GENETIC ANALYSIS OF VARIETAL DIFFERENTIATION IN CEREALS*

IV. POLYGENIC DIFFERENCES IN AGRONOMIC CHARACTERS BETWEEN LOCAL STRAINS OF A BARLEY VARIETY, "HAKATA NO. 2"

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A highly-bred variety of autogamous plants released from breeders with a high level of homozygosity may maintain its characteristics generation after generation, although the range of its distribution is increasing from year to year. Kanda et al. (1952) observed that it was difficult to distinguish statistically two ecological types of the rice variety "Rikuu No. 132", which were grown under markedly different local conditions during more than 10 years. According to Simpson and Duncan (1953), no important genetic changes occurred in 5 cotton varieties (partially cross-pollinated plant) during 5 generations of seed multiplication, and they concluded that well-bred varieties of cotton will maintain their botanical purity during a considerable long period of multiplication. Polygenic segregation during the period of multiplication may be of minor importance from the practical view point. However, how natural selection affects the polygenic characters of cultivated varieties may be of interest in connection with population genetics. In order to obtain some information on this point and to throw some light on the effect of natural selection upon a cross-bred variety, five local strains of such a variety of beer barley were examined in a comparative experiment.

Materials and Methods

"Hakata No. 2" is an old 2-rowed variety of beer barley, which was released from the Breeding Station of Hakata Manufactory of Nihon Brewery Ltd. in 1925. It is a selection from a cross between Australian Chevallier $\times$ Goldthorpe.

5 seed samples of this variety were examined. Letters *A*, *B*, *C*, *D* and *E* stand for the names of the seed samples.

A Obtained from Hokkaido Nat. Agr. Exp. Sta., Sapporo, Hokkaido.

B From Hokuriku Nat. Agr. Exp. Sta., Takata, Niigata Prefecture.

C From Kantô-Tôzan Nat. Agr. Exp. Sta., Kônosu, Saitama Prefecture.

D From Tôkai-Kinki Nat. Agr. Exp. Sta., Tsu, Mie Prefecture.

E From Kyûshû Nat. Agr. Exp. Sta., Tikugo, Fukuoka Prefecture.

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B strain has been kept until 1950 at the Suita Manufactory of Kirin Brewery Ltd. thereupon it was sent to Hokuriku Nat. Agr. Exp. Sta.. Therefore, the period of multiplication of this strain at Takata was short. However, the other strains were grown in each location during a period of more than 12 years.

A comparative study of these strains was conducted in 1953 and 1954 on the experimental fields of the Nat. Inst. Genet., Misima. The plants were grown 10 cm apart in rows spaced 50 cm apart in a randomized block arrangement with 5 replications. 15 plants were selected at random from each plot, and culm length, ear length, number of spikelets on one side and number of ears per plant were determined on individual basis, and grain yield and weight of 1000 grains on plot basis.

Experimental results

Upon visual inspection, the botanical features of all five strains were similar. Differences found among them were of statistical nature. In Table 1, the average means of 2 years for three characters are represented. The differences in these characters between the strains were very slight and statistically non-significant.

Table 1 Comparison between the local strains
A~E (average of two years)

Strains	Grain yield per plant (g)	Number of ears per plant	Date of heading*
<i>A</i>	15.4	15.2	April 20.9
<i>B</i>	14.6	16.5	21.2
<i>C</i>	13.3	16.2	21.2
<i>D</i>	16.0	17.2	20.5
<i>E</i>	14.6	15.5	20.7

* Observed on plot basis.

Table 2 shows the means of 4 characters, namely, culm length, ear length, number of spikelets on one side of ear and weight of 1000 grains. The results of variance analysis are represented in Table 3. The differences in these characters between the local strains were statistically signifi-

Table 2 Results of comparative experiments with the local strains *A~E* in 1953 and in 1954

