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Evaluation of Some Selected IPM Modules for the Management of Tomato Fruit Worm (*Helicoverpa armigera* Hub.)

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Abstract

Effectiveness of selected IPM modules was evaluated against *H. armigera* on tomato under field conditions at Newly Developmental Farm, The University of Agriculture Peshawar, Khyber Pakhthunkhwa - Pakistan during 2011. Chinar (F1 hybrid indeterminate) were transplanted in field in randomized complete block design. Eight IPM modules as treatments including control were evaluated and cost benefit ratio of these modules was also evaluated. Except control seven modules were tested with integration of three control strategies i.e., use of pheromone trap, mechanical egg destruction of target pest and use of *Trichogramma chilonis* as biocontrol agent. Of these seven modules, first six modules also received pesticide of different groups, i.e. Neem seed extract, indoxicarb, emmamectin benzoate, spinosad, lufenuron, chlorantraniliprole respectively. Results revealed that all IPM modules were effective than control, in reducing fruit damage by *H. armigera.* However, lowest fruit damage (5.74%) and maximum tomato yield (22013 kg ha^{-1}) was obtained in M6, where use of chlorantraniliprole was integrated with other control strategies. The same module also revealed highest cost benefit ratio (1: 6.4). It was concluded that integration of different control measure along with judicial use of pesticide in IPM program not only reduced fruit losses but also increased yield and net return.

Keywords: *H. armigera*, Pheromone Trap, Mechanical egg destruction, *Trichogramma chilonis*, Pesticide

1. Introduction

Tomato fruit borer (*Helicoverpa armigera* Hub.) is the major pest that causes significant yield losses in tomato [19]. *H. armigera* feeds on both tomato foliage as well as fruit thereby affecting fruit quality both from human consumption and marketing point of view [5]. In Pakistan, fruit losses by *H. armigera* have been estimated to be in the range of 32-53% [8,7] but the reliable monetary losses in tomato crop are not available. Worldwide, approximately 5 billion US dollars annual losses have been attributed to *H. armigera* [17].

To overcome such loses, chemical control has been heavily relied upon because of its quick action against the pest. But the excessive use of synthetic pesticide not only cause various environmental and health problems [6] but also result in the development of pesticide resistance in pests [11]. Keeping in view, the above mentioned facts as well as 80 % share of total pesticide use that it receive in Pakistan [15], has led us to investigate alternative control strategies. To tackle the problems associated with chemical control, the trend has been shifted towards integrated pest management.

In IPM all the available control measures are usually focused for pest suppression in such a way that pesticide becomes the last option. In IPM, use of pesticide is at least minimized, if cannot be avoided altogether [16]. In a pest problem scenario, failure in control is usually due to inappropriateness in pest monitoring system as well as in selection of proper pesticide [9]. Incorporation of resistant genotype along with proper addressing of the aforementioned reasons can be very effective. Such an IPM strategy has been reported effective in term of reducing pest infestation. Besides other control measures, the use of biocontrol agent, particularly *Trichogramma* species, which are egg parasitoids of lepidopterous pest, have also been documented [12]. In IPM, pest is properly monitored and whose population is periodically suppressed through pheromone traps, biocontrol agent, mechanical egg crushing of pest eggs and larvae as well as chemical integration with an appropriate pesticide at an appropriate time can be accepted from environmental, economic and social point of view. Limited work in Pakistan has been done to develop a control strategy, in which all the available control measures were integrated and implemented at right time against the pest. In the present study, various control measures (resistant genotype, pheromone trap, mechanical egg destruction, *Trichogramma* and application of some pesticide of different groups) were combined together for the management of *H. armigera* on tomato crop, in order to minimize the use of pesticide. Therefore, the present study was designed to evaluate different IPM modules for the management of pest problem with least or no pesticide usage.

