GENETIC ANALYSIS OF PERIOD OF MATURITY AND YIELD IN TALL X DWARF CROSSES OF WHEAT

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Genetic analysis of plant characters like time taken for flowering (full emergence), maturation periods and yield of four wheat varieties, namely, AU44, AU49, Dirk and C273 was attempted through diallel cross technique. It was found that earliness showed additive type of gene action with partial dominance during full emergence and maturity. The local varieties behaved as dominant while the exotic types as recessive. The grain yield also manifested additive type of gene action with partial dominance. Dirk displayed dominance while AU49 showed recessiveness.

INTRODUCTION

Diallel analysis is being extensively used for determining the genetic control of important characters of many crop species in the F_1 generation. In the present studies, the technique has been employed to find out the genetic mechanism controlling spike emergence, period of maturity and final yield in crosses involving tall and dwarf wheat varieties. This may help the wheat breeders in planning breeding programmes vis-a-vis short statured varieties which, on account of their high yield potential, are becoming very popular in the country.

REVIEW OF LITERATURE

While Shen *et al.* (1938) and Poehlman (1949) reported earliness to be governed by multiple genes, Pinthus (1963), Pugsley (1965) and Johnson *et al.* (1966) concluded that the character was simple inherited. For yield, partial dominance was reported by Aamodt *et al.* (1935) in spring wheat. In winter wheat, additive type of gene action was postulated by Whitehouse *et al.* (1958) for yield components and non-additive type for yield. Kronstad and Foote (1964) and Brown *et al.* (1966), on the other hand, reported additive type of control for the expression of yield. In barley the early findings of Grafius *et al.* (1952), Johnson and Aksel (1959) and Aastveit *et al.* (1961) show dominance to play a greater role in the inheritance of yield. The recent report of Upadhayaya and Rasmusson (1967) indicated a substantial amount of additive

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and non-additive genetic variance for yield. In oats, dominance as also over-dominance was reported by Petr and Frey (1966).

MATERIAL AND METHODS

The selected parental material consisted of two wheat varieties, AU44 and AU49 derived from exotic sources and two standard commercial varieties, Dirk and C273. These varieties were crossed in different combinations in 1965-66 as follows: (1) AU44×AU49, (2) AU49×AU44, (3) AU44×Dirk (4) Dirk×AU44, (5) AU44×C273, (6) C273×AU44, (7) AU49×Dirk, (8) Dirk×AU49, (9) AU49×C273, (10) C273×AU49, (11) Dirk×C273 and (12) C273×Dirk.

The hybrids along with respective parents were grown on an average soil in the second week of November, 1966, in a field laid out on randomized block design, with four replications. The distance kept from row to row as also from plant to plant was one foot. Data were recorded on the first generation hybrids and their parents on the following characteristics:

Time taken for flowering (just emergence). The tip emergence of the first (main) spike from sheath was taken as an index of flowering (just emergence). The number of days taken to flower (just emergence) was worked out from the date of sowing and tip emergence of the first (main) spike.

Time taken for flowering (full emergence). The full emergence of the first (main) spike from the sheath was taken as an index of flowering (full emergence). The number of days taken to flower (full emergence) was worked out from the date of sowing and full emergence of the first spike.

Time from full emergence to maturity. The four stages of ripening of the grain are milk stage, yellow ripe, fully ripe and dead ripe. In the present work the date of ripening was recorded as the date when the grain was "fully ripe", *i.e.*, when the grain had become hard but the straw was still yellowish green in colour. The number of days taken to mature was calculated from the date of full emergence and maturity.

Final Yield. The threshing was done on cloth sheet very carefully and yield of grain per plant was recorded in grams. Data were statistically analysed by analysis of variance. The diallel cross technique as developed by Hayman (1954) and Jinks (1954) was applied to the data for the genetic analysis. All the crosses were arranged into arrays. Two statistics, the variance (Vr) of the family means within an array, and the co-variance (Wr) of these means with the non-recurrent parental values were calculated from each diallel table and information on gene interactions was extracted by plotting the co-variance (Wr) of each array against its variance (Vr.). The slope and position of the regression line fitted to the array points lay within a limiting

parabola $Wr^2 = \frac{V}{p} - Vr$ and indicated the degree of dominance and the presence or absence of gene interaction.

