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Effect of Nitrogen Fertilization, Proline, Plant Spacing and Irrigation Intervals on Growth of Maize Plant

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ABSTRACT

The purpose of this research was to study the impact of N levels applied with proline as well as plant distance on the vegetative growth, chemical content, yield, yield components, and quality attributes of maize under different irrigation intervals. The research was undertaken at an experimental field of Agricultural Faculty, El-Mansoura University during 2018-2019. The results showed that application of 150% nitrogen fertilization from recommended dose in presence of 50 mg/l proline significantly increased growth parameters (plant length, fresh and dry weight of flag, leaves area), chlorophyll content, N, P, K and proline content of maize leaves as well as yield attributed (ear length, 1000-graine weight, grain yield and straw yield) and quality of grains (crude proline, fiber, total carbohydrates and oil%). All parameters under investigation recorded high significant values with plant spacing 15 cm. As for irrigation intervals the results revealed that 11 days' intervals were the most suitable for previous maize parameters. So, it could be recommended touse150 N-fertilization in presence of proline + 15 cm plant spacing and 11 days' irrigation intervals.

Keywords: N-fertilization, proline, plant spacing, irrigation intervals and maize plants.

INTRODUCTION

Maize (*Zea mays* L.) is considered one of the most remarkable summer cereal crops grown in Egypt used for human consumption and animal feed. It globally rows the third site at cereal crops family after rice and wheat (Gerpacio and Pingali, 2007) and called ‘King of cereals’. Rising production of maize became one of the most significant objectives of the Egyptian agricultural policy to confront the human and animal requests. Among various cultivated economically significant cereal crops, maize not just has sufficient content of tocopherols, carotenoids and oil, but additionally has huge amounts of protein and starch contrast with other major food crops such as wheat and rice. In spite of the fact that maize is mainly cultivated for carbohydrate production, in the previous several years, it has incresed great significance as an exporter of vegetable oil for the food industry (Ali *et al*., 2013). The maize kernel is composed of around 10% protein, 72% starch, 2% sugar, 5% oil, and 1% ash with the remainder being water (Shrestha *et al.,* 2018). This could be achieved through following the proper management systems which could lead to maximize its productivity. Optimum controlling water, plant density, fertilizer and chemical inputs is important for ameliorative the growth variables responsible for high yield.

Egyptian soils are known to be poor in available nitrogen due to their low content of organic matter and the low a mounts of organic manures added annually. Corn requests high amounts of N (Alimohammadi *et al*., 2011). So, for an optimal yield, the N supply must be available accessible to the needs of the plant. Nitrogen (N) has the largest effect on the productivity and industrial gain of corn (Carmo *et al.,* 2012). Mekdad (2015) reported that increase in yield due to increasing N-fertilization levels could be due to the importance of N as one of the macronutrient elements for plant nutrition and its role in improvement vegetative growth during growing leaf initiation, increment chlorophyll concentration in leaves which may reflected in improving photosynthesis process. Number of marketable ears, the length and diameter of the ears, and the productivity of ears and grains effects by the nutritional condition of N in plants the (Carmo *et al*., 2012). Similarly, Chemical content of maize grains as oil and carbohydrate concentrations are increased significantly by application of N (Ibrahim and Kandil, 2007) also, increasing the proline content and amino acid formation (Ali *et al*., 1999). addition of 120 kg/fed increased significant plant height, number of leaves/plant, ear leaf area/plant (Bamuaafa, 2012).

Proline is the most common compatible solute that happens in a wide variety of plants. It is considered as the most significant amino acids that collect in different tissues of the plant, especially in the leaves, the gathering of this amino acid has a job in the regulation of osmosis in the cell as the proline is packed in the cytoplasm to counterbalance effort osmosis cell sap. Additionally, proline secures enzymes under stress conditions (Meister 2012). Just as proline is an index for dryness where an increase in the leaf proof that the plant sustained from stress. Likewise, it is one of the manners that the plant show protection from any pressure, the gathering of proline in the leaf appearance is a sort of adaptation with dryness to spare the best content of water in the plant (Tarighaleslami, Zarghami *et al.*, 2012).

Optimum density plant ensures the plants to become appropriately both in their aerial and underground parts through various usage of nutrients and solar radiation. Since it is accepted to have impacts on light interception during which photosynthesis happens, the energy manufacturing medium, utilizing green parts of the plant. Additionally, it influences the rhizosphere exploitation and photosphere by the plants particularly when spacing is inadequate and the plants endures clustering together. Great spacing between plant gives the correct plant density, which is the number of plants, permitted on a given unit of land for optimum yield (Ibeawuchi *et al.,* 2008). Higher plant density than optimum level, resulted in severe rivalry among plants for light over ground or for nutrients underneth the ground, thus the plant development slows down and the grain yield decreases. Tahmasbi and Mohasel (2009) showed that increase plant density significantly increased the growth of grain yield and recorded from 85000 plant/ha with 11.13 t/ha. Saadat *et al.,* (2010) stated that the highest number of grains per ear and number of rows per ear were found from 40000 Plant/ha. Futlless *et al.,* (2010) comparing 4 spacing (75 x 25, 75 x 20, 75 x 15 and 75 x 10 cm) they found that maize planted at 75 x 25 cm confer the highest grain yield of 1900 kg/ha. So, they recommended that farmers should adopt the spacing of 75 x 25 cm for utmost productivity. Boloyi

(2014) bespoke a spacing of 90 x 25 cm for farmers since the highest average yield of 232.3 kg/ha came from it comparing with the other spacing of 75 x 25 and 75 x 50 cm that produced lower yields.

