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ESTIMATION OF GENETIC VARIABILITY, CORRELATION ALONG WITH PATH ANALYSIS IN NIGER (*GUIZOTIA ABYSSINICA* L.F. CASS) BREEDING LINES

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ABSTRACT

Niger crop belonging to Asteraceae family is considered as an orphan crop and mainly grown on undulated topographical land. A field experiment was carried out at the Zonal Agricultural Research Station, All India Coordinated Research Project on Niger, Chandangaon, Chhindwara (Madhya Pradesh) during the *kharif* 2021 and 2022 sown at three different dates using forty-two niger breeding lines including two check JNS-28 and JNS-9. The results revealed that the mean sum of square due to genotypes was highly significant at 1% level for almost all the characters studied. High GCV and PCV were showed for biological yield, harvest index (%) and seed yield per plant. As a proportion of the mean, strong heritability and high genetic advancement were noted for biological yield, 1000 seed weight, No. of branches/plant, No. of capitula/ plant, and No. of seeds per capitula. harvest index, oil percent and seed yield/plant. Seed yield/plant exhibits significant and positively correlated with number of branches/plants, number of capitula per plant, number of seeds per capitula, thousand grain weight (gm), biological yield and seed yield/plant pooled over all environments. Path analysis reveal that harvest index (%) showed the highest positive direct effect on seed yield per plant followed by biological yield, No. of branches per plant, oil percent and No. of capitula per plant indicating to be main yield contributing traits. Hence, for enhancement of yield these traits should be considered.
***Keywords*:** Genetic Variability, Correlation, Path Analysis, Niger

Introduction

Mostly produced as an oilseed crop in Ethiopia and India, Niger (*Guizotia abyssinica* L.f Cass), also known as ramtil, 2n=30, is a member of the Astraceae family. In accordance with the self-incompatibility mechanism, Niger is outcrossing species. The seed and oil of this annual dicotyledonous herb are its most popular uses. Regarding nutritional aspects, niger seed contains almost 40% edible oil and fatty acid composed of 75-80% linoleic acid, 7-8% palmitic and stearic acids and 5-8% oleic acid. The Indian specific niger contains 25 oleic and 55 linoleic acid percent (Panda and Sial, 2012 and Getinet and Tekalwold, 1995) and has less linoleic acid and more oleic acids content. In India, it is grown in an area of 83.40 thousand ha with productivity 323 kg/ha and in MP area has reduced drastically from 72 thousand ha in 2014-15 to 10 thousand ha during 2023-24.

Limited genetic variability is the primary reason behind the limitations in the development of improved plant cultivars. Any crop development program that offers precise information for the selection of specific traits requires knowledge of essential genetic factors. Genetic indices that measure the diversity seen in niger breeding lines include genetic progress, heritability, and the genotypic (GCV) and phenotypic (PCV) coefficients of variation. Correlation and path coefficient analysis can be used to describe the

relationship between yield and its components, which is crucial for the selection process. Keeping the above points in view, the assessment of variability of the traits and their direct and indirect positive interrelationship to seed yield/plant must be given topmost prior in selection process in breeding. this research

Method and Material

The present experiment was carried out at the JNKVV, ZARS, All India Co-ordinated Research Project on Niger, Chandangaon, Chhindwara (MP) India during *kharif* 2021 and Kharif 2022. Chhindwara is situated at the height of 683 m above the sea level between $21^0$10' and $22^0$49' N latitude and $78^0$28' and $79^0$25 E longitude. The experiment comprised of 42 niger breeding lines sown in RBD replicated thrice along with two checks i.e JNS 28 and JNS 9. Each niger breeding line was sown in four rows of 2.0m length with spacing of 30cm within rows and 10cm between plants for three different dates of sowing. Observations were taken on eleven quantitative characters namely days to fifty percent flowering, maturity days, plant height (in cm), No. of branches/plant, number of capitula per plant, number of seeds/capitula, harvest index (%), biological yield (g), 1000 grain weight (g), oil (%) and yield per plant (g). As recommended by Panse and Sukhatme (1967) for randomised block design, analysiss of variance (ANOVA) for individual characters was performed based on the mean value per entry each replication. Burton (1952) provided the formula for estimating PCV and GCV, whereas Johnson *et al*. (1955) and Hanson (1953) provided the formula for estimating heritability in the broadest sense. The formula provided by Allard (1960) and Johnson *et al*. (1955) was used to calculate genetic progress. The formulae proposed by Al-Jibouri *et al*. (1958) were used to estimate the phenotypic and genotypic correlation coefficients, while the formula proposed by Dewey and Lu (1959) was used to analyse the route coefficient.

