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THE EFFECT OF NITROGEN FERTILIZATION ON TILLERING AND COMPONENTS OF YIELD IN WHEAT

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The grain yield of grasses and cereals is determined by the number of fertile tillers per unit area, the number of florets per spike and the average seed wt (schleuber and Tucker, 1967, and Single, 1964). The highest yielding varieties produce more tillers, a large percentage of which survives (Black, 1970; Krishnamurthy, 1963).

Nitrogen, phosphorus and potassium increase the leaf area, and the number of leaves per plant. As the number of leaves per tiller is not affected by nutrients, the production of a large number of tillers is important (Langer, 1966). The effect of nitrogen has been found to be much higher in leaf area production than that of phoshorus and potassium (Langer, 1966; Ryle, 1964). Nitrogen seems to increase the number of florets or spikelets per spike (Single, 1964). The number of seeds per spike may or may not increase (Moore, 1962; Stickler and Pauli, 1964) and the seed wt. per spike may decrease or remain the same due to nitrogen fertilization (Black, 1970; Moore, 1962; Schleuber and Tucker, 1964). The number of seeds per spike may or may not increase (Moore, 1962; Stickler and Pauli, 1964) and the seed wt. per spike may decrease or remain the same due to nitrogen fertilization (Black, 1970; Moore, 1962. Schleuber and Tucker, 1964).

This paper deals with an investigation of the tillering of individual plants, the number of spikelets per spike, the number and weight of grain per spike as well as the grain from the experimental material. The most important objective of this experiment was to relate the different components of yield of wheat with one another and to the plot yield. This was studied on three different genetic materials, ie. the varieties.

MATERIALS AND METHODS

A field experiment was laid out at the Bunkhela farm of the Faculty of Agriculture, University of Libya at Tripoli, Libya. Three recommended varieties of wheat, Triticum vulgare var. Sedi Mesri 1, Triticum vulgare var. Florence aurora and Triticum durum var. Chilli were planted on October 22, 1969.

Five rates of nitrogen fertilization i.e. O, 62.5, 125.0, 187.5 and 250.0 kg. nitrogen per hectare were applied as ammonium sulphate before seeding. These treatments were arranged in a split plot design with varieties as main plots and nitrogen fertilization as sub-plots. There were four replications. The sub-plots were 4M. 2M in size. All treatments received 500 kg. per hectare of superphospate (single) and 200 kg. per hectare of potassium sulphate before seeding. The data on total number of tillers and number of fertile tillers produced per plant were obtained from a second outside row in the plot, the plants in this row were thinned to 20 cm. apart. The rest of the plot was undisturbed. The data on the number of spikelets per spike. the number of grains per spike, and wt. of grain per spike were taken from five spikes collected at random from the plot. The data on 1000 grain wt., grain yield and straw yield were taken by harvesting the central third of the plot (2.67 M2 in area). The data on the number of spikes per plot were taken by counting the spikes in one metre length in one row of the plot. After the analysis of variance, the averages were compared by the Duncan's multiple range test.

The data on the number of tillers per plant, the number of fertile tillers per plant, the number of grains per spike, the number of spikelets per spike, and the number of spikes per plot were analysed after square root transformation. The rest of the data were analysed without transformation. Simple linear regression anayses were done for the effect of the number of grains per spike (X3) on the weightof grain per spike (X 4), the number of spikelets per spike (X5), on the weight of grain per spike (X4), the total number of tillers per plant (X1) on the fertile tillers per plant (X2) and of straw yield (X7) on grain yield (Y). Multiple regression analyses were done for the number of tillers per plant (XI) and of fertile tillers per plant (X2) on the number of spikes per plot (X6).

RESULTS

Tillering of wheat : The data on total number of tillers produced per plant, the number of fertile tillers produced per plant and the spikes per plot (8 M2) are presented in table 1.

There was no significant difference among the varieties in the above three characteristics recorded. There was an increase in the total number of tillers per plant, fertile tillers per plant and the spikes per plot (8 M2) because of nitrogen fertilization. 250 kg/ha. nitrogen produced significantly more tillers per plant, more fertile tillers per plant and more spikes per plot than no nitrogen treatment. 187.5 kg/ha nitrogen also had more fertile tillers per plant and spikes per plot than the no nitrogen treatment.

