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GENETIC VARIABILITY STUDIES FOR SEED YIELD AND ITS ATTRIBUTING TRAITS IN OILSEED CROP: NIGER [*GUIZOTIA ABYSSINICA* (L.F.) CASS]

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ABSTRACT

The productivity of the Niger [*Guizotia abyssinica* (L.f.) Cass], an important oilseed crop is very low (325 kg/ha). Understanding the extent of genetic variability present within niger germplasm is pre-requisite for selecting superior plant types, and thereby increasing the production. In order to study the genetic variability present among the available niger germplasm, the present experiment was carried out during *Kharif* 2023 in Augmented Randomised Complete Block Design (ARCBD) using 48 germplasm along with three checks *viz.*, JNS-28, JNS-30 and IGPN 2004-1. This study revealed that, significant variability is present among the germplasm for most of the traits. High Genotypic coefficient of variation was observed for number of branches per plant, number of capitula per plant and thousand seed weight. High Phenotypic coefficient of variation and Genotypic coefficient of variation for the trait seed yield per plant. High heritability coupled with high genetic advance as percent of mean was recorded for days to 50% flowering, plant height, number of branches per plant, number of capitula per plant, 1000 seed weight and oil content. A negative correlation was observed for oil content and seed yield. Number of capitula per plant, number of branches per plant exhibited significantly positive association and had direct effect on seed yield per plant. Hence, these traits should be considered for future Niger crop improvement program.

Key words : Oilseed, Correlation, Heritability, Path analysis and Self-incompatibility.

Introduction

Nigeris an important oilseed crop belongs to the Compositae family (Asteraceae) with diploid chromosome number 2n=30 (Richharia and Kalamkar, 1938; Hiremath and Murthy, 1992 and Dagne, 1994). The crop is originated in tropical Africa and cultivated majorly in Ethiopia and India. It is a highly cross-pollinated crop due to presence of self-incompatibility. Niger oil has pharmaceutical value and used in traditional nutritional application (Ramdhan, 2012). It has good potential for soil conservation. It also forms an excellent intercrop with wide range of other oil seed and non-oil seed crops. These attributes favour its cultivation on hilly areas, marginal and submarginal lands in and around the forests (Ranganatha *et al.*, 2014).

In India, it is grown over an area of 0.08lakh ha with annual production of 0.03lakh tonnes and productivity of 325 kg/ha (India stat, 2023). However, the area under niger cultivation in India is declining since the last decade due to its poor seed set resulting from protandrous self-incompatibility, shattering nature, low harvest index, non-determinant types and cuscuta infestation. Also, lack of exploitable genetic diversity makes breeders difficult to develop high yielding cultivars. Hence studying the relationship among seed yield related traits and assessing the genetic diversity among genotypes accelerates the breeding programmes towards yield enhancement.

Therefore, present study was carried out to characterize niger germplasm, which would help to find donors for seed yield related traits and breed highly productive cultivars.

Materials and Methods

A field trial was conducted during *kharif*, 2023 in augmented block design with plot size 3.6 $m^2$and 45 × 10 cm spacing using 48 niger accessions (Table 1) along with three checks (JNS-28,JNS-30 and IGPN 2004-1). The recommended agronomic and plant protection practices were implemented to raise a good crop stand. Observations were recorded on randomly selected five plants (excluding border plants). Data was taken for nine quantitative traits *viz*., Days to flower initiation, Days to 50% flowering, Plant height, Number of branches per plant, Number of capitula per plant, Number of seeds per capitula, Seed yield per plant, 1000 seed weight and oil content. Oil content was estimated using nuclear magnetic resonance spectroscopy (NMR MQC-5, UK). Analysis of variance (ANOVA) and genetic variability studies were computed with 'R software version v 0.1.7' (Aravind *et al*., 2023) and the Pearson's method (1895) was used to perform correlation analysis. Path coefficient analysis was done to determine the direct and indirect effects of one character on another, as recommended by Wright (1921) and demonstrated by Dewey and Lu (1959).

Table 1 : List of genotypes used in the study.

