

Weather relations on floral phenology and autogamy in niger [*Guizotia abyssinica* (L.f.) Cass] under north- western Himalayas

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ABSTRACT

A study was undertaken for understanding of floral phenology, influence of weather parameters on selfing and seed set in five genotypes of niger [*Guizotia abyssinica* (L.f.) Cass] at CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during *khari*, 2006. The results revealed that the disc florets opened between 9.00 AM to 10.30 AM during sunny days and between 10.00 AM to mid day during cloudy days. The maximum opening of disc florets were recorded between 11.00 AM to 12.00 noon when inflorescence experienced bright sun shine hours between 0.0 to 1.0 hour with a mean value of 0.71 hour. Seed set in all baggings viz., single capitulum two capitula, three capitula, single branch and whole plant ranged between 1.6 to 8.5 per cent. Under open- pollinated conditions, the seed set varied from 35.0 (JNS-4) to 49.6 percent (JNC-6). A maximum temperature of 24.5 to 25.0 °C, minimum temperature of 12.5 to 14.0 °C, bright sunshine (7-8 hours) and higher percentage of foliage wetness were found to be related with maximum flower opening under Palampur conditions. Among different genotypes, JNS-3 recorded highest seed set (6.6 percent) followed by JNC-1 (6.2 percent) in all types of baggings. These genotypes can be selected for the development of inbreds to be utilized in hybrid development programme in niger.

Key words: Niger, *Guizotia abyssinica* (L.f.) Cass, floral phenology, selfing, self compatibility, weather relations

Niger [*Guizotia abyssinica* (L.f.) Cass] though, a minor oilseed crop, is of considerable importance for rainfed conditions in India especially on hill slopes and shallow soils of marginal lands. The farmers grow niger for lower input requirement and its suitability for lands in which no other remunerative crop could be grown during retreating monsoons. Madhya Pradesh, Maharashtra and Orissa contribute more than 80 % of area and production. Niger is also successfully grown in Andhra Pradesh, Bihar, Karnataka and West Bengal.

Niger seed contains 35 - 40 % oil and its cake is a valuable cattle feed particularly for milch animals. Niger oil is also a substitute for sesame oil for pharmaceutical purposes. The niger plant has extremely low harvest index and the additional biomass production does not result in proportionate increase in seed yield (Belayneh, 1986). The lower harvest index could arise due to poor seed set in capitula (Kumar *et al.*, 2006). The improved harvest index could be achieved either through enhanced cross pollination due to honey bee activity or through development of inbred lines. Self compatible lines are desirable for the development of inbred lines to be utilized in hybrid development programme. In cross pollinated crops like niger, the hybrid development is a tedious process due to lack of suitable inbred lines which are obtained with continuous selfing only. This investigation will help in understanding the influence of weather parameters on flower opening and honey- bee

activity on one hand and identification and isolation of suitable genotypes which can be used for inbred development on the other.

An attempt was made to raise this crop under high rainfall conditions of Palam valley and understand floral phenology and weather relations on selfing and seed set in order to identify high self-fertile populations.

MATERIALS AND METHODS

The present investigations were carried out at the experimental farm of the Department of Plant Breeding & Genetics, CSKHPKV, Palampur, Himachal Pradesh (India) during *khari*, 2006. Five niger genotypes viz., CHH-5, JNC-6, JNC-1, JNS-3 and JNS-4 received from Chhindwara (Madhya Pradesh) were used in the study. The sowing was done on July 19, 2006 and all recommended package of practices were followed to raise the crop.

Observations on the floral phenology were made starting from anthesis till maturity. In each genotype, the observations on opening of disc florets were recorded on 20 capitula. Beginning with anthesis, the number of florets opened per day in each capitulum was recorded from morning till mid-day for ten consecutive days along with weather parameters.

