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Response of a Newly Developed Variety of Dwarf Wheat to Nitrogen Level and Supplementary Irrigation

M. A. EL-SHARKAWY[1], F. A. SOROUR[1] AND M. ABAZA[2]

ABSTRACT

The effect of nitrogen fertilizer on the vegetative growth, and the interaction of nitrogen level and soil moisture content during the grain filling period on grain yield and various yield components of the dwarf spring wheat variety 'Sidi Misri 1' were studied in a field experiment containing 4 nitrogen levels and 3 irrigation intensities with 3 replicates.

It appreared that with increasing the supply of nitrogen fertilizer from 0 to 140 kgN/ha, there were almost linear and positive responses in the number of tillers, dry weight and area of leaves per plant, specific leaf weight and total dry weight of the shoot. Significant correlation coefficients of 0.98, 0.99, 0.85, and 0.99 were found between nitrogen levels and these growth attributes, respectively.

Increasing the nitrogen level significantly increased straw production, total grain yield, the number and weight of grains per plant and the number of spikes per plant (or number of productive tillers). On the other hand, no significant responses due to nitrogen treatments were observed with the number of grains per spike and with grain size.

Soil moisture content after anthesis was found not to affect significantly straw yield, total grain yield, number and weight of grains per plant, number of spikes per plant, number of grains per spike and grain size. Only with the number of grains per plant was there a significant interaction between soil moisture and nitrogen level. With higher nitrogen supply, the lowest soil moisture content (60 centibar tension) significantly increased the number of grains per plant.

INTRODUCTION

It is usually found that increasing nitrogen fertilizer, where soil moisture is adequate, enhances the grain yield of wheat (4). Recent reports on the effect of both nitrogen level and moisture supply on the growth and yield of the dwarf Mexican wheats

[1] *Agronomists, Plant Production Dept.;*

[2] *Assistant Professor of Water Science, Soil and Water Dept., Faculty of Agriculture, University of Tripoli, Libya.*

have shown significant responses especially under arid and semi-arid climates (1,3,5,6). Furthermore, attention had been paid to investigate the response of grain yield of the dwarf Mexican wheats to water stress after anthesis (1).

In Libya, wheat is grown under rainfed as well as irrigated conditions. However, only the local varieties are adapted to the limited amount of rainfall during the growing season. Recently imported and locally developed strains of the dwarf Mexican wheats are increasingly recommended as substitutes for the local low yielding varieties. Owing to the relatively higher requirements of these varieties for water and nitrogen supply, attention must be given toward investigating these requirements under the Libyan environment. Cereal production in Libya is extremely dependent on the amount and distribution of rainfall in both the early vegetative phase and the after heading to ripeness stage (7). Moreover, rainfall during the grain filling period in March and April is the most critical factor in determining the success or failure of cereal production. In a recent study, Sgaier (7) have shown that over a period of 29 years the rainfall at Tripoli area in March ranged from 0.2 to 90.6 mm with an overall average of 24.4 mm. He, also, found that rainfall in March was erratic in nature.

In order to find whether water supply during the critical period after anthesis in March and April affects the grain yield of dwarf Mexican wheat, an experiment was conducted with different irrigation intensities and nitrogen fertilizer treatments.

MATERIALS AND METHODS

A field experiment was carried out at the Faculty of Agriculture farm, Tripoli, during the 1972–1973 season. The newly developed variety 'Sidi Misri 1', a selection from the dwarf Mexican wheats, *Triticum aestivum* L., was seeded on 28 November 1972 at the rate of 70 kg/ha on a sandy loam soil which was left fallow for several years. A split-plot design was laid in a super-imposed block arrangement containing 3 irrigation treatments as main plots and 4 nitrogen levels in sub-plots with 3 replicates. Nitrogen fertilizer in the form of ammonium sulfate (21% N) was top dressed as single and split applications at the rate of 0, 60, 100 and 140 kgN/ha starting 3 weeks after sowing. After seedling emergence and until heading (ear emergence), plants were given an equal amount of irrigation water to supplement rainfall during this period. From that time on (during March and April 1973) three soil-moisture regimes were followed. These were established by irrigating when soil-moisture tension in the effective root zone reached 60 centibars (dry), 40 centibars (medium) and 20 centibars (wet). Irrigations were terminated when enough water was applied to bring the whole root zone to field capacity. The required different frequencies and irrigation periods in a schedule were met by controlled sprinkler irrigation system.