Spiklet number, grain number and grain weight : The data on the spikelet number, grain number and grain wt. are given in table 2. The effect of varieties and nitrogen fertilization were significant for these characters.

a) Effect of varieties : the three varieties differed in the three characters studied. Chilli had the highest number of spikelets per spike, Sedi Mesri 1 the highest grain number per spike and Florence aurora the highest wt. of 1000 grains. For the spikelet number, Sedi Mesri I and Chilli were alike. The grain wt. however, was highest in Florence aurora, intermediate in Chilli and lowest in Sedi Mesri 1.

b) Differences due to nitrogen : 250 kg/ha. and 187.5 kg/ha. nitrogen increased the spikelet number, grain number and wt. of 1000 grain over no nitrogen treatment. The other nitrogen rates were also effective in the case of grain number and wt. of 1000 grains.

Grain and straw yield : The data on grain yield per spike, grain yield per plot and straw yield are shown in table 3.

The wt. of grain per spike was affected by nitrogen fertilization in Sedi Mesri 1 and Chilli only. The moderate rates of nitrogen, 62.5 kg/ha and 125 kg/ha produced higher wt. of grain than the no nitrogen treatment.

The grain and straw yield were affected by nitrogen fertilization in Sedi Mesri 1 and Florence aurora only. In Sedi Mesri 1 the two high nitrogen treatments, 250 kg/ha and 187.5 hg/ha, gave high grain yield, medium nitrogen treatments gave intermediate grain yield and no nitrogen treatment gave the lowest

Table 1. The total number of tillers per plant, the number of fertile tillers per plant and the spikes per plot (8 M2) in the three varieties of wheat grain yield under five nitrogen treatments

Nitrogen kg/ha	Variety	Number of tillers		Spikes / plot (X 100)
		Total	Fertile	
0	Sedi Mesri 1	2.3	1.7	12.5
	Florence aurora	2.6	1.4	13.4
	Chilli	2.5	1.6	5.6
	Average	2.4a	1.6a	10.5a
62.5	Sedi Mesri 1	3.1	2.0	16.1
	Florence aurora	3.4	2.3	13.1
	Chilli	4.7	3.1	11.4
	Average	3.7b	2.5b	13.5ab
125.0	Sedi Mesri 1	3.7	2.3	19.6
	Florence aurora	4.5	2.7	12.6
	Chilli	4.1	2.8	11.7
	Average	4.1b	2.6b	14.6b
187.5	Sedi Mesri 1	4.9	3.2	20.6
	Florence aurora	4.5	3.1	16.6
	Chilli	5.8	4.1	14.5
	Average	5.1c	3.5c	17.2b
250.0	Sedi Mesri 1	4.8	3.1	20.3
	Florence aurora	5.5	4.3	16.5
	Chilli	5.4	4.0	13.7
	Average	5.2c	3.8c	16.9b

Numbers followed by the same letter in averages in each column are not significantly different at P = .05, others are.

Table 2. The number of spikelets / spike, the number of grains per spike and the weight of 1000 grains (gm) in three varieties of wheat under five nitrogen treatments.

Nitrogen kg/ha	Variety	Spikelets per spike	No. of grains per spike	weight of 1000 grains
0	Sedi Mesri 1	12.3	40.1	38.1
	Florence aurora	12.8	32.4	50.9
	Chilli	15.3	31.7	43.8
	Average	13.5a	34.7a	44.3
62.5	Sedi Mesri 1	13.3	48.8	41.0
	Florence aurora	13.8	35.1	52.8
	Chilli	16.5	35.5	49.4
	Average	14.5ab	39.8b	47.7b
125.0	Sedi Mesri 1	14.0	59.3	42.0
	Florence aurora	13.5	30.2	53.1
	Chilli	17.3	39.2	49.0
	Average	14.9b	42.9b	48.4b
187.5	Sedi Mesri 1	15.8	61.9	41.7
	Florence aurora	14.8	33.5	52.3
	Chilli	19.3	35.6	52.1
	Average	16.6c	43.7b	48.7b
250.0	Sedi Mesri 1	16.3	53.5	39.5
	Florence aurora	15.8	36.5	54.8
	Chilli	19.5	36.5	49.9
	Average	17.2c	42.1b	48.6b

Numbers followed by the same letter in averages in each column are not significantly different at P = .05, others are.

