Effect of Row Spacing, Seeding Rate and Nitrogen Fertilization on Seed Yield of Perennial Ryegrass under Dryland Conditions[1]

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ABSTRACT

The effects of row spacing, sowing rate, and nitrogen (N) application on seed yield in perennial ryegrass (*Lolium perenne* L.) was investigated for four years in dryland conditions of Ankara, Turkey. Climatic conditions in the study area were continental with annual precipitation less than 500 mm with one-third falling during the growing period. Under such conditions, perennial ryegrass plants did not develop sufficiently to produce seed in the year of planting. Full production was achieved in the second and third year and the stand was extremely poor in the fourth year. Sowing rates (10, 20, and 30 kg ha^{-1}) did not affect seed yield or other characteristics. Row spacing and N application (0, 20, 40, and 60 kg ha^{-1}) significantly affected. Maximum seed yield was obtained by planting in rows 45 or 60 cm apart and applying 40 kg ha^{-1} annually.

Additional key words: Lolium perenne

INTRODUCTION

Perennial ryegrass (*Lolium perenne* L.) is a major constituent of seed mixtures used in lawns, parks and other general use turfgrass areas in Turkey. Therefore, large amounts of ryegrass seed are utilized every year in the country.

Ryegrass is best adapted to cool and humid regions with mild winters (Beard, 1973; Sprague, 1976) However, large parts of Turkey, particularly the interior and southeastern regions, generally receive less than 500 mm average annual precipitation. One-third of the annual rainfall occurs in winter and early spring and would appear suitable for an early maturing crop like perennial ryegrass cv. Linn. Profitable growing of perennial ryegrass for forage or seed may be restricted by the limited and erratic late spring and summer rains (Acikgoz, 1988).

Earlier studies (Lawrance and Heinrichs, 1968; Knowles et al., 1969; Knowles and Buglass, 1971; Lawrance, 1980) obtained highest seed yields in dryland forage grasses with row spacings of 60 cm or more. Nitrogen (N) fertilizers applied at higher rates were found to significantly increase seed yield in ryegrass and other forage grasses (Hebblethwaite and Ivins, 1977, 1978; Hebblethwaite and McLaren, 1979; Canode, 1968). Knowles et al. (1969) and Lawrance (1980) particularly found that dryland grasses produced more seed when fertilized with N at 40 to 60 kg ha^{-1}.

The perennial ryegrass cv. Linn was introduced from the U.S.A. in 1974 and has been grown under the dryland conditions of Ankara. It is also grown as a seed crop under dryland conditions of Inner Anatolia. In this region, seed yield is low, averaging less than 200 kg ha^{-1} (personal observation). Very little information is available on the management of perennial ryegrass for seed production in this region. Therefore, an examination of early varieties and special management practices might benefit seed producers. The objective of this study was to examine effects of row spacing, seeding rates and N fertilization on seed yield in perennial ryegrass under dryland conditions.

MATERIALS AND METHODS

Plots were established at the research station of Ankara Grassland and Animal Husbandry Institute in spring of 1982. Before seeding, 40 kg ha^{-1} N and 60 kg ha^{-1} P_2O_5 were uniformly applied to the experimental area. Plots were arranged in a split-plot design with three replications. Row spacings of 45, 60, and 75 cm were the main plots; seeding rates of 10, 20, and 30 kg ha^{-1} were the subplots; and N fertilization of 0, 20, 40, and 60 kg ha^{-1} were the sub-subplots. The sub-subplot size varied from 48 to 60 m^2 depending upon row spacing. N fertilizers were broadcast on the plots each spring in the form of ammonium nitrate.

Climatic condition at the location is continental with a 55-year average annual precipitation of 386 mm. Average long-term temperature and relative humidity were 12 C and 60% respectively. During the study period, annual precipitation varied from 339 to 512 with approximately one-third falling in March through July. The soil was clay in texture, slightly alkaline (pH = 7.9), rich in lime, and poor in P_2O_5 and N content.

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Each year that seed was harvested, five tillers in each plot were randomly selected for measurement of plant height when the seed heads were fully ripe. An area of 1.8 to 3.0 m^2 in each plot was harvested by hand. Four lots of 100 seeds were taken for determining 1000-seed weight. Differences among treatments were compared using Duncan's multiple range test at P=0.01.

RESULTS AND DISCUSSION

Full seed production did not occur in the year of establishment (first year) due to insufficient plant development. Data were collected in the second, third and fourth years after planting. Full production was obtained in the second and third years but yield decreased yearly. By the fourth year the stand was extremely poor and mean seed yield was reduced to 64 kg ha^{-1} due to lower plant population and plant vigor. Consequently, only results from the second and third years are presented. The analysis of variance indicated that the effect of seeding rates on seed, seed weight and plant height, and their mutual interactions were very small and nonsignificant. For this reason, the values were averaged to give single values for seeding rates (Table 1).

