SELECTION AMONG SEGREGATING POPULATIONS OF WHEAT

Soemarjo Poespodarsono

Agricultural Engineer

Brawijaya University, Indonesia.

Thesis submitted for the degree of

Master of Agricultural Science in

the Faculty of Agricultural Science,

University of Adelaide.

Department of Agronomy,

Waite Agricultural Research Institute,

University of Adelaide.

1980

DECLARATION

This thesis is my own work and has not been published previously for the award of a degree in any university.

Soemarjo Poespodarsono

November 1980

CONTENTS

Contents contd.

SUMMARY

1. A study was made of factors affecting the efficiency of selection for yield of single plants in an F_2 segregating population of wheat and of selecting between plots of genotype at the F_7 generation.
2. Three experiments comparing F_2 plants with their parents P_1 and P_2 were conducted at the Waite Agricultural Research Institute in 1978 and 1979. Seeds were sown at 3.5 cm X 17.5 cm a spacing which provides the commercial density in this environment. In Experiment 1 the seeds of P_1, P_2 and F_2 were sown in separate plots, but in Experiments 2 and 3 P_1, F_2 and P_2 were in sequence in each row of the plots.
3. Each seed in Experiment 1 was weighed and seedling emergence recorded. At harvest the plants were individually assessed for plant weight, main shoot grain yield, head number, final grain yield and plant height. Experiments 2 and 3 handled similarly except that the individual seed weights at sowing were not recorded.
4. It was found that rapidity of emergence was not determined by seed size but there was some tendency for the bigger seeds to give higher yielding plants. In the three experiments the earlier emerging plants had higher yields at maturity. This effect was marked; plants emerging on the first day on average had yields 1.4 times those emerging on day 4.
5. The effects of competition between a plant and its neighbours were studied using serial correlations. Some correlations were negative and some were positive. Serial correlations did not reveal the influence of a plant on its neighbours for all characters observed.
6. Environmental effects were large in relation to genotypic effects. Significant genotype-replicate interactions were obtained. Plant weight, head number and final grain yield were similarly affected

by the environment. There was a strong correlation between final grain yield and plant weight. It also was found that except for plant height there were no significant differences among genotypes.

7. The F_2 mean values varied considerably between replicates in their relation to the parental mean values. The range of the F_2 values covered the combined range of the parental values and transgressive segregation was found in some instances in the F_2.

8. The variance values of the F_2 were not significantly greater than the variances of the parents P_1 and P_2 and only plant height showed clear evidence of segregation, with F_2 variances in some crosses larger than the parental variances. It appeared that the main shoot grain yield was less influenced by microenvironmental variability.

9. The frequency distributions of all characters were skewed to the right except for plant height which was skewed to the left.

10. Three trials involving the F_7 generation were conducted in 3 years but at two sites. The F_7 lines were derived from lines selected or taken at random from an F_5 population. There 30 selected lines and 19 randomly chosen lines. The trials were laid out at as randomized blocks with 2 replicates. The number of plots in each trial was 825, including the check plots. The plot size was 0.60 m X 2.50 m and grain yield was the character measured.

11. Of the three correlations across years and sites only one was significant. It was the correlation of trial results at Charlick over 2 years. It was suggested that the correlation was due to differences among lines in their resistance to nematodes. Only few lines, however, were consistent over three years and two sites.

12. Selection within families at the F_5 generation resulted in relatively better F_7 lines than those taken at random. It was showed that the parents of a cross contributed the stability of lines in the F_7 generation.

ACKNOWLEDGEMENTS

I would like to thank the Indonesian Government and the Australian Government who provided a scholarship under the Australian-Asian Universities Co-operation Scheme to study in Australia.

I have sincerely appreciated the opportunity to work in the Department of Agronomy of the University of Adelaide. In particular I wish to express my gratitude to Dr. R. Knight and Dr. A. Rathjen for their interest and guidance throughout this work and to Mr. T. Hancock for help in computer programming.

