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SELECTION STUDIES FOR GRAIN YIELD IN CERTAIN MUTANT POPULATIONS OF BARLEY

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SUMMARY

An applied micromutation study in barley was planned to increase the yielding capacity without changing drastically other agronomic traits of the "Kaya" variety. In accord with this aim, base populations of the variety irradiated with gamma rays were built up by selecting normal-appearing single plants randomly in the M_2 generation grown at 2 locations in 1985-1986. The control populations were also constructed by applying the same procedure. Mass selection for plant yield was applied to the base populations and selected individuals were tested as M_3 during the 1986-1987. The population means, ranges and the heritabilities were estimated. Mutant populations were compared with their controls and then a second step selection for grain yield was applied in the all M_3 populations and the expected genetic gains were calculated.

The results obtained have shown that mutant populations, particularly those from 15 krad, expressed higher means, ranges, and variation for the plant yield than those of the control populations. Selection differentials for mutant populations were also higher than those of the control and they were in agreement with the actual population means of the M_3 generation. After the second step selection for grain yield in M_3, the expected populations means of the M_4 generation obtained by adding the genetic gains to the means of the M_3 generation were considerably higher as compared to the expected means of the control populations.

It was finally concluded that induced variation in the mutant populations could be effectively utilized by selection.

INTRODUCTION

Mutation breeding has been successfully applied in self-and cross-pollinating crops. The number of mutant varieties were only 50 in 1964 but this number has exceeded to 1200 in 25 years (Anonymous, 1989). As a result of the intense basic research conducted at the beginning, today the more effective mutagens and the treatment methods are known Unfortunately, there is still no possibility

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of using a mutagen in a specific way. Therefore the selection has the most important task in detecting the desired mutations(Anonymous, 1984). Besides, there is still need in devoloping the selection procedures for the evaluation of the variation as well as in analysing the characteristics and the amount of the variation found in the mutant populations. The further studies to be undertaken in this area will cause the mutation breeding to be more effective which was indicated as a practical method after the 1960's (Anonymous, 1977).

The purposes of this study were to determine the micro-mutational variation in the gamma irradiated "Kaya" variety and also to utilize this variation through the selection.

MATERIALS AND METHODS

The seeds of a homozygous two-rowed barley variety "Kaya" (**Hordeum distichum** L.) were irradiated with 15 and 30 krad gamma rays from the 60 Co source in Ankara, in 1984.

The irradiated seeds and untreated seeds as control were sown in order to obtain the M_1 plants. All plots were separately harvested in bulk and they were grown under the two different locations (Bornova and Tokat) as the M_2 generation during 1985-1986. The base populations of each dose were built up by selecting rendomly the normal-looking single plants at the harvest.The number of the sampled plants were 100 at Bornova and 200 at Tokat. The controls were also built up by applying the same procedure.

Following the determination of the yields of the single plants in these populations, the simple statistics such as mean, range and coefficient of variation were calculated and the frequency distributions were drawn. The 25 % highest yielding plants were selected in each population. The progenies of the selected plants were grown in the progeny rows arranged in the Randomized Complete Blocks with 2 replications at Tokat in the Spring, 1987 as M_3. Each population was kept in a separate experiment. The plots were in 1 m length and 30 cm aparts. Twenty seeds were planted in each plot.

At the harvest 2 plants at two sides of each plot were discarded and the remaining plants were harvested. The plot yields were recorded, then the single plant yields were calculated. The data obtained were analysed by using the procedures of Randomised Complete Blocks Design (Stell and Torrie, 1960) and broad-sense heritabilities based on variance components (Gordon et al., 1972) were estimated.

Following the estimation of the parameters given above in order to start a second stage of selection, a 20 % of selection pressure for plot yield was applied in each population. The genetic advance was estimated as proposed by Allard (1960). Expected population means for M_4 were obtained by adding these estimates to M_3 means and also the expected gains were predicted as percent over the M_3 means.

