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Original paper

Evaluation of sowing methods and nitrogen levels for grain yield and components of durum wheat under arid region of Egypt

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Abstract The present experiment was conducted at private farm during 2018/19 and 2019/20 seasons. The investigated area lies within the extremely arid belt, having long hot summer and short warm winter. The main goal of this investigation was to evaluate the effect of different sowing methods on yield components of wheat, using split plot design with three replications. Sowing methods in main plot were broadcasting method, row spacing 10, 15 and 20 cm apart). Nitrogen fertilizer levels in sub plot were 60, 75 and 90 kg N fed^{-1} (fed = 4200 m^{-2}). The increase percentage due to row spacing at 20 cm apart (M4) compared to broadcasting method (M1) were (23.30 & 26.74%) for spike length; (5.11 & 6.94 %) for 1000 grain weight and (8.02 & 7.74%) for grain yield and according ally (3.07 & 3.08%) for harvest index in both seasons, respectively. Overall, from the present study the sowing method in rows with 20 cm apart and the optimum N fertilizer rate (90 kg fed^{-1}) for durum wheat production in the soils of Qasir, Dakhala oasis on silt loam soil was the best treatment.

Keywords durum wheat, sowing methods, row spacing, nitrogen fertilizer levels, arid region

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Introduction

Wheat is one of the most significant crops, its production needs great efforts to overcome the various environmental stresses which affect the growth and yield, such as plant diseases (ABDELAAL & al [1]; ESMAIL & al [2]; HAFEZ and ABDELAAL [3]), drought and heat stress (ABDELAAL & al [4]; ELSABAGH & al [5]). Drought is very harmful abiotic stress affects numerous economic plants such as barley (ABDELAAL & al [6]) and maize (ABDELAAL & al [7]). The exposed wheat plants to water deficit stress resulted in a significant decrease in chlorophyll concentrations and a significant reduction in grain yield. Egypt is considered a desert area (about 94% of its total area), which pull our attention to desert reclamation and to the utilizing of its own natural resources. Egypt is an imperative need to increase both the productivity of existing agricultural land and in meanwhile expand the cultivated area. The New Valley Governorate occupies huge area of the south western desert representing 43.6% of the total area of Egypt underlie by high ground water potentiality; accordingly it is included in the agricultural expansion for Egypt Land Master Plan. Dakhla Oasis is one of three Oases in the New Valley governorate located at the heart of the Western Desert of Egypt. The groundwater is the only water resource for all activities in this Oasis. Durum wheat (Bani Suif, 1) is one of the oldest and traditionally grown wheat plants in Egypt. This varity of wheat was characterized by its high productivity and heat resistance. It is produced as input, row materials for agro-industry for pasta and sphagati production. Previous studies showed that the different planting methods have varying response under different experimental conditions. HUSSAIN & al [8] compared the effect of wider row spacing (45 cm) with normal row spacing (30 cm) on grain yield and yield components in five wheat varieties. Row spacing pointedly effected yield parameters. Many field experiments were conducted in various regions aimed to select suitable spacing apart among rows. Maximum yield was reported by sowing method in row spacing at 30 cm (BAKHT & al [9]) and another one was at 15 cm row spacing (ABBAS & al [10]; ALI & al [11]).

Nitrogen (N) is widely distributed in nature and considers as an essential element for plant growth and is frequently the major limiting nutrient in most agricultural soils (TEKLU and TEKLEWOLD [12]). SELEEM and ANDELDAYEM [13] stated that the best significant values of grain and straw yields/fed were obtained by adding 60 or 90 kg N/fed. On the other hand, the lowest ones were recorded for the control (without addition of nitrogen fertilizer). A field experiments were conducted at the Sudan University by DAGASH & al [14] to investigate the effect of nitrogen fertilization, sowing methods and sowing dates on yield and yield attributes of wheat (*Triticum aestivum L.*), local variety (Wadi Elneel). The results of the study showed that nitrogen application displayed a significant effect on plant height, total dry matter, 1000-seed weight and grain yield in both seasons. Generally, planting on ridge and ridge with line achieved higher 1000-seed weight and grain yield for both seasons. The limited use of fertilizers and the rapid depletion of land in developing countries lead to a count of sustainability. Therefore, elemental balance of nutrients must be achieved with the addition of appropriate quantities for the different growth stages to obtain high production. Nitrogen deficiency or insufficient supply has an adverse effect on yield, protein percentage (ELWAKIL and ALLA [15]), using 100 kg N fed^{-1} (TAMMAM and TAWFILS [16]). So, the present study aimed to evaluate some sowing methods and nitrogen fertilization levels for grain yield and components of durum wheat under arid region of Egypt.

