



Studies on floral biology and autogamy in niger [*Guizotia abyssinica* (L.f.) Cass]

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Abstract

A study was undertaken for systematic understanding of floral biology and to study the effect of selfing on seed set in six niger [*Guizotia abyssinica* (L.f.) Cass] populations at GKVK, Bangalore during 2001. The results revealed that, anthesis took place during 8.00 AM to 8.45 AM and disc florets open up to 10.30 AM during sunny days and up to 11.30 AM during cooler days at Bangalore conditions. The number of heads open ranged from 2 to 5 with a flowering period of about 6 to 7 days. Percent seed set ranged from 0.10 to 2.11% when bagging a single capitulum; zero to 5.35% seed set when bagging two capitulum; 3.33 to 10.16% seed set when bagging three capitula; zero to 1.415 % seed set when bagging a single branch and 2.43 to 4.68% seed set when bagging a whole plant. This phenomenon could be attributed to self-incompatibility in niger. Under open pollinated condition, percent seed set ranged from 26.32 to 56.57% with a mean of 42.59% among the six populations. The maximum percentage of seed set was recorded in KBN-90 (56.57%) and minimum was recorded in Kanakapura local (26.30).

Key words: Niger, floral biology, anthesis, bagging, autogamy

Introduction

Though niger [*Guizotia abyssinica* (L.f.) Cass] is an important oilseed crop in India, it is largely an under exploited crop in respect of genetic and yield improvement. The niger plant has an extremely low harvest index. Any additional biomass production has not resulted in proportionate increase in seed yield [1]. One of the main reasons for that could be lower seed setting in the capitula. Though self-incompatibility is found in niger, a higher seed set is experienced in place with active bee population. This necessitates the immediate requirement of developing high self-compatible populations to enhance seed yield. Hence, a study was undertaken in six niger populations for systematic understanding of floral biology and to study the effect of selfing on seed set and to identify high self fertile populations.

Material and methods

The present investigation was carried out during *rabi* 2001 at GKVK, Bangalore on six niger populations *viz.*, KBN-90, S-66, Number 71, KBN-91, Orissa local and Kanakapura local. Careful observations on flowers in these six populations were made starting from initiation

of the inflorescence-anthesis and maturity of flowers-seed set. From each population, 20-marked inflorescences were considered to record observations on their behavior and development. Observations and measurements on anthers and stigmas were recorded using dissection microscope. Observations on opening of disc florets were made on 20 inflorescences in each population. Each head was labeled and number of florets opened per day in each head was recorded during morning and subsequent shriveling of florets was also recorded during evening. Total number of capitula opened per day was recorded by taking mean of ten randomly selected plants in all populations. *In vivo* germinated pollen grains and number of pollen grains ungerminated was recorded using 1% Acetocarmine stain solution in ten microscopic fields to see the ability of pollen grains to germinate on the stigmatic surface.

In order to study the effect of selfing on seed set and to identify high self-fertile populations, single capitulum, two capitula and three capitula were randomly selected from all the above-mentioned populations and covered with butter paper. Further, single branch and whole plants were also covered using brown paper and cloth bags, respectively. During harvesting all bagged capitula, branch and plant was harvested separately and seed setting was recorded. From each population, 30 capitula were randomly selected and number of seeds was counted and percent of seed setting was calculated. The Percentage of seed set was calculated using the formulae.

Percentage of seed set =

$$\frac{\text{Number of seeds per bagged capitula}}{\text{Mean number of seeds per open pollinated capitula}} \times 100$$

Results and discussion

Studies on floral biology: In niger two to three capitulae (heads) are clustered in leaf axils. The capitula consist of ray florets and disc florets. The receptacle has semi-spherical shape and is 1-1.5 cm in diameter and 0.5-0.9 cm high. The receptacle is surrounded by two rows of involucre bracts.

Ray florets: The capitulum consists of eight to thirteen fertile ray florets, which are sessile, zygomorphic, unisexual, female, ligulate, epigynous and yellow. Among

the six niger populations, the mean length of ray florets ranged from 1.73 cm (Orissa-local) to 2.19 cm (Kanakapura local). The stigma length of ray florets ranged from 0.43 cm (Kanakapura local) to 0.48 cm (No. 71) (Table 1). The stigma is bifid and hairy, curled backward to about 2 mm. The ray florets were the first to open in morning hours between 8.00 and 8.45 am. Earlier workers also have given similar reports [2-5].

