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NATURE AND MAGNITUDE OF GENE ACTION AND GENETIC COMPONENTS OF VARIATION FOR YIELD AND YIELD CONTRIBUTING CHARACTERS IN F_2 GENERATION OF SESAME (*SESAMUM INDICUM* L.)

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ABSTRACT

The results on 6x6 F_2 diallel in sesame revealed that additive component (D) was significant for days to 50 % flowering (4.11 ± 0.51), days to maturity (7.18 ± 1.26), plant height (114.57 ± 6.58), height to first capsule (31.80 ± 2.651), number of branches per plant (0.31 ± 0.033), number of internodes per plant (4.15 ± 0.48), number of capsules per plant (43.72 ± 9.74), number of capsules per leaf axil (0.32 ± 0.010) and oil content (1.85 ± 0.17). The genetic variances of dominant components (H_1 and H_2) were significant for majority of characters. An equal distribution of increaser and decreaser genes in the parents was found for all the characters except for plant height, height to first capsule, number of internodes per plant and number of capsules per leaf axil. Narrow sense heritability was high for height to first capsule (0.72), plant height (0.66), number of branches per plant (0.67), length of capsule (0.64) and number of seeds per capsule (0.54). Biparental mating or diallel selective mating has been suggested for further genetic improvement.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is sixth most important oil seed crop in India and has 18.30 lakh ha area and 7.70 lakh tones production with productivity of 419 kg/ha (FAO, 2012). The breeding methodology depends considerably upon the nature and magnitude of gene action controlling the genetic behaviour of characters. An analysis based on large number of progenies from divers parents is expected to give more reliable estimates. However, to have a clear picture of genetic mechanism of the sesame population the absolute value of variances must be partitioned into its genetic components. Diallel analysis can provide the necessary genetic information for breeding programs (Hill *et al.,* 2001), and has been frequently used to obtain the genetic information regarding various traits in different crops (Bolanos *et al.,* 2001; Stoddard and Herath, 2001; Guines *et al.,* 2002). The information on nature of gene action will be helpful to develop efficient crop improvement programme. The success of plant breeding programs relies heavily on the existence of genetic variability in plants for a particular trait (Arunkumar, 2013). In addition, the additive gene effects are easily fixed, the improvement of the characters with predominant additive effects such as plant height, capsule length, capsule width, number of capsules per plant, and 1000-seed weight can be done by single plant selection or the selection of superior segregates in early generations. The objective of this study was to estimate the nature of gene action for different quantitative and qualitative characters through genetic component analysis in F_2s of a 6 x 6 half-diallel cross in sesame.

MATERIALS AND METHODS

The present investigation was conducted by using F_2 progenies of six parent diallel cross in a Randomized Block Design with three replications at Department of Genetics and Plant Breeding, Junagadh Agricultural University, Junagadh, Gujarat. Each plot with a spacing of 45 x 15 cm^2 consisted of single row of 3 m length. All need based agronomic practices were followed during the crop growth period to raise a good crop. Six parents *viz*., G.Til-1, G.Til-2, Kalyanpur-2, Borda-1, China and G.Til-10 and their 15 F_2's were evaluated during summer 2013. Observations were recorded on randomly selected five plants from parents and 20 plants from F_2s in each entry for 14 quantitative traits for each replication. Genetic components of variation were computed by employing diallel cross method as suggested by Hayman (1954) as well as Jinks (1954) and described in detailed by Mather and Jinks (1982) and Singh and Chaudhary (1985). Per cent oil content in sesame seed was estimated by using Nuclear Near Infrared Magnetic Resonance (NIR- BRUKER make) (FT-NIR Spectrometer, 2011) apparatus.

RESULTS AND DISCUSSION

The F_2 generation of 6 × 6 diallel cross (excluding reciprocals) was analyzed for various components of genetic variance in respect of fourteen characters in sesame. Genetic components of variance *viz.,* D, H_1, H_2, h^2, E, F along with variance ratios and heritability for fourteen characters are presented in Table 1.

