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EFFECT OF ORGANIC MANURING AND SPLITTING OF DIFFERENT LEVELS OF NITROGEN ON WHEAT UNDER SPRINKLER IRRIGATION IN SANDY SOILS

Mowafy, S. A. E.
Agron. Dept. Fac. of Agric. Zagazig Univ., Egypt.

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ABSTRACT : Two field experiments were conducted in the Experimental farm, Faculty of Agriculture, Zagazig University at Khattara, Sharkia Governorate, Egypt during 1999/2000 and 2000/2001 winter seasons to study the effect of four farmyard manure rates (Zero, 15, 30 and 45 m^3/fad.), splitting of nitrogen (3 and 6 splits) and three N levels (30, 60, 90 kg N/fad.) on yield and yield attributes of wheat (Sakha 69 cv) under sprinkler irrigation in sandy soils. Each increase of farmyard manure rate up to 45 m^3/fad. significantly increased each of flag leaf chlorophyll content and area, grain filling rate (GFR) and period (EGFP), plant height, and grain and straw yields/fad. and all of their components in addition to grain protein content.

Addition of N in six instead of three splits significantly increased grain and straw yields and all their attributes with the exception of grain protein content in the second season as well as harvest index in the first season and combined analysis. Each increase in N level from 30 to 90 Kg N/fad. increased significantly all studied traits, except harvest index in the two seasons and their combined.

Grain yield / fad. was positively and significantly correlated with each of flag leaf chlorophyll content (0.957**), GFR (0.952**), EGFP (0.956**), plant height (0.966**), number of spikes/m^2 (0.950**), spike length (0.962**), 1000-gain weight (0.925**), number of grains / spike (0.969**) and gain weight/spike (0.983**). The main sources of grain yield variation according to their relative importance were number of grains/spike (42.71%), number of spikes/m^2 (6.69%) and 1000-grain weight (0.52%). The direct and indirect effects of these characters amounted to 94.56% of grain yield variation.

Results of interactions between organic manure and splitting of nitrogen and between splitting of N and its levels recommended that wheat should be fertilized with 45 m^3/fad. organic manure and 90 kg N/fad. given in six splits, at 10 day by interval up to 60 DAS and this N level should be increased as the response of grain yield/fad. was curvelinear.

INTRODUCTION

Wheat is considered the first leading cereal crop all over the world. In Egypt, increasing wheat yield per unit area is a national interest. To minimize the gab between production and consumption from wheat, intensive efforts are being paid for sustaining wheat production. Sandy soils are considered the main area for the agriculture extension. However, production of wheat in sandy soils is facing many problems, among them the low organic matter content and thus the poor soil fertility level.

Organic matter application is usually associated with the increase of growth and dry matter of wheat under sandy soils conditions due to availability increase of macro and micro nutrients (Barsoom, 1991 and Barsoom *et al.*, 1991). Abd El-Bary and El-Bana (1994) noticed that increasing FYM rates under sandy soil conditions from 2.5 to 20 ton/fad. significantly increased plant height, number of spikes/m2, number of spikelets and grains/spike, N concentration in grain, as well as, grain and straw yields/fad. Also, Attia and Aly (1998) reported that application of rabbit manure (7 ton/fad.) significantly increased plant height, number of spikes/m2, spike length, number of spikelets and grains/spike, 1000-grain weight and hence grain and straw yields/fad. and harvest index. Moreover, El-Bagoury *et al.*, (1998) found that grain protein content showed a significant increase in response to the increase of the added organic matter up to 60 m^3/fad. Furthermore, Yakout *et al.*, (1998) reported that increasing FYM rates from Zero to 60 m^3/ fad. significantly increased wheat yield and its components. Dahdouh *et al.*, (1999) observed that, application of 15 ton/fad. FYM and 45 kg N/fad. significantly increased number of spikes/m^2, 1000- grain weight and grain and straw yields/fad.

Regarding splitting of N, some studies have reported the advantages of splitting N fertilizer in order to increase wheat grain yield and its components under sandy soil conditions (Abd El-Maaboud, 1991 ; Dawood, 1994 ; Moselhy, 1995 ; Abdul Galil *et al.*, 1997 and EL-Hosary *et al.*, 2000). Recently Abdul Galil *et al.*, (2000) observed that each increase in number of N splits from five to seven increased significantly grain filling rate and its duration and hence yield and its components.

Concerning the effect of N ertilizer level on wheat grain yield, ie results of some research work howed that the optimum N ertilization level varied widely in mounts ranging between 80 and 60 kg N/fad. (Fayed, 1992 and EL-Bana and Aly, 1993). Other studies stressed the need of wheat plants to N-fertilizer levels ranged from 90 to 150 kg N/fad. (EL-Nagar *et al.* 1989 ; Abdul Galil *et al.*, 1997 and El-Ganbeehy *et al.*, 2001). Moreover, Attia and Aly (1998) reported that most of wheat yield and its attributes showed a positive response to N application up to 100 kg N/fad for both straw and grain yields/fad. Furthermore, Saleh (2001) showed that application of N fertilizer had a remarkable effect on grain yield and its attributes where the highest grain yield was obtained by application of 107 kg N/fad. Therefore, the aim of this work was to investigate the effect of organic manuring, splitting of different nitrogen levels on wheat yield and its components under sprinkler irrigation in sandy soil.