Water is one of the most bountiful complex on the ground and 2/3 of the ground-level was covered or surrounded with water, but in most part of the world, shortage of water is a factor which is limit the direction of the agricultural products (Reddy *et al.*, 2004). Resources of water in Egypt are constrained and limited crop production in the newly reclaimed lands due to current intensive agricultural production. The agricultural sector consumes more than 84% of available water resources (El-Beltagy and Abo-Hadeed, 2008). Water shortage in Egypt is considered as a factor which limit the growth and plantation of the agricultural plants. Plants often suffer from water deficiency, and the severity of the resulting damage varies building on the duration and intensity of the stress. Other than the obvious impacts of drought stress, the impacts of water deficit are not surly known at the bio-chemical and molecular levels. Extending the irrigation intervals for corn crop decreased vegetative growth; grain yield and yield components (Reza and Mehdi, 2002). Grain yield significantly decreased from 8.67 to 6.83 Mg ha61 with corresponding decrease in seasonal cumulative crop evapotranspiration (ETC) from 59.9 to 55.3 cm, daily ETC from 5.25 to 4.86 mm day^{-1}, WUE from 1.445 to 1.340 kg m^{-3} water with increasing irrigation intervals from 10 to 20 days (Sharaan *et al.,* 2002). Growth and yield components were increased with increasing irrigation based on cumulative pan evaporation. The highest ET_C (60.32 cm) (El-Tantawy *et al.,* 2007). grain yield significantly reduced by 15.8%, ETC by 10.8% with increasing irrigation intervals from 7 to 14 or 21 days (Abdel-Maksoud *et al.*,2008).

So, this is the need of time to develop maize plant management strategy. So, our study was planned to evaluate the effect of levels of N applications with proline as well as plant distance on the vegetative growth, chemical content, yield, yield components, and quality attributes of maize under different irrigation intervals and to determine the optimum treatments should be used by farmers.

MATERIALS AND METHODS

The research was build out at an experimental field of Agricultural Faculty, El-Mansoura University during 2018-2019.

The soil hasclay loam texture, alkaline (pH 7.89). The soil of the trial site has no salt problem (EC 1.02 dSm^{-1} (1:5 w:v) and the organic matter content is low (1.76%), $CaCO_3$ 4.65, SP 59.5% and available N, P and K were determined according to Reeuwijk, (2002) which were 56.62, 7.11 and 191.6 mg.kg^{-1}, respectively.

In split-split plot design an experiment was laid out with three replications, in presence and absence of proline with 3 levels of nitrogen fertilization (50, 100 and 150% from recommended doses) as main plot, 2 different plant distances (10 and 15 cm) as sub plot and 3 levels of irrigation intervals (7, 11 and 15 days) as sub-sub plots. Thus, the total number of the experimental plot were 108 plots.

Nitrogen fertilizer was added in the soil as urea at a 3 rate from recommended dose (120 Kg N/fed.) in two equal proportions, the 1st half at 30 and the 2nd at 45 days after sowing. Phosphorus fertilizer was added as superphosphate at the rate of 200 Kg P_2O5/fed. before sowing. Potassium as potassium sulfate K_2SO_4 was added to the soil before sowing at the rate of 50 Kg K_2O/fed. Plants were sprayed with proline at the rate of 50 mg/l at two growing stage, 30 and 45 days after sowing with adding nitrogen fertilization.

Two levels of plant density: 30 plant/ridge each consisted of 70 x 10 cm and 20 plant/ridge. each consisted of 70 x 15 cm). From the third irrigation, the irrigation treatments were started, which included 7, 11 and 20 days' interval. Irrigation surface was adopted to convey the irrigation water to the experimental plots.

The plot area was 10.5 m^2 (3 x 3.5) having 5 ridges of 3 m in length and 70 cm in width. Planting date was on 15th of May during growing season. Thinning to one plant per hill was done 30 days after planting.

At full maturity, plants were randomly harvested from each plot to record the following traits:

- Plant length (cm), fresh and dry weight of flag (g), leave area (cm^2).
- Ear length (cm), 1000-grain weight (g), while, total grain yield (kg/fed.) and straw yield (kg/fed.) were calculated on the plot bases.
- ∗ Chemical content of leaves as chlorophyll content (a, b and total chlorophyll), N, P and K% as well as proline accumulation were determined according to Gavrilenko and Zigalova (2003), Mertens, (2005), Agrilasa, (2002)and (Marin *et al.,* 2010), respectively.
- ∗ Quality of seeds as Carbohydrates % (Shumaila and Safdar, 2009), fiber and protein according to (AOAC, 2000), and oil% according to

Using CoSTATE Computer Software and the means of treatments were compared by using LSD test at levels of 5% probability. The Randomized Complete Blocks design in split plot outlined by Gomez and Gomez (1984), data were statistically analyzed according to the procedures of ANOVA.

RESULTS AND DISCUSSION

Growth parameters:

Data at Table 1 showed the effect of individual application with nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on growth parameters of maize plant.

Results in Table 1showed that N fertilizer levels and proline significantly influenced plant length, fresh and dry weight of flag, leave area of maize. Growth parameters were the highest at the rate of 150% N from recommended dose in absence of proline (50 ppm) as compared with low application rats. This may be due to the important role of nitrogen in building both of co-enzymes, protein and nuclic acid which reflect to vegetative growth parameters also, the increase in leaf area could possibly be ascribed to the fact that nitrogen increases plant growth and plant height and this resulted in more nodes and internodes, similar results were obtained by (Hafez and Abdelaal 2015;Woldesenbet and Haileyesus 2016 and Ali and Anjum 2017). As for the effect of proline this result was agreement with those of (Al-Shaheen and Soh 2016 and Baddour *et al.*, 2017).

In the same Table, the effect of plant distance was illustrated and found that with increase, the growth parameters under investigation was increased, the highest mean values of plant length, fresh and dry weight of flag, leave area of maize recorded with plant spacing at 15 cm. The increase in plant vegetative may be due to competition for light which, might be responsible for increase in height due to closer intra-row spacing and this might have resulted in longer internodes, also, the higher leaf area per plant in the wider inter-row spacing and intra-row spacing might be due to more availability of growth factors and better penetration of light, consequently increased number of leaves produced and the size of individual leaves in plants at wider row spacing. This result was in agreement with (Nand, 2015; Getaneh *et al*., 2016 and Lihiang and Lumingkewas 2017).

