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Imtiaz Ali Khan
Department of Entomology, The University of Agriculture, Peshawar, Pakistan.

Muhammad Nawaz Khan
Department of Entomology, The University of Agriculture, Peshawar, Pakistan.

Rasheed Akbar
Department of Entomology, The University of Agriculture, Peshawar, Pakistan.

Muhammad Saeed
Department of Agricultural Sciences, University of Haripur, Pakistan.

Abid Farid
Department of Agricultural Sciences, University of Haripur, Pakistan.

Ijaz Ali
Institute of Biotechnology and Genetic Engineering, University of Agriculture, Pakistan.

Mukhtar Alam
Faculty of Agriculture, University of Swabi, Pakistan.

Komal Habib
Department of Entomology, The University of Agriculture, Peshawar, Pakistan.

Walija Fayaz
Department of Entomology, The University of Agriculture, Peshawar, Pakistan.

Sajjad Hussain
Department of Entomology, The University of Agriculture, Peshawar, Pakistan.

Bismillah Shah
Department of Entomology, The University of Agriculture, Peshawar, Pakistan.

Syed Ruidar Ali Shah
Entomology Section, Agriculture Research Institute Tarnab-Peshawar, Pakistan.

Correspondence:
Imtiaz Ali Khan
Department of Entomology, The University of Agriculture, Peshawar, Pakistan.

Efficacy of insecticides against insect pests of maize crop and its influence on natural enemy in Peshawar

Imtiaz Ali Khan, Muhammad Nawaz Khan, Rasheed Akbar, Muhammad Saeed, Abid Farid, Ijaz Ali, Mukhtar Alam, Komal Habib, Walija Fayaz, Sajjad Hussain, Bismillah Shah, Syed Ruidar Ali Shah

Abstract
Insect pests pose heavy threat to maize crop each year in Peshawar-Pakistan. In the present study efficacy of five insecticides, i.e. Acetamiprid 20 SP, Alpha cypermethrin 5 EC, Mixture 80 EC, Perfection 40 EC and DDVP 50 EC were tested in maize field against maize stem borer (*Chilo partellus* Swinhoe), grasshopper **(***Melanoplus differentialis* Thomas), flea beetle (*Chaetocnema pulicaria* Ashmead) and its influence on Ladybird beetle (*Coccinella septempunctata* Linnaeus) was determined during 2009. The results revealed that all the insecticides were effective in reducing pest's population but also adversely affected the natural enemy population. Mixture yielded lowest density of *C. partellus* (1.22 infested plants/10 plants), *M. differentialis* (0.44 individuals/10 plants) and *C. pulicaria* (0.33 beetles/leaf) among the treatments. All the insecticides had adverse effect on population of *C. septempunctata*. Mean density of *C. septempunctata* in Mixture (0.44 beetles/plant) was the lowest among the treatments. In the untreated control mean density of the pests and natural enemy was higher than all the treatments. The yield of maize obtained from Mixture treatment was highest (2.71 ton/ha) than all the other treatments and control. The present results might help in better control of insect pests of maize, mainly using its natural enemies.

Keywords: Insecticides, Insect pests, Maize, Natural enemy

1. Introduction
Maize stem borers, aphids, grasshopper, weevil, flea beetle and shoot fly have significant role in reducing maize yield in Peshawar Valley, Pakistan. The infestation of these insect pests of maize gradually started in July and reached to maximum densities in August to September. The pest disappeared in second week of October (before crop maturity stage) [1].
Insecticides have been mostly used to control insect pests of maize, however, these pesticides also kill their natural enemies. Thus, population of insect pests increase and 43.3% yield loss occur due to killing of natural enemies [2]. Thus, there is need of using more efficient insecticides against the pests and safe alternatives to insecticidal control for saving the natural enemies. The use of natural pesticides are good alternative to control insect pests of maize as they have little side effect on their natural enemies of those insect pests [3].
Keeping in view the importance of maize crop in the economy of Khyber Pakhtunkhwa and the economic losses caused by the different insect pests, the present study aimed to find efficacy of five insecticides against the maize stem borer *Chilo partellus*, grasshopper *Melanoplus differentialis* and flea beetle *Chaetocnema pulicaria* on maize crop and its influence on Ladybird beetle *Coccinella septempunctata*.

