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Research Application Summary

Effects of honeybees pollination on sunflower seed quality and yield attributes

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Abstract

The current study examined the effects of honeybee pollination on sunflower seed and yield quality. It was conducted in two separate sites. Two treatments, honeybee pollinated and open pollinated sunflower plants assigned in a RCBD with three replicate were used. Honeybee pollination improved Seed viability in terms of germination percentage (P≤0.0001), Days to 50% germination (P≤ 0.0008), Germination rate (P≤ 0.025). Seedling plant height (P≤0.003), seedling root length (P≤0.04) and seedling shoot/root ratio (P≤0.02) were positively affected by honey bee pollination, Pollination by honey bee significantly enhanced the yield attributes such as head diameter (P≤0.000), dry weight of 100 seeds (P≤0.000), 100 seed volume (P≤0.000) and number of seeds per kg seeds (P≤0.01). Seed moisture content varied significantly (P≤0.03) between the two treatments whereas seed total oil content (%) did not vary significantly. The study recommends that sunflower producers establish honeybee colonies adjacent to their farms to gain extra yield and income from bee honey products and pollination.

Keywords: Honeybee, pollination, sunflower, Sudan, West Kordofan

Résumé

La présente étude a examiné les effets de la pollinisation par les abeilles sur la qualité des graines de tournesol et le rendement. Elle a été réalisée sur deux sites distincts. Deux traitements, des plantes de tournesol pollinisées par les abeilles et des plantes pollinisées de manière ouverte, ont été assignés dans un dispositif en blocs complètement randomisés avec trois répétitions. La pollinisation par les abeilles a amélioré la viabilité des graines en termes de pourcentage de germination (P≤0,0001), de jours jusqu'à 50 % de germination (P≤0,0008) et de taux de germination (P≤0,025). La hauteur des plants au stade de la plante (P≤0,003), la longueur des racines des plants (P≤0,04) et le rapport entre la partie aérienne et les racines des plants (P≤0,02) ont été positivement affectés par la pollinisation par les abeilles. La pollinisation par les abeilles a également considérablement amélioré les attributs de rendement tels que le diamètre de la tête (P≤0,000), le poids sec de 100 graines (P≤0,000), le volume de 100 graines (P≤0,000) et le nombre de graines par kilogramme de graines (P≤0,01). La teneur en humidité des graines a varié significativement (P≤0,03) entre les deux traitements, tandis que le contenu total en huile des graines (%) n'a pas varié de manière significative. L'étude recommande aux producteurs de tournesol d'établir des colonies d'abeilles à proximité de leurs exploitations pour obtenir des rendements supplémentaires et des revenus grâce aux produits de miel des abeilles et à la pollinisation.

Mots-clés: Abeille, pollinisation, tournesol, Soudan, Kordofan occidental

Introduction

Sunflower (*Helianthus annuus* L.) is the fourth most important oil seed crop in the world trade with annual production of about 9 million tons in cultivated area of over 22 million hectares (Elsheikh *et al*., 2015). It is one of the important oil crops in the world. In Sudan, sunflower is a promising oilseed crop which can be used for many purposes, mainly for edible oil extraction, animal feed and human food (Ahmed *et al*., 2017). The seed of sunflower has high oil content (40-50%) and 30% digestible protein. It can be grown as summer or winter crop under rain-fed and irrigated conditions (Elsheikh *et al*., 2015). Native and early varieties of sunflower were self-incompatible requiring insect pollination for economic seed set and yields. In most sunflower hybrids, seed set, oil percentage, yield and oil content increase when pollinators, primarily honeybees (*Apis mellifera*), are present. In Sudan, due to failure in pollination, the yield of sunflower dropped down to about 300-529 kg/ha during the years 2008-2009 in Blue Nile, Elgedarif and Sinnar States (Altayeb and Nagi, 2015).

Honeybees play an important role in crop production through their efficient pollination in addition to local biodiversity conservation. Several previous studies documented the role of honeybees as pollinators in crop production, including sunflower (e.g Nderitu *et al*., 2008). The current study was undertaken to evaluate the effects of honey bees pollinators on sunflower seeds, seedling growth and yield components in rainfed area of West Kordofan State, Sudan.

Materials and Methods

The study was undertaken at the farm of the University of Alsalam in Elfola Town, Sudan. The two treatments: honeybee pollinated and open pollinated sunflower plants were assigned in a randomized block design with four replicates. The study was conducted in two sites, one of them in Alsalam University Apiculture farm and the second site in the farm of Ministry of Production and Economic Resources as open-pollinated control. Seeds of sunflower Cultivar Hysun33 were used.

Germination percentage, days to 50% germination and germination rate were examined. Seedling growth in terms of seedling height, shoot growth, root growth and shoot/root ratio were recorded. Head diameter (cm), 100-seed volume (ml), 100-seed dry weight (g) and number of seeds per kg seeds were also recorded. Seed total oil content (%) and moisture content (%) were recorded. Data were analyzed using Graph Pad-InStat (version 3.3). T-test was performed to differentiate between means of the two treatments.

