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Original article

Investigation of physiological characteristics and grain yield of pinto bean under irrigation disruption and methods to increase drought tolerance

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Extended abstract

Introduction

Pulses are rich in protein and are an important source of human food after cereals (Ganjabadi et al., 2014). Beans are one of the most important pulses and about 49% of the pulses consumed in the world are supplied through beans (Broughton et al., 2013). Drought stress is an important factor that reduces yield in plant (Liu et al., 2005). Many parts of the world have water scarcity that is a limiting factor for higher yields (Safavi Ghardini et al., 2017). Plans must be adopted to increase water use efficiency. by using materials such as superabsorbent polymers, it can increase water use efficiency. Superabsorbents can absorb large amounts of water (Alahdadi, 2002). Paula et al. (2007) reported that increasing soil moisture increases the plant height of chickpeas and beans. Elami et al. (2011) stated that superabsorbent increased chlorophyll under stress conditions. adequate amount of potassium sulfate fertilizer in the soil facilitates osmotic modification in the soil, as a result of which the osmotic pressure remains in the leaves and thus increases the plant's ability to withstand drought stress. Potassium plays an important role in reducing the effects of drought stress in plants (Molodi, 2015). Fanaei et al. (2010) reported an increase in chlorophyll pigment content in rapeseed with the use of potassium during drought stress, and also stated that the amount of chlorophyll increased with the application of potassium. The aim of this experiment was to investigate the strategies for reducing drought stress damage and also saving water consumption by using superabsorbent polymer, mycorrhizal mycorrhizal fungi, nano-potassium fertilizer and seed pretreatment with hydrogen peroxide.

Materials and methods

In order to effects of irrigation disruption and drought tolerance methods on physiological characteristics and yield of pinto bean, an experiment was conducted as split plot based on randomized complete block design with three replications in Salmas city, northwest of Iran, during spring of 2018. The main plot was irrigation disruption at 3 levels (normal irrigation, irrigation disruption at the end of flowering stage, irrigation disruption at the end of poding stage) and drought resistance as the sub-factor in five levels including (control, use of superabsorbent, use of mycorrhizal fungi, use of nano-potassium fertilizer and seed priming with hydrogen peroxide) was considered.

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Results

The highest amount of total chlorophyll was related to normal irrigation treatment and the lowest amount was related to stop irrigation treatment at flowering stage. The highest total chlorophyll was related to superabsorbent polymer treatment and the lowest amount was related to control treatment. the decrease in chlorophyll concentration in plants under drought stress may be due to the decomposition of chlorophyll by increasing the activity of chlorophylase (Goldani, 2012). The highest proline concentration was related to the experimental treatment of stop irrigation in stage of flowering and control and also the lowest amount of proline was observed in normal irrigation treatment along with superabsorbent consumption. The highest grain yield was related to normal irrigation interaction treatment along with superabsorbent polymer and the lowest amount was related to irrigation stop interaction treatment in the flowering stage along with control treatment. Alhiari et al (2013) by examining the effect of superabsorbent application on yield and yield components of chickpea under drought conditions observed that superabsorbent had a significant effect on yield of chickpea plant.

Conclusion

as respects, the highest grain yield in the normal irrigation experimental treatment was associated with the use of superabsorbent polymer, but according to other experimental treatments, it was observed that the grain yield in the experimental treatment of irrigation cut-off from the end of the poding stage with superabsorbent consumption was almost the same with the experimental treatment of normal irrigation. it should be included in a statistical group, which can play a significant role in saving water consumption, and also by using superabsorbent, drought stress damage can be significantly reduced.