Regarding to the effect of irrigation intervals, the mean values of parameters under study were significantly decreased with increasing irrigation intervals from 7 up to 11 days then decreased at 15 days as in indicate at Table 1 on vegetative growth parameters. Also, the highest values were 223.90, 13.49, 4.07 and 676.25 for plant length, fresh and dry weight of flag, leave area of maize, respectively were realized when the plants irrigated at 11 days while, the lowest one was happened when plants irrigated at 15 days. It could be suggested that increasing water quantity applied to plant led to keep higher moisture content in the soil and this in turn might favored the plant metabolism that leads to increase the plant growth characters and to produce higher dry matterthen a reduction in plant height was observed as irrigation interval prolonged this may be due to the fact that water stress produced short plants. The finding of this study is in agreement with the results of Abo-Marzoka *et al*., 2016; Majid *et al*., 2017.

Table 1. Individual application of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on growth parameters of maize plant.

Treatments	Plant length cm	Fresh weight of flag (g)	Dry weight of flag (g)	Leave area (cm^2)
		Nitrogen and proline fertilization		
50% N	187.35	12.28	3.45	570.26
50% N+ proline	197.53	12.37	3.57	605.88
100% N	212.35	13.09	3.91	648.21
100% N+ proline	225.09	14.07	4.35	677.87
150% N	238.54	13.33	4.02	712.58
150% N+ proline	251.69	14.29	4.47	749.18
LSD at 5%	0.69	0.11	0.03	0.95
		Plant distance		
10 cm	214.95	12.97	3.85	647.61
15 cm	222.57	13.51	4.07	673.72
LSD at 5%	0.28	0.03	0.01	0.32
		Irrigation interval		
7 days	217.78	13.17	3.97	658.00
10 days	223.90	13.49	4.07	676.25
15 days	214.60	13.05	3.84	647.74
LSD at 5%	0.64	0.05	0.03	0.76

It is clear from the data presented in Fig. 1 that, all growth parameters were significantly increased in response to interaction of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval. From the data found that highest mean values recorded with 150 N-fertilization in presence of proline + 15 cm spacing and 11 days' intervals.

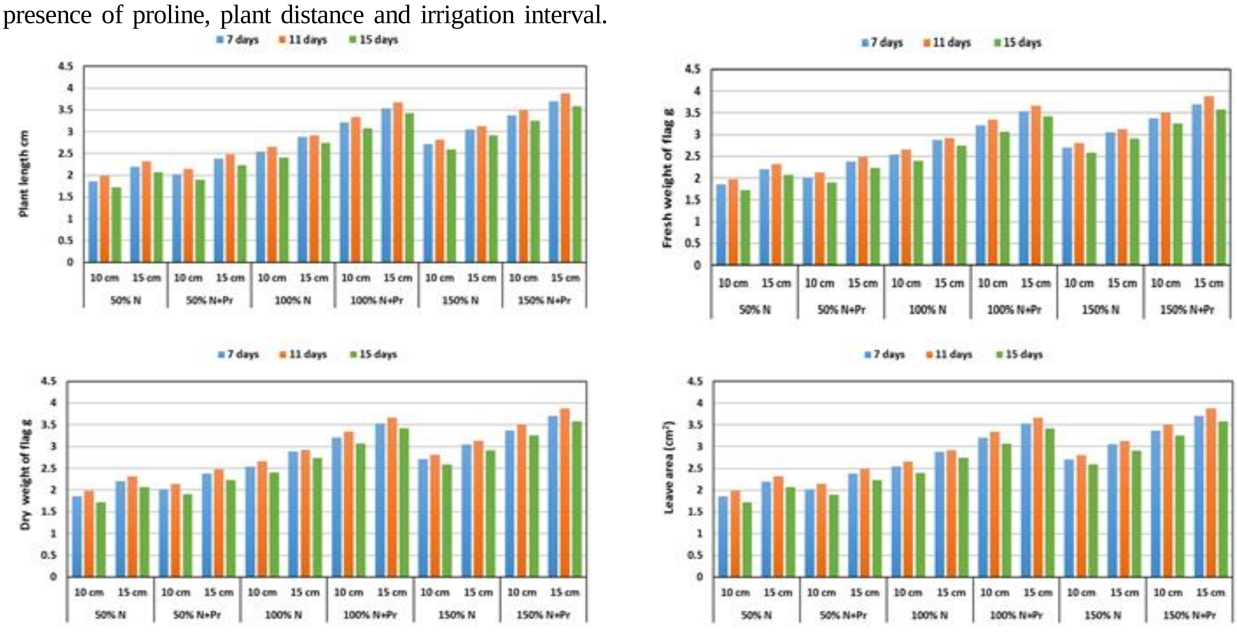

Fig . 1. Interaction effect of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on growth parameters of maize plant.

Chlorophyll content:

Presented data at Table 2 showed the effect of nitrogen fertilization levels and proline on chlorophyll content of maize leaves. Data reflected that with increasing nitrogen fertilization chlorophyll a, b and total chlorophyll increased in absence or presence of proline. The highest mean values of pigment recorded with using highest level of nitrogen fertilization and 50 ppm proline. This may be due to the role of nitrogen in increasing leaf area therefore chlorophyll content of leaves. This in turn caused an increase in photosynthetic levels (Hafez *et al*., 2014). In this respect, these results are in accordance with Hafez and Abdelaal 2015;Woldesenbet and Haileyesus 2016 and Ali and Anjum 2017). Thus, foliar applied proline enhanced the photosynthetic capacity of maize plant. There are number of reports which show that metabolic impairment is a major limitation to photosynthesis as Al-Shaheen and Soh (2016); Alam*et al.* (2016) and Baddour*et al*., 2017).