The non-significant t^2 value indicated the fulfilment of assumptions underlying diallel analysis for all the characters except length of capsule, number of seeds per capsule and 1000-seed weight. The estimates of the components of genetic variance showed that the component D, which measures the variance due to the additive genetic effect was significant for days to 50 % flowering, days to maturity, plant height, height to first capsule, number of branches per plant, number of internodes per plant, number of capsules per plant, number of capsules per leaf axil and oil content. Significant additive gene effect in sesame has been reported for days to 50 % flowering (Lavanya *et al.*, 2006; Sakhiya, 2013); days to maturity (El-Bramawy and Shaban, 2007); plant height (Mothilal and Manoharan, 2005; El-Bramawy and Shaban, 2007); number of branches per plant (Lavanya *et al.*, 2006); number of capsules per plant (Mothilal and Manoharan, 2005; Lavanya *et al.*, 2006; El-Bramawy and Shaban, 2007) and 1000-seed weight (Mothilal and Manoharan, 2005).

The genetic variances of dominant components (H_1 and H_2) were significant for all the studied characters except for H_2 in case number of branches per plant, number of internodes per plant, length of capsule and width of capsule (Table 1) thereby suggesting the importance of non-additive genetic components in the inheritance of these traits. The involvement of non-additive genetic component has been reported by Mothilal and Manoharan (2005) for plant height, number of capsules per plant and seed yield per plant; Lavanya *et al.* (2006) for days to 50 % flowering, number of branches per plant, number of internodes per plant and oil content; El-Bramawy and Shaban (2007) for days to 50 % flowering, plant height, number of branches per plant, number of capsules per plant, 1000-seed weight, oil content and seed yield per plant and Sakhiya (2013) for days to 50% flowering, days to maturity, plant height, height to first capsules, number of branches per plant, number of internodes per plant, length of capsule, width of capsule, number of capsules per plant, number of capsules per leaf axil, number of seeds per capsule, 1000-seed weight, oil content and seed yield per plant.

The h^2, which measures of overall dominance effects of heterozygous *loci*, was found significant and positive for number of branches per plant, number of capsules per plant, number of capsules per leaf axil, oil content and seed yield per plant (Table 1). The results indicated that the mean direction of dominance was positive for these traits. Similar results have been reported by Mothilal and Manoharan (2005) for plant height and number of seeds per capsule; El-Bramawy and Shaban (2007) for days to maturity, number of branches per plant, number of capsules per plant, 1000-seed weight and oil content and Sakhiya (2013) for days to 50 % flowering, days to maturity, length of capsule, width of capsule, number of capsules per leaf axil, number of seeds per capsule and seed yield per plant.

The distribution of increaser and decreaser genes (F) was found non-significant for the characters *viz.,* days to 50 %

Table 1: Estimates of genetic components of variation for different characters in F_2 generation in sesame

Components/ratios	Days to 50 % flowering	Days to maturity	Plant height (cm)	Height to first capsule (cm)	Number of branches per plant	Number of internodes per plant	Length of capsule (cm)
D	4.11** ± 0.51	7.18** ± 1.26	114.57** ± 6.58	31.80** ± 2.651	0.31** ± 0.033	4.15** ± 0.48	0.001 ± 0.004
H_1	20.24** ± 5.13	51.18** ± 12.82	245.46** ± 66.86	90.58** ± 26.923	0.80* ± 0.34	10.91* ± 4.84	0.101** ± 0.039
H_2	19.32** ± 4.58	40.16** ± 11.45	122.52* ± 59.73	63.80** ± 24.051	0.51 ± 0.30	5.65 ± 4.33	0.066 ± 0.034
h^2	-2.06 ± 3.08	0.12 ± 7.71	-12.91 ± 40.20	-2.83 ± 16.188	0.64** ± 0.20	8.16** ± 2.91	0.004 ± 0.023
F	0.85 ± 2.47	11.76 ± 6.17	79.05* ± 32.17	-29.95** ± 12.955	-0.23 ± 0.16	5.67* ± 2.33	-0.030 ± 0.019
E	0.93** ± 3.08	0.37 ± 0.48	10.53** ± 2.49	1.46 ± 1.002	0.08** ± .01	0.84** ± 0.18	0.003 ± 0.001
$(H_1/D)^{1/2}$	1.11	1.34	0.73	0.84	0.81	0.81	5.15
$H_2/4\ H_1$	0.24	0.20	0.13	0.18	0.16	0.13	0.16
K_D/K_R	1.21	4.18	2.78	0.28	0.36	11.68	-0.51
h^2/H_2	-0.11	0.003	-0.11	-0.04	1.27	1.44	0.06
Heritability (ns) %	0.27	0.24	0.66	0.72	0.67	0.45	0.64
t^2	0.002	0.04	0.01	3.46	0.88	0.29	283.24**

*,** Significant at 5% and 1% levels, respectively

Table 1: Cont.....

