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Population density and percent parasitism of natural enemies of pea pests on seven pea (*Pisumsativum* L.) (Fabales: Fabaceae) varieties in Peshawar

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Abstract
Pea is attacked by many insect pests in Pakistan. For efficient control of insect pests of pea crop, population density of pests and its natural enemies is important. The present research project was carried out at the New Developmental Farm (NDF) of The University of Agriculture, Peshawar (UAP) during 2013-14. Seven pea varieties, i.e. Climax (New Zealand NTL), Classic, Leader, Azad P-1, PF-400, Meteor and Peshawar Local (Check) were tested. The results revealed that mean density of Lady bird beetles was non-significantly different among the cultivars, where it was higher on Meteor (4.96 m^{-1}) and lower on Climax (4.22 m^{-1}). Mean density of syrphid flies was non-significantly different among the treatments, whereas it was higher on Climax (7.33 m^{-1}) and lower on Azad P-1 (5.83 m^{-1}). Its density was significantly higher during week 2 (8.62 m^{-1}). Parasitism rate of pea leaf miner parasitoids was higher on Peshawar local (36.29%) and lower on Climax (28.25%). The highest percent parasitism was recorded during week 5 (62.99%). Parasitoids emergence from pea aphids was maximum (80%) from Classic and minimum from Peshawar Local (36.67%). Density and parastitism rate of natural enemies of pea pests was not dependent on pea varieties and weeks, however, the present results will encourage use of natural enemies to overcome the hazards of insecticides and resurgence of pea pests.

Keywords: Natural enemies, Parasitism, Parasitoids, Pea cultivars.

1. Introduction
Pisum sativum is cultivated as winter crop all over the world and is utilized as nutritious vegetable. It contributes to about 40% of total trading in pulses [1]. Cooked green peas are a rich source of proteins. One pound of green peas containing 13.7 g protein, 8 g fat, 36.2 g carbohydrates, 45.1 mg calcium, 29 mg phosphorus and 54 mg ascorbic acid [2]. World widely peas are grown on an area of 528.71 thousands hectares and rank fourth in the production (441.53 thousand tons) among grains legume after soybean, ground and beans [3]. It is grown in many tropical and subtropical countries including Burma, India, Ethiopia, Morocco, Columbia, Ecuador, Peru and Pakistan [1]. Over the last decade, Canada has been the leading producing country of peas in the world [4]. In Pakistan, more than 100,000 hectares is under cultivation, yielding less than1000 kilograms ha^{-1} [2].
Regardless of large number of cultivars in the field, pea yield per unit in Pakistan is still lower than international standard. There are several factors responsible for it, among which poor cultural practices, low weed control and high insect pests and disease attack are important ones. Among insect pests of pea, pea leaf miner (*Phytomyza horticola* Goureau (Diptera: Agromyzidae) is a serious hold back in cultivation of pea causing 90% damage to the pea crop by mining young leaves which leads to stunting and low flower production [1]. Pea aphid infestation causes severe economic losses in pea crop- by reducing crop yield and contamination of crop for processing or fresh market. Plants representing Fabaceae serve as main host for aphid pea that includes field pea, alfalfa and clovers [5].
Biological control utilizing parasitoids and predators that occurring naturally in the environment may have considerable influence on regulation of aphid population [6], but biological control requires more and unpredictable time.
Keeping in view the importance of pea, assessing its higher production the importance of biological control agents of pea leaf miner and pea aphids the main pea pests, different pea varieties were tested to evaluate occurrence of biological control agents on it.

2. Materials and Methods

2.1 Field layout

The present research was conducted at the NDF of the UAP during 2013-14. The experiments consisted of seven treatments, i.e. Climax (New Zealand NTL), Classic, Leader, Azad P-1, PF-400, Meteor and Peshawar Local (Check). Each treatment was measuring 16 m^2 and replicated three times. Plant to plant and row to row distance was kept at 10 cm and 65 cm, respectively. Standard agronomic practices were applied in the field throughout the pea growing season. The field was left open for natural infestation of insect pests and its natural enemies. Data was recorded on natural enemies, i.e. predators and parasitoids of pea leaf miner and aphids at weekly intervals.