***Keywords*:** Drought, Pinto beans, Proline,Yield

Table 1. Characteristics of physical and chemical of soil used in the experiment

pH	K	P	N	OC	Sand	Clay	Silt	Soil texture	EC
	----------ppm-----------		---------------------------------%-----------------------------						ds/m
8.21	273.4	5.1	1.03	0.11	33	18	49	silt	0.57

Table 2. Analysis of variance effects of irrigation disruption and drought resistance on different traits of pinto Bean

S.O.V	df	chlorophyll a	chlorophyll b	Total chlorophyll	Proline	Grain yield	Harvest index
Repeat	2	0.0001	0.0001	0.225	0.694	1135.4	14.56
Stopping irrigation(I)	2	0.007*	0.003**	8.93**	2.40 **	844074**	183.65*
Error a	4	0.0005	0.00025	0.013	0.15	4906.8	20.21
Drought resistance (D)	4	0.0005**	0.00025*	0.276*	0.465**	448434**	20.75*
D × I	8	0.000125	0.00004	0.061	0.105**	22480.5**	7.11
Error b	24	0.000083	0.000042	0.085	0.014	6868.84	6.17
CV (%)		*11.34*	*15.43*	*16.6*	*6.20*	*7.33*	*7.87*

* and **, respectively, significant differences at 5% and 1% probability levels

Table 3. Comparison of mean effects of irrigation disruption and drought resistance on different traits of pinto bean

Experimental factors		chlorophyll a	chlorophyll b	Total chlorophyll	Proline	Grain yield	Harvest index
		------------------mg/g FW	------------------		µmole/g FW	kg/ha	%
irrigation disruption	Normal irrigation (control)	0.104[a]	11	2.563[a]	1.626[b]	1854[a]	34.50[a]
	Stopping irrigation at the end of flowering stage	0.062[b]	0.033[b]	1.025[c]	2.353[a]	356.39[c]	27.70[b]
	Stopping irrigation at the end of pod of stage	0.080[b]	0.052[a]	1.691[b]	1.699[b]	1179.11[b]	32.40[ab]
Drought resistance	Control	0.073[b]	0.041[b]	1.490[b]	2.244[a]	862.9[d]	29.93[c]
	Super absorbent polymer	0.0917[a]	0.053[a]	1.982[a]	1.623[d]	1417.2[a]	33.29[a]
	Pre-treatment of seed with oxygenated water	0.077[b]	0.048[a]	1.775[ab]	1.936[b]	1025. 1[c]	30.57[bc]
	Mycorrhizal fungi	0.087[a]	0.052[a]	1.788[ab]	1.804[c]	1297.3[b]	33.06[ab]
	Nano potassium fertilizer	0.082[ab]	0.049[a]	1.764[ab]	1.856[bc]	1046.4[c]	30.99[a-c]

Means with similar letters in each column are not significantly different by Duncan's test at 5% probability level

Table 4. Comparison of the average irrigation disruption effects of irrigation disruption and drought resistance on different traits of pinto bean

Experimental factors		Proline	Grain yield
		µmole/g FW	kg/ha
Normal irrigation (control)	Control	1.993[def]	1627.21[d]
	Super absorbent polymer	1.240[j]	2133.24[a]
	Pre-treatment of seed with oxygenated water	1.520[i]	1814.21[bc]
	Mycorrhizal fungi	1.473[i]	1927.12[b]
	Nano potassium fertilizer	1.903[efg]	1770.31[c]
irrigation disruption at the end of flowering stage	Control	2.800[a]	160.5[i]
	Super absorbent polymer	2.217[c]	554.10[h]
	Pre-treatment of seed with oxygenated water	2.487[b]	250.8[i]
	Mycorrhizal fungi	2.187[cd]	537.10[h]
	Nano potassium fertilizer	2.073[cde]	280.4[i]
irrigation disruption at the end of poding stage	Control	1.940[efg]	804.2[g]
	Super absorbent polymer	1.413[ij]	1564.3[de]
	Pre-treatment of seed with oxygenated water	1.800[fg]	1011.21[f]
	Mycorrhizal fungi	1.753[gh]	1427.11[e]
	Nano potassium fertilizer	1.590[hi]	1088.13[f]

Means with similar letters in each column are not significantly different by Duncan's test at 5% probability level