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DETERMINATION OF THE FORM AND THE AMOUNT OF THE SECOND DOSE OF NITROGENOUS FERTILIZERS TO BE APPLIED TO WHEAT IN SPRING

NURI YILMAZ

Department Field Crops, Agricultural Faculty,
Black Sea Technical University, 52100 Ordu, Turkey.

Abstract

Studies were conducted to examine the form and the quantity of second dose of nitrogenous fertilizers given to wheat in spring in Yozgat's ecological conditions in Turkey during 1998-1999 and 1999-2000. Sowing, @ 500 seeds per square meter, was done with sowing seeder in the last week of September and 15 kg/da DAP was given at the time of sowing. Of the nitrogenous fertilizers, Ammonium sulphate (21 %N), Ammonium nitrate (26 %N) and Urea (46 %N) was applied @ 0, 20, 40, 60 and 80 kg/ha respectively. The experiment was set up as factorial in randomised blocks design with three replications. The effects of increasing dozes of fertilizer and the nature of nitrogen fertilizer on yield appeared to be important. The highest yield of 3287 kg/ha was obtained with 80 kg/ha Urea and the lowest yield of 1575 kg/ha, was obtained where fertilizer were not applied.

Introduction

Wheat occupies a significant position in Turkish agriculture. It is cultivated as a main crop in the Yozgat province. According to the statistical data of the year 2000, wheat was sown on 78 % of the total cereal production area (449.095 ha) in Yozgat. The total wheat production was 650.000 t and its yield 1850 kg/ha. This yield was however lower than the mean for Turkey (2234 kg/ha), (Anon., 1999, 2001). While wheat in Turkey is cultivated on a large area, but its per ha yield is considerably low. Further it is not possible to open new fields for wheat cultivation so the higher yields could be reached by using the suitable plant production techniques. Besides high yielding seed, irrigation, mechanization, crop rotation and plant protection, fertilization is one of the most important criteria for cultivation also.

Considering the relationships between the fertilizer consumption and the wheat yields of Turkey during 1960-1988 when 0,08 kg/ha fertilizers had been used, the wheat yield was 1100 kg/ha in 1960, and when 64,8 kg/ha fertilizers had been used, the wheat yield was 2170 kg/ha in 1988. With use of higher amounts of fertilizer, the wheat yields had been increased. The consumption of fertilizer for the plant production per unit is 1/3 of world and Asian countries and 1/3 of European countries. Although the Black Sea region used the highest fertilizer (126 kg/ha) in Turkey, but it is lower than European countries (226 kg/ha) and Greece (171 kg/ha) (Eker, 1997). While consumption of fertilizer for plant production in Turkey has increased with time, but this consumption is not enough for getting the higher yields. The significant point is that besides using the higher amounts of fertilizer, the suitable fertilization technique should also be applied. Using the suitable fertilizer forms on time is expected to result in optimum yields. The aim of this study was to determine the amount and the form of the second part of nitrogenous fertilizer for optimum wheat yields under the Yozgat arid conditions in the spring time.

Material and Methods

This study was carried out at the Yozgat, province of Turkey and included the Middle East Anatolia farmer's fields during 1998-2000. The long years' average temperature values were 9.3°C, 9.9°C and 8.6°C during 1998, 1999 and 2000, with total rainfall of 458 mm, 442 mm and 456 mm, respectively (Anon., 2001).

The experimental soils were loamy and light alkaline pH: 7.25-7.62. Although the total potassium content of the soils was high (880-915 kg/ha), the phosphorus content was medium (73-76 kg/ha) and the organic material was low (1.87-2.02%).

The Bezostaja wheat cv., widely sown in this region, was used as the seed material. The experiment was set up in a Completely Randomized Design with three replicates. The plot's area was 6 m². The seeds were sown with cereal tiller at the end of September and were applied with 150 kg/ha DAP (Diammonium phosphate) with sowing (Kün, 1988). After tillering (at the end of March) ammonium sulphate (21 N%), ammonium nitrate (26 N%) and urea (46 N%) were applied in five different doses with control (0, 20, 40, 60 and 80 kg/ha) as the experimental factors in the spring.

Plant height, the number of spike per square meter, the number of seeds per spike, 1000 seeds weight and seed yield were recorded. After the statistical analysis, differences among the average values were compared according to Duncans Multiple Range Test at 5 % probability level (Yurtseven, 1984).

