Gartenbauwissenschaft, **67** (1). S. 23–27, 2002, ISSN 0016–478X. © Verlag Eugen Ulmer GmbH & Co., Stuttgart

Effect of Nitrogen Fertilization on Growth, Yield and Nitrogen Contents of Radishes

Wirkung von Stickstoffdüngung auf Wachstum, Ertrag und Stickstoffgehalt von Rettich

Ismail Guvenc
(Department of Horticulture, Agricultural Faculty of Ataturk University, Erzurum, Turkey)

Summary

In this research, the effect of usual and an excessive amount of nitrogen fertilization on the growth, yield and nitrogen content of five different radish (*Raphanus sativus* L.) genotypes commonly grown in Turkey were investigated. The nitrogen fertilization at the rates of 0, 100 (usual) and 200 (excess) kg ha^{-1} were applied under the field conditions.

No significant effect was determined among the nitrogen doses in terms of number of leaf per plant in radish. The highest root diameter, length, weight and yield were obtained from 200 kg N/ha treatments. On the other hand, total nitrogen and nitrate content of the roots increased with increasing the nitrogen doses. Therefore, normal nitrogen doses should be applied in these radishes to have better yield and healthy crops.

Zusammenfassung

In dieser Arbeit wurde der Einfluss von durchschnittlicher und stark erhöhter Stickstoffdüngung auf das Wachstum, den Ertrag und den Stickstoffgehalt von fünf Rettich-Genotypen, die in der Türkei verbreitet angebaut werden, untersucht. Die Stickstoffdüngung mit unterschiedlichen Mengen (0, 100 und 200 kg ha^{-1}) wurde unter Feldbedingungen durchgeführt.

Die Stickstoffdüngung hatte bei den Rettichen keine signifikante Wirkung auf die Anzahl Blätter pro Pflanze. Bei der Behandlung mit 200 kg N/ha waren der Durchmesser, die Länge, das Gewicht und der Ertrag am höchsten. Gleichzeitig wurde festgestellt, dass der Gesamt-Stickstoff- und Nitratgehalt sich mit steigender Stickstoffgabe ebenfalls erhöhten. Aus diesem Grund sollte die übliche Stickstoffdosis bei Rettichen beibehalten werden, um gute Erträge eines gesunden Produkts zu erhalten

Introduction

Radish (*Raphanus sativus* L.) is an important vegetable crop grown extensively in Turkey. Recently, excessive amounts of fertilizers have been used on many soils for commercial vegetable production in Turkey. Nitrogen is usually more important element for increasing plant growth than any other nutrients (PECK and MACDONALD 1984). Nitrogen fertilization may affect the vegetative growth of plant and nitrate accumulation (PECK et al. 1989). Radish is nitrate accumulating vegetable crop (ALCICEK and BASLAR 1995). Since the reduction products of the nitrate might be toxic for humans, research has been carried out on the prospects to produce radish cultivars with low nitrate contents (NIEUWHOF and JANSEN 1993). One of the most important factors in nitrate accumulation in plants was soil nitrogen (KARACAL and TÜRETKEN 1992; AYDIN and AKTAS 1995; PECHOVA et al. 1999).

The efficiency with which plants absorb and metabolise NO_3 or NH_4 varies with environmental conditions and plant species (BARKER et al. 1983). Numerous studies have shown that the highest growth of plant in radish was recorded with the highest rates of N (JOSHI and CHAUHAN 1985; SRINIVAS and NAIK 1990). On the other hand, nitrogen content of plant parts increased by increasing nitrogen doses (KARAÇAL and TÜRETKEN 1992; AYDIN and AKTAS 1995). Some researcher noted that at low nitrogen levels of the soil genetic differences might be masked by accidental variation (NIEUWHOF and JANSEN 1993)

The objective of this research was to determine the effects of usual and excess nitrogen fertilization doses on growth, yield and nitrogen content of five different radish (*Raphanus sativus* L.) genotypes commonly grown in Turkey.