MATERIALS AND METHODS.

Two field experiments were conducted, in the Experimental farm of the Faculty of Agriculture, Zagazig University at Khattara, Sharkia Governorate, Egypt during 1999/2000 and 2000/2001 seasons to study the effect of farmyard manuring and splitting of three levels of nitrogen on yield and yield attributes of wheat (Sakha 69 cv). The soil of the experimental site is sandy in texture and has a particle size distribution of 89.4, 6.5 and 4.1% for sand, silt and clay, respectively. The soil had an average pH value of 7.9 : 0.49% organic matter and had 10.2 , 2.9 and 127 ppm available N, P and K, respectively (Averaged over of the two seasons for the upper 30 cm of soil depth). Each experiment included three factors as follows :

1- Farmyard manure rates :

a- Without manuring
b- 15 m^3/fad.
c- 30m^3/fad.
d- 45m^3/fad.

2- Number of N splits :

a- Three splits given at 20 , 40 and 60 days after sowing (DAS).
b- Six splits given at 10, 20, 30, 40, 50 and 60 DAS.

3- Nitrogen fertilizer levels :

a- 30 Kg N/fad.
b- 60 Kg N/fad.
c- 90 Kg N/fad.

Phosphorus and potassium fertilizers were applied as base dressing at sowing as superphosphate (15.5 % P_2O_5) and potassium sulphate (50 % K_2O), respectively. Nitrogen was added as ammonium sulphate (20.5%N). The preceding crops were sesame in the first and second seasons. Farmyard manure (FYM) was incorporated at 10 cm soil depth before sowing. The chemical properties of farmyard manure were determined by methods given by Jackson (1958) as shown in Table (1) :

Table (1): Chemical properties of farmyard manure in the two seasons.

Parameters	1st season	2nd season
PH	7.10	6.95
OM%	13.60	12.80
Total N %	0.54	0.57
Available N PPm	304	313
Available P PPm	449	453
Available K PPm	1150	1168

A split-split plot design with four replicates was followed. FYM rates were assigned to the main plots whereas splitting of nitrogen and levels of N were allotted in the 1st and 2nd sub-plots, respectively. The area of plot was 13.5 m^2 (3m. in width and 4.5 m. in length) included 20 rows, 15cm apart. Seeds (80 Kg/fad.) were hand drilled on November 15th and 19th in the two seasons, respectively. The other cultural practices for growing wheat under these conditions were applied.

After ear-emergence, flag leaf area of all plants from 30 cm length of the third row was recorded according to Montogomery (1911). Chlorophyll content of these leaves was determined using chlorophyll meter (SPAD- 502 , soil- plant analysis Development (SPAD) section Minolta camera co., Oska, Japan) according to Peng *et al.*, (1993). Grain sampling was practiced as soon as possible after anthesis which was possible at 85 DAS. Seven grain samples of 100 – grains were taken at week intervales and oven dried for a constant weight at 70°C. Using the orthogonal polynormal tables (Snedecor and Cochran, 1967) it was easy to calculate the grain filling rate (mg/1000-grains/day), as well as, the effective grain filling period (days) according to the proposal of Duncan (1978) and Abdul Galil *et al* (1997). They described it as the period during which the increase in grain weight follows linearity. Therefore, effective grain filling period (EGFP) = $\Delta Y/b$ where ΔY presents total increase in grain weight from the beginning to the termination of grain filling and b is GFR.

At harvest, plant samples were taken from an area of 0.5 m^2 to determine plant height, spike length, number of fertile spikelets/spike, number of grains/spike, 1000-grain weight and grain weight/spike. Grain, straw and total yields (ton /fad.) were determined from a central area of 3.0m^2. Thereafter, harvest index was calculated. The grain crude protein was determined using the Kjeldahal method according to A.O.A.C (1980).

Analysis of variance and combined analysis for the two seasons were carried out as described by Snedecor and Cochran (1967). For comparison between means, Duncan's new multiple range test was applied (Duncan, 1955). The combined data of yield and yield attributes were subjected to simple correlation and path coefficient was calculated according to Svab (1973). In interaction Tables, capital and small letters were used to compare rows and columns means, respectively. These tables are provided with regression coefficients to express the magnitude of variation.

RESULTS AND DISCUSSION

A- Flag leaf chlorophyll content and area :

A.1- Organic manure effect :

The results in Table (2) show that organic manure rates affected significantly flag leaf area and its chlorophyll content in both seasons and their combined analysis. It is evident that each increase in the rate of organic manure from Zero to 45 m^3/fad. was accompanied by a highly significant increase in both characters. These results refer to a beneficial effect to organic manuring under sandy soils conditions due to a possible increase in the availability of macro and micronutrients (Barsoom, 1991 and Barsoom *et al.*, 1991).

A.2. Nitrogen splitting effect :

It is obvious from Table (2) that splitting of N in six instead of three splits was accompanied by a significant increase in both the area of flag leaf and its content from chlorophyll. This was true in the two season and their combined analysis. The role of N in enhancing wheat growth and hence its flag leaf area cannot be denied. It seems evident that addition of N in six splits was more effective than its addition in three splits as it was given in 10 instead of 20 days intervals. These data are in harmony with those reported by Moselhy (1995), Abdul Galil *et al.*, (1997) and (2000) as they reported that 5 splits and 7 splits were more effective than 3 or 5 splits under sandy soil conditions, respectively.

