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SEED YIELD INCREASE IN NIGER CROP IN TO RELATION TO HONEYBEE AND OTHER POLLINATORS

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ABSTRACT. Niger (*Guizotia abyssinica* Cass) is an important minor oilseed crop of hilly and tribal regions and it is used for oil as well as for various other purposes only by the tribal people. Therefore, a systematic study was arranged to document about the increase in the seed yield of niger crop in relation to honeybees (*Aphis mellifera*), as a pollinator in niger crop with paired plot technique at the Niger Research Station (NRS) at Navsari Agricultural University (NAU) and at farmer's field, Vanarasi, Navsari, Gujarat (India) and also studied its relation in terms of cost benefit ratio (CB). The trial was conducted at Niger Research Station (NRS), Vanarasi for 3 years (2013-14, 2014-15 and 2015-16) and also at farmer's field to ascertain the role and involvement of honey bees (*Aphis mellifera*) in swelling the seed yield of niger crop (due to pollination) and its effect on income due to increase in the niger seed yield. Significant differences were observed for number of capitula/plant, number of seeds/capitula, 1000 seed weight and seed yield in both the location for the consecutive 3 years. However, the seed yield and gross returns were considerably higher in first location of T_1 Natural plot/ open pollinated with beehive (*Aphis mellifera)* in all the 3 years data with the maximum seed yield with the gross return was obtained in this treatment.

Keywords: *Aphis mellifera*; pollination; oilseed; insect pollinator; pair plot technique.

INTRODUCTION

Niger (*Guizotia abyssinica* Cass) is a crop of tribal region and is one of the most important minor oilseed crops of India. Niger hasmany different local names but, the most commonly is as *ramtil*, *jagni* or *jatangi* (Hindi), *ramtal* (Gujarati), *karale* or *khurasani* (Marathi), *uhechellu* (Kannada), *payellu* (Tamil), *verrinuvvulu* (Telgu), *alashi* (Oriya), *sarguza* (Bengali), *ramtil* (Punjab) and *sorguja* (Assamese), in various

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parts of the country (Rao and Ranganatha, 1989). The natural habitat is disturbed for many reasons and the vegetation cover is declining now a day's worldwide (Kearns *et al.,* 1998). Agriculture plays a role in declining native pollinators through the modification and elimination of pollinator habitats and the use of excess agricultural chemicals including pesticides, herbicides and fertilizers (Donaldson, 2002). Free (1993) stated that clean and intensive cultivation of land may affect wild insect pollinators. He mentioned practices, such as destruction of hedgerows and rough verges, which destroyed many natural food sources and nesting sites of wild pollinating insects. Generally, it has been concluded that habitat degradation, pesticide misuse, diseases and intensive cultivation of lands may be the causes of decline in managed honeybees and wild pollinators (Gallai *et al.,* 2009). At present, it is grown/ cultivated in the area (land) of about 1.8 lakh ha (Duhoon, 2001). In addition, it is cultivated to a limited extend in Ethiopia, South Africa, West Indies, Zimbabve and India. In India, it is mainly cultivated in tribal pockets of Madhya Pradesh, Orissa, Maharashtra, Bihar, Karnataka and Andhra Pradesh. It is also grown sizeable area in certain region of Arunachal Pradesh, Gujarat, Uttar Pradesh, Tamil Nadu and Rajasthan. Niger although considered as a minor oilseed, is very important in terms of quality and taste of its oil and export potential (Rajpurohit, 2011). Honeybee pollinators are estimated to be involved in producing up to 30 % of the human food supply directly or indirectly; farmers rely on managed honeybees throughout the world to provide these services (Greenleaf and Kremen, 2006). Honeybees are responsible for 70-80% of insect pollination (Johannsmeier and Mostert, 2001). The contribution of managed honeybee pollination to crop production and quality has been estimated to be more than the value of honey and wax production (Shrestha, 2004).