Components/ratios	Width of capsule (cm)	Number of capsules per plant	Number of capsules per leaf axil	Number of seeds per capsule	1000-seed weight (g)	Oil content (g)	Seed yield per plant
D	0.00008 ± 0.0003	43.72** ± 9.74	0.32** ± 0.010	-0.94 ± 1.80	0.004 ± 0.04	1.85** ± 0.17	1.81 ± 1.55
H_1	0.01015** ± 0.0031	715.62** ± 98.90	0.64** ± 0.098	75.68** ± 18.26	0.991* ± 0.46	3.99* ± 1.73	181.20** ± 15.79
H_2	0.00758** ± 0.0028	545.09** ± 88.35	0.40** ± 0.088	51.12** ± 16.31	0.986* ± 0.41	4.01** ± 1.54	171.17** ± 14.11
h^2	0.00128 ± 0.0019	347.68** ± 59.46	0.57** ± 0.059	-3.09 ± 10.98	0.289 ± 0.27	4.32** ± 1.04	538.86** ± 9.49
F	-0.00095 ± 0.0015	84.13 ± 47.59	0.55** ± 0.047	-9.86 ± 8.79	-0.013 ± 0.22	-0.81 ± 0.83	1.68 ± 7.60
E	0.00021 ± 0.0001	9.50** ± 3.68	0.01 ± 0.004	1.56* ± 0.68	0.022 ± 0.02	0.31** ± 0.06	0.61 ± 0.59
$(H_1/D)^{1/2}$	5.81	2.02	0.71	4.48	7.87	0.74	5.01
$H_2/4\ H_1$	0.19	0.19	0.15	0.17	0.25	0.25	0.24
K_D/K_R	-0.04	2.81	-10.15	-0.08	0.66	0.54	1.21
h^2/H_2	0.17	0.64	1.44	-0.06	0.29	1.08	3.15
Heritability (ns) %	0.46	0.31	0.07	0.54	0.04	0.50	0.11
t^2	3.10	0.74	0.31	77.49**	17.22*	0.62	3.09

*, ** Significant at 5% and 1% levels, respectively

flowering, days to maturity, number of branches per plant, length of capsule, width of capsule, number of capsules per plant, number of seeds per capsule, 1000-seed weight, oil content and seed yield per plant, which indicated an equal distribution of increaser and decreaser genes in the parents. Similar results have been reported by Mothilal and Manoharan (2005) for number of branches per plant, number of seeds per capsule, 1000-seed weight and seed yield per plant; El-Bramawy and Shaban (2007) for days to 50 % flowering, days to maturity, number of branches per plant, number of capsules per plant and oil content and Sakhiya (2013) for days to maturity, number of branches per plant, length of capsule, width of capsule, number of seeds per capsule, 1000-seed weight, oil content and seed yield per plant. The distribution was unequal for plant height, height to first capsule, number of internodes per plant and number of capsules per leaf axil. Similar results have been reported by El-Bramawy and Shaban (2007) for plant height and Sakhiya (2013) for number of capsules per leaf axil. The environmental component (E) found significant for days to 50 % flowering, plant height, number of branches per plant, number of internodes per plant, number of capsules per plant, number of seeds per capsule and oil content manifesting play the role in the expression of these traits. Similar results have been reported by Mothilal and Manoharan (2005) for plant height, number of branches per plant, number of seeds per capsule, 1000-seed weight and seed yield per plant; Lavanya *et al.* (2006) for days to 50 % flowering, number of branches per plant, number of internodes per plant and oil content; El-Bramawy and Shaban (2007) for plant height and Sakhiya (2013) for days to maturity, height to first capsule, length of capsule, width of capsule, number of capsules per leaf axil, 1000-seed weight, oil content and seed yield per plant.

The degree of dominance, $(H_1/D)^{1/2}$ suggested over dominance for days to 50 % flowering, days to maturity, length of capsule, width of capsule, number of capsules per plant, number of seeds per capsule, 1000-seed weight and seed yield per plant, while plant height, height to first capsule, number of branches per plant, number of internodes per plant, number of capsules per leaf axil and oil content were influenced by the partial dominance. Hence, in the present study non-additive genetic effects played greater role in the control of seed yield and its components. Similar results in the sesame have been reported by Mothilal and Manoharan (2005).

