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Effect of applications of superabsorbent and drought stress on electrical conductivity, number of seed, diameter of head and percent of protein in sun flower

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Abstract

Sunflower is the most important oil crop in Serbia as well as in some other parts of the world. Sunflower is most sensitive to water deficit stress in its flowering and seed-maturity stages. On the other hand, flower initiation and seed setting stages were reported as the sensitive stages of sunflower life cycle to water deficit. One such mechanism that is ubiquitous in plants is the accumulation of certain organic metabolites of low molecular weight that are collectively known as compatible solutes. The application of super absorbent polymer has a significant impact in reducing drought stress effects and to improve plants yield and stability in agriculture production. The field experiment was laid out in randomized complete block design with split plot design with three replications. Treatments included irrigation as a main plot in four levels included (Full irrigation, water stress in fourth and fifth even leaf, water stress in flowering stage, water stress in fourth and fifth even leaf + water stress in flowering stage) and concentrations of Superabsorbent in three levels included (0, 15 and 30 kg/ha) as sub plot. Analysis of variance showed that the effect of water stress on electrical conductivity, number of seed and diameter of head was significant.

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Introduction

Sunflower is the most important oil crop in Serbia as well as in some other parts of the world. In the Vojvodina Province, in the north of Serbia, sunflower is grown more than any other oil crop, and the acreage planted to the crop averages about 170,000 ha a year. The average yield between 2000 and 2005 was 1.98 t ha^{-1}, ranging from 1.52 to 2.46 t ha^{-1} (Statistical Yearbook of Serbia, 2005). Sunflower is most sensitive to water deficit stress in its flowering and seed-maturity stages (Chimenti *et al.*, 2002). On the other hand, flower initiation and seed setting stages were reported as the sensitive stages of sunflower life cycle to water deficit (Mir-hosseini Dehabadi, 1988). Water deficit decreased sunflower grain yield by 20% but did not affect its harvest index (Cox and Jolliff, 1986). Water stress considerably decreases the grain yield, biomass and vegetative growth period in sunflower (Kamel and Khiyavi, 2002). Head number/unit area, grain number/head and grain weight are the important sunflower grain yield components. Oil content as an oil yield component is also highly important (Mozzafari, 1995). In a study on the effects of irrigation cutoff in different growth stages of sunflower cultivars, Kalhori (2002) found that drought stress severely affected head diameter at flowering stage so that the lowest head diameter was observed at flowering stage when irrigation had been stopped. Sunflower is commonly regarded as a plant that is tolerant to drought and that uses water efficiently. Nevertheless, the crop consumes a large amount of total water due to the fact that it produces high yields and a large vegetative bulk and it has a long growing period coinciding with the warm months of spring and summer (Bošnjak and Marinković, 1992; Škorić, 1992). Sunflower is capable of enduring drought but its yield will be lower in that case, because the plants are forced to take up less available forms of water from the soil. Sunflower is the most susceptible to soil water deficiency at flowering, fertilization and grain fill, whereas at the start and end of the growing period the sensitivity is not so evident (Jana *et al.*, 1982; Unger, 1986; Stone *et al.*, 1996; Erdem and Delibas, 2002). Adequate water and nutrient supply are important factors affecting optimal plant growth and successful crop production. Water stress is one of the severe limitations of crop growth especially in arid and semi-arid regions of the world as it has a vital role in plant growth and development at all growth stages. However, depending upon plant species, certain stages such as germination, seedling or flowering could be the most critical stages for water stress. Seed germination is first critical and the most sensitive stage in the life cycle of plants (Ashraf & Mehmood, 1990) and the seeds exposed to unfavorable environmental conditions like water stress may have to compromise the seedlings establishment (Albuquerque & Carvalho, 2003). Genotype is the most important factor that defines the fatty acid composition (Knowles, 1988), but also the environmental factors during the seed-filling period can widely affect the oil percentage and the unsaturated fatty acid composition of the oil. It has been documented that the ratio of oleic /linoleic acid increases under high temperature during seed maturation and, in opposition, it decreases under lower temperature conditions (Tremolieres *et al.*, 1982). Water stress caused an increase in oleic acid in high oleic sunflower hybrids and also caused a reduction of it in standard hybrids (Baldini *et al.*, 2000). The growth, development and spatial distribution of plants are severely restricted by a variety of environmental stresses. Among different problems faced by crop plants, water stress is considered to be the most critical one (Boyer, 1982). Plants being immobile cannot evade water stress in the same way as mobile organisms. So, they show many morphological and physiological alterations to acclimatize to unfavorable environment (Sakamoto and Murata, 2002). One such mechanism that is ubiquitous in plants is the accumulation of certain organic metabolites of low molecular weight that are collectively known as compatible solutes (Bohnert, *et al.*, 1995). The application of super absorbent polymer has a significant impact in reducing drought stress effects and to improve plants yield and stability in agriculture production (Khadem *et al.*, 2010).

