GENETIC STUDIES ON GEOGRAPHICAL DISTRIBUTION OF BARLEY VARIETIES WITH SPECIAL REFERENCE TO UZU OR SEMI-BRACHYTIC FORMS*

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The writer has previously shown that in Japan there are a large number of barley varieties which have in common a recessive gene for uzu or semi-brachytic growth. Their common characteristics are short and thick culms, compact heads with short, coarse awns and high resistance to lodging. Most interesting is the fact that the uzu barley is cultivated very widely in central and southern Japan with mild winters, occupying 80 per cent of the whole barley acreage in Japan and now it is also grown prevalently in southern coastal region of Korea. However, no variety of this kind can be found in the remaining parts of the world (Takahashi 1942, Takahashi and Yamamoto 1951).

Because of the practical importance and scientific interest of this fact, a series of investigations are being made in order to understand the reasons why such a mutant form has become prevalent only in southern Japan and Korea. The materials used consisted of 14 near-isogenic line pairs, each pair of which differ only in the *Uz* and *uz* alleles but are practically the same in the residual genetic constitution or genetic background. These had been developed from 14 plants heterozygous for the gene pairs among the F_6 or F_8 hybrid populations of a cross between Shanghai-3 and Kobinkatagi.

Results of the First Experiment

The first experiment was performed to determine the pleiotropic effects of the uzu gene relative to those of the normal allele on productive traits in an average genetic background, and further interaction of the normal and uzu alleles with different genetic backgrounds (see Takahashi et al., 1962).

Table 1 shows the general means of yield, 1,000 grain weight, number of heads per 50 cm row, and plant height of the 14 normal and uzu lines grown in the 4 replicated plots and also their differences. It is apparent in this table that the uzu type was always by far shorter in stem length than the normal one. Its yield and 1,000 grain weight were also slightly less than the normal, though not always significantly. As to the number of heads, however, no appreciable difference between normal and uzu was found. These results may be said to

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TABLE 1
General means of the four characters and differences

		Yield (g/plot)	1000 grain weight (g)	No. of heads (50 cm row)	Stem length (cm)
1959	Normal	934.4	18.92	126.1	112.1
	Uzu	895.6	17.61	124.5	94.1
	Difference	38.8	1.31**	1.6	18.0**
1960	Normal	962.7	20.66	151.8	114.4
	Uzu	901.8	20.38	150.3	92.9
	Difference	60.9**	0.28	1.5	21.5**

** Exceeds the 1% level of significance.

accord at large with the expected from the genetical knowledge about ordinary mutant genes.

It must be emphasized however that these might represent only the effects of the alleles in an average genetic background, if these 14 isogenic line pairs could be considered average, and that the differences in various characters between the normal and uzu paired lines are not the same. On the contrary, they are markedly different with isogenic pairs. As seen in Table 2, the variation among isogenics are statistically significant in most cases.

TABLE 2
Analysis of variance for the differences between normal and uzu paired lines in four characters indicated

Source of variation		Grain weight	1000 kernel wt.	Head number	Stem length
1959	Between isogenics	33580.67**	7.3531**	458.62**	82.694**
	Error	11275.20	2.4243	152.04	7.758
1960	Between isogenics	50255.77**	7.6318**	250.39	65.627**
	Error	5767.76	0.8272	191.15	5.945

** Exceeds the 1% level of significance.

Since near-isogenic paired lines are deemed to have practically the same genetic constitution, excepting the *Uzuz* alleles, it is justified to conclude that such a significant variation as to the normal-uzu difference has been resulted from the differential interaction of *Uzuz* alleles with different genetic backgrounds. That is to say, when present with the normal and uzu genes, some genetic backgrounds are more favorable, but some others less favorable for the normal gene than for the uzu gene. In any case, this suggests the possibility of establishing uzu forms superior to the previously existed normal types by the selection of genetic background favorable for uzu.

Results of the Second Experiment

In the second experiment fertilizer responses of the normal and uzu genes were compared, using six selected isogenic pairs. They were grown under three different fertilizer levels, namely, standard, one half and double quantities of three fertilizer elements applications.

In Fig. 1 are shown the yields of each of the normal and uzu lines and the differences in yield—uzu minus normal—as expressed in percentage of the yield of the respective normal line. In the left figure you will find that all the normal lines attain their maximum yield at the standard dressing, but that there is a decrease in yield by surplus dressing. On the other hand, the central figure indicates that, with two exceptions of Nos. 5 and 6, the yields of the uzu lines are greater at the standard and especially heavy dressing than at the light dressing. The right hand figure may indicate more clearly that the uzu is more efficient than the normal as the fertilizer level becomes higher. It may be noted herewith that the two exceptional lines, 5 and 6, had suffered from a marked drop of seed fertility at the standard and double quantities of fertilizer applications, which might have caused their low yields as compared with the contrasting normal lines.