2.2 Insect Predators

2.2.1 Ladybird beetle, *Coccinella septempunctata* L.

C. septermpunctata population was recorded in $1m^2$ area in each treatment. Number of both larvae and adult beetles were counted. The data was converted into means of larvae and adults.

2.2.2 Syrphid Fly, *Episyrphus balteatus* DeGeer

Larvae and adults of *E. balteatus* were weekly recorded in each treatment. Larvae were recorded on aphid pests, while adults on flowers. A single observation for adult syrphid flies was taken for five minutes in 1 sq. m. *E. balteatus* was identified by using standard keys [7] and according to the Biosystematics Database of the World Diptera [8].

2.3 Insect Parasites

2.3.1 Parasite of Pea leaf miner, *Opius sp.*

Leaf miner larvae were brought to the Research Laboratory of the Department of Entomology along with pea leaves for rearing. Leaves were placed in glass vials. Parasitoids emerged from these larvae were collected and recorded their number. Adult parasites were obtained by caging the host leaves containing immature stage of the pest. Larva-pupal endoparasite was determined by the scar on the host pupa. The dead larvae due to host-feeding were clear and their contents were extruded by female parasites. The total number of collected larvae was divided by the parasite infested larvae to determine the percent parasitism. The parasite was identified using standard keys [9, 10].

2.3.2 Pea Aphid Parasitoid, *Aphidius colemani* Viereck.

(Braconidae: Aphidiinae)

Aphid mummies were weekly collected from each treatment and were brought to the laboratory for parasitoids emergence. They were kept at 27±2 ºC temperature and 70±5% relative humidity. The parasitoids were collected after their emergence and card pointed for identification. Percent parasitism rate for the parasitoids were calculated. Parasitoid specimens were air dried, mounted on points, and identified to genus by the available literature [11, 12] and courtesy taxonomists in the Dept. of Entomology. The dead larvae due to host-feeding were clear and their contents were extruded by female parasites.

2.4 Statistical analysis

The data recorded for each parameter was analyzed statically by using Statistix 8.1 software and means were separated by using Fisher Protected Least Significance Difference Test at 5% level of significance [13].

3. Results and Discussion

3.1 Insect Predators

3.1.1 *C. septermpunctata*

The results revealed that mean density of the *C. septermpunctata* was non-significantly different among the cultivars (Table 1). However significant differences were recorded in beetle density during different weeks. Interaction of time and varieties was also statistically significant. Mean higher density of *C. septermpunctata* was recorded on Meteor (4.96) and lower on Climax (4.22). Their density was significantly higher during week 3 (6.10) and lower during week 1 (3.19).

Interaction of time and varieties related the density of predatory *C. septermpunctata* showed that higher density was observed during week 3 on Azad P-1 which was 7.00 beetles and lower during week 1 on Climax which was 2.33 beetles.

Density of the *C. septermpunctata* was lower during the first weeks. It slightly increased during the middle of the season. It decreased again during the final weeks of the cropping season. It was not examined the beetles density increased with the density of aphids and vice versa. It showed the effect of predation on its host (aphids). A direct linkage between prey abundance and *C. septermpunctata* density in the field was observed but it was influenced by chemical application [14]. Ladybird beetle as a natural enemy of aphids is one of the most important factors in contribution to the aphid population reduction [15]. Initially low population of Ladybird beetle was recorded but it peaked during 4th week and then declined later on [16].

Table 1: Mean weekly density of *C. septermpunctata* m^{-1} area on seven pea varieties during 2014.

