Assiut J. of Agric. Sci., 41 (4) (41-62)

Impact of Water Stress and Nitrogen Fertilizer on Yield, Yield Components and Quality of Maize Hybrids (*zea mays* l.).

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Abstract:

Two field experiment were carried out during the two successive seasons of 2008 and 2009 in the Agricultural Experiment Station Farm of the Faculty of Agriculture, Assiut University., to study the effect of three irrigation intervals (15, 25 and 35days), three nitrogen fertilizer rates (40, 80,120 kg N/fed.) and two maize hybrids (Single cross Watania 4 and Three way cross 310) and their interaction on yield, yield components and quality of maize (*Zea Mays* L.).

The obtained results can be summarized as follows:

1- Water stress by extending irrigation intervals to 35 days caused highly significant reduction in yield and other studied characters, as well as grain protein percentage but increased number of days to 50 % tasseling.

2- Increasing nitrogen application level up to 120 kg N/fed. caused highly significant increase in grain yield and its components, protein percentage in grains and number of days to 50 % tasseling.

3- Single cross Watania 4 significantly surpassed three way cross 310 in the mean values of ear length, grains weight/ear, 100-grain weight and grain yield /fed. in the second season only, except number of days to 50 % tasseling and protein percentage no significant difference in both seasons.

4- The interaction between irrigation intervals every 15 days and nitrogen fertilizer rate 120 kg N/fed. gave the highest grain yield (ardab/fed) by planting single crossWatania 4.

Key words: Maize hybrids, Water stress, Irrigation intervals, Yield, Nitrogen fertilization.

Introduction:

Increasing pressing grain yield of cereal crops is an important national target in Egypt in order to face the pressing needs of the fast growing Egyptian population.

Maize (*Zea Mays* L.) is one of the most important cereal crops growing principally during the summer season in Egypt and Yemen. The growing area of maize during 2008 and 2009 seasons was 820274 and 835000 ha.in Egypt but reached 43467 and 37402 ha. in Yemen, respectively. giving an average production of 7977 and 8143 kg/ha. in Egypt and 1514 and1499 kg/ha

Received on:8/11/2010 **Accepted for publication on**: 6/12/2010
Referees: Prof.Dr. Gamal R. El-Nagar Prof.Dr. Abdel-Aziz K. Ahmed

in Yemen, (F.A.O, 2008 and 2009).

The optimum supply of irrigation water and N fertilizer rates are two main factors directly affecting growth and productivity of corn hybrids. Water is considered the limiting factor for agricultural expansion and increasing productivity of field crops. In corn at the prepollination stage, treatments such as water deficit inhibit stigma (silk) elongation and floret development that leads to decrease in kernel set. EL-Sayed (1998) reported that water stress delayed flowering in maize plants. Also, El-morshidy *et al.* (2002) found that days to 50 % silking was 63.46 and 64.14 days with a rang from 57.0 to 68.5 days and no silking to 88 days for white corn S1 lines under favorable and water stress environments, respectively. On the contrary, Ibrahem (2002) and Sharaan *et al.* (2002) recorded that increasing irrigation interval significantly decreased number of days to 50 % tasseling.

Water stress affects almost all plant processes, including photosynthesis, respiration, stomatal conductivity. However, water stress response depends on the intensity, rate and duration of exposure to stress and their stage of crop growth Wajid *et al.* (2004).

Also water stress could be affect photosynthesis via stomata closure, enzyme activity reduction or hormonal aspects of this phenomenon, with changing of photosynthesis, affects plant respiration which become low (Ibrahim and Hala (2007)).

Nitrogen fertilizer is essential to the growth and yield of maize plants. Nitrogen plays a vital role in nutrition and physiological status of plants and promotes changes in mineral composition of plants Mengel and kirkby (1982).Therefore, nitrogen is considerably influenced by the quantity of available nitrogen. Many researchers reported that increasing nitrogen level up to 120 or 150 kg N / fed. led to a significant increase in grain yield and its components, protein percentage in grains and number of days to 50 % tasseling.Similar trend was shown by Badr *et al.* (2003); EL-Nagar (2003); Saleh and Nawar (2003); EL-Rewainy and Galal (2004); EL-Sayed (2006); Ibrahim and Hala (2007); Ahmed (2009); Mansour (2009) and Mansour and abdEL-Maksoud (2009). Using new improved maize hybrids in order to increase the Egyptian maize productivity requires determination of the most appropriate irrigation interval and level of nitrogen fertilizer. Evidently, some workers recorded significant cultivar differences in yield and its components, among them EL-Aref *et al.* (2004); Ahmed and Mekki (2005); Seif *et al.* (2005); Osman (2006) Ahmed (2009) and Mansour and abdEL-Maksoud (2009).