EXPERIMENTAL RESULTS

Time taken for flowering (just emergence)

The F value obtained is highly significant. The values for different arrays and array means are presented in Table I. Dirk is early (108.08 days)

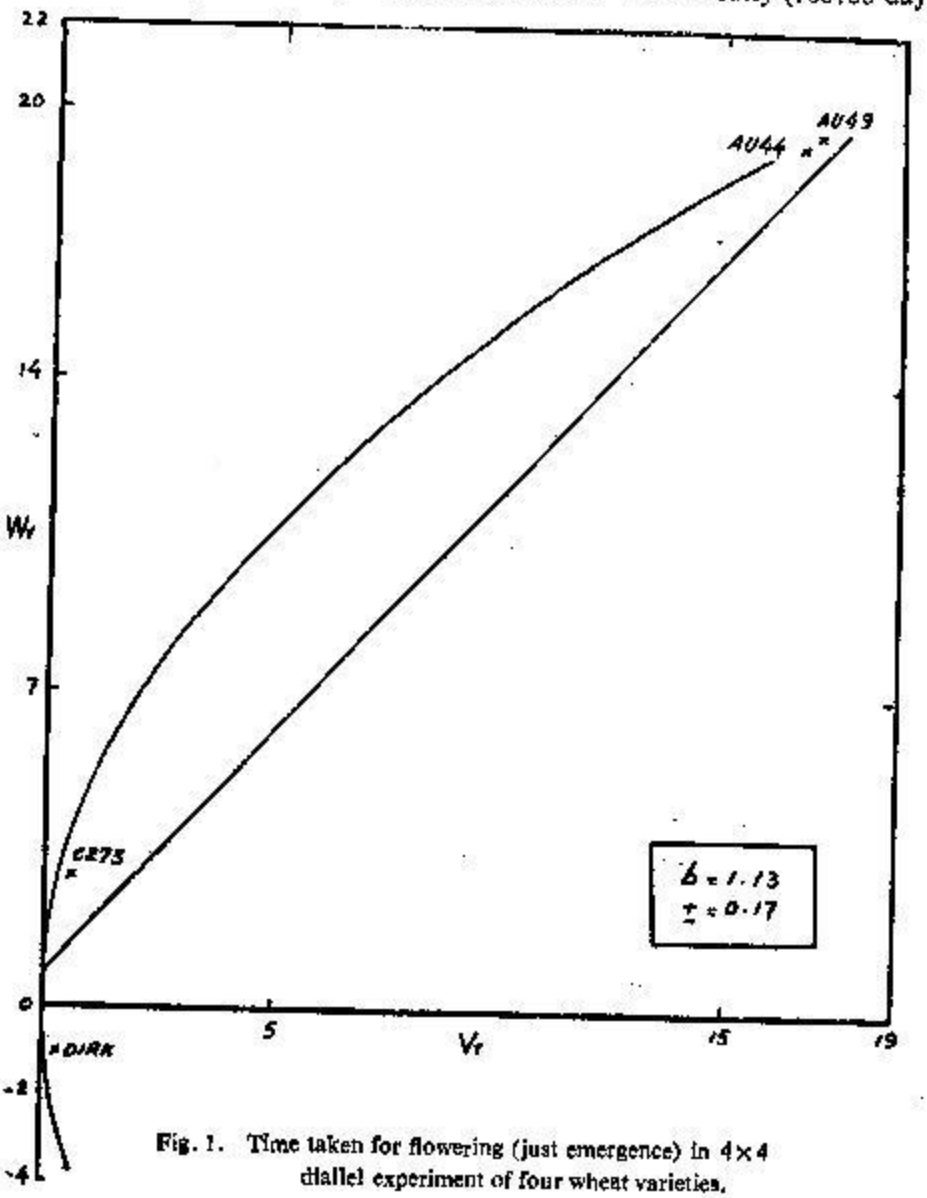

Fig. 1. Time taken for flowering (just emergence) in 4×4 diallel experiment of four wheat varieties.

in flowering, followed by C273, AU49 and AU44. An examination of Fig. 1 indicates that the regression line with a unit slope cuts the Wr axis on the negative side of the origin and it can be said with confidence that over-dominance plays a part in determining the control of this character. As the unit slope does not differ significantly, gene interaction does not seem to play any role. Dirk being closest to the origin, possesses the maximum number of dominant genes and AU44 on the other end of the scale, has the most of the recessive genes.

