EFFECTS OF INBREEDING ON SOME AGRONOMICAL CHARACTERISTICS OF ORCHARDGRASS (*Dactylis glomerata* L.)

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ABSTRACT

This research was carried out on the effects of inbreeding on some agronomic characteristics of orchardgrass in greenhouse in 1996 and 1997. Selfed and outcrossed progenies of four populations of wild orchardgrass were used. Selfing caused decrease in all characters except for crude protein percentage and root weight. The highest inbreeding depression was determined in seed yield and it reduced to 35.97% with selfing. Consequently, the plant number in a population should not be reduced in a selection programme where selfing is not desirable.

INTRODUCTION

Breeding methods for crops varies according to species and its kind of reproduction. *Dactylis glomerata* L. is an allogamous plant (Stebbins, 1950; Sağsöz et al., 1996). Breeding methods such as selection (it may be combined with inbreeding), hybridization and synthetic variety are used to develop a new variety. In some phases of these methods, selfing may be done. The utilization of selfing allows; (**1**) a sufficient homogeneity of the physiological traits such as capacity of reserve recovery, time of regrowth, velocity of growth, time of earing, (**2**) conserving such homogeneity in the subsequent generations of the new cultivars, (**3**) the increasing of efficiency of selection for the additive characteristics by unmasking of the genes and the gene combinations favorable to the vigor in the autotetraploid cocksfoot (Rotili and scotty, 1989; Rotili et al., 1987).

As the hybridization was done among the inbred lines an allogamous plant, heterosis might generate more superior progenies than their parents could be created. On the other hand, selfing in allogamous plants cause depression and undesiriable characters arise. This effect varies from species to species and even, in the same species from genotype to genotype (Demir, 1975; Olivieri and Ziliotto, 1984; Tosun and Sağsöz, 1994).

Krokhin and Federenko (1982) observed that a single selfing affected only the number of caryopsis but not the weight of roots and seedlings. Olivieri and Ziliotto (1984) detected that forage yield per plant were lower in selfs than that of diallel and polycross progenies. Santen and Casler (1987) used 53 tetraploid and 38 diploid S_1 progenies of orchardgrass and established that there were no differences between the S_1 progenies and their parents in terms of quality, whereas, Kalton et al. (1952) found that there was lesser inbreeding depression for leafiness, which may be considered a predictor of forage quality, than for vigor and yield.

The objective of this study was to determine the effect of inbreeding on some agronomic characteristics of wild orchardgrass.

MATERIALS AND METHODS

In this study seeds of four populations of selfed and outcrossed wild orchardgrass provided by Sağsöz et al (1996) were used. The 15 plants from each ecotype and 5 panicle from each plant were bagged before anthesis and the other panicles of same plants were left to outcross.

Ten selfed and 10 outcrossed progenies from each ecotype (4 ecotypes x 20 progenies = 80 plants) were used. The research was conducted in greenhouse in 1996 and 1997. Seeds were sown into wooden box and seedlings with two tillers were transplanted into the pots containing a mixture of soil: farm manure: sand (1:1:1).

Hay yield, crude protein percentage, number of tillers, plant height, seed yield and root weight were measured. Dry root weight per plant was determined in root by drying at 78°C. Five of ten plants were used to determine the vegetative characters (hay yield, crude protein percentage, number of tiller and root weight), the rest of plants were used to measure plant height and seed yield. To determine the forage yield, plants were cut when they were 40 cm height. Three cuttings were made in each year and the related data was calculated from the average of three cuttings.

RESULTS AND DISCUSSION

Hay Yield: The differences between applications and among genotypes were significant for hay yield. The average hay yield of outcrossed and selfed progenies were 17.89 and 14.23 g/plant respectively. The highest hay yield (18.13 g/plant), was determined in the population of Oltu, whereas the population of Uzundere had the lowest hay yield (14.36 g/plant). Hay yield of inbred was 79.73% of that of outcrossed progenies. This data showed that selfing decreased hay yield 21.27 % (Table 1).

The results obtained in this study agree with results reported by Rotili and Scotti (1989). They detected that an increase of selfing in orchardgrass (*Dactylis glomerata* L.) caused decreasing of dry matter yield and increasing the variability among families. Likewise, Olivieri and Ziliotto (1984) reported that yield of selfs in orchardgrass was lower than that of crosses, and the depressive effects of progenies coming from self fertilization were specific for each parental genotypes. They noted that the situation of both self- and out crossing, that appears rather common in polyploid species, is an agreement with the ruderal behavior of orchardgrass that is able to colonize even in small populations.