Result and Discussion

The ANOVA exhibited significant variation among 42 niger breeding lines for all the traits in both the environments *i.e., Kharif,* 2021 and *Kharif,* 2022 indicated the presence of significant variability among the breeding lines for respected traits traits. In the traits studied, the phenotypic coefficient of variance was significantly higher than the genotypic coefficient of variation. In the traits, harvest index % (28.89, 28.57) recorded the maximum value of PCV (%) and GCV (%) followed by yield/plant (26.15, 26.05) and biological yield/plant (25.06, 24.87). Moderate PCV was observed for No. of capitula per plant (13.3,13.10) followed by branches/plant (12.46, 11.25), oil percent (11.44, 11.43) and No. of seeds/capitula (10.93,10.78). whereas low PCV and GCV was observed for TGW (8.20, 7.96), height of plant (7.68, 7.59), days to maturity (4.38, 4.35) and days to 50% flowering (2.67, 2.45). Similar result also found by Ahirwar *et al.,* (2017) for all traits, Panda & Sial (2012) found for days to 50% flowering, height of plant (cm) and No. of capitula/plant and Saraswat *et al.* (2022) found for seed yield. identical results were also observed by Fekadu (2020), Tiwari *et al.* (2016) for almost all the traits. Kumar *et al.* 2022 reported similar result for traits harvest index, number of branches, number of capitula per plant and seed yield.

For each of the eleven yield attributing characters studied, heritability in (BS) was calculated. It is sub-divided into three categories *viz*., high (> 70%), moderate (50- 70%), and low (less than 50). The trait Oil % (99.9) recorded the topmost heritability followed by yield/plant (99.2), biological yield/plant (98.5), maturity days (98.4), height of plant (97.9), harvest index % (97.8), No. of seeds/capitula (97.3), No. of capitula/plant (97.0), 1000 grain weight (94.3), days to 50% flowering (84.4) and No. of branches/plant (81.4). Observations are in consistency with the results of Fekadu (2020), Rani *et al*. (2014), Bisen *et al*. 2015, Suryanarayana *et al*. (2018), Tiwari *et al*. (2018), Saraswat *et al*. (2022). Patil *et al.* (2013) observed similar result for days to 50% flowering, maturity days, height of plant, number of capitula/plant and thousand grain weight. Ahmad *et al.,* (2016) found similar result for seed yield/plant.

Harvest index % (74.6) recorded highest genetic advance as % of mean followed by yield/plant (68.5), biological yield (65.1), number of capitula per plant (34.07), oil % (30.16), number of seeds/capitula (28.08), No. of branches/plant (26.82) and 1000 grain weight (20.42). Plant height (19.87) and maturity days (11.40) showed nearly moderate genetic advance as % of mean. Whereas, days to 50% flowering (5.94) were categorized as exhibited low genetic advance as percentage of mean.

High genetic progress as a percentage of mean was accompanied by strong heritability (h2) in the No. of branches/plant, No.of capitula/plant, No. of seeds/capitula, biological yield/plant, harvest index (%), 1000 grain weight, and seed yield/plant. This suggests that additive gene activity is more common for certain traits. (Panse 1957). Patil (2000), Bisen *et al.,* 2015, Kumar and Bisen, 2016 observed similar results for seed yield, Saraswat *et al.* (2022), Ahirwar *et al.,* (2023) observed similar result for all the traits

studied. As consequently, these qualities have considerable of possibilities for selection. It would be desirable to select these characters depending on their phenotypic performance in order to achieve the targeted outcome. Kumar *et al.,* 2022 reported similar result for the traits number of branches per plant, number of capitula per plant, harvest index, 1000 grain weight and seed yield per plant

The height of plant and maturity days have high heritability value coupled with medium genetic advance over mean suggesting that the predominance role of action in the expression of these traits. Hence, these traits can be improved by mass selection. Similar result also observed by Ahmad *et al* (2016). High heritability with low genetic advance show in days to fifty percent flowering. It indicates non additive gene action. Similar results also attained by Ahirwar *et al*. (2023) for these traits.

