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Effect of pollination by Indian honey bee, *Apis cerana indica* on yield attributing characters and oil content of Niger, *Guizotia abyssinica* Cass. In Surguja of Chhattisgarh

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Abstract

The experiment was undertaken at Rajmohini Devi College of Agriculture & Research Station, Ambikapur (C.G.). Significantly higher number of capitulum setting plant⁻¹ was obtained in treatment with control (36.19 capitulum plant⁻¹). However, the lowest capitulum plant⁻¹ was found with total closed (29.08 capitulum plant⁻¹). The maximum weight of capitulum⁻¹ was observed in treatment with control (0.244 g capitulum⁻¹) but the minimum capitulum⁻¹ weight was found in treatment with total closed (0.094g capitulum⁻¹). The highest seed yield plant⁻¹ was recorded in treatment with control (2.33 g plant⁻¹) and the lowest seed yield plant⁻¹ was obtained in treatment with total closed (0.76 g plant⁻¹). But significantly highest healthy seed was noticed in treatment with control (95.60 per cent). However, the lowest healthy seeds were found in treatment with total closed (3.17 per cent).

Keywords: Indian honey bee, *Apis cerana indica*, Oil content, Pollination, Yield parameter, Niger.

1. Introduction

In the agricultural economy of India, oilseeds are important next only to food grains in terms of area, production and value. The diverse agro-ecological conditions in the country are favorable for growing all the nine annual oilseeds, which include seven edible oilseeds, viz. groundnut, rapeseed-mustard, soybean, sunflower, sesame, safflower and Niger, and two non-edible oilseeds, viz. castor and linseed. Apart from annual oilseeds, a wide range of other minor oil-bearing plants of horticulture and forest origin, including coconut and oil palm are cultivated in the country.

Among the edible oilseed crops, the Niger (*Guizotia abyssinica* Cass, Compositae) is an important oilseed crop cultivated in Ethiopia and India. It is a branched annual herbaceous plant, grows upto a height of 1.8 metre. The Niger plant complete its life cycle in 3-4.5 months. The yellow flower heads of 2-3 cm develop in the leaf axil, in a cluster of two to five. Each head contains about eight ray florets and 40 to 60 hermaphrodite disk florets.

The seeds contains about 40 per cent oil, which is pale yellow with nutty taste and a pleasant odor. The oil and seeds are free from any toxin and oil taste is similar to *desi* ghee. The oil is used for culinary purposes, anointing the body, manufacturing paints and soft soaps and for lighting and lubrication. The Niger oil is good absorbent of fragrance of flowers due to which it is used as a base oil by perfume industry. Niger oil can be used for birth control and treatment of syphilis. Niger seed cake is a valuable cattle feed particularly for milch cattle. Niger is also used as a green manure for increasing soil organic carbon.

2. Materials and Methods

The experiment was undertaken at Rajmohini Devi College of Agriculture and Research Station, Ambikapur, Surguja of Indira Gnanthi Krishi Vishwavidyalaya, Raipur (C.G.) during two consecutive year 2011-12 and 12-13. The Niger crop was sown and the variety was JNC-9, plot size 2x2m², six treatments replicated four times and the statically analysis was done with randomized block design (RBD).

Treatments details

Treatments	Description
T1	Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, Close between 1000 to 1500hrs.
T2	Close the cage between 0700 to 1000hrs and 1500 to 1700 hrs, Open between 1000 to 1500hrs.
T3	Close the cage between 0700 to 1200hrs Noon, and Open between 1200 Noon to 1700hrs.
T4	Open the cage between 0700 to 1200hrs Noon and Close between 1200 Noon to 1700hrs.
T5	Total closed (Total Net)
T6	Control (Total Open)

The cages (Mosquito net) were opened once in a week, in this cages the Indian honey bee *Apis cerana indica* only allowed to visit the Niger flower, other insect pollinators/visitors were escaped with the help of hand net. The treatments which were totally closed with mosquito net, no any insect pollinators/visitors were allowed to visit inside the cage. In the control treatments (totally opened) all the pollinators/visitors were allowed to visit the Niger flower.

