Biological Forum – An International Journal **15(4): 254-258(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Population Improvement in Niger for Yield and Yield Attributing Traits after Two Cycle of Mass Selection

Gururaja M.**, Nandini R., Savithramma D.L. and Rangaiah S.
Department of Genetics and Plant Breeding, University of Agricultural Sciences, GKVK, Bengaluru (Karnataka), India.

(Corresponding author: Gururaja M.)*
(Received: 20 February 2023; Revised: 08 March 2023; Accepted: 15 March 2023; Published: 20 April 2023)
(Published by Research Trend)

ABSTRACT: Niger (*Guizotia abyssinica* (L.f.) Cass) is oil bearing annual, herbaceous plant belonging to the natural order compositae, sometimes referred to as Asteraceae. Niger is a cross pollinated crop and controlling its pollination is very difficult due to the smaller sized inflorescence so that there is no any ruling hybrids are not available in this crop. Hence our main aim is to improvement of niger plant population for yield and yield attributes using mass selection. First we developed base population to create of sufficient genetic variability in a population to select the individual plant based on phenotypic appearance, this was during summer 2018 at University of Agricultural sciences, GKVK, Bengaluru. From base population we selected 500 phenotypically superior plants and tag them and record the observation on quantitative traits. From 500 plant seed yield data we were make three different A1, A2 and A3 population based on seed yield per plant. Among three population we were discussed only A1 population in this article. The selected A1 population group seeds from base population plants were subjected to a two cycle of mass selection. Mean value for yield and yield attributing traits was high in case of A_1 population after second cycle of mass selection over base and first cycle of selection mean values. This could be due to the selection efficiency, it lead to occurrence of different allelic and gene combinations. Mean values of yield and yield attributing traits of base, first and second cycle of mass selection values were subjected to t test, the results revealed significant increase in plant height, primary branches per plant, secondary branches per plant, capsule number per plant, number of seeds per capsule, test weight and seed yield per plant after second cycle of mass selection over base population mean values.

Keywords: Niger, A1 population, Mass Selection, Growth parameters, Yield attributes.

INTRODUCTION

Niger (*Guizotia abyssinica* (L.*f.*) Cass) is an annual diploid species (2n=2x=30) belonging to the family Asteracea, tribe heliantheae and subtribe coriopsidinae. It is a herbaceous crop with moderately branched and grows up to a height of 2 m. In Ethiopia and India, it is cultivated mainly for oil purpose. The seeds of niger are club shaped, ovoid with broad end towards the apex and elongated (Seegeler, 1983). The Ethiopian niger seed contains 40% oil and a fatty acid composition with 75-80% linoleic acid, 5-8% oleic acid and 7-8% of both palmitic and stearic acids (Getinet and Teklewold 1995). However, Indian niger seed contains 36-38% oil with 25% oleic and 55% linoleic acids (Nasirullah *et al*., 1982). Niger is a cross pollinated crop and controlling its pollination is very difficult due to the smaller sized inflorescence so that in niger difficult to develop hybrids and maintaining its purity is even more difficult. Due to certain genetic barriers in niger like self-incompatibility, there is no ample number of varieties or hybrids available commercially for cultivation. Elementary information on floral biology and pollination mechanism has a decisive bearing on rational breeding procedures in crop improvement. Chavan (1961) has also explained that low yields could be the result of low level of selection pressure mounted on the crop over a period of thousands of years to develop it and that breeding technique should become more incisive. As a result of such shortcoming, the currently grown niger cultivars are low yielders with late maturity. Hence, alternative methods like population improvement become an imperative breeding method. Selection strategies for improving populations in crop plants have developed and evolved continuously over the past. The development of superior inbreds or varieties from population involves several selection programs. Systematic population improvement program helps the breeder to generate superior populations with improved performance by directional selection followed by intermating of the reselects. This gives impetus for the development of elite inbred or varietal lines. Further, it enables the development of superior hybrids, synthetics and composites (Seneviratne *et al.,* 1989).

