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In the name of Allah

EFFECT OF NITROGEN FERTILIZATION ON YIELD, PROTEIN AND AMINO ACIDS OF IRRIGATED MEXIPAK WHEAT[1]

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ABSTRACT

Effects of N fertilization of semidwarf Mexipak wheat on yield, protein content, and amino acid composition were studied. Grain and straw yields increased significantly up to 290 kg N/ha. Grain protein and N percentage in the straw increased with increasing N. The N concentration of the wheat plants decreased as the crop approached maturity. The lysine percentages were low while amino acids, in general, were only marginally influenced by N fertilization.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important grain crop in the Middle East where it is grown mostly under dryland conditions. Increased yields depend largely on N fertilization. Response to fertilization depends on soil and environmental and cultural practices as well as

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بنام خدا

اثر کود ازته بر روی عملکرد، پروتئین و اسیدهای آمینه گندم آبی رقم مکزیپک

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خلاصه

اثر کود ازته بر روی عملکرد و میزان پروتئین و ترکیب اسیدهای آمینه گندم نیمه پاکوتاه مکزیپک مورد مطالعه قرار گرفت. عملکرد دانه و کاه با اضافه کردن تا ۲۹۰ کیلو ازت در هکتار افزایش معنی داری نشان داد. میزان پروتئین دانه و درصد ازت کاه با ازدیاد ازت افزایش یافت. غلظت ازت گندم بتدریج تا مرحله رسیدن محصول کاهش داشت. درصد لیسین پائین بود حال آنکه بطور کلی اسیدهای آمینه فقط بمیزان کمی تحت تاثیر کود ازته قرار گرفته بودند.

the cultivar used. The introduction, in the last decade, of short-strawed Mexican wheats allows for greater N application without the risk of lodging. These cultivars are also more adaptable with respect to growth requirements. These factors have made such cultivars competitive as an irrigated crop. Fuehring (1) found that Mexipak outyielded six other cultivars of dwarf and semi-dwarf wheat in Lebanon. Highest yield was 7.7 metric tons of grain per hectare. Response to rate of N fertilization of semi-dwarf wheat in Lebanon is an important concern based on the area allocated to wheat.

In view of the increasing dependence of a large segment of the world's population on wheat, consideration has been focused on the nutritional adequacy of wheat not only with respect to total protein but also the amino acid composition. The grain protein increases with N application (4), but the effect may not be consistent, especially for essential amino acids. Although the total lysine percentage in the grain may increase with N fertilization, an inverse relationship has been observed between protein percentage and lysine in the protein (2, 3). However, the extent to which this relationship is true depends on the amount of protein in the grain (6). Similar inconsistencies are reported for other amino acids. In view of these considerations, the objective of this study was to evaluate the response to N in terms of grain and straw yields, grain protein content, and amino acid composition of Mexipak wheat grown under partly irrigated conditions in the Beqa'a Valley, Lebanon.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Research and Education Center in the Beqa'a Valley, Lebanon, on different but adjacent sites for two growing seasons. Soils at both sites were heavy calcareous soils with the most important difference between them being the content of soil N. Soil N was 0.05% at the site of the 1973-74 experiment and

0.11% for the site of the 1974-75 experiment. The increased N was attributed to a soybean crop during the previous year, whereas site I was previously planted to vegetables. Potassium was not applied in view of the high test values. This region of the Middle East is characterized by hot dry summers and cold rainy winters. The annual average rainfall is about 500 mm which occurs mostly in the fall and winter months. Irrigation is necessary during the late spring and summer months.

For both growing seasons, the design was a randomized complete block with four replications with a total of 20 plots. Individual plots were 4 x 5 m with 21 rows of wheat plants 19 cm apart. Prior to each cropping, 60 kg/ha P were applied as triple superphosphate and disked into the soil. The N treatments were 50, 100, 290, 370 and 550 kg N/ha in split applications as follows: For each level of N, 50 kg were applied at sowing time or shortly thereafter. For the 100 kg level, another 50 kg were applied in early March. At the 290 and 370 kg/ha levels, 80 kg were applied in early March and the remainder in 80 kg lots at about every two weeks. For the highest application rate, 125 kg/ha were applied each time. While the dates varied at each growing season, the rates of application were the same. The N was applied as ammonium sulphonitrate.

Mexipak wheat was drill-planted in December 1, 1973 and November 13, 1974, at a rate of 120 kg/ha. The plots were furrow-irrigated when soil moisture tension was about 0.7 bar on April 1, May 2 and 23, 1974 and on April 9, May 1 and June 15, 1975. Leaf samples for N analysis were collected at two different stages of growth as the plants approached maturation; i.e., after 142 and 176 days in 1974, and after 161 and 176 days in 1975. The youngest mature leaves were selected. Plants from each plot were harvested by hand on July 3, 1974 and July 9, 1975 and subsequently weighed and threshed. Grain weights were recorded. The leaf, straw and grain samples were oven dried at 70°C for 48 hr and finely ground in an electric mill. Total N was determined by the macro-Kjeldahl procedure and protein content determined by multiplying the percentage N by a factor of 5.7. Amino acids were determined by gas-liquid chromatography according to Roach and Gehroke (5). Duncan's multiple range test was used to compare treatment means on grain and straw yield and protein content.