Materials and Methods

The experiment was carried out at Newly Developmental Farm (NDF) of Khyber Pakhtunkhwa-Pakistan during 2011. Based on the results of two years (2009-2010) field screening trail, genotype Chinar (F1 hybrid) which is resistant was well as high yielding (Usman *et al.* [20]) was selected for this experiment.

Tomato seedlings were transplanted in first week of March in separate plots, with each measuring 5.5 m x 2 m. Plants were spaced 60 cm apart with 75 cm between the rows. The experiment was laid out in Randomized Complete Block Design with three replications. In all there were (8 x 3) i.e. 24 experimental units. Normal agronomic practices were followed uniformly. The experimental units were regularly inspected for pest arrival. The Pheromone traps were installed in experimental field 15 days after transplantation. After the moth arrival, mechanical destruction of pest eggs in all experimental treatments was initiated (two times at three days interval). On the third day, after the mechanical egg destruction practice, biocontrol agent *T. chilonis* (eggs parasitoid) @ 75,000 ha^{-1} in the form of trichocards were placed in tomato field twice at weekly interval.

On fifth day of *T. chilonis* release, the pesticide spray (at recommended dose) was done early in the morning with the help of Knapsack sprayer with the intention to protect not only the susceptible stage of *Trichogramma* (adult stage) from direct exposure to pesticide but to target the early larval instars of the pest. Initially the second spray of pesticide was scheduled to be made at fortnight interval but due to minimal density of the pest, second spray application was not carried out. Polythene sheet (20 ft x 3 ft) was hanged around each plot in all replications to protect the adjacent plot from the drift effect of pesticide. The control plot, where no preventive measures were applied, was kept 250 meters away from the main experimental plots. Data were recorded on the following parameters

a. Percent fruit damage: After each picking, weights of tomato fruits were recorded for each plot. The damaged fruits (presence of holes by fruit worm) were separated from the sound tomato fruits and were weighted. The percent damage was determined by the following formula:

$$\text{Percent damaged fruits} = \frac{\text{weight of damaged fruits}}{\text{Total weight of tomato fruits}} \times 100$$

b. *Total yield (kg ha^{-1}):* The weight of sound fruits of each picking was recorded individually for each plot and the yield was calculated by adding the yield from all pickings for each plot. The yield was then converted into per hectare basis with the following formula.

$$\text{Yield (kg ha}^{-1}) = \frac{\text{yield plot}^{-1}}{\text{Plot size (m}^2)} \times 10000$$

IPM modules

M1: Pheromone trap + Mechanical eggs destruction + *T. chilonis* (in the form of trichocard) @ 75000 parasitized eggs ha^{-1} (twice at weekly interval) + Neem seed extract @ 5%

M2: Pheromone trap + Mechanical eggs destruction + *T. chilonis* (in the form of trichocard) @ 75000 parasitized eggs ha^{-1} (twice at weekly interval) + Indoxicarb @125 ml acre^{-1}

M3: Pheromone trap + Mechanical eggs destruction + *T. chilonis* (in the form of trichocard) @ 75000 parasitized eggs ha^{-1} (twice at weekly interval) + Spinosad @ 40 ml acre^{-1}

M4: Pheromone trap + Mechanical eggs destruction + *T. chilonis* (in the form of trichocard) @ 75000 parasitized eggs ha^{-1} (twice at weekly interval) + Emmamectin benzoate @200 ml acre^{-1}

M5: Pheromone trap + Mechanical eggs destruction + *T. chilonis* (in the form of trichocard) @ 75000 parasitized eggs ha^{-1} (twice at weekly interval) + Lufenuron @ 200ml acre^{-1}

M6: Pheromone trap + Mechanical eggs destruction + *T. chilonis* @ 75000 parasitized eggs ha^{-1} (twice at weekly interval) + Chlorantraniliprole @ 80ml acre^{-1}

M7: Pheromone trap + Mechanical eggs destruction + *T. chilonis* (in the form of trichocard) @ 75000 parasitized eggs ha^{-1} (twice at weekly interval)

M8: Control (Check plot)

Cost Benefit Ratio (CB ratio)

Cost benefit ratio of all IPM modules were calculated according to method adopted by Farmanullah *et al.*, [4], to find out the best IPM module having maximum CB ratio.

