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EFFECT OF PLANTING DATES ON APHIDS AND THEIR NATURAL ENEMIES IN CAULIFLOWER VARIETIES

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Abstract

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.

Introduction

Cauliflower (*Brassica oleracea botrytis* DC.) belongs to the family Brassicaceae, which is an attractive vegetable due to its nutritional importance. Continuous efforts are made by the seed industry and growers to improve cauliflower production. Variety selection and crop management practices are the main factors that contribute to growing profitable cauliflower (Zerkoune, 2000). Pakistan is included in top ten Cauliflower producing countries in the world with 11400 hectares of harvested area, 183333 hectogram/ hectare of yield and 209000 tonnes of production in 2007 (Anon., 2008). One of the major problems in cauliflower cultivation is insect pests. Massive quantities of synthetic insecticides are used, giving rise to major concerns about food safety and environmental pollution in addition to the high chemical and labor costs (Ding *et al*., 1996). The current trend in agricultural production is to reduce the quantity of pesticides entering the environment. Adjusting the planting date of row crops, thereby altering the production season, may be another viable method for reducing pesticide use. However, little research has been conducted to determine the influence of crop planting date on crop yield loss. Changes in crop planting date may shift the competitive advantage to the crop, thereby reducing the pest impact (Klingaman & Oliver, 1994).

Nathoo (2003) while working on four summer cauliflower varieties viz., White Contessa, Hybrid Rami, Cashmere and Splendor in year 2000 compared them with cauliflower cv. Local, which is a traditional winter variety grown in Mauritius. Interaction effect was observed between planting date and site and between planting date and variety, which suggests that by adjusting the planting date for the respective zones, the yield can be improved.

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Production of cauliflower has been shown even beyond November in the uplands as long as precautionary measures were taken against insect pests, droughts and diseases (Anon., 1962). All heat tolerant varieties viz., "Snow Peak", "Hsi-shu", "Farmer's Early No. 2", "Farmer's Early No. 3" and "Snow King" were planted at different planting dates from September to December on a monthly basis. Results showed that varieties "Hsi-shu", "Farmer's Early No. 2" and "Farmer's Early No. 3" could mature earlier as compared to other varieties (Anon., 1980).

Ali (2000) studied on the development of *M. persicae* on four different varieties of cauliflower named as (1) "Early Garma" (Local Variety) (2) "Garma "(Indian Variety) (3) "Advanced Early" (4) "China Motia" under laboratory conditions. He concluded that the "China motia" variety was the most favorable for the development of aphids, where as the variety "Early Garma" was least conductive to good aphid development.

To reduce dependence on insecticides for insect control, cultural practices like change in cropping system may be helpful. Therefore, this study was carried out to determine the effect of planting dates on population buildup of aphids on cauliflower. This adjustment may help to minimize aphid infestation. This study also determines the susceptible and resistant varieties, their interrelationship with aphids and natural enemies on cauliflower.

Materials and Methods

The experiment was conducted from 25th August, 2008 to 4th February, 2009, consisting of two trials. First trial was early planting of cauliflower located in the field area of Crop Sciences Institute, National Agriculture Research Center (NARC) Islamabad, Pakistan and the other was late planting trial of cauliflower located in the Experimental Farm of Pir Mehr Ali Shah Arid Agriculture University Rawalpindi. Four varieties of cauliflower viz., Snow Crown, Cashmere, Snow Drift and Shehzadi were used in both trials. The seeds of these varieties were sown in the pots on 25th August, 2008 and seedlings were transplanted in the experimental plot on 23rd September, 2008 in case of early planting trial of cauliflower. For late planting trial, seed sowing was done on 25th September, 2008 and transplantation of these seedlings in the experimental plot was done on 17th October, 2008. Both experiments were laid down according to randomized complete block design (RCBD) with 3 replications was used in the experiment. The size of the plot was 25 x 12 ft., while Row to Row distance was kept 1.5 ft and Plant to Plant distance was 1 ft. There were four rows in each block and each row had 13 plants.

