

Research Article

Pollen and nectar collection preferences of the European honeybee (*Apis mellifera* Linnaeus)

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Abstract

The current experiment was carried out at Agricultural Research Institute (ARI) Tarnab Peshawar, Pakistan during 2021. The main focus of the research was to study the pollen and nectar collection behavior of the European honeybee (*Apis mellifera*) and types of pollen collected in all four season of the year. The foraging behavior was recorded at different intervals of day (8am, 10am, 12pm, 2pm and 4pm). The recorded timing was 1 mint per hive. The results showed that during morning (8am and 10 am) hours, the pollen collection was high as compared to the nectar collection in all seasons. After 12pm pollen collection by the honey bees significantly decreased while an increasing trend was observed in nectar collection, which further remained high until 4pm in all seasons of the year. In summer, the bees start going outside the hives at 8am, while in winter the outgoing activities are little late. In all season the hive collected ten types of pollen with highest amount of pollens in spring season followed by summer season. Lowest pollen collection was recorded in the winter season. Among them maize (*Zea mays*) pollen was highest (35%), followed by brassica and clover (15%). For *Acacia modesta*, *Heliantus annuus* and *Ziziphus jujuba* the collected pollens percentage was recorded as 10%. Approximately 5% of the collected pollens were mixture of from wild plants/weeds.

Keywords: *Acacia*; *Brassica*, Foraging; Nectar; Pollen; *Zea mays*

Introduction

Every living organism in the universe has different requirements for growth and development. Honey bees (*Apis mellifera*) also require nutritional diets. The energy and nutrition requirements are met by two distinct resources i.e. nectar and pollens. Individuals use information on colony pollen levels to closely adjust pollen

foraging activity homeostatically in relation to colony nitrogen requirements [1, 2]. In honey bee colonies, there is division of labor and age ployestism. Young bees remain inside the colony while adult bee collect nectar, pollen and water [3]. The honey bee aging less than 14 days remain inside the colony, on other hand the bee workers initiate foraging behavior when their age

become more than to 2-3 weeks [4]. The average foraging life of a bee has been estimated as less than seven weeks in summer, because of the many risks and severe metabolic costs associated with foraging [5]. Honey bees are important for plants as they pollinate the flowers and improve the quantity and quality of the production. Approximately 70 different types of plants are pollinated by the honey bees. Honey bees not only produce honey but other products of high economic importance i.e. royal jelly, propolis, wax, pollen and venom [6].

Adult bees produce Ethyl oleate and they transfer ethyl oleate to young hive bees via trophallaxis, which delays the age at which they begin foraging [7]. Foraging models traditionally have focused on currency measures based on the energetic return [8]. However, social insect foragers must obtain a range of nutrients, one of the most important of which is protein. Protein in honey bees is collected from plants as pollen [4]. Plants have different types of protein content in the pollen. Honey bees collect pollen all the year to meet their requirements and store in the frames along with honey for the brood rearing [9]. Pollen storage levels may have a more directly measurable effect on colony fitness than honey because they are related to immediate colonial growth/brood production [10, 11].

In honey bees, population growth is the best predictor of a colony's ability to overwinter and reproduce by swarming [12]. High foraging and collection of pollen and nectar increases brood production and colony strength. Nectar is mixed with pollen and fed to the brood for rearing and keeping them healthy. This mixture also fulfills other dietary requirements for vitamins, minerals and lipids. The queen is fed with the royal jelly produced by the glands of the young workers [13, 14].

Nectar is the primary energy source of the colony, providing the raw fuel for the activities of all colony members. Not only are nectar and pollen utilized differently by honey bee colonies, but each is collected in a unique way. Colonies typically recruit more foragers to the task of nectar collection than pollen collection, and only a small percentage of foragers collect both resources simultaneously [15, 16]. The behaviors of nectar and pollen foragers are different, as nectar foragers collect nectar from flowers only while pollen foragers collect pollen, learned from the colony [17]. As a result, only nectar foragers receive direct qualitative information about the resource they are collecting, allowing them to optimize their foraging behavior [18]. The current research was carried out with the objectives of the pollen and nectar collection ability of honeybees and collected pollen types in Peshawar valley.

Materials and Methods

Study site

The present study was conducted at the Agriculture Research Institute Tarnab, Peshawar, Pakistan from March-December 2021. The fields near the hives having different crops/orchards.

Pollen and nectar preferences

A total of 16 boxes of the European honey bee (*Apis mellifera*) was kept for the study near the field. Equal size of the colony and newly mated queens were selected for the studies. The data was recorded on five colonies and the average was then calculated. The bee colonies were inspected weekly. Healthy colonies were selected for the study having 7-8 frame bees. The data was recorded at different intervals i.e. 8am, 10am, 12pm, 2pm and 4pm. The no. of pollen and nectar foragers were recorded per minute.