RESULTS

First Stage Selection

The mean, range and the coefficient of the variation for single plant yield in the base (M_2) populations were given in Table 1. It can be seen in Table 1 that the mutant populations, except the 30 krad Tokat population, had the higher mean and the C.V. than their control populations. The ranges of the mutant populations were wider than those of the controls. At two locations the 15 krad populations had the highest variation for single plant yield.

The results of the selection applied for single plant yield in the base population (M_2) are shown in Table 2.

The means of the groups selected by applying the 25 % selection pressure have considerably increased. For instance the means of the 15 krad Tokat and Bornova populations were increased from 11.61 g and 12.43 g to 23.39 g and 22.42 g respectively. So the selectiion differentials were the highest such 11.78 g and 9.99 g for two selected groups.

The mean, range, F-raito and the heritability values pertinent to plot yield in the groneny (M_3) generation of the selected single plants are given in Table 3.

Table 1. Mean, range and coefficient of variation for single plant yield (g) in the base (M_2) populations.

Population	No.of plants	Mean	Range	C.V.(%)
Control. Tokat	200	9.64 ± 0.41	2.15 - 32.57	59.44
15 krad. Tokat	250	11.64 ± 0.48	1.30 - 49.49	64.86
30 krad. Tokat	200	9.07 ± 0.37	1.02 - 28.28	56.89
Control. Bornova	100	9.88 ± 0.42	2.77 - 29.01	44.02
15 krad. Bornova	100	12.43 ± 0.76	1.28 - 47.14	60.74
30 krad. Bornova	100	14.43 ± 0.65	0.70 - 42.85	54.39

Table 2. The mean, selected proportion, selection differential and phenotypic standart deviation for single plant yield (g) in the base (M_2) population.

Population	Base	Selected	Proportion (P)	Selection differential	Phenotypic St. deviat.
Control. Tokat	9.64	17.50	0.25	7.86	5.73
15 krad. Tokat	11.61	23.39	0.20	11.78	7.53
30 krad. Tokat	9.07	16.09	0.25	7.02	5.16
Control. Bornova	9.88	15.53	0.26	5.65	4.25
15 krad. Bornova	12.43	22.42	0.25	9.99	7.55
30 krad. Bornova	14.43	22.82	0.25	8.38	6.55

The progeny populations, excluding the 30 krad Tokat population, had higher mean than the control. However there were maximum valued individuals exceeding the maximum valued individuals of the controls in general. The F-ratios indicated that the 15 and 30 krad populations from Bornova had significant variation ($P < 0{,}01$). The estimated heritabilities were 0.66 and 0.49 for these two populations.

The single plants yields in M_3 were calculated by dividing the plot yields to the number of plants in each plot in order to obtain the realized genetic gains for single plant yield are Shown in Table 4.

Table 3. The mean, range, F-ratio and broad-sense heritability values pertinent to plot yield (g) in the progeny (M_3) generations of the selected single plants.

Population	No. of progenies	Mean	Range	F-ratio	Heritability
Control. Tokat	50	131.6±18.1	81.0-166.5	NS	0.01
15 krad. Tokat	50	137.2±16.4	100.5-178.5	NS	0.09
30 krad. Tokat	50	120.9±19.7	80.5-182.5	NS	0.12
Control. Bornova	25	102.0±11.8	77.0-130.5	NS	0.25
15 krad. Bornova	25	126.2±16.8	46.0-188.0	XX	0.66
30 krad. Bornova	25	107.0±11.3	40.5-136.5	XX	0.49

XX : Significant at the 0.01 level

Table 4. Selection differentials, means of M_3 and M_2 generations and realized genetic gains after selection for single plant yield (g) in the base (M_2) populations*

Population	Selection differential	Mean		Realized genetic gain
		M_3	M_2	
Control. Tokat	7.86 (2)	8.20 (2)	9.64 (2)	- 1.44
15 krad. Tokat	11.78 (1)	8.40 (1)	11.61 (1)	- 3.21
30 krad. Tokat	7.02 (3)	7.60 (3)	9.07 (3)	- 1.47
Control. Bornova	5.65 (3)	6.40 (3)	9.88 (3)	- 3.48
15 krad. Bornova	9.99 (1)	10.50 (1)	12.43 (2)	- 1.93
30 krad. Bornova	8.39 (2)	6.80 (2)	14.43 (1)	- 7.63

*The values in brackets show the order in each site.