Results and Discussion

The results revealed that all the IPM modules were significantly effective over control (M8) in reducing *H. armigera* fruit damage (Table 1). However, among the tested IPM modules, the M6 was found to be most effective, with lowest fruit damage (5.74%) followed by M3 (7.35%) while M8 was found to be least effective with highest fruit damage (19.10%). IPM modules M4, M5 and M2 are equally effective having 8.08%, 8.33% and 8.54% fruit damage respectively. Tomato yield was also significantly different by application of different IPM modules (Table 1). The yield was significantly higher in M6 (22013 kg ha^{-1}) while lower in control (17959 kg ha^{-1}). It is cleared from the results that integration of different control measures along with judicious use of pesticide in IPM program significantly increase tomato yield as compared to check where no preventive measures were applied. Effect of the tested control of measures (pheromone trap, mechanical egg destruction, *Trichogramma* and pesticide application) have been documented by various researchers. In the present study, all the afore- mentioned control measures were combine together and implemented at appropriate time against pest infestation, with the intention to minimize the number spray application. In IPM program, each control measures contribute in reducing pest density when applied at an appropriate time. Sundaramurthy [18] reported that detoping of the young tender leaves of plant greatly reduced female moth oviposition. Similarly, hand picking and destruction of egg and larvae resulted in the reduction of *H. armigera* infestation by 3-90 percent. *Trichogramma* is an egg parasite of lepidopeterous eggs and is very effective and reduce pest infestation up 70 % when released at right time in the field when fresh eggs of the pest are available [12]. Results revealed that the IPM modules, in which pesticide was integrated with standard control measures, were significantly more effective in reducing fruit damage than modules without pesticide and control. However, among various pesticide integrated modules,

Chlorantraniliprole based modules (M6) was found to be most effective and had 5.74% fruit damage, while neem seed extact based module (M1) was least effective (9.49%) in reducing fruit damage. Module M3, (emamectin benzoate based module), M4 (spinosad based module), M5 (luferon based module) and M2 (indoxicarb based module) being non-significant and equally effective with 7.35%, 8.08%, 8.33% and 8.54% fruit damage respectively, The present findings are in confirmatory with those of Satpute and Barkhade [13] who reported that Chlorantraniliprole (Coragen 20 % SC) is both contact and stomatch posion and proved to be most effective having both ovicidal as well as larvicidal effect against lepidpoterans. It was clear from the results that even single dose of pesticide played significant role when incorporated in IPM program at appropriate time. The present findings are in agreement with Zehnder *et al.* [21] and Cameron *et al.* [3] they reported that IPM program significantly reduce the number of spray application as compare to conventional pest management program. Some researchers Miranda *et al.,* [10] Aggarwal *et al.,* [1] and Sundaramurthy [18] have tested various IPM modules with integration of different control measures in their experiments against *H. armigera* on various crops. So, the present findings cannot be compared with that reported earlier, due to differences in crops and their IPM modules composition.

Table 1: Effect of different IPM modules on *H. armigera* larval fruit damage and yield of tomato.

