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Investigations on Interaction between Insect Pests and Predators of Cauliflower

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Abstract: *The present study was conducted on investigations on interaction between insect pests and predators of cauliflower in the field of Tajpur, Tando Allahyar, during winter season of 2013. Homogenous seedlings of cauliflower were planted in a Randomized Complete Block Design with three replicates plots. The results revealed that four insect pests i.e., whiteflies, thrips, aphids and cutworms were found infesting cauliflower, however, the population of insect pests was significantly different between the dates of observation. Similarly three predator species i.e., zigzag beetles, 7- spotted beetles and 11- spotted beetles were recorded preying on insect pests of cauliflower, the differences in the population of predators among the observation dates was highly significant. It was observed that the population of thrip was maximum (36.21 ± 3.92/leaf) and whiteflies (26.48± 2.20/leaf) on 2nd March, 2013 while aphids reached to its peak (45.30± 1.00/leaf) on 23rd, February, 2013 and cutworms (8.38± 1.55) on 9th March, 2013. The predator zigzag beetles reached to their peak population (2.46 ± 0.31/leaf) on 2nd February, 2013.While 7-spotted beetles (3.15 ± 0.05/leaf) and 11- spotted beetles (2.00 ± 0.23/leaf) reached to their peak on 9th February, 2013. The correlations among the predators such as zigzag beetle,7- spotted beetle and 11- spotted beetle, were non-significant positively associated with white fly (r =0.281 NS), (r = 0.231NS), (r = 0.138 NS), aphids (r =0.235 NS), (r =0.147NS), (r = 0.274 NS) and thrip (r =0.171 NS), (r =0.181NS), (r = 0.067 NS) respectively..*

Keywords: Investigation on interaction between Insect Pest and Predator

INTRODUCTION

Cauliflower, *Brassica oleracea* belongs to family Brassicaceae is a cool-season crop. While it is closely related to broccoli and cabbage, cauliflower is more exacting in its environmental requirements than these other cole crops. Cauliflower is very sensitive to unusually hot weather and drought. It is a very delicious vegetable, which is being cultivated in overall Pakistan. Total area of Cauliflowers and broccoli about 13103 hectors and total production about 227591 tones in Pakistan during 2011-2012. (FAOSTAT-2013)

Cauliflower is one of the important vegetable crops in the world. It contains most of the minerals and vitamins necessary for human diet. The 100gm edible portion of cauliflower contains 90.8gm moisture, 25-30gm calories, 5gm carbohydrates, 2gm dietary fiber and protein,

20mg magnesium, 33mg calcium, 113mg potassium, 53mg sodium, 19mg oxalic acid, 51 IU vitamin-A and 6 IU vitamin-C beside other nutrient elements. It grows best in cool, fairly moist climates, so the foggy coastal climates are considered as prime growing areas (Steven *et al.* 2000). In Pakistan cauliflower is cultivated on an area of about 11.350 thousand hectares with annual production of 206.385 thousand tones (Anonymous, 2009). Cauliflower is the attacked by as many as 24 insect pest species which cause serious economic loss to the crop Devjan and Singh (2002). Among the different insect pests, sucking insect pests are the devastators, aphid, *Aphis gossypii*, jassid, A*mrasca bigutella bigutella*, whitefly, *Bemisia tabaci* and thrip, T*hrips tabaci*, diamond back moth and cut worms are the serious pests in the local condition. These insect pests damaged the crop resulting poor growth of plant and loss of yield (Luckmann and Metcalf, 1994).

The predators are major and successful biological control agents of aphids, mealy bugs, scale insects, thrip, and mites (Khan and Naeem, 2005). Some are specific in their choice of food, many are polyphagous/generalists. Introduction of these predators as bio control agents is widely regarded as the first and still to this day one of the most spectacularly successful instances of biological pest control (Khan and Naeem, 2005). A challenge for ecologists and entomologists is to find out how to use natural enemy communities in a way that the positive interactions between the natural enemies and insect pests are maximized. Interactions have been investigated and the outcome varied;

when a specialist parasitoid wasp (*Aphidius ervi*) interacted with a generalist predator, the carbide beetle *Pterostichus melanarius*, attacking aphids, the carbide primarily acted as an intrigued predator and interrupted aphid population control by the parasitoid (Snyder and Ives, 2001). But generalists can also sometimes maintain pests at a new low level once their numbers have been suppressed by introduced parasitoids (Symondson *et al.*, 2002).

