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Genetic Variability Analysis of Yield and its Components in Niger [(*Guizotia abyssinica* (L. f.) Cass.]

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A B S T R A C T

The present study "Genetic variability analysis of yield and its components in Niger [(*Guizotia abyssinica* (L. f.) Cass.]" was carried out at the Instructional cum Research Farm of S.G. College of Agriculture and research station, Jagdalpur (C.G.) Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *Kharif* 2017. The experimental material comprised of 50 Niger germplasm and 3 check variety of Niger. The experimental materials were sown on September 2017 in RBD design with three replication with the objectives to estimate the genetic variability, heritability and genetic advance. Analysis of variance indicate that the mean sum of square due to genotypes were highly significant for all the characters. High genotypic coefficient of variation and phenotypic coefficient of variation were observed for capitulum per plant and seed yield per plant (g). The high heritability was recorded for the trait days to maturity and straw yield (g) followed by days to 50% flowering and oil content (%), plant height (cm), capitulum per plant, seed yield per plant (g) seed per capitulum, primary branches per plant and harvest index (%). Genetic advance a percentage of mean recorded high for capitulum per plant, seed yield per plant (g), seeds per capitulum, oil content (%), harvest index (%), primary branches per plant, plant height (cm) and straw yield (g).

Introduction

Niger [*Guizotia abyssinica* (L.f.) Cass.] belonging to family Asteraceae is minor oilseed crop with its center of diversity and origin in Ethiopia. Niger constitutes about 3% of Indian and 50% of Ethiopian oilseed production in the world. Niger is the only cultivated species of the genus *Guizotia* with a diploid plant chromosome number of 2n=2x=30 (Bisen *et al.*, 2016). Niger seed belongs to the same botanical family as sunflower and safflower (Compositae). There are six species of *Guizotia* with *G. abyssinica* being the only the cultivated species. It is a dicotyledonous herb, moderately to well branched and grows up to 2 meter in height (Jagtap *et al.*, 2014). Baagoe (1974) has revised this genus and recognized following species: *G. abyssinica* (L. f.) Cass.; *G. scabra* (Vis.) Chiov. Subsp. scabra and subsp. *schimperi* (Sch. Bip.) Baagoe; *G. arborescens* I. Friis; *G. reptans* Hutch; *G. villosa* Sch. Bip.

and *G. zavattarii Lanza*. *Guizotia scabra* contains two subspecies, *scabra* and *schimperi*. *Guizotia scabra* subsp. *schimperi*, known locally as 'mech,' is a common annual weed in Ethiopia (Murthy *et al.,* 1995). There are both herbaceous and woody members as well as annual and perennial ones. *G. abyssinica* is easily distinguished from the other members of the taxon by its large achenes and large head size as well as ovate outer phyllaries (Dagne, 1994b). Niger is commonly known as ramtil, jagni or jatangi (Hindi), ramtal (Gujrati), karale or khurasani (Marathi), uhechellu (Kannada), payellu (Tamil), verrinuvvulu (Telugu), alashi (Oriya), sarguza (Bengali), ramtil (Punjabi) and sorguja (Assamese) in different parts of the country It is the lifeline of tribal agriculture and economy in India (Pandey *et al.,* 2014).

It has high protein content and is semi-tolerant to salinity and performs well under poorly aerated soil conditions (Abebe, 1975). Niger grows well on wide range of soil types. Some strains are salt tolerant and it is a valuable attribute for an oilseed crop. Niger oil has good keeping quality with 70% unsaturated fatty acids free from toxins. It has an advantage of yielding oil and has good degree of tolerance to insect pests, diseases and attack of wild animals. It has good potential for soil conservation, land rehabilitation and as a biofertilizer, consequently the crop following Niger is always good (Bisen *et al.,* 2016). Niger is indigenous to Ethiopia where it is grown in rotation with cereals and pulses. The African and Indian gene pools have diverged into distinct types. On both continents Niger germplasm has been collected and evaluated and is mostly conserved and documented at the Biodiversity Institute of Ethiopia and the Indian National Bureau of Plant Genetic Resources (including zonal centers). The Ethiopian germplasm is collected from farmer's fields and does not include breeding lines. In this monograph the major germplasm characterizations and evaluations at Holetta, Ethiopia and Jabalpur, India are summarized (Getinet and Teklewold 1995).

