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Saboor Naeem
Department of Agriculture, Hazara University, Mansehra, Pakistan

Sajjad Ahmad
Department of Entomology, The University of Agriculture, Peshawar, Pakistan

Mehmood ul Hassan
Department of Agriculture, Hazara University, Mansehra, Pakistan

Muhammad Adil
Department of Agriculture, Hazara University, Mansehra, Pakistan

Muhammad Adil Younis
Department of Agriculture, Hazara University, Mansehra, Pakistan

Muhammad Azeem
Department of Agriculture, Hazara University, Mansehra, Pakistan

Muhammad Ibrahim Tahir
Department of Agriculture, Hazara University, Mansehra, Pakistan

Correspondence
Saboor Naeem
Department of Agriculture, Hazara University, Mansehra, Pakistan

Role of pollinators in pea (*Pisum sativum*) yield at Peshawar valley

Saboor Naeem, Sajjad Ahmad, Mehmood ul Hassan, Muhammad Adil, Muhammad Adil Younis, Muhammad Azeem and Muhammad Ibrahim Tahir

Abstract
The study was conducted at New Developmental Farm (N.D.F), The University of Agriculture, Peshawar, Pakistan, during the year 2015 to determine the role of insect pollinators on pea yield, seed weight and mass in Randomized Completely Block Design (R.C.B.D). The experiment was comprised of two treatments i.e. Pea plants in caged condition (T1) and pea plants in open condition (T2), which were replicated thrice. In each replication one treatment was caged with nylon cloth having mesh no. 49/cm^2 before flowering stage. Pea pods were picked five times in the whole fruiting season and were taken to laboratory, to determine the yield, hundred grain weight and mass. The yield was converted to kg/ha. Higher yield, weight and mass of 2538.8kg/ha, 55.34grams and 53.3ml/100grains respectively of peas were found that were collected from the treatments of open condition as compared to the treatments of caged condition.

Keywords: Insect pollinators, nylon cloth, yield, open condition

1. Introduction
Pea is grown in most part of the world. After soybean and common beans it is the world's third most significant legume grain [1]. In Asia it is cooked as vegetable and use in preparation of soup. Progressive farmers get good profit in pea farming. Green peas can also be grown in controlled environment like greenhouse and polyhouse [2].
One pound of green peas contains 36.1 g carbohydrates, 13.7g protein, 8g fat, 54 mg ascorbic acid, 45 mg calcium and 29 mg phosphorus [3]. Pea is grown for human consumption due to its qualities of higher proteins content i.e. 20-27% on average, balanced amino acid composition, good taste, easy digestion and its good production in suitable pea cultivated areas. Pea seeds are processed to make cereals, flour and green peas etc. From last few years the importance of peas as a grain fodder, green fodder and as a source in hay production has greatly increased. Pea fixes nitrogen, therefore it is considered very beneficial for the treatment of land and also good to the forerunner to next crop also. It can also be used as manure [4, 5].
Studies have shown a very positive impact of pea on human health. It has been found that green peas are very much useful in lowering blood sugar and increasing insulin level [6]. Peas are helpful in anti aging of the skin and tend to provide a natural glow to the skin. The antioxidants which are present in it such as flavonoids, catechin, epicatechin, carotenoid, alpha carotene etc. are helpful in preventing the aging process of skin. High levels of antioxidants in peas prevent several reactions in the body that may cause serious diseases. It is a rich source of many important minerals, which enhances the immune system of our body. Vitamin K present in peas helps in the prevention of serious diseases like Alzheimer's and arthritis. In Alzheimer's afflicted patients, regular consumption of peas limits neuronal damage in the brain [7].
Scientists on the basis of their present research recommend pea as a better option to cure cardiovascular diseases in the future as it is a good source of omega-3 fat in the form of alpha-linolenic acid [8]. Recent researches in Mexico have found that daily intake of pea with other legumes reduces the risk of stomach or gastric cancer [9]. In Pakistan the life span of pea plant of local variety is three months. It is sown during winter to start of a summer, but it mostly depends on the temperature and the environment of an area. Average pea ranges from 0.1 grams to 0.36 grams in weight [10].

In 2015, China has the largest volume of green pea out with 10,821 thousand tons, accounting for 61% of global production followed by India with 3997 thousand tons [11]. During 2011-2012 in Pakistan total production of pea was about 105 thousand metric tons, which was obtained from 15800 hectares of cultivated land [12], while in 2015 Pakistan ranked 9th with 122 thousand tons [11]. During the year 2013-2014 total area under cultivation of the pea crop in Khyber Puktunkhwa was 1865 hectare and production was 13058 tons with an average yield of about 7002 kg per hectare [13].

Pea is a cool season crop, grows vigorously at 12 to 18ºC and able to survive low temperature at seedling stage, it require well drained loamy soil rich in organic matter. The optimum pH ranges from 6.0 to 7.5 [2]. Commonly, in Pakistan it is cultivated in winters and summers of Northern areas. Its contribution in pulses trade is about 40% [14].

2. Material and Methods

Size of the experimental field was 7m x7m. The experiment was laid out in Randomized Complete Block Design (RCBD). A common vining culture of Pea *Pisum sativum* was sown.

The experiment was comprised of two treatments with the size of (3m x 2m). Each treatmentwas replicated three times. Treatments of the experiment were as follows:

T_1; Pea plants in caged condition.

T_2; Pea plants in open condition.