Therefore, the aim of this study was to investigate the effect of three irrigation intervals and three nitrogen levels on yield and its components, as well as grains quality of two maize hybrids.

Materials and Methods

Two field experiments were carried out at the Agricultural Experimental Station Faculty of Agriculture, Assiut University., Egypt, during the two successive growing seasons of 2008 and 2009 to study the effect of different irrigation intervals and nitrogen fertilizer rates on yield, yield components and quality of two maize hybrids.

A. Irrigation intervals:

I_1-Irrigation every 15 days (No. of irrigations7). **I_2-**Irrigation every 25 days (No.of irrigations 4). **I_3 -**Irrigation every 35 days (No. of irrigations 3).

Irrigation interval treatments were practiced after the planting irrigation.

B. Maize hybrids:

H_1-Single cross Watania 4. **H_2-**Three way cross 310.

The two hybrids of maize were obtained from Agriculture Research Center, Ministry of Agriculture and Land reclamation.

C. Nitrogen fertilizer rates:

N_1- 40 kg N / feddan. **N_2-** 80 kg N / feddan.**N_3-** 120 kg N / feddan Nitrogen fertilizer rates were applied before the first irrigation in one dose in the form of ammonium nitrate (33.5% N).

Physical and chemical analysis of the experimental soil according to Klute (1986) is shown in Table (1).Also, meteorological data of the two growing seasons (2008 and 2009) at Assiut condition Table (2).

The experiments were established in randomized complete block design with split plot distribution, combined over irrigation using four replication. The main plots were devoted the two maize hybrids, while the sub plots were included by N fertilizer rates. The experimental plot area was 10.5 m^2 (3 x 3.5 m) consisting of 5 ridges each of 70 cm. width and 3m length 30 cm was between hills of the rate 15 kg/fed. Before planting all plots received 100 kg super phosphates/fed (15.5 % P_2O_5).In addition100 kg potassium sulphat/fed. (48 % K_2O) was added before the first irrigation for all plots.

Table(1):Physical and chemical properties of experimental sites.

Properties	**2008**	**2009**
Mechanical analysis:		
Sand %	26.20	26.60
Silt %	24.20	23.00
Clay %	49.60	50.40
Soil type	Clay	Clay
Chemical analysis:		
PH	7.73	7.80
Organic matter%	1.74	1.62
Total Nitrogen %	0.08	0.07
Total CaCo3%	1.17	1.20

Sowing date was on 4th and 2nd June, 2008 and 2009 seasons, respectively. Maize plants were thinned to secure one healthy plant/hill prior before the first irrigation, which gave a population of 20.000 plants/ fed. The plots were hand hoed once for controlling weeds before first irrigation. Irrigation intervals treatments were practiced from the first irrigation. All recommended cultural operations were carried out as usual in both seasons.

The studied characters:

At harvest time after 120 days from planting, the inner three rows were taken from each subplot in which grain yield was determined on the basis of 15.5 % moisture. Also, five guarded plants were taken randomly and labeled to study growth measurements at 80 days from planting in both seasons.

Data recorded:

1- Tasseling date: number of days from planting to 50 % tasseling appearance on sub-plot basis.
2- Ear length (cm).
3- Grain weight / ear (g).
4- 100-grain weight (g).
5-Grain yield (ardab/ fed).
6- Protein percentage in grains. It was determined using the technique of micro-kjeldahle apparatus according to A.O.A.C. (1990).

All obtained data for the experiment of each season were subjected to the statistical analysis of two factors in Randomized Complete Block Design in Split Plot arrangement, then combined analysis over irrigation treatments was done. Statistical analysis of the collected data was carried out using the computer program Mstat-C. L.S.D.test at 0.05% and 0.01 % level was used to compare between treatment combinations means according to Gomez and Gomez (1984).

