GENETIC STUDIES ON MATURE PLANT REACTIONS TO WHEAT RUSTS AND GRAIN QUALITY IN SOME VULGARE WHEAT CROSSES

By

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I. INTRODUCTION

The rapid increase in the population of U.A.R. has urged the attempts to increase wheat production. Breeding for rust resistance is of great importance in avoiding great losses in yield caused by these diseases which approaches 40 % (Mohamed 1968), in addition to quality due to the decrease in grain weight.

Breeding programs have been concentrated in the breeding for resistance to stem rust only. Evidently, several wheat cultivars were obtained which showed resistance to stem rust, but unfortunately were susceptible to one or both of the other two rusts (leaf and stripe rusts). Due to lack of resistance to the stripe rust in most of the local vulgare cultivars, damage exceeded 25 % of the grain yield (Mohamed 1963).

During the last few years, efforts have been directed to breed for resistance to the three rusts together, to save losses caused by these diseases, and evidently to increase the yield.

In the meantime no serious attempts have been directed to study the inheritance of wheat quality. Sometimes samples of certain cultivars were chemically analysed and quality

characters estimated but were not used by breeders either in the course of selection or when a hybridization program was designed. With the several uses of wheat and progress achieved, wheat quality has to be considered, with regard to protein content in order to increase the feeding value of bread, beside the white colour which is required by the consumers.

These investigations were directed to study two main objectives, first the mode of inheritance of field reactions to each of the three wheat rusts and their associations, and secondly inheritance of two grain quality characters, i.e., grain colour, and protein content.

II. REVIEW OF LITERATURE

a- Inheritance of Field Reaction to Rusts :

1- Stem Rust :

Hayes et al. (1934), found in F_3 progenies of the cross H.44 x (Marquis x Kota No. 11-19-167) and H.44 x (Double cross No. 11-21-28), that the mature plant resistance to stem rust of H.44 appeared to depend on a single genetic factor difference. The moderate plant resistance of lines No. 11-19-167 and 11-21-28 appeared to depend upon factors not allelomorphic to those responsible for mature plant resistance of H.44 type. Since susceptible lines were obtained in F_3 generation, there was indication that more than a single gene pair was necessary to explain mature plant reaction.

Wells and Swenson (1944), suggested two or three gene pairs to govern the reaction to stem rust in the adult stage in a cross between selection of (H.44 - Reward) and Baringo.

Ausemus et al. (1946), reviewed more than 60 papers on the inheritance of resistance to stem rust. Most of these studies indicated that resistance was inherited as a monogenic character, yet digenic, trigenic and even

multigenic ratios were reported. Instances of duplicate, inhibiting, and complementary types of gene actions had also been found.

Swenson et al. (1947), found that at least two or three recessive genes for resistance to stem rust were involved in differentiation between the resistance of the variety Thatcher and the susceptibility of Triumfo.

Koo and Ausemus (1951), studied the field reaction to a collection of races of stem rust in F_3 lines of the three crosses Timstien x Thatcher, Newthatch, Mida. They found that reaction to stem rust under field conditions was dependent on two complementary factors in the cross Timstien x Thatcher, and on one factor in the other two crosses.

Ayad (1953), studied the field reaction to a collection of the prevalent races of stem rust in four crosses. In the two crosses Giza 141 x N.A. 710 and Giza 141 x N.A. 711, resistance was dominant and the field reaction to stem rust was conditioned by two independently inherited factors together giving resistance. Presence of susceptible plants in F_2 indicated that each of the two resistant parents possessed a different dominant gene for resistance, and the susceptible allele of the other. On the other hand, in the

cross Giza 141 x Gabo, susceptibility was dominant, and the field reaction was determined by a single factor difference. In Giza 141 x Line 950, resistance was dominant and the field reaction was inherited on a monohybrid basis.

El-Khishen (1953), from studies on the inheritance of reaction to stem rust in three crosses between Thatcher and each of the varieties White Federation, Baart and Ramona, obtained a monohybrid ratio of 3 : 1 in all of the three crosses. This result indicated that Thatcher possessed one factor for resistance under field conditions in the U.A.R.

Wu and Ausemus (1953), observed some very susceptible plants and lines to stem rust in hybrid progenies, in which the parents were resistant. This result showed that such parents carried recessive factors for susceptibility and the inheritance was multifactorial.

Hakam (1954), studied the inheritance to stem rust in the field rust nursery at Giza using a collection of races 9, 14, 19, 21 and 42. The F_2 and F_3 data of the crosses N.A. 709 x Hindi 62 and N.A. 711 x Hindi D showed that reaction to stem rust was governed by a single factor pair.

Heyne and Johnston (1954), studied the field reaction to at least three known races of stem rust plus some naturally occurring races in F_3 lines of the two crosses of Timstien with (Red Chief and Pawnee). He explained the results on a single factor pair difference, in which Timstien contributed the factor for resistance.