S. no.	Genotypes	S. no.	Genotypes	S. no.	Genotypes
1	AJSR-23	17	IC0567440	33	JN-112
2	BMD-221	18	IC0583730	34	N-10
3	DP24/SP-15	19	IC0605910	35	N-120
4	DP24/SP-33	20	IC110730	36	N-177
5	IC0259377	21	IC15795	37	N-182
6	IC0262514	22	IC331810	38	NSKMS-2
7	IC0262571	23	IC376244	39	NSKMS-14
8	IC0262617	24	IC63596	40	NSKMS-133
9	IC0262664	25	IC74965	41	NSS-5543
10	IC0305779	26	IC74973	42	NSS-5556
11	IC0342590	27	IC75001	43	PCU-28
12	IC0372056	28	IC75009	44	PCU-46
13	IC0372631	29	JN-102	45	PCU-5
14	IC0417531	30	JN-18	46	PHULE-3
15	IC0499252	31	JN-26	47	SD-40
16	IC0561011	32	JN-80	48	SP-100

Results and Discussion

ANOVA of augmented block design

The ANOVA revealed significant mean sum of squares for all traits for different sources of variation (Tables. 2a and 2b). The source of variation forentries (excluding blocks) were found to be significant for all the traits analysed *viz*., days to flower initiation, days to 50% flowering, plant height, number of branches per plant, number of capitula per plant, number of seeds per capitula, seed yield per plant, 1000 seed weight and oil content. Indicating the presence of diversity among these genotypes. Similarly, a wide range of variation for the majority of the traits was reported by Panda and Sial (2012) in niger.

Descriptive statistics

The results on the mean, range and coefficient of variation are presented in Table 3.

Days to flower initiation

Days to flower initiation varied from 33 to 73 with the mean value of 51.71. Minimum days to flower initiation were observed for IC0499252 and maximum days to flower initiation was observed for IC0417531.

Days to 50% flowering

Days to 50% flowering was ranged from 40-82 days with the mean value of 56.76 and early flowering was observed for IC0499252 and late flowering was observed for IC0417531.

Plant height

Plant height varied between 21.64 and 134.68 cm with mean value of 88.07 cm, shortest plant height was observed for IC0262664, while longest plant height was observed for NSS-5556.

Number of branches per plant

Number of branches per plant was observed from 2.8 to 14.47 with mean of 9.56, minimum number of branches per plant about 3 were produced by genotype IC0372631, while maximum 14 by genotype DP24/SP-15.

Number of capitula per plant

Number of capitula per plantranged from 14.34 to 78.14 with mean of 42.12, minimum number of capitula per plant was observed for IC0262664 and maximum number of capitula per plant was observed for IC0259377.

Number of seeds per capitula

Number of seeds per capitula varied between 12.02 and 31.35 with mean value of 18.92, minimum number of seeds per capitula was observed for PCU-46 and maximum number of seeds per capitula was observed for SP-100.

Seed yield per plant

Seed yield per plant ranged from 1.46 to 8.81 with

Table 2a : Analysis of variance of augmented block design.

Source	Df	Mean. Sq								
		DFI	DFF	PH	NBP	NCP	NSC	SYP	TSW	OC
Block (ignoring Treatments)	7	23.13**	10.24*	212.82**	8.75**	167.37**	22.20^{ns}	2.32^{ns}	1.16**	10.89**
Treatment (eliminating Blocks)	50	74.87**	73.47**	686.16**	5.15*	133.65**	43.88**	3.03*	0.79**	19.42**
Treatment: Check	2	0.04^{ns}	0.79^{ns}	520.44**	0.08^{ns}	69.90^{ns}	109.70**	6.97**	0.17**	7.34^{ns}
Treatment: Test and Test vs. Check	48	77.99**	76.50**	693.07**	5.36*	136.31**	41.14**	2.87*	0.82**	19.92**
Residuals	14	2.93	3.20	19.41	1.73	33.29	9.07	1.06	0.01	2.44

^{ns} P > 0.05; * P <= 0.05; ** P <= 0.01

Df- Degrees of freedom, **DFI**- Daysto flower initiation, **DFF**- Days to 50% flowering, **PH**- Plant height (cm), **NBP**- Number of branches per plant, **NCP**-Number of capitula per plant, **NSC**-Number of seeds per capitula, **SYP**-Seed yield per plant(g), **TSW**-Thousand seed weight(g) and **OC**- Oil content (%).