Looking on significance in terms of oil extraction, which having high medicinal values, but knowledge of the diseases of this Niger crop merits attention, niger is a crop of dry areas grown mostly by tribal in interior places due to which desired attention has not been given. Now, the crop is gaining importance and studies are being made on to ascertain there is tremendous contribution of honey bees (*Aphis mellifera*) and many other insects, flies and butterflies in increasing the seed yield of niger crop at the time of flowering (due to pollination) and its ultimately maximizes the income of farmers due to seed yield increase (Sandipan*et al*., 2015a, b). Therefore, a study was planned to document about the role of honeybees as a pollinator in increasing the seed yield in niger crop with paired plot technique at the Niger Research Station (NRS) at Navsari Agricultural University (NAU) and at farmer's field, Vanarasi, Navsari, Gujarat (India) and also studied its cost benefit ratio (CB) of this niger cultivar.

MATERIALS AND METHODS

Objectives	:	To ascertain the contribution of Italian bee (*Apismellifera*) in increasing the seed yield of niger crop.
Location and agro-climatic subregion	:	Niger Research Station (NRS), Vanarasi and at farmers' field (Vanarasi village), Navsari, Gujarat (India), South Gujarat Heavy Rainfall Zone
Details of experiment:		
Ist location (NRS farm)	:	Natural plot with beehive (uncovered)
	:	Covered plot with beehive (covered)
2nd location (Farmers' field)	:	Open pollinated without beehive
	:	Covered plot with beehive (covered)
Crop and variety		Niger, variety GN-1
Treatments	:	-
Design	:	Pair plot technique
Plot size	:	Gross : 20 x 10 m
Spacing	:	30 cm between two rows
	:	10 cm between plant to plant
Replications	:	Non replicated
Fertilizer		
Basal dose	:	10:20:00 NPK/ha
Top dressing	:	10:00:00 NPK/ha
Sowing dates	:	2013-14 :14.08.2013 2014-15 : 08.08.2014 2015-16 : 21.07.2015
Date of harvesting	:	2013-14 : 23.12.2013 2014-15 : 01.12.2014 2015-16 : 02.12.2015

Crop condition

During all the 3 year seasons, the average rainfall was 1568.33 mm, but in the last year it was 929 mm, which was less in comparison to the last two years. The plant population and crop growth were healthy. However, at the time of flowering, the box of honeybee with five frame compartment was placed in the crop. They were seen late in the morning and disappeared early in the evening time (before 5 o'clock), which effect on the seed yield of the niger crop as the pollination activity is reduced.

Calculations

Observation for number of capitula/plant, number of seeds/capitula, 1000 seed weight and seed yield in both the locations was recorded and accordingly cost benefit ratio was worked out.

RESULT AND DISCUSSION

It is now apparent that most of the pulses and oilseeds, fruits and orchard crops including vegetables heavily depend on bees for their pollination. This is also true for seed production of vegetables like onion, cabbage, cauliflower, tabacco, sunnhemp, alfalfa and clovers (http:// agritech.tnau.ac.in/ farm_enterprises/ fe_api_beefloraapollin.html). The

number of colonies of honeybees required per hectare very much depends on the strength of foraging bees in the colony, the crops and prevailing weather conditions.

Significant differences were observed for number of capitula/plant, number of seeds/capitula, 1000 seed weight and seed yield in both the location. However, the seed yield and gross returns were considerably higher in the first location of T1 Natural plot/open pollinated with beehive (*Aphis mellifera)*. The maximum seed yield with the gross return was obtained in this treatment. (*Tables 1, 2* and *3*). Steffan-Dewenter and Tscharntke (1999) found that isolation from natural habitats diminishes abundance and species richness of bees, which are the most important flower-visiting insects. Honeybees were by far the most frequently recorded insects on onion flowers. The high proportion of honeybees, compared to other insects visiting the flowers, indicated that honeybees were the major pollinators of the onion crop at our field site, with both honeybee abundance and seed yield and quality increasing proportionally. Yücel and Duman (2005) reported that the germination rate was greater on average by 12% in onion with honeybee activity (*Figs. 1* and *2*).