Results and Discussion

The combined analysis of variance for irrigation intervals presented in (Table 3) indicated that number of days to 50 % tasseling, ear length, grains weight/ear, 100-grain weight, grain yield /fed. and protein percentage in grains was significantly affected by irrigation intervals and nitrogen fertilizer rates. Furthermore, maize hybrids significantly differed for the studied characters in the second season only, except number of days to 50 % tasseling and protein percentage were insignificant in both seasons, all interactions were insignificant except the interactions between irrigation intervals and N levels were significant for grains weight/ear and 100-grain weight in the second season, also grain yield/fed in the first season, but protein percentage in grains for the two season.

1- Number of days to 50 % tasseling:

Table (4) revealed that increasing irrigation intervals from 15 or 25 to 35 days significantly increased number of days to 50 % tasseling in both seasons. The irrigation every 15 days decreased number of days to 50 % tasseling. These results are in agreement with EL-Sayed (1998); El-murshedy (2002) and Ibrahem (2002), who reported that water stress during flowering stage or increasing irrigation intervals delayed tasselling dates in the second season only. Nitrogen fertilizer significantly affected number of days to 50 % tasseling, N3 (120 kgN/ fed) delayed tasselling dates in two seasons. It could be attributed to the physiological role of nitrogen in plants, as well as nitrogen increased the period of vegetative growth. These results confirmed with those detected by Shafshak *et al.* (1994). Hybrids of maize were insignificantly different for number of days to 50 % tasseling in both seasons. Similar findings were reported by Osman (2006).These results may be attributed to genetic characters, such as Soliman, Mona (2002).

All interactions were insignificant except (HxN) interaction in the first season only. The H_1 (single cross Watania 4) x N_1 (40 kg N/fed) gave the early maize plants for 50 % tasseling.

2- Ear length (cm):

Result in Table (5) showed that ear length was significantly affected by irrigation intervals, as well as nitrogen fertilizer in the two seasons, but hybrids were significantly affected in the second season only.

Irrigation every 15 days gave the highest of ear length. These results are in agreement with those obtained by Ibrahem (2002); Soliman, Mona (2002); EL-Nagar (2003); EL-Gizawy (2005); and Ibrahim and Hala (2007),who reported that increasing irrigation intervals up to 35 days decreased ear length. It is may be attributed to the physiological role of water in plants. N_3 (120 kg N/fed.) gave the highest ear length.

These results confirmed with those detected by Badr *et al.* (2003); EL-Nagar (2003); EL-Rewainy and Galal (2004); Nofal *et al.* (2005) and EL-Sayed (2006) who found that increasing nitrogen fertilizer increased ear length. It is could be attributed to the physiological effect of nitrogen on growth which in turn increased ear length. The hybrid 1 (single cross Watania 4) was higher for ear length in the second season only. Similar information were reported by others EL-Aref *et al.* (2004); Ahmed and Mekki (2005): Seif *et al.* (2005); Osman (2006) and Ahmed (2009).

3- Grains weight / ear (g):

Results presented in Table (6) revealed that grains weight/ear was significantly affected by irrigation intervals, as well as nitrogen fertilizer in the two seasons, but hybrids were significantly affected in the second season only. Irrigation every 15 days gave the highest of grains weight/ear. The results are in accordance with those obtained by Ibrahem (2002); Soliman, Mona (2002) and Abdo (2007) who indicated that increasing irrigation intervals were decreased grains weight/ear. These results may be attributed to the effect of soil moisture deficit during heading stage on flowering, pollination and fertilization. N_3 (120 kg N/fed) gave the maximum grains weight / ear. Similar results were obtained by Saleh and Nawar (2003); Attia *et al.* (2008) and Leilah *et al.* (2009).who found that increasing nitrogen fertilizer increased grains weight/ear. The hybrid 1 (single cross Watania 4) gave highest grains weight/ear than three way cross 310 in the second season only. All interactions were insignificant for grains weight/ear except (IxN) interaction in the second season. The I_1 (irrigation every 15 days) x N_3 (120 kg N/fed) gave the maximum grains weight/ear.

