Evaluation of Genetic Parameters for Yield and Yield Related Attributes in Black Seed (Nigella sativa L.) Accessions under Rainfed Conditions

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Abstract
To investigate the interrelationship between quantitative characters in black seed (*Nigella sativa* L.) accessions, field experiments were conducted with 13 black seed (*Nigella sativa* L.) accessions under rainfed conditions using a randomized complete block design with three replications at the Barani Agricultural research Institute, Chakwal, Pakistan. Heritability values were greater for germination percentage, primary branches per plant, plant height, number of pods per plant, number of grains per pod, 1000 grain weight and grain yield (kg/ha) demonstrating that these attributes are controlled mainly by additive genes and that selection of such attributes may be successful for improving grain yield. Number of grains per pod, 1000- grain weight, number of pods per plant, primary branches per plant and 1000-grain weight had positive and highly significant phenotypic and genotypic correlations with grain yield. Number of pods per plant, primary branches per plant, number of grains per pod and 1000-grain weight also had a positive direct effect on grain yield. It can be concluded that grain yield in black seed can be improved by selecting an ideotype having greater number of pods per plant as well as higher number of grains per pod and 1000-grain weight.
Keywords: Variability, heritability, correlation, path coefficient, *Nigella sativa*

Introduction

Nigella sativa L. or black seeds, a member of *Rananculaceae* is a minor cultivated crop from Morocco to Northern India; in sub-Saharan Africa particularly Niger, and eastern Africa especially Ethiopia (Iqbal *et al*., 2010). It has been used for healthcare since civilization in Egypt, Iran, India, Pakistan, Saudi Arabia, Syria, Turkey and many other countries. Many medical properties have been attributed to the *Nigella sativa* L. *Nigella sativa* L. is rich in nutritional values and contains several chemical constituents having properties to cure various diseases (Iqbal *et al*., 2011). The whole seed or their extracts have antitumor (Khan *et al*., 2009), antidiabetics (Fararh *et al*., 2008), spasmolytic and bronchodilator (Boskabady *et al*., 2010), anti-inflammatory (Hajhashemi *et al*., 2010), antibacterial (Mashhadian and Rakhshandeh, 2011), galactogogue, antioxidant (Kanter *et al*., 2003) and insect repellent effects (Fisher, 2008).

Variation in highly heritable characteristics and qualitative traits provide an estimate of diversity while quantitative traits are exploited to determine the magnitude of genetic variation within germplasm (Iqbal *et al*., 2010).

Yield being a quantitative trait has complex inheritance, which is subjected to environmental fluctuations, requiring indirect selection of simply highly heritable traits for its improvement. Deb and Khaleque (2009) stated that knowledge about the association and interaction of different traits with yield greatly helps the breeder in selection work with more precession and accuracy. The intensity and direction of association of the different traits with yield were estimated with genotypic and phenotypic coefficient of correlation (Mode and Robinson, 1959). The exact picture of the relative importance of direct and indirect influences of the component characters towards seed yield is determined by path analysis (Bhatt, 1973). Path analysis and correlation coefficient was used to evaluate these associations in *Nigella sativa* L. cultivars under rainfed conditions.

The present research work was undertaken to examine the relative significance of direct and indirect influences of the component characters toward grain yield and to identify the most important characters to be considered in *Nigella sativa* breeding improvement programmes.

Materials and Methods

Thirteen black seed genotypes were grown under rainfed condition at the Barani Agricultural Research Institute Chakwal, Pakistan which is located at 32° latitude and 72° longitude with an altitude of 575ams altitude. The location receives mean annual rainfall of 300-450 mm with a respective maximum and minimum temperature of -0.4 and 45°C. The soil is sandy clay loam with an average pH of 7.2. The experimental design was randomized complete blocks with three replications during Rabi 2013-14. The plots consisted of four rows, 4 m in length and the respective spacing between rows and plants were 30 cm and 10 cm respectively. Data regarding number of days to 50% flowering, primary branches per plant, plant height (cm), number of pods per plant, number of grains per pod, 1000-grain weight (g) and grain yield (kg/ha) were recorded.

Analysis of variance and correlation estimates for characters studied were performed by using Statistix software version 8.1.The heritability and genetic advance were measured by following Singh and Chaudhry (1979). Path analysis was performed to find out the direct and indirect effects of all the characters under study by the formula suggested by Dewey and Lu (1959).

Results and Discussion

Highly significant differences were observed among accessions of black seed for all characters studied (Table-1). This considerable variability provides a good prospect for improving characters of interest in *Nigella sativa* breeding programs. Table-1 depicted that high heritability coupled with high genetic advance estimates were recorded for primary branches per plant, number of pods per plant, number of grains per pod, 1000 grain weight and grain yield which indicated that progress on improving grain yield could be achieved through simple selection of these characters. Heritability alone is not a very useful measure but, together with genetic advance, it is valuable (Toncer and Kizil, (2004); Iqbal *et al*., (2011). For plant height, high heritability was associated with low genetic advance, indicating the influence of dominant and epistatic gene effects on this trait**.** (Bibi *et al*., (2012); Iqbal *et al*., (2013); Iqbal *et al*., (2011).