Niger (*Guizotia abyssinica* L. f.) is an important oilseed crop of tropical and subtropical countries like India, Ethiopia, East Africa, West Indies and Zimbabwe. India ranks first in area, production and export of Niger in the world. India and Ethiopia are two major producers in the world. Out of the total oilseed production, it contributes nearly 50 per cent and 3 per cent from Ethiopia and India, respectively. Mostly grown in tribal areas in India, it is considered as "lifeline of tribal agriculture and economy". It has been an important crop as it has the potentially to give sustainable yield under rainfed situation.(Patil *et al.,* 2013.) *G. abyssinica* is cultivated in Ethiopia and the Indian sub continent as a source of edible oilseed (Murthy *et al.*, 1993). Niger (*Guizotia abyssinica* L.) is an important oilseed crop of tropical and subtropical areas of the world. The quality of oil and its suitability for a particular purpose is it for industrial use or for human consumption depends on the proportion of the different fatty acids it contains. There are opportunities which favor cultivation of oilseeds in general in the country which ranges from import substitution of edible oils to export of high value seed and oil. Although efforts have been done to improve oil quality of Niger seed using various breeding strategies, such as genetically modify the degree of unsaturation in oils through genetic engineering (Kinney 1994; Chapman *et al.,* 2001). The oil is considered good for health which is pale yellow with nutty taste and a pleasant odour and can be used as a substitute for olive oil provided it has good keeping quality and self-life. Out of the total oilseed production, it contributes nearly 50 % and 3 % from Ethiopia and India, respectively. Niger is cultivated mainly for its high-quality edible oil amounting to 30-50% of seed weight (Seegler, 1983). Niger is grown over an area of about 3 lakh ha in India in 10 States, with larger area in Chhattisgarh, MP, Maharashtra and Odisa. In India area is 2.61 lakh hectare, production 0.84 MT and yield 3.21 q/ha. In Chhattisgarh area is 0.63 lakh hectare, production 0.11 MT and production 1.74 q/ha (Anonymous, 2016). In Bastar area is 19.09 ('000) hectare, production 6.4 T and yield 231.1 kg/ha (Anonymous, 2009a).

Materials and Methods

Experimental site

The present study "Genetic variability analysis of yield and its components in Niger [(*Guizotia abyssinica* (L. f.) Cass.]" was carried out at the Instructional cum Research Farm of S.G. College of Agriculture and research station, Jagdalpur (C.G.) Indira Gandhi Krishi Vishwavidyalaya Raipur (C.G. during) during *Kharif* 2017. The Bastar plateau zone which comes under zone VII Eastern ghat and plateau zone of Indian Agroclimatic Zone identified by planning commission (Anonnymous, 2009b) (Fig. 1).

Geographical situation and climate

Jagdalpur is at 19.1071° North latitude and 81.9535° East longitude with an altitude of 569 meters above located mean sea level. The region has subtropical and humid climate. The maximum rainfall was received during the month of July 2017. The total rainfall 1677 mm was received during crop season 2017. The periodic meteorological data (*Kharif* 2017) pertaining to weekly rainfall, minimum and maximum temperatures, relative humidity, evaporation and bright sunshine hours of entire crop growing period have been presented in Appendix. The experimental material comprised of 50 Niger germplasm and 3 check variety of Niger. The experimental materials were sown on 11th September 2017 under RBD design with three replication in *kharif* season. Net plot size was 1.0x2.0 m, under this plot size, plot to plot distance 30 cm, Row to row distance of 25 cm and plant to plant distance of 10 cm were maintained. Five competitive plants were randomly selected from each replications and plots and tagged each five plants. All agronomic practices were followed recommended package of practices to raise best for Niger. The experimental material comprised of 50 Niger germplasm and 3 check variety of Niger. The experimental materials were sown on 11th September 2017 under RBD design with three replication in *kharif* season. Net plot size was 1.0x2.0 m, under this plot size, plot to plot distance 30 cm, Row to row distance of 25 cm and plant to plant distance of 10 cm were maintained. Five competitive plants were randomly selected from each replications and plots and tagged each five plants. All agronomic practices were followed recommended package of practices to raise best for Niger.

Statistical analysis

Analysis of variance (ANOVA)

Analysis of variance for the experiment conducted as per R.B.D. will be carried out by model as suggested by Panse and Sukhatme (1985). The ANOVA is a powerful statistical tool for tests of significance.