A few cross-pollinated plants such as maize have given a lead in developing new methodologies, which subsequently have been deployed in other crop plants likewise such methodologies can be applied to niger also. In order to overcome this problem population improvement programs were planned by plant breeders

to improve yield and yield attributing traits. Accumulation of desirable alleles in a population through various breeding techniques is known as population improvement and such breeding procedures that are used for such work are referred to as population improvement approaches. The standard breeding procedure for cross-pollinating crops is recurrent selection and mass selection as described in standard plant breeding text books (Allard, 1960).

Mass selection is an indispensable breeding strategy practised to improve the populations of crop plants particularly those of cross-pollinated species. In recent years there has been a renewed interest in mass selection. Mass selection or individual selection is selection on the basis of the individual phenotype. It may be undertaken in one (intra-population improvement) or two populations (inter-population improvement) to upgrade the performance per se or combining ability. Mass selection breeding method which is a powerful tool for crop improvement in niger in which individual plants are selected on the basis of phenotypes and the harvested seeds of all selected plants were bulk to propagate the next selection cycle. Due to the above discussed limitations in Niger, there is an urgent need for an extensive and comprehensive study to improvise and increase yield levels and the oil content. With this background, the current investigation using modified method of mass selection is carried out.

MATERIAL AND METHODS

For conducting a mass selection cycle in any crops first we have to develop base populations, so that our initial goal is to develop a base population

Development of base population. The experimental material consisted of bulking of the seeds of 54 niger germplasm lines seeds in an equal amount to develop a base population. During summer 2018 sowing of the bulked seeds of all 54 germplasm lines were taken up at University of Agricultural Sciences, GKVK, Bangalore. Large population of Niger (bulking seeds of 54 germplasm accession lines) was maintained with a spacing of 30cm between rows and 10cm within a row. The total experimental plot was divided into 12 equal plots with a length of 4 m and width of 3 m, each plot having 270 to 300 plants and a total 3200-3500 plants were raised. Observations were recorded on 500 phenotypically superior plants based on visual observation for the traits like primary branches, secondary branches and number of capsule per plant.

The seeds harvested from 500 hundred selected plants from the base population were subjected for two cycle of mass selection. All five hundred harvested plants were classified into three categories based on seed yield per plant for further experiments. The first category included those plants having seed yield of less than 2.5g/plant and this was labelled as A1 population (seeds of 164 plants bulked out of 500 plants). Similarly those plants having seed yield of 2.5 g - 3.5 g/plant constituted A2 population (Bulked seeds of 197 plants out of 500 plants), while those plants having seed more than 3.5g/plant constituted as A3 population (Bulked seeds of 139 plants out of 500 plants). A1, A2 and A3 population were further used to as experimental material for applying mass selection. In this research article we were only explain in detail about A1 population only for two cycles of mass selection.

First cycle of mass selection. The seeds belonging to the A1 category (Bulked seeds of 164 plants from base population out of 500 plants), was sown during kharif 2018 in grid type of mass selection at University of Agricultural Sciences, GKVK, Bangalore. Each plot consisted of four meters length and three meter width in spacing of 30 cm between rows and 10 cm between plants within row was maintained, likewise five plots were laid out for A1 population. From total raising plants only 100 phenotypically superior plants were tagged and observations were recorded. After recording observation of about 100 plants the seeds were harvested and bulked within a population of 100 plant seeds and these bulked seeds was used to conduct second cycle of mass selection.

Second cycle of mass selection. A bulked seed of 100 plants from the first cycle of mass selection was used for conducting second cycle of mass selection. The bulked seeds of A1 population were sown during rabi 2018 in grid type of mass selection at University of Agricultural Sciences, GKVK, Bangalore. Each plot consisted of four meters length and three meter width and following a spacing of 30 cm between rows and 10 cm between plants within a row. Five such plots were laid out for A1 population and observations on 100 phenotypically superior plants were recorded based on superior phenotypic characters plants.

While data pertaining to ten quantitative characteristic such as plant height (cm), primary branches, secondary branches, days to flowering, number of capsule per plant, number of seeds per capsule, test weight (g), seed yield per plant (g) and oil content (%) on 100 plants of the A1 populations for two cycles of mass selection were recorded.