A.3. Nitrogen level effect :

It is clear from Table (2) that, raising N level from 30 to 60 and then to 90 Kg N/fad. led to a significant increase in flag leaf area and its content from chlorophyll. This was true in the two seasons with more consistent trend in the combined analysis. The increase in these characters may be due to the role of N on cell enlargement and delay of leaf senescence (Peltonen *et al.*, 1995).

B. Grain filling rate and period:

B.1. Organic manure effect :

In both seasons and their combined, addition of organic manure and the increase of its rate up to 45 m^3/fad. brought a highly significant increase in both the GFR and EGFP. On the average of both seasons, the grain filling rate was

Table (2) : Effect of organic manure rates and number of N splits and N levels on flag leaf chlorophyll content, flag leaf area, grain filling rate and effective grain filling period in the two seasons and their combined.

Main effects and interactions	◆Flag leaf chlorophyll content			Flag leaf blade area (cm^2)			Grain filling rate (mg/1000 grains/day)			Effective grain filling period (days)		
	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined
Organic manure (M)												
Without	37.06 d	38.66 d	37.86 d	15.64 d	17.59 d	16.62 d	794 d	1012 d	903 d	35.58 d	37.23 d	36.41 d
15 m^3/fad.	38.72 c	40.27 c	39.50 c	16.35c	19.33 c	17.84 c	844 c	1101 c	973 c	37.15 c	38.76 c	37.96 c
30 m^3/fad.	41.00 b	43.00 b	42.00 b	17.89 b	20.53 b	19.21 b	963 b	1112 b	1038 b	37.92 b	39.91 b	38.92 b
45 m^3/fad.	43.00 a	45.51 a	44.26 a	19.75 a	21.99 a	20.87 a	1074 a	1122 a	1098 a	38.68 a	40.50 a	39.59 a
F. test	**	**	**	**	**	**	**	**	**	**	**	**
Number of N split (T)												
3 splits	39.20 b	41.01 b	40.11 b	16.91 b	19.31 b	18.11 b	891 b	1076 b	984 b	37.01 b	38.72 b	37.87 b
6 splits	40.69 a	42.71 a	41.70 a	17.91 a	20.41 a	19.16 a	947 a	1097 a	1022 a	37.65 a	39.48 a	38.57 a
F. test	*	*	*	*	*	**	**	**	**	*	**	**
Nitrogen level (N)												
30 kg N/fad.	39.33 c	41.14 c	40.24 c	16.94 c	19.46 b	18.20 c	901 c	1080 b	991 c	37.18 c	38.80 c	37.99 c
60 kg N/fad.	39.95 b	41.72 b	40.84 b	17.35 b	19.71 b	18.53 b	919 b	1083 b	1001 b	37.34 b	39.12 b	38.23 b
90 kg N/fad.	40.56 a	42.72 a	41.64 a	17.94 a	20.40 a	19.17 a	936 a	1097 a	1017 a	37.48 a	39.37 a	38.43 a
F. test	**	**	**	**	**	**	**	**	**	*	**	**
Interactions:												
M x T	N.S	*	N.S	N.S	*	N.S	**	**	**	*	N.S	N.S
M x N	**	N.S	**	*	*	**	**	**	**	N.S	**	*
T x N	N.S	N.S	N.S	N.S	N.S	N.S	**	**	**	N.S	N.S	N.S

◆ Determined using chlorophyll meter (SPAD).

*, ** and N.S indicate significant at 0.05, 0.01 and insignificant, respectively.

increased from 903 to 1048 mg/1000 grain/day when the organic manuring rate was increased from Zero to 45 m3/fad. There was about four days increase in the EGFP due to this increase in the rate of organic manure where it was increased from 36 to 40 days.

According to these data, the increase of flag leaf area and its chlorophyll content which expressed an enhanced growth of wheat due to organic manuring were reflected in a marked increase in both GFR and EGFP. In wheat, the role of post anthesis assimilates in grain filling amounted to more than 70% (Rawson and Evans, 1971). The increase of flag leaf area and its chlorophyll content could account for the increase observed herein in both GFR and EGFP.

B.2. Nitrogen splitting effect :

Splitting of N in six instead of three splits proved to be more effective in enhancing grain filling through a highly significant increase in each of GFR and EGFP in both seasons (Table 2). Though N fertilization continued up to 60 days after sowing where it was given in six or three splits, however, in the former it was given in 10 instead of 20 days as in the latter. These data clearly indicate that under sandy conditions, N should be given in small doses to avoid its losses particularly through percolation. Under the present study, though irrigation was practiced through sprinklers, however, the superiority of six splits of N over the three ones observed in herein, gave some indication to a possible more leaching N losses even under sprinkler irrigation. Similar results were reported by Abdul Galil *et al.*, (2000) when they gave N in seven instead of five doses under sandy soil conditions, but, under flood irrigation.

B.3. Nitrogen level effect :

Each increase of N level from 30 to 90 kg N/fad brought a highly significant increase in each of GFR and EGFP in both seasons. On the average of the two seasons, the grain filling rate increased from 991 to 1001 and then to 1017 mg/1000 grain/day when the N levels was increased from 30 to 60 and then 90 kg N/fad. Also the EGFP was increased from 37.99 to 38.43 days due to this increase of N level.