Table 1. The mean values on the dimensions of different floral organs and number of heads open per day in different niger populations

Genotypes	Length of ray florets (cm)	Length of corolla tube (cm)	Stigma length (cm)		No. of heads open per day
			Ray floret	Disc floret	
KBN-91	1.94	0.56	0.46	0.65	2.26
S-66	2.01	0.64	0.44	0.65	2.81
No. 71	1.95	0.63	0.48	0.66	2.96
KBN-90	1.95	0.48	0.45	0.64	2.48
Orissa local	1.73	0.49	0.45	0.65	2.60
Kanakapura local	2.19	0.55	0.43	0.69	2.50
Mean	1.90	0.56	0.45	0.65	2.60

Disc florets: These are hermaphrodite florets, usually 40-60 per capitulum, arranged in whorls. The florets are sessile, bisexual, complete, actinomorphic, epigynous, Corolla made of five petals, gamopetalous, pale yellow tubular; stamens five, epipetalous, syngenesious, filament long, anthers basifixed. **Gynoecium:** bicarpellary, syncarpous, inferior, unilocular, one ovul on basal placenta. **Stigma:** bifid and hairy. The length of corolla tube of disc floret among the different niger cultivars ranged from 0.48 cm (KBN-90) to 0.64 cm (S-66) with a mean of 0.56 cm. The stigma length of disc floret ranged from 0.64 cm (KBN-90) to 0.69 cm (Kanakapura local) (Table 1) indicating the prevalence of variability for these traits also.

The mean cumulative opening of disc florets among the six niger populations is presented in the Table 2. The opening of the disc florets began from 9.30 AM and prolonged up to 11.00 AM on a cloudy days. On sunny days, the flower opening was quick and was noticed up to 10.35 AM. The duration of opening of disc florets varied from six to seven days in all the niger populations. Number of disc florets opened on the 1st day ranged from 14.40 (KBN-91) to 15.80 (KBN-90); on the 2nd day, the mean cumulative florets opened ranged from 22.47 (KBN-91) to 26.83 (No-71); on the 3rd day, the maximum florets opened in No-71 (33.23) followed by Orissa local (32.76); on the 4th day, number of florets opened ranged from 35.03 (KBN-91) to 39.33 (No. 71); on the 5th day, it was maximum in Orissa local (43.53) and least in KBN-91 (39.43) and on the 6th day, maximum cumulative more number of florets opened was noticed in KBN-90

Table 2. Mean cumulative number of disc florets opened on different days of flowering in six niger populations

Days	Genotypes					
	KBN-91	S-66	No. 71	KBN-90	Orissa local	Kanakapura local
1st day	14.40	14.47	14.87	15.80	14.67	15.50
2nd day	22.47	25.27	26.83	24.70	24.97	24.17
3rd day	29.40	31.57	33.23	31.03	32.76	31.47
4th day	35.03	38.83	39.33	37.37	37.73	38.16
5th day	39.43	43.20	41.97	43.30	43.53	42.63
6th day	43.57	45.17	43.93	47.50	47.20	45.77

(47.50) and KBN-91 (43.57) recorded the opening of minimum number of florets. Earlier workers [2-3, 5-6] have also reported similar findings.

Pollen germination In vivo: In vivo germination was done by crushing stigma and anthers of a floret on 1% acetocarmine stain, to see the ability of pollen grains to germinate on the stigmatic surface of the flower and the results are presented in Table 3. The highest germination was recorded in No. 71 (10.74%), followed by KBN-90 (10.64 %) and lowest was recorded in Orissa local (3.25 %). The results indicated that, there is scope to realize maximum seed setting by deploying the pollinators.