Correlation analysis

The result of Nearly all of the traits displayed higher genotypic correlation values than phenotypic correlation values, according to an analysis of the correlation coefficients between genotype and phenotype. Plant height (-0.213) and harvest index (-0.236) were shown to be negatively correlated with days to 50% flowering, but the trait days to 50% flowering showed a highly significant positive correlation with days to maturity (0.534), followed by oil percentage (0.221), as shown in Table 2. The maturity days showed highly significant correlation with 1000 grain weight (0.313), number of seeds per capitula (0.310), capitula per plant (0.276), oil content (0.204) and biological yield (0.194) while, yield/plant, height of plant (-0.195) found to exhibit negatively significant correlation. Plant height, on the other hand, had a negative correlation with biological yield per plant (-0.238) and a positive correlation with harvest index (0.323). The yield/plant (0.593) is significantly positively correlated with the No. of branches/plant, followed by the No. of seeds/capitula (0.480), No. of capitula/plant (0.479), thousand grain weight (0.464), harvest index (0.348), and biological yield (0.196). The remaining traits showed non-significant negative correlations. The yield per plant (0.598) is significantly positively correlated with the No. of capitula/plant, followed by the number of seeds per capitula (0.526), thousand grain weight (0.523), and harvest index (0.438). The remaining traits show non-significant linkage. The number of seeds per capitula had positive significant relationship with yield per plant (0.632) followed by thousand grain weight (0.487), biological yield (0.321) and harvest index (0.314), while, non-significant correlation was observed for all the other traits. The thousand grain weight had significant positive relationship with yield per plant (0.757) followed by biological yield (0.402) and harvest index (0.355) and biological yield had a significant positive relationship with yield per plant (0.432) while, oil % (-0.272) and harvest index (-0.435) observed significant negative correlation, harvest index (%) exhibited positive correlation with yield per plant (0.598) followed by number of capitula per plant (0.438), thousand grain weight (0.355) while, biological yield (-0.435) and days to flowering (-0.236) observed significant negative correlation, rest of the traits found to be non-significant. The yield per plant was found to have a positive correlation with thousand grain weight (0.757) followed by number of seeds per capitula (0.632), harvest index (0.598), capitula per plant (0.598), branches per plant (0.593), biological yield (0.432) and least for days to maturity (0.215) while, none of the traits observed to be significantly negatively correlated with yield per plant. Similar results were also observed by Suryanarayana *et al*. (2019) and Patil *et al*. (2019) for the traits No. of branches/plant, No. of capitula/plant, No. of seeds/capitula and thousand grain weight. Similar findings align closely with previous studies conducted by Amsalu (2020) and Ahmad *et al*., (2003) for No. of branches/plant, No. of capitula/plant, thousand grain weight. Panda and Sial (2012) for No. of capitula/plant, Patil *et al*., (2013) for thousand grain weight and Jagtap (2014) for No. of capitula/plant and thousand seed weight.

Direct effect

Harvest index (0.754), biological yield (0.708), No. of branches/plant (0.0903), thousand grain weight (0.144), oil percentage (0.070), and number of capitula per plant (0.058) had the highest positive direct effect on yield per plant, which followed the same trend as the second environment. In contrast, days to maturity (-0.0034) and days to flowering (-0.084) had the highest negative direct effect, as revealed in Table 3. For the characteristics of days to 50% flowering, days to maturity, height of plant, No.of branches/plant, No. of capitula/plant, No. of seeds/capitula, and thousand grain weight, Ahmad *et al*. (2016) found similar findings. For plant height, Surayanarayana *et al*. (2018) found a similar outcome. Ahmad *et al*. (2016) found similar outcomes for the following traits: plant height, No. of branches/plant, No. of capitula/plant, No. of seeds/capitula, days to 50% flowering, days to maturity, and thousand grain weight. Similar results were found by Surayanarayana *et al*. (2018) for plant height, number of branches per plant, days to 50% flowering, and number of seeds per capitula. Similar

results were obtained by Patil *et al*. (2013) and Subhangi *et al*. (2019) for the following traits: plant height, No. of branches/plant, No. of seeds/capitula, days to 50% flowering, and thousand grain weight.

Amsalu (2020) observed similar results for plant height, thousand grain weight and oil content; Panda *et al*. (2012) for the traits No. of branches/plant and No. of seeds/ capitula. Teja *et al*. (2024) found similar result for the traits days to 50% flowering, plant height, No. of branches/plant, No. of capitula/plant, No. of seeds/capitula 1000 grain weight and oil content.