Strains	Culm length (cm)		Ear length (cm)		Number of spikelets		Weight of 1000 grains (g)	
	1953	1954	1953	1954	1953	1954	1953	1954
<i>A</i>	101.8	77.2	7.69	7.40	15.8	14.9	42.2	43.1
<i>B</i>	103.0	81.8	7.98	7.73	16.3	15.6	40.4	44.6
<i>C</i>	100.6	79.6	7.94	7.82	16.1	15.6	41.9	45.2
<i>D</i>	105.2	78.4	8.30	8.21	16.6	15.8	45.0	46.4
<i>E</i>	104.6	82.0	8.20	7.93	16.7	15.8	42.1	44.9

cant at the 1 and .5 per cent level, and variances due to years were highly significant. As seen from Table 2, the ears were shorter and the number of spikelets was smaller in *A*, *B* and *C* than in *D* and *E*. The former 3 strains were obtained from northern locations and the latter 2 from the southern ones. In general, one could find in both characters a clinal variation among the strains. The differences between *D* and *E* in ear length may be explained as due to the short period of its multiplication at the

Table 3 Analysis of variance

Factors	d. f.	m. s.			
		Culm length	Ear length	Number of spikelets	Weight of 1000 grains
Year (Y)	1	6751**	0.5121**	7.22**	79.38**
Strains (S)	4	25*	0.7034**	1.36**	15.70**
Blocks (B)	4	23*	0.0669*	0.29	8.81**
Y × S	4	15	0.0194	0.0025	4.89*
Y × B	4	17	0.0582*	0.20	11.52**
S × B	16	9	0.0331	0.14	1.97
Y × S × B	16	6.3	0.0191	0.13	1.60

* Exceeds the 5% level.

** Exceeds the 1% level.

northern location, as previously mentioned. In Table 4, the frequency distribution of ear length is represented for 1953.

Table 4 Frequency distribution of ear length in 1953

Strains	6.5	6.9	7.3	7.7	8.1	8.5	8.9	9.3	9.7	Total
A	—	10	23	19	19	3	1	—	—	75
B	1	5	8	15	23	16	6	1	—	"
C	—	2	14	20	18	18	3	—	—	"
D	1	1	5	8	16	26	12	5	1	"
E	—	1	6	14	24	21	6	—	3	"

The differences between the strains in the examined characters were generally small. In order to find out if such differences are governed by polygenes, it would be necessary to analyze the hybrid populations between the strains having long and short ears and so forth. But in cases, where the interactions between years and strains were non-significant, the explanation of differences between local strains by polygenes seems to be plausible.

Discussion

In cross-bred varieties even of autogamous plants more or less segregations regarding quantitative and undetectable characters take place after releasing. If there are differences between segregants in their reproductive ability in respect to the local conditions where the varieties are grown, there will occur a varietal differentiation during the period of multiplication, as also pointed out by Nijdam (1954).

The effect and role of natural selection upon cultivated plants have been explored by many workers. In wild and cultivated strains of *Trifolium repens*, Daday (1954, a, b, c) found a gene frequency cline which was associated with the isotherm of January.

According to the results of my experiments, statistical differences were found between local strains in several agronomic characters; it is assumed that these dif-

ferences may be due to polygenes.

Hagberg et al. (1952) found that number of loci and polygenes governing ear density exceeds by our speculation. Such a situation probably exists also in respect to other ear characters, i. e. ear length and number of spikelets, which were dealt with in my experiments. Although the number of strains examined was too small to make this hypothesis valid, a clinal variation in ear length and number of spikelets was noticeable. The results of comparative experiments indicate that the original population of "Hakata No. 2" might have been heterozygous regarding ear characters and after releasing polygenic segregations has taken place. It is assumed that the variation found in those characters was due to natural selection through influence of different local conditions.

Summary

5 seed samples of 2-rowed beer barley "Hakata No. 2" were obtained from widely separated locations, ranging from Hokkaido to Kyûshû, and compared with each other in a randomized block arrangement with 5 replications during two years.

The differences found among them were of statistical nature, and upon visual inspection, they were undiscernible. Differences between local strains in grain yield, number of ears per plant and date of heading were non-significant, whereas those in culm length, ear length, number of spikelets and weight of 1000 grains were significant.

It is assumed that these differences may be governed by polygenes. As seen from Table 2 and 4, a clinal variation was found in ear length and number of spikelets. These variations were explained as being the result of polygenic segregations under the pressure of natural selection according to the local conditions.

Literature cited

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