All observations of the crop

(A) Quantitative Parameters

(I) Capitulum setting plant⁻¹: Ten plants were randomly selected from each pollinated situation in each replication and number of capitulum setting was counted. Then mean number of capitulum plant⁻¹ was worked out.

(II) Number of seeds capitulum⁻¹: Total 10 plants were used for study under each pollinated situation in each replication. The capitulum of all the plants were removed. After this seeds were separated from these capitulae and mean number of seeds capitulum⁻¹ were worked out.

(III) Seed yield plant⁻¹(g): Total 10 plants were used randomly for study under each pollinated situation in each replication. The capitulum of all the plants were removed and seeds were separated from these capitulae, then seeds were weighed by electronic balance. Then mean seed yield plant⁻¹ were worked out.

(IV) Weight of capitulum⁻¹(g): Ten capitulum were used from each pollinated situation in each replication then by weighing the capitulum, average weight of capitulum were workout.

(V) Sterility percentage: The chaffy seeds were observed and counted from ten capitulum. Then all seeds (number of healthy seeds + number of chaffy seeds) were determined from each treatment. Finally sterility percentage was determined by the formula:-

$$\text{Sterility percentage (\%)} = \frac{\text{Number of chaffy (sterile) seeds capitulum}^{-1}}{\text{Total number of seeds capitulum}^{-1}} \times 100$$

(VI) Test weight of seeds (g):- Seeds samples were taken randomly from the produce of crop under six different pollinated conditions in each replication. After this 1000 seeds were counted treatment wise separately. Weight of 1000 seeds of each sample was recorded through electronic balance.

(VII) Seed yield (kg plot⁻¹/ kg ha⁻¹):- The crop harvested and tagged into bundles, all bundles were transported to threshing floor. These were kept on threshing floor for sun drying and after sun drying threshing was done plot wise manually. The

mean weight of seeds plot⁻¹ was taken and then converted into kg ha⁻¹.

(B) Qualitative Parameters

(I) Oil content of seeds (%):- The samples of seeds from the produce of each treatment (20gms.) were collected and analyzed for per cent oil content by NMR (Nuclear Magnetic Resonance) with the help of scientists at Jawahar Lal Nehru Krishi Vishwavidyalaya campus, AICRP on Niger, Jabalpur (M.P.). Thus effect of pollination on oil content of seed was worked out.

(II) Germination percentage - The seeds were obtained from the produce of all the six treatments and their germination were tested by keeping 100 seeds of each treatment, in Petri dishes covered with moist filter paper. The filter paper was removed after germination was seen and thereafter germination was recorded. Finally germination percentage of seeds was determined by using the formula-

$$\text{Germination (\%)} = \frac{\text{Number of germinated seeds in patridishes}}{\text{Total number of seeds used for germination}} \times 100$$

3. Results and Discussion

The experiment was laid down during two consecutive year 2011-12 and 2012-13 and results are sown in table 1. To determine the effect of pollination by *Apis cerana indica* in Niger crop as compared to other modes of pollination, T1- Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs. T2-Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs. T3 - Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs. T4- Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs. T5- Total closed (Mosquito net) and T6- Control (Total open) in respect of capitulum setting plant⁻¹, number of seeds capitulum⁻¹, seed yield plant⁻¹(g), weight of capitulum⁻¹ (g), sterility percent⁻¹, test weight of seeds (g), seed yield kg ha⁻¹, oil content of seeds (%), and germination (%) were depicted in (Table 1). The details are given below -