Plants were examined for the presence of aphids and their natural enemies at weekly intervals. Two different sampling techniques were followed for cauliflower aphid population analysis. In plant based sampling, whole plant based sampling from seedling to flowering stage of cauliflower were taken. This technique included sampling of cauliflower aphids like nymphs, alates and apterous adults. Visual count method was used to record the population of aphids and their natural enemies. In both trials data collections were taken at the beginning of the period of aphid immigration in October to the period until the crop was harvested. The data of fluctuating environmental factors (temperature, humidity and rainfall) were recorded from the Regional Agromet Center at Rawalpindi.

The samples of aphids from the nearby tagged plants were collected and preserved in 75% alcohol in glass vials for identification. These collected specimen were identified up to the species level by running the keys of Eastop (1961), Martin (1983), Stroyan (1977) and Blackman & Eastop (1984) under an Olympus binocular having magnifying power of 10X x 10X. Mummified aphids were collected from the sampled plant and kept in glass vials along with moist cotton at room temperature until the adults emerged. Predatory Syrphid fly larvae and pupae were collected by the same procedure as in case of mummies. These parasitoids and predator were identified up to species level.

Data analysis: All the data were collected on weekly basis and analyzed by using statistical computer software including Statistical Package for Social Studies (SPSS® 17.0 Version). Descriptive statistics (Mean, Standard deviation, Sum and Standard error), ANOVA models were used for interpretations and logical conclusions. For graphical representation of the results Microcal Origin® 6.0 programme was used.

Results and Discussion

Evaluation of early and late planting cauliflower: The seasonal mean aphid population was higher (14.42 aphids/ plant) on late planting crop as compared to that on early (6.19 aphids/ plant). On early planting (September 23) crop, aphids were observed for the first time on October 27. Population of aphids started to increase rapidly from mid November and reached at their peak in the 43rd week of the year (December 8). Aphid population was decreasing as the crop was maturing and at harvesting (January 5) the mean population of aphid was 0.61/ plant. On the crop planted on October 17 (late planting), aphids were observed for the first time in the 44th week of the year (October 29). Aphid population suddenly increased on December 10 and then declined up to February 4 (at harvesting). The aphids remained in the plants until the crop was harvested, although the aphid population reduced with crop maturity. In this study, highest aphid population was observed on late planting (October 17) cauliflower crop in the 52nd week of the year (December 24). Overall seasonal aphid population was 2.32 times higher on late (October 27) planting crop than that on early crop (September 23) respectively. *Myzus persicae* was the only species from the aphid that colonized the crop during the whole season.

A total of 1,641 aphids were recorded from selected plants in early planting trial of cauliflower crop, among these, 171 were alates, 486 were apterous adults and 985 were nymph's aphids. A total of 66 mummified aphids were recorded from the selected plants in this trial. It was established that 7,893 aphids were caught from the selected plants in late planting trial, among them 394 were alate aphids, 2,442 were apterous adults and 5,057 were nymphs' aphids. In the present study, it was found that aphid population was high in the late planting crop and very low aphid population was observed in early planting crop. This indicates that changing planting date of cauliflower will affect aphid infestation. In early planting, statistical analysis on weekly basis shows that there were highly significant differences present between alates, apterae and nymphs of aphids such as [$F_{(10, 395)} = 8.055$, $p<0.000$], [$F_{(10, 395)} = 8.920$, $p<0.000$] and [$F_{(10, 395)} = 13.079$, $p<0.000$] as shown in Table 1. There were also highly significant differences present between alate, apterous adult and nymph aphid's populations of late planting cauliflower such as [$F_{(14,539)} = 3.013$, $p<0.000$], [$F_{(14,539)} = 13.557$, $p<0.000$] and [$F_{(14,539)} = 10.709$, $p<0.000$], respectively as shown in Table 2.

