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Effect of Seeding After Barley and Wheat Harvest on Yield Components of Forage Turnip (*Brassica rapa* L.) Cultivars

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Abstract: This research was carried out at the experimental field of Ankara University, Faculty of Agriculture, and Department of Field Crops in 2003 – 2004. The aim of the study was to determine forage turnip (*Brassica rapa* L.) cultivars sown as second crop after barley and wheat harvest in the irrigated areas of middle Anatolia in Turkey. Seeding was done after barley and wheat harvest. Four forage turnip cultivars (Agressa, Volenda, Polybra and Siloganova) were used as a research material. Effect of the seeding time on the forage turnip cultivars was significant and higher leaf and root yield were obtained from the seeding time after barley harvest. The highest root and leaf yield were obtained from Volenda cultivar. This cultivar can be grown as a second crop after barley under irrigated conditions.

Key Words: Forage turnip, root yield, leaf yield

Yem Şalgamı (*Brassica rapa* L.) Çeşitlerinde Arpa ve Buğday Hasatından Sonraki Ekimlerin Verim Komponentlerine Etkisi

Öz: Bu araştırma Ankara Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bölümü deneme tarlasında 2003 – 2004 yıllarında yürütülmüştür. Orta Anadoluda sulanabilen alanlarda arpa ve buğday hasadından sonra 2. ürün olarak ekilebilecek yem şalgamı çeşitlerinin belirlenmesi amacıyla kurulmuştur. Ekimler arpa ve buğday hasadından sonraki tarihlerde yapılmıştır. Araştırmada material olarak dört yem şalgamı çeşidi (Agressa, Volenda, Polybra and Siloganova) kullanılmıştır. Ekim tarihinin yem şalgamı çeşitleri üzerinde etkisi oldukça önemli olmuş ve arpa hasadından sonraki ekimlerden daha fazla kök ve yaprak verimi elde edilmiştir. En fazla kök ve yaprak verimi Volenda çeşidinden alınmıştır. Bu çeşidin sulanan şartlarda arpa hasadından sonra ikinci ürün olarak yem bitkisi amacıyla yetiştirilebileceği gözlenmiştir.

Anahtar Kelimeler: Yem şalgamı, kök verimi, yumru verimi

Introduction

Brassica forage crops are fast growing crops suitable for livestock grazing with quality and productivity. Brassica species contain high crude protein and energy, but their fiber contents are extremely low. The protein content of leaves changes from 15% to 22% while protein content of roots varies from 8% to 10% (Griffin et al. 1984, Jung et al. 1986). Dry matter contents of brassica species were reported between 4 and 8 t ha^{-1} (Rao and Horn 1986, Jung et al. 1983, Kalmbacher et al. 1982). Brassicas are both cold-hardy and drought-tolerant. They can be grown as a second crop – and provide high- quality forage in the late-fall (Koch and Karakaya 1998). Turnips, an excellent late-fall forage, are short- season, fast growing brassicas that reach maximum production within 80 or 90 days after establishment. A significant percentage of fields in irrigated areas of Central Anatolia is left bare between July and October for 3-4 months.

In this r esearch, the yield and quality characteries of four forage turnip cultivars (*Brassica rapa* L.) grown as a second crop after barley and wheat in the irrigated regions of central Anatolia were investigated.

Materials and Methods

This research was carried out at the experimental field of Ankara University, Faculty of Agriculture, Department of Field Crops, during 2003 and 2004. The soil was a clay loam with alkaline properties. Soil pH was 7.73, organic matter 1.37 %, $CaCO_3$ 5.35 %, available P was 4.35 kg da^{-1}, and available K was 130 kg da^{-1}. Monthly precipitations from July to October were 3.0, 0.2, 15.1 and 29.8 mm in 2003, respectively (48.1 mm total) and 6.2, 12.6, 2.7 and 10.9 mm in 2004 (32.4 mm total) and while long period mean precipitation of these months is 69.7 mm. Mean temperature and relative humidity during the experimental period were similar to long period mean temperature.

