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Surveillance Of Insect Pollinators On Cucumbers And Their Effect On Its Yield

Fawad Khan[1], Wasi Ullah[3], Murad Muhammad[12], Inayat Ullah[4], Abdul Basit[2], Mubashir Ahmad[4], Burhan Uddin[5], Arshad Ullah[6], Afia Zaib[7], Ihsan Ullah[8], Muhammad Ajmal Khan[9], Arsalan Ali[10], Qurat Ul Ain[11]

[1]District Medical Entomologist, Health Department Khyber Pakhtunkhwa, Swat, Pakistan.

[2]Department of Horticulture, Faculty of Crop Production Sciences, The University of Agriculture Peshawar, 25120, Pakistan.

[3]District Medical Entomologist, Health Department Khyber Pakhtunkhwa, Dir Upper, Pakistan.

[4]Department of Agricultural Mechanization and Renewable Energy Technologies, The University of Agriculture Peshawar, Pakistan.

[5]Department of Zoology, University of Swabi, Khyber Pakhtunkhwa, Pakistan.

[6]Research Officer, Agriculture Research Institute, Swat, Pakistan.

[7]District Medical Entomologist, Health Department Khyber Pakhtunkhwa, Abottabad, Pakistan.

[8]District Medical Entomologist, Health Department Khyber Pakhtunkhwa, Shangla, Pakistan.

[9]Medical Entomologist, Integrated Vector Management Program, ERSTWHILE FATA, Pakistan.

[10]District Medical Entomologist, Health Department Khyber Pakhtunkhwa, DI Khan, Pakistan.

[11]District Medical Entomologist, Health Department Khyber Pakhtunkhwa, Nowshera, Pakistan.

[12] Department of Botany, University of Peshawar, Peshawar Pakistan.

ABSTRACT

Pollination can be an essential but often neglected ecosystem service to diminish crop yield gaps. The objective of this experiment was to study the effect of pollinators on the yield of cucumber and to identify the pollinator visiting the crop. The experiment was distributed into two plots: caged and uncovered, both replicated four times . The data were recorded on weekly basis. Ripe cucumbers were collected and weighed. Pollinators observed were brought to the entomology museum and were identified by comparison with already identified specimens and expert entomologists. Also photographs were taken of these insect pollinators. Research findings showed that the yield of un-caged plot was significantly higher than the caged one. Results showed that significant increase in the yield has occurred due to pollination by insect. The plant that were covered produced 11.20, 17.25, 22.2 and 10.0 in May,

June, July and August respectively as compared to the uncovered plot which produced 18.03, 25.91, 35.81, and 15.20 during May, June, July and August respectively. Data analysis showed that increased in yield has occurred throughout the growing season of the crop. This clearly shows the positive impact of pollinator on the cucumber yield. Identification results of pollinators showed that four species of honey bees i.e. Small Honey bee (Apis florea), Rock honey bee (Apis cerana), giant honey bee (Apis dorsata), European honey bee (Apis mellifora), three species of Bumble bees, i.e. (Bumbussp. 1, Bumbussp 2, Bumbussp. 3), three species of butterflies i.e. cabbage butterfly (Pieris brassicacy Ak. butterfly, (Dainuschrysippusi, alfalfa butterfly (Coliaserate) and syrphid fly (Syrphissp.) visit cucumber flowers.

INTRODUCTION

Most of cucurbits are monoecious; therefore insect pollination is essential factor for enhancing their yield. Bees visit plants primarily for gathering, food for themselves and for their brood. Boney bees visit many flowers in order to gather enough food. Thus bees have become principal agents for cross-pollination in all cucurbits and they are physically well suited to this job. Bees are known to work comfortably in one-mile radius of their hives (Eckert, 2006). Pollination is the transfer of pollen from the anther to stigma. The transfer of pollen to any flower on the same plant or clone is self-pollination or selfing. The transfer of pollen to a flower on a different plant is cross-pollination. Self-pollination is usually accomplished by gravity or by the actual contact of the shedding anther with sticky stigmatic surface. In cross-pollination wind and insects are the important agents of pollen transfer. Plants are referred as self-pollinated when the amount of cross pollination is less than 4 % and as cross pollinated when cross pollination is predominant. The latter is almost entirely true of cucurbit plants (Codony et al., 2005).