TABLE 1.—4×4 *diallel. Time taken for flowering (just emergence)*

	AU44	AU49	Dirk	C273
AU44	115.05	113.35	107.15	110.09
AU49	113.35	110.70	107.92	108.28
Dirk	107.15	107.92	107.80	109.47
C273	110.09	108.28	109.47	109.00
Array mean	111.41	110.06	108.08	109.21

Time taken for flowering (full emergence)

Analysis of variance was applied to both parental as well as F_1 values and the differences were found to be highly significant. The actual values (Table 2) indicate that AU44 takes the maximum time followed by AU49, C273 and Dirk. Fig. 2 shows that regression line cuts the Wr axis just above the origin from which it can be deduced that additive type of gene action with partial dominance is involved. As the regression line does not deviate significantly from the unit slope, presence of interaction is not assumed. From the order of the array points it will be seen that Dirk, being closer to the origin, possesses the most dominant genes and AU49, being away from the origin, has most recessive genes.

TABLE 2.—4×4 *diallel. Time taken for flowering (full emergence)*

	AU44	AU49	Dirk	C273
AU44	121.90	120.79	113.47	115.29
AU49	120.79	121.15	113.18	114.51
Dirk	113.47	113.18	113.05	114.43
C273	115.29	114.51	114.43	113.40
Array mean	117.86	117.41	113.53	114.41