A general tendency of decreasing seed yields with increasing stand age has been noted for forage grasses. Lawrence (1963), Canode (1968) and Knowles et al. (1969) found that yields usually declined after the second seed crop in several dryland grasses. Decreased seed yield of perennial ryegrass with increasing stand age has been reported by Roberts (1965) and Hebblethwaite and Ivins (1977). Results from this study indicated that age of stand affected seed yield and could not be prevented from declining even with addition of higher rates of N fertilizer. It was not practical, therefore, to maintain the ryegrass stand beyond the second year under dryland conditions of Ankara.

Table 1. Effect of row spacings and N fertilization on seed yield, seed weight and plant height in the first and second seed harvests, 1983 and 1984, Ankara, Turkey.

N rate (kg ha^{-1})	Row spacing (cm), 1983				Row spacing (cm), 1984			
	45	60	75	Ave.	45	60	75	Ave.
Seed yield (kg ha^{-1})								
0	568.3	564.3	589.7	574.1 c[1]	301.3	244.7	220.6	255.5 d
20	626.0	525.7	681.0	610.9 b	301.7	316.0	278.0	298.6 c
40	642.3	850.3	658.0	716.9 a	344.3	310.0	300.7	318.3 b
60	709.0	724.0	692.3	708.4 a	374.7	357.3	289.3	340.3 a
Ave.	636.4 z	666.1 x	654.8 y	652.6	330.5 x	307.0 y	272.2 z	303.2
1000-seed weight (g)								
0	1.91	1.93	2.05	1.96 b	1.88	1.88	2.02	1.93 c
20	1.86	2.04	2.01	1.97 b	1.91	1.98	2.02	1.97 b
40	1.95	2.02	2.07	2.01 a	1.96	2.04	2.07	2.02 a
60	1.91	1.97	2.07	1.98 b	1.89	1.97	2.02	1.96 bc
Ave.	1.91 z	1.99 y	2.05 x	1.98	1.91 z	1.97 y	2.03 x	1.97
Plant height (cm)								
0	58.3	58.3	63.5	60.1 a	57.8	56.0	61.0	58.3 b
20	58.5	58.7	62.0	59.8 a	57.0	63.8	65.3	62.0 b
40	58.8	62.3	61.4	60.8 a	68.8	73.8	69.5	70.7 a
60	59.0	64.0	64.9	62.6 a	68.8	73.8	69.5	70.7 a
Ave.	58.7 x	60.9 x	63.1 x	60.8	64.1 x	65.9 x	66.0 x	65.3

[1]Means in the same column or line for each year followed by the same letter are not significantly different P=0.01 using Duncan's multiple range test.

Results from several forage grasses studies indicated that wide row spacings resulted in higher seed yield under dryland conditions (Crowle, 1966; Knowles and Buglass, 1971; Lawrence and Heinrichs, 1968). However, wider row spacings gave reduced or did not influence seed yields for shorter species such as Kentucky bluegrass (*Poa pratensis* L.) and red fescue (*Festuca rubra* L.) for both dryland and irrigated conditions (Austenson and Peabody, 1964; Crowle, 1966; Canode, 1968). Our results are in agreement with this finding, the row spacing of more than 45 cm was of no advantage for seed production in perennial ryegrass (Table 1). Total seed yield of 967 kg ha^{-1} was obtained with 45 cm row spacing and 973 kg ha^{-1} with 60 cm row spacing.

Perennial ryegrass responded favorably to N fertilizers, affecting seed yield and seed weight in both years and plant height in 1984. No clear difference among 40 and 60 kg ha^{-1} in total seed yield was observed (1035 and 1047 kg ha^{-1}). Apparently more than 40 kg ha^{-1} N was not beneficial to ryegrass under this climatic condition. Similar results were obtained in earlier studies with dryland grasses (Crowle, 1966; Lawrence and Heinrichs, 1968; Lawrence, 1980). But studies with ryegrass (Hebblethwaite and Ivins, 1977; 1988) indicated that in humid regions optimum levels ranged from 80 to 120 kg ha^{-1} N, depending on the soil residual N levels. As known responses of grasses to N fertilizers are mainly related to seasonal precipitation and more than 40 kg ha^{-1} N levels either have no effect or decrease ryegrass seed yield under limited moisture conditions of Ankara.

Row spacings and N fertilization affected the seed weight but differences were small. The highest 1000-seed weight was found in 75 cm row spacing with 40 kg ha^{-1} fertilization. In other studies with several grass species, wide rows resulted in heavier seeds but the influence of N fertilizers on seed weight was variable (Canode, 1968). Hebblethwaite and Ivins (1977) indicated that the level of N application had little affect on 1000-seed weight in ryegrass. Row spacing did not affect the plant height but 40 and 60 kg ha^{-1} N fertilization increased it significantly in 1984. There is a tendency for more lodging in plots seeded at wide row spacings and fertilized with high N rates. Lodging was particularly a serious problem in plots seeded with 75 cm row spacing with 60 kg ha^{-1} N fertilization.

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