Full Length Research Paper

Effect of honeybee (*Apis mellifera*) pollination on seed yield and yield parameters of *Guizotia abyssinica (L.f.)*

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A flower of *Guizotia abyssinica* (L.F.) opens and liberates pollen early in the morning, the style emerges about midday and the plant is thus basically self-sterile. Hence *G. abyssinica* is a cross pollinated crop with cross pollination percentage ranging from 0 to 100 percent. Locally, the role of honeybees' pollination is still poorly understood and till now is not sufficiently appreciated. Hence, this experiment was carried out to evaluate the effect of the honeybee pollination on seed yield and yield parameters of *G. abyssinica* at the farm of Mekelle Agricultural Research Center. The study had three treatments; these were crops caged with honeybee, caged without honeybee and open pollinated. The obtained data related to seed yield and yield parameters were statistically analyzed using one way analysis of variance (ANOVA). The highest seed yield/ha was found in crops caged with honeybees (16.7 quintal) followed by open pollinated crops (13.3 quintal), while crops excluded from insects had the lowest yield (9.6 quintal). So the study discovers that honeybees and other insect pollination had a significant effect on seed yield of *G. abyssinica*. Therefore, it is recommended to keep sufficient number of honeybee colonies in the vicinity of *G. abyssinica* fields during its flowering period to increase the pollination efficiency and thereby enhance seed productivity.

Key words: *Guizotia abyssinica*, honeybee, insects, pollination.

INTRODUCTION

Guizotia abyssinica (L.f.) is one of the indigenous and important oil crops both for domestic and commercial uses in Ethiopia (Weiss, 2000; Ethiopian Ministry of Agriculture, 2011). It is commonly known as Ramtil, Kalatil, Gurellu, Tilangi, Neuk, Noog and Nug (Dhurve, 2008). *G.abyssinica* has the highest share and contributes up to 50% of the Ethiopian oil seed crop production (Weiss, 2000; Ethiopian Ministry of Agriculture, 2011). Honeybees visit its flowers for harvesting pollen and/or nectar (Haftom et al., 2014),

which in turn results into floret cross pollination (Dhurve, 2008).

G. abyssinica flower opens and liberates pollen early in the morning, while the style emerges about midday and the plant is thus basically self-sterile, although self-pollination has been recorded (Weiss, 2000). *G. abyssinica* is a cross pollinated crop with cross pollination percentage ranging from 0 to 100% depending on the genotype and other environmental factors (Subhas, 2005). However, the effect of insect foragers more
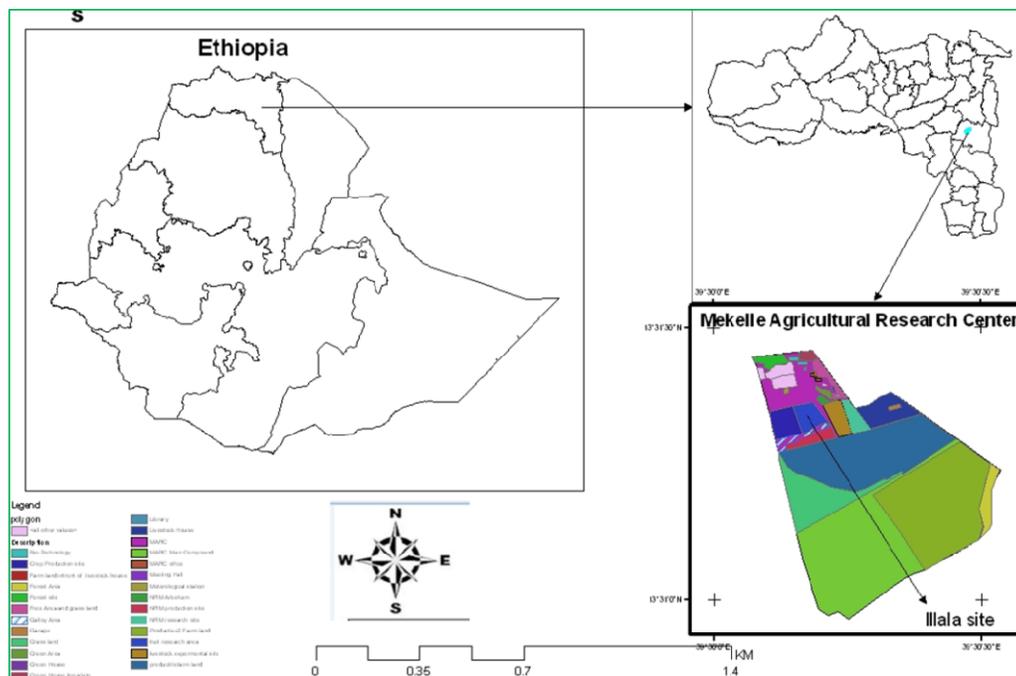
Figure 1. Location map of Mekelle Agricultural Research Center.