2. Materials and Methods
In the present research efficacy of five different insecticides was tested against insect pests of maize and its influence on natural enemies was determined. The experiment was conducted at the Research Farm of Khyber Pakhtunkhwa Agricultural University Peshawar. Cultivar Azam (*Zea mays var. Azam*) was sown in the first week of June, 2009 as Randomized Complete Block (RCB) design with three replications. The plot size was kept at 8x6 m^2. Row to row and plant to plant distance was kept at 75cm and 15cm, respectively. There were ten rows per plot. Standard agronomic practices such as irrigation, fertilization and hoeing were given to the crop throughout the growing season.

Maize stem borer damage was recorded by counting the infested plants (shot holes, fresh faeces and dead hearts) on ten randomly selected plants in each treatment and control in the month of July.

Population of grasshopper and Ladybird beetle were recorded on ten randomly selected plants while of flea beetle on ten randomly selected leaves in each treatment and control. The post treatment data of population of the grasshopper and beetle were recorded on maize after 24h, 48h and 72h. The grain yield data were taken after threshing the cobs from each treatment and control.

The insecticides were applied twice in August at 15 days intervals using knapsack sprayer. In control blank spray was done. The insecticides applied against insect pests of maize are listed in Table I.

Table 1: List of insecticides tested in the experiment on maize during 2009.

Treatment	Trade name	Common name	Field solution
T1	Acetamiprid 20% SP	Acetamiprid	3%
T2	Simba 5% EC	Alpha cypermethrin	3%
T3	Mixture 80% EC*	Alpha+chloro+DDVP	5%
T4	Perfection 40% EC	Dimethoate	3%
T5	DDVP 50% EC	DDVP	4%
T6	Control		

*Mixture is a commercially available product.

2.2 Statistical analysis

The data recorded after two applications of insecticides were averaged and statistically analyzed by using ANOVA and means were separated by using Fisher protected LSD [4].

3. Results and Discussion

3.1 Effect of insecticides on insect pests of maize

3.1.1 *C. partellus*

All the insecticides were effective in reducing *C. partellus* infestation (Table 2). Mean number of *C. partellus* infested plants one day after treatment were significantly lower in plots treated with Alpha cypermethrin (2.0 infested plants/10 plants), Mixture (2.0 infested plants/10 plants) and Perfection (1.67 infested plants/10 plants). Mean number of *C. partellus* infested plants were significantly lower among treatments in Mixture two day (1.0 infested plants/10 plants) and three days (0.67 infested plants/10 plants) after treatment. No significant difference was found in the overall mean number of pest infested plants among the treatments. In untreated control mean number of the pest infested plants remained significantly higher than all the treatments. Earlier researcher have also reported efficacy of insecticides against maize stem borer in maize. Efficacy of five insecticides, i.e. Azodrin 400 EC, Cyperkill, Magnum SI 525, Lorsban 40 EC, Talstar 10 EC and Thiodan 35 EC was determined against maize stem borer. All the insecticides significantly reduced the insect pests infestation compared to the untreated control [5]. Infestation of *C. partellus* was greatly reduced in maize crop by the application of insecticides [6].

Table 2: Mean number of *Chilo partellus* infested plants/10 plants after insecticidal application on maize crop during 2009.

Treatment	Post Spray Interval			Overall mean
	24h	48h	72h	
Acetamiprid	3.00 b	1.67 bc	1.33 bc	2.00 b
Alpha Cypermethrin	2.00 c	2.00 b	1.67 b	1.89 b
Mixture	2.00 c	1.00 c	0.67 c	1.22 b
Perfection	1.67 c	1.67 bc	1.00 bc	1.44 b
DDVP	3.00 b	1.67 bc	1.33 bc	2.00 b
Control	4.33 a	4.00 a	4.33 a	4.22 a

Means in columns followed by different letters are significantly different at 5% level of significance using Fisher protected LSD.