Material and Methods

This study was conducted under field conditions at Agricultural Faculty of Ataturk University Turkey in 1996 and 1997, with five different radish (*Raphanus sativus* L.) genotypes commonly grown by Turkish farmers (ANON. 1996). These genotypes consisted of (1) 'Fındık', (2) 'Kestane', (3) 'Bayır', (4) '8 TR-18' and (5) 'Antep'. The soil of the experimental area was of loamy texture with neutral pH. The experimental soil had 1.1–1.3 % organic matter, 36.0–38.4 kg/ha N, 41.4–45.3 kg/ha P_2O_5 and 1100–1240 kg/ha K_2O in 1996 and 1997 respectively.

The experimental design combined a randomised complete blocks with 3 replications. The N rates tested were N_0: 0, N_1: 100 and N_2: 200 kg/ha as ammonium nitrate (NH_4NO_3). N_1 dose was accepted as usual (normal) dose according to the previous reports (GÜNAY 1984; GÜVENC 1996). In low N doses, no significant difference among the genotypes was determined in term of nitrate accumulation (NIEUWHOF and JANSEN 1993). Therefore, N_2 was applied as excessive N dose in

this research. Additionally, all plots received 80 kg P_2O_5/ha (GÜNAY 1984) as triple super phosphate. All of the P_2O_5 and half of the NH_4NO_3 fertilizers were broadcasted uniformly prior to planting onto the soil surface by hand and incorporated. The remaining half of nitrogen was given 20 days after the planting (SRINIVAS and NAIK 1990). Seeds were sown on July 27 in 1996 and July 25 in 1997. The plants were thinned after emergence to maintained at an inter and intra row spacing of 20 cm (GÜNAY 1984) with a plot size of 2.1 x 1.2 m. During the development phases, all of the plant care practices have been irrespectively applied on the plants in each plot.

The number of leaves per plant, weight, diameter and length of root, total nitrogen and nitrate content of root and the yield were determined. All of the observations except yield were made on randomly selected 40 plants. The total N content were determined according to Kjehldal procedure and nitrate analyses with Phenol disulphonic acid method (KACAR 1972). Data were subjected to ANOVA and the differences between means were tested according to LSD.

Table 1. Effects of nitrogen fertilization on growth in radishes.
Wirkung der Stickstoffdüngung auf das Wachstum von Rettich.

N (kg/ha)	'Fındık'	'Kestane'	'Bayır'	'8 TR-18'	'Antep'
			Number of leaf per plant		
			1996		
0	7,93 NS	8,23NS	9,06 NS	11,02NS	10,40 NS
100	10,23	8,83	9,63	13,14	12,05
200	9,06	9,03	10,83	13,00	12,76
			1997		
0	8,01 NS	9,00 NS	10,00 NS	10,83NS	9,87 NS
100	9,53	9,34	10,62	12,77	11,87
200	9,40	9,37	10,91	13,28	12,06
			Root weight (g)		
			1996		
0	137,33c*	220,00c*	213,31b**	225,56c**	376,66b**
100	167,35b	321,42b	251,60a	295,67b	456,61a
200	196,33a	385,22a	273,36a	333.47a	498,38a
			1997		
0	143,14c**	263,78c*	220,15c*	261,25c*	344,01c*
100	176,78b	337,14b	270,72b	320,44b	403,84b
200	191,46a	354,35a	304,11a	350,55a	440,23a
			Root diameter (cm)		
			1996		
0	5,75b**	8,01c*	6,53b**	5,71b*	7,77 b**
100	5,95b	9,58b	7,41a	6,58ab	8,26a
200	6,60a	11,20a	7,58a	7,16a	8,53a
			1997		
0	5,81b**	8,60c*	7,00b*	6,21c**	7,60b*
100	6,26a	9,78b	7,97a	7,14b	8,46a
200	6,40a	10,91a	8,04a	7,67a	8,69a
			Root length (cm)		
			1996		
0	8,06 NS	7,9c*	5,08b*	18,83b*	13,93c*
100	8,08	9,1b	6,38a	21,76a	16,33b
200	8,25	10,6a	7,00a	21,83a	18,15a
			1997		
0	8,31 NS	8,37c**	5,38c*	20,08b**	13,50c*
100	8,84	9,56b	6,83b	22,88a	15,00b
200	8,99	10,50a	7,49a	22,95a	16,63a

(*): Significant at the $P<0.01$ levels.
(**): Significant at the $P<0.05$ levels.
(NS): Non significant at the $P=0.05$

Results

Number of leaves per plant

The results obtained from different doses of nitrogen treatment on the number of leaves per plant showed no differences for both years. However, the application of 200 kg N/ha gave a slight increase in terms of leaf number per plant (Table 1).

