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PERFORMANCES OF FORAGE TURNIP (*Brassica rapa* L.) CULTIVARS UNDER DIFFERENT NITROGEN TREATMENTS

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ABSTRACT: The effects of five nitrogen rates (0, 50, 100, 150 and 200 kg ha^{-1}) on root, leaf yields and some yield components of four forage turnips (Agressa, Siloganova, Polybra and Volenda) were evaluated under the Black Sea Coastal Area Conditions in Turkey in the 2002 and 2003 growing seasons. The root yield, root dry matter yield, root crude protein yield, root diameter, root length, leaf yield, leaf dry matter yield, and leaf crude protein yield were determined. Root and leaf yields and their yield components of forage turnip cultivars increased along with increase of nitrogen doses. The highest root and leaf dry matter yields were obtained from cultivar Volenda (7.19 and 5.24 t ha^{-1}, respectively) in the treatments of 150 kg per hectare nitrogen.
Key Words: Forage turnip, nitrogen fertilizer, root yield, leaf yield

YEM ŞALGAMI (*Brassica rapa* L.) ÇEŞİTLERİNİN AZOTLU GÜBRELEMEYE KARŞI PERFORMANSLARI

ÖZET: Karadeniz Bölgesi sahil koşullarında beş farklı azot dozunun (0, 50, 100, 150 ve 200 kg/ha) dört yem şalgamı çeşidinin (Agressa, Siloganova, Polybra ve Volenda) yumru, yaprak verimi ve verim öğeleri üzerine etkilerinin belirlendiği bu araştırma 2002 ve 2003 yetiştirme periyodunda yürütülmüştür. Araştırmada yumru verimi, yumru kuru madde verimi, yumru ham protein verimi, yumru çapı, yumru boyu, yaprak verimi, yaprak kuru madde verimi ve yaprak ham protein verimi belirlenmiştir. Azotlu gübrelemenin artmasıyla yem şalgamı çeşitlerinin yumru ve yaprak verimi ile diğer verim öğeleri artmıştır. En yüksek yumru ve yaprak kuru madde verimleri hektara 150 kg azotlu gübreleme uygulanan Volenda çeşidinden (sırasıyla 7.19 ve 5.24 t/ha) elde edilmiştir.
Anahtar Kelimeler: Yem şalgamı, azotlu gübreleme, yumru verimi, yaprak verimi

1. INTRODUCTION

Forage brassica is an annual crop which is highly productive and digestible can be grazed 80 to 150 days after seeding, depending on the species. In addition, crude protein levels are high, varying from 15 to 25 percent in the leaf and 8 to 15 percent in the roots, depending on the level of nitrogen fertilization and weather conditions. Most *Brassicas* are relatively low in dry matter content, but their total dry matter production per unit area is high relative to most cereals and forage grasses (Rao and Horn, 1986). The dry matter of 4 to 8 t ha^{-1} has been reported (Albayrak and Çamaş, 2005; Albayrak et al., 2004; Jung et al., 1986; Rao and Horn, 1986; Jung et al., 1983; Kalmbacher et al., 1982) for *Brassica* ssp. The crude protein content of forage turnip is higher in leaves than in roots, but roots accumulated more NO_3 than leaves (Pelletier et al. 1976). *Brassicas* have extremely high yield potential when grown on high fertility soils. The *Brassica* species require large amounts of nitrogen. Nitrogen fertilizers are one of the major costs for production of these crops (Karakaya and Koch, 1995). Pelletier et al. (1976) and Jung et al. (1984) reported that increasing nitrogen fertilization increased dry matter yield and crude protein content in forage turnip.

The objective of this research was to determine effects of different rates of nitrogen fertilizers on yield and nutritional value of four forage turnip cultivars (*Brassica rapa* L.).