Table 2b : Analysis of variance of augmented block design.

Source	Df	Mean. Sq								
		DFI	DFF	PH	NBP	NCP	NSC	SYP	TSW	OC
Treatment (ignoring Blocks)	50	77.66**	74.48**	703.29**	5.59**	147.59**	44.63**	3.10*	0.92**	20.83**
Treatment: Check	2	0.04^{ns}	0.79^{ns}	520.44**	0.08^{ns}	69.90^{ns}	109.70**	6.97**	0.17**	7.34^{ns}
Treatment: Test	47	67.67**	65.81**	502.80**	5.91**	150.30**	14.80^{ns}	2.43*	0.97**	21.39**
Treatment: Test vs. Check	1	702.25**	629.17**	10492.08**	1.67^{ns}	175.56*	1316.24**	26.83**	0.01^{ns}	21.78**
Block (eliminating Treatments)	7	3.22^{ns}	3.06^{ns}	90.46**	5.57*	67.81^{ns}	16.87^{ns}	1.84^{ns}	0.25**	0.80^{ns}
Residuals	14	2.93	3.20	19.41	1.73	33.29	9.07	1.06	0.01	2.44

^{ns} P > 0.05; * P <= 0.05; ** P <= 0

Df-Degrees of freedom, **DFI**- Days to flower initiation, **DFF**- Days to 50% flowering, **PH**- Plant height (cm), **NBP**- Number of branches per plant, **NCP**-Number of capitula per plant, **NSC**-Number of seeds per capitula, **SYP**-Seed yield per plant(g), **TSW**-Thousand seed weight(g) and **OC**- Oil content (%).

mean value of 4.56, minimum seed yield per plant was observed for IC0262664 and maximum seed yield per plant was observed for JN-80.

Thousand seed weight

Thousand seed weight was reported between 2.47 and 6.09 with mean value of 4.43, minimum thousand seed weight was observed for NSS-5543 and maximum thousand seed weight was observed for DP24/SP-33.

Oil content

Oil content ranged from 29.74 to 47.83 with mean value of 38.62, minimum oil content was recorded for IC0417531 and maximum oil content was recorded for N-120.

Co-efficient of variation (C.V)

The highest value of co-efficient of variation (C.V) was found in case of seed yield per plant (20.90), followed by number of seeds per capitula (14.07%), number of branches per plant (13.64%), number of capitula per plant (13.41), plant height (4.63%), oil content (4.01%), days to flower initiation (3.43), while, days to 50% flowering (3.25%) and 1000 seed weight (2.57) had lower C.V values.

Frequency distribution of different quantitative traits in niger

Frequency distribution of different quantitative traits was presented in Fig. 1. The traits like days to 50% flowering, number of capitula per plant, number of seeds per capitula and seed yield per plant had positive skewness. It indicates that more proportion of genotypes lower end of distribution. Selection of these genotypes will improve the positively skewed traits. Negative skewedness was observed for plant height, number of branches per plant, 1000 seed weight and oil content. Even though there was a negative skewness for plant height, dwarf plant varieties might be selected from the lower end of the distribution to improve this feature. Significant variability was present in most of the traits,