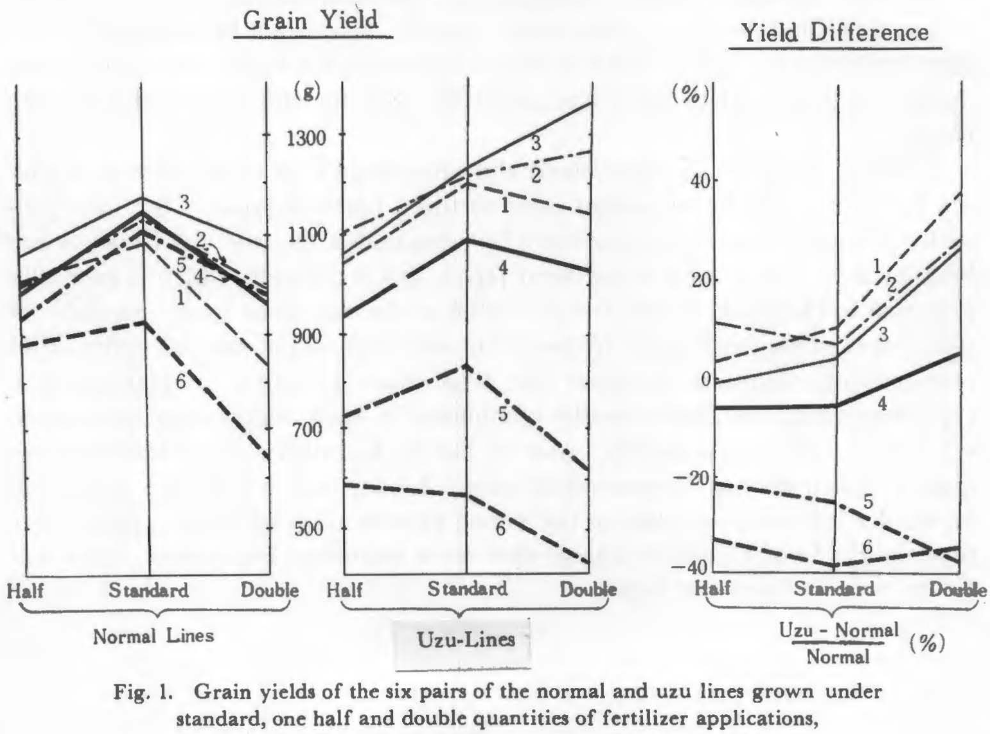

Fig. 1. Grain yields of the six pairs of the normal and uzu lines grown under standard, one half and double quantities of fertilizer applications, and the difference in yield (uzu − normal) as expressed in percentage of the yield of the respective normal line.

It may be possible to conclude from these that the uzu type fit well for an extremely higher soil fertility, while the normal type is more adaptive to rather lower fertility environments than the uzu type.

Consideration of the Geographical Distribution of Uzu Barley

Let us consider first how uzu barley originated and spread widely in the central and southern Japan. It is plausible to suppose that the uzu barley has arisen spontaneously by mutation from the normal type barley and happened to be picked up and isolated by some careful, fore-sighted farmer. Unless it was isolated, the mutant would have been eliminated sooner or later, because of its inferior competitive ability to the normal as was exemplified by our recent competition experiment with isogenic lines (Takahashi, Hayashi and Moriya, unpublished). It may also be certain that, in the remote past when light dressing of fertilizers was practised, the uzu barley was still relatively too low in yield to supercede the existing normal varieties, in spite of its advantageous characters, such as short awn, plump grain, dwarf growth and especially high tolerance to lodging, which are especially preferred by the Japanese farmers. Its wide-spread use has been fostered by the success in breeding new higher yielding varieties of this type one after another and also active recommendation of these varieties by governmental and local agricultural agents. It can not be neglected at the same time that a definite trend to heavy manuring for barley and other crops during these several decades has paved the way for the success of uzu type barley.

We do not know so much about the physiological or genetical reason why the uzu barley has never spread over northern parts of Japan. But, it is generally believed from their experience by agronomists that the uzu barley is less tolerable to severe winters of northern Japan. Spring sowing, which is generally practised in Hokkaido, seems less favorable to the uzu than to the normal. A study on the changes in gene frequency in some hybrid populations under different growing conditions disclosed that, when sown in spring in Hokkaido, uzu type segregants had been mostly eliminated in each segregating generation, whereas the same populations, sown in fall in Kurashiki, maintained the frequency of uzu gene at its theoretical level. In this case, a handicap may be in its smaller leaf-area per plant at the young growth stage of the uzu plant. So, these might be the possible agents that have delimited the spread of the uzu barley over the northern Japan.