Materials and Methods

The present experiment was conducted at private farm of El-Qasr village in El-Dakhla Oasis, New Valley, Egypt during 2018/19 and 2019/20 seasons. Map of the study area was presented in Figure 1. The investigated area lies within the extremely arid belt, having long hot summer and short warm winter (Table 1). Soil characterization was presented in Table 2.

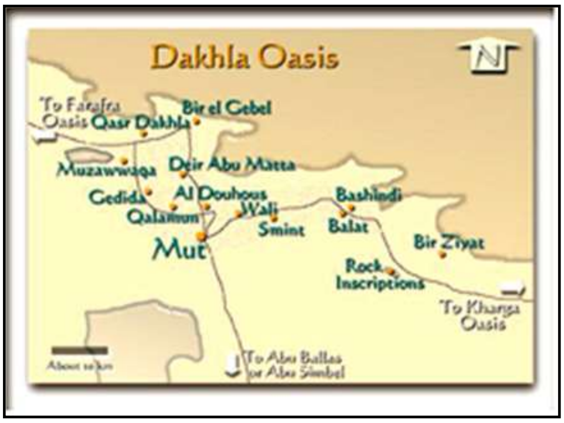


Figure 1. Location map of the Al-Qasr in Dakhala Oasis

The main goal of this investigation was to evaluate the effect of different sowing methods and Nitrogen fertilizers levels on yield components of wheat, using spilt plot design with three replications. Sowing methods were put in the main plot including: Broadcasting method, row spacing (10, 15 and 20cm apart) and Nitrogen fertilizer levels were put in the sub plot design including 60, 75 and 90 kg fed^{-1}. The experiment consists of 4 sowing methods X 3 Nitrogen rates =12 treatment with 3 replicates for each treatment. The unit plot size was 10.5 m^2 (3.5 X 3.5 m) and the total number of plots was 36 experimental units. The physical and chemical analyses of experimental soil used during the two seasons (2018/2019 and 2019/2020) were demonstrated in Table (2). Agronomic practices were followed as usually done for the wheat crop at El-Dakhla region. Nitrogen was applied in split doses; that is one-third at planting and two-third at mid-Tillering while phosphorus was applied in full dose at planting time. Seeds of this wheat cultivar (*Beni-suif 1)* were sown at a rate of 80kg fed^{-1} on 2nd day of November in 2018/19 and 2019/20 seasons, respectively. This Varity of wheat was characterized by its high productivity and heat resistance.

Table 1. Monthly temperature (°C) at New Valley during 2018/2019 and 2019/2020 at wheat grown seasons.

season	2018/2019			2019/2020		
Temp. Month	Max °C	Min °C	Mean °C	Max °C	Min °C	Mean °C
10/16	334	19.4	26.4	32.7	16.1	24.3
11/16	28.7	13.0	20.6	27.1	10.6	19.0
12/16	21.7	6.5	13.7	25.1	9.2	17.1
1/17	21.6	4.5	12.5	21.7	4.7	13.1
2/17	22.6	5.1	13.8	28.1	9.2	17.8
3/17	27.5	10.4	19.0	33.1	12.3	22.7
4/17	33.7	14.7	24.2	37.1	16.9	27.0

Table 2. Some physical and chemical characteristics of the experimental soils.

Character	Soil depth (cm)	
	0-20	20-40
Clay	4.10	4.10
Silt	64.00	64.00
Sand	31.90	29.90
Texture	Silt loam	Silt loam
pH (1:2.5)	7.41	7.74
ECe (dS m^{-1})	3.27	4.28
$CaCO_3$ (%)	11.36	9.66

Data recorded

Spike length (cm), Number of spike m^{-2}, 1000 grain weight (gm), Grain yield (ton fed^{-1}) and Grain Protein (%)

Soil samples and irrigation water were determined by Soil and Water Lab at El-Karga Agricultural Station according to PIPER [17]; JACKSON [18]; KLUTE [19], protein content was calculated through determined the total nitrogen, protein content of wheat seeds was calculated by multiplying N % in the seeds by a factor of 5.7 (AOAC [20]). Statistical analyses were done by The MSTAT-C computer program was used to perform all the analysis of variance with the procedure outlined by STEEL and TORRIE [21].