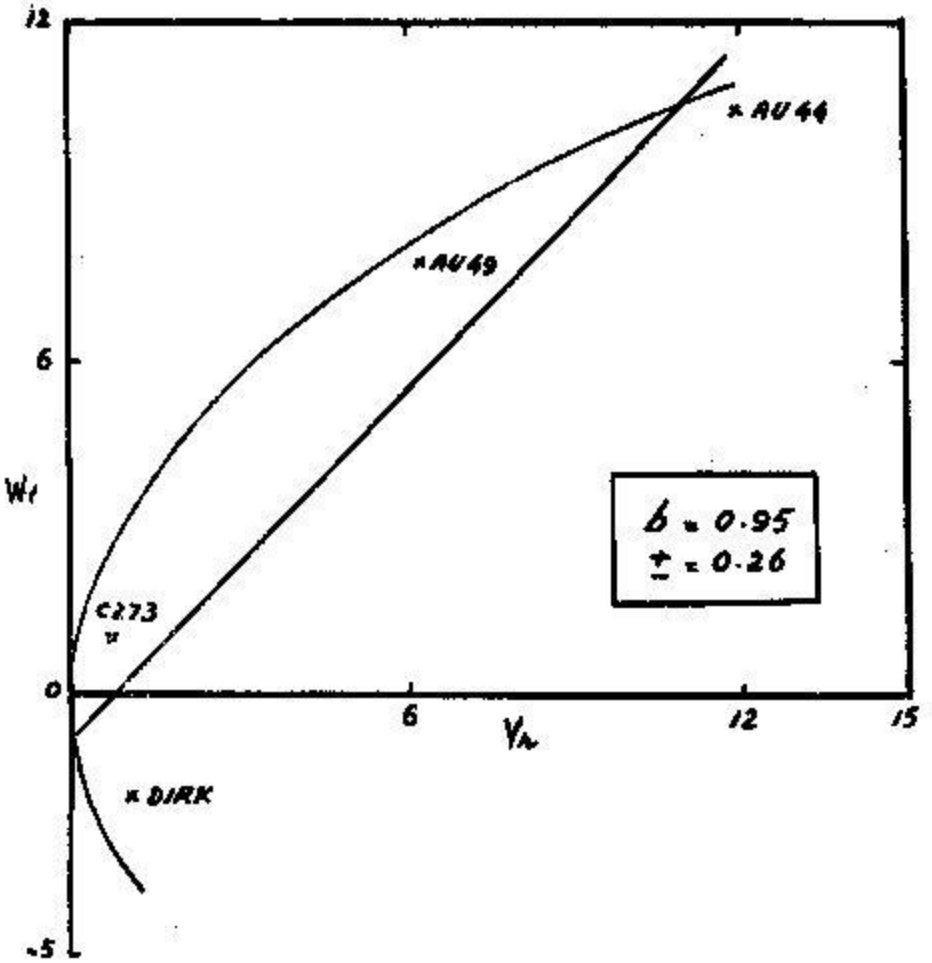

Fig. 2. Time taken for flowering (full emergence) in 4×4 diallel experiment of four wheat varieties.

Time from full emergence to maturity

The F value obtained was highly significant. The actual values (Table 3) show that C273 (43.00 days) takes the maximum time followed by Dirk (42.68 days), AU49 (40.96 days) and AU44 (40.70 days). A reference to Fig. 3 indicates that the regression line intersects the Wr axis just above the origin; thus, the gene system can be attributed to the additive mechanism without any indication of gene interaction. The position of the array points is the same as in the previous case.

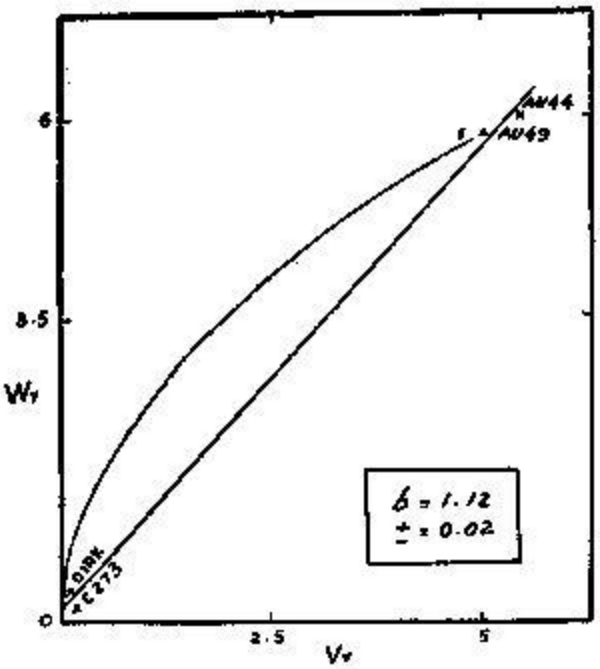

Fig. 3. Time from full emergence to maturity in 4×4 diallel experiment on four wheat varieties.

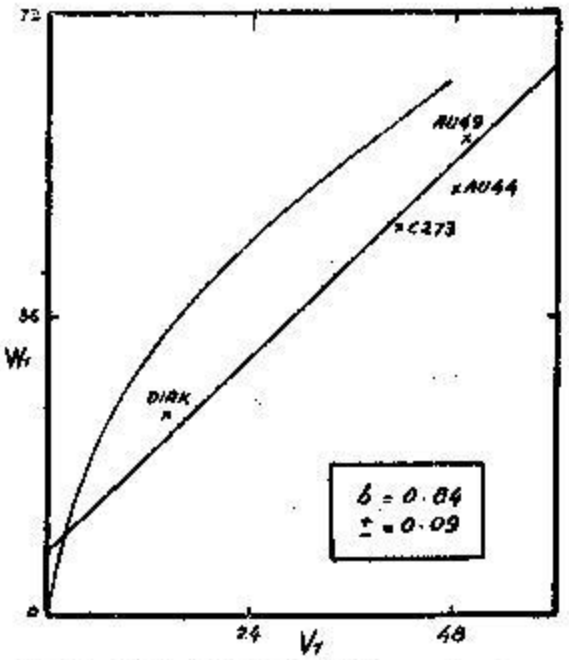

Fig. 4. Final yield in 4×4 diallel experiment on four wheat varieties.

