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INFLUENCE OF POLLINATORS (EUROPEAN AND INDIAN HONEYBEES) ON NIGER, *GUIZOTIA ABYSSINICA* PRODUCTIVITY

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ABSTRACT

Niger (*Guizotia abyssinica* Cass.) is a traditional crop of tribal farmers in the agency area of Viskhapatnam district of Andhra Pradesh. Experiment was conducted at Regional Agricultural Research Station, Chintapalle during 2018-19 and 2019-2020. Results revealed the floral biology of the niger flower with flower spread of 41.2 mm, capitula diameter of 12.7 mm, stamen length of 5.15 mm, pistil length of 11.01 mm, and average number of florets (disc & ray florets) per flower as 39.86. The maximum relative abundance (19.71) of bees was recorded at 09:30 hour, after which its relative abundance was found decline due to hot weather. Maximum foraging speed of 7.41, 6.48 and 7.75 seconds per flower was found with Indian bees at 09:30; 11:00; 13:30 hours respectively followed by foraging speed of 8.74, 8.00 and 8.49 seconds per flower by little bees at 09:30; 11:00; 13:30 hours respectively. Maximum foraging rate was found with Indian bees at 09:30,; 11:00,; 13:30 hours which visited 8.74, 7.97 and 8.91 flowers per minute, respectively followed by European bees at 09:30; 11:00; 13:30 which visited 6.52, 4.88 and 7.84 flowers per minute, respectively. All the bees were observed as top workers on the Niger flowers. Among four treatments, (T4) Open pollination was found effective as it is pollinated by all types of bees (Little bee, Indian bee, Stingless bee etc.) and other pollinators and recorded the highest yield (8.85 q/ha) compared to individual bee pollination and without bee pollination. Lowest yield of 2.25 q/ha was recorded in crop caged without bees (T3). The quantity of honey produced was non-significant, but there was a significance difference in pollen collection by European and Indian bees.

***Keywords*:** floral biology, foraging rate, foraging speed, Niger, productivity, relative abundance of bees, type of bee workers.

Introduction

Niger (*Guizotia abyssinica* Cass) is a traditional crop of tribal farmers and it is one of the important minor oilseed crops of India. Niger is known by many local names but, the most common are Verrinuvvulu, Aadusulu, Valiselu (Telgu), Uhechellu (Kannada), Payellu (Tamil), Ramtil, Jagni or Jatangi (Hindi), Ramtal (Gujarati), Karale or Khurasani (Marathi), Alashi (Oriya), Sarguza (Bengali), Ramtil (Punjab) and Sorguja (Assamese), used in various parts of the country (Rao and Ranganatha, 1989). Niger is cultivated in about 1.8 lakh ha (Duhoon, 2001) and it is also cultivated to a limited extent in Ethiopia, South Africa, West Indies, Zimbabwe and India. In India, it is mainly cultivated in tribal pockets of Madhya Pradesh, Orissa, Maharashtra, Bihar, Karnataka, and Andhra Pradesh and certain regions of Arunachal Pradesh, Gujarat, Uttar Pradesh, Tamil Nadu, and Rajasthan sizable areas. In Andhra Pradesh, it is cultivated by tribal farmers as a traditional crop only in the agency area of Visakhapatnam and it is grown on 6000 hectares with 2000 tons of production and 350-750 kg productivity (Anonymous, 2023). Niger although considered a minor oilseed but its oil is very important in terms of quality, taste and export potential

(Rajpurohit, 2011). Oil content in grains is 35-45 percent and it is used in cooking, soap making, paints and in manufacturing beauty products. Now the crop is gaining importance due to the export value of niger oil in the market which is in turn affected by the tremendous contribution of honey bees (*Aphis dorsata* & *Apis cerana*) and many other pollinators, flies, and butterflies in increasing the seed yield of niger crop at the time of flowering (due to pollination) and ultimately maximizing the income of farmers due to seed yield increase (Sandipan *et al*., 2015a, b) and also increase in honey yield.