Results and discussion

Response of wheat yield and its attributes to sowing methods

Our results showed a significant difference between the sowing methods (Table 3) and among the different N levels (Table 4). The main effects of the different sowing methods on agronomic parameters were presented in Table 3. The maximum agronomic parameters values were obtained from plant cultivation in row spacing at 20 cm apart (M4) compared to broadcasting method (M1) in both seasons. The increase in percentage due to row spacing at 20 cm apart (M4) compared to broadcasting method (M1) were (32.30 & 26.74%) for spike length; (2.35 & 12.53%) for number of spikes/m^2; (5.11 & 6.94 %) for 1000 grain weight; (8.02 & 7.74%) for grain yield; and (3.07 & 3.08) for harvest index in both seasons, respectively. The length of spike plays a vital role in wheat towards the grains spike^{-1} and finally the yield (SHAHZAD & al [22]). Similar results were obtained by ALI & al [11] who found that the highest spikes per m^2 were observed at across drill sowing technique of 30 x30 cm^{-2}. Similar results were in agreement with MOLLAH & al [23]. Generally, all agronomic parameters values under the study tended to increased significantly with increasing the row spacing apart (Table 3). Data observations, indicate the grain yield significantly increased with increasing row spacing from 10 cm (M2) to 15 cm (M3) until at 20 cm apart (M4) in both seasons (Table 3). Also, the increase percentage in grain yield due to sowing at 15 cm (M3) compared to sowing at 10 cm (M2) was 4.8% in both seasons. While these increase reached (6.25 & 5.61%) due to sowing row spacing at 20 cm (M4) in comparison to sowing at 15 cm (M3). This could be attributed to positive effect of wider rows on wheat plant through leaf area duration and net assimilation rate at all growth stages of wheat plants. Also, proper row spacing leads to less competition between wheat plants which affects on important yield attributes (SALAMA & al [24]). Additionally, the positive effect of wider rows might be due to the higher light transmission rate at the top and basal parts of plant population at booting stage, and the circulation of air reinforced. With the improved aeration and light transmission condition, quality of population and individual, and wheat yield significantly increased (ZHENG & al 25). These results in agreement with those obtained by BAKHT & al [9] who obtained maximum 1000-grain weight (gm) as results of sowing method at 30 cm apart. DIN & al [26] found that row spacing at 40 cm significantly increased grain weight/Spike. Similar results were obtained as results of row spacing method at 30 cm as reported by BAKHT & al [9], as at 15 cm row spacing (ABBAS & al [10]; ALI & al [11]**)** as at 40-45 (SCHILLINGER and WUEST [27]). These results agreed with early findings by MOLLAH & al [23]**.**

Table 3. Effect of sowing methods on some agronomic parameters

Sowing Methods	Spike length (cm)		Number of spikes m^{-2}		1000 Grain weight (gm)		Grain yield (ton fed^{-1})	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
M1	8.11	7.89	301.7	370.1	58.33	57.45	2.991	2.971
M2	8.00	8.00	301.6	387.0	59.22	58.22	2.904	2.893
M3	9.22	9.33	307.5	402.8	60.67	60.22	3.040	3.033
M4	10.00	10.00	308.8	416.5	61.33	61.44	3.228	3.199
LSD 0.05	0.72	0.65	1.3	4.1	0.61	0.45	0.41	0.39