Chlorophyll content of maize leaves indicated at Table 2, were increased with increasing plant spacing and recorded high mean values at 15 cm in distance. This may be duo to that wide leaves increase the leaf chlorophyll level so, increment the phosynthetic process. Both wide leaf and high chlorophyll content led to a photosyntat process into dry materials and encourage the height development of the plant. This study supports Shafi*et al.* (2012) and Lihiang and Lumingkewas (2017).

Significant increase was happened in chlorophyll content (a, b and total) at the same Table, with increasing irrigation intervals up to 11 days then decreased at 15 days. This could be due to increasing irrigation intervals led to decrease in leave are exhibits poor leaf growth and less photosynthesis.

The interactive effects of N-fertilizer in absence and presence of proline, plant distance and irrigation interval on chlorophyll content (a, b and total) is indicated in Fig. 2, the results revealed that the highest mean values of previous parameters found with using 150 N-fertilization in presence of proline + 15 cm spacing and 10 days' intervals.

Table 2. Individual application of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on chlorophyll content of maize plant.

Treatments	Chlorophyll a mg/g FW	Chlorophyll b mg/g FW	Total chlorophyll mg/g FW
Nitrogen and proline fertilization			
50% N	0.714	0.448	1.162
50% N+ proline	0.724	0.459	1.183
100% N	0.757	0.480	1.237
100% N+ proline	0.801	0.512	1.313
150% N	0.768	0.488	1.256
150% N+ proline	0.812	0.520	1.332
LSD at 5%	0.002	0.005	0.006
Distance			
10 cm	0.752	0.477	1.228
15 cm	0.774	0.492	1.266
LSD at 5%	0.001	0.003	0.002
Irrigation interval			
7 days	0.763	0.486	1.249
10 days	0.779	0.494	1.273
15 days	0.747	0.472	1.219
LSD at 5%	0.002	0.003	0.003

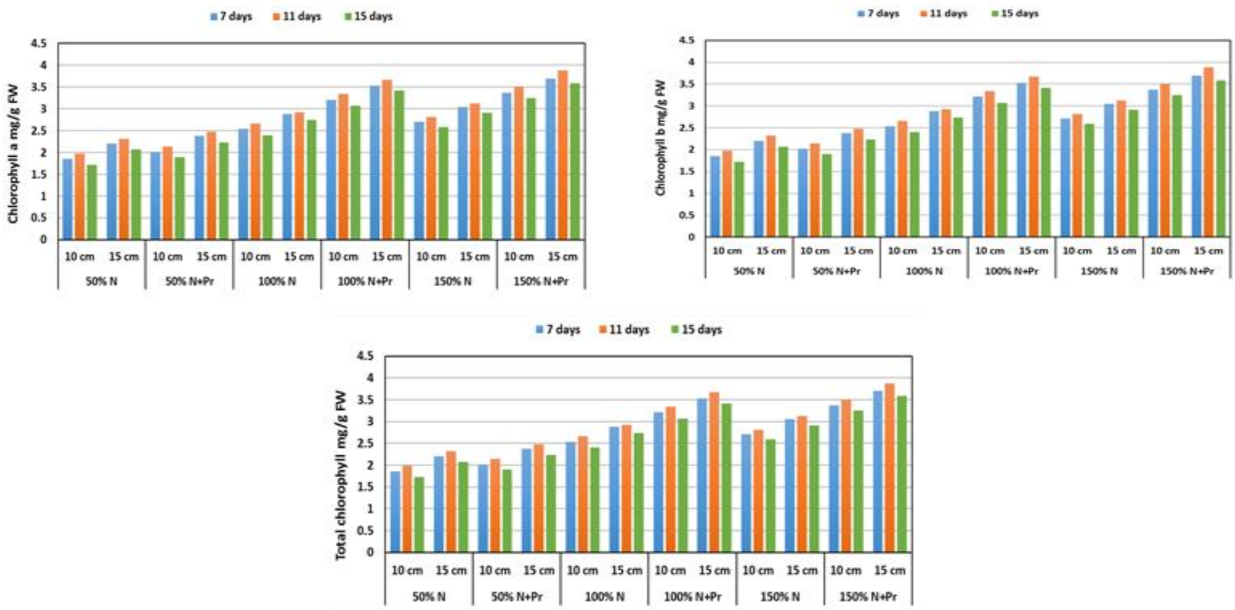

Fig . 2. Interaction effect of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on chlorophyll content of maize plant.

N, P, K% and proline content mg/kg:

Table 3 illustrated the mean values of N, P, K % and proline content of leaves as affected by N-fertilization with proline in foliar way. It's clear from the data that application of nitrogen fertilization levels increased N, P, K % and proline content in absence or presence of proline, and found that, highest values observed with application of 150% N+50 ppm proline. This may be owed to the effective role of nitrogen in availability of nutrient in soil then its absorption by roots Similar results were obtained by Hafez and Abdelaal 2015;Woldesenbet and Haileyesus 2016 and Ali and Anjum 2017).Thus, application of exogenous proline could be an efficient means of decrease the adverse effects of irrigation interval on plants as has been observed in the present study (Alam *et al*. 2016 and Baddour *et al*., 2017).

Analysis of variance at the same Table, indicated that plant spacing had highly significant effect on N, P, K% and proline content, and found that with increase distance to 15 cm, N, P, K% and proline content were increased(Mahdi and Ismail 2015).

Respecting the nutritional status and proline content of maize plant as influenced by three irrigation intervals are shown in Table 3. The content of N, P, K and proline recorded higher values with irrigation at the shorter regime from 7 up to 11 days' interval then decreased at 15 days. This finding could be ascribing to the way that when soil moisture decreased, the nutrient mobility in the soil is towered and the rate of nutrients flow to root absorption zone decreased. In addition, the calculation of the gathered data reveals that the values of the above contents significantly varied within the irrigation treatments. Similar results were obtained by Abo-Marzoka *et al*., 2016; Abdou *et al*., 2017 and Majid *et al*., 2017.