Data Analysis:

Mean and Percentage change improvement.

Mean: sum of all plant observation recorded divided by number of plants

Change in mean value of first cycle of A1 population and second cycle of mean value over base population mean

Change in mean value of A1 = Means of A1 population in 1st cycle of mass selection - Means of A1 population in base population. And also calculated the

Percent Change improvement =

$$\frac{\text{New Value - Old Value}}{\text{Old Value}} \times 100$$

If the result is positive, it is an increase

If the result is negative, it is a decrease

t Test statistics

The test statistic is calculated as

$$t = \frac{(x_1 - x_2)}{\sqrt{\frac{(s_1)^2}{n_1} + \frac{(s_2)^2}{n_2}}}$$

Where x is the sample mean, s^2 is the sample variance, n is the sample size, μ is the specified population mean and **t** is a Student t quantile with n-1 degrees of freedom. A null hypothesis of no difference between

sample and population means has clearly been rejected. If t test shows alternate hypothesis then there is a difference in samples and population means has clearly been accepted.

RESULT AND DISCUSSION

Substantial response to selection was observed in A1 selected population for all the characters studied including seed yield per plant. The yield difference between base population and A1 selected populations was high. Seed yield increased in mean value from 2.33 g per plant to 3.43 g per plant in A1 population which accounts to an overall increase of 47.21 per cent over a base population (Table 1 and 2). The traits like plant height also exhibited a higher mean value from 108.16 cm to 115.05 cm in A1, which accounts to an overall increase of 6.37 per cent. Primary branches per plant also increased mean value from 6.40 per plant to 8.34 per plant in A1, which accounts to an overall increase of 30.31 per cent. Secondary branches per plant increased mean value from 13.21 per plant to 15.94 per plant in A1, which accounts to an overall increase of 20.66 per cent. Traits like number of capsule per plant increased from 34.01 to 48.00 per plant in A1, which accounts to an overall increase of 41.13 per cent. The mean value of number of seeds per capsule increased from 29.60 to 32.70 in A1, which accounts to an overall increase of 10.60 per cent. The mean value of test weight increased from 2.95 g to 3.14 g in A1, which accounts to an overall increase of 6.44 per cent. Oil content mean value increased from 34.18 percent to 36.19 percent in A1, which accounts to an overall increase of 5.88 per cent. The traits like primary branches per plant, secondary branches per plant, number of capsule per plant, number of seeds per capsule, test weight (g), seed yield per plant (g) and oil content (%) showed higher value as compare to the base population mean value, this could be due to the fact that the base population and selected population have different allelic combinations hence the trait expression for A1 population was high compared to the base population. There by mass selection was effective in the present material. This is clearly evident from the fact that selected populations showed an increase in yield per plant as compared to the base population. Similarly all other characters also exhibited an increase in mean values as compared to base population. Such effectiveness of mass selection has also been reported by several workers in different crops. The increase in yield to the extent of 29 per cent in population I and 31 per cent in population II have been reported by Virupakshappa *et al*. (1986). The increase in seed yield through mass selection has also been reported in sunflower by Semihnenko and Kamennobrodskaja (1962). Based on mean values after first cycle of mass selection of A1 population with base population mean results of yield and yield attributing traits were subjected to t test, the results revealed significant increase in plant height, primary branches per plant, secondary branches per plant, capsule number per plant, number of seeds per capsule, test weight and seed yield per plant, whereas days to 50% flowering showed a negative significant decrease, thus early flowering is seen in A1 population as compared with the base population (Table 3).

After second cycle of mass selection yield mean value increased from 3.43 g per plant to 3.98 g per plant in A1 population, which accounts to an overall increase of 16.03 per cent over first cycle of selection (Table 4). The traits like primary branches per plant recorded as increase mean value from 8.34 per plant to 10.07 per plant in A1, which accounts to an overall increase of 20.74 per cent. Traits like number of capsule per plant increased mean value from 48.00 per plant to 58.71 per plant in A1, which accounts to an overall increase of 22.31 per cent over a first cycle of mass selection. The mean of number of seeds per capsule increased mean value from 32.74 per capsule to 36.96 per capsule in A1, which accounts to an overall increase of 12.88 per cent. From first cycle of selection the test weight increased mean value from 3.14 g to 3.26 g in A1 population which accounts to an overall increase of 3.82 per cent, 4.58 per cent and 3.79 per cent, respectively after second cycle of selection. Oil content increased mean value from 36.19 percent to 36.32 percent in A1, which accounts to an overall increase of 0.35 per cent after second cycle of selection.