However, the utilization of bees in pollination not only increases the yield of various crops but also improves their quality and it also helps in uniform maturity and early harvest of the crop. Hence the present study was carried out to know the influence of bee pollination on the productivity of crops and to know bees' activity in crops.

Materials and Methods

The experiment was conducted during *late Kharif*, 2018-19 and 2019-2020 at the Regional Agricultural Research Station, Chintapalle, Visakhapatnam. The soil is red sandy loam under Rainfed conditions with a cropping pattern of Rice / Maize during early *Kharif* followed by Niger / Rajmash during late *Kharif*. The experiment was laid in an observational plot with Four treatments *i.e.* T_1 Crop caged with Indian Bee; T_2 Crop caged with European Bee, T_3 Crop caged without Bees, and T_4 Open pollination in 10 X 10 m^2 plot size. The crop was raised by following all recommended agronomic practices. Observations were recorded on the following parameters *i.e.* Flower biology; Relative abundance of bee pollinators at 09:30,; 11:00 and 13:30 hours; Foraging speed of honeybees at 09:30; 11:00 and 13:30 hours; Foraging rate of honeybees at 09:30; 11:00; 13:30 hours; Foraging mode of bees; Number of capitula / plant; Number of seeds / capitula; Test weight; Seed yield / ha. from full flowering stage to the harvest of the crop. Data on Flower biology; Relative abundance of bee pollinators; Foraging speed and Foraging rate of honeybees were collected from open pollination treatment and the remaining parameters were collected treatment-wise. Data of the following parameters were recorded.

Flower biology: Flower structure was measured on Flower spread, Capitula diameter, Stamen and Pistil length with the help of a digital Vernier caliper. The number of florets in the flower was counted and taken as average.

Relative abundance of bee pollinators: The relative abundance of bees visiting the flowers of Niger was recorded at 09:30; 11:00; and 13:30 hours of the day. It was recorded as number of specific bees visiting the flowers of Niger per meter square per 5 minutes.

Foraging speed of honeybees: Foraging speed was recorded at 09:30; 11:00 and 13:30 hours of the day. It was recorded as time spent by each bee species per flower (mostly in seconds).

Foraging rate of honeybees: Foraging speed was recorded at 09:30,; 11:00, and; 13:30 hours of the day. It was recorded based on bee species visiting the number of flowers per minute.

Foraging mode of bees: The foraging mode of bees was also recorded.

Yield parameters *viz*., number of capitula per plant, number of seeds/capitula, test weight (1000 seeds) and seed yield / ha were recorded.

Results and Discussion

Floral biology

During the full bloom or flowering stage, data was recorded on average floral biology of Niger flower as, flower spread 41.2 mm, capitula diameter 12.7 mm, Stamen length 5.15 mm and Pistil length 11.01 mm, respectively; with the average number of florets (disc & ray florets) per flower as 39.86.

Relative abundance of bee pollinators

Data on the number of bees that visited the open pollination plot in one m^2 area per 5 minutes was recorded irrespective of bees., Results revealed that the maximum relative abundance of bees was 19.71 at 09:30 hours, later its relative abundance and activity were found to decline due to hot climatic conditions at 11:00 and 13:30 hours with 12.88 and 9.90 number of bees, respectively. The relative abundance of bees declined from the initial flowering to the maturity stage of the crop. As reported by Kant *et al.,* 2013, foraging behavior of bees was maximum during the early hour *i.e.* 10:00 to 11:00 AM later declined and second peak activity was observed during the late evening hours, which is in correlation with our study. Findings were also corroborated by the results of Singh *et al.,* (2006) who reported that the foragers on litchi had higher population during the early flowering stage than maturity stage of the crop.

Foraging behavior of bees

Data on the foraging behavior of bees was recorded revealing that, the maximum foraging speed found with Indian bees was 7.41, 6.48, and 7.75 seconds per flower at 09:30,; 11:00, and 13:30 hours, respectively followed by Little bees which was 8.74, 8.00 and 8.49 seconds per flower at 09:30,; 11:00, and

13:30 hours, respectively. Moderate foraging speed was found with European bees at 09:30,; 11:00, and 13:30 hours *i.e.* 15.52, 14.20 and 14.36 seconds per flower, respectively. The least foraging speed was found with Stingless bees *i.e.* 29.34, 19.92 and 21.64 seconds per flower at 09:30,; 11:00, and 13:30 hours.