Root growth

In this study, maximal root growth was obtained with N_3 doses. The root weight of radishes was significantly higher in the treatment of both nitrogen doses when compared to the control group (Table 1). The root weight was the highest in 200 kg N/ha treatment and the lowest in the control treatment. Diameter and length of roots showed similar trend as was the case for root weight. The highest root diameter and length in five radish genotypes were obtained from 200 kg N/ha application.

Root yield

There were statistically significant differences among the N doses on the root yield in radish in both experimental years. The highest root yields were recorded at the 200 kg N/ha application followed by 100 kg N/ha and control treatments for both cultivars and years (Table 2).

Nitrogen content

Total nitrogen content of root in five radish genotypes increased with higher nitrogen applications in both years (Figure 1). The total N absorbed by root was positively related to amount of nitrogen applied. On the other hand, nitrogen application significantly increased nitrate accumulation in genotypes (Figure 2).

Discussion

Responses of the radish plants to nitrogen fertilizers were consistent in both years. Present results indicated that there were no significant differences among N

Table 2. Effects of Nitrogen fertilization on root yield of radishes.
Wirkung der Stickstoffdüngung auf den Ertrag von Rettich.

N (kg/ha)	'Fındık'	'Kestane'	'Bayır'	'8 TR-18'	'Antep'
			Root yield (kg/plot)		
			1996		
0	5,49c*	8,77c*	8,53b*	9,02c**	17,06b*
100	6,69b	12,84b	9,90a	11,82b	20,26a
200	7,84a	15,40a	10,93a	13,33a	22,04a
			1997		
0	6,23b**	10,52c*	9,00c**	9,90c*	13,80b*
100	7,17a	13,48b	10,60b	12,62b	16,84a
200	7,46a	14,16a	11,58a	13,57a	17,60a

(*): Significant at the $P<0.01$ levels. (**): Significant at the $P<0.05$ levels.

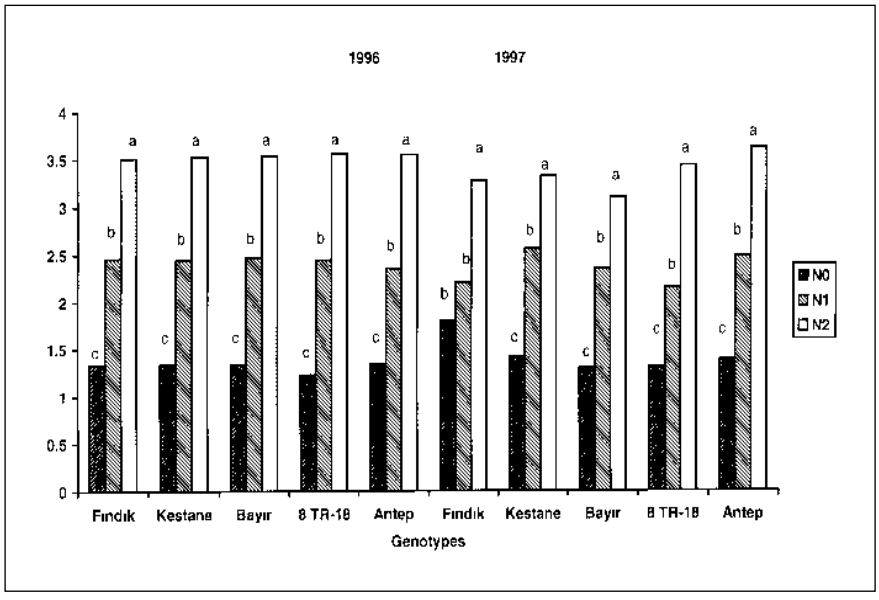


Figure 1. Effect of nitrogen fertilization on total nitrogen content (%) in radishes. Different letters in a column are significantly different ($P<0.05$). *Einfluss der Stichstoffdüngung auf den Gesamt-Stickstoffgehalt (%) in Rettich. Abweichende Buchstaben in den Spalten weisen auf signifikante Unterschiede hin ($P<0.05$).*