Based on mean values after second cycle of mass selection of A1 population with first cycle of mass selection mean values of yield and yield attributing traits were subjected to t test, the results revealed significant increase in plant height, primary branches per plant, secondary branches per plant, capsule number per plant, number of seeds per capsule, test weight and seed yield per plant (Table 5).

Table 1: Mean values of A1 populations of base, after first and second cycle of selection for seed yield and its components.

Characters	Mean values		
	A1 Population of base population	After first cycle of selection	After second cycle of selection
Plant height (cm)	108.16	115.05	125.84
Primary branches $^{-1}$	6.40	8.34	10.07
Secondary branches^{-1}	13.21	15.94	19.52
Days to 50% flowering	41.00	39.00	37.00
Number of capsule per plant	34.01	48.00	58.71
Number of seeds per capsule	29.60	32.74	36.96
Test weight (g)	2.95	3.14	3.26
Seed yield per plant (g)	2.33	3.43	3.98
Oil content %	34.18	36.19	37.32

Table 2: Percent improvement for yield and yield attributing traits in A1 population after first cycle of mass selection over base populations mean value.

Character	Mean values of population	Change in population mean	% improvement over base population
Plant height (cm)	(A1-BP)= 115.05-108.16	6.89	6.37
Primary branches per plant	(A1-BP)=8.34- 6.40	1.94	30.31
Secondary Branches per plant	(A1-BP)= 15.94-13.21	2.73	20.66
Days to 50% flowering	(A1-BP)= 39.00-41.00	-2.00	-4.87
Number of capsule per plant	(A1-BP)= 48.00-34.01	13.99	41.13
Number of seeds per capsule	(A1-BP)=32.74- 29.60	3.14	10.60
Test weight (g)	(A1-BP)= 3.14-2.95	0.19	6.44
Seed yield per plant (g)	(A1-BP)= 3.43-2.33	1.10	47.21
Oil content (%)	(A1-BP)= 36.19-34.18	2.01	5.88

BP- Base population; A1- Population

Table 3: T test value for yield and yield attributing traits between mean values of A_1 population (After first cycle of mass selection) of Niger with A1 of base population.

Character	Mean values of A1 population and base populations		Mean difference between A1 population and base population	T statistic value
	A1 Population	Base Population		
Plant height (cm)	115.05	108.16	6.89	8.42**
Primary branches $^{-1}$	8.34	6.40	1.94	11.18**
Secondary branches^{-1}	15.94	13.21	2.73	8.38**
Days to 50% flowering	39.00	41.00	-2.00	-4.43**
Number of capsule per plant	48.00	34.01	13.99	13.71**
Number of seeds per capsule	32.74	29.60	3.14	6.46**
Test weight (g)	3.14	2.95	0.19	4.74**
Seed yield per plant (g)	3.43	2.33	1.10	14.42**
Oil content %	36.19	34.18	2.03	3.67**

Table 4: Percent improvement for yield and yield attributing traits in A1 populations after second cycle of mass selection over first cycle mean values of A1 populations.

Character	Mean values of population	Change in population mean	% improvement over base population
Plant height (cm)	In A_1 (M_2-M_1)=125.84-115.05	10.79	9.37
Primary branches per plant	In A_1 (M_2-M_1)=10.07-8.34	1.73	20.74
Secondary Branches per plant	In A_1 (M_2-M_1)=19.52-15.94	3.58	22.45
Days to 50% flowering	In A_1 (M_2-M_1)=37.00-39.00	-2.00	-5.12
Number of capsule per plant	In A_1 (M_2-M_1)=58.71-48.00	10.71	22.31
Number of seeds per capsule	In A_1 (M_2-M_1)=36.96-32.74	4.22	12.88
Test weight (g)	In A_1 (M_2-M_1)=3.26-3.14	0.12	3.82
Seed yield per plant (g)	In A_1 (M_2-M_1)=3.98-3.43	0.55	16.03
Oil content (%)	In A_1 (M_2-M_1)=37.32-36.19	1.13	3.21