A highly significant interaction between N-fertilizer in absence and presence of proline, plant distance and irrigation intervals affected the concentration of N, P and K and proline content in leaves of maize plant. During the season the treatment of 150 N-fertilization in presence of proline + 15 cm spacing and 10 days' intervals maintained significantly higher N, P and K concentrations as well as proline content than other treatments as shown in Fig 3.

Table 3. Individual application of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on N, P, K% and proline content mg/kg of maize plant.

Treatments	N%	P%	K%	Proline mg/kg
Nitrogen and proline fertilization				
50% N	1.81	0.226	1.41	10.90
50% N+ proline	2.12	0.238	1.56	14.57
100% N	2.45	0.278	1.92	12.04
100% N+ proline	2.76	0.330	2.49	15.96
150% N	3.05	0.290	2.10	13.37
150% N+ proline	3.35	0.343	2.62	17.50
LSD at 5%	0.03	0.002	0.06	0.12
Distance				
10 cm	2.51	0.271	1.89	13.66
15 cm	2.67	0.297	2.14	14.45
LSD at 5%	0.01	0.001	0.03	0.04
Irrigation interval				
7 days	2.56	0.285	2.01	14.02
10 days	2.78	0.297	2.15	13.51
15 days	2.43	0.270	1.89	14.64
LSD at 5%	0.01	0.001	0.04	0.06

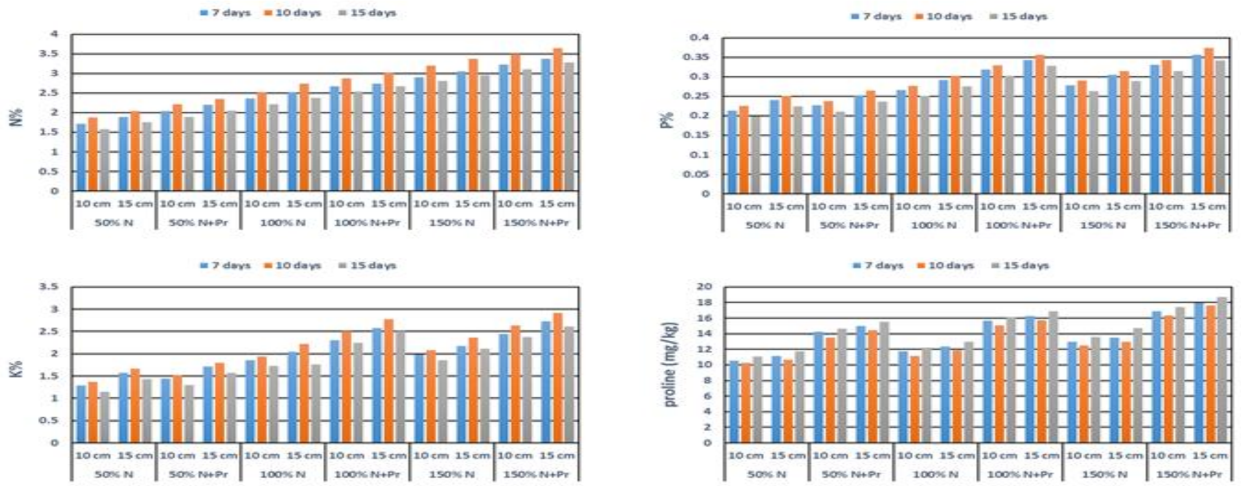

Fig 3. Interaction effect of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on N, P, K% and proline content of maize plant.

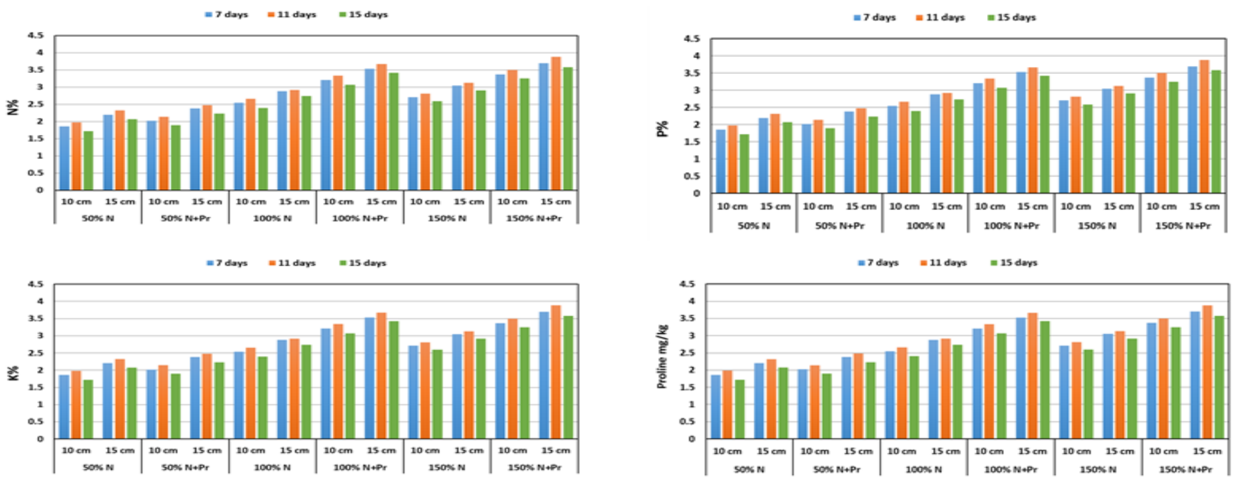

Fig 3. Interaction effect of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on N, P, K% and proline contebnt of maize plant.