At boot stage, plant samples were taken for determination of the dry weight of the shoots, number of tillers and the dry weight and area of leaves. Straw and grain yield as well as various yield components were determined later in May.

RESULTS AND DISCUSSION

The amount and distribution of the rainfall in the 1972–1973 season is given in Table 1. The winter of that year was exceptionally wet with a total rainfall of 404 mm. However, the majority of precipitation occurred in January (232 mm); whereas rainfall in December, February and March were 55.9, 41.8 and 45.7 mm, respectively. As usual, no rain was recorded in April and May of the same year.

Table 1 Recorded rainfall during the 1972–1973 season at the Faculty of Agriculture farm, Sidi Misri, Tripoli, Libya

Month	Rainfall (mm)	Month	Rainfall (mm)
October	28.4	February	41.8
November	—	March	45.7
December	55.9	April	—
January	232.5	May	—

I. Effect of nitrogen supply on vegetative growth

Figure 1 illustrates the response of tiller formation to nitrogen level. The number of tillers increased linearly with increasing nitrogen fertilization from 0 to 140 kgN/ha. A significant correlation coefficient ($r = 0.98^{**}$) was found between the nitrogen level and the number of tillers produced. The average number of tillers per plant was 2.3, 3.9, 4.7 and 6.8 at 0, 60, 100, and 140 kgN/ha, respectively. The differences due to fertilizer treatments were highly significant (LSD 1% = 1.9 tillers/plant). It appears therefore that tillering capacity of the dwarf wheat variety 'Sidi Misri 1' is greatly stimulated by nitrogen supply.

Results of Figure 2 show that a positive linear relationship exists between levels of nitrogen and dry weight per shoot. The correlation coefficient was highly significant

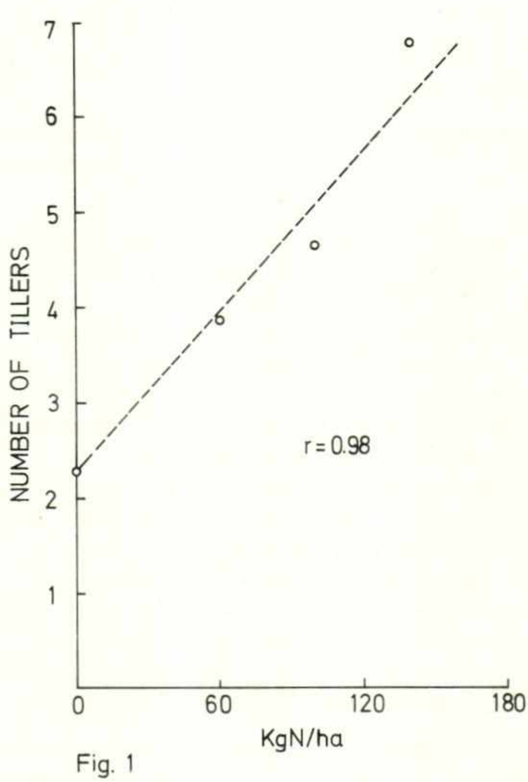

Fig. 1. Effect of nitrogen level on total number of tillers.