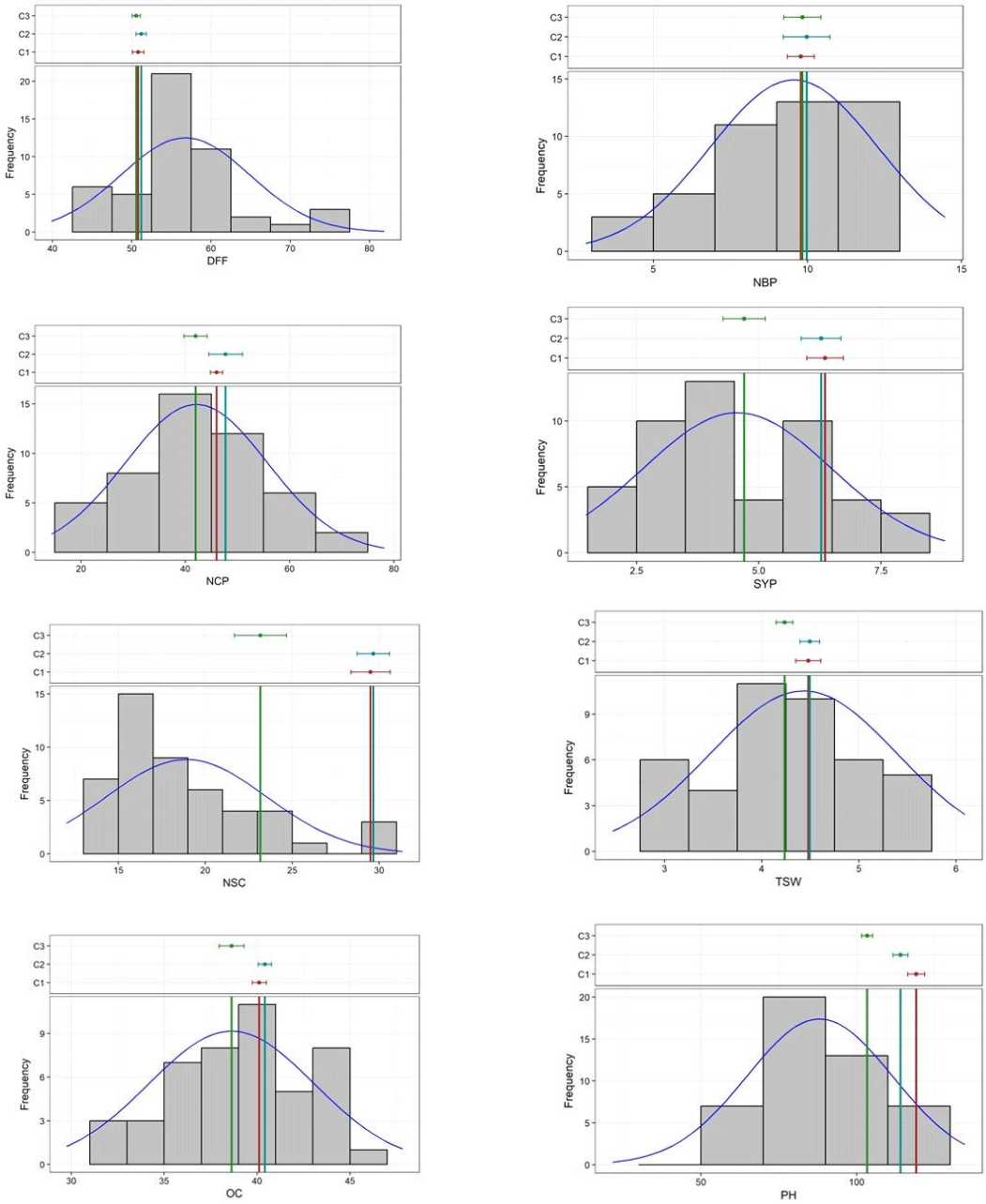

Fig. 1 : Frequency distribution of quantitative traits in niger.

genotypes with high seed yield and oil content could be isolated for developing a high yielding variety.

Genetic variability

The genetic variability exhibited high Phenotypic coefficient of variation and Genotypic coefficient of variation for seed yield per plant (34.20, 25.72) respectively followed by number of capitula per plant (29.11, 25.68), plant hight (25.46, 24.96), thousand seed weight (22.20, 22.06), number of branches per plant (25.43, 21.37) (Table 4). This result agrees with the findings of Amsalu (2020), similar results were found for seed yield, number of capitula per plant and number of branches per plant by Suryanarayana *et al*. (2018), this indicates selection of these traits based on phenotype characteristics may be useful for niger improvement program. The estimates of phenotypic coefficients of variation were higher than those of genotypic coefficients of variation, indicating the amount of environmental influence on the expression of the traits. Similarly, Bhoite *et al*. (2023), Baghel *et al*. (2018) and Tiwari *et al*. (2016) also observed that PCV was higher than the GCV for all characters. The difference between GCV and PCV were low for 1000 seed weight, days to flower initiation and days to 50% flowering this indicates that the traits are not influenced by the environment and has good scope for improvement of these traits through selection. Similar