(A) Quantitative Parameters

(a) Capitulum setting plant⁻¹ The mean of two year (2011-12 and 12-13) indicated that the maximum number of capitulum setting plant⁻¹ was found significantly superior in treated plot control (Total open, 36.19 capitulum plant⁻¹) followed by treatment, Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs (34.85 capitulum plant⁻¹), Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs (33.56 capitulum plant⁻¹), Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs (33.24 capitulum plant⁻¹), Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs (32.92 capitulum plant⁻¹). The least number of capitulum setting plant⁻¹ was found in treated plot with total closed (29.08 capitulum plant⁻¹). All the treatments were found significantly lower capitulum over the treated plot control. However, there was no significant difference found between the T2 -Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs (33.24 capitulum plant⁻¹), T3-Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs (32.92 capitulum plant⁻¹) and T4-Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs (33.56 capitulum plant⁻¹). The treatments T1- Open the cage between 0700 to 1000hrs and 1500 to 1700hrs,

close between 1000 to 1500hrs. (34.85 capitulum plant⁻¹), T2-Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs. (33.24 capitulum plant⁻¹), T4-Open the cage between 0700 to 1200hrs Noon and Close between 1200 Noon to 1700hrs. (33.56 capitulum plant⁻¹), T5-Total closed (29.08 capitulum plant⁻¹) and T6-Control (Total open) (36.19 capitulum plant⁻¹) (Table 1) had significant difference with each other. The present study is more or less in the conformity of earlier workers to Munawar (2009) who recorded in canola rapeseed, *Brassica napus* with more number of pods developed in treatments plants caged with honeybees (81.00) and lowest in plants caged without honeybees (52.00).

(b) Weight of capitulum⁻¹ (g)

The two year data revealed that the highest capitulum weight was observed in control (Total opened) treatment (0.244 g) followed by Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs (0.193 g), Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs (0.188 g), Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs (0.179 g) and Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs (0.157 g). The crop which was under total closed condition recorded lower capitulum weight (0.094g) compared to other treatments. The treatments like Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs (0.157 g) and total closed (0.094 g) were found significantly low capitulum weight. The treatments except total closed were found significant with each other (Table 1).

(c) Seed yield plant⁻¹ (g)

The average of two year data 2011-12 and 12-13 (Table 1) indicated that the significantly higher seeds yield plant⁻¹ were recorded in treatment control (2.33 g plant⁻¹). The lower seed yield plant⁻¹ was recorded in treatment with total closed (0.76 g plant⁻¹). All the treatments were recorded significantly lower yield like Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs (1.16 g plant⁻¹), Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs (1.47 g plant⁻¹), Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs (1.28 g plant⁻¹) were found statistically at par among each other. Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs (1.64 g plant⁻¹) and in treatment with total opened (2.33 g). Munawar *et al.* (2009) who reported in canola, highest yield in caged with honeybees (7.6g) and lowest was in caged without honeybees (1.51g).

(d) Sterility/ chaffyness (%)

The pooled data of two year (2011-12 and 12-13) revealed that the significantly higher sterility per cent was recorded in treatment with total closed (96.81 per cent) followed by Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs (24.74 per cent), Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs (20.92 per cent), Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs (17.81 per cent) and Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs(17.46 per cent) respectively. The least sterility per cent was observed in treatment with total opened (4.40 per cent). Treatment with total closed (96.81 per cent) was recorded highest sterile seed and it was significantly superior

over all the treatments. However, significantly low sterility per cent was observed in treatment Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs (17.81 per cent), Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs (17.46 per cent), Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs (24.74 per cent), Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs (20.92 per cent) and Control (Total open 4.40 per cent) (Table 1).

(e) Healthy seeds (%)

The two year data (2011-12 and 12-13) revealed that the significantly higher percentage of healthy seeds were recorded in treatments with control, total opened (95.60 per cent) whereas, all the treatments were found significantly lower healthy seed over the control. Minimum per cent of healthy seeds were found in treatment total closed (3.17 per cent). There were significant difference observed among the treatments. All the treatments were recorded significantly lower healthy seeds than control (Table 1).