Maximum foraging rate of 8.74, 7.97 and 8.91 flowers visited per minute was found with Indian bees at 09:30,; 11:00, and 13:30 hours, respectively followed by European bees *i.e.* 6.52, 4.88 and 7.84 flowers visited per minute at 09:30,; 11:00, and 13:30 hours, respectively. A moderate foraging rate of 5.55, 3.40 and 6.11 flowers visited per minute were found with Little bees at 09:30,; 11:00, and 13:30 hours, respectively. The lowest foraging rate was found with Stingless bees as remained more than one minute on each flowers.

It was recorded that when more Italian and Indian bees were foraging in the experiment and seed production plots, the population of rock bees declined meagerly to zero. These findings are in corroboration with that of Guruprasad, (2001), Painkra *et al.* (2015), and Tiwari *et al.* (2020), who also reported maximum foraging behavior and activity were with Indian bees, Italian bees and Little bees.

All the bees were observed as top workers on the Niger flowers.

Yield parameters

Results revealed that, among the four treatments, the maximum number of capitula per plant was recorded in Open pollination treatment (44.25), followed by crop-caged with European bees treatment (38.90) and Crop caged Indian bee treatment (37.42). The least number of capitula per plant was observed in crop caged without bees (36.80). Among the four treatments, a maximum number of seeds/capitula was observed in Open pollination treatment (45.11), followed by Crop-caged with European bee treatment (28.60) and Crop caged Indian bee treatment (19.77). The least number of seeds / capitula was observed in Crop caged without bees treatment (3.83).

Among four treatments, Open pollination was found effective with all types of bees (Little bee, Indian bee, Stingless bee and other Pollinators) that allowed to pollinate the Niger crop freely and recorded the highest yield (3.49 q/ha) compared to individual bee pollination and without bee pollination. The lowest yield (0.9 q/ha) was recorded in Crop caged treatment without bees. Quantity of honey produced was nonsignificant, but there was a significant difference in pollen collection between European and Indian bees. Our findings of maximum yield and other yield parameters were found in open pollination as reported earlier by Prashant *et al.* (2017).

Table 1: Relative abundance of pollinators, foraging speed, foraging rate and foraging mode of bee pollinators:

S. No.	Pollinators	Relative abundance of bee pollinators (Irrespective of type of bees)			Foraging speed of honeybees			Foraging rate of honeybees			Foraging mode of bees
		09:30	11:00	13:30	09:30	11:00	13:30	09:30	11:00	13:30	
1.	Indian bee				7.41	6.48	7.75	8.74	7.97	8.91	
2.	European bee				15.52	14.20	14.36	6.52	4.88	7.84	
3.	Little bee				8.74	8.00	8.49	5.55	3.40	6.11	Top worker
4	Stingless bee				29.34	19.92	21.64	1.0	1.10	1.0	
		19.71	12.88	9.90	15.25	12.15	13.06	5.45	4.33	5.96	

All bees and pollinators were found top workers.

Table 2: Yield parameters and cost benefit ratio (CBR):

T.No.	Treatments	No. of capitulum /plant	Actual (Avg. Florets during seed setting)	Seeds / capitula	% Seed Set	Test weight (1000 seeds)	Yield (q/ha)	Gross returns	Cost of cultivation	BCR
T_1	Crop caged with Indian bee	37.42	39.86	19.77	-50.40	2.673	5.95	35,700	24938	1.43
T_2	Crop caged with European bee	38.90	39.86	28.60	-28.24	3.13	7.52	45120	24938	1.80
T_3	Crop caged without bees	36.80	39.86	3.83	-90.39	2.12	2.25	13500	24938	-0.54
T_4	Open pollination	44.25	39.86	45.11	+13.17	3.38	8.85	53100	22120	2.4

Plate 1 : Influence of pollinators (European and Indian honeybee) on Niger productivity.

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