Indirect Effects

Through oil percentage (-0.020), maturity days (-0.048), biological yield (-0.011), 1000 grain weight (-0.005), and capitula per plant (-0.009), the days to 50% blooming had a negative indirect influence. Through the harvest index percentage (0.022), plant height (0.200), No. of seeds/capitula (0.0026), and biological yield/plant (0.003), it also demonstrated a favourable indirect effect. Days to maturity had the positive indirect effect via on plant height (0.0007). Additionally, it showed a negative indirect influence through harvest index percentage (-0.0001), number of seeds per capitula (-0.0011), days to blooming (-0.0019), branches per plant (-0.0013), and thousand seed weight (-0.0011). Through the harvest index (0.0071), No. of branches/plant (0.0029), number of capitula per plant (0.0016), and No. of seeds/ capitula (0.0006), plant height showed a favourable indirect effect. It also exhibited least negative indirect effect *via* biological yield/plant (-0.0052) followed by days to 50 percent flowering (-0.0051) and days for maturity (-0.0043).

One trait, the days to 50% flowering (-0.0004), had a negative indirect effect, whereas the No. of branches/plant had a positive one through harvest index percentage (0.0349), days to maturity (0.0095), biological yield/plant (0.0195), plant height (0.0123), oil percentage (0.0074), thousand grain weight (0.0503), and the No. of seeds/capitula (0.0488) and capitula/plant (0.0468). The No. of capitula/plant had a positive indirect effect through the following measures: thousand grain weight (0.0321), No. of seeds/capitula (0.0320), No. of branches/plant (0.0305), harvest index percentage (0.0264), days to maturity (0.0165), plant height (0.0043), biological/plant (0.0078), days to 50% flowering (0.0068), and oil percentage (0.0008). The harvest was positively impacted indirectly by the No. of seeds/capitula. The No. of seeds/capitula had a favourable indirect impact on harvest, biological yield/plant (0.0006), and thousand grain weight (0.0009) harvest Index % (0.0006), days to maturity (0.0006) and oil % (0.0003). Rest of the characters were found to have negligible positive and negative indirect effect.

Plant height (-0.0224) and oil percentage (-0.0170) showed a negative indirect effect of thousand grain weight, while the No. of branches/plant (0.0803), number of capitula per plant (0.0787), number of seeds per capitula (0.0724), biological yield/plant (0.0606), harvest Index percentage (0.0526), days to maturity (0.0456), and days to flowering (0.0092) showed a positive indirect effect. Via thousand grain weight (0.2983), No. of seeds/capitula (0.2316), No. of branches/plant (0.1527), days to maturity (0.1414), days to 50% flowering (0.0984), and number of capitula per plant (0.0942), biological yield/plant showed a favourable indirect influence. Additionally, it showed a negative indirect influence through plant height (-0.1715), oil percentage (-0.1941), and harvest index percentage (-0.3042).

Through the No. of capitula/plant (0.3383), No. of branches/plant (0.2917), plant height (0.2490), No. of seeds/capitula (0.2465), thousand grain weight (0.2756), oil percentage (0.0836), and days to maturity (0.0224), the harvest index (%) had a favourable indirect effect. Additionally, it showed a negative indirect influence through days to blooming (-0.1998) and biological yield/plant (-0.3239). The oil percentage had a negative indirect effect on biological yield/plant (-0.0192) and thousand grain weight (-0.0083), but a positive indirect effect was seen in the number of seeds per capitula (0.0124), No. of branches/plant (0.0058) (-0.0015), days to 50% flowering (0.0168), days to maturity (0.0144), harvest index (0.0078), and plant height (0.0031). These results corroborate those of earlier research by Amsalu (2020), Panda *et al*. (2012), Subhangi *et al*. (2019) and Suryanarayana *et al*., (2018) for almost all the traits under study.

The number of branches/plant, number of capitula/plant, biological yield, and thousand grain weight all had a greater impact on seed yield than any other character studied, according to correlation & path analysis conducted altogether. To increase the seed production in Niger, would be desirable to assign these characters higher priority in the selection and different breeding program.

