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Response of Bread Wheat to Nitrogen Fertilization Levels in Al-Qassim Region, Saudi Arabia

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ABSTRACT. This study considered the effects of six nitrogen fertilization levels (120, 180, 240, 300, 360 and 420 kg N/ha) on the biological and grain yields, yield components, plant height and heading date of the commercial bread wheat cultivar "Yecora Rojo". Two experiments were conducted during the two seasons, 1989/90 and 1990/91 at the Agricultural Experiment Station, College of Agriculture and Veterinary Medicine, King Saud University, Al-Qassim branch, Saudi Arabia. The experiments were set up in a complete randomized block design with four replications.

The results indicate that nitrogen fertilization levels had significant effects on number of spikes/m^2, number of kernels/spike, and plant height in the two seasons. High nitrogen levels resulted in significant increases in grain yield, harvest index values and number of days to heading in the second season only. On the other hand, nitrogen levels had no significant effects on either biological yield or kernel weight, in the two seasons. It could be concluded that the optimum nitrogen fertilization level for Al-Qassim region lies between 240 and 300 kg N/ha.

Introduction

Several high yielding semi-dwarf wheat cultivars were introduced to the Kingdom of Saudi Arabia due to the appreciated encouragement and subsidization offered by the government to wheat growers. Although these cultivars are well known to have a high yield potentiality, they are greatly influenced by many cultural practices, particularly the amount of applied nitrogen fertilizer.

Effect of nitrogen fertilization on wheat crop has been subjected to a great deal of investigation and is still receiving much attention because nitrogen supply, in many soils of the world, is not sufficient for optimum yield. Many investigators have indicated that the amount of nitrogen fertilizer greatly affects wheat grain yield and its components (Black 1982, Eissa *et al.* 1990, and Eissa 1991). However, the magnitude of yield increase would depend on fertilizer level, time of application as well as the source of nitrogen fertilizer (Ghandorah 1986, and Vaughan *et al.* 1990). In Saudi Arabia, Rawajfih *et al.* (1984) found that grain yield increased with the increment of nitrogen level up to 400 kg N/ha. Significant responses in grain yield to increased nitrogen level from zero to 100 kg N/ha, were also reported by Ghandorah (1985). For sandy soils, Rabie *et al.* (1991) recommended 230 kg N/ha.

The main objective of this investigation was to determine the optimum fertilization levels required for producing high biological and grain yields of wheat in Al-Qassim region.

Material and Methods

This research was carried out during the two successive wheat growing seasons 1989/90 and 1990/91 at the Agricultural Experiment Station, College of Agriculture and Veterinary Medicine, King Saud University, Al-Qassim Branch. The soil type of the experimental site is classified as sandy and its available nitrogen content is about 11 ppm (Rabie *et al.* 1991). The wheat cultivar used in this study was Yecora Rojo, the widely distributed commercial cultivar, recommended by the Ministry of Agriculture and Water in the Kingdom.

The experiment which was repeated for the two reasons, was set up in a complete randomized block design with four replications. The experimental plot consisted of 8 rows, 3 m long and 20 cm apart. A basal dressing of phosphorus fertilizer was applied in the form of triple super phosphate at a rate of 180 kg P_2O_5/ha during land preparation. The field experiments were planted on December, 7 and 15 of 1989 and 1990, respectively, using a seeding rate of 160 kg/ha. The irrigation was applied by the center pivot system during the two growing seasons.

Six nitrogen fertilizer levels; 120, 180, 240, 300, 360 and 420 kg N/ha were used in the form of urea. Four equal splits from the amount of each level, were applied during the four critical wheat growth stages: seedling, tillering, booting and heading.

From each plot, only the six central rows were harvested to avoid border effects. The biological yield was determined as the weight of the above ground dry matter. Grain yield was also weighted after threshing and both were adjusted to ton/ha. Harvest index was obtained by dividing the grain yield by the biological yield. Before harvesting, number of spikes/m^2 was determined by hand counting two 2.5 m row sample from each plot. Moreover, ten randomly selected main spikes from each plot were collected, threshed, their grains were counted and the average was calculated to record number of kernels per spike. A 1000-seed random sample from each plot, was hand counted for determination of kernel weight. Plant height was recorded by calculating the average length of five randomly selected plants measured from the ground level to the top of the terminal spikes excluding the owns. The number of days from sowing to heading date was determined when approximately 50% of plot plants headed.

