ISSN 2347-6893

Investigation of Superabsorbent Polymer and Water Stress on Physiological Indexes of Maize

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Abstract

To study the effects of using superabsorbent polymers on physiological two hybris of maize in deficit Irrigation condition .an experiment carried out in split plot factorial based on completely Randomized Block design (RCBD) with three replication in 2012years. Deficit Irrigation was applied by three different Irrigation amount . Super absorbent polymers in 3levels were and two veriety of maize allocated in sub plots. there was significant difference between Irrigation levels in all experimental Traits by increasing in deficit irrigation.Results of this research showed water stress significantly decreased relative water content (RWC) LAI,Ash percentage in both hybrids, and increased Cell membrane percentage and SPAD,ADF percent.whereas the application of super absorbent polymer compensated the negative effect of drought stress, especially in high rates of polymer application .These mentioned rates of polymer had the best effect to all of the studied traits. These findings can be suggested that the irrigation intervals of corn could be increased by application of super absorbent polymer.

Key words: Super absorbent; physiological; water stress.zea maize.

Council for Innovative Research

Peer Review Research Publishing System

Journal: JOURNAL OF ADVANCES IN BIOLOGY

Vol 4, No.3

editor@cirjab.org

www.cirjab.com , editorsjab@gmail.com

Introduction

Faryab agriculture is the largest freshwater consumer all around the world. In a way that, about 90 percent of freshwater is using for the agriculture industry [3]. Iran consists of a mainly dry and semi dry climate that very hot summers and cold winters are as its characteristics.Water deficit stress is the most adverse enviromental condition that can seriously reduce crop yield.To survive the stress, numerous morphological,physiological and biochemical changes occur in various plants species [24].The reactions of the plants to water stress differ significantly at various organizational levels depending on intensity and duration of stress as well as plant species and its stage of development [2].Georinget al. [4] also found that increasing water stress progressively decreased plant water potential, leaf area, net photosynthetic rate, starch and soluble protein contents and nitrate reductase activity in moth bean genotyps.Super absorbent polymers can hold 400-1500g of water per dry gram at hydrogel [17].The use of superabsorbent polymers has a great importance for their role in the increase of water absorption capacity and retention of water shortage conditions and the decrease of bad effects of drought stress, [17].Corn (Zea mays L.) is an important plant that is used as human food (20-25%) livestock and poultry feed (60- 70%) and as raw material in industry (5%) . The dearth of water is on the important factors for corn production.Researches show that suitable water management in corn farms and availably of water can increase yield and water use efficiency and corn silage and grain quality [18].In the case water stress (Prado et al., [10]Siddiqueet al., [22],adaptation to these stresses has been attributed to the stress-induced increase in carbohydrate levels.Khadem et al., [14] in an experiment on the effect of animal manure and super absorbent polymer on corn reported that by in creasing drought stress from irrigation after 70 mm evaporation of basin class A to 140 mm Biological yield, Relative water capacity, leaf chlorophyll content (SPAD value) reduced significantly but with using 35% super absorbent +65% animal manure the highest yield obtained in both non stress and stressed condition in corn.Georing[4] also found that increasing water stress progressively decreased plant water potential, leaf area, net photosynthetic rate, starch and soluble protein contents and nitrate reductase activity in moth bean genotyps.Increasing concentration of NDF of maize silage could mean that lesser amounts of other forage would have to be grown or purchased by dairy farmer to meet NDF requirement [5].Environments where drought stress occurs prior to pollination and is followed by rainfall during pollination and grain filling, produced corn silage with increased ADF and starch content [12].Heidari and Moaveni[6]repoeted that under water stess, dehydration of plant tissue can result in an increase in oxidative stress,which cause deterioration in chloroplast structure and an associated loss in chlorophyll. this leads to decrease in the photosynthetic activity.Roustampouret al.,[20] showed that drought stress caused a decrease in seed yield through a decrease water content, chlorophyll index and leaf area duration and superabsorbent caused an increase in leaf area duration and consequently a higher increase in seed yield with a significant and positive effect on chlorophyll index ecpect 1678 degree growth day.In the present article, we seek to evaluate the impact of drought stress and application of different ratios of super absorbent, super ABA 200 on corn SC500 and SC700.Superabsorbentpolymer by high ability in water holding could improve the bad effect of deficit irrigation in this research.

MATERIALS AND METHODS

The experiment was carried out in Seed and Plant Improvement Institute, Karaj, Iran. Experimental design randomized complete block design with split factorial arrangement with three replications. Main plots were included irrigation levels (irrigation after 75 as control (I1), 100(I2), 120(I3) mm evaporation pan of class A in main plot. three levels of super absorbent polymer (Tarawat A200) at S1(Controlwithout application of superabsorbent polymer), S2 (100 kg.ha-1), S3(200kg. ha-1), super absorbent used before planting into 15cm depth of furrows.And two veriety of maize serotinousSC700 and medium SC500 are used. To make polymers inflated, they were immediately irrigatedMethod of irrigation was hydrophlum tubes and amount of water used measured by 2 inch contour. The soil texture of the research site was loam-clay with a pH of 7.5 and the Electrical Capacity (EC) was 0.7 dsm-1.Statistical analyses were performed using Mstat-C computer program.The means were compared according to Duncan multiplerang test.