Mostly honeybees visit plants to obtain nectar within most flowers, usually around the ovary close to the carpel. These nectarines secrete a sweet solution called nectar, which is offered by the flower as lure to its insect visitors. In sucking the solution they inevitably become dusted with pollen grain as they brush against the anther. When the insect visits another flower it deposits some of the pollen dust to the stigma resulting in gynoecious fertilization (McGregor, 2007). Pollination is essential in all crops to ensure fertilization in order to obtain better and high yields. In most of the cross-pollinated crops such as fruits, vegetables, insect pollination is indispensable. Therefore in developed countries the producers of such crops usually hire honeybee colonies to greatly increase their produce (Stephan, 2008). Pollination, especially the Cross-pollination done by the insects is necessary for the production of seeds and fruit in a variety or cucurbits. Insects are more efficient in cross-pollination as different insects pollinated many species of flowers and insects like higher Hymenoptera Lies locally abundant pollen or nectar resources. One study shows that insects, which help in pollination, are Hymenoptera (50%), Diptera (25%) beetles (15%), Lepidoptera (10%) and other orders of insects (5%) (Keith, 1995).

Cucurbits such as cucumber, squash, pumpkin and melons are cross-pollinated crops. They require insect vectors, particularly honeybees, for pollination and subsequent fruit set. Poor fruit production in these crops is commonly a result of inadequate pollination. Cucurbit flowers only remain uncovered for one day. As a result, there is only a small window of opportunity for pollination to occur. If pollination does not occur, the flowers simply drop off the plant. In this case, no fruit is produced. If only partial pollination occurs, the resulting fruits are small and deformed. Successful pollination of some cucurbits requires as many as twenty bee visits per flower (Keith, 1994). The preceding literature suggests the importance of

pollinators and the role of pollinator in affecting the yield of cucurbits. A lot of work has been done in the world but in Pakistan no work on the listing of pollinators of cucurbits has been done so far. Similarly, no information is available on the role of pollinators in affecting the yield of cucumbers. The present research was carried out with the aim to list the pollinators of cucurbits and to find out the impact of pollinators on yield of cucumber.

Materials and methods

Field experiments were conducted in the district Peshawar at Malakander farm to study the effect of pollinators on cucumber yield. The research site can be classified as semiarid and the maximum wind speed is 35 km/h. It located at 34.01° N latitude, 71.35° E longitude at an altitude of 350m above sea level in Peshawar valley with a sub-tropical climate (Ahmad et al. 2019). Peshawar is located approximately 1600 km north of the Indian Ocean. The research farm is irrigated by the Warsak canal from river Kabul (Alam et al. 2020; Ali et al., 2021). Where the Indus River also enters the city in the Northwest and then splits into various other small channels (Basit et al., 2021). Generally, its subsoil strata are composed of boulders, gravels and overlain of sands by clays and silts. The valley of Peshawar is covered with split-up deposits of sands, silt and pebbles of recent geological times (Basit et al., 2021). Both the summer and winter weathers are extreme (Basit et al. 2019; Muhammad et al., 2021) characterized by severe winter and hot prolonged summer where the average minimum temperature during winter is 5 °C while during summer, the average maximum temperature reaches up to 45 °C. The wettest month (with the highest rainfall) is March (78 mm) and driest month (with the lowest rainfall) is June (7 mm) approximately (Gilani et al., 2021; Sajid et al. 2020). Local variety was sown in March. The plot size was kept 4×8m2. Row-to-row distance was kept 2 meter and plant-plant distance was kept 20cm. The data were collected on weekly basis from May to August. All the standard agronomic practices were followed throughout the whole research.

Two experimental plots were maintained:

1. Caged plots

In this experiment all the sub plots were kept covered with nylon cloth just before the flowering period in order to stop the entry of all kinds of pollinating insects. There were 3 replications in this experiment. Cloth selected for caging was such that air and sunshine fully reached the plants and no active pollinator species had access to the cucumber plants.

2. Uncovered plots

All the plots under this treatment were kept uncovered i.e. without cover. These plots were kept uncovered to all kind of pollinating insects in order to study and identify the pollinating insects. This experiment was also replicated 3 times.

Data Recording and analysis

Data recording the yield of cucumber were recorded from May to August. The ripe marketable cucumbers

were harvested from caged and un-caged plots separately on weekly basis and were weighted.

Collection of pollinators

Collection of pollinators was done from cucumber field. For this purpose fields were visited during clear weather and all the insect pollinators visiting cucumber were collected and preserved for identification. Collection was done with the help of hand net, traps, forceps and other insect collecting materials. The collected specimens were transferred to the killing jar. Specimens were properly mounted and prepared for identification. Identification was done with the help of available literature (Abbas, 2000) and by comparison with. Already identified specimen at Entomology Museum of the Department of Entomology, The University of Agriculture Peshawar-Pakistan. Colored plates of all the-pollinators have been taken for quick identification using a digital camera. All the collected and identified specimens were deposited at the Insect Entomology Museum.