The distance between treatments was 50cm both vertically and horizontally. In each replication one treatment was left open for pollinators to visit the flowers and one was caged with nylon net before flowering stage to stop pollinators from visiting the flowers. Standard agronomical practices were applied during the research work.

2.1 Yield (kgha^{-1})

Yield from open and caged treatments was determined through electrical balance and converted into kgha^{-1} by using the equation.

$$\text{Yield (kgha}^{-1}) = \frac{\text{Yield plot in kg}}{\text{Area of sub plot (m}^2)} \text{x} 10000 \text{ m}^2$$

2.2 Hundred Grains Weight (H.G.W)

Hundred grains were collected from each treatment of all the replications and weighted by electrical balance in grams.

2.3 Hundred Grains Mass (H.G.M)

Hundred seeds were taken from each plot and then their size was determined.

Size was found according Archimedes principle through Eureka container i.e. "volume of any object immersed in water placed in a container is equal to a volume of water displaced" [15]. The water displaced was collected in a graduated cylinder to measure the volume/mass of 100 seeds in ml.

2.4 Caging of Treatments

Three treatments i.e. one in each replication, was caged by nylon cloth having mesh no. 49/cm^2.

2.5 Statistical Analysis

The collected data were subjected to statistical analysis. Significance of the data was tested at 5% level of significance by using ANOVA, for further highlighting significance of variance among each treatment R.C.B.D test was applied.

3. Results and Discussion

3.1 Role of pollinators in Pea Yield at Peshawar valley

Pods were picked separately from each treatment replication upon its maturity and were taken to a laboratory for measuring the yield, 100 grains weight (HGW) and 100 grain mass (HGM). On completion of picking (5 times) the yield was calculated and converted to kg/hectare. The data were then subjected to statistical analysis. The results are given in Table 1 and their complete analysis in appendices No. 1 to 3.

3.2 Yield/hectare (kg)

The Table 1 shows that a yield of 2732.2 kg/hectare was obtained from the Pea plants which were caged with net having no entry of pollinator i.e. T1, while those that were left open (T2) have a yield of 2538.8 kg/hectare.

Statistical analysis of data shows significant difference between yield of T1 and T2.

3.3 Hundred Grains Weight (HGW)

From the Table 1 below we infers that the mean weight of the 100 seeds collected from the peas of a treatment plots in caged condition (T1) was 54.46 grams. The mean value of weight obtained from 100 peas was raised to 55.34 (gm) of plants in open condition (T2).

The statistical analysis shows a significant difference between T1 and T2.

3.4 Hundred Grain Mass (HGM)

The Table 1 indicates that mean 100 grain mass of pea from the plants in caged condition (T1) treatment was 53.3 ml. The mass of the Peas was 55 ml in the treatment of plants in open condition (T2).

The results of analysis shows that the hundred grain mass of peas collected from both the treatments are significantly different from each other at $P \leq 0.05$.

Table 1: Role of pollinators in insecticide treated and untreated fields yield/hectare, weight/100 seeds and 100 grain mass.

S. No.	Treatments	Yield/hectare (kg)	Hundred grain weight (gm)	Hundred grain mass (HGM) (ml)
1	Pea plants population in caged condition (T1)	2372.2	54.46	53.3
2	Pea plants in open condition (T2)	2538.8	55.34	55.0

Our results show an agreement with the findings of Irshad and Stephen (2014) [16]. They found that pollinators aid very much in sexual and augmented seed production and high yield. They further stated that globally pollinators are worth 217 billion US $. Vaz *et al*., (2013) [17] concluded that the absence of pollinators resulted in a considerable decrease in yield of cowpea *Vigna unguiculata.* They suggested that the fertilization ratio in un caged conditioned plants (open to pollinators) was more than plants in caged condition which is in accordance to our study. Our results are at par with findings made by Karanja *et al*., (2013) [18] who determined that pollinator has a great role in coffee production.

Our findings show resemblance with the study done by Douka and Fohouo (2013) [19] on the effect of *Apis melifera* as a

pollinator on yield of *Phaseolus vulgaris*. They reported highly improved fruiting rate, number of seeds and pods in flowers that was accessed by that particular pollinator. Pole *et al*., (2012) [20] concluded that the yield is highly dependent upon visiting of *Apis melifera* in the crop. They suggested that more frequently the visits made by bees in the plants, higher will be the production and thus have similar findings with ours. Our study shows concurrence with the findings made by Rashmi *et al*., in 2010 [21]. They noticed maximum pod set, length and volume, seed and100 pod weight, seed size and number of seeds/pod of pigeon pea (CMS line) in open condition of plants.

Garbaldi *et al*., (2009) [22] observed that in the absence of pollinators yield is reduced by 95% in those crops which are highly pollinators dependent, while a decrease in production of the crops that are moderately dependent was 65% averagely. Abrol (2007) [23] found that insect pollination contributes very much in the yield of rapeseed and mustard and thus shows concurrency to our result.

4. Conclusion and Recommendations

Pollinators have a major role in yield of pea at Peshawar valley. They are also the important contributor in higher hundred grain weight and mass. Less pea yield with less pea weight and size was recorded in the plots where pollinators were prevented. Success of pea plant as food depends upon the prevalence of insect pollinators in the fields. Farmers are advised to avoid all those practices which can harm and reduce the activity of pollinators. They should encourage bee keepers to place their bee hives near to their fields, such that to enhance the pollination, more ever, biological control agents should be used by the farmers for the control of pests.

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