$Y_{ij} = \mu + g_i + r_j + e_{ij}$

Where, i = 1, 2, 3... g
j = 1, 2, 3... r
Yij = Yield of jth genotype in ith replication
μ = General mean
gi = Effect of ith replication
rj = Effect of jth genotype
eij = Uncontrolled variation associated with ith replication and jth genotype

Parameters of variation

Range: The range of the distribution was expressed by the limit of the smallest and the largest value of each observation.

Mean: This was found out by summing up of all the observations and dividing the sum by the number of observations.

Heritability: Heritability in broad sense h^2b defined as the proportion of the genotypic variance to the total variance (phenotypic variance) was estimated by Hanson *et al.,* (1956).

$$h^2b(bs) = \frac{\sigma^2 g}{\sigma^2 p} \times 100$$

where,

$\sigma^2 g$ = genotypic variation

$\sigma^2 p$ = phenotypic variation

Genetic advance: The expected genetic advance (G.A.) was calculated as per the method suggested by Johnson *et al.,* (1955).

$$\Delta \text{ G.A.} = K.\sigma p.\ h^2$$

where,

K = Constant (Standard selection differential) having value of 2.06 at 5% selection intensity.

σp = Phenotypic standard deviation.

h^2 = Heritability estimate.

Genetic advance as percentage of mean: Genetic advance as percentage of mean was calculated by the following formula:

$$\text{Genetic advance as \% of mean} = \frac{GA}{\text{Mean}} \times 100$$

where,

GA = Genetic Advance

Genotypic and phenotypic co-efficient of variation: The genotypic and phenotypic co-efficient of variation were calculated using formulae the following suggested by Burton (1952).

$$GCV(\%) = \frac{\sqrt{\sigma^2 g}}{\text{Mean}} \times 100$$

$$PCV\ (\%) = \frac{\sqrt{\sigma^2 p}}{\text{Mean}} \times 100$$

Where,

GCV = Genotypic co-efficient of variation

PCV = Phenotypic co-efficient of variation

Results and Discussion

Genetic variability parameters

Analysis of variance

Analysis of variance indicate that the mean sum of square due to genotypes were highly significant for all the characters *viz*.,seed yield per plant, test weight (g), capitulam per plant, primary branches per plant, seed per capitulam, plant height at harvesting(cm), days to 50% flowering, days to maturity, oil%, straw yield (g) harvest index (%). Similar results have been found by Panda and Sial. (2012) for days to 50% flowering, plant height, number of capitula per plant. Patil *et al.,* (2013) observed similar findings for number of primary branches per plant, number of secondary branches per plant, plant height, number of capitulam per plant, days to maturity. Bisen *et al.,* (2015) observed similar results for number of branches per plant, number of capitula per plant, plant height, oil content (%), days to 50% flowering, days to maturity.

Parameters of genetic variability

Genetic variability measures of variability include, mean, range, genotypic coefficient of variance, phenotypic coefficient of variance, heritability (broad sense) % genetic advance as per cent of mean for all characters. Genetic parameters of variation are discussed character wise here as under.

Mean and range

Mean is the sum of all observations in a sample divided by their number and range is the highest and lowest value of all the observation in a sample. The overall mean and range for yield and its components revealed that there is substantial amount of genetic variability present for most of the characters under study in Niger.

Seed yield per plant

Seed yield per plant ranged from 0.56g (BN-13) to 1.39g (BN-48) with a mean value 0.93. Maximum seed yield per plant was recorded in BN-48 and minimum seed yield per plant was recorded in BN-13. The genetic parameter of variation and analysis of variation where large amount of genetic variability available with this material under present investigation. So seed yield improvement along with component traits can be achieved either by direct and indirect selection. Similar results were reported by Sevantilal (2016) for seed yield per plant. Maximum seed was 1.51g and minimum seed was 0.59g recorded.

Test weight (g)

1000 seed weight ranged between 2.83g (BN-13) to 3.81 g (Birsa niger-3) with the average 3.35g maximum 1000 seed weight was recorded in Birsa niger-3 and minimum 1000 seed weight was recorded in BN-13. Similar results have been found in Ahmad *et al.,* (2016).

Number of capitulum per plant

The observation data of number of capitulam per plant ranged between 8.87 (BN-13) to 23.9 (Phule karala) with a general mean 16.37. The maximum number of capitulum per plant was observed in Phule Karala. and minimum number of capitulum per plant was observed in BN-13.

Primary branches per plant

The trait primary branches per plant ranges between 3.70 (BN-13) to 11.48 (BN-39) with an average value of 8.72. The maximum number of primary branches was found in BN-39 and minimum number of primary branches per plant was found in BN-13.

