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GENOTYPIC AND ENVIRONMENTAL EFFECTS
ON GROWTH HABIT IN WHEAT
(*Triticum aestivum* L.)

A thesis
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In the name of GOD the most compassionate and the most merciful.

In memory of my father and brother

ABSTRACT

A large part of wheat's world-wide adaptability is due to flexibility arising from spring-winter habit of growth. Genetic and environmental effects on growth habit in wheat were studied by considering the response patterns of 43 diverse lines to combined variations in temperature and photoperiod under natural conditions in the Manawatu region of New Zealand. Four environments were sampled by having a range of sowing dates from early winter to early summer.

The responses were evaluated using 14 developmental and adaptive attributes, and different techniques of univariate and multivariate analyses. Two pooled analyses were used; (a) 37 genotypes over all 4 environments (excluding six genotypes which did not flower in the two later sowings), (b) all 43 genotypes pooled over two early sowings. Estimates of heritability and genotypic correlation were obtained as well as the usual phenotypic analyses of ordinary correlation and genotype X environment patterns.

There was highly significant genotypic variation for all characters except leaf appearance and tiller production rates. Macro environment variance was the largest significant variance component, indicating that all characters were affected in a major way by environmental effects. Genotype X environment interaction variance was non-significant only for the numbers of fertile tillers and total tillers (in both analyses), and for main stem height in analysis (a). The narrow sense full heritabilities estimated by analysis (a) were very low (0.06% - 3.7%) for flowering characters, leaf appearance and tiller production rates; low (11% - 18.5%) for leaf, spikelet and internode numbers; and moderate (34% - 57%) for tiller fertility ratio, fertile and total tiller numbers, main stem height and peduncle length. However, the restricted heritabilities were moderate to high for most of the characters (except leaf appearance and tiller production rates). Because of the narrower range of environments, but broader range of genotypes, in analysis (b), genotypic variance and heritability estimates were higher than in analysis (a).

Genotypic correlation was highly significant between flowering characters and leaf number (0.81 - 0.998). It was also highly significant between these characters and total tiller number, and negative and highly significant between the flowering characters and fertility ratio of tillers. Genotypic correlation between spikelet number, and flowering characters and leaf number was significantly moderate to high.

Phenotypic correlation for only the flowering characters, leaf and spikelet numbers was in good agreement with genotypic correlation in analysis(a). Despite of highly significant and negative phenotypic correlation between leaf appearance as well as tiller production rates and the flowering characters, the genotypic correlation between them was low and non-significant. This was in moderate level for fertile tiller number, main stem height, peduncle length and internode number.

General performances (line means) and response patterns of genotypes to environments (GE means) were significantly different. Six genotypes did not flower in spring sowings and one genotype (CRAW 45) flowered very late only on a few tillers. They were therefore classified simply as 'true winter wheat'. Duration of growth cycle was dependent on pattern of response, and was generally indicated by a larger number of leaves. The number of spikelets increased also, in parallel to increase in leaf number.

Genotype x environment means of seven characters, which showed highly significant genotype x environment interaction, were subjected to principal component analysis in order to delineate the genotypes on the basis of similar response pattern. This resulted in two principal component scores for each genotype for each character. Then cluster analysis was applied successfully to classify the genotypes on the basis of these scores. Another five groups were recognised in this way, and defined according to their means of principal component score for each character. The five group were as follows.

(1) Facultative wheats with moderate vernalization response and photoperiod sensitivity; (2) semi-spring wheats with moderate vernalization response and day neutral (photoperiod insensitive), (3) spring wheats with weak vernalization response and day neutral; (4) spring wheats with strong photoperiod sensitivity and weak or no vernalization requirement, (5) spring wheats with relatively strong photoperiod sensitivity and no vernalization response.

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