The present study on the response or interaction insect pest and predators was carried out in the field at Tajpur, Tando Allahyar. The aim of present study is to collect data about interaction of sucking insect pests and predators on cauliflower for a more precise estimation of its abundance in order to construct suitable bio-control programmes.

REVIEW OF LITERATURE

Wright et *al.* (1960) determined the importance of beetle predators on the natural control of cabbage root fly, experiments were carried out in 1958 and 1959 using various types of barriers to obtain different levels of beetle populations on cauliflower plots. A barrier of DDT-treated straw, placed in the soil around some plots, decreased the numbers of beetles within them and allowed a greater number of eggs and larvae of cabbage root fly to survive than on the untreated plots, resulting in greater crop damage. Another type of barrier allowed the beetles to enter plots but made it difficult for them to leave. On these, fewer cabbage root-fly eggs and larvae survived and the crop damage was much less than on the plots surrounded by straw barriers. Where plants were treated with insecticide the root-fly population was reduced to a minimum and crop yields were considerably increased. The insecticide, however, caused a reduction in the numbers of predatory beetles.

Theunissen *et al.* (1995) studied during two consecutive years, the effects of intercropping fresh market white cabbage with two species of clover on pest populations and yield. White cabbage cv. Minicole was intercropped with *Trifolium repens* (white clover) and *Trifolium subterraneum* (subterranean clover) as compared to the monocrop. During the season observations were made on pest population developments, especially of *Mamestra brassicae* L. (cabbage moth), *Brevicoryne brassicae* L. (cabbage aphid), *Delia brassicae* L. (cabbage root fly), and evaluation of caterpillar feeding injury. At harvest the yield in quantity and quality was determined to be able to assess the gross financial result. Intercropping effects in terms of suppression of oviposition and larval populations of various pests were found. Although no pesticides were used and competition reduced the weight, the quality of the intercropped cabbages lead to a better financial result compared to the monocropped cabbage crop. The results are discussed in the perspective of the practical implications in the context of IPM.

Banks (1999) observed that the Using alternating patches of weeds and crop [broccoli, *Brassica oleracea* (L.), vegetation composition and the spatial scale at which the vegetation was fragmented were manipulated in a factorial design field experiment. The effects of these manipulations were different for two common agro ecosystem predators sampled. Seven spotted lady beetles, *Coccinella septempunctata* (L.), were unaffected by vegetation-composition treatments but responded strongly to fragmentation-scale manipulations. The beetle *Pterostichus melanarius* (Illiger) was unaffected by both fragmentation-scale and vegetation-composition manipulations. These findings highlight the challenge of developing a predictive theory of the effects of vegetation diversification on assemblages of predators in agro ecosystems.

Latif *et al.* (1999) studied that cauliflower was transplanted on eight different dates starting from 15th September to 30th December, at a fortnight interval during 1990 and 1992, at Faisalabad, to monitor the impact of sowing time on the intensity of aphid infestation and crop yield. A definite pattern of aphid incidence in relation to different dates was found. With delay in transplanting, aphid density gradually increased and the crop yield decreased. Transplanting made in September and October remained practically free of aphid while, that sown in November and December were progressively more severely damaged by the pest during both the years. High head yield (141.95 and 285.32 q/ha.) was obtained in crop transplanted on October 15, during both the years. Transplanting made after this date, reduced the yield drastically and no head could be recovered in the month of December during both the years. The regression equations indicated that one day delay in transplanting the crop, resulted in an increase of 5.84 aphids / leaf in 1990-91 and 1.18 / leaf in 1992-93 whereas, the decrease in head yield was 1.37 and 2.47 q/ha. in the respective years.