Wiggin (1955), using the results from crosses between Kentana 52 and the Chinese monosomics, concluded that Kentana 52 carried two loosely linked genes on chromosome 20, one giving resistance to race 56 and the other to race 15 B. It appeared more probable, however, that Kentana 52 carried gene Sr_6 which was located on chromosome 20 and gave resistance to both races. In addition, this variety might carry two other genes, one giving resistance to each race. The gene for resistance to race 15 B would be Sr_7 and the gene for resistance to race 56 would come from Kentana 52.

Attia (1956), assumed one major gene controlling mature plant resistance in crosses of Giza 139, Giza 141 and Mokhtar with the susceptible variety Hindi 62 to a collection of prevailing races of stem rust in Egypt. He also found no susceptible plants in the progenies of crosses between resistant varieties, showing that these

varieties might carry the same major gene for resistance.

Pal et al. (1956), studied the inheritance of resistance to stem rust in two crosses; NP 789 x Frondosa and Ridly x Pb. C. 518. The data of the F_2 and F_3 progenies of the cross NP 789 x Frondosa indicated that the reaction to stem rust was controlled by three complementary genes.

Aslam (1957), reported that three independent factors conditioned the segregation of resistant x resistant parents involving Kenya Farmer, Kenya 58 and Kenya 117A. The results from resistant x susceptible crosses were explained by postulating two or more genes for susceptibility.

Smith (1957), studied the inheritance of stem rust reaction in the cross Mindum (durum) x Vernal (emmer), using F_1, F_2 and F_3 data. He found that the resistance of Vernal was strongly dominant, and the stem rust reaction under natural conditions in this cross was inherited on a single factor difference.

Aslam and Ausemus (1958), found in crosses of Kenya Farmer with each of the varieties Marquis, Kentana, and

Lerma, that the mature plant reaction to a collection of races of stem rust in the field, appeared to be inherited on a relatively simple basis, with resistance dominant.

El-Khishen and Selim (1958), studied the genetic behaviour of mature plant resistance in wheat under Alexandria field conditions. In eight crosses between resistant x susceptible varieties, resistance was completely or partially dominant. F_2 results showed a simple monohybrid ratio of 3 resistant : 1 susceptible, indicating that reaction to stem rust was controlled by one pair of genes. Data obtained from the crosses including the resistant varieties gave a dihybrid ratio of 15 resistant : 1 susceptible, indicating that resistant genes were not identical in the two parents of each cross. In susceptible x susceptible crosses no resistant plants were obtained in the F_2, indicating that all susceptible varieties carried identical genes for susceptibility.

Ghosh et al. (1958), found that susceptibility to stem rust was dominant in the cross NP 790 (resistant) x NP 775 (susceptible). The F_2 segregation of 13 susceptible: 3 resistant indicated that some factors, presumably from NP 775, inhibited the resistance derived from NP 790.

Murty and Lakhani (1958), studied the two crosses, Triticum vulgare "NP 710" x Triticum durum "E 931" (Gaza) and Triticum vulgare "NP 718" x Gaza. They noticed from F_1 progenies that susceptibility of T. vulgare parents to stem rust was dominant. The F_2 segregation in the two crosses appeared to be under the control of duplicate factors.

Omar (1958), reported that field resistance to a collection of races of stem rust appeared to be governed by two complementary factors, (R and S). The factor (R) existed in three alleles R, R_1 and r, while the factor (S) existed in two alleles S, s. The RS combination was resistant, R_1 S was moderately resistant, Rs or rS were moderately susceptible and R_1 s or rs were susceptible.

El-Khishen and Khadr (1959), showed that susceptibility was dominant in crosses between resistant x susceptible varieties, and the F_2 segregated into a simple ratio of 3 susceptible : 1 resistant. While in the other crosses of the same group a dihybrid ratio was obtained of 13 resistant : 3 susceptible, indicating the presence of an inhibitor gene for susceptibility. Three different pairs of genes were suggested in some crosses of resistant varieties, while in other crosses of the same group two

pairs of genes were found. Data obtained from crosses including susceptible x susceptible varieties gave a ratio of 15 susceptible : 1 resistant, indicating two factors with duplicate effect for susceptibility.

Heerman (1960), reported that the adult reaction to race 15B of stem rust was controlled by at least four independent pairs of genes. Two dominant genes were derived from Khapli emmer and another two dominant genes from Stewart.

Fuad (1961), found that Kenya Farmer had two genes for resistance to race 15 B and three other genes for resistance to race 11 that were partially dominant and had a cumulative effect. In Frontana, he had found one gene conditioning moderate resistance to race 15 B and two genes conditioning moderate resistance to race 11.

Omar and Hassanein (1961), crossed the local variety Mokhtar with eleven introduced varieties. They studied the inheritance of field reaction to stem rust, in eleven crosses, in F_1 and F_2 generations under artificial epidemics of a collection of races of stem rust. The results suggested the presence of two different factors (R and S) controlling field resistance. Resistant