It can be seen from Table 4 that the genetic gains were negative in all populations. Besides, populations with large selection differential gave the higher progeny means at two locations.

Second Stage Selection

The results of the selection applied with a p=0.20 selection pressure for plot yield in the progeny (M_3) populations are shown in Table 5.

Table 5. Selection differential, expected genetic gain, expected mean in M_4 and percent of gain after selection for plot yield in progeny (M_3) populations.

Population	Selection differential	Expected genetic gain	Mean (M_3)	Expected mean in M_4	Gain (%)
Control. Tokat	24.9	0.36	131.6	132.0	0.3
15 krad. Tokat	26.0	3.07	137.2	140.3	2.5
30 krad. Tokat	29.6	5.01	120.9	125.9	4.1
Control. Bornova	21.7	6.72	102.0	108.7	6.6
15 krad. Bornova	44.5	37.47	126.2	160.7	27.3
30 krad. Bornova	19.6	15.38	107.9	123.3	14.3

It could be seen from Table 5 that the 15 and 30 krad Tokat and the 15 krad Bornova populations had the higher selection differentials than those of the controls. The genetic gains expected were higher in all mutant populations as compared to controls. The highest value was 37.47 g for 15 krad Bornova population.

The expected progeny (M_4) means were 160.7 g and 140.3 g for 15 krad Bornova and 15 krad Tokat populations respectively. The highest gain expected over the M_3 was 27.3 % for the 15 krad Bornova population.

DISCUSSION

The amount of variation for grain yield following the mutagenic treatment is a very important base for the usage of micromutation technique in the breeding. Although this trait has a low heritability, the breeding studies aiming high yield have consentrated on the grain yield (Gaul, 1964-1965-1966; Gaul et al., 1969; Yıldırım et al., 1987). The aim of a breeding program is always to increase the mean when the yield is directly considered. Therefore the right side of the normal distribution has been important and only those individuals or families which will give genotypes having extreme values than the mother variety could be interesting (Aastveit, 1977).

Some workers have reported that the means of the populations treated with mutagens had a tendency of decreasing or they stayed unchanged as parallel to variation type. The decreases in the means were explained by the high frequencies of the harmfull mutations as compared to the profitable ones (Aastveit, 1968; Bhatia and Swaminathan, 1962; Borojevic, 1965-1966; Brock, 1965; Gaul, 1964-1965; Scossiroli, 1965-1966-1967; Yıldırım, 1980; Yıldırım et al., 1987). Scossiroli (1966) has indicated that if a selection for high fertility was applied in the irradiated populations the mean should not be dropped. In this study, since the base populations were constructed following a strong single plant selection for the macro mutant types in the mutant populations, the means have not decreased but the variation have increased especially in the 15 krad populations. The selection differentials obtained as a result of the single plant selection in these populations were considerably higher than those of controls so high means for single plant yields should be expected in the progenies. However the selection differential calculated in the base population could not be an estimate of the genetic advance. The genetic gain or advance is a function of phenotypic standard deviation, selection intensity and the heritability value. Here the genetic gain could not be estimated due to absence of a heritability estimate.