Response of wheat yield and its attributes to Nitrogen fertilization

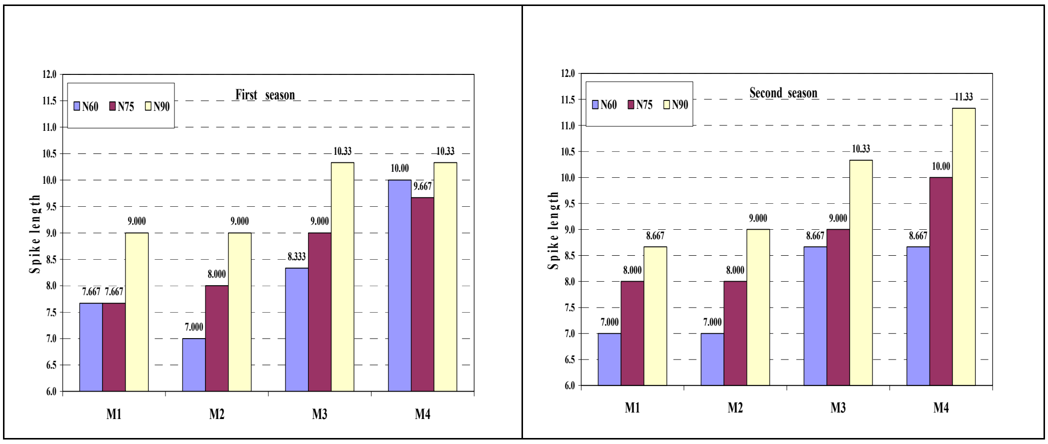
The obtained data in Table 4 showed a significant effect of applied N fertilizer levels on durum wheat and its parameters. Similarly, increasing N fertilizer levels significantly increased wheat parameters. The highest spike length (9.67 & 9.83 cm) was obtained by the application of 90 kg fed^{-1} N; which was (17.21% & 25.54%) increasing over the applied rate of 60 kg N fed^{-1} (N1). Number of spike m^{-2} was significantly increased by 7.59% over the application of 60 kg N fed^{-1} (N1) in the 2nd season. While, Number of spike m-2 was not significantly affected in the 1st season. Recorded results in Table (4) stated clearly that the increase in 1000 grain weight was (2.95 & 11.25%) over the application of 60 kg N fed^{-1} (N1) in both seasons, respectively. Similar results were obtained by BAKHT & al **[9]** who obtained maximum 1000-grain weight (gm) with sowing method at 30 cm apart, and sowing method at 15 cm apart ABBAS & al [10]. Additionally, the highest grain yield (4.42 & 4.46 ton fed^{-1}) was obtained by the application of 90 kg ha^{-1} N; which was (30.87% & 40.76 %) increase over the applied rate of 60 kg $Nfed^{-1}$ (Table 4). Similar results were found by (IQBAL & al [28]**)** who revealed that, maximum grain yield was recorded with application of 120 kg N/ha, but in contrast, nitrogen rate of 46 kg/ha gave the highest grain yield. Similarly, the maximum grain yield was obtained from the maximum expression of important yield attributes (HAIDARY and ALZUUBAIDY [29]**)**. This might be due to encouraging the vegetative growth which leads to increasing the weight of kernels per spike (SHUKRA & al [30]**)**. The recorded results are in agreement with the results of GERBA & al [31].

Table 4. Effect of Nitrogen fertilizer levels on some agronomic parameters

N Fertilizer Levels.	Spike length (cm)		Number of spikes m^{-2}		1000 Grain weight (gm)		Grain yield (ton fed^{-1})	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
N 60	8.250	7.834	304.6	380.5	59.58	56.33	3.375	3.167
N 75	8.584	8.750	304.5	392.4	58.75	59.00	3.750	3.708
N 90	9.665	9.832	305.6	409.4	61.34	62.67	4.417	4.458
LSD 0.05	0.45	0.65	NS	1.8	0.82	0.71	0.045	0.052

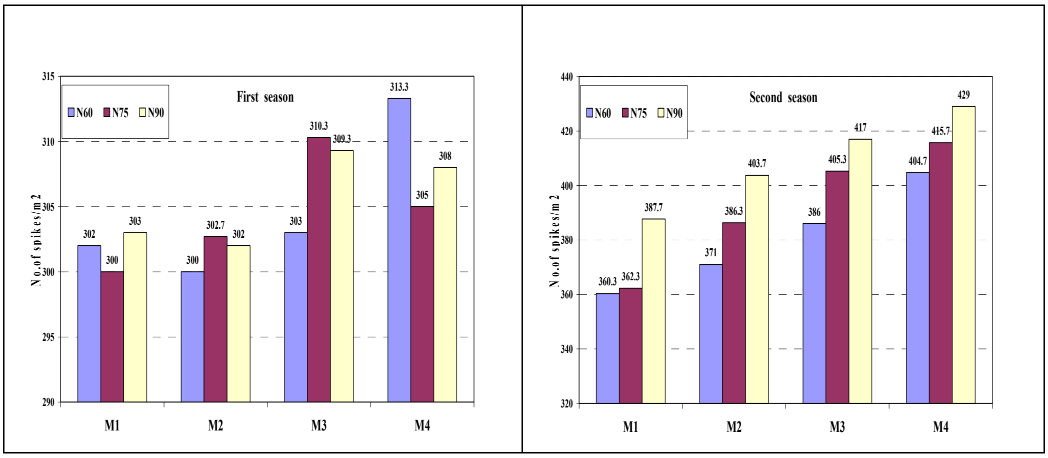
Interaction effects on agronomic parameters