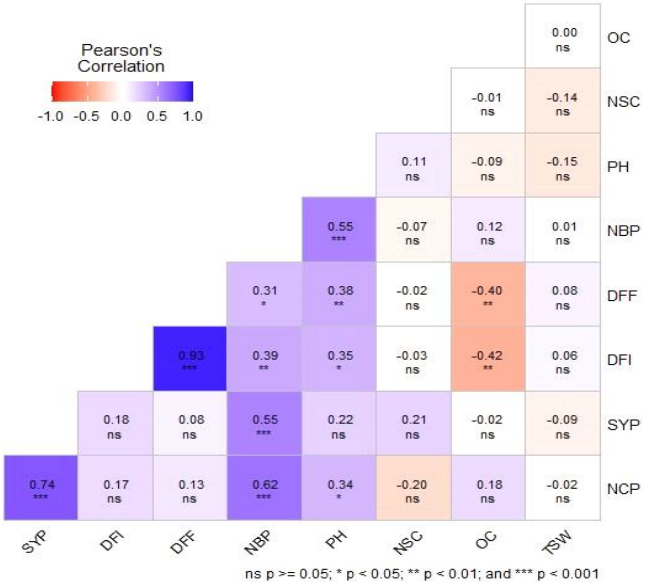

Fig. 2 : Correlation analysis among yield and yield component traits in niger.

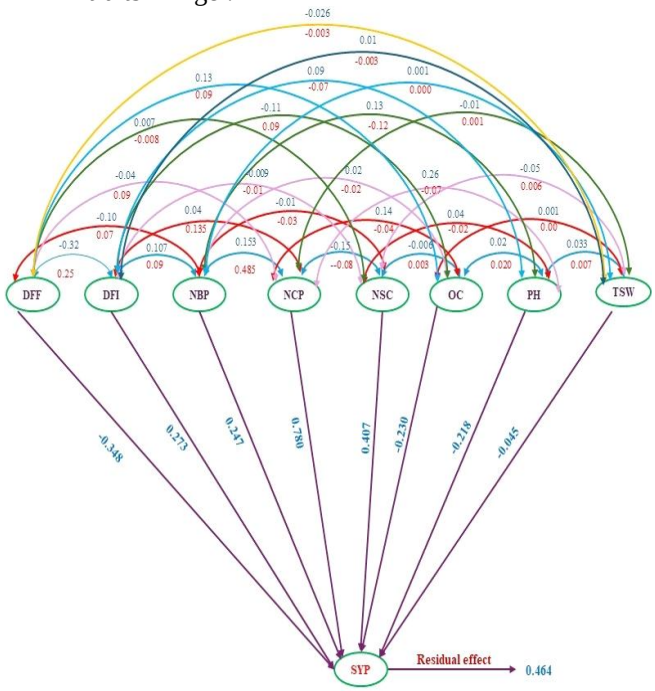

Fig. 3 : Partitioning of correlation into direct and indirect effects by path analysis.

results were obtained for days to 50% flowering by Pushpa *et al*. (2023). The presence of high genetic variation provides a greater potential for crop improvement.

Estimates of heritability are useful in predicting the inheritance of characters from parents to their offsprings. High heritability was recorded for thousand seed weight (98.67), plant height (96.14), days to flower initiation (95.66), days to 50% flowering (95.14), oil content (88.61), number of capitula per plant (77.85), number of branches per plant (70.67). Similar results were reported for days

Table 3 : Descriptive statistics of yield parameters and oil content in 48 genotypes of niger.

S. no.	Trait	Mean	Min	Max	CV
1	DFI	51.71	32.81	72.81	3.43
2	DFF	56.76	39.85	81.85	3.25
3	PH	88.07	21.64	134.68	4.63
4	NBP	9.56	2.80	14.47	13.64
5	NCP	42.12	14.34	78.14	13.41
6	NSC	18.92	12.02	31.35	14.07
7	SYP	4.56	1.46	8.81	20.90
8	TSW	4.43	2.47	6.09	2.57
9	OC	38.62	29.74	47.83	4.01

to 50% flowering, number of branches per plant, number of capitula per plant, plant height, thousand seed weight by Saraswat *et al*. (2022). This indicates that selection for these traits will be effective for the expression of these traits in the succeeding generations. Therefore, good improvement can be made if some of these traits are considered as selection criteria in future breeding program.