Forage turnip (*Brassica rapa* L.) cultivars (diploid cultivars Agressa, Siloganova, tetraploid cultivars Polybra and Volenda) were obtained from Field Crops Department Agricultural Faculty of the Ankara University. Two experiments were set up: the first on July 1 after harvesting barley, and the second after harvesting wheat on July 15 as a second crop, for two years, 2003 and 2004. The experimental design was a randomized complete block with three replications for each experiment. Two experiments were combined for each

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year and analyzed considering the seeding date, and seeding date x cultivars interactions were calculated accordingly. Seeding rate was 8 kg ha^{-1} and each plot consisted of 10 rows, 4 m length and 20 cm row spacing. Plots were irrigated five times through experiments in each year. As a fertilizer, 100 kg ha^{-1} ammonium nitrate was uniformly applied to all plots after sowing. Weeds were removed by hoeing as needed. 10 plants from each replication were taken at harvest stage for morphological measurements. Root diameter and root length were measured for individual plants. Harvest was carried out approximately 4 months after seeding. After harvest, green leaf yield and fresh root yield were determined and the samples were dried in ovens at 70 ^{0}C to a constant weight for dry matter content (Martin et al. 1990). Dried samples were ground and Nitrogen was found determined by using Kjeldah method. Amount of N from each sample was multiplied by 6.25 and crude protein content was calculated. Fresh yield obtained from each plot, dry matter and crude protein contents were calculated as fresh, dry matter and crude protein yields per hectare.

Data were analyzed by analysis of variance using MSTAT-C program, and means were compared using Duncan's multiple range test at the $P \leq 0.05$ level.

Results and Discussion

The results of this study which was carried out for two years and two different seeding dates were presented in Table 1 and 2. In the 2003, seeding after barley, there were significant differences among the cultivars in terms of root length, diameter and yield components (Table 1). The Volenda cultivar was the most productive cultivar with a 26.50 t ha^{-1} root yield and 20.36 t ha^{-1} leaf yield. Agressa and Siloganova cultivars produced significantly less root and leaf yields.

In the 2003, root and leaf yields of the cultivars in the seeding after barley were higher than the yields obtained from seeding after wheat (Table 1). Cultivar Volenda was the most productive cultivar in this seeding date. The root diameter of Volenda was 5.69 cm. This cultivar produced high yields (24.63 t ha^{-1}, 19.21 t ha^{-1} root and leaf yields, respectively) under irrigated conditions. The lowest root diameter, (4.80 cm) and root yields (16.70 t ha^{-1}) were found in Siloganova.

Seeding dates significantly influences the yield. Yields obtained from the seeding after barley were consistently higher than those obtained from the seeding after wheat. Some *Brassica* species need longer growth periods and the temperatures and light intensities in autumn seemed to affect dry matter production (Guillard and Allinson 1988). *Brassica* species can be planted as a second crop, following small grains. This method could be economical. *Brassica* species establish quickly and produce high – quality autumn and winter forage (Koch and Karakaya 1998).

They found that root and leaf yields increased with the seeding after barley. These studies were in agreement with our study which was resulted in higher forage yields with the seeding of after barley harvest.

Table 1. Root and leaf yields and their components of forage turnip seeded after barley and wheat in 2003

Cultivars	Root length (cm)	Root diameter (cm)	Root yield (t ha^{-1})	Root dry matter yield (t ha^{-1})	Root crude protein yield (t ha^{-1})	Leaf yield (t ha^{-1})	Leaf dry matter yield (t ha^{-1})	Leaf crude protein yield (t ha^{-1})
Seeding After Barley Harvest								
Agressa	15.28 a*	5.66 a	17.31 d	1.93 c	0.37 c	14.58 b	1.83 c	0.36 b
Volenda	12.27 b	5.75 a	26.50 a	2.83 a	0.51 b	20.36 a	2.90 a	0.53 a
Polybra	12.38 b	5.74 a	24.48 b	2.93 a	0.54 a	20.91 a	2.38 b	0.53 a
Siloganova	11.94 b	4.93 b	19.40 c	2.13 b	0.39 c	16.56 b	2.40 b	0.47 a
Mean	12.97	5.52	21.92 A	2.46 A	0.45 A	18.10 A	2.38 A	0.47 A
LSD	1.19	0.35	149.3	14.86	3.02	218.1	29.39	8.194
Seeding After Wheat Harvest								
Agressa	12.26	5.53 a	16.75 c	1.88 b	0.33 c	12.55 c	1.57 d	0.32 d
Volenda	11.61	5.69 a	24.63 a	2.62 a	0.40 b	19.21 a	2.65 a	0.55 a
Polybra	11.39	5.69 a	20.88 b	2.51 a	0.44 a	19.32 a	2.24 b	0.47 b
Siloganova	10.50	4.80 b	16.70 c	1.62 c	0.31 c	14.85 b	2.03 c	0.40 c
Mean	11.44	5.43	19.74 B	2.16 B	0.37 B	16.48 B	2.12 B	0.44 B
LSD	1.199	0.21	137.90	15.22	2.677	116.60	11.82	2.449
Mean	12.20	5.47	20.83	2.31	0.41	17.29	2.25	0.45
LSD	2.035	0.20	117.30	17.51	7.06	99.76	18.46	3.77

* Means of each Brassica cultivar in a column followed by the same lower case letters and means of main seeding seasonal effects, followed by the same upper case letters, are not significantly different according to Duncan's Multiple Range Test.