TABLE 3.—4×4 *diallel. Time from full emergence to maturity*

	AU44	AU49	Dirk	C273
AU44	38.40	39.02	42.37	43.02
AU49	39.02	39.00	42.88	42.93
Dirk	42.37	42.88	42.90	42.58
C273	43.02	42.93	42.58	43.50
Array mean	40.70	40.96	42.68	43.00

Final Yield

Analysis of variance indicated that the differences among the genotypes were highly significant. The actual values (Table 4) indicate that AU44 (43.13 grms.) is the highest yielder followed by C273 (40.64 grams.), AU49 (39.88 grams.) and Dirk (30.77 grams.). An observation of the Fig. 4 indicates that the regression line passes through the Wr axis above the origin, meaning thereby, additive type of gene action for this character with partial dominance. As the regression line deviates significantly from the unit slope, some interaction of genes is indicated. From the position of the array points it becomes evident that Dirk, being towards the origin, possesses the top dominant genes while AU49, which is situated away from the base, has the maximum number of recessive genes.

TABLE 4.—4×4 *diallel. Final Yield*

	AU44	AU49	Dirk	C273
AU44	46.60	47.20	32.67	46.07
AU49	47.20	34.05	33.60	34.88
Dirk	32.67	33.60	25.20	31.60
C273	46.07	44.68	31.60	40.22
Array mean	43.13	39.88	30.77	40.64

DISCUSSION

Allard (1956) while emphasizing the genotypic environment interaction in *Nicotiana rustica* demonstrated the stability of additive genetic effects as compared to dominance effects which were variable under different environments. In the present studies, earliness was considered in three different ways: the time taken from setting to just emergence of the spike from the boot, the time taken from just emergence to full emergence and the time taken from full emergence to maturity. It was observed that genetic control in the early stage was over-dominance which changed to additive pattern in the subsequent stages. This may be due to comparatively low maximum temperature prevailing at the time of just emergence which became quite normal for growth during the later stages of investigation. It is quite surprising that heterotic effects should be accentuated by the prevalence of low temperatures rather than high temperature, as has been demonstrated in *Arabidopsis thaliana* by Griffing and Langridge (1963). They explained their results on the basis of temperature-sensitive alleles to explain differential heterosis over a range of temperatures. The present studies are preliminary in nature but tend to show that the same explanation may be advanced in case of flowering period in wheat. The additive type of gene action controlling heading date was also reported by Shen *et al.* (1938), Poehlman (1949) and Pinthus (1963). The tall statured local varieties possessed most of the dominant genes for earliness and maturity, while semi-dwarf exotic selections (AU44 and AU49) had the maximum of recessive genes. This is quite in agreement with Shen *et al.* (1938) and Pinthus (1963) and contrary to the findings of Poehlman (1949), who demonstrated dominance of lateness over earliness.

In respect of yield, the graphical representation (Fig. 3) depicts additive pattern of gene action with partial dominance. These results are contrary to the findings of Whitehouse *et al.* (1958), who observed over-dominance for yield and additive type of control for the yield components. However, these results are quite in agreement with those obtained by Kronstad and Foote (1964) and Brown *et al.* (1966). Most of the variability in yield was found by them to be associated with high general combining ability and they ascribed it to additive effects of genes with essentially no epistasis or dominance. It is apparent that additive type of gene action for the expression of yield is very predominant in wheat and many other self-pollinated crops including sorghum, soyabean, linseed, snapbean, tomatoes and cotton. This implies that productive homozygous lines can be easily isolated in the subsequent generation. This is substantiated by the fact that large number of high yielding varieties have been developed from the self-pollinated crop in the past.

An examination of Vr/Wr graph (Fig. 4) shows that the local tall-growing varieties, being nearer the origin are dominant over the short statured exotic selections. Further it will be observed that low yielding types are associated with dominant genes. AU44 (Table 4) is the best potential parent and its cross with AU49 showed the maximum yield. Since the quality of bread is of paramount importance, the AU44×C273 cross is likely to give good segregates in the later generations.

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