Where M1- First cycle of mass selection means values; M2- Second cycle of mass selection mean values

Table 5: T test value for yield and yield attributing traits between A1 populations of two cycles of selection

Character	Mean values of A1 population of two cycle of selections		Mean difference between two cycle of mass selection	T statistic value
	After 2nd cycle selection	After 1st cycle selection		
Plant height (cm)	125.84	115.05	10.79	8.70**
Primary branches $^{-1}$	10.07	8.34	1.73	8.31**
Secondary branches^{-1}	19.52	15.94	3.58	8.68**
Days to 50% flowering	37.00	39.00	-2.00	-4.72
Number of capsule per plant	58.71	48.00	10.71	7.76**
Number of seeds per capsule	36.96	32.74	4.22	5.02**
Test weight (g)	3.26	3.14	0.12	2.07**
Seed yield per plant (g)	3.98	3.44	0.55	5.20**
Oil content %	37.32	36.19	1.13	0.49

Mean value for yield and yield attributing traits was high in case of A_1 population after second cycle of mass selection over base and first cycle of selection mean values. This could be due to the selection efficiency it leads to occurrence of different allelic and gene combinations. Similar reports have been reported by Jenoria and Verma (1978).

CONCLUSIONS

Niger is highly cross-pollinated crop, controlling of pollination is very difficult hence, in this study

improvement of existing cultivars of niger lines by two cycles of mass selection. After two cycles of mass selection improvement was observed in yield and yield attributing traits in niger population as compared with the base population.

Acknowledgement. The authors acknowledge all the members of Department of Genetics and Plant Breeding, UAS, Bangalore, Karnataka, India for providing all the facilities to carry out this research work.
Conflict of Interest. None.

REFERENCES

Allard (1960). Principles of Plant Breeding. *Proc. Natl. Acad. Sci. U. S. A., 46*, 1371-1377.

Chavan, V. M. (1961). Niger and safflower. Indian Central Oilseeds Committee, Hyderabad. pp-66.

Getinet, A. and Teklewold, A. (1995). An agronomic and seed-quality evaluation of niger (*Guizotia abyssinica* Cass.) germplasm grown in Ethiopia. *Plant Breed.,114***,** 375-376.

Jenoria, M. P. and Verma, S. N. P. (1978). Whorled phyllotaxis in niger, *Indian J. Genet., 38*, 106-114.

Nasirullah, K. T., Mallika, S., Rajalakshmi, K. S., Pashupathi, K. N., Ankaiah, S.,Vibhakar, M. N., Krishnamurthy, K. V., Nagaraja, A. and Kapur, O. P. (1982). Studies on niger seed oil (*Guizotia abyssinica*) seed oil. *J. Food Sci. and Technol., 19*, 147-149.

Seegeler, C. J. P. (1983). Oil plants in Ethiopia. Their taxonomy and agricultural significance. Centre for Agricultural Publication and Documentation, PUDOC, Wageningen.

Semihnenko, P. G. and Kamennobrodskaj, V. P. (1962). Methods which improve the yield character of sunflower seed. *Agrobioligija, 2,* 525-531.

Seneviratne, K. G. S., Ganesh, M. G., Ranganatha, G., Nagaraj. K., Singh, B. and Patra, G. J. (1989). Character association and path coefficient quantitative traits in niger. *Indian J. Agril. Sci., 59*(3), 442-445.

Virupakshappa, K., Shivashankar, G. and Channarayappa (1986). Response to selection in niger. *SABRAO J., 18*(2), 83-88.

How to cite this article: Gururaja M., Nandini R., Savithramma D.L. and Rangaiah S. (2023). Population Improvement in Niger for Yield and Yield Attributing Traits after Two Cycle of Mass Selection. *Biological Forum – An International Journal, 15*(4): 254-258.