Seeds per capitulum

The variation of seeds per capitulum ranges 17.43 (BN-13) to 39.60 (BN- 48) with an average 29.87. the maximum number of seeds per capitulum was recorded in BN-48 and minimum number of seeds per capitulum was recorded in BN-13. Similar results have been reported by Tiwari *et al.,* (2016) and Ahmad *et al.,* (2016).

Plant height

The variation for plant height ranged 68.55 cm (BN-13) to 141.54 cm (BN-25) with a general mean 105.66 cm. The highest plant height was observed in BN-25 and the lowest plant height was observed in BN-13.

Days to 50% flowering

Days to 50% flowering was ranged from 39.60 (BN-10) to 53.66 (BN-26) with an average value 45.98. The maximum day to 50% flowering was observed in BN-26 and minimum days to 50% flowering were observed in BN-10.

Days to maturity

Variation for days to maturity ranged between 77.00 (BN-11) to 98.00 (BN-24) with a general mean 86.17. The Maximum days to maturity was noticed in BN-11, the minimum days to maturity was noticed in BN-24. Similar results have been obtained by Tiwari *et al* (2016).

Oil per centage

Oil per centage ranged from 19.15% (BN-20) to 37.89% (BN-48) with an average value 30.61%. The maximum oil per cent was recorded in BN-48 and minimum oil per cent was recorded in BN-20.

Harvest index

Harvest index ranged from 15.83% (BN-43) to 34.60% (BN-47) with a general mean 24.04%. The maximum harvest index was observed in BN-47 and minimum harvest index was observed in BN-43.

Straw yield per plant

Straw yield was ranged between 3.12g (BN-1) to 4.65g (BN-22) with an average value 3.86g. The maximum straw yield was noticed in BN-22 and minimum straw yield was noticed in BN-1 (Table 1).

Genotypic and phenotypic coefficient of variation

Genotypic and phenotypic coefficients of variation are simple measures of variability; these measures are commonly used for the assessment of variability. The relative values of coefficient give an idea about the magnitude of variability present in a genetic population. Thus, the components of variation such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were computed. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are categorized as low (less than 10%), moderate (10-20%) and high (more than 20%) as suggested by Sivasubramanian and Madhavamenon (1973). The phenotypic coefficients of variation were marginally higher than the corresponding genotypic coefficient of variation indicated the influence of environment in the expression of the character under study.

High genotyphic coefficient of variation and phenotypic coefficient of variation were noticed for capitulum per plant (23.61%, 24.58%) and seed yield per plant (g) (22.34%, 23.73%). The moderate GCV and PCV was recorded for seeds per capitulum (18.35%, 19.81%), primary branches per plant (17.04%, 18.54%), harvest index (%) (17.49%, 19.03%), oil percentage (17.00%, 17.27%), plant height (cm) (12.00%, 13.23%), straw yield (g) (10.62%, 10.65%). The lowest GCV and PCV were recorded for days to 50% flowering (8.05%, 8.18%), 1000 seed weight (g) (5.55%, 7.57%), days to maturity (5.06%, 5.08%). Highest GCV and PCV were recorded for seed yield per plant by (Ahmad *et al.,* 2016) and Rani *et al.*, (2010) for plant height. Moderate GCV and PCV were recorded for primary branches per plant, seed per capitulum, plant height, by Tiwari *et al.*, 2016. Low GCV and PCV were observed for days to 50 % flowering, days to maturity by Ahmad *et al.*, (2016). Similar results have been obtained by Tiwari *et al.*, (2016) for days to 50% flowering, days to maturity, test weight (g).

Heritability (Broad sense)

Heritability estimates the degree of variation in a phenotypic trait due to genetic variation between individuals in that population. It is useful in the selection of elite types from homozygous material (Table 2).

Table.1 Analysis of variance for seed yield and its component in Niger at Jagdalpur (C.G.)

