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Effects of Nitrogen Levels and Forms on the Yield and Yield Components of Lentil (*Lens culinaris* Medic.)

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Abstract: This study was carried out to determine the most suitable nitrogen forms and levels for lentil cultivar (Sazak-91) in eastern Turkey in 2000-2001 and 2001-2002 growing seasons. Four nitrogen levels (0, 20, 40 and 60 kg ha^{-1}) and four nitrogen forms (ammonium nitrate, ammonium sulphates, urea and organic N) were applied in Sazak-91 lentil cultivar to find out their effects on the yield and some yield components. Plant height, first pod height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per plant, grain yield per area, harvest index and 1000 seed weight were measured. Grain yield per area and some yield components were affected by nitrogen forms and levels significantly. Application of nitrogen up to 40 kg ha^{-1} significantly increased grain yield per area, the highest grain yields per area were found to be 1422, 1632 and kg ha^{-1} in the first year and the second year, respectively. The average yield was 1527 kg ha^{-1}. Ammonium sulphate gave the highest grain yield as 1360, 1572 and 1466 kg ha^{-1} in both years and two years average, respectively. The lowest grain yield per area was found as 927, 1152 and 1039 kg ha^{-1} from control parcels in both years and two years average, respectively.

Key words: Lentil (*Lens culinaris* Medic.), nitrogen, level, form, yield

INTRODUCTION

Grain legumes are the most important protein and mineral food crops in the world, especially in developing countries[1]. Among them, lentil as an important grain legume in Turkey. Lentil, which has occupied the top position in terms of popularity, comes the second as the area sown and the production in Turkey. It is an important plant to be used in fallowing areas. It is grown on 470 000 ha and production exceeds 470 000 tones. However national yield have been 1000 kg ha^{-1} stagnant on average.

The nutritive quality of grain legumes is greatly influenced by agronomic factors[2]. Poor fertilization area is considered to be an important factors. The present study was carried out to determine the effect of Nitrogen levels and forms on lentil.

MATERIALS AND METHODS

The experiment was conducted in the fields of Faculty of Agriculture, Yüzüncü Yıl University in Complete Randomized Block Design with three replications. The study was carried out to determine the most suitable nitrogen form and level for lentil cultivar (Sazak-91) in 2000-2002 seasons. Four nitrogen levels (0, 20, 40 and 60 kg ha^{-1}) and four nitrogen forms (ammonium nitrate, ammonium sulphate, urea and organic N) were applied. Sowing date was on 28 October in 2000 and 27 October in 2001 by hand in 1x5 m plots (5 m^2) in rows with 20 cm apart. At the sowing, 60 kg ha^{-1} P_2O_5 as Triple Super Phosphate was applied. The weed control was reformed, when needed.

Harvest was done on 25 June 2001 and 2 July 2002, excluding one row from both sides of each plot and 50 cm from both ends (0.6x4 m= 2.4 m^2). Data on grain and biological yields were recorded from the whole plot, but the yield components data were recorded from randomly selected plants in each plot. Soil samples were analyzed at the laboratories of Department of Soil, Faculty of Agriculture, Yüzüncü Yıl University. The experimental soil was strongly alkaline, organic matter content wasn't enough and as the soil reaction the pH was 8.4 (Table 1). Monthly rainfall, relative humidity and average temperatures are shown on Table 3.

Table 1: Chemical and physical analysis of the experimental soils

Soil property	2000-01	2001-02
Texture	Sandy-loamy-clay	Sandy-loamy
Organic matter content (%)	0.51	0.57
Phosphorus content (ppm)	9.31	4.92
Lime content (%)	12.71	14.27
Salt (%)	0.22	0.41
pH	8.45	8.42

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Data on investigated characters were subjected to analysis of variance and means were separated according to Duncan Multiple Range Test.

RESULTS AND DISCUSSION

The analysis of variance showed that both nitrogen levels and nitrogen forms significantly affected all characters investigated except 1000 seed weight (Table 2). Dose x Form interaction was statistically significant for all characters studied except the number of secondary branches and 1000 seed weight in first year and average of two years, number of primary and secondary branches and 1000 seed weight in second year. Level x Form x Year interaction was also statistically significant for plant height, number of secondary branches, number of pods per plant, number of seed per plant and grain yield.