In order to identify the high self-fertile genotypes,

Table 1: Mean dimensions of different floral organs in niger populations

Genotype	Number of ray florets	Length of ray floret (cm)	Length of Corolla tube (cm)	Stigma length (cm)	
				Ray floret	Disc floret
CHH-5	6-8	1.8	0.60	0.56	0.64
JNC-6	7-8	2.0	0.40	0.58	0.65
JNC-1	7-9	1.9	0.45	0.47	0.69
JNS-3	7-11	1.7	0.50	0.49	0.65
JNS-4	8-12	1.8	0.45	0.51	0.64

Table 2: Mean cumulative number of disc florets opened on different days of flowering in niger

Days/Date	Genotypes					Mean
	CHH-5	JNC-6	JNC-1	JNS-3	JNS-4	
I/13.10.06	6.3	8.4	7.1	9.6	7.8	7.8
II/14.10.06	11.4	15.7	15.8	16.3	14.8	14.8
III/15.10.06	19.8	21.6	24.3	20.1	19.7	21.1
IV/16.10.06	20.6	25.3	27.6	27.3	26.8	25.5
V/17.10.06	24.3	29.4	31.3	29.6	32.4	29.4
VI/18.10.06	29.3	32.6	36.4	34.7	37.8	34.2
VII/19.10.06	32.4	39.3	42.6	39.8	40.3	38.9
VIII/20.10.06	46.7	52.7	44.3	44.1	46.1	46.8
IX/21.10.06	49.6	-	47.9	46.3	48.4	48.1
X/22.10.06	-	-	-	50.1	-	50.1

single capitulum, two capitula and three capitula were randomly selected in each genotype and covered with butter-paper bags. In addition, the single branch and whole plant in each genotype were covered with muslin cloth bags. All bagged capitula, single branch and whole plant were harvested separately and seed set was recorded.

$$\text{Percent seed set} = \frac{\text{Total number of seeds set}}{\text{Number of capitula} \times \text{mean number of disc florets}} \times 100$$

The weather parameters such as rainfall, maximum and minimum temperatures and bright sunshine hours were obtained from Agrometeorological Observatory of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur and leaf wetness was recorded from Automated Weather Station installed in the adjoining field.

RESULTS AND DISCUSSION

Niger plant normally bears 35-40 flower heads (capitula) under favorable conditions. Two to three capitula are clustered in leaf-axils (Prasad, 2005). The flowers on capitula are of two types; viz., ray florets and disc florets.

Ray florets:

Among the five niger genotypes studied, the four

genotypes viz., CHH-5, JNC-6, JNC-1 and JNS-3 recorded eight ray florets each while in JNS-4, the mean number of ray florets ranged from eight to twelve. The mean length of ray florets varied from 1.7 (JNS-3) to 2.0 cm (JNC-6) while the stigma length varied from 0.47 (JNC-1) to 0.58 cm (JNC-6) (Table 1). Maiti *et al.* (1988); Getinet and Sharma (1996) and Kumar *et al.* (2006) have also reported similar findings.

Disc florets

The opening of disc florets is usually completed in 5-8 days (Chavan, 1961) while under cooler weather conditions of Palampur, the disc flower opening is completed in 8-10 days. A floret opens and liberates pollen in the morning hours, style emerges during mid-day and stigma lobes separate and curl backward by evening. Stigma lobes rarely curl sufficiently to touch the style and thus, the plant is basically cross-pollinated. In the present study, the length of corolla tube ranged from 0.40 (JNC-6) to 0.60 cm (CHH-5). The stigma length of disc florets varied from 0.64 (CHH-5, JNS-4) to 0.69 cm (JNC-1).

The mean number of disc florets opened on the first day ranged from 6.3 (CHH-5) to 9.6 (JNS-3) (Table 2). Likewise on the eighth day, the maximum cumulative number of disc florets opened was noticed in JNC-6 (52.7); on the ninth day, it was observed in CHH-5 (49.6) and on the tenth day, the process of floret opening was almost complete except in JNS-3 in which a maximum of 50.1 florets were opened.

