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Effect of interaction between manure and super absorbent on the yield and yield components and some physiological traits in Rapeseed (*Brassica napus cvs Zarfam*) under water deficit

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ABSTRACT

In iran, water is a scarce resource, due to the high rainfall variability. The water stress effects depend on deficit timing, duration and magnitude. This study investigated the effects of interaction between manure and super absorbent (zeolite and superabsorbent polymers) on the yield and yield components and some physiological traits in Rapeseed (Brassica napus cvs Zarfam) under water deficit. Research was conducted with complete randomized block experimental design with split -Factorial arrangement with three replications. In this experiment, the main plots consisted of water deficit with 3 levels: 1-Normal Irrigation , 2- Cut Irrigation in flowering, 3- Cut Irrigation in silique feeding , And super absorbent (zeolite and superabsorbent polymers) application were performed at three levels: 1-(Control) Non super absorbent , 2- Zeolit 10 ton per hector , 3- superabsorbent polymers 8 Kg per hector. And manure applications were performed at three levels: 1- No manure (Control) 2- manure 20 ton per hector 3- manure 40 ton per hector , were allotted to sub plots. Results of analysis of variance indicated that the interaction effects of water deficit, super absorbent and manure application on the characteristics Plant height, the number of silique per plant, the number of grain in silique, grain yield, biological yield, harvest index and oil percentage were significant at the 1% level, However, the Branches per plant and 1000grain Weigh of water deficit treated with super absorbent and manure application were significant at the 5% level. In this study, the maximum grain yield (4228.4 kg ha-1) was obtained from Normal Ir Zeo 10ton/ha manure 40 ton per hector. Water stress at silique feeding reduced oil content of seed. The result of table 4 showed the highest and lowest seed oil percentage achieved from* (I_0* S *C_1) *stage (49.71%) and* (I_2* Z_0S_0 *C_2) *with average (40.1%) treatment, respectively. There was not significant with(* I_2* Z_0S_0* C_0), (I_2* Z_0S_0 *C_1) ,(I_2* S *C_2) *and(* I_1* Z_0S_0* C_0) *the most total above ground biomass and number of grain per plant were observed on* (I_0*Z*C_2) *treatment with average (9896.7 Kg/ha) and (371.4 N.O) respectively.*

Keywords: Canola, zeolite and superabsorbent polymers, manure applications, water deficit stress, yield and yield component.

INTRODUCTION

Canola (*Brassica napus*) is the third most important source of plant oil in the world after soybean and plam oil,Canola also an excellent is rotation crop to control crop pests and soil diseases and has a good stable yield [6]. It grows in areas that receive more than 300 mm rain on well drained soils with a good potential for growing oilseed [24]. When plants suffering from drought stress, they show a series of physiological, morphological and biochemical reaction to resist against the stress condition [20]. Efficient management of soil moisture is important for agricultural production in the nutrient and scare water resources [4]. In the past Irrigation has been a key solution to resolving this problem, but due to the increasing social demands to water, today it is not a reasonable alternative and it increase financial cost [7].

Drought stress limited plant growth and crops productivities significantly [5]. Igbadum *etal* 1n 2006 showed that the crop yield response was very muchdependent on the amount of water applied at different crop development stages [10]. Than the overall seasonal water applied [14]. The timing of moisture stress occurrence is more important than the intensity of the stress [11]. The worst time to experience water stress on many grain crops is during stem elongation and flowering. Gan *et al* in 2003 found that canola stressed at earlier growth stages exhibited recovery, whereas stressed during pod development severely reduced most of the yield components [8]. Masoud Sinaki *et al* in 2007 found that the highest rapeseed yield reduction was obtained when water stress occurred at flowering and then at pod developmental stages [16]. The available water in soil is one of the most important factors of increasing crop yields [9].

One of the new strategies to increasing impact of manure at during drought stress that using natural ingredients such as zeolites. Selective adsorption and controlled release and long-time availability of nutrients that plant growth is improved [21]. Causing stress in a stage of plant's growth without losing its performance from the point of view of saving water and well irrigation for the arid and semi arid areas for researchers. On the other hand, the use of superabsorbent polymers can be a general solution for the farming in Iran [30]. There were several marks of superabsorbent polymers in Iran's markets that used in fields, gardens and landscapes [18]. three-dimensional networks of flexible polymer, and because of few numbers of widthwise connections [12] are able to absorb and store water hundreds times of their dry weight Super absorbents, depending on their source and structure, are divided in two main groups of natural and synthesis[1].