(f) Test weight (1000 seeds)

The pooled data of two year (2011-12 and 12-13) indicated that the highest seed weight and non-significant difference was observed in treatment like total open (4.59 g) followed by Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs (4.38 g), Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs (4.27 g), Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs (4.07 g) and Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs (3.97 g). The plot which was total closed (3.32 g) recorded lowest seed weight compared to other treatments (Table 1). Munawar (2009) reported the test weight of seed of canola, *Brassica napus* was with highest seed weight plants caged with honeybees (26.00g) and lowest was in plants caged without honeybees (9.30g). Mupade *et al.*(2009) reported highest test seed weight in one frame *A. florea* colony (7.10g) followed by four frame *A. c.* colony (6.60g), two framed *A. mellifera* colony (6.20g) and lowest in open pollination(5.5g).

(g) Seed yield (kg ha⁻¹)

The average of two year data (2011-12 and 12-13) revealed that the treatment, total open (513.00 kg ha⁻¹) observed significantly superior to all other treatments. Treatments like open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs (312.00 kg/ha⁻¹), Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs (283.87 kg/ha⁻¹) Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs (271.25 kg/ha⁻¹) Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs (218.12 kg/ha⁻¹) were found significantly lower seed yield (Table 1). Gaddanakeri *et al.* (2008) who also recorded the higher seed yield of sunflower (849 kg ha⁻¹) in intercropping system of sunflower + niger and lowest was in sole crop of sunflower (747 kg ha⁻¹) indicating the role of pollinators in both cross pollinated crops.

(B) Qualitative parameters

(a) Oil content (%)

The pooled data of two years (2011-12 and 12-13) indicated that the highest oil content of niger seeds was recorded in total open (33.95 per cent) followed by Close the cage between

0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs (32.93 per cent) Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs (32.48 per cent) Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs (31.81 per cent) and Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs (30.89 per cent). Whereas, the lowest oil percentage was found in treatment, total closed (21.09 per cent). There was significant difference recorded among the treatments (Table 1). Dhurve (2008) who also reported the highest oil content in niger seed when sprayed with 10 per cent sugar syrup (40.10 per cent) followed by open pollination without any spray (40.00 per cent) and sugarcane juice 10 per cent (39.93 per cent) however the lowest oil content was in crop sprayed with Bee-Q 1.25 per cent (38.76 per cent).

(b) Germination per cent

The pooled data (2011-12 and 12-13) indicated that the germination per cent of niger seed was significantly highest in the treatment with control (78.37 per cent) whereas other treatments were found significantly lower germination per cent, like Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs (72.75 per cent), Open the cage between 0700 to 1200hrs. Noon and Close

between 1200 Noon to 1700hrs (71.25 per cent), Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs (67.75 per cent) and Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs (66.12 per cent). The lowest germination per cent was found in treatment with total closed (63.37 per cent). The treatments, Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs (67.75 per cent) and Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs (66.12 per cent) and there were no significant difference observed among the treatments. However, the treatments Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs (72.75 per cent), Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs (71.25 per cent), Total closed (63.37 per cent) and control (78.37 per cent) were found significant difference among the treatments (Table 1). Dhurve (2008) who recorded highest germination in Niger seed in treatment like open pollination with cacambe 10 per cent (81.00 per cent) and the least germination was in crop caged without bees (64.00 per cent). Mupade *et al.* (2009) recorded that the *Apis florea* colony with one frame having highest of germination (90.00 per cent) followed by four frame *A. carana* (89.00 per cent) and two frame *A. mellifera* colony (88.00 per cent).

Table 1: Pollination by *Apis cerana indica* on yield, yield attributing characters and oil content of Niger during year 2011-12 and 12-13