Results and Discussions

Seed viability, days to 50% germination, Germination rate. As shown in Table 1, germination percentage, days to 50% germination and germination rate of seeds of honeybees' pollinated sunflower plants versus openly-pollinated ones were highly significantly different ($P \leq 0.0001$), ($P \leq 0.0008$) and ($P \leq 0.025$), respectively. Previous studies (e.g. Venata *et al*., 2014) indicated that the germination percentage was significantly enhanced by honeybee pollination on sunflower. Days to 50% germination was shorter for pollinated seeds whereas un-pollinated seeds took significant longer time to reach 50% germination. This could presumably be ascribed to the fact that pollinated seeds were larger in size and weight which might accelerate germination process in terms of availability of stored food materials releasing energy for the growing embryo. Germination rate per day for pollinated plant seeds was also faster than that of open pollinated ones. Seed size and volume positively affected germination parameters.

Plant seedling vigor. As depicted in Table1, the honeybee pollinated seeds gave significantly higher seedling plant height (P≤0.003), root length ((P≤0.04)) and shoot/root ratio ((P≤0.02)) in contrast to openly-pollinated seeds. It is known that good plant vigor is a function of good seed quality. It was noted in this study that there were significant differences between Seedling root and shoot lengths, seedling shoot/root ratio consistent with previous findings reported by Rajasri *et al*. (2012) that root length, shoot length and seedling germinating under honeybee pollination was higher compared to under open pollinated ones.

Sunflower yield attributes. Significant higher values were obtained in honeybees pollinated sunflowers in terms of plant head diameter (P≤0.0002), 100-seed dry weight (P≤0.000), 100-seed volume (P≤0.000) and number of seeds per kg seeds (P≤0.01) as compared to in unpollinated sunflower (Table 2). It seems plausible that empty seeds, a frequent phenomenon in sunflower heads, might primarily be due to lack of or poor pollination which decrease seed dry weight and hence yield. It was documented that sunflower seed yield was increased by 43% when pollinated by honeybees (Chambo *et al*., 2011).The current result agrees with previous study by Altayeb and Nagi (2015) who pointed out that pollination by honeybees increased sunflower 100-seed weight as compared to hand pollination and other pollinating insects. Earlier, Oz *et al*. (2009) pointed out that honeybee pollination of sunflower hybrid seeds improved seed set ratio, 100-seed weight, number of filled seeds per head and seed yield per head.

Table 1. Effects of honeybees pollination on Sunflower seed viability and seedling vigor

Germination parameters	Honeybee pollinated seeds	Open-pollinated seeds	P- Value
Germination %	91.4 ±4.3	34.4 ±6.21	0.0001
Days to50% Germination	4.8 ±2.4	11.4 ±1.90	0.0008
Germination rate per /day	3.1 ±0.25	2.3±0.35	0.0025
Seedling plant height(cm)	4.8 ±0.82	3.8 ±0.58	0.002
Seedling root length(cm)	24.2 ±3.69	16.1±3.46	0.040
Shoot/ root ratio	5.3 ±0.87	4.1±0.57	0.016

Table 2. Effects of honeybees pollination on some yield attributes of Sunflower

Yield attributes	Honeybees pollinated seeds	Open pollinated seeds	P-Value
Head diameter(cm)	19.8 ±0.65	15.5±1.73	0.0002
100 seed dry weight (g)	8.5 ±0.37	7.4 ±0.35	0.0002
100 seed volume (ml)	11.7 ±1.16	9.7 ±0.58	0.0004
Number of seeds per /kg seeds	12305 ±515.06	14312 ±575.39	0.0108
Oil content (%)	43.6±4.52	38.4±2.01	0.140
Moisture content %	7.2 ±1.80	4.00±0.42	0.030

Seed oil and moisture content. The results showed that the seed total oil content (%) was not significantly (P≤0.14) different between the two treatments. Moisture content, in turn, varied significantly (P≤0.03) between the two treatments (Table 2). Due to limited resources in the lab, it was not possible to obtain total oil content using more than three replications. Therefore artifacts may have affected the result of oil content. However, previous studies revealed that seed moisture content of sunflower hybrids was not affected by seed oil content (Maza and Jayas, 1991).

Beekeeping community response. The response of farmers and beekeepers in North and West Kordofan States was tested in this study using a structured questionnaire where a purposive sample of 50 respondents was used. Gender wise, 96% of respondents were males, only 4% were females. Results showed that about 70% of the respondents were either beekeepers, farmers and concurrently worked as beekeepers and government employees practicing beekeeping. About 80% of them used modern honey production hives. Out of the responded persons, 72% produced honey and wax only whereas 12% produced royal jelly in addition to honey and wax. About 88% of the beekeepers used 2-3 honeybee colonies per 0.74 ha located inside and beside the farm. All respondents stated that pollination by honeybees improved their crops yield in terms of fruits size, seed size and seed shape, hence crop productivity was enhanced.

Conclusion and recommendation

The current study examined the role of honeybees as pollinators in improving sunflower seed quality and yield attributes. Farmers who do beekeeping in the study area, establishing honeybee colonies adjacent to their farms, confirmed the role of honeybee pollination in increasing crops productivity, both in quantity and quality. The study recommends that sunflower producers should establish honeybee colonies adjacent to their farms so as to gain extra yield and income obtained from bee honey pollination and products.

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