Environmental factors also play a vital role in the population build up for aphids and their natural enemies. It was observed in early planting trial that aphid population was highest at mean temperature 13.8°C, humidity level 70.8% and 62.8 mm mean rainfall. Aheer *et al*., (2007) found that aphid population decreased when maximum temperature and minimum temperature reached to the optimum limits i.e., 28.30°C and 9.57°C during 2001, 30.60°C and 10.0°C. It was also noted that the attack of aphids was maximum during 51, 52 and 54 weeks of the year (in the month of December and January) when the temperature was low such as 13.1°C, 12.5°C, and 9.6°C (mean temperature) with high relative humidity like 70.07%, 70.6% and 76. 6%. Temperature plays an important role in the population build up of aphids. There are numerous factors which effect the speedy increase and decrease of aphids population. Both the physical and biological factors are much vital causing the variations in the densities of aphid population (Naeem, 1996).

Table 1. Comparison of aphid and their natural enemies' population on early planting cauliflower.

Insects	Mean ± Std. deviation	F	Sig.
Alate	0.43 ± 0.841	08.055	0.000 ***
Apterous	1.23 ± 1.969	08.920	0.000 ***
Nymph	2.49 ± 4.294	13.079	0.000 ***
Mummified aphids	0.17 ± 0.469	09.849	0.000 ***
Syrphids	0.03 ± 0.157	01.708	0.077 N.S.
Coccinellids	0.01 ± 0 .100	01.268	0.247 N.S.

*** Shows highly significant difference and N. S. shows non-significant difference

Table 2. Comparison of aphid and their natural enemies' population on late planting cauliflower.

Insects	Mean ± Std. deviation	F	Sig.
Alate	0.73 ± 01.031	03.013	0.000 ***
Apterous	4.52 ± 0 5.769	13.557	0.000 ***
Nymph	9.36 ± 11.892	10.709	0.000 ***
Mummified aphids	0.49 ± 00 .849	05.786	0.000 ***
Syrphids	0.06 ± 00.252	02.675	0.001 ***
Coccinellids	0.00 ± 00 .043	01.000	0.452 N.S.

*** Shows highly significant difference and N. S. shows non-significant difference

Bhambhro (2002) also reported that natural enemies of aphid could play an important role in reducing pest number. A total of 66 mummified aphids were recorded from the selected plants in early planting cauliflower and 264 from late planting. Two species of hymenopterous parasitoids emerged from the mummies of the *M. persicae,* belonging to the family Braconidae and sub-family Aphidiinae. *Aphidius colemani* and *Diaeretiella rapae* were these two species of parasitoid. A total numbers of 15 individuals of predators were collected from early planting crop among these, 10 were Syrphids (*Episyrphus balteatus*), 4 were Ladybird beetles (*Coccinella septempunctata*) and 1 was Green lacewing (*Chrysoparla carnea*). In case of late planting cauliflower, total 33 individuals of predators were collected; among these 32 were Syrphids belonging to the species *E. balteatus.* Only one individual of seven spotted lady bird beetle was caught from the marked plants.

In early planting trial (mid September), the highest population of mummified aphids was recorded in 49th week (December) when the population of aphids was also at their peak level. The first Syrphid was recoded in 46th week (late November) and maximum population was recoded in 49th week (December) when the highest density of aphids was observed in case of early planting trial. The rate of parasitism calculated was 3.86% and rate of predation was 0.82%. In case of Parasitoids, on weekly basis there was highly significant difference present between mummified aphids such as [$F_{(10, 395)} = 9.849$, $p<0.000$]. While in predators, such as syrphids and coccinellids, on weekly basis there were non-significant difference present as [$F_{(10, 395)} = 1.708$, $p<0.000$] and [$F_{(10, 395)} = 1.268$, $p<0.000$] shown in Table 1.