The equal distribution of positive and negative genes in the parents helps the breeders in selecting desirable traits without losing other traits of interest. In the present study, the ratio, $H_2/4H_1$ was below the maximum value of 0.25, which suggested the asymmetrical distribution of positive and negative genes in the parental lines for days to maturity, plant height, height to first capsule, number of branches per plant, number of internodes per plant, length of capsule, width of capsule, number of capsules per plant, number of capsules per leaf axil and number of seeds per capsule. The similar findings have been reported by Mothilal and Manoharan (2005) for plant height, number of branches per plant, number of seed per capsule; Lavanya *et al.* (2006) and Sakhiya (2013) for number of branches per plant, number of internodes per plant, number of capsules per plant. The ratio, $H_2/4H_1$ was 0.25 or

nearly 0.25, which suggested the symmetrical distribution of positive and negative genes in the parental lines for days to 50 % flowering, 1000-seed weight, oil content and seed yield per plant. The similar results have been reported by Lavanya *et al.* (2006) for days to 50 % flowering and oil content and Sakhiya (2013) for seed yield per plant.

The ratio of total number of dominant to recessive alleles in the parents (K_D/K_R) was greater than one for days to 50 % flowering, days to maturity, plant height, number of internodes per plant, number of capsules per plant and seed yield per plant, which indicated more number of dominant genes than recessive genes in the parents. The present findings are in accordance with those of Lavanya *et al.* (2006) for days to 50 % flowering and number of internodes per plant; Mothilal and Manoharan (2005), El-Bramawy and Shaban (2007) for days to maturity and seed yield per plant and Sakhiya (2013) for days to 50 % flowering, days to maturity, number of capsules per plant and seed yield per plant. For the characters like height to first capsule, number of branches per plant, length of capsule, width of capsule, number of capsules per leaf axil, number of seeds per capsule, 1000-seed weight and oil content, an excess of recessive genes was evident. Similar results have been reported by Mothilal and Manoharan (2005), Lavanya *et al.* (2006) and El-Bramawy and Shaban (2007) for number of branches per plant and Sakhiya (2013) for height to first capsule and oil content.

Knowledge of number of gene groups which exhibit dominance and responsible for particular traits is important for the genetic progress through selection. In the present investigation, the value of h^2/H_2 was <1 for days to 50 % flowering, days to maturity, plant height, height to first capsule, length of capsule, width of capsule, number of capsules per plant, number of seeds per capsule and 1000-seed weight indicating that number of group of genes could not be estimated properly of a particular character. Similar results have been reported by Mothilal and Manoharan (2005) and Sakhiya (2013) for plant height, number of seeds per capsule and 1000-seed weight; Lavanya *et al.* (2006) for number of capsules per plant, El-Bramawy and Shaban (2007) for 1000-seed weight. The value of h^2/H_2 was >1 for number of branches per plant, number of internodes per plant, number of capsules per leaf axil, oil content and seed yield per plant indicating that more than one gene group controlled the particular trait. The present findings are in accordance with those of Mothilal and Manoharan (2005) for number of branches per plant and seed yield per plant; Lavanya *et al.* (2006) for number of branches per plant, number of internodes per plant and oil content; El-Bramawy and Shaban (2007) and Sakhiya (2013) for number of branches per plant and oil content. However, this parameter (h^2/H_2) can be underestimated when the dominance effects of all the genes concerned are not equal in size and distribution, when the distribution of genes is correlated (Jinks, 1954) or when complementary gene interaction occur (Mather and Jinks, 1971).

The heritability estimates in narrow sense were high for the characters *viz.*, height to first capsule, plant height, number of branches per plant, length of capsule, number of capsules per plant and number of seeds per capsule. Similar results have been reported by Mothilal and Manoharan (2005) for plant height and number of branches per plant; Lavanya *et al.* (2006) for number of branches per plant and Sakhiya (2013) for height to first capsule, plant height and length of capsule. The moderate estimates of heritability were observed for days to 50 % flowering, number of internodes per plant, width of capsule and oil content. Low narrow sense heritability was observed for days to maturity, number of capsules per plant, 1000-seed weight and seed yield per plant. Since non-additive genetic effects played major role along with very high to moderate heritability for most of the characters in present study, little response to selection is expected in the early generations. Genetic diversity in crop plants is essential to sustain level of high productivity (Tripathi *et al.*, 2013). It is therefore, suggested that selection should be delayed to advanced generations and some sort of intermating may be employed in early generations followed by pedigree method with careful progeny tests in advanced generation to achieve better success. The single seed descent method would be useful to maintain high variability for exercising selection in later generation.

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