Super absorbent polymers can hold 400-1500g of water per dry gram at hydro gel [19]. 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, [19]. These polymeric organic materials and hydro gels, apart from improving soil physical properties, also serve as buffers against temporary drought stress and reduce the risk of plant failure, during its establishment [11]. These materials decrease the number of irrigation times by increasing the gaps of irrigation, therefore water cost and energy will be saved [23].Studies were conducted by Tohidi – moghadam *etal* in 2009 to determine water stress decreased total biomass, grain yield and yield component, Hi at during maturity stage. Field results showed that drought stress and absence of super absorbent lead to decrease in all agronomic parameters [27].

Therefore, the aim of this study was whether manure and super absorbent (zeolite and superabsorbent polymers) applications supply to canola might be a strategy to increasing the water deficit tolerance.

MATERIALS AND METHODS

The field experiment was carried out in Varamin region in Iran at during 2010- 2011. This study investigated the effects of interaction between manure and super absorbent (zeolite and superabsorbent polymers) on the yield and yield components and some physiological traits in Rapeseed (*Brassica napus cvs Zarf am*) under water deficit. Research was conducted with complete randomized block experimental design with split - Factorial arrangement with three replications. In this experiment, the main plots consisted of water deficit with 3 levels: 1-Normal Irrigation(I0) , 2- Cut Irrigation in flowering (I1) , 3- Cut Irrigation in silique feeding (I2). And super absorbent (zeolite and superabsorbent polymers) application were performed at three levels: 1-(Control) Non super absorbent (Z0S0), 2- Zeolit 10 ton per hector (Z0), 3- superabsorbent polymers 8 Kg per hector (S0). And manure applications were performed at three levels: 1- No manure (Control) (C0) 2- manure 20 ton per hector (C1) 3- manure 40 ton per hector (C2), were allotted to sub plots.

The site is located at 19':35''N latitude, 39':51''E longitude, with an altitude of 1000 m above sea level. This region has a semiarid climate (<200 mm annual rainfall). Before the experiment began, soil samples were taken to determine the physical and chemical properties. Composite soil samples were collected from a depth of 0 – 30 and 30- 60 cm. They were air – dried, crushed and tested for physical and chemical properties. The soil was a montmorillonite clay loam, low in nitrogen (0.4 mg.kg-1), low in organic matter (7 mg.kg-1) and alkaline with a pH of 7.4 and electrical conductivity of EC = 0.87 dS m-1.Initially, Plant nutrient feed of phosphorus was added by applying 70 Kg/ha triple super Phosphate after cultivation. Nitrogen fertilizer was added by applying 85Kg/ha in three periods; application of 50% N at cultivation time, application of 25% N fertilizer at stem elongation stage and application of 25% N fertilizer in beginning of flowering stage. A subplot size of 1.8 × 5 m, having nine rows five meter long each was used. Uniformity of sowing depth was achieved by using a hand dibbler to make holes of 3 cm deep. All the experimental units were irrigated after planting. At physiological maturity stage used to determine .Yield components of five plants randomly selected. Yield components such as the plant height, The number of branches per plant, the number of silique per plant, The number of grain in silique, The number of grain in plant were measured. To determine the 1000grain weight and grain yield: silique of each plot was harvested in each plot after grain moisture reached 12% and the weight of each grain was calculated in the laboratory and, finally the harvest index was computed as the ratio of grain yield to total above ground biomass. Within each plot, an area of 3.2 m2 was hand harvested to determine grain yield and total above ground biomass.

Statistical analysis

The end of the experiment, the results of each of the characters, after expansion to hectar. all data were analyzed using the SAS (9) (SAS Institute Inc. 1997)computer software. When ANOVA showed significant treatment effects, Duncan's multiple range test ($p< 0.05$) was applied for mean separation when F values were [25].

RESULTS

Results of analysis of variance indicated that the interaction effects of water deficit, super absorbent and manure application on the characteristics Plant height, the number of silique per plant, the number of grain in silique, grain yield, biological yield, harvest index and oil percentage were significant at the 1% level, However, the Branches per plant and 1000grain Weigh of water deficit treated with super absorbent and manure application were significant at the 5% level (Table 1, 2).