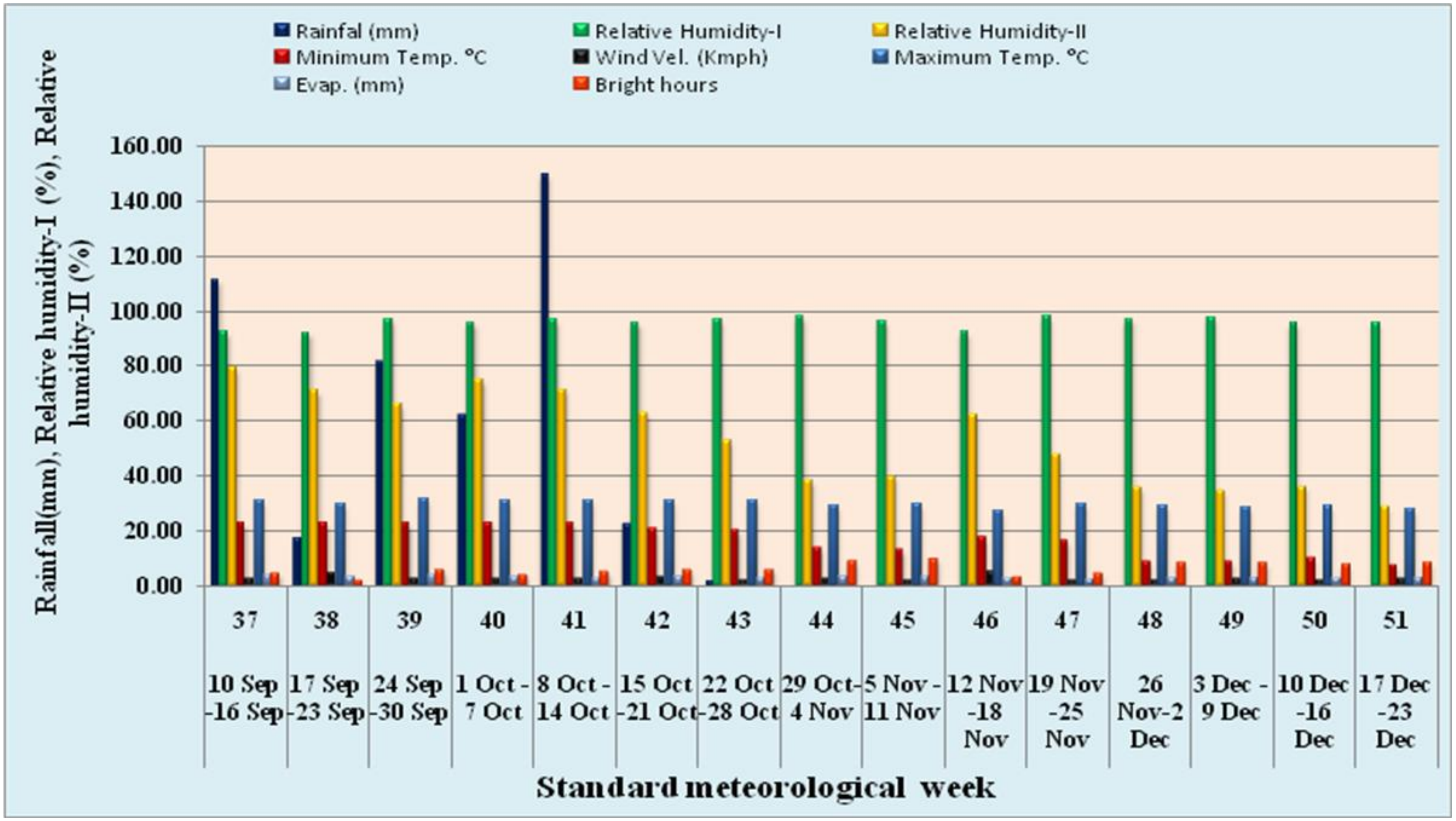
S. No.	Characters	Mean Sum of Square		
		Replication	**Genotypes**	**Error**
1	Seed yield per plant (g)	0.010	0.134**	0.005
2	Test weight (g)	0.156	0.133**	0.029
3	Capitulum per plant	0.428	46.068**	1.247
4	Primary branches per plant	0.072	7.021**	0.403
5	Seed per capitulum	3.751	95.035**	4.972
6	Plant height (cm)	2.03	488.26**	6.31
7	Days to 50% flowering	0.132	41.569**	0.452
8	Days to Maturity	0.169	57.161**	0.189
9	Oil content (%)	0.648	82.133**	0.871
10	Harvest index (%)	6.618	56.287**	3.252
11	Straw yield (g)	0.001	0.503**	0.008

*, **, Significant at 5 and 1 per cent levels, respectively.