Treatments	Capitulum setting plant ⁻¹		Pooled	Weight of capitulum ⁻¹ (g)		Pooled	Seed yield plant ⁻¹ (g)		Pooled	Sterility (%) chaffy seeds		Pooled
	2011-12	2012-13		2011-12	2012-13		2011-12	2012-13		2011-12	2012-13	
T1-Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs.	34.97	34.74	34.85	0.178	0.137	0.157	1.139	1.198	1.16	17.98 (4.28)	17.64 (4.25)	17.81 (4.26)
T2-Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs.	32.95	33.53	33.24	0.239	0.148	0.193	1.192	1.763	1.47	16.69 (4.13)	18.24 (4.32)	17.46 (4.22)
T3-Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs.	33.42	32.42	32.92	0.191	0.168	0.179	1.574	0.997	1.28	26.28 (5.14)	23.21 (4.85)	24.74 (5.00)
T4- Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs.	32.95	34.18	33.56	0.232	0.145	0.188	1.838	1.453	1.64	21.57 (4.69)	20.28 (4.55)	20.92 (4.62)
T5- Total closed (Mosquito net)	28.32	29.85	29.08	0.079	0.109	0.094	0.606	0.919	0.76	97.09 (9.87)	96.53 (9.85)	96.81 (9.86)
T6-Control (Total open)	35.17	37.21	36.19	0.299	0.190	0.244	2.473	2.203	2.33	4.92 (2.92)	3.89 (2.08)	4.40 (2.20)
SEM ±	1.37	0.52	0.44	0.0196	0.0140	0.014	0.2299	0.0786	0.129	0.1855	0.1090	0.1379
CD(p=0.05)	4.14	1.55	1.34	0.06	0.04	0.04	0.69	0.24	0.39	0.56	0.33	0.42

Contd...

Treatments	Healthy seed (%)		Pooled	Test weight(1000 seeds) (g)		Pooled	Yield (kg/ha)		Pooled	Oil content (%)		Pooled
	2011-12	2012-13		2011-12	2012-13		2011-12	2012-13		2011-12	2012-13	
T1-Open the cage between 0700 to 1000hrs and 1500 to	82.00 (9.08)	82.34 (9.10)	82.17 (9.09)	4.095	3.856	3.97	161.25	381.25	271.25	30.08	31.71	30.89

1700hrs, close between 1000 to 1500hrs.												
T2-Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs.	83.26 (9.15)	81.74 (9.06)	82.5 (9.11)	4.285	3.873	4.07	170.25	266.00	218.12	30.57	33.05	31.81
T3-Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs.	73.70 (8.60)	76.77 (8.79)	75.23 (8.70)	4.697	3.858	4.27	158.50	409.25	283.87	32.14	33.72	32.93
T4- Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs.	78.41 (8.88)	79.71 (8.95)	79.06 (8.91)	4.830	3.946	4.38	271.75	352.25	312.00	30.58	34.38	32.48
T5- Total closed (Mosquito net)	2.89 (1.83)	3.45 (1.98)	3.17 (1.90)	3.288	3.370	3.32	79.50	211.25	145.37	26.73	15.45	21.09
T6-Control (Total open)	95.06 (9.77)	96.15 (9.83)	95.60 (9.80)	4.890	4.307	4.59	353.25	672.75	513.00	33.50	34.40	33.95
SEM ± CD (p=0.05)	0.1107 0.33	0.065 0.20	0.080 0.24	0.646 NS	0.388 NS	0.392 NS	12.25 36.92	15.66 47.20	19.50 58.77	0.40 1.21	0.74 2.25	0.26 0.79

Contd.....

Treatments	Germination (%)		Pooled
	2011-12	2012-13	
T1-Open the cage between 0700 to 1000hrs and 1500 to 1700hrs, close between 1000 to 1500hrs.	74.75	70.75	72.75
T2-Close the cage between 0700 to 1000hrs and 1500 to 1700hrs, Open between 1000 to 1500hrs.	71.50	64.00	67.75
T3-Close the cage between 0700 to 1200hrs Noon and Open between 1200 Noon to 1700hrs.	68.50	63.75	66.12
T4- Open the cage between 0700 to 1200hrs. Noon and Close between 1200 Noon to 1700hrs.	73.00	69.50	71.25
T5- Total closed (Mosquito net)	64.25	62.50	63.37
T6-Control (Total open)	80.25	76.50	78.37
SEM ± CD(p=0.05)	0.964 2.91	1.924 5.80	1.261 3.80

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4. Conclusion

Over all on the basis of above results it can be concluded that the maximum quantitative and qualitative parameters were recorded in control pollination (Total open) however the lowest were obtained in treatment Total closed.

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