Schmaedick (1999) observed that the Knowledge of factors causing mortality in herbivorous insects is essential to developing a better understanding of their population dynamics and more effective strategies to manage their abundance in crops. In this study we used 2 methods of predator exclusion to evaluate the effects of arthropod predators on *Pieris rapae* L. eggs and larvae on cabbages (*Brassica oleracea* variety capitata L.) in New York State. Survivorship of *P. rapae* on cabbage plants caged to exclude predators was compared with survivorship on plants in cages that were opened at the bottom to allow access by arthropod predators but not larger predators such as birds. Two cohorts were followed in each of 2 unsprayed cabbage plots in each of 2 yr for a total of 8 cohorts. Estimated mortality of eggs and larvae from arthropod predators ranged from 23 to 80%,

averaged 53% for all 8 cohorts, and affected mainly the eggs and 1st instars. Exclusion experiments were also conducted comparing mortality of individual *P. rapae* eggs protected from predators by rings of Tanglefoot with that of eggs that were left exposed to predators. Mortality attributed to arthropod predators for the entire egg stage among 6 cohorts placed in each of 2 fields ranged from 0 to 44%. Our experiments demonstrate that *P. rapae* eggs and 1st instars suffer variable, but often quite high mortality from arthropod predators in cabbage fields. Recognizing the important role of these predators is a 1st step toward developing ways to maximize their activity in commercial fields.

Halaj and Wise (2001) examined that the more consensus is now emerging on the magnitude and frequency of cascading trophic effects in aquatic communities, the debate over their terrestrial counterparts continues. We used meta-analysis to analyze field experiments on trophic cascades in terrestrial arthropod-dominated food webs to evaluate the overall magnitude of trophic cascades and conditions affecting their occurrence and strength. We found extensive support for the presence of trophic cascades in terrestrial communities. In the majority of experiments, predator removal led to increased densities of herbivorous insects and higher levels of plant damage. Cascades in which removing predators led to decreased herbivory also were detected but were less frequent and weaker, suggesting a predominantly three trophic-level behavior of arthropod-dominated terrestrial food webs. Despite the clear evidence that cascades often decreased plant damage, residual effects of predation produced either no or only minimal changes in overall plant biomass. Agricultural systems and natural communities exhibited similarly strong effects of predation on herbivore abundance. However, resulting effects on plant damage and community-wide effects of trophic cascades on plant biomass usually were highly variable, and only in the managed agricultural systems did predators occasionally have strong indirect effects on plant biomass. Our meta-analysis suggests that the effects of trophic cascades on the biomass of primary producers are weaker in terrestrial than aquatic food webs.

MATERIALS AND METHODS

The present study was carried out "investigations on interaction between insect pests and predators of cauliflower" in the experimental field at Tajpur, Tando Allahyar during the Rabi season 2013.

Homogenous seedlings about 20 days old were collected from farmers fields at Tajpur Tando Allahyar and transplanted on well prepared ridges keeping 45 cm distance between ridge to ridge and 30 cm distance between plant to plant. There were three plots, each plot consisted an area of 5x5 meters.

All the cultural agronomical operations were applied as per recommendation. However, spray of any kind of pesticide was avoided throughout the growing period for proper exploitation of insect pests and predators.

For recording observation, ten plants were selected randomly for each replication. Five leaves were selected from each selected plant and examined carefully for recording the population of insect pests and predators and their average was worked out on per leaf basis. The observations were started after two weeks of transplanting and continued till the crop harvested.

The data thus collected were subjected to analysis of variance according to Randomized Complete Block Design, were compared by using Randomized Complete Block Design, while mean values were compared by using least significant difference (LSD) test. The analysis was done through statistix-8.1 computer software.

RESULTS

The present study was carried out to investigations on interaction between insect pests and predators of cauliflower in the experimental area of Tajpur, Tandoallahyar, during Rabi season 2013. The result on individual insect is presented below:-

Insect pests of cauliflower

Thrips

The data regarding population development of thrips recorded on cauliflower during January 5, 2013 through April 7, 2013 at weekly interval are shown in the Table -1. The results revealed that the thrips appeared in the initial stage of the crop and remained active throughout the season. The peak population of thrips was observed during March 2, 2013 (36.2±3.92/leaf) and minimum population was recorded on March 5, 2013 (2.37±0.32/leaf) respectively. These results demonstrated that the thrips were more active in the 1st week of February to 2nd week of March, and then it declined gradually.