In late planting cauliflower, first mummy of aphids was recorded in the week 45 (early November) and then the population trend of mummified aphids goes upward. The

maximum population of mummies was observed when the population of its host was also maximum. Parasitism rate (the proportion of aphids that were mummified) of late planting cauliflower crop was 3.3%. In case of predators, the first syrphid was observed in the week 48 (late November) and the highest population of syrphids was observed in the week 50 (early December) and at this stage the population of aphids was also high but not maximum. The rate of Predation of late planting cauliflower in 2008-09 was calculated as 0.42%. On weekly basis, statistical analysis shows highly significant differences present between population densities of mummified aphids and syrphids such as [$F_{(14, 539)} = 5.786$, $p<0.000$] and [$F_{(14, 539)} = 0.001$, $p<0.000$] and non-significant difference among coccinellids mentioned as [$F_{(14, 539)} = 01.000$, $p>0.425$] as shown in Table 2.

Performance of four varieties of cauliflower according to their planting dates: In case of early planting of cauliflower varieties, the crop matured earlier and didn't experience severe infestation of aphids. Generally the populations of aphids become severe in the months of December and January but in this case of early planting the crop was matured on late December and harvested in the first week of January. Cauliflower varieties of late planting trial became mature in the month of February and experienced the maximum infestation by aphid's population in the month of December and January. This is why the late planting crop was subjected with high population of aphids as compared with the early planting crop as shown in Fig. 3. Previous studies have also shown that aphid infestation increased on late planted crop and reduced the yield as compared to normal planting (Aheer *et al*., 1993).

In case of variety "Snow Crown", total of 454 aphids were recorded and this variety had shown second highest population of aphids in case of early planting trial. About 27.64% aphids from the whole trial were present on this variety. In late planting "Snow Crown", overall 2062 aphids were counted and almost 26.13% aphids were present on this variety from the total population of aphids on late planting cauliflower crop. This variety of cauliflower was moderately susceptible for aphids in case of late planting.

In variety "Cashmere", minimum population of aphids was recorded from early planting trial and maximum population was recorded from late planting trial. This variety was noticed to be slightly resistant against aphids in case of early planting trial and highly susceptible against aphids in late planting trial. Significantly low aphid infestation on early sown varieties has been reported. It has also been suggested that early maturing varieties would avoid outbreaks of aphids (Barabas & Benovsky, 1985).

It was observed that variety "Snow Drift" performed poor as compared to other varieties in early planting trial. This result was opposite to the late planting trial in which "Snow Drift" variety performed the best. It was recorded that in early planting trial, maximum population densities of aphids were present on variety "Snow Drift" and minimum aphids were observed on this variety in late planting trial throughout the season. This variety was susceptible against aphids in early planting and resistant in case of late planting cauliflower. "Snow Drift" performed the best against aphids as this cultivar "Snow Drift" was found the least preferred to aphids throughout the season (Younas, 2004).

The variety "Shehzadi" performed better after "Cashmere" against aphids. It was concluded that 22.9 % aphids from total aphid's population were counted in this variety in case of early planting. When the variety "Shehzadi" was planted late in season, it showed poor performance against aphids after "Snow Crown". It was considered as moderately susceptible variety for aphids in late planting trial.

