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INHERITANCE OF LEAF ANGLE IN *TRITICUM AESTIVUM* L.

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INDEX WORDS

Triticum aestivum, wheat, leaf angle, erect leaves, diallel, additive gene effects.

SUMMARY

A 6 × 6 diallel was prepared to study the inheritance of leaf angle in *T. aestivum* L. Genetic analysis in terms of diallel cross parameters and graphic analysis indicated the control of additive gene effects in the expression of this character. The results of F_1 analysis were supported by the analysis of F_2 data.

INTRODUCTION

The value of erect leaves in giving increased crop growth rate has been demonstrated in rice (HAYASHI & ITO, 1962; MATSUSHIMA et al., 1964; TANAKA et al., 1966; JENNINGS & AQUINO, 1968; CHANG & TAGUMPAY, 1970), wheat (MAKSIMCUK, 1966; TANNER et al., 1966), barley (GARDNER et al., 1965; TANNER et al., 1966; PEARSE et al., 1967) and maize (PENDLETON et al., 1968). However, YAP & HARVEY (1972) and WINTER & OHLROGGE (1973) could not detect any significant beneficial effect of leaf angle on crop growth rate in barley and maize, respectively.

The merit of erect leaves is determined by the crop canopy and growing conditions (YAP & HARVEY, 1972). If varieties were developed with a higher leaf area index (SAEKI, 1960; DUNCAN, 1971) at population density giving maximum yield and/or in environment-management situations capable of supporting a higher leaf area index (WINTER & OHLROGGE, 1973), upright leaves might increase grain yield significantly.

From the physiological studies cited above, it becomes apparent that erect leaves should form the breeding objective to develop plant types suitable for heavy fertilization and capable of supporting a high plant population per unit area. With this objective the present investigation into the inheritance of leaf angle in *Triticum aestivum* L. was initiated.

The genetic studies on this aspect have been very few. SEETHARAMAN & SRIVASTAVA (1971) reported that erect flag leaf in a rice mutant was controlled by a single recessive gene. However, YAP & HARVEY (1972), from a 7 × 7 F_1 diallel study over

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two years in barley, observed highly significant additive gene effects for flag leaf angle. Degree of dominance was in the range of partial dominance in both years. The results of the F_1 analysis were supported by the F_2 analysis.

MATERIAL AND METHODS

The present investigation was carried out in 1972–73 at Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar.

A 6 × 6 diallel was prepared involving P_1 = Raj 829, P_2 = WL 332, P_3 = UP 301, P_4 = Raj 716, P_5 = HD 1938 and P_6 = UP 304 as parental lines. The first three were broad angled (94.9, 48.6 and 59.1 degrees, respectively), whereas the latter three were narrow angled (32.3, 37.7 and 36.9 degrees, respectively).

The trial consisted of parents, F_1's (including reciprocals) and F_2's (excluding reciprocals). The experiment was laid out in a randomised block design with three replications. Parents and F_1's were represented by single row plots. The row length was 3 meter. Row to row and plant to plant spacing was 23 and 15 centimeters, respectively. Fertilizers were applied at the rate of 134 kg N, 67 kg P_2O_5 and 40 kg K_2O per hectare. The first irrigation was given after 22 days. Four additional irrigations were given each at suitable intervals.

Ten competitive plants were selected at random for recording observations on parents and F_1's. For F_2's observations were made on 40 randomly selected competitive plants. All the observations were recorded just after ear emergence.

The angle between the stem and the mid rib of the flag leaf and that between the stem and the mid rib of the third leaf from the top of the main tiller were measured with the help of a protractor. The two observations were pooled and means were worked out on plot basis.

The genetic parameters for F_1 data were estimated according to the procedure outlined by HAYMAN (1954) and as used by AKSEL & JOHNSON (1963). The treatment of F_2 data followed the same general form as that of F_1 except that contribution of h was halved (JINKS, 1956). The genetic parameters from F_2 data were computed following the equations used by LEE & KALTSIKES (1971). For both the analyses group randomisation was used. Graphic analysis was based on Vr and Wr statistics derived from diallel tables (JINKS & HAYMAN, 1953).

RESULTS

Analysis of variance revealed highly significant differences among the treatments.

Diallel analysis in terms of genetic parameters. Homogeneity of Wr – Vr was shown by the Wr – Vr variance analysis of F_1 and F_2 data (Table 1). This showed the satisfactory fulfilment of the assumptions of the diallel analysis.

Genetic components of variation from analysis of F_1 and F_2 data are presented in Table 2.

A highly significant additive component of genetic variation in both the cases revealed that expression of leaf angle was under the control of additive gene effects. The dominance component of variation was non-significant. Significance of F in

Table 1. Analysis of variance of Wr – Vr for F_1 and F_2 data for leaf angle.

Source	Degrees of freedom	M.S.	
		F_1	F_2
Line (Arrays)	5	2559.56 N.S.	1685.63 N.S.
Blocks	2	17415.53	24479.82
Error	10	11100.95	1906.71

N.S. = Non significant

Table 2. Estimates of components of genetic variation from analysis of F_1 and F_2 data for leaf angle.