Pollen type

The pollen was collected with the help of pollen trap and was separated based on color

and was further identified using the pollen identification key. The overall weight and each pollen type/color weight was recorded.

Statistical analysis

The recorded data were subjected to statistical analysis using computer program Statistix. LSD was applied on means.

Results and Discussion

The pollen and nectar collection preferences in spring season 2021 is presented in (Fig. 1). Pollen collection was high at 8 am (8 foragers/minutes) and significantly high at 10 pm (12 foragers /minutes) and significantly reduced at 12 pm, 2 pm and 4 pm with 10, 8 and 6 foragers per minute respectively. On other hand nectar collection was lowest at 8 am (7 forager/minute) and 10 pm and increases significantly at 12 pm (12 foragers /minutes), 2 pm (18 foragers /minutes) and 4 pm (12 foragers/minutes). A Significantly higher number of pollen collectors were recorded at 8am and 10 am in summer seasons. The trend decreased with time. On other hand a significant increase of nectar collectors was recoded a12 pm, 2 pm and 4 pm, which was lowest at 8 and 10 am in morning (Fig. 2).

The (Fig. 3), shows data regarding fall foraging of honey bee colonies. In fall season no significant different were recorded in both foragers at 8 am and 10 am. At 12pm a significantly increase in number of nectar collectors were recorded. For nectar the collection was slow in start at 8am and 10 am and increased significantly at 12pm, 2pm and 4pm. In winter due to low temperature low nectar and pollen foragers were recorded at 8am with no significant difference between both foragers. The number increased at 10am and 12pm for pollen and then decreased at 12 pm. A high number of pollen foragers were recorded at 12pm, 2pm and 4pm. highest nectar foragers activity was recorded at 12pm and 2pm (Fig. 4).

The honey bee colonies collected a 10 types of pollen during all the foraging seasons. Pollen collection was high in spring season followed by summer. In fall the pollen amount was less compared with other two seasons. In winter very limited amount of pollen was collected by the colonies as there were few flowering plants. Maize pollen was the most abundant by percentage in late spring and summer season. The total percentage was 35%, followed by brassica and clover with 15% share each. *Acacia modesta*, *Heliantus annuus* and *Ziziphus jujuba*. percentage were only 10%. The bee colonies also collected pollen from other plant sources like wild flower plants/weeds. Their combine percentage was 5% of the total collected pollen amount (Fig. 5).

Our studies show that the pollen foragers were high in early part of the day at 8 am and 10 am and then decreased with increase with time 12pm, 2pm and 4 pm. The nectar foragers were lowest at 8 am and 10 am and significantly increased at 12pm, 2pm and 4pm. These results are in similarity with those of earlier studies done by [14]. They recorded significantly higher number of pollen foragers at 8am and 10 am. Further they also recoded that the nectar forager increased at 12pm onward. This may be related that due high amount of pollen availability. A similar result was also obtained by Camazine [1], who reported high pollen collection in the morning and then gradually decreased. Further he reported high nectar collection in after noon timing. Fewell and Winston [19] also reported high nectar collection in after noon timings. They related this behavior with the colony requirements.

The foraging behavior of *Apis cerana* and *Apis mellifera* and different day timings. They found peak pollen at morning time and high nectar foragers at noon [20]. Thorp [21] studied pollen collection by bees and found that bees collect pollen in early timing. The

reasons for higher pollen collection in early morning due to the new opening of the flowers which contain pollen and are not visited by the bees. Another reason could be the temperature at morning, the temperature is low, and pollen are in powder form. Takkis *et al.* [22] studied that flowers have nectar glands and secretes nectar as a reward for the visitor for pollination job. Nectar secretion is linked with high temperature and sun light. With increase in temperature the glands start secretion of the nectar which usually starts at 10am and last till 2pm in

noon. In our studies we recorded high nectar foragers and this could be the main reason for high nectar foraging at noon time as high amount of nectar in flowering plants is available. Abou-Shaara [23] also reported that pollen foragers are high in morning due to high amount of pollen in morning, which gradually decrease and nectar increases in noon due to the secretion of flowers which enhance nectar foraging. Ghosh *et al.* [9], also reported that there is negative correlation between pollen collection and high temperature.