Table.2 Genetic parameters of variation for seed yield and its component in Niger at Jagdalpur

S. No.	Character	Mean	Range		PCV (%)	GCV (%)	Heritability	Genetic advance as % of mean
			Max.	**Min.**				
1	Seed yield per plant	0.93	1.39	0.56	**23.73**	**22.34**	0.89	**43.31**
2	Test weight (g)	3.35	3.81	2.83	7.57	5.55	0.54	8.40
3	Capitulam per plant	16.37	23.9	8.87	**24.58**	**23.61**	0.92	**46.72**
4	Primary branches per plant	8.72	11.48	3.70	18.54	17.04	0.85	32.28
5	Seed per capitulam	29.87	39.60	17.43	19.81	18.35	0.86	35.01
6	Plant height (cm)	**105.66**	141.54	68.55	13.23	12.00	0.96	24.24
7	Days to 50% flowering	45.98	53.66	39.00	8.18	8.05	0.97	16.32
8	Days to Maturity	86.17	98.00	77.00	5.08	5.06	**0.99**	10.37
9	Oil percentage	30.61	37.89	19.51	17.27	17.00	**0.97**	34.47
10	Harvest index	24.04	34.60	15.83	19.03	17.49	0.84	33.11
11	Straw yield	3.86	4.65	3.12	10.65	10.62	**0.99**	21.82

Fig.1 Weekly meteorological data



In the present experiment it has been made to estimate the heritability in broad sense by variance component analysis.

It is generally expressed in per cent *viz*., low (< 50 %), moderate (50-7-%), and high (> 70%) as suggested by Robinson (1966). If heritability in broad sense is high it indicates characters are least influenced by environment and selection for improvement of such characters may be useful. If heritability in broad sense is low the characters are highly influenced by environmental effects and selection of such characters for genetic improvement is not useful due to masking effect of the environment on the genotypic effect.

In the present experiment most of the characters showed high estimates of broad sense heritability. The high heritability was recorded for the trait days to maturity (99%) and straw yield (g) (99%) followed by days to 50% flowering (97%) and oil per centage (97%), plant height (cm) (96%), capitulum per plant (92%), seed yield per plant (g) (89%), seed per capitulum (86%), primary branches per plant (85%), harvest index % (84%). In this experiment the moderate heritability was recorded for the characters test weight (g) (54%).

High heritability for seed yield per plant, capitulum per plant, seeds per capitulam, number of primary branches per plant, plant height days to maturity days to 50% flowering by (Tiwari *et al.,* 2016) similar results have been found for number of capitulum per plant, plant height by (Patil *et al.,* 2013) similar results have been found for number of capitulum per plant by (Ahmatd *et al.,* 2016). Similar results have been found for seed yield per plant, oil per cent, days to maturity, days to 50% flowering, plant height, capitulum per plant by Vinod and Rajani (2016).

Genetic advance

Genetic advance is the improvement in the mean genotypic value of selected plants over the parental population. Heritability estimates along with genetic advance are normally more helpful in predicting gain under selection than heritability estimates alone. However it is not necessary that a character showing high heritability will also exhibit high genetic advance (Johnson *et al.,* 1955).

The magnitude of genetic advance as per cent of mean was categorized as high (> 20%), moderate (10% - 20%), and low (< 10%). If the value of genetic advance is high, it shows that the character is governed by additive genes and selection will be rewarding for improvement of such trait. If the value of genetic advance is low, it indicates that the character is governed by non additive genes may be useful. High genetic advance for seed yield per plant, number of capitulum per plant was recorded by Ahmad *et al.,* (2016) similar results have been found for plant height by Tiwari *et al.,* (2016) similar results have been reported by Rani *et al.,* (2010) for plant height. Similar results have been found for plant height, primary branching per plant, seed yield per plant, capitulam per plant by Vinod and Rajani (2016). Genetic advance as per cent of mean (at 5% intensity) recorded high for capitulam per plant (46.72%), seed yield per plant (g) (43.31%), seeds per capitulum (35.01%), oil per cent (34.47%), harvest index (%) (33.11%), primary branches per plant (32.28%), plant height (cm) (24.24%), straw yield (g) (21.82%). Moderate genetic advance was recorded for days to 50% flowering (16.32%), days to maturity (10.37%), and low genetic advance was recorded for test weight (g) (8.40%). High heritability estimates in broad sense along with high genetic advance as per cent of mean (at 5% intensity) was recorded for capitulam per plant, seed yield per plant (g) seeds per capitulam, oil per cent, harvest index (%), primary branches per plant, plant height (cm) and straw yield (g). It indicates that most likely the heritability is due to additive gene effects and selection may be effective.

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