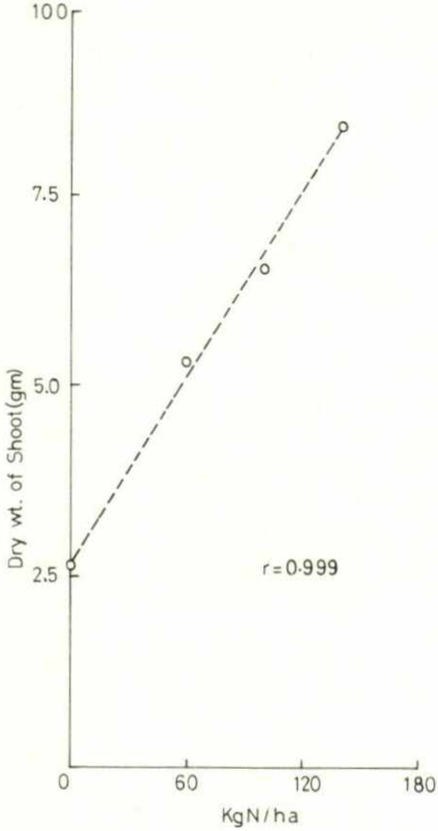

Fig. 2. Effect of nitrogen level on the dry weight of shoot.

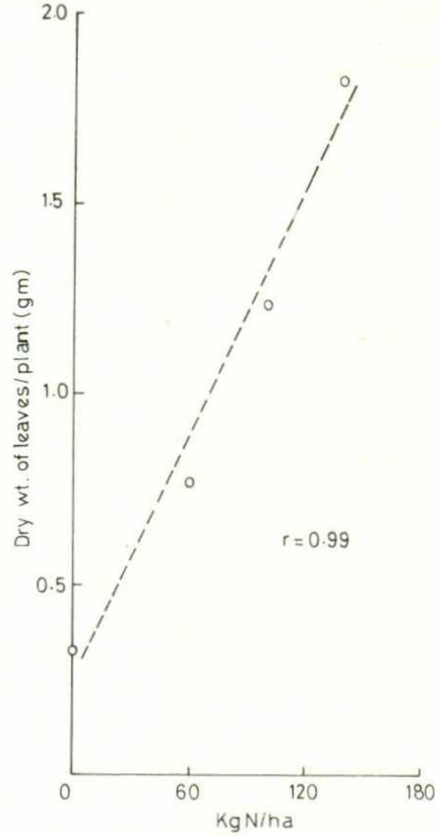

Fig. 3. Effect of nitrogen level on the dry weight of leaves per plant.

(r = 0.99**). The addition of 0, 60, 100 and 140 kgN/ha correspond with average shoot dry weight of 2.7, 5.3, 5.5 and 8.4 g, respectively. Differences among nitrogen treatments were highly significant (LSD 1% = 2.8 g/plant).

Increasing nitrogen supply from 0 to 140 kgN/ha have significantly increased the dry weight of leaves per plant (Fig. 3). A positive and significant correlation coefficient of 0.99** was revealed between nitrogen levels and the dry weight of leaves. Compared with 0 nitrogen level the addition of 60, 100 and 140 kgNa/ha has increased the leaf dry weight by 133, 276 and 452%, respectively.

Figure 4 indicates that the total leaf area per plant was linearly increased with increasing nitrogen fertilization (r = 0.99**). Application of 60, 100 and 140 kgN/ha has increased leaf area per plant by 93, 220 and 350% as compared to the O level, respectively. However, it appears that the response of leaf area to nitrogen supply was less than that of leaf dry weight (see Figs. 3 and 4). This tendency is further illustrated in Figure 5 as a percentage change in leaf specific weight. Values of leaf specific weight were 5.3, 6.5, 6.3 and 6.6 mg/cm^2 at 0, 60, 100 and 140 kgN/ha, respectively. Specific weight of leaves was positively correlated with nitrogen supply (r = 0.85*).

In conclusion, this experiment indicates that there is a positive influence of increased nitrogen fertilizer on the number of tillers, dry weight and area of leaves, specific leaf weight and total dry weight of shoot of the dwarf variety 'Sidi Misri 1'.