Statistical analysis for the presented data in Figures 2, 3 and 4 indicated that there was a significant difference between the sowing levels and N levels and their interactions in relation to all agronomic parameters. The maximum values of agronomic parameters under the study were obtained from the interaction among the treatment of sowing at 20 cm row spacing apart and fertilized 90 kg N ha^{-1} (M4 X N3). This interaction gave the maximum values of (10.33 & 11.3 cm) for spike length and (63.00 & 65.00 gm) for 1000 grain weight in both seasons, respectively (Fig.2,3 and 4) Also, number of spike m^{-2} was significantly affected in the 2^{nd} season with maximum value (429.0).



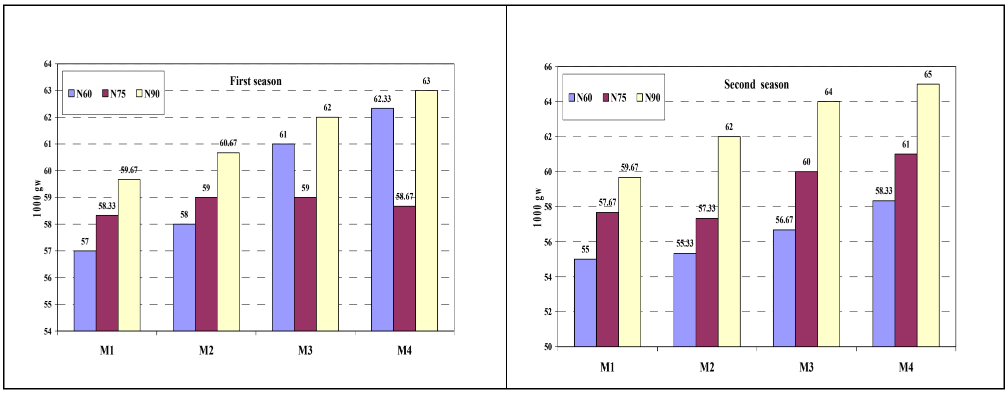
Spike length (cm) in the 1^{st} season   Spike length (cm) in the 2^{nd} season

Figure 2



Number of spike m^{-1} in the 1^{st} season   Number of spike m^{-1} in the 2^{nd} season

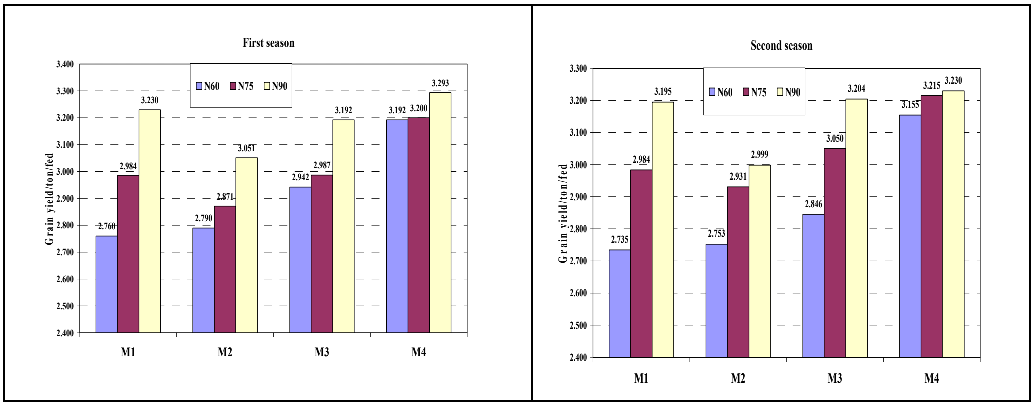
Figure 3



1000 grain weight (gm) in the 1^{st} season   1000 grain weight (gm) in the 2^{nd} season

Figure 4

Our obtained results in Figure 5 showed that the highest grain yield for durum wheat was observed at 20 cm row spacing apart and fertilized with 90 kg N fed^{-1}. The increase in grain yield shows a consistent trend as the other parameters. The productivity of grain yield (3.292 & 3.229 ton fed^{-1} were obtained due the interaction among the method of cultivation at a wider row space (20 cm) fertilized with the highest nitrogen fertilizer rate (90 kg N fed^{-1}) in both seasons, respectively.