The direct assessment and improvement of grain yield itself may be deceptive due to complex inheritance of this character and the pressure of the environmental components**.** Therefore, it is significant to consider the data for the relative contribution of different characters toward grain yield performance. Positive and highly significant associations were found between grain yield and number of pods per plant, number of grains per pod and1000-grain weight at genotypic and phenotypic level (table-2). These results recommended that any positive increase in these traits will improve the grain yield of black seed. Both at genotypic and phenotypic levels number of pods per plant was positively interrelated with number of grains per pod and 1000 grain weight which revealed that an increase in number of pods per plant would increase number of grains per pod and 1000 grain weight and ultimately grain yield would enhance (table-2). These results are in concurrence with the findings of Bardideh et al., (2013); Toncer and Kizil, (2004); Iqbal et al., (2011).

Step-wise regression study for grain yield (kg/ha) as dependent variable and the other agronomic attributes kept as independent variables revealed that primary branches per plant, number of pods per plant, number of grains per pod and 1000-grain weight are the most essential attributes which accounted for maximum of total variation present in grain yield (Table-3).

Direct and indirect effects in path coefficient analysis revealed that primary branches per plant, number of pods per plant, number of grains per pod and 1000-grains weight had positive direct effects on grain yield (Table-4). Compared with genotypic and phenotypic correlations, path analysis verified that number of pods per plant, number of grains per pod and 1000-grain weight was most important contributors to grain yield. Similar investigations were stated by Bardideh et al., (2013). Path analysis of grain yield also indicated that number of pods per plant exerted the maximum direct effect. This character's key contributions to grain yield, could therefore be used to boost up grain yield in black seed breeding programs.

Conclusion

The results of present study recommended that number of pods per plant, number of grains per pod and 1000-grain could be used as selection criteria in black seed breeding programs and exploited more proficiently for black seed improvement.

Table-1: Analysis of Variance, Heritability in broad sense (h^2) and Genetic Advance (GA) for yield and yield related attributes in black seed accessions

Source	Days to 50 (%) flowering	Primary branches per plant	Plant height (cm)	No. of pods/plant	No. of grains /pod	1000-grain weight	Grain yield (kg/ha)
Var	15.5342**	5.180**	71.641**	32.721**	218.614**	0.199**	11273.4**
CV%	4.05	10.72	5.38	11.63	7.42	8.63	8.56
h2	64.43	81.62	81.39	92.22	84.21	80.89	93.21
G.A	2.77	1.820	6.99	6.88	14.67	0.43	118.39

* and ** Significant at 0.05 and 0.01 level respectively

Table-2: Phenotypic (upper diagonal) and genotypic (lower diagonal) correlation coefficient for yield and yield related characters in black seed accessions

Characters	Days to 50 (%) flowering	Primary branches/ plant	Plant height (cm)	No. of pods/plant	No. of grains/pod	1000-grain weight	Grain yield (kg/ha)
Days to 50 (%)		0.361*	-0.147	-0.328*	0.138	-0.311*	0.331*
Primary branches/ plant	0.312*		0.239	0.373*	0.346*	0.318*	0.383*
Plant height (cm)	0.128	0.283*		0.071	0.025	0.154	0.101
No. of pods/plant	-0.321*	0.417**	0.056		0.329*	0.529**	0.613**
No. of grains /pod	0.167	0.304*	0.041	0.371*		0.312	0.638**
1000-grain weight	-0.316*	0.3378*	0.159	0.629**	0.341*		0.458**
Grain yield(kg/ha)	0.392*	0.689**	0.174	0.618**	0.649**	0.589**	

* and ** Significant at 0.05 and 0.01 level respectively

Table 3: Stepwise regression for grain yield (kg/ha) in Black Seed (*Nigella sativa)* accessions

Characters	Intercept	Standard error	R^2	F
Primary branches per plant	0.02	0.31	7.90	26.21**
No. of pods per plant	0.02	2.361	45.87	20.32**
No. of grains per pod	1.05	0.720	21.50	16.29**
1000 grain weight	2.18	22.15	10.40	18.43**

* and ** Significant at 0.05 and 0.01 level respectively

Table-4: Path analysis for grain yield (kg/ha) in black seed (*Nigella sativa)* accessions

Characters	Direct effect	Indirect effect				
		No. of Primary branches/plant	No. of Pods/plant	No. of Grains/pod	1000 grain weight	Correlation with grain yield
No. of Primary branches/plant	0.182	-	0.1001	0.0739	0.0482	0.4118
No. of Pods per plant	0.324	0.1281	-	0.1925	0.0295	0.6517
No. of Grains per pod	0.261	0.1562	0.2210	-	0.0375	0.6839
1000 grain weight	0.187	0.0892	0.1301	0.1198	-	0.5182

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