S. No	IPM Modules	Percent fruit damage	marketable yield (kg ha^{-1})
M 1	Pheromone trap + mechanical egg destruction + trichocard + neem seed extract	9.49 c	20003 d
M 2	Pheromone trap + mechanical egg destruction + trichocard + indoxicarb	8.54 cd	20737 c
M 3	Pheromone trap + mechanical egg destruction + trichocard + emmamectin benzoate	7.35 de	21134 b
M 4	Pheromone trap + mechanical egg destruction + trichocard + spinosad	8.08 cd	21003 b
M 5	Pheromone trap + mechanical egg destruction + trichocard + lufenuron	8.33 cd	20148 d
M 6	Pheromone trap + mechanical egg destruction + trichocard + chlorantraniliprole	5.74 e	22013 a
M 7	Pheromone trap + mechanical egg destruction + trichocard	13.33 b	19536 e
M 8	Control	19.10 a	17959 f
LSD (0.05%)		**1.9395**	**167.33**

Means in columns with similar letters are non-significantly different at α = 0.05 (LSD Test)

Cost benefit Analysis

The ultimate goal of farmers is to earn more money from crop. Cost benefit ratio is very important as it presents the actual picture of how much is gained by adopting control strategy for managing the pest problem. Table 2 revealed that highest CB ratio was recorded for M6 (1: 6.4) and lowest for M7 (1:3.00). The CB ratio calculated for remaining modules M3, M4, M2 and M1 was (1:6.20), (1:6.00), (1:5.00) and (1:3.8) respectively. On the basis of effectiveness as well as on the basis of CB ratio, M6 is the on the top followed by M3 and M4. In the present study the cost of control was depended on cost of pesticide, as all the controls measures (pheromone trap + mechanical egg destruction + trichocard) were kept constant in all modules. Among the tested pesticide, chlorantraniliprole is the most expensive while neem seed extract and lufenuron was the most economical pesticide. From the cost benefit analysis, it could be concluded that chlorantraniliprole based module was the most efficient in reducing fruit damage and gave high marketable yield with highest net return. The present findings cannot be compared with the findings of earlier researchers because of the different IPM modules used in the present study. Also, the cost of control fluctuates with time as well as it varies from region to region.

Table 2: Cost benefit analysis of different IPM modules

IPM modules		Marketable yield (kg hac^{-1}) A	Gross income (Rs.) B	Cost of control (Rs. ha^{-1}) C	Return over control (Rs. ha^{-1}) D	Net increase over control (Rs. ha^{-1}) E= D-C	C : B E=D/C
M1	Pheromone trap + mechanical egg destruction + trichocard + neem seed extract	20003.3	480080.0	10214.0	49056.0	38842.0	3.8
M2	Pheromone trap + mechanical egg destruction + trichocard + indoxicarb	20737.3	497696.0	11050.0	66672.0	55622.0	5.0
M3	Pheromone trap + mechanical egg destruction + trichocard + emmamectin benzoate	21133.7	507208.0	10635.0	76184.0	65549.0	6.2
M4	Pheromone trap + mechanical egg destruction + trichocard + spinosad	21003.0	504072.0	10464.0	73048.0	62584.0	6.0
M5	Pheromone trap + mechanical egg destruction + trichocard + lufenuron	20148.3	483560.0	10436.0	52536.0	42100.0	4.0
M6	Pheromone trap + mechanical egg destruction + trichocard + chlorantraniliprole	22013.3	528320.0	13192.0	97296.0	84104.0	6.4
M7	Pheromone trap + mechanical egg destruction + trichocard	19535.7	468856.0	9500.0	37832.0	28332.0	3.0
M8	Control	17959.3	431024.0	-	-	-	-

Where

Average market price of tomato kg^{-1} = Rs. 24/- ; Pheromone Trap @Rs. 200 = Rs. 2000 ha^{-1}; Tricocard @ Rs. 15 (50 cards x 15) = Rs 750 ha $^{-1}$, Labor cost for egg crushing @ Rs. 3000 ha $^{-1}$; Labor cost of pesticide spray = Rs. 600 ha^{-1}

Pesticide cost ha^{-1}: NeemSeed extract = Rs. 864; Indoxicarb = Rs. 1700/; Emmamectin benzoate = Rs. 1285/; Spinosad = Rs. 1114/; Lufenuron = Rs. 1086/; Chlorantraniliprole = Rs. 3842

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