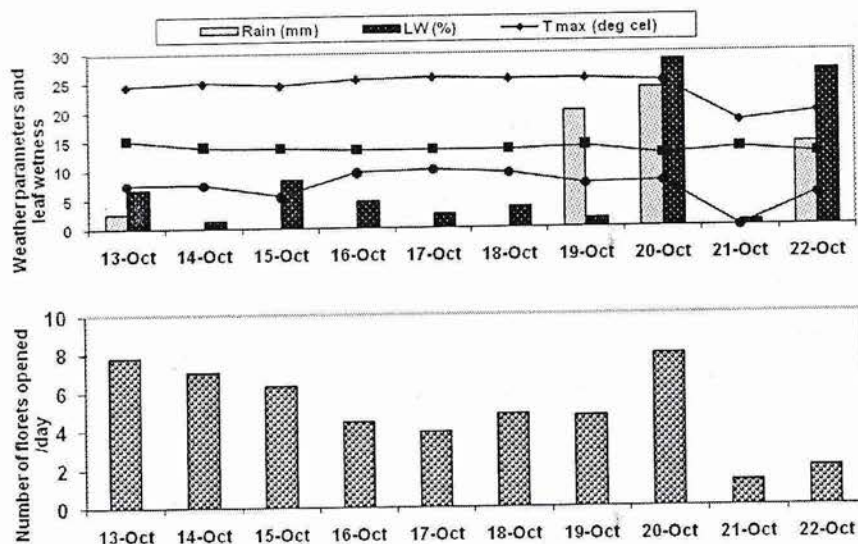


Fig.1: Weather relations of floret opening in niger

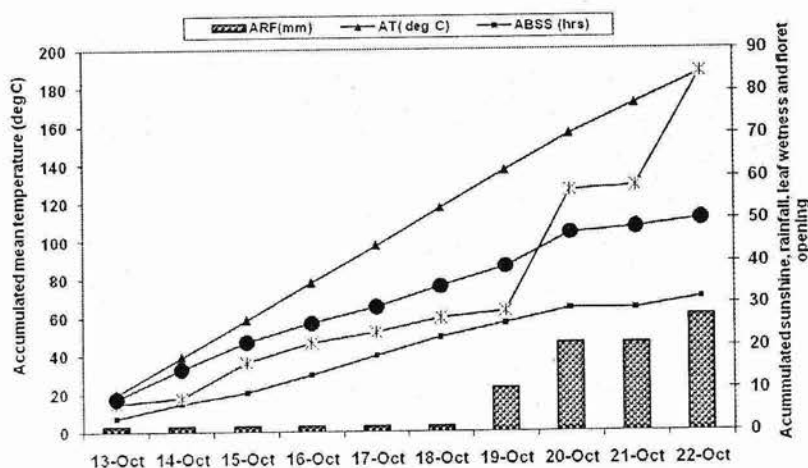


Fig.2: Accumulated weather as related to floret opening in niger

Chavan, 1961 had also reported a mean maximum of 45.8 florets opened in a flower head in variety Kanakpura Local. The genotype CHH-5 was slow in floret opening in initial days but, the rate increased as days progressed. It is pertinent to mention that CHH-5 and JNC-6 showed highest disc floret opening on eighth day. On the other hand, JNC-1 and JNS-3 recorded fast floret opening initially and later progressed at decreased rate.

Weather during disc floret opening

The disc floret opening started on 13th October and declined gradually up till 22nd October, 2006. The period was relatively wet with 60 mm rainfall against the normal of 10 mm. The relative humidity varied between 52-80 %. During this period, the maximum temperature ranged

between 18.0-25.8 °C against the normal of 23.7-24.7 °C while the minimum temperature varied between 12.5-14.0 °C which was near normal (12.9-14.2 °C). Maximum floret opening coincided with maximum temperature of 24.5-25.0 °C and minimum temperature of 12.5 -14.0 °C (Fig.1). At 18.0-25.6 °C, the flowering period of individual capitulum was found to be 8-10 days whereas at 25-27 °C, niger is reported to take 5-16 days. The temperature at flowering affects the duration and pollen fertility and the temperature of 30 °C or above adversely affects the both (Prasad, 2005). In the present study, the process of floret opening showed a declining trend during October 16 to October 18 which were rainless having moderately dew induced foliage wetness nights and sunny days. Overcast and rainless day as observed on October 21, recorded the lowest mean floret opening of

Table 3: Percent seed set under different bagging methods in various genotypes of nigar