Yield attributed:

Concerning the effect of nitrogen fertilization and proline on yield and its component, data at Table 4 clearly showed that increase in nitrogen fertilization levels increased ear length, 1000-grain weight, total grain yield and straw yield in in absence or presence of proline. But found highest mean values of this parameters with application of 150 %N from recommended presence of foliar 50 ppm proline. These results might be attributed to the effect of nitrogen on the vigor vegetative growth and accumulation of photosynthesis assimilates which produce high number of grains/row and grains/ear and meristematic activity of maize plant and increasing yield attributes as final grain yield. These results are in accordance with (Hafez and Abdelaal 2015; Woldesenbet and Haileyesus 2016 and Ali and Anjum 2017). With some help from foliar application of proline to avoid stress by irrigation interval These results are similar to the findings of (Alam *et al.* 2016; Al-Shaheen and Soh 2016).

Yield attributes viz; ear length, 1000-grain weight, total grain yield and straw yield significantly influents by plant spacing present in Table 4. The maximum yield attributes were obtained with distance at 15 cm comparing with 10 cm. This might be due to plant receive more sunlight by the canopy of plant and sufficient nutrient from the soil which results higher growth of plant and maximum yield attributes. The increase in number of grains in high plant space might be due to availability of more resources resulting in less competition. When the number of individuals per area is increased beyond the optimum plant density, there is a series of consequences that are detrimental to ear ontogeny that result in barrenness. Also could be due to more resources (nutrients +water) availability for relatively less number of plants which they utilized efficiently. Low grain weight in high plant population density was may be due to less photosynthesis availability for grain development on account of high inter-specific competition which resulted in high rate of respiration and low rate of photosynthates as a result of enhanced mutual shading (Zamir *et al*., 2011). This result was in agreement with (Nand, 2015; Getaneh *et al*., 2016 and Lihiang and Lumingkewas 2017).

Concerning to the effect of the irrigation intervals, it was found as shown in Table 4 that irrigation intervals significantly enhanced the parameters ofear length, 1000-grain weight, total grain yield and straw yield. The highest values of the parameters under investigation recorded up to the irrigation interval 11 days then decreased at 15 days. could be attributed to the fact that frequent irrigation would provide the crop with adequate moisture in the surface layer in which most of the maize roots exists, thus resulting in better crop nourishment and consequently higher yield. Also, the final grain yield depends upon the number of seeds/cob produced and extent to which the grains are filled. Increasing irrigation intervals up to 15 days will decrease the soil moisture availability in the root zone, which in turn decrease vegetative growth of corn plant and dry matter accumulation during filling of grains, as well as reducing nutrients absorption from soil. Similar results were reported by Abo-Marzoka *et al*., 2016; Abdou *et al.,* 2017 and Majid *et al*., 2017.

Table 4. Individual application of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on yield attributed of maize plant.

Treatments	Ear length cm	1000 grain weight g	Total grain yield ton/fed	Straw yield ton/fed
Nitrogen and proline fertilization				
50% N	15.61	27.00	2.65	3.72
50% N+ proline	16.11	27.42	2.77	3.83
100% N	17.61	28.55	3.13	4.12
100% N+ proline	19.64	29.97	3.65	4.58
150% N	18.11	28.99	3.24	4.25
150% N+ proline	20.12	30.58	3.75	4.72
LSD at 5%	0.10	0.07	0.05	0.05
Distance				
10 cm	17.37	28.40	3.08	4.09
15 cm	18.36	29.11	3.32	4.31
LSD at 5%	0.05	0.03	0.02	0.02
Irrigation interval				
7 days	18.01	28.67	3.20	4.22
10 days	18.88	29.91	3.33	4.37
15 days	16.71	27.67	3.07	4.03
LSD at 5%	0.05	0.03	0.03	0.04

As for the interaction effect between the data under investigation as illustrated by Fig. 4, the results found that using N-fertilization at the rate of 150% from recommended dose in presence of 50 mg/kg proline under 15 cm plant spacing with 10 days irrigation interval realized the highest mean values of yield attributed of maize plant.