2. MATERIALS AND METHODS

Field studies were conducted at Black Sea Agricultural Research Institute (15 km east of Samsun, Turkey) in Çarşamba Plain (elevation 4 m). The experiments were carried out during two growing seasons (2002 and 2003) on clay-loam soil. Soil pH was 7.1; organic matter 1.98%; available P, 72.5 kg ha^{-1}; available K, 234 kg ha^{-1}. The monthly rainfall for July through October was 79.9, 14.3, 34.6 and 42.2 mm in 2002 (171.0 mm total) and 37.7, 3.4, 94.4 and 194.7 mm in 2003 (330.2 mm total), respectively. Mean precipitation of the 27 years for the same months was 201.1 mm, and the full-year mean was 705.0 mm. Forage turnip (*Brassica rapa* L.) cultivars (diploid cultivars Agressa, Siloganova; tetraploid cultivars Polybra and Volenda) were obtained from the Field Crops Department of Agricultural Faculty in Ankara University.

The experiment was conducted in a split block design with 3 replications. Forage turnip cultivars were applied in main plots, nitrogen treatments were in subplots. Fertilizer, 0, 50, 100, 150 and 200 kg N ha^{-1} were applied before seeding in 2002 and 2003. Calcium amonium nitrate 26 % was used. Seeding rates were 8 kg ha^{-1}. Individual plot size was 2.4 x 4 m= 9.6 m^2. Sowing was done by hand on 10 and 8 July in 2002 and 2003, respectively. Plots were irrigated five times through growing period in every year. 10 plants from each replication were taken at harvest stage for morphological measurements. Root diameter and root length were measured in individual plants. Plots were harvested on 8 and 10 October in 2002 and 2003, respectively. Two square meters (2 times 1 m^2) area were harvested in each plot (Anon. 2003). After harvest, fresh yields of leafs and roots were determined separately and samples were dried in ovens at 70 ^oC to a constant weight for dry matter content (Martin et al. 1990). Dried samples were grounded and the amount of N was found by using kjehldal method (Nelson and Sommers, 1980). Crude protein content was calculated multiplying N amount of each sample by 6.25.

All statistical analyses were done using GLM producers of SAS (1998). The data in 2002 and 2003 were analysed together. Means were compared using Duncan's multiple range tests at the 0.05 probability level.

3. RESULTS AND DISCUSSION

The two-year average root and leaf yields and their yield components of the 4 forage turnip cultivars under different N levels are shown in Table 1and Table 2.

The forage turnip cultivars differed in their response to N fertilizer treatments. Generally, plots receiving 150 kg N ha^{-1} produced more root and leaf yields than plots fertilized with 50, 100 and 200 ha^{-1} or nonfertilized, at all forage turnip cultivars. The

Table 1. The effect of nitrogen doses on root yield, root dry matter yield, root crude protein yield, root diameter and root lenght.

Cultivars	Nitrogen Doses (kg ha^{-1})					
	0	50	100	150	200	mean
	Root yield (t ha^{-1})					
Volenda	32.36	41.45	74.76	75.51	67.71	58.36 a
Polybra	30.82	49.70	56.09	69.16	63.60	53.87 b
Siloganova	27.97	39.48	45.09	51.21	47.54	42.26 c
Agressa	22.82	40.25	45.12	51.32	41.63	40.23 c
mean	28.49 d	42.72 c	55.27 b	61.80 a	55.12 b	
LSD	Cultivar x Nitrogen=3.54**					
	Root dry matter yield (t ha^{-1})					
Volenda	2.98	4.67	6.82	7.19	5.98	5.53 a
Polybra	2.41	4.44	4.76	7.16	5.01	4.75 b
Siloganova	2.37	3.52	3.70	4.57	4.94	3.82 c
Agressa	2.11	4.09	3.98	5.10	3.90	3.84 c
mean	2.47 d	4.18 c	4.82 b	6.01 a	4.96 b	
LSD	Cultivar x Nitrogen=0.44**					
	Root crude protein yield (t ha^{-1})					
Volenda	0.30	0.51	0.82	0.89	0.65	0.63 a
Polybra	0.24	0.47	0.51	0.86	0.62	0.54 b
Siloganova	0.24	0.37	0.45	0.59	0.58	0.45 c
Agressa	0.19	0.41	0.39	0.60	0.41	0.40 d
mean	0.24 d	0.44 c	0.55 b	0.74 a	0.57 b	
LSD	Cultivar x Nitrogen=0.056**					
	Root diameter (cm)					
Volenda	6.04	6.8	7.58	7.72	7.29	7.08 a
Polybra	5.87	6.58	7.26	7.86	7.48	7.01 a
Siloganova	5.72	6.48	6.87	7.39	6.86	6.67 b
Agressa	5.27	5.93	6.23	6.52	6.47	6.08 c
mean	5.73 d	6.45 c	6.98 b	7.37 a	7.02 b	
LSD	Cultivar x Nitrogen=0.173**					
	Root lenght (cm)					
Volenda	11.71	12.63	13.90	14.89	13.02	13.23 a
Polybra	12.65	12.56	13.33	14.02	13.28	13.17 ab
Siloganova	11.07	11.54	11.80	12.66	12.85	11.98 c
Agressa	11.77	12.31	13.05	13.99	13.01	12.83 b
mean	11.79 d	12.26 c	13.02 b	13.89 a	13.04 b	
LSD	Cultivar x Nitrogen=0.466**					