Statistical analysis of variance and comparisons of means were made for all obtained data according to Steel and Torrie (1980). The combined analysis of variance of the two seasons were also computed.

Results and Discussion

The combined analysis of variance over the two seasons, presented in Table 1, showed that seasons had significant effects on all studied traits except harvest index. Therefore, the results of the two seasons (1989/90 and 1990/91), are discussed separately. The analyzed data indicated that nitrogen fertilization levels had no significant effects on either biological yield or kernel weight in both seasons. However, the greatest biological yields were obtained when 240 and 300 kg N/ha were applied in the two seasons, respectively. Although kernel weight showed no specific trend, the heaviest kernels were weighted from the plots in which 420 kg N/ha were added in both seasons (Table 2).

TABLE 1. Combined analysis of variance for yield and other agronomic traits of the wheat cultivar, Yecora Rojo as affected by six nitrogen levels.

	df	Mean squares							
		Grain yield tons/ha	Biological yield tons/ha	No. of spikes /m^2	No. of kernels /spike	1000-grain wt	Plant height	Days to heading	Harvest index
Season	1	20.76**	84.45**	9976.33**	805.24**	1221.29**	38.52*	1875.00**	0.0001
Reps	3	0.10	0.63	2577.17	7.00	17.91	89.35**	0.53	0.003
Reps × seasons	3	0.05	0.66	2201.05	21.35	13.25	2.13	1.00	0.004
Treatments	5	0.77*	1.92	17875.83**	107.03**	7.52	21.04*	12.85**	0.014**
Seasons × treat.	5	0.39	2.18	1215.03	13.82	6.48	44.87**	8.70**	0.005
Error	30	0.25	0.96	1044.71	5.52	4.63	7.54	0.53	0.002
Total	47	–	–	–	–	–	–	–	–

*, ** Significant at 0.05 and 0.01 level of probability, respectively.

On the other hand, nitrogen fertilization levels showed significant effect on grain yield, harvest index and days to heading in the second season only (Table 2). However, the highest grain yields resulted from the application of 240 and 300 kg N/ha in the two seasons, respectively. Similar results obtained by Ghandorah (1985); Gravelle *et al.* (1988) and Vaughan *et al.* (1990). Moreover, increasing nitrogen fertilization levels resulted in corresponding increases in the harvest index values. The significance of this increase, in the second season, could be due to the significant differences among the grain yield means. The present results are in a good agreement with those obtained by Ghandorah (1985 and 1986). Similarly, number of days to heading was significantly different from one season to another (Table 1). The aver-

TABLE 2. Means of yield and other agronomic traits of the wheat cultivar; Yecora Rojo, as affected by six nitrogen levels for two growing seasons.

N. levels kg/ha	Biological yield		Grain yield		Harvest index		No. of spikes/m^2		No. of kernels/spike		1000 kernel weight		Plant height (cm)		Days to heading	
	1989/90	1990/91	1989/90	1990/91	1989/90	1990/91	1989/90	1990/91	1989/90	1990/91	1989/90	1990/91	1989/90	1990/91	1989/90	1990/91
120	8.54	5.84	4.11	2.44 c	0.48	0.42 c	325 c	316 c	40.95 c	29.85 d	46.24	37.82	60.0 bc	57.0 b	82	68 c
180	8.37	6.06	4.20	2.81 b	0.52	0.47 b	414 b	340 c	43.90 b	34.05 c	45.22	37.31	62.5 ab	61.8 a	83	69 c
240	9.87	6.16	5.00	3.32 ab	0.53	0.55 a	422 b	386 bc	44.50 b	34.42 c	45.31	34.81	66.3 a	57.5 b	83	70 bc
300	7.50	6.23	4.09	3.52 a	0.54	0.57 a	417 b	393 b	45.90 b	37.87 bc	47.67	36.60	60.0 b	57.5 b	84	71 b
360	7.53	5.58	4.15	3.14 b	0.55	0.56 a	402 b	396 b	48.90 a	43.75 a	46.66	36.85	56.3 c	62.3 a	83	73 a
420	9.30	5.31	4.69	3.11 b	0.51	0.59 a	479 a	453 a	44.30 b	39.35 b	49.34	36.53	60.0 bc	58.3 b	83	74 a
LSD	NS	NS	NS	0.37	NS	0.05	45	52	2.71	4.19	NS	NS	5.31	2.41	NS	1.30
C.V.	14.53	10.58	15.27	8.11	10.19	7.63	7.30	9.07	4.03	7.63	4.82	5.59	5.81	2.72	0.67	1.22