3.1.2 *M. differentialis*

All the five insecticides had effectively reduced *M. differentialis* on maize (Table 3). Mean number of *M. differentialis* infested plants/10 plants were significantly lower in Mixture (1.00 infested plants/10 plants) and Alpha Cypermethrin (1.33 infested plants/10 plants) one day after chemical treatment. It was significantly lower in Mixture (0.33 infested plants/10 plants) and Perfection (1.00 infested plants/10 plants) two days after treatment. No pest infested plants were recorded in Mixture three days after chemical application. Overall mean number of infested plants were lowest in Mixture (0.44 infested plants/10 plants) than the other treatments. In control the mean number of pest infested plants were significantly higher than all the treatments. Some earlier researcher had also reported high efficacy of different insecticides against grasshopper on maize. Malathion was found most effective in controlling *M. differentialis* on maize [7]. Insecticides gave better protection from *M. differentialis* in maize field [8]. Efficacy of formulated insecticides, i.e. carbaryl, diflubenzuron and Malathion was tested against grasshopper. The insecticides markedly reduced the grasshopper population as compared to control [9]. Efficacy of cyhalothrin, a widely used pyrethroid insecticide with combination of other insecticides to control grasshopper was determined. The results found that cyhalothrin was effective insecticide with less infestation of grasshopper in treated plots as compared to control [10].

Table 3: Mean number of *M. differentialis* infested per 10 plants after insecticidal application on maize crop during 2009.

Treatment	Post-spray interval			Overall Mean
	24h	48h	72h	
Acetamiprid	4.67 b	3.00 bc	1.00 b	2.89 bc
Alpha Cypermethrin	1.33 c	1.67 bc	1.33 b	1.44 de
Mixture	1.00 c	0.33 c	0.00 c	0.44 e
Perfection	3.67 bc	1.00 c	0.67 b	1.78 cd
DDVP	4.67 b	4.33b	2.00 b	3.67 b
Control	10.33 a	9.33 a	9.00 a	9.56 a

Means in columns followed by different letters are significantly different at 5% level of significance using Fisher protected LSD.

3.1.3 *C. pulicaria*

All the five insecticides had significantly reduced *C. pulicaria* than control but there were found number significant differences in mean number beetles/leaf among the treatments (Table 4). Generally, pest density remained lower in Mixture treatment. The three day over all mean number beetles/leaf was significantly lower in Mixture (0.33 beetles/leaf) and Perfection (0.44 beetles/leaf). Density of the pest remained significantly higher in control than the treatments. Efficacy of lambda-cyhalothrin and carbofuran insecticides to control *C.*

pulicaria was studied. All the insecticides reduced the population of *C. pulicaria* as compared to control [11]. The present results are in agreement with the finding of some earlier researchers. Population of *C. pulicaria* was greatly decreased by insecticides application [12]. Efficacy of different systemic insecticides (imidacloprid thiamethoxam and chlorpyrifos) was evaluated for control of the flea beetle. Insecticides provided a high level of flea beetle control as compared to check [13]. Effect of four insecticides, i.e. SpinTor (spinosad), BotaniGard (*Beauveria bassiana*), Neemix (azadirachtin) and Surround (kaolin) was tested against flea beetle in maize crop. The pest population was significantly reduced in treated plots [14].

Table 4: Mean number of *C. pulicaria*/leaf after insecticidal application on maize crop during 2009.

Treatment	Post-Spray Interval			Overall Mean
	24h	48h	72h	
Acetamiprid	1.33 b	1.00 b	0.66 b	1.00 bc
Alpha Cypermethrin	1.00 b	0.67b	0.66 b	0.78 bc
Mixture	0.33 b	0.33 b	0.33 b	0.33 c
Perfection	0.67 b	0.33 b	0.33 b	0.44 c
DDVP	1.67 b	1.33 b	1.00 b	1.33 b
Control	3.33 a	3.66 a	3.67 a	3.56 a

Means in columns followed by different letters are significantly different at 5% level of significance using Fisher protected LSD.

3.1.4 Influence of insecticides on natural enemy *C. septempunctata*

Mixture (1.00 beetles/plant) and Acetamiprid (1.00 beetles/plant) had significantly reduced *C. septempunctata* density on maize plants one day after treatment (Table 5). Density of the beetle was significantly lower in Acetamiprid (1.00 beetles/plant), Mixture (0.33 beetles/plant) and Perfection (1.00 beetles/plant) two days after chemical application. There were found no significant difference among the treatments regarding insecticides effect on *C. septempunctata* three days after treatment. The three days over all mean number of beetles/plant were significantly lower in Mixture (0.44 beetles/plant) than the other treatments. Density of the beetle remained significantly higher in control than the treatments 48 and 72 hrs after treatment.