particularly honeybees have not so far been exclusively studied locally. Even honeybee pollination is important in crop production as water or fertilizer (Jacobs et al., 2006), local farmers keep honeybees for honey and/or wax uses only (Gidey and Mekonen, 2010). Moreover, the role of honeybees for pollination of the local farming systems is still poorly understood and till now not sufficiently appreciated (Jacobs et al., 2006). Despite local knowledge on the economic importance of honeybee pollination, it is also common to see insecticide application when honeybees are at high traffic. Hence, this study was designed to determine the effect of honeybee pollination on seed yield and yield parameters *G. abyssinica*.

MATERIALS AND METHODS

Description of study areas

The study was conducted during the 2013 cropping season at Mekelle Agricultural Research Center, Illala site (Figure 1). It is located North East of Mekelle at an elevation of 2012 m and at N13°31'21. 2" latitude and E39°30'14.7" longitude.

Experimental setup

For this experiment plants were grown with the recommended agronomic package practices. The crop was planted with a seed rate of 10 kg/ha, 40 cm distance spacing between rows and 10 cm distance between plants. Diammonium phosphate and Urea were applied immediately after sowing and tinning of seedlings at a rate

of 100 kg/ha, respectively. Tinning of seedlings was done two weeks after sowing. The study was conducted in a complete randomized block design (RCBD) with three treatments and four replications in an experimental plot size of 3 m × 3 m. The treatments were crops caged with honeybee (one colony of five combs), caged without honeybee and open pollinated (exposed to all insects including honeybees) (Figure 2). The cages were put immediately before the beginning of blossom and colony transferring was done at 5 to 10% flowering stage of the plant. This stage of flowering was selected to secured feed (pollen and nectar) for the honeybee pollinatores.

Number of head flowers, plant height and flowering period

The total number of flowers/plant was determined by counting the total number of head flowers. The height of the plant was measured from ground level to the tip of the longest branch with the help of a measuring tape. The flowering period of the plant was determined by recording the flower starting and ending date of the plants. Nine plants were selected to study the effect of mode of pollination on flowering period of the plant. To study the number of head flowers/plant and plant height ten plants were also selected.

Number of pods and seeds per plant and seeds per pod

Seeds were measured after drying the plants. The seed yield/ha was obtained by taking the weight of clean grains collected in the central area of each net plot (1 m by 1.2 m) in all treatments. To obtain the average number of pods per plant, samples were taken from five randomly selected plants from each plot. The number of seeds per pod was determined by taking five seed pods/plant from a total of five plants per plot. Evaluation of average weight of seeds was made through weighing of 1000 seeds. To know the total number of seeds/plant, the seeds were separated and counted manually.

Figure 2. The treatment: Crops caged with honeybee, caged without honeybee and open pollinated.

Table 1. Number of head flowers, flowering period and plant height.

Treatment	Number of head flowers	Height (cm)	Flowering period (days)
Open pollinated	52.6 (1.71)[b]	106.0	20.61[c]
Caged with honeybees	48.3 (1.67)[b]	108.4	24.58[b]
Caged without Insects	64.8 (1.79)[a]	108.9	28.78[a]
SE	0.02	2.0	0.71
LSD	0.04	NS	1.99
P value	<0.001	0.559	<0.001

Figures in the parentheses are head flowers per plant (Log (base10) transformed values. Means in rows followed by the same letter are not significantly different at P<0.05 probability level. NS =non significant

Harvesting time

Date of harvest was investigated by recording the number of days starting from its time of sowing to its time of harvesting. Time of harvest was identified by observing plants that start to shatter their seeds or plants that open their seed pods. The harvesting was made immediately after the seeds start to shatter.

Statistical analysis

The obtained data related to seed yield and yield parameters were statistically analyzed using one way analysis of variance (ANOVA) and least significant difference /LSD/ was calculated to identify the significant differences among the treatments means. The data for the number of seeds/pod, head flowers/plant and seeds/plant were subjected to ANOVA after data transformed using *log(base 10).* The data were analyzed using Genstat 14th version statistical software.

