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RESPONSE OF MAIZE YIELD AND YIELD COMPONENTS TO SOAKING SEEDS IN SOME MICRONUTRIENTS SOLUTIONS UNDER WATER STRESS CONDITIONS

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ABSTRACT

A field experiment was conducted at Agricultural Research Station, Sebha, Libya in 2010 summer season to determine the effect of soaking seeds in four micronutrients solutions (Fe, Fe+Mn, Fe+Mn+Zn and Fe+Mn+Zn+Cu) under three irrigation scheduling (100, 85 and 70 % of crop evapotranspiration) on yield and yield components of maize crop.

***Results indicated that**, there are significant influences of irrigation levels, soaking seeds in some micronutrients solution and their interaction on plant hight, shelling %, 100-grain weight, grain weight (g/ plant and grain yield (kg/ha). The grain yield increased by 13.6, 18.4, 22.0 and 17.0% as compared with the control treatment for Fe, Fe+Mn, Fe+ Mn+ Zn and Fe+ Mn+ Zn+ Cu treatments, respectively.*

***Conclusively,** the data indicated that, there are not significant effects of irrigation levels, soaking seeds in micronutrients solution and their interaction on number of rows/ear length and ear diameter.*

Key words: Maize, yield, yield components, seeds soaking, irrigation scheduling, sprinkler irrigation, water stress.

INTRODUCTION

Early seedling development and uniform crop stand establishment in an important for crop yield (Harris, 1996). Different abiotic stresses such as drought can delay germination and increase abnormal seedling development (Bougne *et al.*,2000). Poor crop stand can promote weed populations causing competition for water, light and limiting nutrients (Kropff and Van Laar, 1993).

Sufficient mineral nutrient reserves in the seed are necessary to maintain seedling growth until root uptake start supplying soil nutrients. This is particularly important for crops grown on soils with low nutrients availability (Asher,1987).

Various techniques are employed to improve seed quality , to reduce the time between sowing and seedling emergence and also to minimize biotic and abiotic stresses during germination e.g. use of biotechnology, hybrid seeds, mechanical seed treatments and various seed treatments like seed coating, pelleting or soaking in different solution (Farooq *et al*.,2012).

Seed priming is a pre-sowing seed treatment in which seeds are soaked in water and dried back to storage moisture content until furtheruse. Seed priming in water has been shown to decrease time between sowing and emergence and to improve seedling vigour (Parera and Cantliffe,1994; Harris,1996). Nutrient seed priming is a technique in which seeds are soaking in nutrient solution instead of simple water. Nutrient seed priming increases the seed nutrient contents along with the priming effect to improve seed quality for better germination and seedling establishment. Priming seeds in solutions of macro- or micro-nutrient has been shown to improve yield of many crops, such as rice, wheat, forage legumes and maize (Peeran and Natanasabapathy, 1980; Wilhelm *et al*., 1988; Sherrell, 1984 and Imran *et al.*,2013).

Seed soaking in nutrients can help crop plants to cope with stress factors such as, decrease of nutrients and drought and can increase crop yield (Harris *et al.,* 1999; Harris *et al.,* 2000).

Therefore, the present study investigates perspectives for seed soaking in water and various micro-nutrients solutions on maize crop under water stress conditions. After establishing and optimizing the soaking conditions, a field experiment was conducted to investigate the effects of seed soaking in four micro-nutrients solutions (Fe, Mn+Zn, Fe+Mn+Zn and Fe+Mn+Zn+Cu) on yield and yield components of maize under three irrigation scheduling (100, 85 and 70 % of crop eavapotranspiration).

MATERIALS AND METHODS

Micro-nutrients seeds priming:

Micro-nutrients seeds priming is a technique, in which seeds are soaking in mineral micro-nutrients solutions for a particular time duration, dried back to initial moisture contents and stored for further use. Maize seeds were primed for 6 h by soaking in distilled water and nutrient solutions containing Fe, Fe+Mn, Fe+Mn+Zn and Fe+Mn+Zn+Cu, respectively. Concentration of micro-nutrients in the priming solutions are shown in Table 1. Distilled water-priming seeds were used as control treatment.