Table 1: Mean squares of some agronomic traits

			M.S			
S.O.V	*df*	*Plant height*	*Branches per plant*	*Number of silique per plant*	*Number of grain in silique*	*Number of grain per plant*
Block	*2*	*38451.6 ns*	*284.13 ns*	*199872.2**	*1002.8 ns*	*722000.11ns*
Irrigation (A)	*2*	*52301.2 ns*	*5888.01 ns*	*208052.2 **	*4993.4 **	*4492255.7 ***
Error(a)	*4*	*20011.9*	*390.3*	*33945.13*	*772.6*	*485480.6*
super absorbent (B)	*2*	*273006.1 **	*1333.3 ns*	*33221.11 ns*	*6876.2 ns*	*1285432.1**
Manure(C)	*2*	*300288.01**	*1996.6 ns*	*25001.77 ns*	*9080.3 ns*	*2072002.6 **
*(A*B)*	*4*	*183055.1 **	*2677.2 ns*	*90222.2 **	*93343.6 ***	*13375452.6 ***
*(A*C)*	*4*	*201888.2 **	*1700.2 ns*	*85411.11 **	*125559.2 ***	*25000276.2***
*(B*C)*	*4*	*299001.1 **	*5662.2 **	*30001.17 ns*	*16003.2 **	*99873201.2 ***
*(A*B*C)*	*8*	*775799.6 ***	*7901 **	*218887.6 ***	*175999.2 ***	*33452872.2 ***
Error(bc)	*48*	*45071.6*	*886.4*	*15807.5*	*2249.2*	*223372.1*
CV		*13.2*	*5.7*	*9.3*	*15.1*	*14.7*

**, ** means significant in 0.05 and 0.01 level of probability respectively and nS: non-significant.*

Table 2. Mean squares of some agronomic traits and seed qualitative parameter.

				M.S		
S.O.V	*df*	*1000grain Weight*	*grain yield*	*total above ground biomass*	*HI*	*Percentage of Oil*
Block	*2*	*0.411 ns*	*22725401.6 ns*	*49872021.2 ns*	*68.1**	*0.000087*
Irrigation (A)	*2*	*0.0901 ns*	*225483252.7***	*40700488.6***	*42.01 ns*	*0.01040***
Error(a)	*4*	*0.0125*	*18171192.6*	*30792005.14*	*11.25*	*0.00017*
super absorbent (B)	*2*	*0.445 ns*	*280333872.2**	*283375222.1**	*32.01 ns*	*0.0182**
Manure(C)	*2*	*0.218 ns*	*332870001.6**	*272272145.2**	*29.45 ns*	*0.0035 ns*
*(A*B)*	*4*	*0.799 **	*725483211.2***	*1223452218.6***	*111.25**	*0.145***
*(A*C)*	*4*	*1.341 **	*880372006.3***	*1625418000.1***	*488.2 ***	*0.331***
*(B*C)*	*4*	*0.908**	*600483222.2 ***	*1012183172.1***	*105.72**	*0.0311**
*(A*B*C)*	*8*	*1.001**	*1000872225.1***	*2877000229.6***	*900.2***	*0.401***
Error(bc)	*48*	*0.139*	*39453111.2*	*41425222.2*	*20.32*	*0.0022*
CV		*12.1*	*17.3*	*19.2*	*6.5*	*2.4*

**, ** means significant in 0.05 and 0.01 level of probability respectively and nS: non-significant.*

Data of triple interactive effects between that water deficit treated with super absorbent and manure application have been demonstrated in table 3, 4.

Table 3. Mean comparisons of triple interactions on some agronomic traits

Treatment	Plant height (Cm)	Branches per plant(N.o)	Number of silique per plant(N.o)	Number of grain in silique (N.o)	Number of grain per plant(N.o)
I0* Z0S0* C0	94.1 d	3 b	17.3 bc	12.1 bc	214.6 de
I0* Z0S0 *C1	103 cd	3.27 b	20.1 ab	14.1 b	285.6 bc
I0* Z0S0 *C2	105.1 c	3.51 ab	21.1 ab	14.3 b	296.5 b
I0* Z *C0	100.5 cd	3.1 b	17.5 bc	12.8 bc	231.2 d
I0* Z*C1	124 ab	3.49 b	21.12 ab	15.1 ab	348.6 a
I0* Z*C2	128 a	3.9 ab	25.1 ab	16.4 ab	371.4 a
I0* S* C0	100.3 cd	3.3b	19.1 b	13.3 b	256.7 cd
I0* S *C1	118.2 b	3.6 ab	23.5 ab	16.2 ab	355.8 a
I0* S *C2	129.1 a	3.7 ab	25.3 a	17.73 a	368.4 a
I1* Z0S0* C0	80.4 e	2.65 b	14.8 bc	8.4 cd	107.5 ef
I1* Z0S0 *C1	86.7 de	2.94 b	17.1 bc	9.2 cd	149.8 d
I1* Z0S0 *C2	95.9 cd	3.2 b	18.9 b	10.4 c	185.7 e
I1* Z *C0	84.7 de	2.9 b	15.7 bc	11.5 bc	181.4 e
I1* Z*C1	113.9 bc	3.52 ab	18.5 b	14.5 b	262.7 c
I1* Z*C2	122.6 ab	3.7 ab	18.9 b	15.4 ab	303.8 b
I1* S* C0	86.1 de	2.9 b	15 bc	12.8 bc	190.4 e
I1* S *C1	113.5 bc	3.1 b	17.6 bc	13 bc	231.4 d
I1* S *C2	123.4 ab	4.7 a	18.7 b	14.87 ab	298 b
I2* Z0S0* C0	82.3 e	2.45b	11.7 c	4.1 e	50.8 g
I2* Z0S0 *C1	87.5 de	3.1 b	13.2 bc	5.8 de	77 fg
I2* Z0S0 *C2	97.8 ed	3.5 b	14.6 bc	6.2 de	82.4 f
I2* Z *C0	85.5 de	2.7 b	13.9 bc	6.9 de	113.3 e
I2* Z*C1	115.5 b	3.5 b	14 bc	8.2 cd	116.8 e
I2* Z*C2	123.5 ab	3.8 ab	17.8 b	9.9 cd	144.4 d
I2* S* C0	87.8 de	3.1 b	11.8 c	7.2 d	59.6 fg
I2* S *C1	117.5 b	3.5 b	13.5 bc	7.7 cd	132.2 de
I2* S *C2	124.9 ab	3.9 ab	14.3 bc	8.2 c	135.2 de