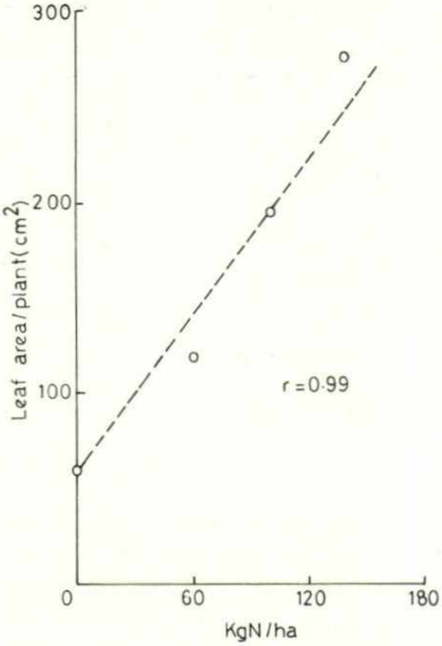

Fig. 4. Effect of nitrogen level on the leaf area per plant.

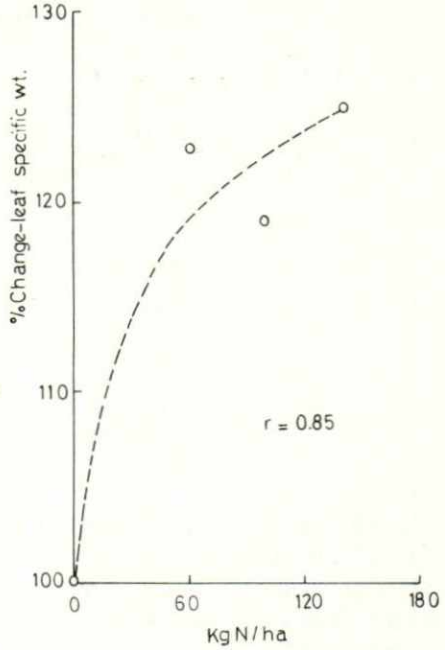

Fig. 5. % change of leaf specific wt as affected by nitrogen level.

II. Effect of nitrogen supply and soil moisture level during the grain filling period on wheat yield and its components

Table 2 reveals the positive effect of nitrogen level and soil moisture content on straw production. However, differences were significant only among nitrogen treatments; differences due to soil moisture levels and interaction with nitrogen were not significant. Compared with 0 nitrogen fertilizer, the application of 60, 100 and 140 kgN/ha significantly increased straw production by 49, 46 and 46.5%, respectively. Application of 4 irrigations (soil water tension = 20 centibars) increased the straw yield by 1.37 tons/ha over the single irrigation treatment (60 centibars of soil water tension). However, this difference was not significant.

Table 2 Effect of nitrogen level and soil-water tension on straw yield (tons/ha)

	Soil-water tension (centibar)			
kgN/ha	20	40	60	Mean
0	5.17	5.45	4.74	5.12
60	8.51	7.28	7.13	7.64
100	8.30	6.57	7.52	7.46
140	9.33	6.72	6.45	7.50
Mean	7.83	6.51	6.46	

LSD for nitrogen levels at 5% = 1.00; at 1% = 2.25 tons/ha.

Differences due to soil-water tension and interaction were not significant.

Table 3 Effect of nitrogen level and soil-water tension on grain yield (tons/ha)

	Soil-water tension (centibar)			
kgN/ha	20	40	60	Mean
0	1.34	1.56	1.10	1.33
60	2.66	2.23	2.71	2.53
100	3.03	2.60	2.98	2.87
140	3.32	2.28	2.89	2.83
Mean	2.59	2.17	2.42	

LSD for nitrogen levels at 5% = 0.77; at 1% = 1.16 tons/ha.
Differences due to soil-water tension and interaction were not significant.