The statistical analysis of data showed highly significant ($P<0.05$) differences in the population of thrips between the dates of observations.

Whiteflies

The results on mean population of whiteflies recorded on cauliflower are shown in the Table -1. The results indicated that the whiteflies remained active throughout the crop season. It increased gradually and reaches its peak during Feb. 16, 2013(19.20±1.38/leaf) followed by January 05, 2013 (3.34±0.62/leaf).

The results of statistical analysis revealed a significant differences ($P<0.05$) among the time intervals.

Aphids

The data regarding population development of aphids recorded on cauliflower during January 5, 2013 through April 7, 2013 at weekly interval are shown in the Table -1. It may be seen from the results that aphids appeared in the initial stage of the crop and remained active up to the maturity of crop.

The peak population of aphids was observed during February 23, 2013 (45.30±1.00/leaf). While lowest population was observed in the 7th April, 2013(10.00± 0.37/leaf)

The statistics analysis of data showed that the differences in the population development of aphids between the observation dates were highly significant.

Cutworms

The results on mean population of cutworm recorded on cauliflower at weekly interval from January 5, 2013 through April 7, 2013 are shown in the Table -1. It may be seen from the results that cutworm appeared on January 5, 2013 and remained active upto the maturity of crop.

The peak population of cutworm was observed on March 9, 2013 (8.38±1.55/leaf) followed by January 12, 2013 (0.52±0.42/leaf).

The statistics analysis of data revealed that highly significant difference in the pest population between the observation dates.

Table 1. Mean population of insect pests on cauliflower at Tajpur, Tando Allahyar during Rabi season 2013.

Date of observation	Thrips (Mean±S.E)	Whitefly (Mean±S.E)	Aphid (Mean±S.E)	Cutworm (Mean±S.E)	Temperature	Relative Humidity %
5th January	2.37±0.32	3.34±0.62	18.19±1.32	0.68±0.36	17.85	65.00 %
12th January	2.75±0.78	4.95±2.72	20.15±2.31	0.52±0.42	18.74	63.85%
19th January	6.60±0.92	6.78±0.85	19.20±0.21	0.91±0.33	17.64	57.14%
26th January	9.37±1.73	8.35±0.92	23.23±0.33	0.85±0.42	18.83	58.80%
2nd February	13.78±1.64	10.25±1.78	27.10±0.62	1.32±0.92	18.86	56.80%
9th February	24.78±3.95	12.15±1.56	33.12±1.86	2.25±0.80	19.79	60.80%
16th February	22.95±2.88	19.20±1.38	38.56±1.91	2.78±0.82	19.32	53.57%
23rd February	29.40±2.15	18.15±2.52	45.30±1.00	3.33±0.92	19.53	48.42%
2nd March	36.21±3.92	26.48±2.20	19.73±0.89	6.52±1.33	22.42	63.85%
9th March	28.50±2.36	21.50±2.00	18.56±1.13	8.38±1.55	24.42	62.57%
16th March	9.78±0.63	19.20±1.33	20.26±1.04	6.28±0.38	26.61	67.29%
23rd March	9.33±0.43	11.45±1.41	13.44±1.43	5.33±0.40	26.39	60.71%
30th March	8.52±0.32	12.15±1.05	12.33±1.33	4.10±0.72	26.39	61.56%
7th April	4.30±0.46	10.21±2.00	10.00±0.37	2.36±0.9	27.10	61.70%
Mean±S.E	14.90±1.62	13.39±1.59	22.51±1.12	3.25±0.73	21.70	60.15%

Zigzag Beetle (*Menochilus sexmaculatus* F.)

The results mean populations of zigzag beetles recorded on cauliflower at weekly interval during January of 2013 through April 7th 2013 are shown in Table -2. The results depicted that the zigzag beetle appeared on first week of January, 2013 and remained active upto the maturity of crop.

The peak population of zigzag beetle was observed on February 2, 2013 (2.46±0.31/leaf) followed by 16th March, 2013 (0.11±0.10/leaf) respectively.

The statistics analysis of data showed that the differences in the population of zigzag beetles among the observation date were highly significant.

7- Spotted Beetle (Coccinella *septempunctata* Linn.)