Field experiment:

The field experiment was conducted at the Research Station Farm, Sabha, Libya. For each of three replicates, *Zea maize* seeds were sown in drills 50cm apart and 30 cm within hills on an area of 10.5 m^2 (1st of June 2010). Field soil is a (sand 93.9 %, 4.0 % silt and 2.1 % clay). Some physical properties relevant to irrigation are given in Table (A).

Table 1: Concentrations and salts used for micro-nutrients maize seeds Priming

Concentrations and salts used
Control (Distilled water primed)
Fe 1000 ppm as $FeSO_4$
Fe+Mn 1000 ppm Fe as$FeSO_4$ + 500 ppm Mn as $MnSO_4$
Fe+Mn+Zn 1000 ppm Fe as$FeSO_4$+ 500 ppm Mn as $MnSO_4$+100 ppm Zn as $ZnSO_4$
Fe+Mn+Zn+Cu1000 ppm Fe as$FeSO_4$ + 500 ppm Mn as$MnSO_4$+100ppm Zn as $ZnSO_4$ +50 ppm Cu as $CuSO_4$

Table (A): Some physical properties of different soil layers of the experimental soil.

Depth (cm)	Field capacity (%)	Wilting Point (%)	Available water (%)	Bulk density
0-20	11.5	5.6	5.9	1.51
20-40	11.0	5.3	5.6	1.61

Plants were thinned to secure on plant per hill, three weeks after planting. All other cultural practices were carried out as recommended for corn crop. The sprinkler irrigation system, which used in the experimental farm, was a solid system, the manifold posited in the center of the field. It has three pairs of sprinkler laterals. Each pairs has a valve for on and off. The sprinkler lateral included four rotating sprinkler. The spacingbetween laterals and sprinklers were 14x18 m. Sprinkler discharge was 1.5 m^3 h^{-1} at 3 bar muzzle pressure. The corn plants were irrigated by different amounts of water. Amounts of water were determined as a percentage of the crop evapotranspiration (ETc), percentage one of the following three treatments: 100 % of ETc (6820 m^3ha^{-1}), 85 % of ETc (5797 m^3ha^{-1}) and 70 % of ETc (4774 m^3ha^{-1}). The daily ETo was computed according to Allen *et al.,* 1998. Irrigation treatments were started after full emergence at which each treatment was irrigated according to irrigation scheduling treatments.

Experimental design:

An experiment was laid out in a randomized complete block design by strip-plot arrangement with three replicates. The irrigation schedule, *i.e.* 100, 85 and 70 % of ETc were assisted in main plots, while the soaking seeds in micro-nutrients treatments (Control, Fe, Fe+Mn, Fe+Mn+Zn and Fe+Mn+Zn+Cu) were allocated in the sub-plots.

At harvest, random sample of five guarded plants for each experimental unit were taken and plant height (cm), numbers of ears plant^{-1} , numbers of rows ear^{-1}, 100-grain weight (g), grain weight ear^{-1},shelling percent. Grain yield ha^{-1} was determined per each plot then transferred to grain yield (kg ha^{-1}), after modified the moisture content at 15%.

All collected data were analyzed with analysis of variance (ANOVA) procedures using the MSTAT-C statistical software package (Michigan state university, 1983). Differences between means were compared by LSD at 5% level of significant (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Data illustrated in Table 1 declared the significant influences of irrigation levels, soaking seeds in some micronutrients solutions and their interaction on plant height, soaking seeds in micronutrients solutions increased the mean values of plant height by 11.36. 11.60, 12.07 and 11.87% as compared with the control treatments. The maximum value of plant height was registered at 100% irrigation level and when seeds priming with Fe+ Zn+ Mn solution. This increasing due to the sufficient both available water in the soil and micronutrients in the seeds, which led to an increase in absorption of both water and micronutrients and consequently increase the metabolic mechanisms in the plants to increased plant height by increased cell elongation. The same trend was observed by Tahir (1983) and Harris *et al.* (2007).

