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GENE ACTION IN LINSEED (*LINUM USITATISSIMUM* L.)

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Abstract

Genetic analysis of seed yield and its components were estimated in Linseed through diallel cross analysis revealed the role of both additive and non-additive gene action for all the eleven characters. Average degree of dominance revealed the presence of over dominance for all the characters except days to 50% flowering, days to maturity, plant height and number of seed/capsule showed partial dominance. The distribution of genes in the parents with positive and negative effects were asymmetrical for all the characters, the ratio of dominance and recessive alleles (KD/KR) indicated that the dominant alleles were more frequent than the recessive alleles for all the characters studied except for plant height, number of capsules/plant, number of seeds/capsules and 1000-seed weight, where recessive genes were frequent. The ratio determines the extent of genetic gain that can be made in a particular direction. If the alleles present in the population are predominantly of recessive nature, the extent of genetic advance will be limited. The ratio of $(\hat{h}^2/\hat{H}_2)$ which estimate the number of gene groups suggested that at least one major gene groups for all the characters under study was observed except days to 50% flowering and days to maturity. The coefficient between parental order of dominance (Wr + Vr) and parental measurement (Yr) was found to be negative for all the characters except days to 50% flowering. This indicated that higher expression of these traits was controlled by recessive genes. The negative correlation suggested preponderance of dominant genes while positive value suggested preponderance of recessive genes in the expression of trait.

Key words : Linseed, gene action**,** additive and non-additive, diallel analysis.

Introduction

Linseed (*Linum usitatissimum* L.), 2n = 30 is a strictly self-pollinated crop of industrial importance. It is used for oil production and also in food industries because of its nutritional merits, essential poly unsaturated fatty acids such as alpha-linolenic acid and rich supply of soluble dietary fiber. Flaxseed oil is used as an industrial drying oil due to its high linolenic acid content (Green, 1986; Muir and Westcott, 2003). However, some flax genotypes have been developed which contain very low levels of linolenic acid in their oil, making them suitable for use as edible-oil (Green, 1986 and Rowland, 1991). Improvement of yield is one of the most important objectives in any crop breeding program. Yield itself is very complex trait, which depends upon number of its components, which are major determinant of yield potential of a crop variety. It is well known fact that yield is governed by polygenic inheritance and this is also true for many complex yield contributing component characters. Knowledge of genetic behavior and type of gene action controlling target traits is a basic principle to design an appropriate breeding procedure for genetic improvement purposes. Hence, the success of any selection or hybridization breeding program depends on precise estimates of genetic variation components for the interested traits consisting of additive, dominance and non-allelic interaction effects (Jinks, 1983). The genetic improvement of seed yield and its components is one of the main objectives of flax breeding programs (Lay and Dybing, 1989). The appropriate breeding strategy is needed to enhance the genetic potential of new cultivar for developing sound breeding strategy, the knowledge of components of variance involved in the inheritance of yield and its contributing characters is of paramount impotence. Therefore, to study the nature and magnitude of gene action was undertaken in the present study.

Materials and Methods

The experimental materials consisted of 10 genotypes of linseed derived from different origins. These genotypes

Table 1 : Estimates of b1, sb, (b-o)/sb, (1-b)/sb and t^2 for attributes in a 10-parent diallel cross of linseed.

Character	b	S_b	(b-0)/S_b	(b-1)/S_b	t^2
Days to 50% flowering	0.70	0.19	3.76	-1.63	0.41
Days to maturity	0.75	0.20	3.66	-1.23	0.07
Plant height	0.80	0.11	6.88	-2.26	2.39
Number of secondary branches/plant	0.46	0.23	1.98	-2.33	0.59
Number of capsules/plant	0.38	0.16	2.37	-3.86	4.09
Number of seeds/capsule	0.59	0.24	2.49	-1.73	0.18
1000-seed weight	0.66	0.17	3.91	-1.99	0.96
Seed yield/plant	0.49	0.22	2.20	-2.31	0.69
Biological yield/plant	0.58	0.24	2.38	-1.72	0.15
Harvest index	0.51	0.20	2.53	-2.39	1.0
Oil content	0.88	0.50	1.77	-0.24	3.09

of linseed were evaluated in a Randomized block design with three replication at Student structional Farm of N. D. University of Agriculture and Technology, Kumarganj, Faizabad (U.P.), India during *rabi* 2011-12. The entries were sown in a two row of 3 meter length with inter row spacing of 25 cm apart with plant to plant distance of 10 cm. The fertilizer doses in the experiment area was applied rate-120 Kg, N, 60 Kg, P and 50 Kg, K as per hectare. The recommended agronomic practices were adopted in orders to raise a good crop. Observations were recorded on 10 randomly taken plants from each genotype in each replication for days to 50% heading, plant height (cm), effective tillers/plant, total number of tillers/plant, days to maturity, ear length (cm), number of grains/spike, 1000-seed weight (g), harvest Index (%), biological yield/ plant (g) and seed yield/plant (g). The various components of variance in diallel crosses were estimated by Hayman (1954a).