Table 5: Mean population reduction of *Coccinella septempunctata*/plant after insecticidal application on maize crop during 2009.

Treatment	Post-Spray Interval			Overall Mean
	24h	48h	72h	
Acetamiprid	1.00 b	1.00 bc	0.67 b	0.89 cd
Alpha Cypermethrin	2.33 a	1.33 b	0.67 b	1.45 bc
Mixture	1.00 b	0.33 c	0.00 b	0.44 d
Perfection	2.33 a	1.00 bc	0.33 b	1.22 bc
DDVP	2.67 a	1.67 b	1.00 b	1.78 b
Control	3.33 a	3.00 a	3.33 a	3.11 a

Means in columns followed by different letters are significantly different at 5% level of significance using Fisher protected LSD.

Adverse effects of insecticides on natural enemies such as *C. septempunctata* in maize crop have also been reported by some earlier researchers [15, 16]. Effect of insecticide (Permethrin) against insect pests and its adverse effect on predators (Ladybird beetles) was studied under field conditions. However they observed that insecticide (Permethrin) applications significantly and consistently decreased the abundance of Ladybird beetles, green lacewings, and damsel bugs compared with untreated plots [17]. Five insecticides, i.e. pyriproxyfen, imidacloprid, deltamethrin + heptenophos, lambda-cyhalothrin and *Bacillus thuringiensis* were examined for their acute detrimental side-effects at field rates on adult Ladybird beetle. They evaluated that pyriproxyfen, imidacloprid and *B. thuringiensis* were safe for Ladybird beetles adults but the other two preparations deltamethrin + heptenophos, lambda-cyhalothrin were moderately harmful to them [18].

Toxicity of pirimicarb, imidacloprid, dimethoate, lambda-cyhalothrin, flonicamid and spinosad to Ladybird beetle was studied. Pirimicarb was harmless to the predator but having some residual toxicity at high concentrations to both larval and adult stages. Imidacloprid was highly toxic to the larval stage by residual and ingestion exposure but caused very low adult mortality. Dimethoate and lambda-cyhalothrin were highly toxic to both the larval and adult stages of the Ladybird [19].

3.1.5 Yield (Ton/ha) of maize

Table 6 shows yield data of treated and control plots. Highest yield of maize was obtained from plots treated with Mixture (2.71 ton/ha), Alpha Cypermethrin (2.39 ton/ha) and Perfection (2.53 ton/ha). In control maize yield was lowest with 1.81 ton/ha. The present results are in agreement with those of some earlier researchers. Efficacy of five insecticides, i.e. Azodrin 400 EC, Cyperkill, Magnum SI 525, Lorsban 40 EC, Talstar 10 EC and Thiodan 35 EC against maize stem borer was tested. According to them the yield of maize was non-significantly different in the treated and untreated plots [5]. Efficacy of different systemic insecticides imidacloprid thiamethoxam and chlorpyrifos for control of the flea beetle was determined. Insecticides provided a high level of flea beetle control as compared to check. The highest yield was obtained from imidacloprid and thiamethoxam treated plots than chlorpyrifos treated plots [13].

Table 6: Mean grain yield (ton/ha) of maize after application of the insecticides against insect pests during 2009.

Treatment	Yield (ton/ha)
Acetamiprid	2.22 bc
Alpha Cypermethrin	2.39 abc
Mixture	2.71 a
Perfection	2.53 ab
DDVP	2.11 cd
Control	1.81 d

Means in columns followed by different letters are significantly different at 5% level of significance using Fisher protected LSD.

4. Conclusion

Population of *C. partellus*, *M. differentialis* and *C. pulicaria* were significantly reduced by application of insecticides but *C. septempunctata* population was also greatly affected by the chemicals. Mixture was found the most effective insecticides having less population of all the pests but it also greatly reduced population of the natural enemy. Yield of grain maize was highest in Mixture treatment and lowest in control. Use of mixture may work better against *C. partellus*, *M. differentialis* and *C. pulicaria* on maize in the absence or low population of natural enemies.

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