Heritability and genetic advance are important selection parameters. Heritability along with genetic advance is more helpful in predicting the gain under selection than heritability estimates alone. High heritability coupled with high genetic advance as percent of mean was recorded fordays to flower initiation, days to 50% flowering, plant height, number of branches per plant, number of capitula per plant, thousand seed weight and oil content. Similar trend was observed for number of branches and number of capitula per plant by Ahmad *et al*. (2016). Revealing the influence of additive gene action for these traits. Hence, the improvement of these traits can be made through direct phenotypic selection. Medium heritability with high genetic advance as percent mean was recorded for seed yield per plant. Similar results were obtained by Gururaja *et al*. (2021). It revealed that seed yield per plant is governed by additive gene effects and medium heritability is due to environmental effects and selection may be effective for this trait.

Correlation

To find out the extent of association between the traits, correlation analysis was done. In this study correlation coefficient analysis was estimated between seed yield and other traits are given in Fig. 2. The traits *viz*., number of capitula per plant, number of branches per plant exhibited significantly positive association with seed yield per plant. Similar results were observed by Patil *et al*. (2019),

Reddy *et al*. (1992), Lakshyadeep *et al*. (2005), Dalvi

Table 4 : Estimates of genetic variability parameters of niger genotypes.

Trait	Mean	GCV	Category	PCV	Category	hBS	Category	GA	GAM	Category
DFI	51.71	15.56	Medium	15.91	Medium	95.66	High	16.23	31.39	High
DFF	56.76	13.94	Medium	14.29	Medium	95.14	High	15.92	28.06	High
PH	88.07	24.96	High	25.46	High	96.14	High	44.47	50.50	High
NBP	9.56	21.37	High	25.43	High	70.67	High	3.54	37.07	High
NCP	42.12	25.68	High	29.11	High	77.85	High	19.69	46.75	High
NSC	18.92	12.65	Medium	20.34	High	38.70	Medium	3.07	16.24	Medium
SYP	4.56	25.72	High	34.20	High	56.58	Medium	1.82	39.92	High
TSW	4.43	22.06	High	22.20	High	98.67	High	2.00	45.20	High
OC	38.62	11.27	Medium	11.97	Medium	88.61	High	8.45	21.89	High

et al. (2005), Ali *et al*. (2008), Khuntey and Kumar (2015) and Kumar and Bisen (2016) indicating that these were the major yield determining traits in niger.

Path coefficient analysis

Path coefficient technique splits the correlation coefficients into direct and indirect effects thus helps in understanding components that influence a given correlation and can beuseful in formulating an efficient selection strategy (Sabaghnia *et al*., 2010). In the present study the traits *viz.*, number of capitula per plant, number of seeds per capitula and number of branches per plant were showed direct effect on seed yield per plant given in Fig. 3. Similar results observed by Patil *et al*. (2019) for number of capitula per plant, number of seeds per capitula. It revealed true relationship between them and direct selection for these traits would be rewarding for yield improvement.

Conclusion

A total of 48 niger genotypes were assessed based on yield and yield related traits. This revealed, sufficient genetic variation present among the traits. The present study concluded that seed yield, number of seed per capitula have high coefficient of variation. Hence, selecting these traits would be effective for transferring characters to next generation. High heritability coupled with high genetic advance as percent of mean was recorded for days to flower initiation, days to 50% flowering, plant height, number of branches per plant, number of capitula per plant, thousand seed weight and oil content indicating direct selection is highly effective for these traits. The traits number of capitula per plant and number of branches per plant showed significant positive association and direct effect on seed yield per plant. This indicates the simultaneous improvement of these characters through selection. It is suggested that importance should be given on these characters, while making selection for desired improvement in niger. Genotype IC0259377 produced more number of capitula per plant, SP-100 produced more number of seeds per capitula, JN-80 produced maximum seed yield per plant and N-120 yielded maximum oil content. Hence, these genotypes (IC0259377, SP-100, JN-80 and N-120) can be used as potential breeding material in crossing programs for development of cultivars with high seed yield and oil content.

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Conflict of interest : None

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