Table 3. The weight of grain / spike, grain yield and straw yield in three varieties of wheat under five nitrogen treatments .

Variety	Nitrogen kg / ha	Grain wt/spike gm	Grain yield kg/8 M2	Straw yield kg/8 M2
Sedi Mesri 1	0	1.59a	0.93a	1.98a
	62.5	2.18b	1.91b	4.23
	125.0	2.62b	1.97b	4.49bc
	187.5	2.39.b	2.48c	5.45cd
	250.0	2.10b	2.67c	6.04d
Florence aurora	0	1.83a	1:55a	3.81a
	62.5	2.02a	1.44a	3.79a
	125.0	1.75a	1.61ab	4.98bc
	187.5	1.81a	1.76ab	4.85ab
	250.0	1.92a	2.14b	6.05c
Chilli	0	1.55a	0.26a	0.97a
	62.5	1.58a	0.40a	1.34a
	125.0	2.29b	0.48a	1.95a
	187.5	2.15b	0.41a	1.72a
	250.0	1.96ab	0.40a	2.20b

Numbers followed by the same letter in averages in each column are not significantly different at P = .05, others are.

The straw yield of Sedi Mesri 1 was higher in 250 kg/ha and 187.5 kg/ha nitrogen treatments than 62.5 kg/ha and no nitrogen treatment. In Florence aurora 250 kg/ha nitrogen gave higher grain and straw yields than 62.5 kg/ha and no nitrogen treatment.

There was highly significant linear correlation of the weight of grain per spike (X4) on the number of grains per spike (X 3). Sedi Mesri 1 and Florence aurora did not show a linear correlation of the wt. of grains per spike (X4) on the number of spikelets per spike (X5). There was a highly significant correlation of the wt. of grains per spike (X4) on the number of spikelets per spike (X5). There was also a highly significant correlation of X4 on X5 in Chilli variety (table 4). The regression equations for X4 on X3 obtained were :

Sedi Mesri 1	$X4 = -1.517 + 0.509\ Z3$
Florence aurora	$Z4 = -0.487 + 0.406\ Z3$
Chilli	$Z4 = -1.790 + 0.816\ Z3$
where	$Z3 = \overline{X3 + 0.5}$
and for X5 on X4 were :	
Sedi Mesri 1	$X4 = 0.626 + 0.406\ Z5$
Florence aurora	$X4 = 1.214 + 0.171\ Z5$
Chilli	$X4 = -2.506 + 1.041\ Z5$
where	$Z5 = \lfloor X5 + 0.5$

Multiple regression analysis of the effect of the number of tillers per plant (X1) and the number of spikes per plant (X2, fertile tillers) on the number of spikes per plot(X6) showed a highly significant relationship in Sedi Mesri 1 and Chilli varieties while this was not significant in Florence aurora. In Sedi Mesri 1 the partial regression co-efficients were both positive while in chilli the co-efficient for number of tillers per plant (X1) was positive, and that for number of fertile tillers per plant (X2) was negative (table 5). The multiple regression equations obtained were :

Sedi Mesri 1	$Z6 = 1.280 + 0.308\ Z1 + 1.352\ Z2$
Florence aurora	$Z6 = 1.485 + 0.191\ Z1 - 0.197\ Z2$
Chilli	$Z6 = -3.527 + 2.706\ Z1 - 1.507\ Z2$
	$Z1 = \overline{X1 + 0.5}, Z2 = \lfloor \overline{X2 + 0.5}, Z6 = \lfloor X6 + 0.5$

Highly significant positive linear correlations of fertile tillers (X 2) on the total tillers produced (X1) were obtained in all the three varieties of wheat (table 6). There was also a highly significant positive linear correlation of grain yield (Y) on straw yield (X7) in Sedi Mesri, Chilli varieties and Florence aurora.