Components of genetic variation	F_1 analysis	F_2 analysis
D	527.96** ± 49.48	527.96** ± 50.26
H_1	146.48 ± 125.61	149.41 ± 127.60
H_2	72.82 ± 112.21	16.09 ± 113.99
h^2	7.13 ± 75.52	–27.92 ± 76.72
F	246.93** ± 120.88	443.93** ± 122.79
$(H_1/D)^{0.5}$	0.52	0.53
$(H_2/4H_1)$	0.12	0.03
(K_D/K_R)	2.60	8.55
(h^2/H_2)	0.09	1.73

* = Significant at 5% level.
** = Significant at 1% level.

both analyses indicated non-symmetrical distribution of dominant and recessive alleles of each gene in the parents. Positive values of F revealed the excess of dominant alleles. The interpretation of the estimators from F_1 and F_2 analyses is not given because of non-significance of the corresponding components of variation.

Graphic analysis. The Vr, Wr graphs from F_1 and F_2 analyses are given in Fig. 1 and 2, respectively.

The regression coefficient of Wr on Vr was significantly different from zero and non-significantly different from unity in both the cases. This again showed fulfilment of the assumptions involved in the analysis. Partial dominance was revealed for leaf angle by positive interaction of Wr axis with regression line in both F_1 and F_2 analyses.

The proximity of parents UP 304 and WL 332 near to origin in F_1 Vr, Wr graph indicated the presence of relatively more dominant alleles in them. Parents Raj 829 and Raj 716 were away from the origin indicating the presence of relatively more recessive genes in them. Parents HD 1938 and UP 301 occupied a position between the above two groups.

However, distribution of parents in F_2 Vr, Wr graph differed from that of F_1 Vr, Wr graph. Parent WL 332 had the maximum number of dominant alleles followed

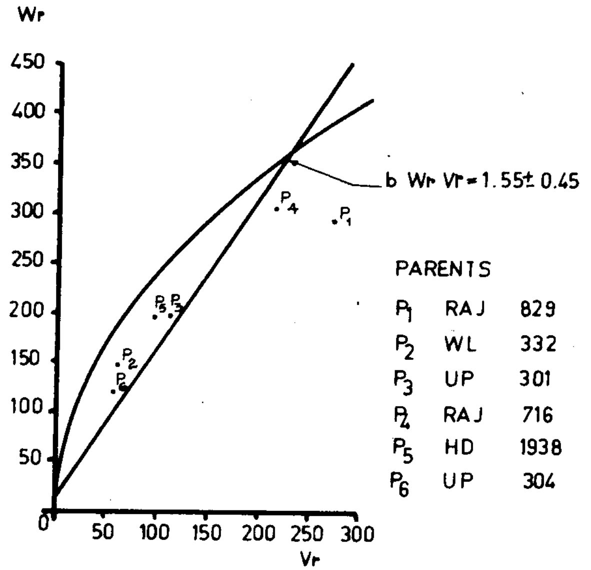

Fig. 1. (Left). F_1 Vr, Wr graph.

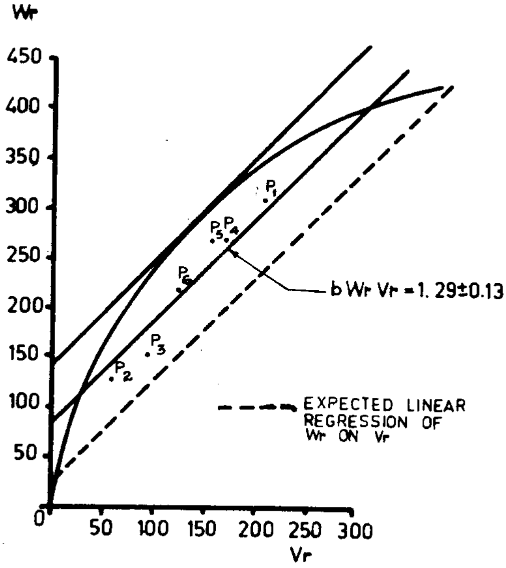

Fig. 2. (Right). F_2 Vr, Wr graph.

by UP 301. Raj 829 possessed maximum number of recessive genes followed by Raj 716 and HD 1938.

DISCUSSION

A number of research workers have emphasised the role of erect leaves in increased crop growth rate. DONALD (1968) reported that significance of leaf angle was based on the concept that in a dense community near vertical leaves would permit adequate illumination of a greater area of leaf surface than would occur in a canopy of long, horizontal or drooping leaves, in which upper leaves would be overlit and lower leaves harmfully shaded. This provides a new means of selection for high yields. A genetic analysis of this character becomes necessary for formulating the appropriate breeding procedure to incorporate or to improve upon this character.

Genetic analysis of F_1 and F_2 data for leaf angle in terms of diallel cross parameters gave highly significant D estimates. Graphic analysis of F_1 and F_2 data showed the operation of partial dominance for leaf angle. All these analyses pointed out predominant role of additive gene effects in the determination of leaf angle. Similar observations were made by YAP & HARVEY (1972) in barley.

On the basis of scattering of parents in F_1 Vr, Wr graph, parents can be grouped in three categories: (1) Raj 716 and Raj 829 (2) HD 1938 and UP 301 (3) WL 332 and UP 304. Parents Raj 716 and Raj 829 had relatively more recessive genes, whereas parents WL 332 and UP 304 had more dominant genes. The other two parents are intermediate in this distribution. To create greater variability for leaf angle in F_2, a cross between categories would be more effective than within categories. A cross between parents in categories (1) and (3) would be expected to give maximum variation for selection for leaf angle in F_2.

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