B.4. Interaction effect :

Some of the interactions affected significantly the aforementioned characters, but most of them did not bring additional information than the main effects, therefore, such interaction are not presented.

C. Wheat yield attributes :

C.1. Organic manure effect :

A clear trend was observed regarding plant height, number of

Table (3): Effect of organic manure rates and number of N splits and N levels on wheat yield attributes in the two seasons and their combined.

Main effects and interactions	Plant height (cm)			Number of spikes/m²			Spike length (cm)			Number of fertile spikelet/spike		
	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined
Organic manure (M)												
Without	72.92d	77.38d	75.15d	292.94d	312.13d	302.54d	7.471d	7.468d	7.469d	13.77d	14.24d	14.01d
15 m³/fad.	75.53c	80.87c	78.20c	305.64c	320.81c	313.23c	8.793c	8.706c	8.751c	14.35c	15.10c	14.73c
30 m³/fad.	78.37b	84.98b	81.68b	313.80b	329.87b	321.84b	9.129b	9.718b	9.424b	15.73b	16.70b	16.22b
45 m³/fad.	83.77a	87.63a	85.70a	323.81a	338.37a	331.09a	9.824a	10.80a	10.31a	17.67a	17.90a	17.79a
F. test	**	**	**	**	**	**	**	**	**	**	**	**
Number of N split (T)												
3 splits	77.01b	81.29b	79.15b	305.40b	321.92b	313.66b	8.621b	8.988b	8.805b	15.03b	15.68b	15.36b
6 splits	78.28a	84.15a	81.22a	312.69a	328.67a	320.68a	8.988a	9.359a	9.174a	15.73a	16.29a	16.01a
F. test	**	*	*	**	**	**	*	*	*	*	*	*
Nitrogen level (N)												
30 kg N/fad.	77.01c	81.56c	79.29c	305.77c	321.82c	313.80c	8.708c	9.073b	8.891c	15.12c	15.62c	15.37c
60 kg N/fad.	77.48b	82.57b	80.03b	308.68b	324.83b	316.75b	8.779b	9.187ab	8.983b	15.34b	15.89b	15.62b
90 kg N/fad.	78.45a	84.02a	81.24a	312.70a	329.24a	320.97a	8.927a	9.260a	9.094a	15.68a	16.46a	16.07a
F. test	**	**	**	**	**	**	*	*	**	*	**	**
Interactions:												
M x T	**	**	**	**	**	**	*	NS	NS	*	*	**
M x N	**	*	**	*	NS	NS	*	NS	NS	NS	NS	NS
T x N	**	*	**	**	NS	**	NS	NS	NS	NS	NS	NS

Table (3) : Cont.

Main effects and interactions	Thousand grain weight (gm)			Number of grains/spike			Grain weight/spike (gm)		
	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined
Organic manure (M)									
Without	36.26d	37.14c	36.70d	33.82d	35.49d	34.66d	1.202d	1.289d	1.246d
15 m^3/fad.	36.87c	38.91b	37.89c	35.29c	37.28c	36.29c	1.325c	1.400c	1.363c
30 m^3/fad.	37.87b	39.11b	38.49b	36.90b	38.73b	37.82b	1.490b	1.607b	1.549b
45 m^3/fad.	39.22a	40.59a	39.91a	39.21a	41.04a	40.13a	1.664a	1.758a	1.711a
F. test	**	**	**	**	**	**	**	**	**
Number of N split (T)									
3 splits	37.12b	38.64b	37.88b	35.75b	37.67b	36.71b	1.381b	1.475b	1.428b
6 splits	37.99a	39.24a	38.62a	36.87a	38.60a	37.74a	1.460a	1.552a	1.506a
F. test	*	*	*	**	*	*	**	*	*
Nitrogen level (N)									
30 kg N/fad.	37.31c	38.65c	37.98c	35.82c	37.76c	36.79c	1.391c	1.488c	1.440c
60 kg N/fad.	37.57b	38.93b	38.25b	36.28b	38.16b	37.22b	1.416b	1.504b	1.460b
90 kg N/fad.	37.79a	39.23a	38.51a	36.81a	38.49a	37.65a	1.455a	1.549a	1.502a
F. test	*	**	**	**	**	**	**	**	**
Interactions:									
M x T	**	**	**	NS	NS	NS	**	*	**
M x N	**	NS	NS	**	NS	**	*	*	**
T x N	**	NS	NS	**	NS	NS	**	**	**

*, ** and N.S indicate significant at 0.05, 0.01 and insignificant, respectively.

spikes/m^2, spike length, number of fertile spikelets / spike, 1000-grain weight, number of grains/spike and grain weight/spike where each increase in the rate of organic manure from Zero to 45 m^3/fad. resulted in a significant increase in each the forementioned characters (Table 3). As shown from the combined data, increasing organic manure rates from zero to 45 m^3/fad. increased plant height by 10.6 cm, number of spikes by 28.6 spikes/m^2, spike length by 2.84 cm, No. of spikelets by 3.78 spikelets, 1000-grain weight by 2.96 gm, grain number by 5.47/spike and grain weight by 0.465 gm/spike. This favourable effect of organic manuring on these yield attributes was also observed on flag leaf area and its chlorophyll content as well as GFR and EGFP (Table 2). These results ascertain those reported by Abd El-Bary and El-Bana (1994), Attia and Aly (1998) and Dahdouh *et al*., (1999).