Means with the same letter in each column have not statistically significant difference.

Table 4. Mean comparisons of triple interactions on some agronomic traits and seed qualitative parameter

Treatment	1000grain Weight(gr)	grain yield (Kg/ha)	total above ground biomass(Kg/ha)	HI (%)	Percentage of Oil (%)
I0* Z0S0* C0	3.24 b	3127.6 c	7934.7 cd	39.42 de	44.98 c
I0* Z0S0 *C1	3.38 b	3349.5 bc	8794.6 bc	38.09 e	46.57 bc
I0* Z0S0 *C2	3.47 b	3489.6 bc	8987.4 b	38.83 de	45.73 bc
I0* Z *C0	3.63 ab	3332.9 bc	8593.1 bc	39.61 de	48.65 ab
I0* Z*C1	3.79 ab	3718.4 b	9387.6 ab	41.7 cd	49.64 a
I0* Z*C2	3.98 ab	4228.4 a	9896.7 a	43 c	48.97 ab
I0* S* C0	3.63 ab	3402.9 bc	8517.4 bc	39.95 de	48.65 ab
I0* S *C1	3.92 ab	3817.2 ab	9092.1 ab	42 cd	49.71 a
I0* S *C2	4.35 a	4101.8 ab	9511.1 ab	43.12 bc	49.28 a
I1* Z0S0* C0	2.97 b	2796.2 cd	6243.2e	44.79 bc	42.46 d
I1* Z0S0 *C1	3.14 b	2993.8 cd	7208.5 d	41.53 cd	44.65 c
I1* Z0S0 *C2	3.29 b	3189.6 c	7811.2 cd	40.83 cd	44.01 cd
I1* Z *C0	3.4 b	3078.5 c	7151.3 d	43.05 c	46.87 bc
I1* Z*C1	3.67 ab	3511.8 bc	7882.5 cd	44.55 bc	47.39 b
I1* Z*C2	3.79 ab	3681.5 bc	8098.5 c	45.46 b	46.8 bc
I1* S* C0	3.42 b	3106.2 c	7201.4 d	43.13 bc	45.18 c
I1* S *C1	3.62 ab	3386.4 bc	8013.5 c	42.26 cd	46.47 bc
I1* S *C2	3.84 ab	3627.5 bc	8109.5 c	44.73 bc	44.49 c
I2* Z0S0* C0	2.7 b	1804.5 e	5133.4 f	35.15 f	40.72 d
I2* Z0S0 *C1	2.9 b	2591.9 d	6153.1 e	42.12 cd	41.11 d
I2* Z0S0 *C2	3.08 b	2855.4 cd	6967 de	41 cd	40.1 d
I2* Z *C0	2.93 b	2578.7 d	6112.4 e	42.2 cd	44.91 c
I2* Z*C1	3.49 b	3238.6 c	6636.6 de	48.8 a	44.6 c
I2* Z*C2	3.75 ab	3145.7 c	7303.5 cd	43.06 bc	43.82 cd
I2* S* C0	3.15 b	3052.5 c	6149.1 e	49.6 a	44.26 cd
I2* S *C1	3.2 b	2867.6 cd	7067.2 de	40.6 d	45.36 bc
I2* S *C2	3.45 b	3108.8 c	7613 cd	40.8 cd	41.85 d

Means with the same letter in each column have not statistically significant difference.