RESULTS AND DISCUSSION

Number of head flowers, flowering period and plant height

Flowering period and number of head flowers of *G. abyssinica* were significantly affected by the mode of pollination. Plants caged without honeybees had the highest number of head flowers/plant, while plants caged with honeybees had the smallest number (Table 1).

Crops caged without insects had also the longest flowering period (28.8 days), whereas open pollinated crops had the smallest flowering period (20.6 days). Similarly, Oz et al. (2009b) revealed flowering period and number of flowers/plant affected by the mode of pollination and the longest flowering period was reported in canola crops caged without bees followed by open pollinated crops. This might be the reason for the early maturation of the plants exposed to insects, that is, open pollinated crop was harvested 8 days earlier than plants caged without insects. This may indicate that mode of pollination had a great contribution for early maturation of seeds.

Plant height was not significantly affected by the mode of pollination (Table 1). Plants caged without honeybees and those caged with honeybee had 108.9 cm and 106.0 cm height, respectively. Also in Faba bean (*Vicia faba* L.), self-pollinated crops had higher height than plants pollinated by bees (Musallam et al., 2004).

Number of pod, seed per pod and seed per plant

Significant variation was observed in number of seeds/pod among the treatments (Table 2). Plots caged with honeybees had the highest number of seeds/pod (30.9), while the plants caged without insects had the least number of seeds/pod (7.8). Sattigi et al. (2004) also

Table 2. Number of seed pod, seed per pod and seed per plant.

Treatment	Number of seed pod/plant	Number of seeds/pod	Number of seeds/plant
Open pollinated	47.3	18.2 (4.03)[b]	702.2 (25.249)[b]
Caged with honeybees	51.8	30.9 (5.46)[a]	1089.7 (32.356)[a]
Caged without Insects	62.0	7.8 (2.63)[c]	656.4 (24.410)[c]
LSD	NS	0.740	4.500
P value	0.052	<.001	0.001

Figures in the parentheses are head flowers per plant (Log (base10) transformed values. Means in rows followed by the same letter are not significantly different at P<0.05 probability level. NS =non significant

Table 3. Seed yield/ plant and seed yield/ ha.

Treatment	Seed weight per plant (gm)	Seed yield/plot (gm)	Seed yield/ha (kg)
Open pollinated	3.0 (1.65)[b]	159[ca]	1324[ac]
Caged with honeybees	5.7 (2.32)[a]	200[a]	1669[a]
Caged without Insects	2.9 (1.63)[b]	115[c]	960[c]
LSD	0.30	57.1	475.9
P value	< 0.001	0.03	0.03

Means in rows followed by the same letter are not significantly different at P<0.05 probability level.

found the highest (33.0) and the least number of seeds/pod (17.8) in crops caged with bees and without honeybees, respectively. In sunflower, crops caged with honeybees increased significantly the percentage of seed setting, number of filling seeds/head, compared with crops caged without honeybees (Oz et al., 2009a). As indicated in Table 2, the highest number of seeds/plant (1089.7) were found in plants caged with honeybee followed by open pollinated plants (702.2), whereas the least number of seeds/plant was found in plants caged without insects (656.4). However, the number of pods/plant was not affected by the mode of pollination and non-significant difference was noticed among the treatments (Table 2).

Seed yield/plant and seed yield/ha

Significant variation was observed among the treatments regarding seed yield/plant and seed yield/ha (Table 3). Plant caged with honeybees had the highest seed yield/plant (5.7 g), while plants caged without honeybees had the lowest yield (2.9 g).

Mode of pollination had a significant effect on the seed yield/ha (Table 3). The highest seed yield/ha was obtained from crops caged with honeybees (16.7 quintal) followed by open pollinated plots (13.3 quintal), whereas crops excluded from insects had the lowest yield (9.6 quintal). The higher yield of crops caged with honeybees might be due to the higher pollination efficiency of the honeybees inside the cage. Rao and Suryanarayana (1990) also reported three times higher yield in plots caged with honeybees as compared with plots caged without honeybees.

CONCLUSION AND RECOMMENDATION

This study revealed that honeybees and other insect pollinators had a significant effect on seed yield of *G. abyssinica*. The highest seed yield/ha was obtained from crops caged with honeybees (13.3 quintal), whereas crops excluded from insects had the lowest yield (9.6 quintal).

Therefore, it is recommended to keep sufficient number of honeybee colonies in the vicinity of *G. abyssinica* fields during its flowering period to increase the pollination efficiency and thereby enhance seed productivity.

Conflict of Interest

There are no conflicts of interests regarding this publication.

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