The realized genetic gains were found to be negative. The aim of the selection is to increase the population mean in order to obtain a genetic gain. Since the progeny means of the selected plants were behind the means of the base populations, the negative genetic gains have resulted in. This implied that the selection applied for single plant yield was unsuccessful. On the other hand the positive relationships between the high selection differantials and the high progeny means in the resulting populations could be interpreted as the transfer of the potential to the progenies. In other words, selection could be successful in the determination high yielding plants. Infact, when the mutation technique has applied the actual mean increase realized over the control in the progeny could be considered as gain (Gaul, 1966; Gaul et al., 1969; Gustafsson et al., 1968; Hansel et al., 1972). Such a gain could only be realized as the result of the micro-mutations affecting the yield positively, in case of homozygous parent materials. The high occurences of poligenic mutations as compared to the macro mutations following the treatments with mutagens have been reported and their suitability to breeding aims have also been proposed (Borojevic, 1965; Gaul, 1964-1965; Gill et al., 1974; Hansel et al., 1972; Scossiroli, 1965). In this study the best selected individuals appeared to be in the 15 krad populations at two location. The inferior progeny mean observed in the 30 krad Tokat population could be explained by the negative effect of the micro mutations due to the high dosage. These results were also supported by the estimates of the second stage selection for plot yield in M_3.

Considering the selection procedure employed in the study and the magnitude of the changes obtained it can be postulated that improved selections resulted from micromutations. Hadjichristodolou et al. (1984) reached the same conclusion. One difficulty in working with micromutations is that environmental variation masks small differences in grain yield or other quantitative characters, so biometrical anaysis is necessary to detect the genetic changes as also emphasized by Gaul (1965). However micromutans might have better chance of direct use than macro mutants.

ÖZET

ARPA MUTANT POPULASYONLARINDA DANE VERİMİ İÇİN SELEKSİYON ÇALIŞMALARI

Mikromutasyon yöntemi uyarınca Kaya arpa çeşidinin verim kapasitesini arttırmayı amaçlayan bu çalışma 1985-1987 yılları arasında Bornova ve Tokat'ta yürütülmüştür. Gama ışınlarının 15 ve 30 krad dozları uygulanarak elde edilen M_2 mutant populasyonlarında, makro mutant tipler sıkı bir şekilde seçildikten sonra, her iki yörede tarlalarda kalan normal görünüşlü bitkiler arasından tesadüfi örnekleme ile başlangıç populasyonları oluşturulmuştur. Daha sonra bu populasyonlardan % 25 oranında yüksek verimli bitkiler seçilmiştir. Seçilen bitkiler iki tekerrürlü tesadüf blokları deneme deseninde M_3 generasyonu olarak sonraki yıl döl testine alınmışlardır. Her populasyon ayrı denemeye yerleştirilmiş, dane verimi için populasyon ortalaması, değişim aralığı ve kalıtım derecesi tahminleri elde edilmiştir. Mutant populasyonlar ile kontrolları arasındaki karşılaştırmalar bu istatistikler kullanılarak yapılmıştır. Bu değerlendirmelerden sonra tüm M_3 populasyonlarında dane verimi için ikinci bir seleksiyon uygulanmış ve beklenen genetik kazanç ve M_4 döl ortalamaları tahminlenmiştir. Elde edilen sonuçlar, özellikle 15 krad dozundan gelen mutant populasyonların tek bitki verimi bakımından kontroldan daha yüksek ortalama, değişim aralığı ve varyasyon katsayısına sahip olduğunu göstermiştir. Ayrıca tahmin edilen seleksiyon diferensiyalleri ile döl (M_3) ortalamaları arasında sıkı bir uyum bulunmuştur. Parsel verimi için yapılan seleksiyondan sonra mutant populasyonlarda yüksek genetik kazançlar tahmin edilmiştir. Genetik kazançları M_3 ortalamalarına ekleyerek hesaplanan beklenen M_4 ortalamaları özellikle 15 krad

populasyonlarında belirgin olarak yüksek olmuştur. Elde edilen sonuçlar, Kaya mutant populasyonlarında dane verimi için kalıtsal varyasyon bulunduğunu ve bu varyasyondan seleksiyon yoluyla yararlanmanın mümkün olduğunu göstermiştir.

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