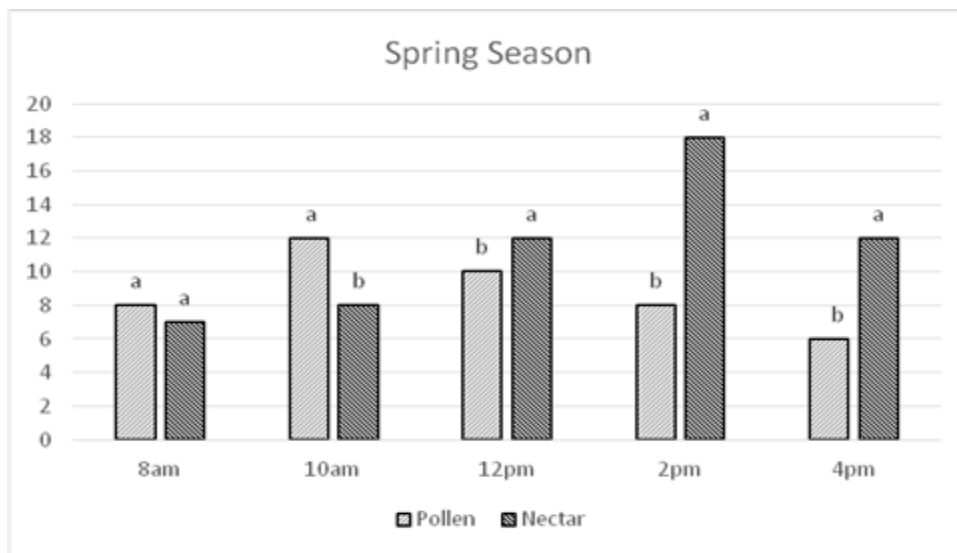


Figure 1. Pollen collection, nectar collection and outgoing bees during spring season

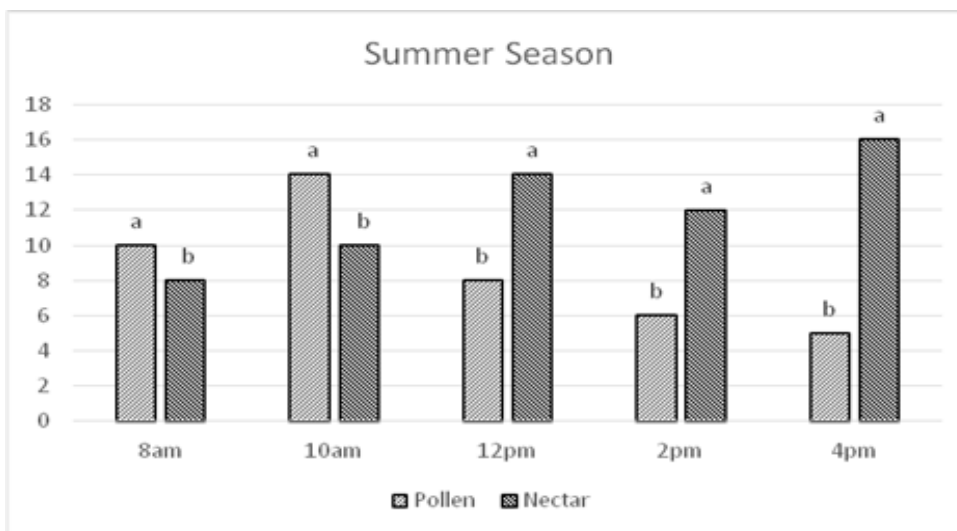


Figure 2: Pollen collection, nectar collection and outgoing bees during Summer Season

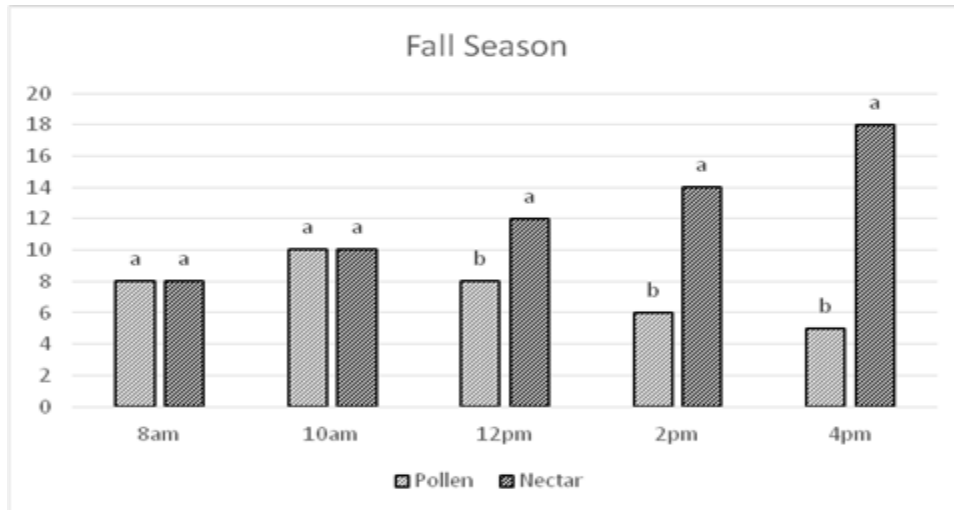


Figure 3: Pollen collection, nectar collection and outgoing bees during fall Season