Figure 1 - Honeybees and other pollinators activity in niger crop

Figure 2 - Open and covered plot of niger field with honeybee cage

Table 1 - Seed yield with cost benefit ratio (CB ration) for the year 2013-14

	Treatment	No. of capitula/pl	No. of seeds/ capitula	1000 seed weight (g)	Seed yield (kg/ha)	Gross returns (Rs.)	Cost of cultivation	Net income (Rs.)	BC ratio
1st Location (NRS)	T_1 Natural plot/ open pollinated with beehive (uncovered)	**33**	**39**	**4.95**	**401**	**24060**	**9938**	**14122**	**2.42**
	T_2 Covered plot with beehive (covered)	27	32	4.72	339	20340	10938	9402	1.85
2nd Location (Farmers' field)	T_3 Open pollinated without beehive	26	30	4.59	287	17220	7938	9282	2.16
	T_4 Covered plot with beehive (covered)	25	28	4.58	319	19140	10938	8202	1.74

- Cost of niger seed calculated Rs. 6000 per quintal
- Cost of honey not included

Interpretation

Significant differences were observed for number of capitula/plant, number of seeds/capitula, 1000 seed weight (NS) and seed yield in the both location. However, the seed yield and gross returns were considerably higher in T_1 Natural plot with *Aphis mellifera* (*Fig. 3*). The maximum seed yield of 401 kg/ha with the gross return of Rs.14122 was obtained in this treatment, followed by open pollinated without beehive (*Table 1 and pooled results Table 4*).

Table 2 - Seed Yield with cost benefit ratio (CB ration) for the year 2014-15

	Treatment	No. of capitula/pl.	No. of seeds/ capitula	1000 seed weight (g)	Seed yield (kg/ha)	Gross returns (Rs.)	Cost of cultivation	Net income (Rs.)	BC ratio
1st Location (NRS)	**T_1 Natural plot/ open pollinated with beehive (uncovered)**	**22**	**21**	**4.10**	**275**	**16500**	**9538**	**6962**	**1.72**
	T_2 Covered plot with beehive (covered)	18	16	4.00	238	14280	10538	3742	1.35
2nd Location (Farmers' field)	**T_3 Open pollinated without beehive**	15	13	3.85	175	10500	7038	3462	1.49
	T_4 Covered plot with beehive (covered)	17	14	3.95	225	13500	10538	2962	1.28

- Cost of niger seed calculated Rs. 6000 per quintal
- Cost of honey not included

Interpretation

Significant differences were observed for number of capitula/plant, number of seeds/capitula, 1000 seed weight (NS) and seed yield in the both location. However, the seed yield and gross returns were considerably higher in first location of T_1 Natural plot/open pollinated with beehive (*Aphis mellifera)*. The maximum seed yield of 275 kg/ha with the gross return of Rs.16500 was obtained in this treatment (*Table 2 and pooled results Table 4*).

Table 3 - Seed yield with cost benefit ratio (CB ration) for the year 2015-16

	Treatments	No. of capitula /pl.	No. of seeds/ capitula	1000 seed weight (g)	Seed yield (kg/ ha)	Gross returns (Rs.)	Cost of cultivation	Net income (Rs.)	BC ratio
1st Location (NRS)	**T_1 Natural plot/ open pollinated with beehive (uncovered)**	**27**	**23**	**4.00**	**337**	**20220**	**8038**	**12182**	**2.51**
	T_2 Covered plot with beehive (covered)	21	17	3.80	283	16980	9538	7442	1.78
2nd Location (Farmers' field)	**T_3 Open pollinated without beehive**	18	15	3.85	271	16260	7038	9222	2.31
	T_4 Covered plot with beehive (covered)	19	15	3.90	269	16140	9538	6602	1.69

- Cost of niger seed calculated Rs. 60 per kg
- Cost of honey not included

Interpretation

Significant differences were observed for number of capitula/plant, number of seeds/capitula, 1000 seed weight (NS) and seed yield in the both location. However, the seed yield and gross returns were considerably higher in first location of T_1 Natural plot/open pollinated with beehive (*Aphis mellifera)*. The maximum seed yield of 337 kg/ha with the gross return of Rs. 20220 was obtained in this treatment (*Table 3 and pooled results Table 4*).