The highest plant height was obtained with 60 kg ha^{-1} nitrogen application as 26.9, 33.0 and 29.9 cm and from organic N as 28.3, 31.8 and 30.1 cm in both years and as average of two years, respectively (Table 2). The lowest plant height was obtained from control plots and from urea form. Islam and Afandi[3], Kumar *et al.*[4] reported similar results about plant height. The highest first pod

Table 2: The effect of nitrogen levels and forms application on yield and some yield components of lentil in Turkey

			Level (kg da^{-1})			Form				
	Years	Control	20	40	60	A. nitrate	A. sulphates	Urea	Organic N	Mean
Plant height (cm)	2000-01	23.9c	25.7b	25.9b	26.9a	25.6b	25.5b	22.9c	28.3a	25.6b
	2001-02	26.7d	29.2c	31.7b	33.0a	29.3b	31.7a	27.8c	31.8a	30.1a
	Mean	25.3d	27.4c	28.8b	29.9a	27.5c	28.6b	25.3d	30.1a	
First pod height (cm)	2000-01	7.7d	9.5c	10.4b	11.7a	8.9c	10.9a	9.0c	10.5b	9.8b
	2001-02	8.2d	10.4c	11.8b	13.2a	10.1c	12.1a	9.8c	11.6b	10.8a
	Mean	7.9d	9.9c	11.1b	12.5a	9.5c	11.4a	9.4c	11.1b	
Number of branches/plant	2000-01	1.4c	1.8b	2.1a	2.1a	1.7c	1.9b	1.8c	2.0a	1.8b
	2001-02	1.7c	2.1b	2.4a	2.3a	2.0c	2.2ab	2.0c	2.3a	2.1a
	Mean	1.5c	1.9b	2.3a	2.2a	1.8c	2.0b	1.9c	2.1a	
Number of secondary branches	2000-01	1.7a	1.7a	1.5a	1.2b	1.5	1.5	1.6	1.4	1.5b
	2001-02	1.9d	2.2c	2.6a	2.3b	2.2b	2.4a	2.1c	2.4a	2.2a
	Mean	1.8bc	1.9ab	2.1a	1.7c	1.9	1.9	1.9	1.8	
Number of pod/plant	2000-01	14.8d	20.1c	25.5a	23.6b	18.2d	23.7a	20.6c	21.4b	21.02b
	2001-02	17.3d	22.5c	29.0a	25.3b	20.1d	27.5a	22.3c	24.4b	23.5a
	Mean	16.1d	21.3c	27.3a	24.5b	19.2d	25.6a	21.4c	22.9b	
Number of Seeds/plant	2000-01	18.8c	23.1b	28.5a	28.4a	21.8d	27.3a	24.2c	25.3b	24.7b
	2001-02	19.4d	25.1c	32.6a	28.3b	22.4d	30.6a	25.0c	27.2b	26.2a
	Mean	19.1d	24.1c	30.4a	28.3b	22.1d	28.9a	24.6c	26.3b	
Grain yield (kg ha^{-1})	2000-01	927.0c	125.0b	1422.0a	1272.0b	1144.0c	1360.0a	1075.0d	1295.0b	1218.0b
	2001-02	1152.0c	1444.0b	1632.0a	1458.0b	1416.0c	1572.0a	1239.0d	1460.0b	1421.0a
	Mean	1039.0c	1348.0b	1527.0a	1365.0b	1280.0c	1466.0a	1157.0d	1377.0b	
Harvest index (%)	2000-01	32.3c	34.1b	35.2a	35.3a	33.5b	34.5a	33.6b	35.2a	34.2b
	2001-02	34.8c	36.1b	37.1a	36.9a	35.5c	36.3b	35.2bc	37.8a	26.1a
	Mean	33.5c	35.1b	36.1a	36.1a	34.5c	35.4b	34.4c	36.5a	
1000-seed weight (g)	2000-01	56.8	57.3	57.3	57.2	57	57.1	57.3	57.2	57.1b
	2001-02	60.9	60.0	59.7	60.2	60.3	60.4	59.9	60.1	60.1a
	Mean	58.8	58.6	58.4	58.6	58.6	58.7	58.6	58.6	

* For each row within each treatment, means follows by the same letter do not differ significantly at 5% probability level following DMRT.