Means followed by the same letter and column are not significantly different at p= 0.05 level.

Polybra, Siloganova and Agressa cultivars produced significantly less root and leaf yields all fertilizer levels except 50 kg N ha^{-1} when compared with the Volenda cultivar. The two-year average root yields from the 0, 50, 100, 150 and 200 kg N ha^{-1} treatments were 28.29, 42.72, 55.27, 61.80 and 55.12 tons per hectare, respectively (Table 1). The two-year average leaf yields from the 0, 50, 100, 150 and 200 kg N ha^{-1} treatments were 20.17, 25.00, 30.79, 34.78 and 32.85 tons per hectare, respectively (Table 2). Increasing N fertilization increased root and leaf yields in our study. However, root and leaf yields in all cultivars were decreased in 200 kg N ha^{-1} treatment. Cultivar x nitrogen interactions on root and leaf yields were significant because of different responses of cultivars to nitrogen fertilizer. Karakaya and Altınok (2002) obtained 32.73 and 43.47 t ha^{-1} root and leaf yields from forage turnip in Ankara conditions, respectively. Uzun (1996) found that root and leaf yields in forage turnip were 15.34 and 24.53 t ha^{-1} in Bursa conditions, respectively. Mülayim et al. (1996) reported that root yield in forage turnip was 66.57 t ha^{-1} in Konya conditions. These results are consistent with our findings.

The highest root and leaf dry matter yields were obtained from 150 kg nitrogen treatments (7.19 and 5.24 t ha^{-1}, respectively) (Table 1, 2). Jung et al. (1984) reported that increasing N fertilization increased dry matter yield. However, root and leaf dry matter yields in all cultivars were decreased in 200 kg N treatment. Our results are similar to Jung et al. (1984).

The dry matter yields of 4 to 8 t ha^{-1} have been reported (Kalmbacher et al. 1982; Jung et al. 1983; Jung et al. 1986; Rao and Horn 1986; Albayrak et al. 2004; Albayrak and Çamaş, 2005) for *Brassica ssp*. Karakaya and Altınok (2002) obtained 2.42 and 4.56 t ha^{-1} root and leaf dry matter yields from forage turnip. Griffin et al. (1984) indicated that root+leaf dry matter yield varied from 1.18 to 5.07 t ha^{-1} in forage turnip. Our results are similar to those researchers' findings.

The Polybra, Siloganova and Agressa cultivars produced significantly less root and leaf crude protein yields in all fertilizer levels when compared with the Volenda cultivar. The 2-year average root crude protein yields from the 0, 50, 100, 150 and 200 kg N ha^{-1} treatments were 0.24, 0.44, 0.55, 0.74 and 0.55 tons per hectare, respectively (Table 1). The two-year average leaf crude protein yields from the 0, 50, 100, 150 and 200 kg N ha^{-1} treatments were 0.28, 0.39, 0.56, 0.64 and 0.46 tons per hectare, respectively (Table 2). Cultivars x nitrogen interactions on root and leaf crude protein yields were significant because of different responses of cultivars to nitrogen fertilizer. Jung et al. (1984) and Pelletier et al. (1976) reported that increasing N fertilization increased crude protein yield. Of more importance to the producer is that quality of forage turnip herbage is more comparable to a concentrate than traditional forage because of the relatively low fiber and high protein content (Wiedenhoeft and Barton, 1994). Jung et al. (1986) reported that crude protein yields in forage turnip were 1.54 and 2.01 t ha^{-1} in root and leaf, respectively. Karakaya and

Table 2. The effect of nitrogen doses on leaf yield, leaf dry matter yield and leaf crude protein yield.