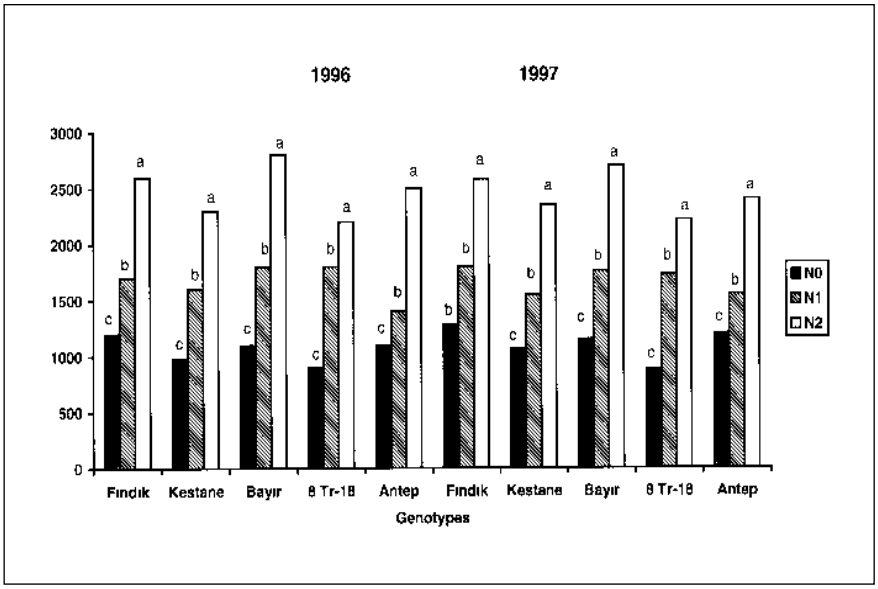


Figure 2. Effect of nitrogen fertilization on nitrate accumulation (ppm) in radish. Different letters in a column are significantly different ($P<0.05$). *Einfluss der Stichstoffdüngung auf die Stickstoffanreicherung in Rettich. Abweichende Buchstaben in den Spalten weisen auf signifikante Unterschiede hin ($P<0.05$).*

doses in terms of the number of leaves per plant. However, N application strongly increased root growth, root yield and nitrate accumulation in both years. Other studies noted that nitrogen fertilization could affect vegetative growth such as root growth (HORST et al. 1985; PECK et al. 1989; GUVENC 1995; PARTHASARATHI et al. 1999), and high N rates usually increased plant size (MULLINS 1987).

Hence numerous studies have shown that the highest growth of plants in radish was recorded at the highest N rates (JOSHI and CHAUHAN 1985; SRINIVAS and NAIK 1990). Present results obtained in this study in terms of root size of radish supported by the results of previous studies (JOSHI and CHAUHAN 1985; SRINIVAS and NAIK 1990). On the other hand BARKER et al. (1983) reported that root growth of radish was generally reduced with decreasing N level, which is again in agreement with the results of present study. In this study, root yield was increased with increasing rates of N, and the highest yield was recorded at the highest N rate (Table 2). Similar results have also been reported in some radishes (JOSHI and CHAUHAN 1985; SRINIVAS and NAIK 1990) stating that root yield of radish was increased with increase in the amount of nitrogen.

In this research, nitrogen content of the radish roots was significantly affected by nitrogen fertilization. There was a much greater increase in nitrate N as well as total nitrogen in the root parts. Furthermore, the data from this study strongly indicated that nitrogen fertilization was more responsive for nitrate accumulation of root on radish genotypes. In this experiment, due to the similar reaction of all radish genotypes to the supply of nitrogen was the most important factor determining total nitrogen and nitrate content of the roots. These results are also consistent with the findings of some other researcher (KARACAL and TÜRETKEN 1992; NIEUWHOF and JANSEN 1993; MALAKOUTI et al. 1998).

In conclusion, the results of this study suggest that the radish genotypes tested had increased the growth characteristics with the increasing N doses. But this was not very acceptable outcome in term of the nitrate accumulation, which is harmful for human health. Therefore, the normal nitrogen doses should be applied in these radishes to have better yield and healthy crops for human nutrition.