Table 1. Averages of yield (g/plant), crude protein (%) and their relative values (%) obtained from the selfed and the outcrossed progenies of four ecotypes in two years.

	Hay Yield (g/plant)				Crude Protein Percentage (%)			
Ecotype	Outcros.	Selfed	Mean	Rel.Val[1/]	Outcros.	Selfed	Mean	Rel.Val[1/]
Oltu	20.01	16.25	18.13 **a**	81.20	13.21 **a**	12.23 **bc**	12.72	92.58
Ulubağ	18.00	13.71	15.86 **ab**	76.17	12.25 **bc**	12.49 **abc**	12.37	101.96
Uzundere	16.45	12.26	14.36 **b**	75.43	11.85 **c**	12.89 **ab**	12.37	100.31
Olur	17.08	14.71	15.90 **ab**	86.12	13.25 **a**	12.57 **abc**	12.91	94.87
Mean	17.89 **A**	14.23 **B**	16.06	79.73	12.64	12.55	12.59	97.43
F Value[2/]	A=29.83**, B=5.41*, AxB=0.44				A=0.25, B=2.00, AxB=5.86*			

[1/]That of outcrossed progenies was accepted as100.

[2/] A= Pollination, B= Ecotype; * and ** indicate significance at %5 and %1 level, respectively.

Yield is a complex trait probably conditioned by many loci with multiple alleles (Busbice and Wilsie, 1966; Ayacock and Wilsie,1968). Decreasing of vigor and yield with

inbreeding is primarily attributed to the loss of heterozygosity. Busbice and Wilsie (1966) reported that a high frequency of loci in alfalfa contains three or four different alleles and that the rapid loss of vigor with the inbreeding was due to a rapid loss of heterozygosity.

Crude Protein Percentage: The average crude protein percentages are shown in Table 1. There were no significant differences between the outcrosses and selfs and among the genotypes, whereas, the interaction of reproduction x genotype was significant. Crude protein percentage of the outcrossed and selfed progenies were 12.64% (11.85-13.25%) and 12.55% (12.33-12.89%) respectively.

The crude protein percentage of S_1 progenies was nearly same that of outcrossed progenies (relative value 99.29%). Santen and Casler (1987) studied the 38 tetraploid and the 53 diploid S_1 progenies of *Dactylis glomerata* L. and noted that there were no detectable average inbreeding effects for the traits related to forage quality. Kalton et al. (1952) found that there was less inbreeding depression for leafness, which may be considered a predictor of forage quality, than for vigor and yield. Rice and Dudley (1974) did not find any difference for oil percentage, which is the quality character, in the S_1 and the S_2 generations of autotetraploid maize (*Zea mays* L.).

The Number of Tiller: The number of tiller in the selfed plants (49.08) was lower than that of outcrossed (71.18). Whereas, differences among populations were not significant. The relative value for average tiller number in the S_1 progenies was 69.02% (Table 2).

It was noted that vegetative vigor in the S_1 generation of alfalfa decreased to 20-30% (Wilsie, 1958). The decreasing of the tiller number which is the component of forage yield can be related to decreasing of heterozygosity.

Table 2. Averages of the number of tiller and plant height (cm) and their relative values (%) obtained from the selfed and the outcrossed progenies of four ecotypes in two years.

	The Number of Tillers				Plant Height (cm)			
Ecotype	Outcros.	Selfed	Mean	Rel.Val.[1]	Outcros.	Selfed	Mean	Rel.Val.[1]
Oltu	72.9	48.4	60.65	66.39	106.2	81.4	93.8	76.65
Ulubağ	66.8	47.6	57.20	71.26	94.2	80.8	87.5	85.77
Uzundere	73.2	48.2	60.70	65.85	94.1	82.1	88.1	87.15
Olur	71.8	52.1	61.95	72.56	94.7	73.1	83.9	77.19
Mean	71.18 **A**	49.08 **B**	60.13	69.02	97.30 **A**	79.35 **B**	88.33	81.69
F Value[2]	A= 59.69**, B=0.51, AxB=0.29				A=30.25**, B=1.57, AxB=0.91			

[1] That of outcrossed progenies was accepted as100.

[2] A= Pollination, B= Ecotype; ** indicate significance at %1 level.

Plant Height: Plant height was measured in generative plants and the data related to this character are presented in Table 2. Plant height in the outcrossed (97.30 cm) and the S_1 progenies (79.35 cm) varied significantly. According to these results, selfing decreased the plant height 18.31 %. Although the group of Oltu had the highest plant height, the most reduction in height with inbreeding was in this ecotype.