Grain yield was significantly improved with nitrogen supply (Table 3). Addition of 60, 100 and 140 kgN/ha increased the grain yield over the control by 90, 116 and 113%, respectively. On the other hand, grain production was not significantly affected by the supplementary irrigation after anthesis. Values of grain yield were 2.42 and 2.59 tons/ha at 60 and 20 centibar water tension. The lack of response in grain yield to supplementary irrigation may be due, at least in part, to the heavy rainfall preceding ear emergence (Table 1).

Number of grains per plant was significantly increased by the addition of nitrogen fertilizer (Table 4). Application of 0, 60, 100 and 140 kgN/ha yielded 61, 95, 150 and 115 grains per plant. It appears therefore that increasing nitrogen supply beyond 100 kgN/ha has reduced number of grains per plant. However, the reduction was not significant.

Soil moisture level has no apparent effect on plant grain number. On the other hand, differences due to nitrogen X soil moisture interaction were highly significant. At all nitrogen levels, the lowest soil moisture content (60 centibars of water tension) tends

Table 4 Effect of nitrogen level and soil-water tension on number of grains per plant

	Soil-water tension (centibar)			
kgN/ha	20	40	60	Mean
0	53	60	70	61
60	104	85	97	95
100	140	146	163	150
140	121	76	147	115
Mean	105	92	119	

LSD for nitrogen levels at 5% = 47; at 1% = 71 grains/plant
for interaction at 5% = 21; at 1% = 30 grains/plant.
Differences due to soil-water tension were not significant.

to enhance the number of grains per plant. Differences were significant only at the higher levels of nitrogen supply.

From these results, it is apparent that the grain number per plant is stimulated by higher nitrogen levels and lower soil moisture content after anthesis. The highest grain number of 163 grain per plant was obtained at 100 kgN/ha and soil water tension of 60 centibar. As an average of all nitrogen treatments, the moderate soil moisture level of 40 centibar tends to decrease the plant grain number as compared to the highest and the lowest soil moisture content.

Table 5 Effect of nitrogen level and soil-water tension on the weight of grains per plant (g)

	Soil-water tension (centibar)			
kgN/ha	20	40	60	Mean
0	2.17	2.73	3.00	2.63
60	4.45	3.09	4.35	3.96
100	5.03	5.83	5.89	5.58
140	5.16	3.37	6.57	5.03
Mean	4.20	3.75	4.95	

LSD 5% for nitrogen levels = 2.54 g.
Differences due to soil-water tension and interaction were not significant.

Table 5 indicates the positive effect of nitrogen level on the weight of grains per plant. Increasing nitrogen supply by 60, 100 and 140 kgN/ha has significantly increased the grain weight by 51, 112 and 91% over the control, respectively. Here also there is a tendency toward reducing the weight of grains per plant by a further increase of nitrogen supply beyond 100 kgN/ha. No significant differences were observed due either to soil moisture content or to the nitrogen X soil moisture interaction. However, the moderate level of soil moisture (40 centibar) apparently reduced the grain weight as compared with the lowest (60 centibar) and the highest (20 centibar) soil moisture level.

It is shown in Table 6 that the number of spikes per plant (or number of productive

Table 6 Effect of nitrogen level and soil-water tension on number of spikes per plant

	Soil-water tension (centibar)			
kgN/ha	20	40	60	Mean
0	2.20	2.27	3.33	2.60
60	3.67	2.80	3.27	3.24
100	3.27	4.53	5.47	4.42
140	3.40	2.87	4.87	3.71
Mean	3.58	2.87	4.03	

LSD 5% for nitrogen levels = 1.7 spike/plant
Differences due to soil-water tension and interaction were not significant.

tillers) was significantly increased by nitrogen supply. Addition of 0, 60, 100 and 140 kgN/ha have produced 2.6, 3.2, 4.4 and 3.7 spikes per plant. On the other hand, no significant difference was detected due to irrigation treatments. However, the moderate soil moisture level of 40 centibar gave the lowest number of spikes per plant as compared with 20 and 60 centibar moisture levels.