Results and Discussion

Plant height: The results of analysis of variance and the average values for plant height are given in Table 1. Different nitrogen doses significantly affected the plant height which varied from 70.3-85.4 cm according to years. As the plant height increased upto 40 kg N/ha treatment, the additional fertilizer amounts didn't affect the plant height. The results obtained from this study are similar to those reported by Pendleton & Duncan (1960); Rohde (1963); Ülgen & Alemdar (1979); Hazar & Ceylan (1985); Liboon & Tabelisma (1985); Katkat *et al.*, (1987) and Güzel *et al.*, (1988).

The different forms of nitrogen fertilizers affected plant height statistically (Table 1). As the mean of years, the effect of ammonium sulphate on the plant height (76.3 cm) was lower than of ammonium nitrate (81.1 cm) and urea (81.4 cm). The effectiveness of the ammonium nitrate and ammonium sulphate fertilizers in the plant connect with their external concentrations. As the low quantities of these fertilizers don't affect the plant development, in the high quantities of these fertilizers, plant development differs highly. Also the urea is quickly absorbed with plant roots and vegetative tissues, hydrolyzed with the enzyme areas and used in advantage (Güneş *et al.*, 2000). The results have shown similarities with other studies.

The number of ear per square meter: Different nitrogen levels significantly affected the number of ear per square meter (Table 1). The highest number of ear per square meter (388.4 ears/m²) was obtained from 80 kg N/ha and the other higher number was obtained from 60 kg N/ha (360.2 ears/m²), 40 kg N/ha (314.8 ears/m²) and 20 kg N/ha (295.4 ears/m²) as compared to and 0 kg N/ha (247.7 ears/m²) respectively. Lahky (1984), Hazar & Ceylan (1985), Lahky (1986) and Güzel *et al.*, (1988) stated that the nitrogen fertilization increased the number of ear per square meter in wheat.

Table 1. F Values of all traits examined for nitrogen form and doses.

Variation sources	SD	1999					2000				
		Plant height (cm)	Ear No./m²	Grain No/Ear	1000 grain weight (g)	Biological yield	Plant height (cm)	Ear No./m²	Grain No./Ear	1000 grain weight (g)	Biological yield
N. Form	2	4.2*	6.2**	0.6	7.3**	30.4**	6.7**	4.1*	0.7	1.8	1.9
N. Dose	4	1.9	8.6**	1.9	11.9**	38.2**	55.6**	9.6**	16.7**	4.7**	42.1**
FxD Int.	8	0.5	2.9*	0.1	1.5	9.6**	1.9	0.9	1.5	2.7*	0.8
Error	28										
General	44										

Variation sources	Means of years					
	SD	Plant height	Ear No./m²	Grain No./Ear	1000 grain weight	Biological yield
Year	1	2293.5**	133.2**	368.7**	955.0**	1543.5**
N. Form	2	7.4**	9.1**	0.1	7.5**	18.2**
Year x Form Int.	2	2.2	1.2	1.2	3.7*	4.8**
N. Dose	4	23.5**	16.5**	11.8**	14.3**	77.4**
Year x Dose Int.	4	7.8**	1.7	2.8*	4.9**	4.8**
Form x Dose Int.	8	0.9	1.2	0.7	1.9	4.9**
Year x Form x Dose Int.	8	0.8	2.4**	0.4	1.7	3.1**
Error	56					
General	89					

*, ** Significant at 0.05 and 0.01 % respectively.

Table 2. Average values of the plant height (cm) studied for each nitrogen form and doses*.

Years	Nitrogen forms	Nitrogen doses (kg/ha)					Means of forms	Means of years
		0	20	40	60	80		
1999	A. Sulphate	44.6	46.2	43.0	49.5	51.0	46.8 **B**	
	A. Nitrate	45.6	49.3	54.5	53.2	52.1	50.9 **AB**	
	Urea	52.4	47.9	52.7	57.9	60.6	54.9 **A**	
Means of doses		47.5	47.8	50.0	53.5	54.6		50.7
2000	A. Sulphate	92.9	101.4	107.6	115.0	111.7	105.7 **B**	
	A. Nitrate	99.1	104.9	116.0	118.5	117.6	111.2 **A**	
	Urea	87.2	103.6	115.4	116.7	119.7	108.5 **AB**	
Means of doses		93.0 **C**	103.3 **B**	113.0 **A**	116.7 **A**	116.3**A**		108.5
Means of years	A. Sulphate	68.7	73.8	75.3	82.2	81.4	76.3 **B**	
	A. Nitrate	72.3	77.1	85.2	85.8	84.9	81.1 **A**	
	Urea	69.8	75.7	84.0	87.3	90.1	81.4 **A**	
Means of doses		70.3 **C**	75.5 **B**	81.5 **A**	85.1 **A**	85.4 **A**		
General mean								79.6

* Differences between the means pointed out using different letters are significant at 5 % probability level.