C.2. Nitrogen splitting effect :

It is evident from Table (3) that the increase in the number of N splits from three to six splits reflected in a significant increase in each of the yield attributes. This was true in the two seasons and their combined. Similar effect was observed in flag leaf content from chlorophyll, flag leaf area and grain filling rate and period (Table 2). Also, under sandy soil conditions, splitting of N was found to increase the efficiency of added N (Moselhy, 1995 and Abdul Galil *et al*., 1997).

C.3. Nitrogen level effect :

In both seasons, each N increment secured a highly significant increase in plant height, No. of spikes/m^2, spike length, No. of fertile spikelets /spike, 1000-grain weight and number and weight of grains/spike. These data were ascertained by the combined analysis. It seems evident that the application of N was effective to favour the growth of wheat expressed in longer spikes and as well favoured the development of these spikes as expressed in larger No. of spikelets and hence 1000 grain weight and number and weight grains/spike. These results are in agreement with those obtained by many authors under sandy soil conditions (Fayed, 1992 ; El-Bana and Aly, 1993 ; Attia and Aly, 1998 and Saleh 2001). The response of wheat to N fertilizers could be attributed to the bad need of wheat plants to its additions as the soil of the experimental site was sandy and poor in ites fertility level form available N (10.2 ppm).

C.4. Interaction effect :

Data in Table (3-a) show a significant effect to the interaction between organic manure rates and N levels on number and weight of grains/spike (combined).

Table (3-a) : Effect of interaction between organic manure and N levels on number and weight of grains/spike (combined).

N levels (kg N/fad.)	Organic manure (m^3/fad.)				Regression coefficient
	Zero	15	30	45	
	Number of grains / spike				
30	D 34.17 b	C 35.77 c	B 37.63 b	A 39.60 c	0.91
60	C 34.77 a	B 36.34 b	B 37.72 b	A 40.05 b	0.86
90	D 35.02 a	C 36.74 a	B 38.11 a	A 40.73 a	0.93
Regression coefficient	0.43	0.49	0.24	0.57	
	Grain weight / spike (gm)				
30	D 1.232 b	C 1.333 c	B 1.510 c	A 1.683 c	0.08
60	D 1.238 b	C 1.354 b	B 1.538 b	A 1.706 b	0.08
90	D 1.267 a	C 1.400 a	B 1.598 a	A 1.744 a	0.08
Regression coefficient	0.018	0.034	0.044	0.031	

Table (3-b) : Effect of interaction between N levels and number of N splits on grain weight/spike (combined).

Number of N splits	N levels (kg N/fad.)			
	30	60	90	Regression coefficient
3 splits	B 1.412 b	A 1.425 b	A 1.447 b	0.018
6 splits	C 1.467 a	B 1.493 a	A 1.558 a	0.046

It is evident from Table 3-a that the increase of N level was more effective on number and weight of grains/spike at the highest than the lowest rate of organic manure and hence than that when organic manure was not added. The highest number and weight of grains spike (40.73 and 1.744 gm, respectively) was obtained when wheat plants were fertilized with 45 m^3/ fad organic manure coupled with the addition of 90 kg N/fad.

Data given in Table 3-b showed that grain weight/spike in the combined analysis was significantly affected by the interaction between N levels and number of N splits. It is evident that the grain weight /spike was significantly increased at highest N level when N was given in six instead of three splits where the increase beyond 60 kg N/fad. was not significant. Therefore the highest grain weight/spike (1.558 gm) was obtained when wheat plants were fertilized with 90 kg N/fad. given in six splits.

D. Yield, harvest index and protein content :

D.1. Organic manure effect :

The increase of rate of organic manure reflected a highly significant increase in each of grain, straw and total yields /fad. and protein content as well. This was observed in the two seasons and their combined, but harvest index did not follow a consistent trend in the two seasons and hence was not significantly affected by organic manure rates according to the combined analysis (Table 4).

The increase observed in grain and straw yields due to addition of organic manure is rather expected as all grain and straw yields attributes were increased due to this addition and the increase in the rate of addition (Tables 2 and 3). It seems evident that the increase in wheat yields due to addition of the organic manure could be explained through its favourable effect on water retention and hence on applied nutrients against leaching losses. Abd El-Bary and El-Bana (1994), Attia and Aly (1998), Yakout *et al.*, (1998) and Dahdouh *et al.*, (1999) reported similar results.

D.2. Nitrogen splitting effect :

A clear trend was observed in each of grain, straw and total yield /fad. due to splitting of N. In both seasons and their combined, the increase in number of splits from three to six was accompanied by a highly significant increase in each of the formentioned characters. But harvest index followed two different trends in the two seasons and hence was not significantly affected as observed from the combined analysis. Grain protein content was significantly increased due to

Table (4): Effect of organic manure rates and number of N splits and N levels on wheat yield and grain protein content in the two seasons and their combined.