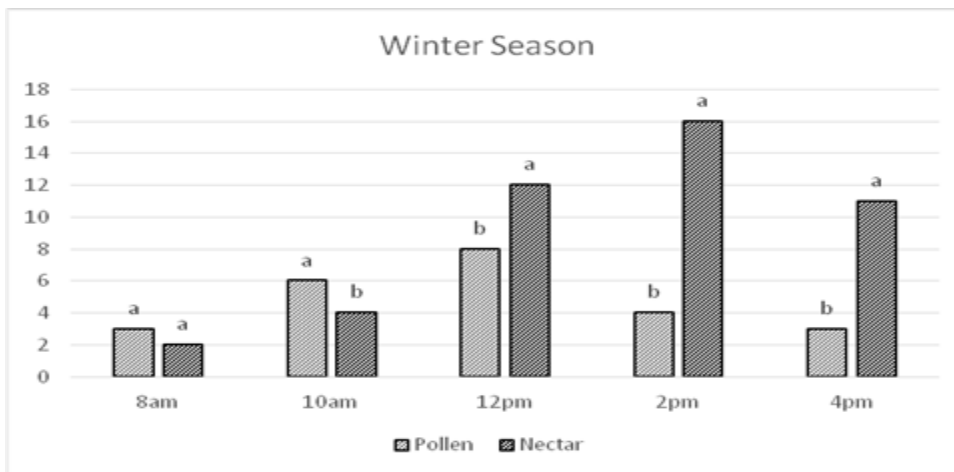


Figure 4: Pollen collection, nectar collection and outgoing bees during winter Season

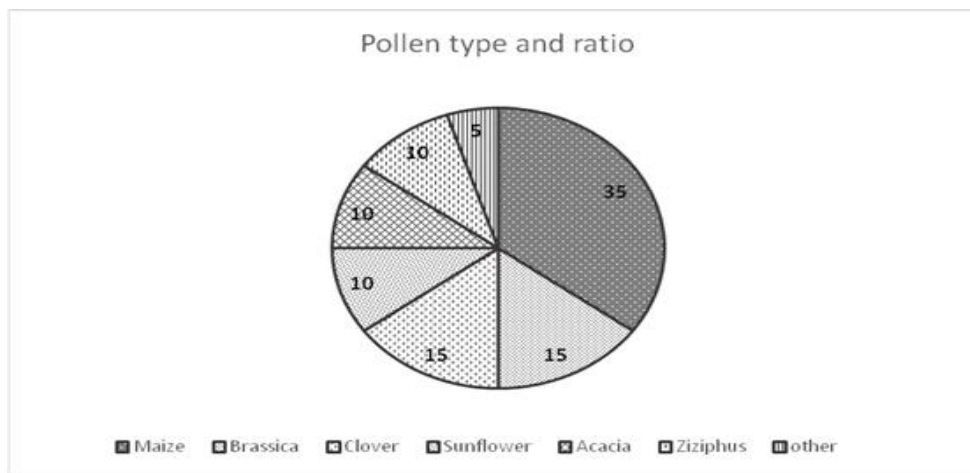


Figure 5: Type and Percentage of Pollen types collected by the bee colony through the study

In this study a more than 10 types of different pollen were collected during spring and summer seasons. Very low amount pollen collection was recorded in fall and winter. A similar observation was also recorded by Hassan *et al.* [10]. They reported high number of pollen collection by bees in spring and summer seasons. The reasons are many plants start blooming in spring seasons which provide high amount of pollen to bees. In spring mostly brassica, acacia and other wild flowers and plants start flowering. Said *et al.* and Omoloye and Akinsola [24, 25] reported that foraging and pollen collection varies in different seasons and it also depends on type of flowering plants. Some plants are rich in pollen production while other in nectar secretion. In our studies high percentage of maize pollen was recorded. The reason is that maize plants has highest amount of pollen compare to other flower plants. Brassica, clover, acacia and sunflower also produces pollen but lesser in amount as their flowers has more nectar. Protein and lipid required for the colony is mainly fulfilled by consuming the pollen [9]. Further studies should be carried out in different localities to recorded the pollen preferred by honey bees for collection and their duration.

Conclusion

It is concluded from the study that high pollen foraging was recorded before 12 pm and high nectar foraging was started after noon. A total of ten types of pollen were collected in all season, with the highest percentage of maize pollen followed by brassica and clover. Pollen collection was high in the spring and summer season.

Authors' contributions

Designed the experiment: M Afzaal & H Ali, Helped in recorded the data and analysis: F Amin, M Younus & M Israr, Wrote the manuscript: M Afzaal, H Ali, F Amin & M Younus.

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