation from five plants. The number of leaves infested leaves was judged by the appearance of serpentine mine on the leaves. The percent leaf and pod damage were worked out by using following formula:

Per cent leaf infestation=(Number of infested leaves/total number of leaves)×100

2.2 Cost-benefit analysis of the treatments

The grain yield from the net plot of 12 m^2 area was recorded from each treatment and then yield was converted into kg ha^{-1} and increase in yield over control (%) was computed.

Increase in yield over control (%)=(yield in treated plot- yield in control plot)/ Yield in control plot ×100

The benefit-cost ratio of each module was calculated taking into account of the prevailing market price of inputs and outputs i.e., the produce, pheromone trap, intercropping and labour charges.

2.3. Statistical analysis

Data obtained on various aspects was subjected to ANOVA as per Randomized Block design. Data related to percent leaf infestation due to *Phytomyza horticola* was transformed by arc sin ($q=\sin^{-1} x$) transformation method.

3. Results and Discussion

3.1. Percent leaf infestation by P. horticola

Percent leaf infestation by *P. horticola* was estimated during the years, 2016–17 and 2017–18, the data are presented in Table 2 and 3, during the year 2016-17, when the overall mean of the per cent leaf infestation by *P. horticola* was considered together, the minimum percent infestation (13.72%) was observed in module 2 followed by module 4 (19.22%), and the highest infestation were observed in module 3 (54.54) over the untreated control (40.41). Similarly, in the year 2017-18, the minimum percent leaf infestation was found in module 2 (11.20%) followed by module 1 (15.70%) and the highest infestation were observed in module 3 (17.20%)

Table 2: Estimation of per cent leaf infestation due to *P. horticola* in different IPM modules during *rabi*, 2016-17

Treatment module	3rd SW	4th SW	5th SW	6th SW	7th SW	8th SW	9th SW	10th SW	11th SW	%reduction over control	Overall mean population
Module -1	8.60 (16.98)*	18.80 (25.67)	14.36 (22.14)	30.20 (33.28)	20.50 (26.8)	29.26 (32.67)	33.6 (35.29)	17.26 (24.42)	4.40 (11.52)	60.00	19.64
Module-2	5.88 (14.00)	17.10 (22.78)	9.54 (17.85)	19.38 (26.06)	9.80 (18.05)	24.60 (26.66)	21.54 (27.60)	12.20 (20.34)	3.46 (9.50)	68.54	13.72
Module-3	6.40 (14.4)	16.42 (22.8)	14.40 (22.26)	25.60 (30.36)	14.58 (22.39)	28.60 (32.26)	32.00 (34.38)	23.20 (28.72)	5.00 (14.30)	54.54	54.54
Module-4	7.70 (16.06)	17.22 (24.8)	12.04 (20.24	26.30 (30.8)	19.72 (26.32)	31.20 (33.87)	31.60 (34.12)	21.00 (27.18)	6.20 (14.49)	43.63	19.22
Module-5	11.20 (19.56)	25.30 (30.18)	33.20 (35.16)	52.00 (46.12)	57.00 (49.00)	68.00 (554.50)	71.00 (57.39)	35.00 (36.25)	11.00 (19.36)	-	40.41
SE(m)	0.748	0.85	0.87	0.75	0.91	1.18	1.44	1.18	1.41	-	-
CD (*p*=0.05)	2.261	2.59	2.64	2.28	2.7	3.59	4.37	3.58	4.26	-	-

*Data in the parenthesis are in angular ($\sin^{-1}x$) transformed values; SW: Standard week

Table 3: Estimation of per cent leaf infestation due to *P. horticola* in different IPM modules during *rabi,* 2017-18

Treatment module	3rd SW	4th SW	5th SW	6th SW	7th SW	8th SW	9th SW	10th SW	11th SW	%reduction over control	Overall mean population
Module -1	7.92 (16.26)*	19.42 (26.02)	10.8 (19.06)	29.2 (32.59)	14.8 (22.56)	21.00 (27.19)	21.8 (27.77)	14.4 (22.25)	2.00 (7.67)	77.77	15.70
Module-2	6.18 (14.33)	15.16 (22.88)	8.00 (16.32)	24.2 (29.30)	8.3 (16.6)	14.06 (21.9)	14.32 (22.16)	8.8 (17.16)	1.94 (7.87)	78.44	11.20
Module-3	8.94 (17.34)	19.66 (26.29)	11.20 (19.49)	36.2 (36.92)	14.76 (22.54)	28.40 (32.16)	23.6 (28.9)	10.8 (19.13)	2.2 (7.35)	75.55	17.20
Module-4	6.64 (14.88)	16.04 (23.58)	9.80 (18.27)	34.4 (35.84)	19.16 (25.90)	21.80 (27.49)	20.40 (26.78)	14.42 (22.26)	2.25 (7.6)	75.00	16.06
Module-5	12.30 (20.52)	23.9 (29.58)	35.60 (36.25)	58.00 (49.58)	73 (58.67)	62.00 (51.9)	48.50 (44.12)	29.5 (32.88)	9 (17.45)		39.08
SE(m)	0.52	0.709	0.81	1.52	0.68	1.55	0.97	0.66	1.38		
CD (*p*=0.05)	1.596	2.14	2.45	4.95	2.07	4.7	2.94	2.02	4.18		