Results and Discussion

The progress in plant breeding developments upon the nature, magnitude and inter relationship of heritable and non-heritable variance in the expression of the character, the first attempt to partition the genotypic variance into its components was made by Fisher (1918) has been divided into three components *viz*. additive of fixable gene action (average effect of genes), dominance (intra-allelic interaction of the genes) and epistasis (inter-allelic interaction of genes). Additive gene action is the result of additive genetic variance while non-additive is due to dominance and epistasis, additive and dominance gene effects cannot be accurately measured when significant epistasis is present. In autogamous crop like linseed, more emphasis has been given to additive or fixable gene in this study. The variance component analysis as suggested by Hayman (1957), the regression coefficient 'b' indicated deviation from unity for most of the traits, indicated that the variability among the attributes was due to involvement of additive and non-additive genes. The genetic architecture of all the materials for eleven characters of linseed crop was studied through different genetic models to find out the nature and magnitude of gene action (tables 1, 2 and 3). The component of analysis exhibited the inheritance of the trait in F_1 generations. The additive component $\hat{D}$ was highly significant for all the characters. The dominance component showed highly significant performance for all the traits expect number of seeds/capsule, while the values of $\hat{H}_1$ were higher than the values of $\hat{H}_2$ for all the characters. The presence of additive gene action for most of the traits including seed yield per plant implies that early generation selection may be useful for the improvement of these traits. However, for traits showing both additive and dominance components of variance, heterosis breeding may be useful, but chances of exploiting hybrid vigour through hybrid varieties in linseed due to its autogamous nature are bleak at present (Sood *et al*., 2007). The positive or positive and significant value of component indicated that the dominant genes were frequently distributed than the recessive genes for all the traits. Kiran *et al*. (2012) has also reported the similar conclusion for seed yield and related production traits in linseed. The dominance effects (h^2) in the combinations were significant and positive under heterozygous conditions, which indicated presence of dominance genetic variance including yield. The significant component indicated considerable involvement of environment for environmental effects. The mean degree of dominance $(\hat{H}_1/\hat{D})^{0.05}$ was estimated more than unity indicating over dominance for most of the characters while partial dominance showed less value than unity,

Table 2 : Estimates of parameters $\hat{D}$, $\hat{F}$, $\hat{H}_1$, $\hat{H}_2$, $\hat{h}^2$, $\hat{E}$ and other related statistics for 11 quantitative characters in 10 × 10 diallel crosses of linseed.

Source of variance	Days to 50 % flowering	Days to maturity	Plant height	Number of secondary branches/plant	Number of capsules/ plant	Number of seeds/ capsule	1000-seed weight	Seed yield/ plan	Biological yield/ plant	Harvest index	Oil content
$\hat{D}$	29.41** ±2.66	74.15** ±4.12	92.80** ±4.16	96.99** ±16.43	1565.36** ±385.34	0.94** ±0.12	2.05** ±0.28	4.66** ±1.12	64.48** ±6.95	3.36** ±1.13	1.01** ±0.29
$\hat{F}$	12.30 ±6.13	7.68 ±9.51	-47.86** ±9.60	12.08 ±37.91	-745.62 ±889.08	-0.12 ±0.28	-0.10 ±0.65	2.58 ±2.59	59.87** ±16.04	6.87* ±2.61	0.50 ±0.66
$\hat{H}_1$	19.22* ±5.65	25.26* ±8.77	32.72** ±8.86	129.46** ±34.97	3724.89** ±820.23	0.50 ±0.26	3.07** ±0.60	14.56** ±2.39	75.62** ±14.80	37.24** ±2.41	5.41** ±0.61
$\hat{H}_2$	16.17** ±4.80	23.57* ±7.46	25.33** ±7.53	110.92** ±29.72	3211.77** ±697.10	0.41 ±0.22	2.62** ±0.51	11.69** ±2.03	51.78** ±12.57	29.29** ±2.04	5.08** ±0.52
$\hat{h}^2$	21.83** ±3.22	36.08** ±4.99	11.29 ±5.04	23.45 ±19.89	836.92 ±466.61	-0.08 ±0.15	2.36** ±0.34	6.26** ±1.36	15.75 ±8.42	6.92** ±1.37	0.31 ±0.35
$\hat{E}$	0.49±0.80	0.80±1.24	1.09±1.25	1.03±4.95	36.86±116.18	0.35**±0.04	0.01±0.08	0.40±0.34	0.98±2.10	0.37±0.34	0.01±0.09
$(H_1/D)^{0.5}$	0.81	0.58	0.59	1.16	1.54	0.73	1.22	1.77	1.08	3.33	2.31
$(H_2/4H_1)$	0.21	0.23	0.19	0.21	0.26	0.21	0.21	0.20	0.17	0.20	0.23
(KD/KR)	1.70	1.19	0.39	1.1	0.73	0.84	0.96	1.37	2.50	1.89	1.24
(h^2/H_2)	1.35	1.53	0.45	0.21	0.26	-020	0.90	0.54	0.30	0.24	0.06
R	0.49	-0.36	-0.03	-0.54	-0.51	-0.22	-0.59	-0.24	-0.16	-0.15	-0.47
t^2	0.41	0.07	2.39	0.59	4.09	0.18	0.96	0.69	0.15	1.0	3.09
Byx	0.70	*0.75*	0.75	0.46	0.38	0.59	0.66	0.49	0.58	0.51	0.88
(1-b/Sb)	-1.63	-1.23	-2.26*	-2.33*	-3.86**	-1.73	-1.99*	-2.31*	-1.72	-2.39*	-0.24