Main effects and interactions	Grain yield/fad. (ton)			Straw yield/fad. (ton)			Total yield/fad (ton)			Harvest Index (%)			Grain protein content (%)		
	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined	1999/2000	2000/2001	Combined
Organic manure (M)															
Without	1.293d	1.388d	1.341d	2.326d	2.646d	2.486d	3.618d	4.034d	3.826d	35.7a	34.4	35.1	8.361d	9.066d	8.714d
15 m³/fad.	1.399c	1.470c	1.435c	2.493c	2.804c	2.648c	3.892c	4.274c	4.083c	35.9a	34.4	35.2	9.085c	9.499c	9.292c
30 m³/fad.	1.492b	1.541b	1.517b	2.717b	3.044b	2.881b	4.208b	4.585b	4.397b	35.5a	33.6	34.6	9.605b	10.16b	9.882b
45 m³/fad.	1.596a	1.671a	1.634a	3.007a	3.262a	3.135a	4.603a	4.934a	4.769a	34.7b	33.9	34.3	10.46a	10.71a	10.58a
F. test	**	**	**	**	**	**	**	**	**	*	NS	NS	**	**	**
Number of N split (T)															
3 splits	1.424b	1.503b	1.464b	2.581b	2.887b	2.734b	4.004b	4.390b	4.197b	35.6	34.3a	34.9	9.156b	9.852	9.504b
6 splits	1.466a	1.532a	1.499a	2.690a	2.991a	2.841a	4.156a	4.523a	4.340a	35.4	33.9b	34.6	9.599a	9.864	9.731a
F. test	**	**	**	**	**	**	**	**	**	NS	*	NS	*	NS	*
Nitrogen level (N)															
30 kg N/fad.	1.430c	1.502c	1.466c	2.598c	2.905c	2.752c	4.028c	4.407c	4.218c	35.5	34.1	34.8	9.136b	9.678b	9.407c
60 kg N/fad.	1.443b	1.519b	1.482b	2.631b	2.936b	2.784b	4.073b	4.455b	4.264b	35.5	34.1	34.8	9.506a	9.757b	9.631b
90 kg N/fad.	1.462a	1.532a	1.497a	2.678a	2.976a	2.827a	4.140a	4.508a	4.324a	35.4	34.0	34.7	9.490a	10.14a	9.815a
F. test	**	**	**	**	**	**	**	**	**	NS	NS	NS	*	**	*
Interactions:															
M x T	NS	**	**	**	**	**	**	**	**	NS	NS	NS	NS	NS	NS
M x N	**	**	**	**	**	**	**	**	**	NS	NS	NS	NS	**	*
T x N	NS	NS	*	*	NS	NS	*	NS	**	NS	NS	NS	**	NS	NS

*, ** and N.S indicate significant at 0.05, 0.01 and insignificant, respectively.

splitting of N in six than in three splits in the second season as ascertained by the combined analysis. Similar effects were observed in all grain yield, as well as, straw yield attributes (Tables 2 and 3). Also, similar results were reported by Dawood (1994), Moselhy (1995), Abdul Galil *et al.*, (2000) and El-Hosary *et al.*, (2000).

These results are expected as under sandy soil conditions, added nitrogen, even in NH_4 form, suffers from excessive NO_3 leaching when given in large doses. Therefore, splitting N in six splits was a successful practice to minimize these losses and as well, satisfied wheat plant requirements more efficiently as it was given in 10 instead of 20 days intervals.

D.3. Nitrogen level effect :

It is obvious from Table (4) that the increase in the nitrogen fertilizer levels was accompanied by a significant increase in grain, straw and total yields/fad., as well as, grain protein content. This was true in the two seasons with more consistent trend in combined analysis. However, harvest index was not significantly affected by N levels in the two seasons and their combined. These results are in accordance with those reported by Fayed (1992), El-Bana and Aly (1993), Abdul Galil *et al.*, (1997) and El-Ganbeehy *et al.*, (2001). The increase of grain protein content due to the increase of N level up to 90 kg N/fad. indicates that the grain yield increase was ceiled as in otherwise causes a dilution effect to the content of grains from protein was always reported by (Mowafy, 1999).

D.4. Interaction effect :

Data of combined analysis presented in Table (4-a) revealed that grain yield of wheat/fad. was significantly affected by the interaction between organic manure rates and number of N splits. Results indicated that grain yield showed greater response to the increase of N splits as the rate of organic manure addition was increased therefore the highest grain yield/fad (1.66 ton) was recorded when wheat plants received 45 m^3/fad and six N splits whereas the lowest one (1.33 ton/fad) was obtained when organic manure was not added and N was given in three splits.

It is evident from Table (4-b) that the increase of N level was more effective on grain yield (ton/fad.) at the highest than the lowest rate of organic manure and hence than when organic manure was not added.

Data given in table 4-c showed that both the increase of N fertilizer level from 30 to 60 and thus 90 kg N/fad along with the increase of number of N splits from

Table (4-a) : Effect of interaction between organic manure and number of N splits on grain yield (ton/fad.) (combined).

Number of N splits	Organic manure (m^3/fad.)				Regression coefficient
	Zero	15	30	45	
Three splits	D 1.327 b	C 1.419 b	B 1.500 b	A 1.608 b	0.046
Six splits	D 1.354 a	C 1.450 a	B 1.532 a	A 1.660 a	0.050

Table (4-b): Effect of interaction between organic manure and N levels on grain yield (ton/fad.) (combined).