Genotype	Bagging type	Total capitula selfed	Capitula in which seed set observed	Total number of seeds set	Percent seed set
CHH-5 (50)	Single Capitulum	10	2	5	5.0
	Two Capitula	20	5	6	2.4
	Three Capitula	30	9	7	1.6
	Single Branch	78	24	47	3.9
	Whole Plant	118	38	117	6.2
				Mean percent seed set	3.8
JNC-6 (53)	Single Capitulum	10	5	7	2.8
	Two Capitula	20	4	10	5.0
	Three Capitula	30	7	17	4.9
	Single Branch	86	19	59	6.3
	Whole Plant	136	33	107	6.5
				Mean percent seed set	5.1
JNC-1 (48)	Single Capitulum	10	1	4	8.0
	Two Capitula	20	3	8	5.4
	Three Capitula	30	6	17	5.7
	Single Branch	64	23	78	6.8
	Whole Plant	98	41	97	4.8
				Mean percent seed set	6.2
JNS-3 (50)	Single Capitulum	10	3	10	6.7
	Two Capitula	20	8	26	6.5
	Three Capitula	30	18	49	5.5
	Single Branch	89	34	109	6.5
	Whole Plant	119	67	249	7.5
				Mean percent seed set	6.6
JNS-4 (48)	Single Capitulum	10	1	2	4.0
	Two Capitula	20	7	18	5.2
	Three Capitula	30	13	27	4.2
	Single Branch	96	42	178	8.5
	Whole Plant	119	91	278	6.1
				Mean percent seed set	5.6

Figures in parenthesis indicate mean number of disc florets per capitulum

1.3 per day. On October 20, highest floret opening of 7.9 coincided with highest leaf wetness of 28.5 % accompanied by rainfall of 23.8 mm and dewfall. A cursory look indicates that the higher floret opening was observed to be related to more humid and higher foliage wetness days either due to dewfall or rain, however this relation does not seem to hold good in later days apparently due to floral ontogeny.

Perusal of bright sun shine hours and disc floret opening indicate that disc florets started opening at about 9.00 AM and continue till 10.30 AM on sunny days while under cloudy weather conditions, the floret opening started at about 10.00 AM and remained open till 12.00 noon. The maximum opening of disc florets were recorded between 11.00 AM to 12.00 noon when inflorescence experienced bright sun shine hours between 0.0 to 1.0 hours with a mean value of 0.71 hour. Higher accumulated mean temperature, leaf wetness, bright sunshine hours were found to be related with higher

floret opening (Fig. 2).

Effect of selfing on seed set

The number of seeds set under different bagging methods in different niger genotypes is presented in Table 3. In general, genotypes showed variable behavior in seed setting in different baggings. Among the different genotypes, JNS-3 recorded the highest seed set (6.6 percent) followed by JNC-1 (6.2 percent) in all the types of baggings. The lower seed set in JNS-4, JNC-6 and CHH-5 could be attributed to self-incompatibility (Sujatha, 1993). Absence of pollinators (bees) in two capitula, three capitula, whole branch and whole plant bagging could have resulted into lower seed set. Similar results were recorded by earlier workers in niger (Riley and Belayneh, 1989). However, Channarayappa, 1987 observed that the seed set was reduced to 0.72 and 0.13 seeds per capitulum in whole plant bagging

Table 4: Effect of bagging pattern on percent seed set in various genotypes of niger

Genotype	Seed set (%)	
	Butter paper bagging	Muslin cloth bagging
CHH-5	3.0	5.1
JNC-6	4.2	6.4
JNC-1	6.4	5.8
JNS-3	6.2	7.0
JNS-4	4.5	7.3

Table 5: Percent seed set in open pollination in various genotypes of niger

Genotype	Number of seed set per capitulum	Seed set (%)
CHH-5	21.7	43.4
JNC-6	26.3	49.6
JNC-1	19.4	40.4
JNS-3	21.9	43.8
JNS-4	16.8	35.0

in two populations of niger and no seed set was recorded in single capitulum bagging. Patil, 2003 also observed minimum seed set in single bud bagging in niger. In the present investigation, the seed set in individual capitulum varied from 2.8 (JNC-6) to 8.0 (JNC-1). An increase in percent seed set was observed in muslin cloth bagging compared to butter paper bagging in all genotypes except for JNC-1 (Table 4). On the other hand, Patil, 2003 observed that oil paper bagging was superior to fine muslin cloth and craft paper bagging. Nemomissa *et al.* (1999) also reported the variable frequency of self compatibility in 9 genotypes originating from different localities. Under open pollination, the seed set ranged from 35 percent in JNS-4 to 49.6 percent in JNC-6 (Table 5).

As the two genotypes viz., JNS-3 and JNC-1 were good seed setter in all the bagging types, these should be involved in the development of inbreds to be utilized in hybrid development programme in niger. A maximum temperature of 24.5 to 25.0 °C, minimum temperature of 12.5 to 14.0 °C, bright sunshine (7-8 hours per day) and more percentage of foliage wetness coincided with maximum floret opening

under Palampur conditions.

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