Woodhouse and Johnson (1991) reported that hydro-absorbents can play a crucial role in germination rates because of improving water accessibility. Johnson and Piper (1997) found that fruit quality was better using polymers in the growing media as water stress reduced during the growth cycle. Application of hydrogel at the rate of 2 g/kg increased the water holding potential of sand from 171% to 402% (Johnson, 1984). Research results on red beans showed that consumption of super absorbent polymer significantly increased some traits such as grain yield and harvest index Aspyk *et al.* (2000). Kouhestani *et al.* (2009) showed that application of super absorbent polymer improved yield and yield components of corn (Zea mays) in dry stress condition by increasing the soil's water holding capacity, less leaching of nutrients, rapid and normal growth of root and better soil aeration. Motivation and aims of the study were effect of applications of superabsorbent and drought stress on electrical conductivity, number of seed and diameter of head in sun flower.

Material and methods

Location of experiment

The experiment was conducted in 2013 at the Research Station and natural resources in sistan (In Iran) which is situated between 38° North latitude and 61° East longitude and at an altitude of 483m above mean Sea Level.

Composite soil sampling

The soil of the experimental site belonging loam. Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics.

Field experiment

The field experiment was laid out in randomized complete block design with split plot design with three replications.

Treatments

Treatments included irrigation as a main plot in four levels included (Full irrigation, water stress in fourth and fifth even leaf, water stress in flowering stage, water stress in fourth and fifth even leaf + water stress in flowering stage) and concentrations of Superabsorbent in three levels included (0, 15 and 30 kg/ha) as sub plot.

Data collect

Data collected were subjected to statistical analysis by using a computer program MSTATC. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments` means.

Results and discussion

Number of seed

Analysis of variance showed that the effect of water stress on number of seed was significant (Table 1). The maximum of number of seed (1719) of treatments Full irrigation with 30 kg/ ha superabsorbent was obtained (Table 2). The minimum of number of seed (909.3) of treatments water stress in fourth and fifth even leaf + water stress in flowering stage with 0 kg/ha superabsorbent was obtained (Table 2). Analysis of variance showed that the effect of superabsorbent on number of seed was significant (Table 1). Water stress considerably decreases the grain yield, biomass and vegetative growth period in sunflower (Kamel and Khiyavi, 2002).

Table 1. Anova analysis of the sun flower affected by water stress and Superabsorbent.

S.O.V	df	Number of seed	Diameter of head	1000 grains weight	Electrical conductivity
R	2	4.000	66.083	25.935	499.425
Water stress (I)	3	603796.917**	376.185**	790.806**	197352.773**
Error a	6	129.778	36.157	81.912	254.645
Superabsorbent (S)	2	130743.750**	194.250**	223.67 **	305494.675**
I*S	6	5784.417**	4.213 ns	2.293 ns	11796.589**
Error b	16	412.333	19.597	28.901	451.304
C.V	-	1.44	18.32	10.38	3.75

*, **, ns: significant at p<0.05 and p<0.01 and non-significant, respectively.

Diameter of head

Analysis of variance showed that the effect of water stress on diameter of head was significant (Table 1). The maximum of diameter of head (35.67) of treatments Full irrigation with 30 kg/ ha superabsorbent was obtained (Table 2).

The minimum of diameter of head (18.00) of treatments water stress in fourth and fifth even leaf + water stress in flowering stage with 0 kg/ha superabsorbent was obtained (Table 2). Analysis of variance showed that the effect of superabsorbent on diameter of head was significant (Table 1). In a study on the effects of irrigation cutoff in different growth stages of sunflower cultivars, Kalhori (2002) found that drought stress severely affected head diameter at flowering stage so that the lowest head diameter was observed at flowering stage when irrigation had been stopped.

1000 grains weight

Analysis of variance showed that the effect of water stress on 1000 grains weight was significant (Table 1). The maximum of 1000 grains weight (69.69) of treatments Full irrigation with 30 kg/ ha superabsorbent was obtained (Table 2). The minimum of 1000 grains weight (39.68) of treatments water stress in fourth and fifth even leaf + water stress in flowering stage with 0 kg/ha superabsorbent was obtained (Table 2). Analysis of variance showed that the effect of superabsorbent on 1000 grains weight was significant (Table 1).

Table 2. Comparison of different traits affected by water stress and Superabsorbent.