N levels (kg N/fad.)	Organic manure (m^3/fad.)				Regression coefficient
	Zero	15	30	45	
30	D 1.331 c	C 1.416 c	B 1.502 c	A 1.614 c	0.047
60	D 1.340 b	C 1.434 b	B 1.515 b	A 1.634 b	0.048
90	D 1.350 a	C 1.453 a	B 1.532 a	A 1.654 a	0.050
Regression coefficient	0.010	0.019	0.015	0.020	

Table (4-c) : Effect of interaction between N levels and number of N splits on grain yield (ton/fad.) (combined).

Number of N splits	N levels (kg N/fad.)			Regression coefficient
	30	60	90	
Three splits	C 1.448 b	B 1.461 b	A 1.481 b	0.016
Six splits	C 1.484 a	B 1.501 a	A 1.513 a	0.014

three to six splits interacted in favour of having more grain yield/fad. similar effect was observed on the grain weight/spike (Table 3-b).

E. Yield analysis :

E.1. Correlation :

Results of simple correlation coefficients in Table 5 indicate that grain yield/fad was significantly and positively correlated with flag leaf chlorophyll content, plant height, number of spikes/m^2, spike length, 1000-grain weight, number of grain/spike, grain weight/spike, straw yield/fad, GFR and EGFP. It seems that the increase in number of spikes /m^2 was not on the expense of grain weight /spike as indicated by the significant positive association between them (0.952**).

The positive association between grain yield/fad and all of its attributes was reported by others, such as Darwiche (1994) and Moselhy (1995). It is quite evident that the increase in either grain filling rate or its duration was reflected in a significant increase in 1000-grain weight as indicated by the positive association between this weight and grain filling rate (0.905**) and period (0.886**).

E.2. Path analysis :

Partitioning of simple correlation coefficients between grain yield/fad and each of number of spikes/m^2, number of grains/spike and 1000-grain weight are shown in Table 6.

It is clear from the results that the direct effect of number of spikes/m^2, as well as, its indirect effects through number of grains/spike and 1000- grain weight were positive and amounted to 0.2586, 0.0660 and 0.6254, respectively.

For number of grains/spike the results showed that the direct effect, as well as, the indirect effect via 1000- grain weight and number of spikes/m^2 were positive, and reached. 0.6535, 0.2475 and 0.0680, respectively.

Concerning 1000- grain weight the results revealed that the direct effect as well as indirect effect via number of spikes/m^2 and number of grains /spike were positive and valued 0.0721, 0.2366 and 0.6163, respectively.

Direct and joint effects of the studied characters i.e. number of spikes/m^2, number of grains /spike and 1000-grain weight to grain yield variation are presented in Table 7.

It is clear from the results that number of grains/spike had the highest direct effect with about 42% while 1000- grain weight had the lowest direct effect with about 0.52%, number of spikes/m^2 with about 6.69%. Finally, it is of interest to note that, the three studied characters caused more

Table (5) : Simple correlation coefficients between grain yield/fad. and some of its attributes (combined).

Characters	1	2	3	4	5	6	7	8	9	10
Y-Grain yield/fad.	0.957**	0.966**	0.950*	0.962**	0.925**	0.969**	0.983**	0.987**	0.952**	0.956**
1- Flag leaf chlorophyll content	-	0.941**	0.931**	0.906**	0.927**	0.944**	0.963**	0.954**	0.942**	0.906**
2- Plant height	-	-	0.919**	0.904**	0.933**	0.965**	0.979**	0.975**	0.941**	0.888**
3- Number of spike / m^2	-	-	-	0.945**	0.910**	0.957**	0.952**	0.944**	0.922**	0.940**
4- Spike length	-	-	-	-	0.865**	0.919**	0.926**	0.931**	0.874**	0.977**
5- 1000-grain weight	-	-	-	-	-	0.943**	0.932**	0.941**	0.905**	0.886**
6- Number of grains/spike	-	-	-	-	-	-	0.976**	0.973**	0.943**	0.920**
7- Grain weight/spike	-	-	-	-	-	-	-	0.985**	0.970**	0.920**
8- Straw yield/fad.	-	-	-	-	-	-	-	-	0.964**	0.929**
9- Grain filling rate	-	-	-	-	-	-	-	-	-	0.877**
10- Effective grain filling period	-	-	-	-	-	-	-	-	-	-

Table (6): Partitioning of simple correlation coefficient between grain yield and its components of wheat.

Sources of variation	Value
1- Number of spikes / m^2 :	
Direct effect	0.2586
Indirect effect via No. of grains / spike	0.0660
Indirect effect via thousand grain weight	0.6254
Total (ry_1)	0.9500
2- Number of grains / spike :	
Direct effect	0.6535
Indirect effect via thousand grain weight	0.2475
Indirect effect via No. of spikes/m^2	0.0680
Total (ry_2)	0.9690
3- Thousand grain weight :	
Direct effect	0.0721
Indirect effect via No. of spikes/m^2	0.2366
Indirect effect via No. of grains / spike	0.6163
Total (ry_3)	0.9250

Table (7) : Direct and joint effects of grain yield components presented as percentages of grain yield variation of wheat.