Grain yield ton fed^{-1} in the 1st season Grain yield ton fed^{-1} in the 2nd season

Figure 5

The increase in grain yield might be due to the enhancement in agronomic parameters under the study including the higher spike length, number of spike and 1000 grain weight resulted from the interaction among (M4 X N90) compared to broadcasting method fertilized with a rate of 60 kg fed^{-1}. Application of fertilizer has positive effect on spike length (GERBA & al [31]). In contrast the lowest grain yields were obtained due to cultivation by broadcasting methods fertilized with 60 kg N fed^{-1}. Recorded data in Tables (1, 2 and 3) show clearly that wheat plants in these plots were very small in spike length (7.67 & 7.00 cm); slightly little in number of spike m^{-2} (302.0 & 360.3) less weight in 1000 grain weight (57.0 & 55 gm).

Grain Protein Percentage (GPP)

Statistical analysis of data in Figure 6 showed clearly significant difference between the sowing methods in relation to grain protein percentage (GPP). The maximum grain protein percentage (GPP) values were obtained from plant cultivation in row spacing at 20 cm apart (13.78 & 24.95) in (M4) compared to broadcasting method (13.41 & 14.2) in (M1) in both seasons, respectively. The increase percentage in grain protein percentage (GPP) due to row spacing at 20 cm apart (M4) compared to broadcasting method (M1) were (2.76 & 5.28%)

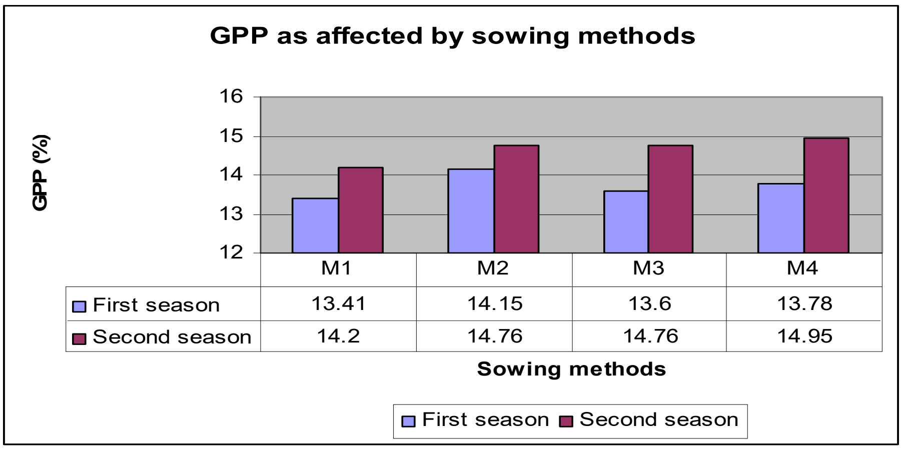


Figure 6. Main effect of sowing methods on grain protein percentage

The achieved data in Figure 7 presented the effect of N fertilizer levels on grain protein percentage (GPP). Increasing N fertilizer levels significantly increased protein percentage during both seasons. Maximum values of grain protein percentage (GPP) were recorded as a result of applying N fertilizer at a rate of 90 kg fed^{-1} in both seasons.

These results are in agreements with the recorded results with AHMED & al [32] they, proved that increasing N fertilizers rate significantly increased protein contents. N accumulation plays a crucial role in both limiting yield and contributing to the determination of grain protein in durum wheat. CHIBSA & al [33] found that grain and straw crude protein content ranged between (GSTCP) (11.98% to 15%) as a results of N application between 46 and 69 kg N ha^{-1}. Similarly, GERBA & al [31] reported that durum wheat exhibited the highest N concentration in grain and straw, resulted in a greater grain and total N uptake.