Water stress treatments		Number of seed	Diameter of head	1000 grains weight	Electrical conductivity
Full irrigation	0	1569 c	28.00 abcd	59.87 bc	550.8 d
	15	1639 b	32.67 ab	62.67 ab	451.4 f
	30	1719 a	35.67 a	69.69 a	311.1 g
water stress in fourth and fifth even leaf	0	1509 d	22.33 def	49.62 defg	546.4 d
	15	1584 c	23.33 cdef	54.28 bcde	436.0 f
	30	1669 b	31.33 abc	57.75 bcd	337.9 g
water stress in flowering stage	0	1229 g	18.00 efg	42.83 fg	860.4 b
	15	1314 f	22.33 def	44.86 efg	642.3 c
	30	1419 e	26.33 bcde	50.91 cdef	500.0 e
water stress in fourth and fifth even leaf + water stress in flowering stage	0	909.3 i	13.33 g	39.68 g	974.9 a
	15	1089 h	16.33 fg	41.76 fg	666.3 c
	30	1246 g	20.33 defg	47.61 defg	512.4 de

Any two means not sharing a common letter differ significantly from each other at 5% probability.

Electrical conductivity

Analysis of variance showed that the effect of water stress on electrical conductivity was significant (Table 1). The maximum of electrical conductivity (974.9) of of treatments water stress in fourth and fifth even leaf + water stress in flowering stage with 0 kg/ha superabsorbent was obtained (Table 2). The minimum of electrical conductivity (311.1) of treatments Full irrigation with 30 kg/ ha superabsorbent was obtained (Table 2). Analysis of variance showed that the effect of superabsorbent on electrical conductivity was significant (Table 1).

Percent of protein

Analysis of variance showed that the effect of water stress on percent of protein was significant (Table 3). The maximum of percent of protein (21.52) of treatments water stress in fourth and fifth even leaf + water stress in flowering stage with 30 kg/ha superabsorbent was obtained (Table 4). The minimum of percent of protein (9.130) of treatments Full irrigation with 0 kg/ ha superabsorbent was obtained (Table 3). Analysis of variance showed that the effect of superabsorbent on percent of protein was significant (Table 4).

Protein yield

Analysis of variance showed that the effect of water stress on percent of protein was significant (Table 3). The maximum of protein yield (788.89) of treatments water stress in fourth and fifth even leaf + water stress in flowering stage with 30 kg/ha superabsorbent was obtained (Table 4). The minimum of protein yield (584.02) of treatments Full irrigation with 0 kg/ ha superabsorbent was obtained (Table 3). Analysis of variance showed that the effect of superabsorbent on protein yield was significant (Table 4).

Table 3. Anova analysis of the sun flower affected by water stress and Superabsorbent.

S.O.V	df	Percent of protein	Protein yield	Percent of oil	Oil yield
R	2	0.827	21742.573	0.299	127599.496
Water stress (I)	3	137.924 **	52620.651*	388.040**	5067785.239 **
Error a	6	0.577	8709.792	2.680	30671.079
Superabsorbent (S)	2	44.102 **	376807.226**	46.431**	1074440.125 **
I*S	6	2.146 *	6865.701 ns	0.443 ns	14580.150 ns
Error b	16	0.637	10320.036	0.316	30691.337
C.V	-	5.52	13.47	1.41	7.91

Percent of oil

Analysis of variance showed that the effect of water stress on percent of oil was significant (Table 3). The maximum of percent of oil (49.86) of treatments Full irrigation with 0 kg/ ha superabsorbent was obtained (Table 4). The minimum of percent of oil (30.36) of treatments water stress in fourth and fifth even leaf + water stress in flowering stage with 0 kg/ ha superabsorbent was obtained (Table 3). Analysis of variance showed that the effect of superabsorbent on percent of oil was significant (Table 4).

Oil yield

Analysis of variance showed that the effect of water stress on percent of oil was significant (Table 3). The maximum of oil yield (3511) of treatments Full irrigation with 30 kg/ ha superabsorbent was obtained (Table 4). The minimum of oil yield (1042) of treatments water stress in fourth and fifth even leaf + water stress in flowering stage with 0 kg/ ha superabsorbent was obtained (Table 3). Analysis of variance showed that the effect of superabsorbent on oil yield was significant (Table 4).

Table 4. Comparison of different traits affected by water stress and Superabsorbent.

Water stress treatments		Percent of protein	Protein yield	Percent of oil	Oil yield
Full irrigation	0	9.130 g	584.02 c	46.13 c	2765 bc
	15	9.310 g	783.98 c	47.59 b	2994 b
	30	11.18 f	1028.96 b	49.86 a	3511 a
water stress in fourth and fifth even leaf	0	11.01 f	667.01 bc	40.29 ef	2216 de
	15	14.13 e	744.97 bc	41.20 e	2468 cd
	30	15.66 d	977.96 a	43.23 d	2764 bc
water stress in flowering stage	0	13.42 e	613.34 bc	35.17 h	1747 f
	15	14.05 e	728.57 bc	36.37 g	1920 ef
	30	17.42 c	1002.11 a	39.33 f	2196 de
water stress in fourth and fifth even leaf + water stress in flowering stage	0	16.93 cd	548.78 c	30.36 j	1042 g
	15	19.61 b	583.09 b	32.14 i	1278 g
	30	21.52 a	788.89 a	35.03 h	1668 f

Any two means not sharing a common letter differ significantly from each other at 5% probability

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