Variety	Mean density of *C. septermpunctata* m^{-1} in week									Overall Mean
	1	2	3	4	5	6	7	8	9	
Climax	2.33h	3.00fgh	5.67a-e	4.33b-h	5.67a-e	4.67a-h	4.67a-h	4.00c-h	3.67d-h	4.22
Classic	3.33efgh	3.00fgh	6.67ab	5.33a-f	6.67ab	5.00a-g	4.67a-h	4.33b-h	4.67a-h	4.85
Leader	3.33efgh	3.67d-h	6.00abcd	4.67a-h	5.67a-e	5.00a-g	4.67a-h	4.67a-h	5.00a-g	4.74
Azad P-1	3.00fgh	3.00fgh	7.00a	5.00a-g	5.33a-f	5.00a-g	4.67a-h	4.00c-h	4.00c-h	4.56
PF-400	3.67d-h	2.67gh	4.67a-h	4.67a-h	6.00abcd	5.33a-f	5.00a-g	4.33b-h	4.67a-h	4.56
Meteor	3.00fgh	4.33b-h	6.33abc	5.33a-f	5.67a-e	5.67a-e	4.00c-h	5.00a-g	5.33a-f	4.96
Peshawar Local	3.67d-h	3.67d-h	6.33abc	5.67a-e	5.00a-g	5.33a-f	4.33b-h	4.67a-h	4.00	4.37
Mean	3.19d	3.33d	6.10a	5.00bc	5.71ab	5.14bc	4.10c	4.43c	4.48c	ns

Means in columns and rows followed by different letters are significantly different at 5% level of significance (LSD test).

ns = Non-significant
LSD value for varieties = 0.8037
LSD value for weeks = 0.9113
LSD value for interaction = 2.411

3.1.2 *Prosopis juliflora*

Density of *P. juliflora* was non-significant different on pea cultivars, however it was statistically significant during different weeks (Table 2). The data also revealed significant difference for the interaction of time and varieties. Mean

higher density of *P. juliflora* was counted on Climax (7.33) and lower on Azad P-1 (5.83). Significantly higher density of *P. juliflora* was recorded during week 2 (8.62) and lower during week 4 (3.48).

Interaction of time and varieties for the density of *P. juliflora* showed that higher density was recorded during week 2 on Leader (11.33) and lower during week 4 on PF-400 (2.00).

Table 2: Mean weekly density of *Prosopis juliflora* m^{-1} area on seven pea varieties during 2013-14.

Variety	Mean no. of *P. juliflora* m^{-1} in week				Overall Mean
	1	2	3	4	
Climax	8.33bc	8.67abc	8.33bc	4.00fghi	7.33
Classic	7.33cd	7.33cd	8.33bc	3.67ghi	6.67
Leader	5.00d-h	11.33a	8.33bc	3.33hi	7.00
Azad P-1	5.00d-h	6.00c-h	8.67abc	3.67ghi	5.83
PF-400	6.33cdef	8.33bc	7.33cd	2.00i	6.00
Meteor	4.33e-i	11.00ab	6.67cdef	4.00fghi	6.50
Peshawar Local	7.00cde	7.67cd	7.00cde	3.67ghi	6.33
LSD Test	6.19b	8.62a	7.81a	3.48c	ns

Means in columns and rows followed by different letters are significantly different at 5% level of significance (LSD-test).

ns = Non-significant
LSD value for varieties = 1.3664
LSD value for time intervals = 1.0329
LSD value for interaction = 2.7328

The Syrphid fly density was non-significantly different on the seven pea cultivars. Density of the fly was significantly different during weeks. The decrease in density, with the passage of time may be due to absence of aphids as well as flowers in the plants. A positive relationship between the amount of available floral resources and abundance of syrphid fly species along the flowering weeks was recorded [17]. Our results are in accordance with the study of [18]. They had reported that increase in population of syrphid fly occurred and highest density was recorded in the 3rd week of March. They also noticed gradual decline in the fly population in the 4th week of March and 1st week of April.

3.2 Parasitoids

3.2.1 Parasitism in pea leaf miner by *Opius sp.*

Parasitism rate of pea leaf miner by its parasitoids was higher on Peshawar local (36.29%) though out the season and lower on Climax (28.25%) (Table 3). Regarding time intervals, the highest percent parasitism was recorded during week 5 (62.99%) and lowest parasitism during 1st week (8.69%).