Table 7 Effect of nitrogen level and soil-water tension on number of grains/spike

	Soil-water tension (centibar)			
kgN/ha	20	40	60	Mean
0	28	25	24	26
60	28	31	27	29
100	42	33	31	35
140	35	26	39	33
Mean	33	29	30	N.S.

N.S. (No significant differences due to treatments).

Although there is a tendency toward increasing the number of grains per spike with increased nitrogen level, the differences were not significant (Table 7). Also, no effect of soil moisture level was observed on the grain number per spike.

Almost identical responses were found with grain size as estimated by the weight of 1,000 grains (Table 8). It appears from these data that grain size was not affected either by nitrogen supply or by soil moisture content.

Table 8 Effect of nitrogen level and soil-water tension on grain size (g/1000 grains)

	Soil-water tension (centibar)			
kgN/ha	20	40	60	Mean
0	40.7	45.0	42.9	42.9
60	43.0	44.1	44.4	43.8
100	36.4	40.3	44.0	40.2
140	42.8	45.1	44.1	44.0
Mean	40.7	43.6	43.8	N.S.

N.S. (No significant differences due to treatments)

Finally, it may be concluded that this investigation has revealed the positive response of straw production, grain yield and its various components to nitrogen supply. In contrast, no apparent response was observed with soil moisture content after anthesis. This lack of response to soil moisture may partially be attributed to the ample supply of rainfall before ear emergence.

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استجابة صنف جديد من القمح القصير الساق لمعدلات الأزوت والري التكميلى

م. ع. الشرقاوى — ف. ع. سرور — م. أباظة

المستخلص

درس تأثير كل من التسميد الأزوتي على النمو الخضرى والتفاعل بين مستوي الأزوت والمحتوي الرطوبي للتربة خلال فترة نضج الحبوب وأمتلائها على محصول الحبوب والمكونات المختلفة له لصنف قصير الساق من القمح الربيعى وهو سيدى المصري/١ . اشتملت التجربة على أربعة معدلات للأزوت وثلاث مستويات للرطوبة .

وتتلخص النتائج في النقاط التالية :—

١ — أدت زيادة معدلات الأزوت من صفر إلى ١٤٠ كجم / هكتار إلى استجابة خطيــة موجبة في عدد الفروع ، الوزن الجاف والمساحة الورقيــة للأوراق للنبات ، الوزن النوعى للأوراق ، الوزن الجاف الكلى للمجموع الخضري . وكانت معاملات التــلازم معنوية بين مستويات الأزوت وهذه القياسات حيث أعطت القيمة : ٩٨ر٠ ، ٩٩ر٠ ، ٩٩ر٠ ، ٨٥ر٠ ، ٩٩ر٠ على التوالى .

٢ — زاد معنويا كل من محصول القش ، المحصول الكلى للحبوب ، عدد ووزن الحبوب للنبات عدد السنابل للنبات (عدد الفروع المثمرة للنبات) زيادة معدل الأزوت . وعلى عكس ذالك لم تحدث استجابة معنــوية نتيجة لمعاملات الأزوت في عـــدد حبوب السنبلة أو حجم الحبوب .

٣ — لم يؤثر معنويا المحتوي الرطوبي للتربة علي محصــول القش ، المحصول الكلي للحبوب ، عدد ووزن الحبوب للنبات ،عدد السنابل للنبات ،عدد حبوب السنبلة أو حجم الحبوب. وقد ظهر تفاعل معنوى فقط بين رطوبة التربة ومعدل الأزوت في حالة عدد الحبوب للنبات.

٤ — زاد معنويا عدد الحبوب للنبات في حالة أقل محتوي رطوبي للتربة (٦٠ سنتيبارا) مع أعلى المعدلات للأزوت .