Table 3: Meteorological data at the experimental site

	2000-01			2001-02		
Months	Average temp.(°C)	Relative humidity (%)	Rainfall (mm)	Average temp. (°C)	Relative humidity (%)	Rainfall (mm)
September	17.9	50.5	1.7	18.9	40.0	1.5
October	11.8	61.1	2.7	11.4	57.0	56.2
November	5.5	64.1	14.3	3.9	65.3	82.9
December	1.0	73.8	60.7	1.2	67.0	51.3
January	-0.6	76.1	17.0	-3.3	68.1	30.8
February	0.3	74.0	28.2	-0.8	71.7	7.7
March	6.3	70.4	46.2	3.4	68.6	66.6
April	9.6	65.2	32.6	6.9	69.5	107.4
May	12.5	63.2	28.0	12.3	57.6	54.8
June	19.6	49.1	4.5	17.9	49.5	20.4
July	23.1	52.6	6.8	22.6	46.4	3.1
August	24.0	41.3	-	-	-	-
Average/ Total	10.9	61.7	242.7	8.5	60.0	482.7

Source: Anonymous[11]

height was obtained with 60 kg ha^{-1} nitrogen application (11.7, 13.2 and 12.5 cm) and from ammonium sulphate form (10.9, 12.1 and 11.4 cm) in both years and as average of two years. A significant effect of 40 and 60 kg N ha^{-1} were observed on the number of primary branches. While the highest number of primary branches was obtained from organic N as 2.0, 2.3 and 2.1 branches/plant, ammonium nitrate and urea forms gave the lowest number of primary branches. The lowest number of secondary branches was obtained with 60 kg ha^{-1} nitrogen level as 1.2 branches/plant, the highest number of secondary branches were recorded from control and 20 kg N ha^{-1} nitrogen application. It wasn't observed any differences between nitrogen forms in the first year. The highest number of secondary branches was obtained with 40 kg ha^{-1} nitrogen application in second year and average of two years. Ammonium sulphate and organic N gave the highest number of secondary branches in second year. There were non-significant differences between nitrogen forms in the mean of two years. Similar effects were observed by Hattar and Haddad[5]. Who reported that primary branches were significantly affected by ammonium sulphate form with 25 and 50 kg ha^{-1} nitrogen application as 2.8 and 3.1.

The application of 40 kg ha^{-1} nitrogen and ammonium sulphate gave the highest number of pods per plant in both years and two years average (Table 2). Hattar and Haddad[5], Sharma and Singh [6], Kumar *et al.* [4], Rahman and Miah[7] reported similar results about number of pods per plant. Number of seeds per plant and grain yield were found similar to those for the number of pods per plant. While the highest seed per plant from 40 kg ha^{-1} nitrogen levels 27.3, 28.5 and 32.6 seed/plant, in both years and average of two years, respectively. The lowest seed per plant was from control plots. The highest number of seed per plant was recorded from ammonium sulphate among the nitrogen forms.

Application of nitrogen up to 40 kg ha^{-1} significantly increased grain yield. The highest grain yields per area were found to be 1422, 1632 and 1527 kg ha^{-1} and ammonium sulphate gave the highest grain yield per area as 1360, 1572 and 1466 kg ha^{-1} in both years and two years average as, respectively (Table 2). There was a significantly difference by the grain yield between the first and second year. It might be due to meteorological datas (Table 2). Grain yield per area was affected by the number of pods and seeds per plant. Higher number of pods and seeds per plant, resulted higher grain yield per area. Kumar *et al.*[4] reported that the number of pod and grain yield per area were significantly increased by 20 kg N ha^{-1} (as urea). There is a difference between two studies. It might be due to soil structure and fertilization used. On the other hand, Bremer *et al.*[8] reported that grain yield per area significantly increased by 50 kg N ha^{-1}.

The highest harvest index were obtained 40 and 60 kg N ha^{-1} and the difference between this doses was found non significant. While the first year of the study the highest harvest index was obtained from ammonium sulphate as 34.5% and organic N as 35.2%, the second year and average of two years from organic N as 37.8 and 36.5%, respectively. There was no significant effect of nitrogen levels and nitrogen forms on 1000 seed weight. Similar effects were observed by Kulaz *et al.*[9], Sharma and Singh[6]. However, in contrast to Kumar *et al.*[4], Hoque and Haq[10] reported that nitrogen application increased 1000 seed weight.

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