The result on mean population of 7- spotted beetle recorded on cauliflower during January 5,2013 at weekly interval are shown in the Table -2 . It can be evident from the results that the population of 7- spotted beetle did not remain similar throughout the season; it appeared in the 1st week of January and remained active upto the maturity of crop.

The peak population was observed on the 23rd h Feb. 2013 (2.20±0.02/leaf), followed by 2nd Feb. 2013 (0.17±2.10/leaf).

However, the statistics analysis of data showed significant differences in the population of 7- spotted beetle between the observation dates.

11- Spotted Beetle (*Coccinella undecempunctata* Linn.)

The data pertaining to population development of 11- spotted beetle recorded on cauliflower during Jan. 5, 2013 through April 7, 2013 at weekly interval are shown in the Table -2 . The results revealed that 11 - spotted beetle appeared on 5st, January 2013 and remained active upto the maturity of crop.

The maximum population was recorded on 9th Feb. 2013 (3.13±0.13/leaf) followed by 19th January 2013 (0.11±0.14/leaf).

The statistics analysis of data showed significant differences in the population of 11- spotted beetle among the date of observations.

Table 2. Mean population of insect predators per plant on cauliflower at Tajpur, Tando Allahyar during Rabi season 2013.

Date of observation	Zigzag Beetle (Mean±S.E)	7 spotted Beetle (Mean±S.E)	11 spotted Beetle (Mean±S.E)	Temperature	Relative Humidity %
5th January	1.00±0.10	0.90±1.23	0.11±1.20	17.85	65.00 %
12th January	0.23±0.43	0.88±1.16	0.23±1.10	18.74	63.85%
19th January	0.85±1.13	0.66±1.20	0.11±0.14	17.64	57.14%
26th January	0.68±0.21	0.80±1.19	1.21±0.32	18.83	58.80%
2nd February	2.46±0.31	0.17±2.10	2.03±0.33	18.86	56.80%
9th February	1.96±1.21	3.15±0.05	3.13±0.13	19.79	60.80%
16th February	1.15±0.03	2.00±0.08	1.17±1.09	19.32	53.57%
23rd February	2.20±0.02	1.16±0.02	1.19±2.13	19.53	48.42%
2nd March	0.81±0.06	1.00±0.03	0.43±0.04	22.42	63.85%
9th March	1.9±0.32	1.20±0.12	0.22±0.06	24.42	62.57%
16th March	0.11±0.10	0.30±0.08	0.79±0.06	26.61	67.29%
23rd March	0.33±0.12	0.26±0.03	0.24±0.40	26.39	60.71%
30th March	0.35±0.06	0.27±0.077	0.29±0.10	26.39	61.56%
7th April	0.43±0.04	0.11±0.13	0.16±0.40	27.10	61.70%
Mean±S.E	1.03±0.29	0.92±0.53	0.80±0.12	21.70	60.15%

Correlation of predators with insect pests of cauliflower

The correlation among the predators with insects pest of cauliflower are presented in Table-3 which showed that Zigzag beetle were non-significant positively association with white fly (r = 0.281NS), aphid (r = 0.235NS) and thrip (r = 0.171NS), 7-Spotted beetle were non-significant correlated with white fly (r = 0.231NS) aphid (r = 0.147NS) and thrip (r = 0.181NS), 11-Spotted beetle were non-significant (r = 0.138NS) correlation with white fly, aphid (r = 0.274 NS) , and thrip (r = 0.067NS). However, cutworm negative significantly correlated with predators, which is suggested that increased in predator's population on simultaneously cutworm population will be deceased.

Table 3: Correlation coefficient (r) of predators with insect pests on Cauliflower at Tajpur, Tando Allahyar during Rabi season 2013.

Predators V/S insect pests	White fly	aphid	cutworm	Thrip
Zigzag beetle	0.281NS	0.235NS	-0.538*	0.171NS
Seven spotted beetle	0.231NS	0.147NS	-0.548*	0.181NS
11-Spotted beetle	0.138NS	0.274 NS	-0.587*	0.067NS

Table 10: Average monthly meteorological data during experimental period January to April 2013

Months	Temperature °C	Relative humidity %

	Minimum	Maximum	Minimum	Maximum
January	12.55	21.86	58.15	86.45
February	13.65	28.52	50.04	85.77
March	18.82	34.25	39.00	82.28
April	19.88	35.67	38.94	81.69

Source: Regional Agromet Center Tandojam

DISCUSSION

Insect pests cause serious losses to the growing vegetables like cauliflower from sowing up to maturity, resulting poor marketable yield. For management of these insect pests predators are good biological agents and provide effective control of the insect pests by also provide against environment and soil pollution.