DISCUSSION

Increasing the efficiency of available water and fertilizer in agricultural systems with low moisture and fertility soil is possible by applying super absorbent polymers such as zeolite. Applying appropriate dose of zeolite and nitrogen in not water stress and water stress conditions is the key point in crop management to optimizing productivity

Acceleration of flowering and/or maturity probably contributed to reduce the impact of drought stress in canola genotypes. The decrease in yield and yield components, in different safflower genotypes, due to water deficiency, has also been reported by other researchers [11,15].

The result of triple interactions table showed, the highest plant height, number of silique per plant , number of grain in silique and 1000grain weight were obtained under normal Irrigation with super absorbent(S) and manure application (40 ton/ha)(I_0*S*C_2) with average (129.1Cm),(25.3 N.O) , (17.73 N.O) and (4.35 gr) respectively. And the lowest plant height achieved from (I_1* Z_0S_0* C_0) Treatment with average (80.4 cm). But Yuan Weihong et al. in 2001 reported as nitrogen increased, plant height decreased apparently [28], Which disagree with our study. It seems that, Zeolite improved soil cation exchangeable capacity and so water and nutrients were accessible for canola plants. Increase of canola plant height has been reported due to nitrogen availability [22].

In this investigation, the most grain yield and total above ground biomass and number of grain per plant were observed on (I_0*Z*C_2) treatment with average (4228.4 Kg/ha), (9896.7 Kg/ha) and (371.4 N.O) respectively. On the other hand, lowest grain yield and total above ground biomass, number of silique per plant, number of grain in silique , number of grain per plant and1000grain weight were assigned of (I_2* Z_0S_0* C_0) Treatment with average (1804.5 Kg/ha) ,(5133 Kg/ha), (11.7 N.O), (4.1 N.O) , (50.8 N.O) and (2.7 gr) respectively. But the result of table (4) showed the highest harvest Index (HI) was achieved on (I_2*S*C_0) treatment with average (49.6%) that was not significant with (I_1*Z*C_1) treatment.

The oil content was measured in seed. Water stress at silique feeding reduced oil content of seed. The result of table 4 showed the highest and lowest seed oil percentage achieved from (I_0* S *C_1) stage (49.71%) and (I_2* Z_0S_0 *C_2) with average (40.1%) treatment, respectively. There was not significant with(I_2* Z_0S_0* C_0), (I_2* Z_0S_0 *C_1) ,(I_2* S *C_2) and(I_1* Z_0S_0* C_0).Researcher showed grain yield and oil percentage are most sensitive to water stress at flowering and less sensitive during the vegetative (26) .Lovelli *etal*, in 2006 reported that water stress, during the flowering stage , affected the oil concentration of canola seeds[15]. However, grain yield and oil percentage seed 1000grains weights and some qualities characteristics were reduced under water deficit stress and absence of super absorbent and manure application (8). Researches of Yazdani *et al* in 2007 on soybean showed that application of super absorbent polymer under drought stress causes the increase of grain yield and the total dry weight of soybean [29]. Tohidi- Moghadam *et al* in 2009 reported that super absorbent polymer is able to store water in an effective way and under stress condition gives it to the plant. According to their idea, these materials prevent water and nutrition materials washing and therefore increase canola yield [27].

In this investigation, available strategies for an improved tolerance to water deficit are discussed. These results indicate that irrigation at flowering and grain filling stages of canola are sensitive under water deficit stress. The Grain yield timing can have a considerable effect on physiological characteristic oilseed.

The results of this study showed the number of silique per plant and number of grains per silique reduced at cut Irrigation flowering and grain filling stage, the reason seems to be shortage of assimilate. Tesfamariam *etal* in 2010 who believed that water stress imposed during flowering delayed maturity by 114 growing degree days [26].

Interactions super absorbent and manure application under water deficit stress condition was caused the negative effects of stress can be reduced and grain yield was less declined than control treatment.

Anyia and herzog. in 2010 which suggested that although significant differences were observed among irrigation treatments for a variable number of grain per plant, this was the least affected by the safflower in soil moisture tension [3].

CONCLUSION

Applying appropriate dose of super absorbent and manure as a complement for it in non water stress and water stress conditions is an important point in crop management to optimizing productivity. This research was shown that interaction effects super absorbent and manure application can increase the survival capacity of rapeseed under water deficit stress conditions. Drought stress decreased yield and yield components on the other hand, using super absorbent and manure application in field situation increases agricultural characters.

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