The number of ear per square meter was significantly affected with the different forms of nitrogen (Table 1). As for the mean of years, the highest ear number (351.7 ears/m²) was obtained from urea. The other higher ear number was obtained from ammonium nitrate (323.8 ears/m²) and ammonium sulphate (288.5 ears/m²) (Table 3). There were no statistical differences between urea and ammonium nitrate.

The number of grain per ear: In the first year, varying nitrogen levels didn't affect the number of grain per ear, but the grain number was increased by nitrogen fertilization in the second year (Table 1). The differences between years resulted from different climatic factors. The grain number increased with nitrogen application. However, there were no statistical differences among the 40, 60 and 80 kg N/ha applications (Table 4). Lahky (1984), Hazar & Ceylan (1985), and Katkat *et al.*, (1987) also found similar results. The number of grain per ear didn't change by varying forms of nitrogen for both years and for mean of the years. The means of grain numbers were 25.8 seeds/ear (urea), 25.6 seeds/ear (ammonium nitrate) and 25.5 seeds/ear (ammonium sulphate).

Thousand grain weight: Different nitrogen doses significantly ($p< 0.05$) affected the 1000 grain weight in the wheat (Table 1). For the mean of years, the highest thousand-grain weight (41.6 g) was obtained from 80 kg N/ha application. The higher thousand-grain weights were 40.7 g, 39.7 g, 37.8 g and 37.5 g from 60, 40 and 20 0 kg N/ha applications, respectively (Table 5).

Katkat *et al.*, (1984), Hazar & Ceylan (1985) and Hagras (1985) stated that high doses of nitrogen application increased the thousand-grain weight in the wheat. On the other hand, Rohde (1963) found that the 1000 grain weight showed differences among the wheat cultivars by varying nitrogen levels. But Liboon & Tabelisma (1985) stated that different nitrogen doses didn't affect the 1000 grain weight in the wheat. The results showed that the 1000 grain weight was affected by the ecological conditions.

The 1000 grain weight changed with different forms of nitrogen in the first year and for the mean of the years (Table 1). The highest 1000 grain weight (40.4 g) was obtained from urea followed by ammonium nitrate (39.5 g) and ammonium sulphate (38.4 g) respectively.

Grain yield: The results of analysis of variance and means of grain yield are given in Table 1 and Table 2 respectively. The effects of increasing nitrogen levels on grain yield were significant and the highest grain yield was obtained from 80 kg N/ha application (2749 kg/ha) according to the means of years. The other higher grain yields were obtained from 60 kg/ha (2394 kg/ha), 40 kg/ha (2066 kg/ha), 20 kg/ha (1879 kg/ha) and 0 kg/ha (1575 kg/ha) respectively. Rohder (1963), Laopirajana *et al.*, (1972), Johnson *et al.*, (1973), Ülgen & Alemdar (1979), Alptürk (1979), Özer & Dağdeviren (1984), Fatyga (1985), Fowler *et al.*, (1989) and Öztürk & Genç (1989) reported that nitrogen application had increased the grain yield in wheat. In these studies the nitrogen application had not affected grain yield in linear and the extreme nitrogen application decreased the grain yield. But in this study the grain yield increased with high nitrogen levels in linear. It would suggest that that the higher nitrogen levels should be applied.

As the different forms of nitrogen affected grain yield in the first year and for means of the years, different forms of nitrogen did not affect the second year grain yield (Table 1). For means of years, however, there were no statistical differences between urea (2289 kg/ha) and ammonium nitrate (2152 kg/ha) in relation to grain yield, but the ammonium

Table 3. Average values of the number of ears per square meter (ear/m²) studied for each nitrogen form and doses*.