The result of present study carried out to investigations on interaction between insect pests and predators of Cauliflower indicated that there were four insect pests' i.e thrips, white flies, aphids and cutworms infesting cauliflower throughout the season. Further it was observed that three predator species viz., Zigzag beetles, 7-spotted beetles and 11-spotted beetles were found preying on the above maximum insect pests. It was noted that the population of predators remained low, they appeared in the month of January and increase slowly in the middle of the crop season when the population of insect pests reaches to their peak.

The results demonstrated that thrip population was maximum (36.21±3.92/leaf) during the 2nd March, 2013, while the population of white flies reaches its peak during the same date (26.48±2.20/leaf) whereas the population of aphids was greater during 23rd February,2013 (45.30±1.00/leaf). However, the cutworms reach to their peak during 9th March, 2013 (8.38±1.55/leaf). Thus it was observed that 1st, 2nd, and 3rd week of March was the critical period of insect pest infestation on cauliflower.

The population of Zigzag beetle was maximum during 2nd February ,2013 (2.46±031/leaf), similarly 7 and 11-spotted beetles also reaches to their peak during 9th February,2013 (3.15±0.05/leaf) and (3.13±0.13 /leaf) respectively.

The statistical analysis of data both for insect pests and predators showed a significant difference in the population of insect pests and predators between the data of observation.

These results are also supported by the findings of Latif et *al.* (1999) who reported that with belong in transplanting the aphid density gradually increased and the crop yield of cauliflower decreased. Zaz (2001) reported that the aphid was associated with Cole crops throughout the growing period from April to October with two population peak on cauliflower (1st week of June and cabbage 1st week of June and October) the maximum population was recorded on cauliflower followed by cabbage. Devjani (1997) found that four species of syrphids, two coccinellids and one neuroptera were associated with the colonies of aphids on cauliflower while Collier etal, (2003 b) reported that aphids were the most numerous pests insects and high number of Brevicoryne brassicae cabbage aphids Myzus persicae, and potato aphids were found at several sites larvae were considerably less numbers slugs and slug damage were also evident at several sites and one location, slug had damage 295 of 300 cabbage heads. However, Muniz and Nebreda (2003) reported that cabbage white flies and Plutella has recently become very serious pests on certain European brassica crops.

Whereas, Rao et al (2003) reported that pests were negatively correlated with minimum temperature and were positively correlated with relative humidity, negatively correlated with the maximum temperature and were positively correlated with related humidity on cauliflower. However, Devjani and Singh (2002) reported that cauliflower was attacked by as many as 24 insect pests belong to the 5 orders and 12 families 19 insect species of natural increase belonging to 4 orders and 6 families. Farrag and Zakzouk (2000) reported that diversely in pests and their numbers populations of the white flies are fluctuated on cauliflower and bean, giving the mean of 267 and 362 adults per plant. Aphids reach to 372.7and 98.7 adults per plant on cauliflower and bean respectively.

The present study results are similar to Bana *et al.* (2012) who reported that the cabbage crop was found to be infested by two major pests i.e., aphid (*Lipaphis erysimi* (Kalt.)) and diamondback moth (*Plutella xylostella* (L.)). The infestation of *L. erysimi* started in the last week of November and reached peak in third and fourth week of January during *Rabi* 2008–09 and 2009–10, respectively.