Table 3: Mean weekly parasitism (%) by *Opius sp.* parasitoids of pea leaf miner on pea varieties during 2013-14.

Variety	Parasitism (%) of *Opius sp.* in week							Overall Mean (%)
	1	2	3	4	5	6	7	
Climax	10.15	14.82	26.72	33.76	55.61	35.17	21.52	28.25
Classic	6.85	16.13	27.42	43.10	65.99	40.00	24.73	32.02
Leader	12.90	20.24	22.90	42.41	60.53	46.71	19.32	32.14
Azad P-1	6.74	19.64	28.68	53.01	61.54	42.86	26.67	34.16
PF-400	6.10	19.05	27.05	48.05	69.86	42.76	22.99	33.69
Meteor	9.90	20.17	28.19	51.23	59.92	44.51	27.50	34.49
Pesh. Local	8.16	22.73	29.85	54.51	67.59	49.11	22.09	36.29

It is clear from the results that parasitism of pea leaf miner by its parasitoids was lower in the start of the infestation of leaf miner on pea crop. It gradually increased in the middle of the season but again decreased in final weeks. The increase and decrease with time occurred with the population of pea leaf miner (host) fluctuations. Our results are in agreement with that of [19] who reported that parasitization of pea leaf miner was on the peak during the 9th standard week (Feb 26–Mar 04) in the year 2010-2011, which resulted in maximum of 71.68% parasitization.

3.2.2 Parasitism of Pea aphids by *Aphidius colemani*

Maximum number (80%) of *A. colemani* were recorded from aphids mummies collected from the Classic and minimum (36.67%) from Peshawar Local (Fig. 1).

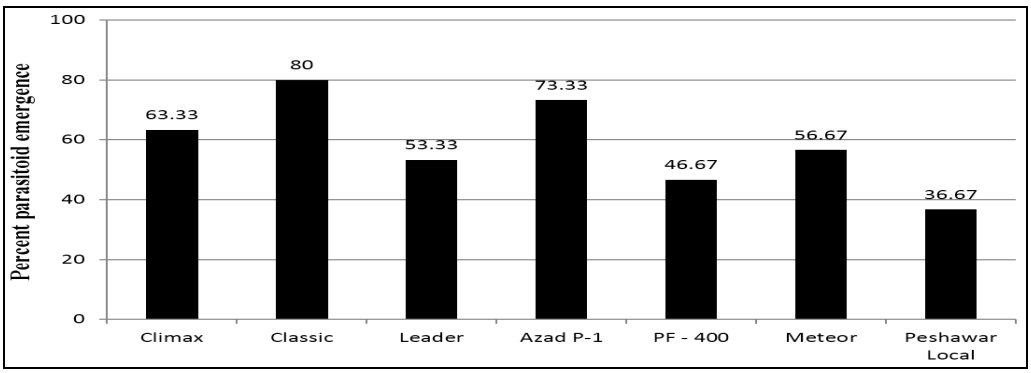

Fig 1: Emergence (%) of *A. colemani* from pea aphid on seven pea varieties during 2013-14.

Parasitoids emergence varied from the collected mummies of different pea varieties. The differences in the resistance of the aphids on different varieties of pea to parasitism rate suggested that selection for parasitoids to overcome pea aphid resistance may be consistently stronger among different varieties of pea. The possible evolutionary response in difference in resistance may be due to the genetic variation within the population of the parasitoid *Aphidius ervi*. Research on aphids and their parasitoid in selected vegetables ecosystems confirmed the occurrence of 18 aphid species; among them 14 species were parasitized [20]. Pea aphids specialized on alfalfa are physiologically more resistant to parasitism by *Aphidius ervi* than pea aphids specialized on clover [21].

4. Conclusion

The present research yielded contradictory findings to those already reported. We had found no specific effect of different varieties of pea on the population dynamics of natural enemies of pea pests rather it was depending on its host's (prey) density. The differences might be due to the fact that different pea varieties, variations in climatic, edaphic and topographic conditions, etc. were tested in the present and earlier research projects.

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