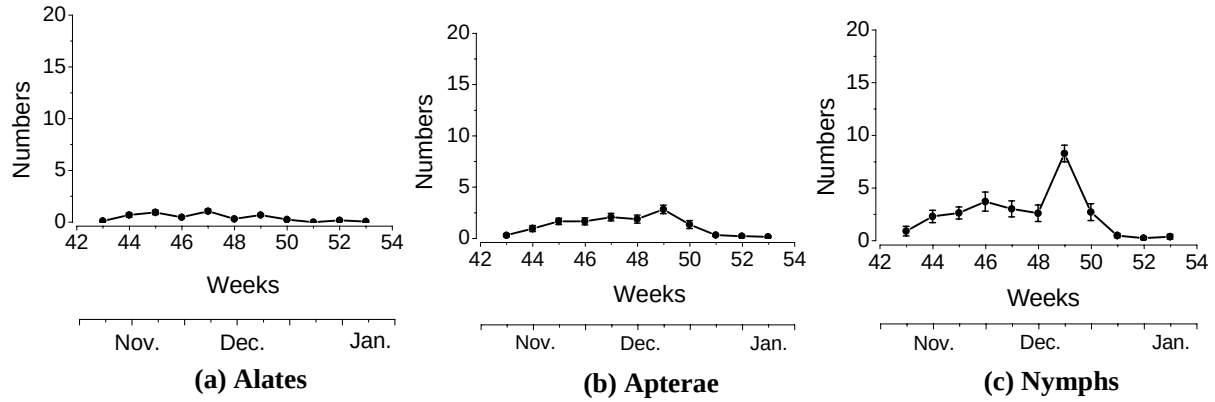

Fig. 1. Population trends of alates (a), apterae (b) and nymphs aphid (c) (Mean/plant ± S.E.) on early planting cauliflower in 2008-09.

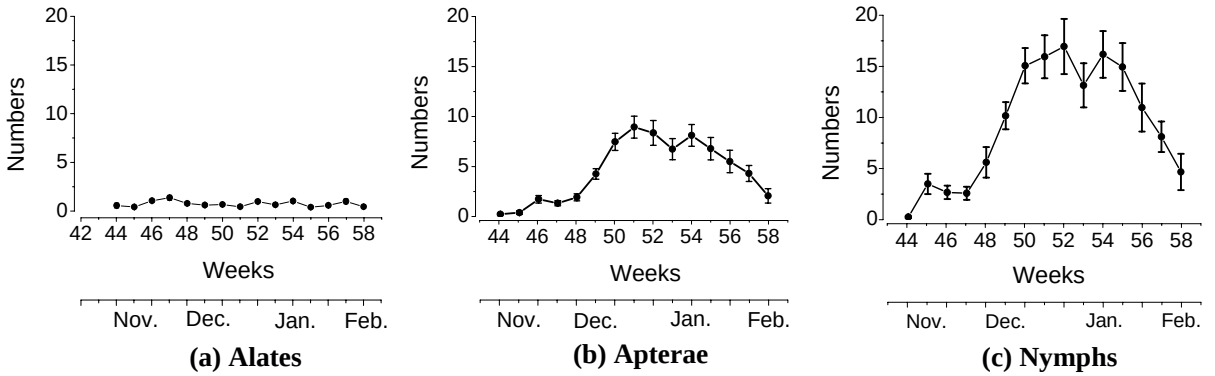

Fig. 2. Population trends of alates (a), apterae (b) and nymphs aphid (c) (Mean/plant ± S.E.) on late planting cauliflower in 2008-09.

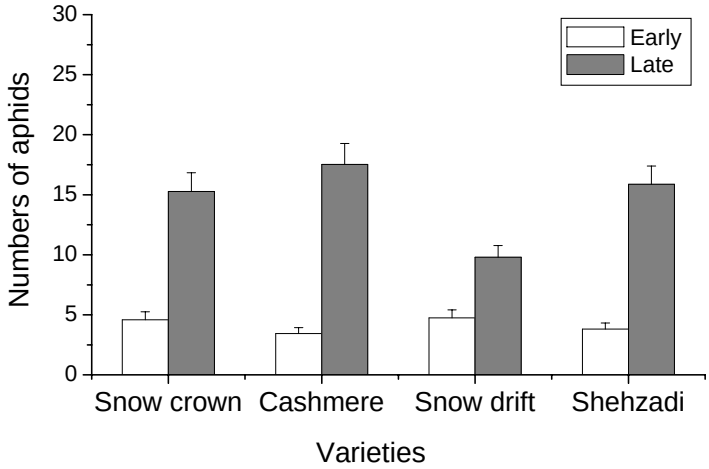

Fig. 3. Comparison of aphid population (Mean / plant ± S.E.) between early and late planting cauliflower varieties in 2008-09.

From this research, it is concluded that early planting of cauliflower in the month of September can reduce pest population below damaging level. In this study, the populations of natural enemies like parasitoids and predators and their responses on pest population were analyzed so that the use of hazardous chemicals could be avoided. It is recommended for the growers of cauliflower that early planting of variety "Cashmere" and late planting variety "Snow Drift" in Rawalpindi and Islamabad conditions may be adopted to reduce the aphid attack.

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