Relative water content was calculated according to:

RWC (%) = [(FW – DW) / (TW – DW)] × 100

Turgid weight (TW)

Dry weight (DW)

Fresh sample weight (FW)

Cell membrance stability

measuring cell membrane stability with following formulas ;

Percentage injury:[1-(1-T1/T2) / (1-C1/C2)] ×100

T1 = sample EC before autoclaving

T2 = sample EC after autoclaving

C1 = control samples EC before autoclaving

C2 = control sample EC after autoclaving

Chlorophyll Index(SPAD)

Drought stress increased the total rate of chlorophyll content.Drought stress has caused increased in chlorophyll content when compared to the control condision[14].SPAD reading was significantly affected by irrigation frequency There was an inverse proportional relationship betweenthe irrigation interval contents ofchlorophyll fromleaves[15].The least value for chlorophyll content was obtained in S3(47.7), but the most value was obtained at S1(50.51) that has not statiticaldeffirence with S2 . Chlorophyll content has been known as a proper index for evaluation of stress intensity.In drought stress, tolerance genotype(SC700) showed high content of chlorophyll(51.12).Leaf area reduced by drought stress in this condition Plants for using of maximum sunlight increased the leaf chlorophyll; therefore plants could use of maximum sunlight with minimum leaf area [6]. Maximum leaf chlorophyll index was obtained in I3(53.83)and the lowest amountwas obtained in I1(45.99).(Table2).Interaction between irrigation and super absorbent was not significant.Movahedidehnaviet al.,[15] reported similar results that chlorophyll index(SPAD) increased by drought stress.

RWC

The application of SAP substantially increased the RWC in corn leaves at different growth stages.Application of superabsorbent polymer could conserve different amounts of water in itself thereby increasing the soil's capacity for water storage, ensuring more available water; thus the RWC content in leaves, as well as plant growth and yield increased under water stress [23]. Santos et al., [21].reported that RWC decreased in drought stress in comparison with non-stress conditions. In this study Irrigation, super absorbent and Irrigation × Super absorbent had significant effect on relative water content (Table1).Mean comparison showed that increasing of drought intensity caused a significant reduction on RWC (Table 2). RWC decreased by increasing of evapotranspiration in plant society. In full irrigation(75mm evaporation),RWC was83.23% and in intensive stress, it was 75.23%. Increasing superabsorbent polymer application could increase some what the RWC, therefore the highest RWC seen in 200 kg ha-1 superabsorbent,in all irrigation treatments use super absorbent polymer up 200 kg.ha-1 increased trace the RWC 3.2% and 6.o6% and8.8.02%respectivly in control and mild stress and intensive stress. Effect of RWC on veriety and irrigation was significant($p \leq 05$) and KSC700 had more relative water content than KSC500 in control condition . In drought stress conditions, the cultivars that are resistant to drought had more RWC[9].

Cell membrane stability

The percentage of cell membrane stability affected by drought stress as far as it increased by increasing drought stress intensity[13].The percentage of cell membrane stability decreased significantly by superabsorbent polymer(table2).Drought stress intensity decreased by superabsorbent.On the other hand cell membrane stability decreased by increasing leaf relative water content. The pressure inserter from inside the cell for cell growth provide by ncreasing relative water content, and ultimately cell membrane stability decreased by cell wall stretch. Soil physical condition and preserving water capacity in soil was improved by superabsorbent polymer and it cause that plant has been a less would to invest to increase the cell membrane stability[10]**.**Cell membrane stability significantly affected by interaction of irrigation and superabsorbent polymer (Table1).Minimum cell membrane stability was obtained by applying 200 kg/ha and full irrigation(75mm evaporation) with 46.78 and maximum cell membrane stability was obtained in treatment without applying superabsorbent polymer and sever stress. Probably this phenomenon was due to high ability of superabsorbent polymer to absorb water and conserve it in the soil.Hybrid KSC700 has more stability in water stress condition.

LAI

According to analysis of variance effect of irrigation treatments on LAI of plant was significant at 1% level (Table1). By increasing severity of drought stress,LAI was significantly reduced. The highest and lowest LAI were 5.9 and 7.1 belonged to complete irrigation treatment (I1) and severe drought stress treatment (I3) respectively. Huttermannet al.[8] reported a positive linear relationship between the number of irrigations and LAI value. Treatment effect of super absorbent corn leaf area index was significant at 1% level, the leaf area increased with increasing the amount of super absorbent. Treatment S3 is the highest mean LAI of 7.01 and treatment S0 is the lowest mean LAI of 6.04. superabsorbent by storage of water and nutrients and release them in drought conditions, can provide favorable conditions for plant growth and reduce effects of water stress. Probably, the decrease in leaf area is a response to stress for adapting water deficitconditions and survival through decreasing cell turgor pressure [10].Interaction between irrigation and veriety was significant. Hybrid Ksc700 under normall irrigation has more LAI than KSC500.