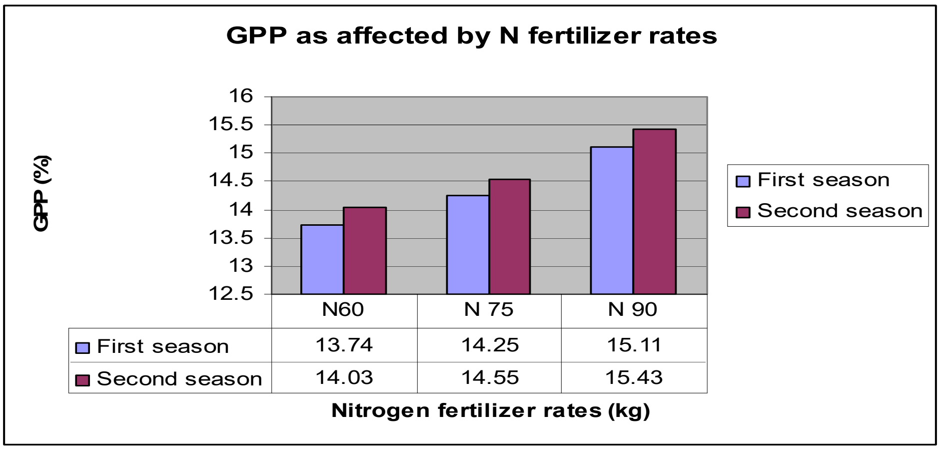


Figure 7. Main effect of N fertilizer levels on Grain Protein Percentage

The interaction effect between sowing methods and N fertilizers levels was demonstrated in Figure 8. The maximum values of grain protein percentage were obtained from sowing method in rows at 20 cm apart treated with 90 kg N fed^{-1} in both seasons. The increase in protein % due to nitrogen fertilizer may be attributed to the role of nitrogen in protein assimilation where, most of absorbed N is used in the synthesis of protein in a process involving reduction of nitrate to ammonium before incorporation into amino acids. Similar results were reported by BUXTON and CASLER [34].

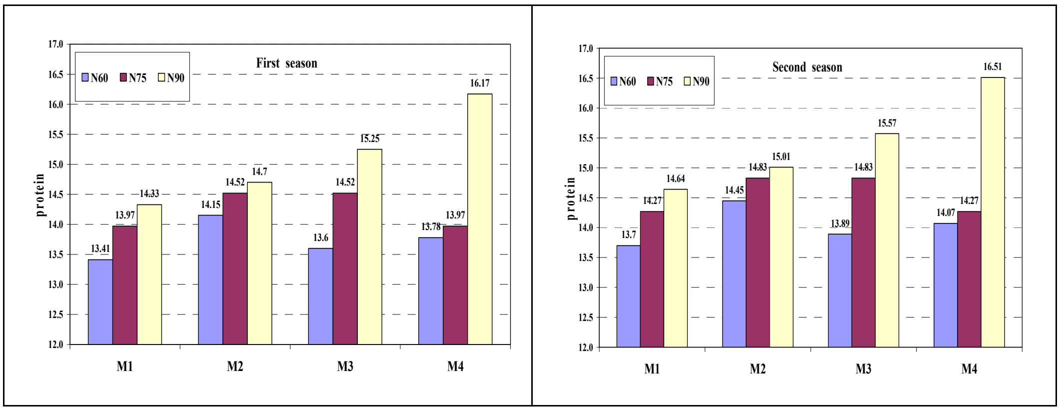


Figure 8. Interaction effects between sowing methods and N fertilizer levels on Grain Protein Percentage in the 1st season and in the 2nd season

Conclusion

In the present research we study broadcasting method, row spacing (10, 15 and 20 cm apart) and nitrogen fertilization levels (60, 75 and 90 kg fed^{-1}) on the growth traits of durum wheat (Bani Suif, 1). Our results revealed that the increase percentages according to row spacing at 20 cm apart compared to broadcasting method were (23.30 & 26.74%) for spike length; (5.11 & 6.94 %) for 1000 grain weight; (8.02 & 7.74%) for grain yield and (3.07 & 3.08%) for harvest index in both seasons, respectively. Generally, from the present study the sowing method in rows with 20 cm apart and the optimum N fertilizer rate (90 kg fed^{-1}) give the best results for durum wheat production.

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Conflict of Interest

The authors have no conflict of interest to declare.

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