Florence aurora showed significant correlation (P = .05) (Table 6). The following equations describe these relationships :

X2 on X1	Sedi Mesri 1	$X2 = 0.166 + 0.613\ X1$
	Florence aurora	$X2 = -0.283 + 0.776\ X1$
	Chilli	$X2 = -0.676 + 0.848\ X1$
Y on X7	Sedi Mesri 1	$Y = 0.526 + 0.330\ X7$
	Florence aurora	$Y = 1.975 + 0.130\ X7$
	Chilli	$Y = 0.135 + 0.152\ X7$

Table 4. The effect of the number of grains per spike (X3) on the wt. of grain per spike (X4) and of number of spikelets per spike (X5) on wt. of grain per spike in three varieties of wheat.

Wheat Variety	REGRESSION OF X4 on X3			REGRESSION OF X4 on X5		
	r2	b	f	r2	b	f
Sedi Mesri 1	0.75	0.509	53.26 □□	0.01	0.416	1.61 NS
Florence aurora	0.46	0.405	15.44 □□	0.04	0.171	0.82 NS
Chilli	0.46	0.616	15.36 □□	0.54	1.040	20.77 □□

NS represents not significant □□ represents significant at P = .01

Table 5. The effect of the total number of tillers per plant (X1) and number of fertile tillers per plant (X2) on the number of spikes per plot (X6) in three varieties of wheat.

	Regression of X6 on X1 and X2			
Variety	b	C	R2	F
Sedi Mesri 1	0.308	1.352	0.59	6.30 □□
Florence aurora	0.190	-0.107	0.01	0.12 NS
Chilli	2.706	-1.507	0.54	9.87 □ □

NS represents not significant □ □ represents significant at P = .01

Table 6. The effect of total number of tillers produced per plant (X1)on the number of fertile tillers produced per plant (X2) and of straw yield (X7) on yield of grain (Y) .

	Regression of X2 on X1			Regression of Y on X7		
Variety	r2	b	f	r2	b	f
Sedi Mesri 1	0.75	0.613	54.05 □ □	0.73	0.331	47.69 □ □
Florence aurora	0.89	0.746	141.82 □ □	0.30	0.130	5.97 □ □
Chilli	0.89	0.848	150.16 □ □	0.63	0.152	30.32 □ □

□ Represents statistical significance at P = .05
□ □ represents statistical significance at P = .01

DISCUSSION

The three varieties used in the experiment were similar in the production of total number of tillers, the number of fertile tillers and the spikes per plot (table 1). The number of fertile tillers produced depended upon the tillering capacity of the three varieties (table 6). The total number of tillers per plant and the number of fertile tillers per plant affected the number of spikes per plot (table 5). It is, therefore, evident that in these varieties, the capacity of the plant to produce tillers (fertile as well as vegetative) is related to the population of the spike bearing wheat culms. Nitrogen fertilization increased the tillering and spike bearing culms but this effect was more evident in the latter. High nitrogen rates were required for this purpose.

The three varieties differed in the spike characteristics. The grain number and the grain weight appeared to be more important for grain yield than the spikelet number in the spikes (tables 2, 3). High nitrogen rates were necessary for increasing the spikelet number while lower rates of nitrogen were also effective in the grain number and grain wt. (table 2). The heavier spikes were produced by medium rates of nitrogen and not by high nitrogen rates.

The spikes containing more grains also had high wt. of grain. The weight of grain per spike was not affected by the number of spikelets in each spike except in one variety which was the poorest yielder. The yield of grain and straw increased with nitrogen fertilization but this increase was not significant in the low yielding Chilli variety.

ABSTRACT

Two vulgare types and one durum type of wheat under five rates of nitrogen fertilization were compared for different components of grain yield. Tillering and spike population were found to be related and were affected by nitrogen fertilization. Grain number and grain wt. were also related to each other. More spikelets did not increase grain wt. per spike or per plot (grain yield). Medium nitrogen rates produced heavier spikes than high rates. Sedi Mesri 1 appears to be the highest yielding variety under high rates of nitrogen.

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