Source of variation	C.D. %	%
1- Number of spikes/m^2	0.0669	6.69
2- Number of grains / spike	0.4271	42.71
3- Thousand grain weight	0.0052	0.52
4- No. of spikes/m^2 × No. of grains / spike	0.0341	3.41
5- No. of spikes/m^2 × thousand grain weight	0.0889	8.89
6- No. of grains / spike × thousand grain weight	0.3235	32.35
R^2	0.9456	94.56
Residual	0.0544	5.44
Total	1.0000	100.00

than 94% of the variation in grain yield.

According to these data, the increase of these three yield component due to addition of organic manure, splitting of N or the increase of N level to 90 kg N/fad. could account for the increase of grain yield. The interaction between organic manure rate and in particular N level, clearly indicate the need of both for sustaining grain yield under sandy soil conditions.

E.3. Regression analysis :

The present study seeks also to determine the maximum and optimum N levels which produce the highest and optimum grain yields in order to define the profit obtained from the increase of N level beyond 30 kg N/fad. or from the addition of organic manure.

The response equations to N level at the different organic manure rates were as follows :

$$Y' = a + bx - cx^2$$

$$Y_0 \text{ (check)} = 1.331 + 0.009X$$

$$Y_{15} = 1.415 + 0.019\ X$$

$$Y_{30} = 1.501 + 0.015\ X$$

$$Y_{45} = 1.614 + 0.02\ X$$

According to these response equations, it is evident that grain yield/fad. showed a curvelinear increase to N fertilization at the four organic manure rates due to the insignificance of c value. Accordingly this N level should be increased in future studies, and hence neither the maximum or optimum N level could be defined.

It is interesting to note here that the response was almost similar at the three organic manure rates being about 0.02 ton/fad., however, the grain yield obtained at the lowest N level (30 kg N/fad.) was much higher (1.614 ton/fad.) at the highest organic manure rate than at the zero rate (1.331 ton/fad.) giving a difference of about 0.283 ton/fad i.e. about 2 ardabs/fad. indicating the beneficial effect of organic manuring.

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تأثير التسميد العضوى وتجزئ مستويات مختلفة من النيتروجين على القمح تحت نظام الرى بالرش بالأراضى الرملية

صابر عبد الحميد السيد موافى
قسم المحاصيل – كلية الزراعة – جامعة الزقازيق – مصر

أقيمت تجربتان حقليتان بمزرعة كلية الزراعة – جامعة الزقازيق بمنطقة الخطارة – محافظة الشرقية خلال موسمى ١٩٩٩/٢٠٠٠ ، ٢٠٠٠/٢٠٠١ لدراسة تأثير أربعة معدلات من التسميد العضوى (صفر ، ١٥ ، ٣٠ ، ٤٥ م٣ /فدان) وتجزئ ثلاث مستويات من النيتروجين (٣٠ ، ٦٠ ، ٩٠ كجم ن /ف) على ثلاث أو ست دفعات وذلك على المحصول ومكوناته وبعض مؤشرات النمو لصنف القمح سخا ٦٩ تحت ظروف الأراضى الرملية ونظام الرى بالرش. يمكن تلخيص أهم النتائج على النحو التالى :

١- أدت كل زيادة في معدل التسميد العضوي من صفر إلي ٤٥م٣ / ف إلي زيادة معنوية في مساحة ورقة العلم ومحتواها من الكلوروفيل ، معدل امتلاء الحبوب وفترة الامتلاء الفعالة ومحصولي الحبوب والقش وجميع مكوناتهما وكذلك محتوي الحبوب من البروتين في حين لم يتأثر دليل الحصاد سوى فى الموسم الأول .

٢- أدي تجزئ النيتروجين علي ست دفعات إلي زيادة معنوية في محصول الحبوب ومساهماته فيما عدا محتوي الحبوب من البروتين في الموسم الثاني ودليل الحصاد في الموسم الأول والتحليل التجميعي للموسمين

٣- أدت كل زيادة في معدل التسميد النيتروجيني من ٣٠إلي ٩٠ كجم ن/ف إلي زيادة معنوية في جميع صفات الدراسة ما عدا دليل الحصاد الذي لم يتأثر خلال الموسمي وفي التحليل التجميعي للموسمين

٤- كان هناك تداخل فعل بين معدلات التسميد العضوي ومستويات التسميد النيتروجيني علي معظم الصفات تحت الدراسة حيث لوحظ زيادة في الاستجابة للتسميد النيتروجيني عند زيادة معدل التسميد العضوي أو زيادة عدد دفعات تجزئ النتروجين

٥- وجد ارتباط موجب ومعنوي بين محصول الحبوب / فدان وكلا من محتوي ورقة العلم من الكلوروفيل ، معدل امتلاء الحبوب ، الفترة الفعالة لامتلاء الحبوب ، ارتفاع النبات ، وعدد السنابل /م٢ ، طول السنبلة ، وزن الألف حبة وعدد ووزن حبوب السنبلة

وتوصى هذه الدراسة بإضافة ٤٥ م٣ / فدان سماد بلدى مع تجزئ جرعة النيتروجين (٩٠ كجم ن / فدان) على ست دفعات تضاف كل ١٠ أيام وحتى ٦٠ يوم من الزراعة ، كما يوصى فى الدراسات المستقبلية بزيادة مستوى التسميد النيتروجينى عن ٩٠ كجم ن / فدان حيث كانت استجابة محصول الحبوب خطية .