Table 2. Root and leaf yields and their components of forage turnip seeded after barley and wheat in 2004

Cultivars	Root length (cm)	Root diameter (cm)	Root yield (t ha^{-1})	Root dry matter yield (t ha^{-1})	Root crude protein yield (t ha^{-1})	Leaf yield (t ha^{-1})	Leaf dry matter yield (t ha^{-1})	Leaf crude protein yield (t ha^{-1})
Seeding After Barley Harvest								
Agressa	12.86	5.29 b*	16.11 c	1.86 c	0.33 c	13.14 c	1.47 d	0.32 d
Volenda	12.05	5.33 b	20.86 a	2.22 b	0.36 b	20.41 a	2.92 a	0.58 a
Polybra	12.09	5.75 a	20.14 a	2.41 a	0.44 a	20.93 a	2.36 b	0.48 b
Siloganova	12.01	4.85 c	18.10 b	1.99 c	0.38 b	14.88 b	2.07 c	0.41 c
Mean	12.25 A	5.30	18.80 A	2.12 A	0.38 A	17.34 A	2.20 A	0.45 A
LSD	1.267	0.227	102.9	13.600	2.368	129.20	20.80	4.233
Seeding After Wheat Harvest								
Agressa	10.55	5.62 a	13.86 d	1.54 c	0.26 c	11.27 c	1.41 d	0.28 c
Volenda	10.77	5.70 a	20.04 a	2.15 a	0.31 ab	19.19 a	2.57 a	0.48 a
Polybra	10.14	5.75 a	18.05 b	2.18 a	0.35 a	19.62 a	2.28 b	0.51 a
Siloganova	10.07	4.87 b	16.13 c	1.67 b	0.28 bc	13.44 b	1.87 c	0.37 b
Mean	10.38 B	5.48	17.02 B	1.88 B	0.30 B	15.88 B	2.03 B	0.41 B
LSD	1.30	0.24	82.61	10.42	4.88	162.50	26.42	4.94
Mean	11.31	5.39	17.91	2.00	0.34	16.61	2.11	0.43
LSD	1.54	0.20	87.97	15.87	3.40	31.79	9.56	2.23

* Means of each Brassica cultivar in a column followed by the same lower case letters and means of main seeding seasonal effects, followed by the same upper case letters, are not significantly different according to Duncan's Multiple Range Test.

In 2004, similar to 2003, significant sources of variation for measured parameters in the seeding after barley and seeding after wheat were observed. The effect of seeding date on most of measurements was significant.. In 2004, the seeding after barley harvest, significant differences among the cultivars were observed, with the exception of root length (Table 2). The root, leaf, leaf dry matter, leaf crude protein yields of the cultivar Volenda were the highest (20.86, 20.41, 2.92 and 0.58 t ha^{-1}, respectively). Agressa, Siloganova cultivars produced significantly less root and leaf yields. In the 2004 seeding after wheat harvest, significant differences among the cultivars were observed, with the exception of root length (Table 2). The highest root and leaf yields were found in Volenda and Polybra cultivars. The plant diameter of Siloganova cultivar was the lowest (4.87 cm). In both years, root and leaf yields obtained from the seeding after barley harvest was higher than the yields after wheat harvest.

Volenda is a tetraploid with very high yields and it has high dry matter content, it is also cold resistance cultivar. Polybra, Siloganova and Agressa cultivars produced significantly less root and leaf yields when compared with the Volenda cultivar. Karakaya and Altınok (2002) obtained 32.73 t ha^{-1} and 43.47 t ha^{-1} root and leaf yields from forage turnip in Ankara conditions, respectively. Uzun (1990) found that root and leaf yields of 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. Our findings are similar to the researchers' findings.

Albayrak et al. (2004) found that the highest root and leaf dry matter yields were obtained from Volenda cultivar 6.18 and 5.37 t ha^{-1} , respectively. The dry matter yields have been reported between 4 and 8 t ha^{-1} (Wiedenhoeft 1993, Jung et al. 1986, Rao and Horn 1986, Jung et al. 1983, Kalmbacher et al. 1982) 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} of forage turnip. Similar findings were found in our research.

Conclusion

The yield and quality characterities of four forage turnip cultivars grown as a second crop after barley and wheat harvest in the irrigated regions of Central Anatolia were investigated. Root and leaf yields after barley harvest were higher than the yields obtained from plots sown after wheat.

The Volenda cultivar had the highest root and leaf yields. According to our results, Volenda cultivar could be seeded after barley harvest as a second crop and could be a good source of alternative forage.

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