Whereas, the infestation of diamondback moth started from the third week of November and reached its peak in the first week of January. The maximum and minimum temperatures showed significant negative correlation with aphid and larval population of diamondback moth, whereas, relative humidity and sunshine hours showed non-significant correlation. The coccinellid beetle was recorded as an important predator of aphid, which was maximum in the second and third week of January during 2008–09 and 2009–10, respectively. These results are also supported by the findings of Fozia *et al.* (2012) who reported that the aphids, commonly known as „Plant lice are soft bodied insects which damage different types of plants including valuable fruit & vegetable crops. Among aphids, the cabbage aphid *Brevicoryne brassicae* (L.) is one of the most important pests of cruciferous crops like cabbage, cauliflower, knol-khol, kale, turnip etc. It is a small blue grey colored aphid with short cornicles (tube like structures at the end of abdomen) & body covered with waxy secretions. The cabbage aphids feed on the underside of leaves in large clusters, in the center of cabbage heads, flowers, and flower-stalks & on the youngest leaves. Cabbage aphid damages leaves & flowers of plants directly by sucking sap & indirectly by secreting honey dew which attracts sooty mould. The aphid is also a vector of 11 non-persistent, 5 semi-persistent & 4 persistent plant viruses (Ulusoy & Bayhan, 2006).

The present studies agree with Siddiqui *et al.* (2009) who reported that the aphids are essential pest of cultivated crops in Pakistan. They not only trim down the yield of crops, but also serve as vector of diseases. The experiment was carried out to determine the influence of planting dates on aphid and their natural enemies in cauliflower varieties. There were two target planting dates (late September and late October) and four cauliflower varieties (Snow Crown, Cashmere, Snow Drift and Shehzadi). Green peach aphid, Myzus persicae was the only aphid species present on the cauliflower crop in 2008-2009. Aphid population was significantly lower in early planting cauliflower trial (late September) while in case of late planting cauliflower trial (late October) it was significantly higher. The rate of parasitism and predation on early planting trial were 3.86 % and 0.82%. In late planting trial, the rate of parasitism and predation were 3.3 % and 0.42 %. The variety “Cashmere” performed the best and considered resistant against aphids amongst early planted varieties, however, it was susceptible when planted during late season. The variety “Snow Drift” which was comparatively susceptible to aphid attack when planted during early season (late August) but proved resistant when planted during late season (late September) as minimum population of aphid was estimated on this variety. Patra *et al.* (2013) reported that the Cabbage aphid reached its peak on 9th February (14.17 aphids/inch 2 leaf) and 16th February (11.03 aphids/inch 2 leaf) of 2011-12 and 2012-13, respectively. Highest parasitized larvae of diamond back moth by *Cotesia plutellae* were found on 15th and 8th March with 10.42 and 10.50% larval parasitisation during both the seasons, respectively, whereas maximum coccinellid was observed on 23rd February of 2011-12 and 2012-13 crop seasons with 11.67 and 9.67 coccinellids/ 5plants, respectively. Both maximum and minimum temperature had play major role to build up the population of diamond back moth, *C. plutellae* and coccinellids beetle while aphid population was enhanced only by maximum temperature. Relative humidity and rainfall had negative influence on pests and natural enemies during the study period.

The present studies agree with Sow *et al.* (2013) who reported that larvae and pupae of *P. xylstella* were higher for the dry season than the rainy season. There was a negative correlation between temperature and *P. xylostella* populations, and a strong relationship between *P. xylostella* populations and the age of cabbages. Females oviposited on young cabbages where the presence of young larvae was important, whereas older immature stages were mainly found in older cabbage plants. Parasitoid populations were higher for the dry season than the rainy season. High temperatures did not increase the pest populations and parasitism rate. There was no effect found on pest, plants and natural enemies due to rainfall. There was a positive correlation between pest populations and parasitism. Four Hymenoptera species were found: *Oomyzus sokolowskii*, *Apanteles litae*, *Cotesia plutellae* and *Brachymeria citrae*, but they were not efficient to control the *P. xylostella* populations.

The correlation of predator and insect pests were non significant in positive directions was observed, while predators have significant negative correlation with cutworm which is proposed that increased in predators population at mean time cutworm population will be decreased.

Conclusions

- It may be concluded that four insect pests were observed on cauliflower throughout the season these includes, thrips, whiteflies, aphid and cutworm. The population of pests was more during the March.

- However among predators, the zigzag beetle, 7 spotted beetle and 11 spotted beetles also remained on cauliflower throughout the season. It was found that predators population improved as pest population increased. The statistical differences in the population of predators were significant.

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