Literature

ALCICEK, A. and S. BASLAR 1995: Bitki ve sularda asırı nitrat birikiminin sonucları. Ekoloji Çevre Dergisi **14**, 15–18.

AYDIN, G. and M. AKTAS 1995: The effect of Various Ammonium Sources on the Growth and Nitrate Accumulation in Lettuce (*Lactuca sativa* L.) Grown in Perlite. Tr. J. of Agriculture and Forestry **19**, 103–109.

ANONOYMUS 1996: Tohumluk Programı.Tarım ve Köy isleri Bakanlığı, TÜGEM Yayını, Ankara, 147.

BARKER, A. V., J. F. LAPTANTE and R. A. DAMON 1983: Growth and composition of radish under various regimes of nitrogen nutrition. J. Amer. Soc. Hort. Sci. **108**, 1035–1040.

GÜNAY, A., 1984: Sebzecilik: Özel Sebze Yetistiriciliği, Çağ Matbaası, Ankara, 312.

GÜVENC, I. 1995: Farklı azot kaynaklarının turpta yumru gelismasi ve yumru verimine etkisi. Türkiye II. Ulusal Bahce Bitkileri Kongresi, 346–349.

GÜVENC, I. 1996: Effects of nitrogen levels on Growth and yield of radish. I. National Symposium of Vegetable Growing, 263–267.

HORST, G. L., L.B. FENN and N.B. DUNNING 1985: Bermuda grass turf response to nitrogen sources. J. Amer. Soc. Hort. Sci. **110**, 759–761.

JOSHI, O.L. and K.S. CHAUHAN 1985: Effect of nitrogen and sulphur on vegetative growth, yield and quality of radish. Indian J. Hort. **42**, 263–267.

KACAR, B. 1972: Bitki ve toprağın kimyasal analizleri: II. bitki analizleri. A.Ü. Ziraat Fakültesi Yay. No. **453**, 646.

KARACAL, I. and I. TÜRETKEN 1992: Normal ve asırı dozlarda azot uygulamasının marul (*Lactuca sati-*

va)'da nitrat ve nitrit birikimine etkisi. Türkiye I. Ulusal Bahçe Bitkileri Kongresi, Cilt **II**, 33.

MALAKOUTI, M. J., M. NAVABZADEH and S. H. R. HASHEMI 1998: Effect of different amount of N-fertilizers on the nitrate accumulation in the edible parts of vegetables. Soil and Water Journal, **11**(1–2), 14–21.

MULLINS, C. A., 1987: Effect of nitrogen fertilization on production of mechanically harvested snap bean. HortScience **12**(1), 34–36.

NIEUWHOF, M. and R. C. Jansen 1993: Effect of nitrogen fertilization on nitrate content of radish (*Raphanus sativus* L.). Gartenbauwissenschaft **58,** 130–134.

PARTHASARATHI, M, K. S. KRISHNAPPA, M. C. GOWDA, N. S. REDDY and M. ANJANAPPA 1999: Growth and yield of certain radish varieties to varying levels of fertility. Karnataka Journal of Agricultural Sciences **12**, 148–153.

PECHOVA, B., J. PRUGAR, M. MEDVED, and D. Miklovic 1999:. Processes of nitrate accumulation in vegetable crops. Horticultural Abstracts **69**, 5083.

PECK, N. H. and G. E. MACDONALD 1984: Snap bean plant responses to nitrogen fertilization. Agronomy J. **76**, 247–253.

Peck, N.H., G. E. MACDONALD and A. V. GARDNER 1989: Snap bean plant responses to sources and rates of nitrogen and potassium fertilizer. HortScience, **24** 619–623.

SRINIVAS, K. and L. B. Naik 1990: Growth and yield of radish (R*aphanus sativus* l.) in relation to nitrogen and potash fertilization. Indian J. Hort **47**, 114–119.

Eingereicht: 28.06.01/18.09.01

Anschrift des Verfassers: Ismail Guvenc, Department of Horticulture, Agricultural Faculty of Ataturk University, 25240 Erzurum, Turkey, e-mail: iguvenc@atauni.edu.tr.