Table 4 - Year wise and pooled analysis (Two sample t- test / Independent sample test)

Treatment	Year 2013		Year 2014		Year 2015		Pooled	
	t value	Result	t value	Result	t value	Result	t value	Result
T_1 & T_2	**3.927**	**	**3.077**	**	**2.983**	*	**3.757**	**
T_3 & T_4	0.674	NS	1.214	NS	0.579	NS	0.476	NS
S_1 & S_2	**3.796**	**	**3.441**	*	**3.464**	*	**2.692**	*
S_3 & S_4	1.303	NS	0.622	NS	0.000	NS	0.161	NS
W_1& W_2	0.930	NS	0.474	NS	0.903	NS	1.059	NS
W_3 & W_4	0.110	NS	0.448	NS	0.352	NS	0.339	NS

Treatment	Year 2013		Year 2014		Year 2015		Pooled	
	t value	Result	t value	Result	t value	Result	t value	Result
T_1 & T_3	4.359	**	5.283	**	5.534	**	5.213	**
S_1 & S_3	5.295	**	5.688	**	4.177	**	4.063	**
W_1 & W_3	1.390	NS	1.103	NS	0.725	NS	1.541	NS

* Significant; **Highly significant; NS=Non significant
T_1: Natural plot with beehive (uncovered), Ist location (NRS) - **No. of capitula/ plant**
T_2: Covered plot with beehive (covered), Ist location (NRS) - No. of capitula/ plant
T_3: Open pollinated without beehive, 2nd location (farmers' field) - No. of capitula/ plant
T_4: Covered plot with beehive (covered), 2nd location (farmers' field) - No. of capitula/ plant
S_1: Natural plot with beehive (uncovered), Ist location (NRS) - **No. of seeds/ capitula**
S_2: Covered plot with beehive (covered), Ist location (NRS) - No. of seeds/ capitula
S_3: Open pollinated without beehive, 2nd location (farmers' field) - No. of seeds/ capitula
S_4: Covered plot with beehive (covered), 2nd location (farmers' field) - No. of seeds/ capitula
W_1: Natural plot with beehive (uncovered), Ist location (NRS) - 1000 seed weight (g)
W_2: Covered plot with beehive (covered), Ist location (NRS) - 1000 seed weight (g)
W_3: Open pollinated without beehive, 2nd location (farmers' field) - 1000 seed weight (g)
W_4: Covered plot with beehive (covered), 2nd location (farmers' field) - 1000 seed weight (g)

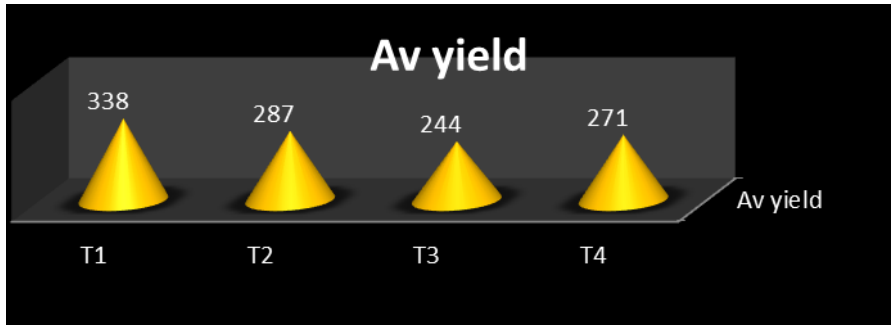

Figure 3 - Average seed yield of niger crop

Economics:

- Average cost of niger seed @ Rs. 60 per kg
- Cost of niger cultivation @ Rs. 7038
- Cost of beehive (five frame compartment): 2500
- Last year (2015) the cost of beehive was only 1000 - charged as only the maintenance amount was taken for the beehive.

CONCLUSION

It is said from the conducted experiment that the use of insect pollinators as honeybees (*Apis mellifera*) in niger crop is significantly helpful to increase the seed yield of niger crop in T_1 Natural plot with beehive (uncovered). As the honeybee pollinator increases the pollination activity by which the cultivator can increase their niger seed yield and income.

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