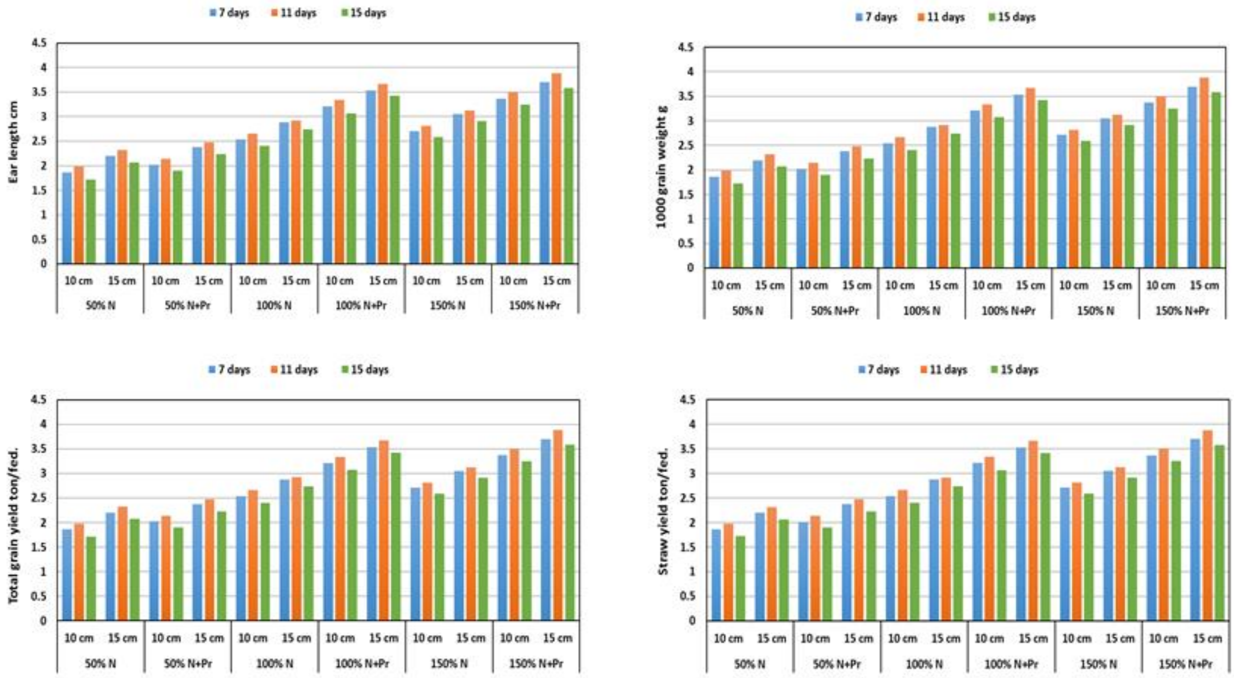

Fig . 4. Interaction effect of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on yield attributed of maize plant.

Grains quality:

As shown from this investigation, data at Table 5 showed that using different rats of nitrogen fertilization in absence or presence of proline significantly effect on yield quality (crud protein, total carbohydrates, crud fiber and oil%). The highest mean values of grain quality indicated with application of 150% N +proline. Increasing grain quality content of maize may be due to an increase in available N-around root zone, which increase nitrogen supply to plant under high fertilization level of nitrogen, whereas, nitrogen plays an important role in the synthesis of protein. These findings concur with theresults obtained by (Hafez and Abdelaal 2015;Woldesenbet and Haileyesus 2016 and Ali and Anjum 2017). As for the effect of proline the same results are in agreement with the findings of (Abd El-Samad *et al*., 2010; Al-Shaheen and Soh 2016 and Baddour *et al.*, 2017).

The crude protein, total carbohydrates, crud fiber and oil% were significantly affected by plant spacing as presented at Table 5. The maximum protein (9.00%), total carbohydrates (75.59 %), crud fiber (2.52 %) and oil (2.95 %) was observed with high plant spacing 15 cm. This was attributed to the higher resources (nutrients +water) for grains which reflected on comparatively quality content in maize plant.Similar results were obtained by (Nand 2015 and Lihiang and Lumingkewas 2017).

Data at Table 5 indicated the effect of irrigation intervals on maize grain quality as crude protein, total carbohydrates, crud fiber and oil%. The grain quality significantly affected by irrigation intervals from 7 up to 15 days. The highest mean values recorded at 11 days then decreased up to 15 days. This may be duo to reduce the available soil moisture in the root zone which in turn reduced yield attributed as well as quality of the grains Similar results were reported by Abo-Marzoka *et al*., 2016; Abdou *et al.*, 2017 and Majid *et al*., 2017.

Table 5. Individual application of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on quality of maize grains.

Treatments	C. protein %	Total carbohydrates %	C. fiber %	Oil %
Nitrogen and proline fertilization				
50% N	7.85	73.25	1.66	2.03
50% N+ proline	8.18	73.68	1.82	2.19
100% N	8.64	74.94	2.30	2.69
100% N+ proline	9.48	76.67	2.92	3.37
150% N	8.85	75.43	2.42	2.87
150% N+ proline	9.68	77.06	3.08	3.55
LSD at 5%	0.15	0.11	0.03	0.02
Distance				
10 cm	8.56	74.76	2.21	2.62
15 cm	9.00	75.59	2.52	2.95
LSD at 5%	0.10	0.06	0.03	0.02
Irrigation interval				
7 days	8.77	75.18	2.36	2.79
10 days	9.05	76.28	2.20	2.90
15 days	8.52	74.06	2.54	2.66
LSD at 5%	0.09	0.07	0.02	0.02

Interaction effect between treatments under investigation significantly increased crude protein, total carbohydrates, crud fiber and oil%as shownin Fig. 5. The highest values recorded with using 150% N-fertilization+50 mg/kgproline under 15 cm plant spacing with 10 days' irrigation intervals.

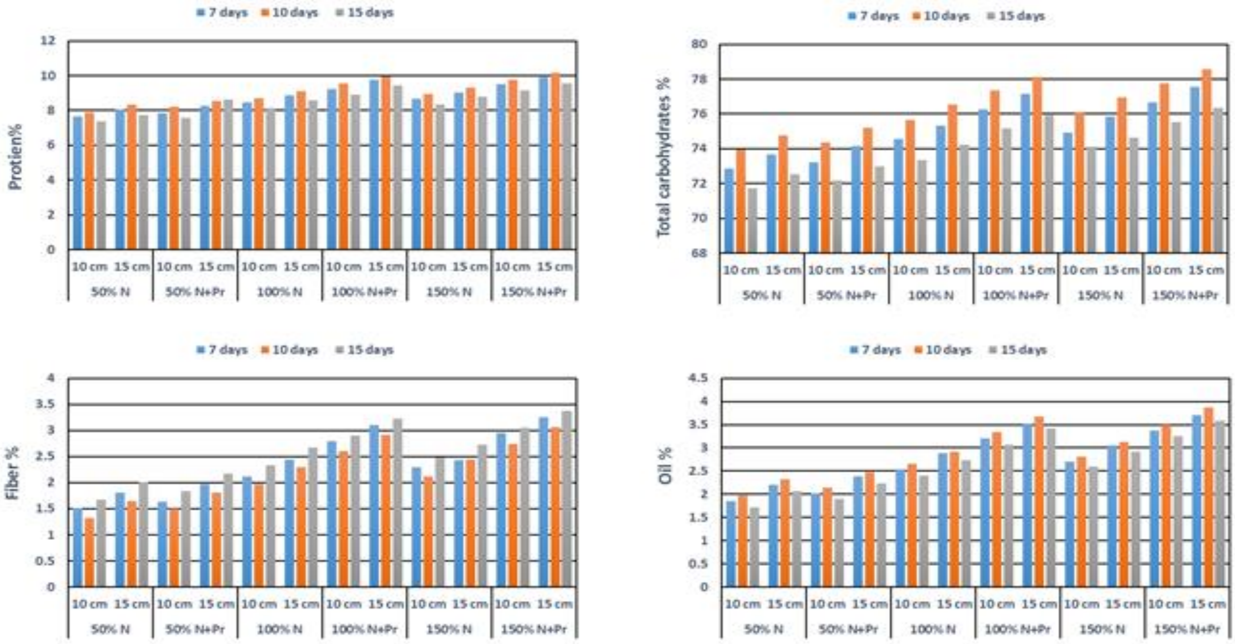

Fig . 5. Interaction effect of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on maize graine quality.