Years	Nitrogen forms	Nitrogen doses (kg/ha)					Means of forms	Means of years
		0	20	40	60	80		
1999	A. Sulphate	192.0	209.0	188.6	252.3	263.3	221.0 **B**	
	A. Nitrate	160.3	257.0	275.0	239.3	274.3	241.2 **AB**	
	Urea	215.6	215.3	251.6	299.3	479.6	272.3 **A**	
Means of doses		189.3 **C**	227.1 **BC**	238.4 **BC**	263.6 **B**	339.1 **A**		251.5
2000	A. Sulphate	292.6	330.0	332.0	445.3	380.0	356.0 **B**	
	A. Nitrate	302.0	364.0	400.0	459.6	506.3	406.4 **A**	
	Urea	324.0	397.3	442.0	465.6	427.0	411.2 **A**	
Means of doses		306.2 **C**	363.7 **BC**	391.3 **AB**	456.8 **AB**	437.7 **A**		391.2
Means of years	A. Sulphate	242.3	269.5	260.3	384.8	321.6	288.5 **B**	
	A. Nitrate	231.1	310.5	337.5	349.5	390.3	323.8 **AB**	
	Urea	269.8	306.3	346.8	382.5	453.3	351.7 **A**	
Means of doses		247.7 **D**	295.4 **CD**	314.8 **BC**	360.2 **AB**	388.4 **A**		
General mean								321.3

* Differences between the means pointed out using different letters are significant at 5% probability level.

Table 4. Average values of the number of grain per ear (grains/ear) studied for each nitrogen form and doses*.

Years	Nitrogen forms	Nitrogen doses (kg/ha)					Means of forms	Means of years
		0	20	40	60	80		
1999	A. Sulphate	19.7	21.3	21.2	20.7	22.9	21.1	
	A. Nitrate	19.3	19.5	21.6	20.1	21.8	20.4	
	Urea	19.9	20.8	22.1	21.3	23.6	21.5	
Means of doses		19.6	20.5	21.6	20.7	22.8		21.0
2000	A. Sulphate	24.3	31.1	31.1	30.7	32.2	29.9	
	A. Nitrate	28.7	28.9	30.5	32.1	33.2	30.7	
	Urea	24.7	29.5	30.9	32.8	32.4	30.1	
Means of doses		25.9 **C**	29.8 **B**	30.8**AB**	31.9 **AB**	32.6 **A**		30.2
Means of years	A. Sulphate	22.0	26.2	26.1	25.7	27.6	25.5	
	A. Nitrate	24.0	24.2	26.0	26.1	27.5	25.6	
	Urea	22.3	25.1	26.5	27.1	28.0	25.8	
Means of doses		22.8 **C**	25.2 **B**	26.2**AB**	26.3 **AB**	27.7 **A**		
General mean								25.6

*: Differences between the means pointed out using different letters are significant at 5% probability level.

Table 5. Average values of the 1000 grain weight (g) studied for each nitrogen form and doses*.

Years	Nitrogen forms	Nitrogen doses (kg/ha)					Means of forms	Means of years
		0	20	40	60	80		
1999	A. Sulphate	31.3	29.4	30.9	32.1	33.8	31.5**B**	
	A. Nitrate	28.4	28.6	34.2	34.8	37.4	32.7**AB**	
	Urea	31.9	33.2	34.2	34.7	39.6	34.7**A**	
Means of doses		30.5**C**	30.4**C**	33.1**BC**	33.9**B**	36.9**A**		32.9
2000	A. Sulphate	43.6	44.2	46.9	48.0	44.1	45.3	
	A. Nitrate	46.0	45.6	44.9	48.8	46.8	46.4	
	Urea	43.9	45.7	47.0	45.7	48.1	46.1	
Means of Doses		44.5**B**	45.2**B**	46.3**AB**	47.5**AB**	46.3**A**		45.9
Means of tears	A. Sulphate	37.4	36.8	38.9	40.0	38.9	38.4**B**	
	A. Nitrate	37.2	37.1	39.6	41.8	42.1	39.5**AB**	
	Urea	37.9	39.5	40.6	40.2	43.8	40.4**A**	
Means of doses		37.5**C**	37.8**C**	39.7**B**	40.7**AB**	41.6**A**		
General mean								39.4

* Differences between the means pointed out using different letters are significant at 5% probability level.

Table 6. The effects of different nitrogen form and doses on wheat grain yield (kg/ha)*.