Table 3. Percent pollen germination in vivo in niger

Genotypes	Total number of pollen grains observed	No. of germinated pollen grains	Percentage of germination
	KBN-91	298	14
S-66	272	19	6.98
No. 71	242	26	10.74
KBN-90	263	28	10.64
Orissa local	246	8	3.25
Kanakapura local	364	13	3.57

Effect of setting on seed set: Seed set under different bagging methods in different niger populations are presented in Table 4. Bagging of single capitulum, two capitula, three capitula, single branch and the whole plant resulted in zero or negligible number of seed set. The data from Table 4 provides a very interesting aspect on the number of seed set under normal conditions (about 16 seeds per capitulum). Lower seed set could be attributed to self-incompatibility and lack of cross compatible pollen within a capitulum. Lack of pollinators would have also caused lower seed set in the bags with two capitula also. Similar results were recorded by earlier workers [7-8] in niger. However, bagging of three capitula resulted in high percent seed set across all the populations. This observation, in the backdrop of lower seed set recorded in whole plant bagging needs to be confirmed by repeated trial on bagging three capitula. Further, it is worthwhile to know the effect of covering two or more than two plants within a single bag to know the effect of selfing.

Table 4. Seed set under different bagging methods in different populations of niger

Varieties	Different bagging types	No. of capitula selfed	No. of capitula in which seed set recorded	Total no. of seeds in all cases	Percentage seed set	Range
KBN-90	Single capitulum	38	6	13	1.78	1-5
	Two capitula	39	7	40	5.35	1-11
	Three capitula	57	14	104	9.53	1-11
	Branch covering	13	2	2	0.80	0-1
	Whole plant covering	12	4	6	2.61	1-2
Orissa local	Single capitulum	63	1	1	0.10	0-1
	Two capitula	69	4	7	0.62	1-2
	Three capitula	68	27	88	7.95	1-11
	Branch covering	15	0	0	0.00	Nil
	Whole plant covering	8	4	6	4.60	1-2
S-66	Single capitulum	29	3	5	1.17	0-2
	Two capitula	29	0	0	0.00	Nil
	Three capitula	46	12	69	10.16	1-23
	Branch covering	10	2	2	1.36	0-2
	Whole plant covering	12	4	5	2.82	1-2
KBN-91	Single capitulum	48	5	19	2.11	1-10
	Two capitula	57	11	49	4.57	1-11
	Three capitula	67	24	172	3.33	1-11
	Branch covering	15	1	4	1.42	0-1
	Whole plant covering	9	6	8	4.68	1-2
No. 71	Single capitulum	51	2	7	0.84	2-5
	Two capitula	50	0	0	0.00	Nil
	Three capitula	43	11	43	6.14	1-9
	Branch covering	13	1	2	0.94	0-2
	Whole plant covering	13	4	7	3.25	1-3
Kanakapura local	Single capitulum	92	4	17	1.50	1-8
	Two capitula	101	11	34	2.73	1-7
	Three capitula	116	32	232	8.56	1-17
	Branch covering	11	1	1	0.73	0-1
	Whole plant covering	10	3	3	2.43	1-2

Under open pollination, seed set ranged from 26.30 to 56.57 percent with a maximum seed set in KBN-90 (Table 5).

It is clear from the study that, among the populations KBN-91 and KBN-90 recorded the highest seed yield in all the types of bagging. These are the advanced breeding lines specifically selected for seed yield, perhaps the higher seed yield in the both populations could be attributed to higher percentage of seed set. However, the populations, No. 71 and Orissa local which are old, but popular even today were not the ones with higher percentage of autogamy but with lower autogamy percent. It is possible that over the years there has been a good mixture of desirable and undesirable genotypes for this trait in these two populations. The higher seed setting lines, i.e., KBN-90 and KBN-91 may be screened further for presence of self-compatibility in niger. This indicates the presence of self-compatibility in Indian lines of niger which are the good signs of genetic improvement programme of niger.

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Table 5. Mean, range and percentage seed set in open pollination in different niger population

Varieties	No. of seed set/capitulum	Range		% seed set
		Lowest	Highest	
KBN-90	19.13	7	30	56.57
KBN-91	18.79	3	40	38.70
S-66	14.75	4	27	46.97
No-71	16.27	2	42	42.51
Orissa local	16.58	3	37	44.48
Kanakapura local	12.34	1	46	26.30
Mean	16.31	3.33	38.66	42.59

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