*Data in the parenthesis are in angular ($sin^{-1}x$) transformed values; SW: Standard week

over the untreated control (module 5). The present findings were in agreement with the findings of Singh and Saravanan (2008) who evaluated the bioefficacy of insecticides viz Acetamiprid, Imidacloprid, Thiamethoxam, neem oil and NSKE against pea leaf miner and concluded that the imidacloprid proved 100% population reduction @ 5 days after spraying followed by acetamiprid. Similarly, Guantai et al., 2015, found that Dimethoate 30 EC @ 750 ml ha^{-1} was found effective against leaf miner. However, Sharma et al. (2016) evaluated the performance of four IPM modules against leaf miner and disease like root rot / wilt and Ascochyta blight in Kullu valley of Himachal Pradesh during rabi season 2010-11 and 2011-12 on pea crop. The findings of two years experiments revealed that the IPM module consisting of seed treatment by seed soaking in streptocycline @ 200 ppm followed by seed treatment with carbendazim (Bavistin 50 WP) @ 2.5 / kg seed succseeded by two foliar sprays with a mixture of lambda-cyhalothrin 5 EC @ 0.8 ml l^{-1} (0.04%) and carbendazim @ 0.1% (Bavistin 50 WP) at the 50% flowering of the crop. 2nd spray of mixture of acetamiprid @ 0.005% (Polar 25 SP) and triademefon @ 0.05% (Bayeton 2%) after 15 days of the first spray, was found to be most effective in minimizing the leaf infestation by leaf miner and root rot/ wilt incidence with 85.1% and 98.2% reduction over control, respectively.

3.2. Cost benefit analysis of the different IPM modules

The cost: benefit analysis has been calculated for different IPM modules are presented in Table 4 and it was revealed that highest ratio of 1:7.3 was obtained in the module 1, next highest cost: benefit ratio 1:5.9 was occurred in module 4 fallowed by 1:4.6 in module 3 and however the lowest cost benefit ratio of 1:3.2 found in module 2. Similarly, during the year 2017-18, it was revealed that highest ratio of 1:8.5 was obtained in the module 1, next highest cost: benefit ratio 1:4.5 was occurred in module 4 fallowed by 1:39 in module 2 and however the lowest cost benefit ratio of 1:2.25 resulted in the module 4. The present findings were somewhat similar with the findings of Kumar et al. (2015) who reported that the

Table 4: Cost- benefit analysis of different IPM modules against Pea leaf miner (*P. horticola*) infesting pea

Treatment module	Grain yield of pea (kg ha^{-1})		yield increase over control (kg ha^{-1})		Grain yield of mustard (kg ha^{-1})		Additional income (₹ ha^{-1}) [A]		Additional cost (₹ ha^{-1}) [B]		Net profit (₹ ha^{-1}) [A-B]		Cost: benefit ratio (CBR)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Module -1	704	630.59	362.3	362.3	-	-	10869	11593.6	3966.8	4066.8	6902	7526.8	1:7.3	1:8.5
Module-2	895	938.5	622	669.1	105	120	21810	25611.6	5089	5189.8	16721	20421.8	1:3.2	1:3.9
Module-3	753	705.00	480	437	123	140	18582	18884	3303	3403	15279	15481	1:4.6	1:4.5
Module-4	502	510	229	231.71	-	-	15060	7414.72	2180	2280	12880	5134	1:5.9	1:2.2
Module-5	273	278.29	-	-	-	-	-	-	-	-	-	-	-	-

maximum benefit-cost ratio of 1:4.28 was obtained from the plots treated with neem leaves extract 5% at weekly interval starting with the initiation of pod formation.

4. Conclusion

The cost: benefit analysis calculated for different IPM modules revealed that highest ratio of 1:7.3 and 1:8.5 were obtained in the module 1. The results of evaluation of different integrated pest management modules revealed that module 1 comprising of Pheromone trap1st spray with NSKE 5% followed by second spray of Imidacloprid 17.8SL @ 0.25 ml l^{-1} at 15 days interval was most economical as well as effective in management of major insect pests of pea, hence this module can be considered for recommendation to farmers of this region.

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