Ash Percent:

irrigation levels has significant effect at 5% level (Table 1) , there wasn't any significantly difference between amount of superabsorbent polymers and hybrids. therefore all levels of superabsorbent and hybrid treatmentsallocated in same statistically groups (Table 2).Ash percent was once of qualitic traits thatevaluated in this experiment. The ash percent is markingof all minerals except Iodine and choler ions, because these elements sublimateby burning in electrical furnace. Each deficiency of minerals in food of herbivorous can lead to some disease such as milk fever and Grass Telany [11]. Haj Hassaniaslet al., [5] reported that with drought stress in three forage crops (Corn, sorghum and millet) ash percent decreased significantly and in sorghum the ash percent was more than millet and corn respectively.

Fiber(ADF)

This attribute of a statistically Influenced by irrigation levels at 1% was a significant difference (Table1). the maximum amount of fiber under irrigation at 75mm evaporation 34.1% and minimum amount was 30.9% .(Table2)Reduce thepercentage of fiber (ADF) in forage plants under drought stress conditions due to reduced cell wall components made in this condition [3].There were not any significant differents between verieties.Zarrinabadietal., [26]reported that the amount of fiber and dry under ambient conditionsand can be genetic.Inthis study,thesuperabsorbenteffectoncrudefiber contentwas significantly at 5% (table1).With increasing use of superabsorbent, crude fiberpercentage was decreased.In S3 (super absorbent 200 kg) amount of crude fiber was 29.76 percent.However, in no consumption of superabsorbent ,percentage of crude fiber was33.61%, we can imagine this will lower the amount of forage digestibility.there was not significant difference between S2 and S3treatments.In this experiment, no significant interactions between irrigation and superabsorbent.

Table1: Results of analysis of variance for effect of drought stress and polymer on SPAD index,RWC% , LAI, Cell membrence stability٪,Ash percentage and ADF Fiber(%)

Treatment	Degree of freedom	Mean square					
		RWC%	SPAD index	ADF Fiber(%)	Ash (%)	LAI	Cell membrence٪stability
Replication	2	0.023	3.45	194.48	0.116	4.552	0.2361
Irrigation	2	3.302	753.003**	2457.23 **	1.266*	561.125**	21.80**
Error	4	0.013	126.614	16.51	0.118	36.689	0.911
Super absorbent	2	146.679**	544.64*	105.32 *	0.134	6.596**	8.459 **
Irrigation×super absorbent	4	17.268**	78.96	49.25	0.201	2.369**	0.194
Variety	1	12.717**	23.39*	27.07	0.231	11.236**	14.741*
Irrigation× variety	2	1.867*	9.73	49.78	0.132	5.337*	0.577*
Super absorbent× variety	2	0.669	1.46	27.07	0.206	16.162	1.041
Irrigation×super absorbent× variety	4	0.887	0.590	31.38	0.224	6.347	1.02
Error	30	0.005	14.98	18.39	0.206	4.302	0.784
Coefficient of variance		4.46	5.88	7	5.3	5.6	3.1

Table2:Mean square of compound effects in SPAD index ,Leaf Area Index(LAI), Cell membrence stability, relative water content(%), And ash percent in different treatments.

Factors	RWC%	SPAD index	Ash(%)	ADF Fiber(%)	LAI	Cell membrence stability(%)
Irrigation						
75 mm evaporation	83.23a	45.99c	7.83a	30.9c	7.195a	44.72a
100mmevaporation	78.63b	49.83b	7.42b	32.83b	6.32b	51.78b
120mmevaporation	75.23c	53.83a	7.38bc	34.1a	5.96c	56.04c
Superabsorbent						
control	77.64a	49.48ab	7.79a	33.61 a	6.04c	56.32a
100 kg ha^{-1}	79.81ab	50.51a	7.76a	31.82 b	6.8b	51.12b
200 kg ha^{-1}	81.67a	47.7c	7.82a	29.76 b	7.01a	48.84c
variety						
KSC700	80.36a	51.128a	7.80a	30.67 a	6.79a	49.6b
KSC500	76.77b	44.62b	7.78a	30.25 a	5.92b	53.43a

NOTE: The numbers in each columns have same alphabet aren't different significantly with together

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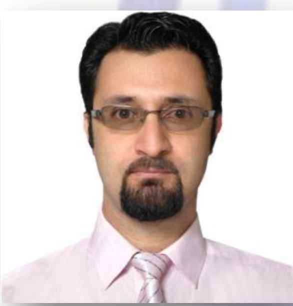

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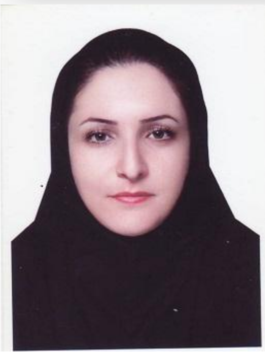

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