Years	Nitrogen forms	Nitrogen doses (kg/ha)					Means of forms	Means of years
		0	20	40	60	80		
1999	A. Sulphate	821	655	820	1226	1249	958 **C**	
	A. Nitrate	826	1188	1363	1176	1537	1221 **B**	
	Urea	874	1083	1206	1629	2686	1489 **A**	
Means of doses		840**C**	975**BC**	1130**BC**	1343**AB**	1824**A**		1217
2000	A. Sulphate	2304	2675	2929	3321	3458	2937	
	A. Nitrate	2358	2875	2908	3658	3675	3083	
	Urea	2259	2978	3167	3362	3887	3104	
Means of doses		2307**C**	2783**BC**	3001**AB**	3444**A**	3673**A**		3042
Means of years	A. Sulphate	1573**g**	1665**g**	1875**fg**	2273**b-e**	2354**b-d**	1948**B**	
	A. Nitrate	1573**g**	2031**d-f**	2135**c-f**	2413**bc**	2606**b**	2152**A**	
	Urea	1582**g**	1941**e-g**	2187**c-f**	2495**bc**	3287**a**	2289**A**	
Means of doses		1575**D**	1879**CD**	2066**BC**	2394**AB**	2749**A**		
General mean								2129

* Differences between the means pointed out using different letters are significant at 5 % probability level.

sulphate significantly decreased the grain yield (1948 kg/ha) (Table 6). Ülgen & Alemdar (1979) reported that urea and ammonium nitrate had positive effects on the wheat grain yield than ammonium sulphate. Our results are in harmony with the results of these researchers.

The interaction between the nitrogen form and doses was statistically significant and the highest grain yield (3287 kg/ha) was obtained from 80 kg/ha urea application (Fig. 1). The lowest grain yield was found in the control plots.

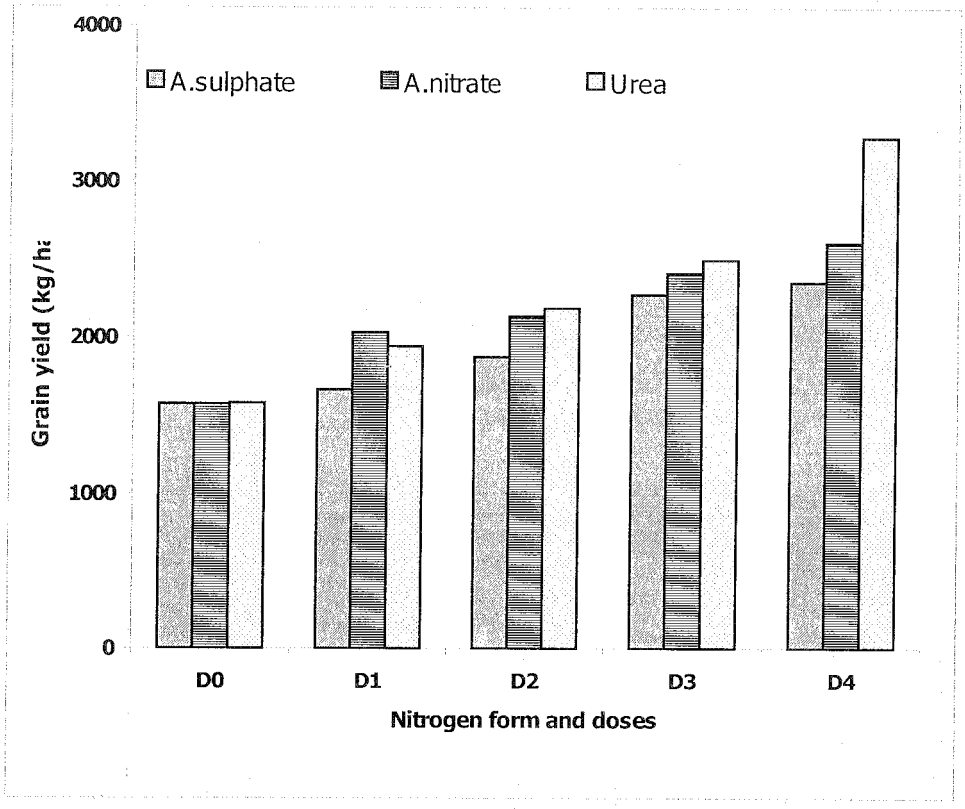

Fig. 1. Interaction between the nitrogen form and doses for grain yield.

Conclusion

The different nitrogen form and doses significantly affected the grain yield of wheat under the ecological conditions of Yozgat in Turkey during the years 1998-99 and 1999-2000. Highest grain yield (3287 kg/ha) was obtained from 80 kg/ha and the lowest grain yield (1575 kg/ha) in the control plots.

Taken the topographical and ecological conditions of Yozgat into consideration, the nitrogen fertilization should be applied @ 80 kg/ha and urea form in two doses both at the sowing time and spring time.

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