Similar results were observed in different crops. Ayacock and Wilsie (1968) found that plant height was reduced due to selfing in alfalfa. Townsend and Remmenga (1968) reported that plant height in selfed *Trifolium hybridum* was less than that in their parents. They used control progeny as a reference, and found that there were 16, 33, 30 and 46% reductions in plant height for the S_1, S_2, S_3 and the S_4 generations respectively.

In this study, the reduction rate of plant height with inbreeding, was less than that of hay yield. Since plant height is the only component that contributes to total forage yield its complexity may be less, that is, fewer loci and/or multiple alleles may be involved in the inheritance of this trait, and with fewer interactions to lose during inbreeding, so the reduction in height is less (Ayacock and Wilsie, 1968).

Seed Yield: The differences between reproduction and among the populations for seed yield were significant. The average seed yield (3.72 g/plant) of two years in inbred progenies was 64.22% that of outcrossed progenies (5.81 g/plant). The highest effect of inbreeding among characters examined was seen in seed yield. The highest seed yield was obtained in the group of Ulubağ (5.32 g/plant), but only the difference between Ulubağ and Olur populations was significant (Table 3).

Krokhin and Fedorenko (1982) determined that seed set was lower in the inbreeding progenies than that of the outcrossed ones in *Festuca pratensis*, *F. rubra* and *Dactylis glomerata*. Seed yield is a complex character determined by yield components. Reduction in seed yield with selfing might be resulted from decreasing tiller number, meiotic abnormalities and the loss of heterozygosity. Myers and Hill (1943) studied the chromosomal association and behavior during meiosis in the first generation progenies of orchardgrass. They noted that the average percentage of metaphase I sporocytes with univalent of the inbred progenies were from two or three times as great as for their respective parents in all families.

Table 3. Averages of seed yield (g/plant), root weight (g/plant) and their relative values (%) obtained from the selfed and the outcrossed progenies of four ecotypes in two years.

	Seed yield (g/plant)				Root Weight (g/plant)			
Ecotype	Outcros.	Selfed	Mean	Rel.Val.[1/]	Outcros.	Selfed	Mean	Rel.Val.[1/]
Oltu	6.28	3.84	5.06 **ab**	61.05	83.89	72.69	78.29 **a**	86.65
Ulubağ	6.43	4.21	5.32 **a**	65.47	47.09	44.97	46.03 **b**	95.50
Uzundere	5.95	3.76	4.85 **ab**	63.19	39.08	38.12	38.60 **b**	97.54
Olur	4.57	3.07	3.82 **b**	67.18	67.72	65.64	66.68 **ab**	96.93
Mean	5.81 **A**	3.72 **B**	4.77	64.22	59.45	55.35	57.40	94.16
F Value[2/]	A= 43.62**, B=7.67**, AxB=1.52				A=0.31, B=6.11**, AxB=0.10			

[1/] That of outcrossed progenies was accepted as100.

[2/] A= Pollination, B= Ecotype; ** indicate significance at %1 level.

Researchers reported that increase of similar magnitude from parent to inbred progeny were obtained for percentage of anaphase I sporocytes with lagging and dividing chromosomes and for percentage of quarted with micronuclei. They also determined that the number of seeds per panicle were negatively correlated with the incidence of metaphase I univalents, anaphase I laggards and micronuclei.

Busbice (1968) reported that a small reduction in seed yield resulted from the loss of heterozygosity affected the physiology of the gametes, gametophytes and the maternal parent. He noted that most of the loss of seed yield with inbreeding could be accounted for inbreeding in the developing zygote. Reduced seed yield with inbreeding did not result from failure of gametes to unite in fertilization but resulted from a loss of heterozygosity in the zygotes, this loss being lethal to many of the zygotes. Lethality, resulted from inbreeding in the developing zygote, is suggested to be primary factor that limits the production of seed in alfalfa after selfing and other consanguineous matings. Epistatic gene action may be the important factor in zygote viability; recessive lethals in the homozygous state at one locus may mask the effects of viability genes at other loci (Busbice, 1968).

Root Weight: The data related this character are given in Table 3. No significant differences were found between the outcrossed (59.45 g/plant) and the selfed (55.35 g/plant) progenies. The average dry root weight in inbred progenies was 6.9% lesser than that of outcrossed progenies. On the other hand, variation among populations was significant and the highest root weight was obtained in the group of Oltu (78.29 g/plant). However, the highest reduction in root weight with selfing was detected in the same group (13.35%).

Krokhin and Fedorenko (1982) observed that a single selfing affected only the number of caryopsis but not the weight of roots and seedlings. Similar results were also obtained in our study.

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