Cultivars	Nitrogen Doses (kg ha^{-1})					
	0	50	100	150	200	mean
	Leaf yield (t ha^{-1})					
Volenda	25.28	28.73	37.07	41.34	37.50	33.98 a
Polybra	20.18	24.49	30.61	29.87	32.52	27.53 b
Siloganova	16.74	26.11	28.19	34.99	32.58	27.72 b
Agressa	18.48	20.68	27.32	32.92	28.79	25.64 c
mean	20.17 e	25.00 d	30.79 c	34.78 a	32.85 b	
LSD	Cultivar x Nitrogen=1.99**					
	Leaf dry matter yield (t ha^{-1})					
Volenda	2.97	3.35	4.91	5.24	4.09	4.11 a
Polybra	2.42	3.19	3.99	3.95	3.80	3.47 b
Siloganova	2.11	3.26	3.69	4.92	3.77	3.55 b
Agressa	1.99	2.36	2.92	3.80	3.22	2.86 c
mean	2.37 d	3.04 c	3.87 b	4.48 a	3.72 b	
LSD	Cultivar x Nitrogen=0.34**					
	Leaf crude protein yield (t ha^{-1})					
Volenda	0.34	0.42	0.65	0.79	0.52	0.55 a
Polybra	0.29	0.41	0.66	0.58	0.49	0.49 b
Siloganova	0.27	0.43	0.53	0.63	0.45	0.46 b
Agressa	0.21	0.29	0.38	0.57	0.36	0.36 c
mean	0.28 e	0.39 d	0.56 b	0.64 a	0.46 c	
LSD	Cultivar x Nitrogen=0.43**					

Means followed by the same letter and column are not significantly different at p= 0.05 level.

Altınok (2002) obtained 0.82 and 1.00 t ha^{-1} root and leaf crude protein yields from forage turnip, respectively. The differences of root and crude protein yield may have arisen from environmental conditions such as precipitation and temperature recorded during the vegetative cycle of growth, and cultivars in the experiment.

The two-year average root diameters from the Volenda Polybra, Siloganova and Agressa cultivars were 7.08, 7.01, 6.67 and 6.08 cm, respectively (Table 1). The two-year average root diameters from the 0, 50, 100, 150 and 200 kg N ha^{-1} treatments were 5.73, 6.45, 6.98, 7.37 and 7.02 cm, respectively (Table 1). Increasing nitrogen doses, root diameter also increases in forage turnip cultivars. The highest root diameter was found 7.86 cm in 150 N ha^{-1} treatments in Polybra cultivar.

Increasing nitrogen doses, root length also increases in forage turnip cultivars, just like the root diameter (Table 1). The 2-year average root length from the 0, 50, 100, 150 and 200 kg N ha^{-1} treatments were 11.79, 12.26, 13.02, 13.89 and 13.04 cm, respectively. The highest root length was found 14.89 cm in 150 N treatments in Volenda cultivar (Table 1). It was previously reported that root diameter and root length in forage turnip ranged from 5.13 to 9.07 cm and 9.75 to 40.86 cm, respectively (Mülayim et al. 1996; Atalay, 1997; Beşpınar 2003). Our results similar to those researchers' findings.

4. CONCLUSION

Four forage turnip cultivars were evaluated for root and leaf yields and their yield components, and recovery of applied N under five levels of N fertilization in the Black Sea Coastal Area. Root and leaf yields were closely associated with the amount of N applied, with most cultivars showing increased yields at the higher rates of N. The magnitude of the increase ranged with cultivars as well as with the rates of N applied. The Volenda cultivar produced the highest yields under all applied levels. Nitrogen fertilizer increased the crude protein content in all cultivars. The Volenda Cultivar had the highest root and leaf crude protein yields.

The Volenda cultivar gave the greatest response to N fertilizer in terms of yield and yield components under the Black Sea Coastal Area Conditions.

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