RESULTS AND DISCUSSION

Though grain yield increased with increasing N rate, the effect was not significant beyond 290 kg/ha (Table 1). Straw yield showed a similar trend. However, yields for 1974-75 were higher than those for 1973-74, and the percentage response was lower in that year. The higher yields were largely attributed to higher levels of soil N at the site of the second cropping since both sites were relatively similar and there were little differences in management and climatic conditions. Grain protein and % N in the straw increased with increasing rates of N. Grain protein increased from 10.5 to 14.6% and from 10.4 to 15.7%. The data indicated that application of N in excess of 290 kg/ha had little effect in increasing grain protein significantly but greatly increased the N content of the straw. Fertilization at such high rates may only be justified if the nutritive value of either or both the grain and straw was considered. However, straw is not an important animal feed in the Middle East.

Deficiency symptoms of N were apparent at the 50 and 100 kg/ha levels in the 1973-74 season, while in no case did lodging occur. Foliage analysis showed that N increased from 2.0% to 4.8% for the 1973-74 cropping after 142 days; while for the 1974-75 cropping, after 161 days, the N content ranged from 2.4% at 50 kg/ha to 5.1% N at the 550 kg/ha rate. Most values were in excess of critical deficient

Table 1. Grain and straw yields and protein or N percentage of Mexipak wheat with N fertilization for 1973-74 and 1974-75 seasons.

Applied N	1973-1974 Grain	1973-1974 Straw	1974-1975 Grain	1974-1975 Straw
	(kg/ha)			
50	2658a*	3742a	4464a	7570a
	(10.5a)†	(0.18a)	(10.4a)	(0.24a)
100	3706b	4951b	5114b	9404b
	(11.1a)	(0.21a)	(11.0b)	(0.30b)
290	5168c	6778c	5980c	11090b
	(13.6b)	(0.51b)	(14.7c)	(0.49c)
370	5665c	6950c	6308c	12383b
	(13.9b)	(0.58b)	(15.5d)	(0.64d)
550	5493c	8312d	6351c	13401b
	(14.6b)	(0.72c)	(15.7d)	(0.78e)

*Means followed by the same letter are not significantly different using Duncan's multiple range test ($P<0.01$).

†Percentage protein in grain and N in straw.

N contents for this stage of growth and, as expected, decreased at the second sampling as the plants approached maturity.

The amino acid composition of the grain as a function of N application rate for the 1973-74 season is presented in Table 2. In general, percentage values of the 14 amino acids tended to increase slightly with increasing N applications. Exceptions to this trend were found for isoleucine, threonine, glutamic acid, tyrosine and lysine, the values of which decreased at either the 370 or 550 kg/ha rate of N. In virtually all cases, levels of amino acids in the grain were lower at the 100 kg N/ha rate than at the 50 kg rate. The depression was presumably due to a dilution effect in view of the higher yield response at this level. Discrepancies between the sum of the amino acids and total crude protein are due to the fact that not all the amino acids were measured.

The percentage of most amino acids increased with N rate; i.e., the respective values for leucine were 3.51, 4.38, 5.82 and 5.95% of total crude protein at the 100, 280, 370 and 550 kg N/ha rates. Of the amino acids that differed from this trend, lysine was the most notable. The proportion of lysine in the protein increased with increasing N application rate to 290 kg/ha and decreased thereafter; i.e., 1.42, 1.89, 2.13, 1.72 and 1.57%, respectively. This was in contrast to other reports which show that lysine in wheat declines as the protein percentage and N rate increase (1, 2, 3). Since lysine is the most limiting amino acid, comparison of Mexipak with other wheats is also of interest. For example, Hojjati and Maleki (3) showed that lysine increased from 0.35 to 0.47% in wheat grain (*Triticum aestivum* L. em Thell., cv. Roushan) as N increased from 0 to 200 kg/ha. Lysine in the protein ranged from 3.23 to 2.26%. In this study with Mexipak, lysine was much lower; i.e., 0.15 to 0.23%. However, the lysine percentage in the protein was in the order of 1.4 to 2.1. Thus, though

Table 2. Amino acid percentage of Mexipak wheat grain as influenced by N fertilization (1973-74).

Amino acids	N application rate (kg/ha)				
	50	100	290	370	550
	--------------------%--------------------				
Alanine	0.50	0.45	0.58	0.70	0.77
Valine	0.23	0.15	0.23	0.39	0.41
Glycine	0.79	0.64	0.87	0.96	0.95
Isoleucine	0.15	0.09	0.12	0.26	0.21
Leucine	0.59	0.39	0.61	0.81	0.87
Proline	1.41	1.02	1.48	1.93	2.18
Threonine	0.35	0.24	0.32	0.52	0.44
Serine	0.97	0.56	0.77	1.14	1.29
Cysteine	0.20	0.10	0.23	0.24	0.28
Phenylalanine	0.30	0.21	0.32	0.37	0.40
Aspartic acid	0.60	0.48	0.67	0.80	0.83
Glutamic acid	2.73	2.60	3.38	4.15	3.94
Tyrosine	0.12	0.09	0.31	0.18	0.18
Lysine	0.15	0.21	0.29	0.24	0.23

Mexipak may be high yielding and adaptable to a wide range of environments, its content of amino acids particularly lysine is lower than older wheat cultivars. Fertilization appears to have only a marginal effect in increasing amino acids in the grain. In the selection of new cultivars, the amino acid percentage should be a major criterion of wheat quality.

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