Table 1 : Various parameters of genetic variability resulting for yield attributing traits in Niger genotypes

S.No.	Characters	Mean	Range	PCV %	GCV%	Hb (%)	GA as (%) of mean
1	Days to 50 percent flowering	59.48	56.50-62.17	2.67	2.453	84.4	5.948
2	Days to maturity	102.11	92.67-111.67	4.38	4.353	98.4	11.402
3	Plant height	91.99	78.33-109.83	7.68	7.598	97.9	19.843
4	Number of branches per plant	8.71	6.67-11.17	12.46	11.256	81.5	26.825
5	Number of capitula per plant	29.02	20.67-34.83	13.3	13.102	97.0	34.073
6	Number of seeds per capitula	34.64	24.50-41.17	10.93	10.786	97.3	28.083
7	1000 grain weight	4.08	3.52-4.85	8.20	7.968	94.3	20.427
8	Biological yield	31.21	18.67-45.50	25.06	24.871	0.985	65.162
9	Harvest index %	14.36	8.65-23.92	28.89	28.577	0.978	74.608
10	Oil %	33.66	30.02-45.15	11.44	11.435	0.999	30.169
11	Yield per plant	4.34	1.85-5.95	26.15	26.052	0.992	68.502

Table 2: Significant phenotypic correlations (pooled) among various attributes

Traits	DF	DM	PH	BP	CP	SC	TGW	BY	HI %	Oil %	YP
DF	1	0.5341***	-0.2133*	-0.0038	0.1012	-0.033	0.0678	0.1222	-0.2364**	0.2219*	-0.1482
DM		1	-0.1956*	0.3376***	0.2762**	0.3109***	0.3138***	0.1944*	0.0291	0.2042*	0.2154*
PH			1	0.1211	0.0717	0.03	-0.1505	-0.2385**	0.3234***	0.0433	0.1145
NBPP				1	0.4796***	0.4800***	0.4643***	0.1965*	0.3486***	0.0733	0.5934***
NCPP					1	0.5268***	0.5230***	0.1291	0.4386***	0.014	0.5983***
NSPC						1	0.4877***	0.3217***	0.3145***	0.174	0.6325***
TGW							1	0.4026***	0.3555***	-0.1138	0.7576***
BY								1	-0.4350***	-0.2719**	0.4325***
HI %									1	0.1096	0.5987***
Oil %										1	-0.0684
YP											1

Here, DTF (Days to 50 percent flowering), DTM (Days to maturity), PH (Plant height), NBPP (Number of branches per Plant), NCPP (number capitula per plant), NSPC (Number of seeds per capitula), TGW (1000 Grain weight), BY (Biological yield), HI % (Harvest Index) and PYPP (Yield per plant)

Table 3: Genotypic path coefficient resulting direct and indirect effects of different contributing characters on seed yield per plant

Traits	DF	DM	PH	NBPP	NCPP	NSPC	TGW	BY	HI %	Oil %
DF	**-0.0842**	-0.048	0.02	0.0003	-0.009	0.0026	-0.0054	-0.0117	0.0223	-0.0202
DM	-0.0019	**-0.0034**	0.0007	-0.0013	-0.001	-0.0011	-0.0011	-0.0007	-0.0001	-0.0007
PH	-0.0051	-0.0043	**0.0215**	0.0029	0.0016	0.0006	-0.0034	-0.0052	0.0071	0.001
BP	-0.0004	0.0347	0.0123	**0.0903**	0.0468	0.0488	0.0503	0.0195	0.0349	0.0074
CP	0.0062	0.0165	0.0043	0.0305	**0.0588**	0.032	0.0321	0.0078	0.0264	0.0008
SC	-0.0001	0.0006	0	0.001	0.001	**0.0018**	0.0009	0.0006	0.0006	0.0003
TGW	0.0092	0.0456	-0.0224	0.0803	0.0787	0.0724	**0.144**	0.0606	0.0526	-0.017
BY	0.0984	0.1414	-0.1715	0.1527	0.0942	0.2316	0.2983	**0.7083**	-0.3042	-0.1941
HI %	-0.1998	0.0224	0.249	0.2917	0.3383	0.2465	0.2756	-0.3239	**0.7542**	0.0836
Oil %	0.0168	0.0144	0.0031	0.0058	0.001	0.0124	-0.0083	-0.0192	0.0078	**0.0701**
YP	**-0.1608**	**0.2199**	**0.1171**	**0.6541**	**0.6105**	**0.6474**	**0.7832**	**0.4361**	**0.6016**	**-0.0687**

R Square = 0.9820, Residual Effect = 0.1342

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