Note- *, ** significant at 5% & 1% probability levels, respectively.

Table 3 : Cooperative evaluation of the finding on gene action and average degree of dominance for 11 characters in 10 parent diallel cross of linseed.

Characters	Variance component analysis			Combining ability analysis		Average degree of dominance
	$\hat{D}$	$\hat{H}$	$\hat{H}_2$	*gca*	*sca*	$\sqrt{(\hat{H}_1/D)}^{0.05}$
Days to 50% flowering	HS	S	HS	HS	HS	PD
Days to maturity	HS	S	S	HS	HS	PD
Plant height	HS	HS	HS	HS	HS	PD
Number of secondary branches/plant	HS	HS	HS	HS	HS	OD
Number of capsules/plant	HS	HS	HS	HS	HS	OD
Number of seeds/capsule	HS	NS	HS	HS	HS	PD
1000-seed weight	HS	HS	HS	HS	HS	OD
Seed yield/plant	HS	HS	HS	HS	HS	OD
Biological yield/plant	HS	HS	HS	HS	HS	OD
Harvest index	HS	HS	HS	HS	HS	OD
Oil content	HS	HS	HS	HS	HS	OD

which was confined to days to 50% flowering, days to maturity, plant height (cm) and number of seeds/capsule. The value of this ratio $(\hat{H}_2/4\hat{H}_1)^{1/2}$ was less than the theoretical vale f 0.25 for all the character except number of capsules/plant indicated asymmetrical distribution of positive and negative genes among the parents in this study. The proportion of all dominant and recessive indicated that the dominant alleles were distributed more frequently than recessive ones for all the traits except for plat height, number of capsules/plant, number of seeds/ capsule and 1000-seed weight. The predominance of dominant alleles was also confined by positive of covariance of additive and dominant effect $\hat{F}$ for these characters. The proportion of dominant and recessive allele among the parents determines the extent of genetic advance that can be made in a population. If the genes are dominant in nature, the extent of genetic advance will be thigh, on the other hand, genetic advance will be limited, if recessive genes, are predominant. The proportion of genes was fairly high for all the characters plant height, number of capsules/plant, number of seeds/ capsule and 1000-seed weight, which indicated the possibility of high amount of genetic gain.

The ratio of $(\hat{h}^2/\hat{H}_2)$ is an important Masseur of gene groups, which control the charecters and explant the exact of its dominant effects. The value of this ratio was found less than unity for all the characters except days to 50% flowering and days to maturity. If clearly signifies that at least one major gene group is involved in controlling the inheritance of these attributes. However, much reliance cannot be placed on this ratio $(\hat{h}^2/\hat{H}_2)$, which under estimated the number of genes and does not provide any sound information about the group of genes exhibiting a little or no dominance. The complimentary gene interactive may also depress the ratio, hence the number of group of genes reported, may be higher/lower than the actual number involved. Hu (1985a) reported that eight characters related with yield generally under polygenic control whereas, number of branches per plant was governed by single gene, thus, it is assumed that a major gene group dominance in nature was responsible for controlling the inheritance. The positive values of coefficient of correlation (r) between parental order of dominance and parental measurement indicated that negative genes were mostly played a dominance role for all the traits.

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