On the other hand, data illustrated in Tables 2 and 3 declared no significant effects for irrigation levels, soaking seeds in micronutrients solutions and their interaction on number of rows/ear, ear length and ear diameter.

Data illustrated in Tables 4 and 5 declared the significant influences of irrigation levels, soaking seeds in some micronutrients solution and their interaction on shelling %, 100- grain weight, grain weight (g/plant) and grain yield (kg/ha).

The maximum mean value for shelling % was recorded at 100% irrigation level. Soaking seeds in micronutrients solutions decreased shelling % as compared with the control treatment. The maximum shelling % value was recorded at 100% irrigation level and the control treatment for soaking seeds (Table 4).

Soaking seeds in Fe, Fe+Mn and Fe+Mn+Zn solutions increased the 100 grain weight as compared with the control treatment. The maximum mean values was recorded at soaking seeds in Fe+Mn solution treatment.

Soaking seeds in micronutrients solutions increased both weight (g/plant) and grain yield (kg/ha) in all treatments as compared with control treatments (Table 5).

The mean values of grain yield (kg/ha) increased by 13.6, 18.4, 22.0 and 17.0% as compared with the control treatments for Fe, Fe+Mn, Fe+ Mn+ Zn and Fe+ Mn+ Zn+ Cu, respectively (Table 5). This may act as an advantage not only during early seedingdevelopment but also during reproductive and grain filling stages. Similar long lasting effects of seed priming treatments on yield formation have been reported for maize (Harris *et al.,* 2007) and soybean (Arif *et al*., 2007).

Asher (1987) reported that sufficient mineral nutrients reserves in the seeds are necessary to maintain seeding growth until root uptake start supplying soil nutrient. This is particularly important for crop grown on soils with low nutrients availability. Also, Harris *et al*., (1999) and Harris *et al*., (2000), found that seed soaking in nutrients can help crop plants to cope with stress factors such as, decrease of micronutrients and drought and can increase crop yield.

Conclusively, the previous results led to conclude that, Maize seeds soaking in micronutrients solution can help crop to cope with stress factors such as, decrease of nutrients and drought and can improve seed quality and minimize biotic and abiotic stresses during germination. Grain yield of maize can be increased by 13.6-22.0 % if seeds soaking in micronutrients solutions before seedling.

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استجابة محصول الذرة الشامية ومكوناته لنقع البذور في محاليل بعض العناصر الصغرى تحت ظروف الإجهاد المائي

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أجريت تجربة حقلية بمزرعة مركز البحوث الزراعية – سبها - ليبيا ,خلال الموسم الصيفي٢٠١٠ لدراسة مدى استجابة محصول الذرة الشامية ومكوناته لنقع البذور في محاليل بعض العناصر الصغرى (حديد،حديد +منجنيز ،حديد+منجنيز+زنك، حديد+منجنيز+زنك+نحاس) تحت ثلاثة مستويات مختلفة من كمية مياه الرى (٨٥.٧٠ و١٠٠% من البخر- نتح).

أشارت النتائج المتحصل عليها الى :

وجود تأثير معنوي لمعاملات الري ونقع البذور في محاليل بعض العناصر الصغرى والتفاعل بينهما على كل من ارتفاع النبات، نسبة التفريط. وزن ١٠٠ حبه، وزن الحبوب (بالجرام/النبات) محصول الذرة (بالكيلو جرام/ الهكتار) زاد المحصول بنسبة ١٣,٦ ،١٨.٤ ، ٢٢.٠، ١٧,٠ % بالمقارنة بمعاملة الشاهد لمعاملات نقع البذور في محاليل تحتوى على الحديد، الحديد + المنجنيز، الحديد + المنجنيز + الزنك، الحديد + المنجنيز + الزنك + النحاس على التوالي.

كما أشارت النتائج أيضا إلى انه لا يوجد تأثير معنوي لمعاملات الري، نقع البذور في محاليل بعض العناصر الصغرى والتفاعل بينهما على كل من غدد الصفوف/بالكوز، طول الكوز وقطر كوز الدرة.