Results

Effect of Pollinators on Cucumber Yield

Data given in the table 1 showed the yield of cucumber obtained from the two plots i.e. covered and uncovered for the month of May. Research findings showed that during the May the yield obtained from the uncovered plot after Week 1, Week 2, Week3 and Week 4 was 3.78, 4.228, 4.688 and 5.339 kg, respectively. Yield obtained from the covered plots was 2.150, 2.41, 2.67 and 3.87 kg. The total yield for the uncovered and covered plot was 18.035 and 11.20 Kg respectively in May. Analysis of the data showed that the yield obtained from the uncovered plot was significantly different from the yield of the covered plot.

Table 1. Effect of pollinator on the yield (kg) of cucumber in the month of May, 2019

Treatment	Weeks 1	Weeks 2	Weeks 3	Weeks 4	Total
Uncovered	3.78	4.228	4.688	5.339	18.035
Covered	2.150	2.40	2.60	3.90	11.20

Table 2 shows the yield of cucumber obtained from the two plots i.e. covered and uncovered for the month of June. Yield obtained from the uncovered plot for the month of June was 6.12, 6.250, 6.515and 6.902 kg for Week I, Week 2, Week 3 and Week 4 respectively. Yield obtained from the covered plots was 3.402 (Week 1), 4.550 (Week 2,), 4.950 (Week3) and 4.320 (Week 4) Kg. Total yield obtained in June for the uncovered and covered plot was 25.903 and 17.225Kg respectively. Significant yield difference was recorded between the yield of uncovered the covered plots.

Table 2. Effect of pollinator on the yield (kg) of cucumber in the month of June, 2019

Treatment	Weeks 1	Weeks 2	Weeks 3	Weeks 4	Total
Uncovered	6.12	6.250	6.521	6.902	25.903
Covered	3.402	4.550	4.950	4.320	17.225

Yield data for July, as given in the table 3 showed that the cucumber yield obtained from uncovered plot for Week1 was8.250 kg, for Week 2 it was 8.528, for the 3rd Week 9.385 kg and for Week 4 the yield was 9.653 Kg. Yield obtained from the covered plots was 5.23, 5.32, 5.90and 5.45 Kg for the same period. Total yield for the uncovered and covered plot was 36.81 and 22.2 Kg respectively in July. Here again the yield of the uncovered plot was significantly better than the yield of the covered plot.

Table 3. Effect of pollinator on the yield (kg) of cucumber in the month of July, 2019

Treatment	Weeks 1	Weeks 2	Weeks 3	Weeks 4	Total
Uncovered	8.250	8.528	9.385	9.65	36.813
Covered	5.23	5.32	5.90	5.45	22.20

Data given in table 4 show the yield for the Month of August. During Week 1, Week 2, Week 3 and Week 4 the yield obtained was4.355, 3.475, 3.425 and 3.45 Kg respectively. Yield obtained from the covered plots was 2.428, 2.638, 2.327 and 2.709 Kg for the given weeks respectively. Total yield obtained from the uncovered was 15.20kg and from the covered plot the yield was 10Kg. Analyzed data showed that the yield of the uncovered plot was significantly higher than the yield of the covered plot.

Table 4. Effect of pollinator on the yield (kg) of cucumber in the month of August 2019

Treatment	Weeks 1	Weeks 2	Weeks 3	Weeks 4	Total
Uncovered	4.355	3.475	3.425	3.45	15.20
Covered	2.428	2.638	2.327	2.709	10

Table No 5 showed the overall yield from May, June, July, and August. It is clear from the table that the yield of cucumber from the uncovered plot was significantly higher than the yield obtained from covered plot during the entire growing season. Data show that the yield was 18.035 Kg for May which increased to 25.93in June. Increase in yield continued and in July it increased to 36.875. The yield declined to 15.20 in August. For the covered crop the yield was 8.10, 14.33, 19.12, and 6.50 Kg. The total yield from the whole growing season was 69.96 Kg for the uncovered plot while 48.05 Kg was for the covered plot. Analysis of the data showed that month-wise and seasonal data were significantly different between covered and uncovered plots.

Table 5. Effect of pollinator on the total yield (kg) of cucumber of during 2019

Treatment	May	June	July	August	Total
Uncovered	18.035	25.93	36.875	15.20	96.96
Covered	8.10	14.33	19.12	6.50	48.05

Recorded pollinator species of cucumber

The following insect species were recorded as pollinators of cucumber.