4- 100-grain weight (g):

Data in Table (7) reported that irrigation intervals significantly affected 100-grain weight, the highest value was obtained at irrigation every 15 days in both seasons. Such findings may be attributed to the effect of prolonged irrigation intervals, which decreased the available soil moisture in the root zone during the gowning season and this in turn reduced plant growth, dry matter accumulation, translocation of metabolites and nutrients to grain during grain filling stage. These results are consistent with those reported by Ibrahem (2002); Soliman, Mona (2002); EL-Nagar (2003); EL-Gizawy (2005); and Abdo (2007).Hybrids of maize were significant in the second season only. H_1 (single cross Watania 4) gave the highest value of 100-grain weight. These results are in agreement with those reported by EL-Aref *et al.* (2004); Ahmed and Mekki (2005); Seif *et al.* (2005);

Osman (2006) and Ahmed (2009) and Mansour and AbdEL-Maksoud (2009).Nitrogen fertilizer had significant effect on 100-grain weight in the two seasons. N_3 (120 kg N/fed) gave the maximum value. This may be attribute to the physiological role of nitrogen in plants growth (i.e. photosynthetic, accumulation of dry matter in grains). These results are in agreement with those obtained by Badr *et al.* (2003); EL-Nagar (2003); EL-Sayed (2006); Attia *et al.* (2008) and Ahmed (2009) and Leilah *et al.* (2009).

All interactions were not significant except (IxN) interaction in the second season only. High value of 100-grain weight was obtained at I_1 (irrigation every 15 days) x N_3 (120 kg N/fed). The results are in agreement with those revealed by EL-Nagar (2003); EL-Sayed (2006) and Ibrahim and Hala (2007).

5-Grain yield (ardab / fed):

Mean squares in Table (3) indicated highly significant differences was found between irrigation intervals as well as nitrogen fertilizer rates on grain yield (ardab/fed) in both seasons. while maize hybrids had a significant effect in the second season only. The interaction between irrigation intervals and nitrogen fertilizer was significant on grain yield (ardab/fed) in the first season only. Results in Table (8) and fig.1 indicated that mean grain yield (ardab/fed) was affected by irrigation intervals in both seasons. Increasing irrigation intervals up to 35 days were decreased significantly grain yield than 25 and 15 days by 8.14, 13.12 and 7.60, 14.97 (ardab/fed) for 2008 and 2009, respectively. Meanwhile, the highest grain yield was obtained at irrigation every 15 days; 17.20 and 23.76 ardab/fed. for the 2008 and 2009 seasons, respectively. The reduction in growth and yield components (ear length, grains weight/ear and 100-grain weight) decreased grain yield by irrigation every 25 and 35 days. This may be attributed to the unbalanced soil water-air under these conditions, which led to reduction all photosynthetic pigments and photosynthesis activity as well as the adverse relations between hormones and biological processes in the whole plant organs. Similar results were obtained by Ibrahem (2002); Soliman, Mona (2002); Wajid *et al.* (2004), EL-Gizawy (2005); and Abdo (2007) and Ibrahim and Hala (2007).

Results presented in Table (8) and fig. 2 showed that increasing nitrogen fertilizer rates, significantly increased grain yield ardab/fed. in both seasons These increases in the second season were more pronounced than those obtained in the first season. The highest yields in 2008 and 2009 seasons were obtained by using 120 kg N/fed.; 12.75 and 19.03 ardab/fed., respectively. These results may be due to the increase photosynthetic surface, which in turn resulted in an

increase in metabolic processes and building more grain yield. These results confirm with those by Mengel and kirkby (1982); Badr *et al.* (2003); EL-Nagar (2003); Saleh and Nawar (2003); EL-Rewainy and Galal (2004); Nofal *et al.* (2005); EL-Sayed (2006); Ibrahim and Hala (2007); Attia *et al.* (2008); Ahmed (2009); ALJobouri and Arowl (2009) and Leilah *et al.* (2009).

Data in Table (8) showed that the two maize hybrids differed significantly for grain yield (ardab/fed) in the second season only at 5% probability level. Single cross Watania 4 (H_1) surpassed three way cross 310 (H_2) in grain yield by 0.25 and 1.71 ardab/fed. in 2008 and 2009 seasons, respectively. Grain yield of maize hybrids was highest in the second season than in first one. These results may be due to high temperature and low relative humidity % in the first season than the second one as shown in (Table2).These results were similar with those found by Ibrahem (2002); EL-Aref *et al.* (2004); Ahmed and Mekki (2005); Seif *et al.* (2005); Osman (2006) Ahmed (2009) and Mansour and abdEL-Maksoud (2009).