I gratefully acknowledge the assistance given by Mr. S.S. Jantke, Mr. J. Lewis, Mr. P.A.E. Ellis, Mr. J.W. Chigwidden and the others in preparing the material, sowing and harvesting.

I will always remember the staff and post graduate students in the Department of Agronomy who gave me congenial surroundings during my study.

DEDICATION

To my wife, Sri Pratiwi, and
my sons, Arundi Kriptanto,
Boni Jianto and Christian
Sarnanto who encouraged and
helped me during my study.

INTRODUCTION

This thesis is concerned with selection of single plants in the early generations following a cross of two parents of wheat. It is also concerned with the testing of plots of F_7's lines over different sites and years.

In the breeding of self-pollinated crops the breeder faces the difficulty of making an accurate phenotypic assessment of single plants and the selection of desirable homozygous genotypes. Most of the characters of interest to him such as yield and quality are quantitative. These characters are under the control of many genes each with small effect on the phenotype. The expression in single plants of quantitative characters is also influenced by the microenvironment which tends to blur the genetic differences between the plants. Microenvironmental variation always occurs even in the small area occupied by a selection block and increases the variability amongst plants making it more difficult to assess them individually.

The microenvironment affects the growth of a plant from the moment germination occurs. Soetono (1975) found with a cultivar of barley that the earlier emerging seedlings gave bigger plants than those with a later emergence. In view of this finding, the present experiment was concerned with comparing the effects of seedling emergence and growth in an F_2 segregating population with the emergence and growth of its parents. If early emergence was determined by the microenvironment and this resulted in large differences in yield it would mean that it would be difficult to select among F_2 plants on a basis of yield and achieve a genetic improvement.

In the pedigree method of breeding, selection may begin on single plants in the F_2 and be continued until the genotypes of the desirable plants are homozygous. It would be advantageous if an accurate assessment

could be made in an early generation analysis of hybrids and some knowledge gained of the relative importance of heredity and environment in determining the expression of characters. Theoretically the phenotypic variance of a segregating population of plants should be much larger than among individuals of the homozygous parents. However, it often happens in a breeding programme with wheat that the variances of the F_2 and parents are not statistically different (Knight, personal communication).

Selection on a single plant basis may be practised if the plants are at a wide spacing or at a crop density. At wide spacing every plant can grow and show maximal expression of its characters. The plants are more easily handled and provide more seed for testing in the next generation. A low density, however, implies that the selection block will occupy a larger area and have greater soil heterogeneity and microenvironmental variation. Furthermore the expression of a genotype will be different from what it would be under the competitive conditions of normal crop density. The factors limiting growth will be different. At crop density, every plant is subject to strong interplant competition. Only a smaller area is needed and it is possible to select under conditions similar to those in which the crop will be grown. It was considered that the results of the present study would be more meaningful to selection if the plants were grown at a crop density.

Many breeders have stated that selection for yield in the F_2 is not effective. The matter is worthy of study as Shebeski (1967) on theoretical grounds has indicated that the F_2 generation has a higher proportion of genotypes with a favourable combination of genes than in any subsequent generation.

As selection based on yield has not been notably successful some workers have suggested that plant characters related to yield should be

considered when undertaking selection. Other characters may be less influenced by heterozygosity, genotype-environment interactions or competition effects than is yield itself. Hence this study of the F_2 and parents at a crop density has considered yield as well as related characters.

In the final stages of the pedigree method, selection moves away from individual plants to selection between plots of each genotype. Furthermore tests are conducted over different sites to enable selection of genotypes with wide adaptation or sometimes specific adaptation. Usually stable high yielding lines are the main interest of such tests. Some statistical analyses of the genotype-environment interactions present in these tests have been suggested, but the validity of the analysis for any test is still debated.

Some aspects of such tests, the prediction of desirable genotypes and the effect of environmental variability, form the background to the second part of this study on F_7 lines of wheat.