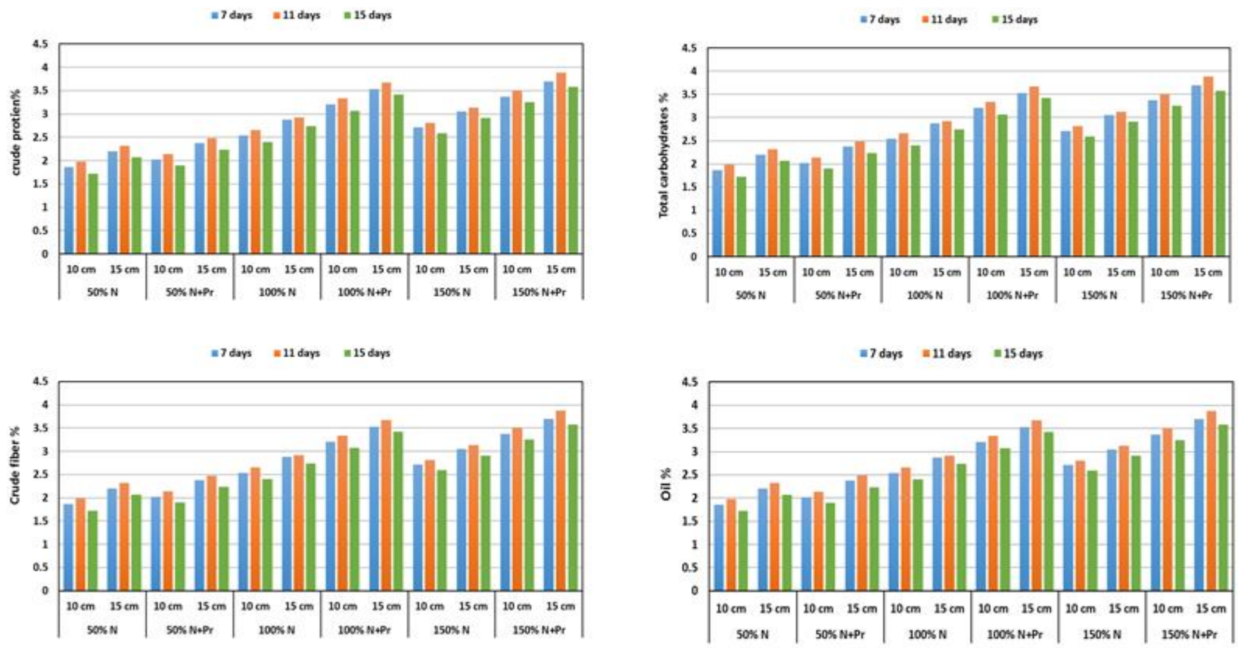

Fig. 5. Interaction effect of nitrogen fertilization in absence and presence of proline, plant distance and irrigation interval on maize graine quality.

CONCLUSION

From the findings of the present research it can be concluded that when the maize efficiently served, it gave high grain yield and good quality. Throughout the growth period the increased nitrogen level in presence of proline was beneficial for maintaining and improving the green and dry matter fodder maize yield with wide space between plants under different irrigation intervals. Therefore, it is recommended that 150% nitrogen applications from recommended dose and foliar application of 50 mg/kgproline with 15 cm plant distance under 10 days' interval irrigation are the most economical strategy for obtaining best quality grain maize yield.

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تأثير التسميد النيتروجيني و البرولين و المسافة بين النباتات والري علي نمو الذره

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يهدف البحث إلىتحديد مستويات التسميد النيتروجيني المناسبه فى وجود وعدم وجود البرولين و المسافه المناسبه بين النباتات تحت فترات مختلفه من الري على نبات الذره. تم إجراء البحث فى المزرعه الخاصه بكليه الزراعه – جامعه المنصوره خلال الفتره ٢٠١٨-٢٠١٩. أظهرت النتائج أن استخدام ١٥٠% من الجرعه الموصي بها من التسميد النيتروجيني مع رش ٥٠ ملجم/كجم برولين أدى الى زياده معنويه فى صفات النمو (طول النبات ، الوزن الطازج والجاف لورقه العلم، مساحه الاوراق)، محتوى الكلوروفيل و نسبه الاوراق من النيتروجين والوفوسفور والوبتاسيوم والبرولين كذلك محصول النبات (طول الكوز، وزن الـ١٠٠٠ حبه، محصول الحبوب والقش) بالاضافه الى جوده الحبوب (نسبه البروتين والالياف، الكربوهيدرات و الزيت). كذلك وجد أن أفضل مسافه بين النباتات هى ١٥ سم للحصول على افضل النتائج للصفات تحت الدراسه. أما بالنسبه لفترات الري المختلفه وجد أن الريكل ١٠ أيام هى أفضل الطرق للحصول على أعلى القيم للصفات الخاصه بنبات الذره تحت الدراسه. و من خلال هذه التجربه يمكن التوصيه باستخدام سماد نيتروجيني بمعدل ١٥٠% من الموصى به مع الرش بالبرولين و مسافات الزراعه ١٥ سم بين النباتات تحت فترات رى كل ١٠ أيام.