*Means within a column followed by the same letter are not significantly different according to L.S.D. at 5% level of probability.

age days to heading were 83 and 70 days for the two seasons respectively (Table 2). Generally, increasing nitrogen fertilizer levels resulted in steady delay in the heading of the second season only (Table 2). Similar results were reported by Ghandorah (1985) and Eissa (1991). The nonsignificant response and/or the different responses of such traits from season to another, could be attributed to the unsteady weather and/or heterogenity of the soil (Termen 1979, Ghandorah 1986 and Jacobsen and Westermann 1988).

The number of spikes/m^2, number of kernels/spike and plant height were significantly affected by nitrogen fertilization levels in both seasons (Table 2). Generally, corresponding increases in number of spikes/m^2 were associated with the increment of nitrogen level in both seasons (Table 2). The application of high nitrogen levels during tillering stage stimulates tiller production. This has been documented by Gravelle *et al.* (1988) and Eissa (1991). Moreover, number of kernels/spikes responded positively to the increase of nitrogen level up to 360 kg N/ha in the two seasons of this investigation (Table 2). Similar results were recorded by Ghandorah (1986) and Gravelle *et al.* (1988). Increasing nitrogen fertilization levels to 240 and 360 kg N/ha resulted in the tallest plants in the two seasons. Plant height decreased significantly when more than 240 and 360 kg N/ha were used in the two seasons, respectively. These results are in accordance with the results of Ghandorah (1985) and Eissa (1991).

Based on the obtained results, it could be concluded that the recommended dose of nitrogen to the commercial Yecora Rojo in Al-Qassim region lies between 240 and 300 kg N/ha. Applying less than the recommended dose might cause economic losses, while adding more nitrogen is not warranted.

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استجابـة قمـح الخـبز لمستويات التسميـد النيـتروجيني في منطقـة القصـيم بالمملـكة العربيـة السعوديـة

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المستخلص . أُجري هذا البحث لدراسة تأثير ستة مستويات من التسميد النيتروجيني هي **١٢٠، ١٨٠، ٢٤٠، ٣٠٠، ٣٦٠** و **٤٢٠** كجم/هكتار ، على المحصول البيولوجي ، محصول الحبوب ، مكونات المحصول ، طول النبات وتاريخ التزهير للصنف التجاري يوكرا روجو . أجريت تجربتان في موسمي **١٩٨٩/١٩٩٠**م و **١٩٩٠/١٩٩١**م في مزرعة محطة البحوث الزراعية ، كلية الزراعة والطب البيطري ، جامعة الملك سعود فرع القصيم بالمملكة العربية السعودية ، وقد استخدم في تنفيذ التجربتين تصميم القطاعات العشوائية الكاملة في أربعة مكررات .

أوضحت النتائج أن مستويات التسميد النيتروجيني كان لها تأثيرًا معنويًا على صفات عدد السنابل في المتر المربع ، عدد حبوب السنبلة وطول النبات في كلا الموسمين . كما أدت زيادة مستويات التسميد النيتروجيني إلى زيادة محصول الحبوب وقيم معامل الحصاد وعدد الأيام اللازمة للتزهير في الموسم الثاني فقط . ومن ناحية أخرى لم تظهر آثار معنوية لمعدلات السماد المستخدمة على أي من المحصول البيولوجي أو وزن الألف حبة في أي من الموسمين ، واتضح أن المعدل الأمثل من التسميد النيتروجيني في منطقة القصيم يقع ما بين **٢٤٠** إلى **٣٠٠** كجم نيتروجين للهكتار .