All interactions were insignificant except the interaction between irrigation intervals and N fertilizer rates which was significant effect for grain yield (ardab/fed) in the first year only. Table (8) also showed that the highest grain yield (ardab / fed) was recorded with irrigation interval every 15 days and by application 120 kg N/fed.;19.37 and 26.59(ardab/fed) for the first and the second year, respectively. Also, the lowest grain yield (ardab/fed) was found by irrigation interval every 35 days and used 40 kg N/fed.;3.12 and 6.25(ardab/fed) for 2008 and 2009 years, respectively. The results are in agreement with those revealed by EL-Nagar (2003); EL-Sayed (2006) and Ibrahim and Hala (2007).

6-Protein percentage in grains:

Results in Table (9) indicated that protein percentage in grains was significantly affected by irrigation intervals and nitrogen fertilizers in both seasons.Differences between the two hybrids were insignificant in both seasons. The highest value of protein percentage in grains was obtained at irrigation every 15 days. These results are in agreement with those reported by EL-Nagar (2003) and Ibrahim and Hala (2007). N_3 (120 kg N/fed) gave the high value of protein percentage in grains. These results are obtained with those reported by EL-Nagar (2003); Saleh and Nawar (2003); EL-Rewainy and Galal (2004) and EL-Sayed (2006).

All interactions were insignificant except I_1 (irrigation every 15 days) x N_3 (120 kg N/fed). in both seasons. Similar results were findings by EL-Nagar (2003) and Ibrahim and Hala (2007).

Conclusion

The highest maize grain yield per feddan under the condition Assiut governorate could be obtained by irrigation every 15 days and application of 120 kg N/feddan when Single cross Watania 4 was planted.

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تأثير الإجهاد المائي والتسميد النيتروجيني على المحصول ومكوناته والجودة لهجن الذره الشامية

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يعتبر الماء من أهم العوامل التي تعوق التوسع الزراعي أفقياً ورأسياً وزيادة انتاجية معظم المحاصيل الحقلية. كذلك نجد أن التسميد الأزوتي من العوامل الهامة التي تؤثر على النمو والانتاجية والجودة لمحاصيل الحقل النجيلية، لذلك أجريت هذه الدراسة على بعض هجن الذرة الشامية خلال موسمي 2008،2009 بمحطة التجارب الزراعية بكلية الزراعة – جامعة أسيوط -، لدراسة تأثير ثلاث فترات ري (15، 25، 35يوم) وثلاثة مستويات تسميد نيتروجيني (40،80،120 كجم ن/فدان) على الحاصل ومكونات المحصول والجودة لهجينين من الذره الشامية (هجين فردي وطنية 4 وهجين ثلاثي 310).

ويمكن تلخيص النتائج على النحو التالي:

1- تسبب الإجهاد المائي الناتج عن زيادة الفترة بين الريات إلى 35 يوما انخفاضا معنويا في حاصل الحبوب وغيره من الصفات المدروسة، وكذلك نسبة البروتين في الحبوب ولكن أدى ذلك الى زيادة عدد ألايام من الزراعة حتى طرد 50% من النورات المذكرة.

2- أدت زيادة التسميد النيتروجيني حتى 120 كجم ن/فدان زيادة معنوية في حاصل الحبوب ومكوناته ونسبة البروتين في الحبوب وعدد ألايام من الزراعة حتى طرد 50% من النورات المذكرة.

3- تفوق هجين فردي وطنية4 معنويا على الهجين الثلاثي 310 في طول الكوز، وزن حبوب الكوز، وزن المائة حبة ومحصول الحبوب/فدان .في الموسم الثاني فقط ، باستثناء عدد ألايام من الزراعة حتى طرد 50% من النورات المذكرة وكذلك نسبة البروتين لا يوجد فرق معنوي بين الصنفين في كلا الموسمين.

4- أعطى الري كل 15يوم مع التسميد النيتروجيني بمعدل 120 كجم أزوت/فدان أعلى حاصل حبوب للفدان عند زراعة الهجين الفردي وطنية 4 (27.51 أردب/فدان).