S.No	Common Name	Technical Name
1	AK Butterfly	Dainuschrysippus
2	Cubbage butterfly	Pierisbrassicae
3	Alfalfa butterfly	Coliaserate
4	Bumble bec	Bumbus species 1
5	Bumble bce	Bumbus species 2
6	Bumble bec	Bumbus species 3
7	Syrphid fly	Syrphis species
8	Small bee	Apis florae
9	Rock bee	Apiscerana
10	Giant bee	Apisdorsata
11	European bee	Apismellifera

Recorded pollinator species

During the study 11 pollinator species were recorded. These include: three Bumble bee species (Bumbus species I, Bumbusspecies2, Bumbus species 3), four honey bee species, 1 Apis florea, 2 Apis cerana, 3 Apisdorsata, 4 Apis. mellifera, three species of butterflies i.e. AK butterfly (Dainuschrysippus), Cabbage butterfly (Pieris brassicae), Alfalfa butterfly (Coliaserate) and a Syrphid fly (Syrphis species).

1. Bumble bees

Three species of bumble bees were recorded including Bumbussp., Bumbus sp. 2, Bumbussp. 3. These insects are very effective pollinators. Linsely (2008) reported these insect as pollinators of cucurbits. Faegri and Valido (2005) stated that bumble bees are very effective pollinators because of their pilosity. They further stated that bumble bees can work in unfavorable weather as compared to honey bees.

2. Honey bees

Four species of Honey bees including Apisflorea, Apiscerana, Apismillifera and Apisdorsata were recorded visiting the cucumber flowers. Schultz (2006) showed that honeybees form 95 % of insects visiting on the cucurbits (bitter gourd, cucumber etc.). This shows that cucurbits are good forage for bees and in return they pollinate theflowers.

3. Butterflies

Butterflies are diurnal visiting different flowers during day time. These insects are less efficient in pollinating the flowers. Due to their thin legs, butterflies cannot pick up much pollen as compared to behaving specialized pollen collecting legs. The adults of butterflies are harmless but their larvae are often pest of crop (Olison, 2006). Based on the statement of Olison, butterflies cannot be relied upon for efficient pollination and the services of other efficient pollinators will be required for efficient pollination of cucumber. Three species of butterflies Daniuschrysippus, Pieris brassicae and Coliaserate were recorded visiting cucumber flowers.

4. Syrphid fly

One syrphidfly species (Syrphissp.) was recorded frequently visiting the cucumber flower. According to Barkrneyer (2009) syrphid flies are among the efficient pollinators visiting flowers for pollen and nectar.

DISCUSSION

Role of pollinators in enhancing yield and quality of crops is a much researched subject. Insect pollination of flowers is an essential step in the sexual reproduction of cucurbits and Angiosperms. Most angiosperm species rely on insects or other animals, rather than wind, for transfer of pollen among individual plants. The pollinators in-turn benefit by obtaining floral resources such as nectar or pollen. Pollination is not only mutually beneficial to the interacting plants and animals, but also serve humanity directly through the yield of many crops, and indirectly by contributing to the healthy functioning of unmanaged terrestrial ecosystems (Bohart, 2006).

Most of cucurbit species are monocious i.e. having separate male and female flower on the same plant. For good fruit set the services of pollinators are necessary for cross pollination. According to Thomson (2006) pollinator insects are the most source of increase yield of cucumber, pumpkin and bitter gourd. He also stated that natural pollination as well as cross-pollination as a combined method gives great yield as compared to the natural pollination. In the present experiments yield of cucumber was compared between two plots i.e. plots uncovered to natural pollinators and plots caged to restrict the entry of pollinators.

Yield data showed that significantly more yield was obtained from plots that were uncovered and pollinators freely visited the flowers all the times. Tables 1to 5 show that yield is consistently and significantly higher in insect pollinated plots throughout the growing season. Decline in yield in August could be due to the fact that the crop was reaching maturity, therefore less fruit set and yield was recorded. However, the yield in this stage was also significantly higher in insect pollinated crop. Fruit set also occurred in caged plots i. e without insect pollination. This could be due to pollination done by wind. Sneep (2006) reported that natural pollination as well as cross-pollination as a combined method gives great yield as compared to the natural pollination. This shows that fruit set is also done by some natural pollination done by wind.

The reason for the more yield was assumed that pollinators are involved for the higher yield because of frequent visits of the pollinators (Bees, Butterflies, Bumble Bees etc.) to the uncovered plot. While the low yield was due to no access of the pollinators to the covered plot and hence pollination did not take place and as a result low yield was obtained during the whole research.

Our findings regarding the increase in yield due to pollinators are in agreement with those of the Labergeet al. (2006) who recorded 60 percent increase in the yield of cucumber. This may be due to the full utilization of pollinators. Similarly, Wafa et al. (2007) reported increase in the yield per acre of cucumber vegetable in the uncovered fields that were uncovered. In another study, Parker (2006) found that crops caged with pollinators produced 25 percent more yield than those crops which were caged without pollinators in a research conducted for the one year.

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