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Original article

Comparison of some responses of sesame, purslane and hemp in different growth stages to water deficit stress

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Extended abstract

Introduction

Water deficit stress occurs when a combination of physical and environmental factors reduces the availability of water in the root environment and the structure of the plant, thereby reducing crop yield. One of the most important stresses is WDS, which may occur under low rainfall conditions, high temperatures and winds. The response of the plant to WDS depends on the stage of growth in which the drought occurs at that stage. WDS limits photosynthesis by stomata to close and, thus alter the physiological traits and productivity of plants such as synthesis of photosynthetic pigments, antioxidant enzyme activities, proline, anthocyanin, and etc. Tolerant crops cultivation is a quick and low-cost methods that could be used to increase the yield of crops and economically productive under stress conditions. Thus, the aims of this experiment was to study the effect of WDS on seed germination indices, seedling physiological traits, yield and physiological and biochemical responses of sesame, hemp, and purslane under laboratory and field conditions.

Materials and Methods

Field experiment was performed as a split-plot based on a randomized complete block design with three replications. Irrigation levels based on the potential for evapotranspiration at three levels (40%, 70% and 100%) and three plant species (sesame, purslane and hemp) were as main plots and sub plot, respectively. Germination test was conducted as a factorial based on a completely randomized design with three replications to evaluate the effect of drought stress (at four levels of zero, -3, -6 and -9 bar) and sodium silicate (at three levels of zero, 1.5, and 3 mM) on germination characteristics of these three plants. After checking the normality of data distribution assumption, the studied traits were statistically analyzed by the Statistical Analysis System software (SAS) for germination and field experiments. The differences among means were using the least significant difference (LSD) test at 0.05 level of significance.

Result and discussion

The highest GP (86%) was achieved purslane seed under the non-stress condition and lowest GP (39.33%) was in hemp seed under -9 bars. Increasing the WDS severity, GR showed a significant decrease in the three crops. Although, in all three crops, GP and GR showed significantly reducing compared to the non-stress condition, the rate of GP reduction were different. These reductions in sesame, hemp, and purslane seeds compared to the control treatment were 15.3, 24.6, and 48.06%,

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respectively and rate of GR reduction was 37.1, 28.7, and 59.8%, respectively Seed priming with sodium silicate at the level of 1.5 mM in drought levels increased the mean weight of seedling vigor index. The effect of WDS on total chlorophyll of sesame, hemp, and purslane seedlings was significant. Among the osmotic potential levels, -3 bars treatment had the highest total chlorophyll content (37.1 µg/g FW). The interaction effects of year × WDS × crops on seed yield were significant. Mean comparison of triple interaction showed that the purslane plant in both years and sesame plant in the first year under non-stressed conditions (100% PET) had the highest seed yield (1389.8, 1355.7, and 1352.4 kg/ha, respectively). The lowest this trait was related to hemp plant under severe stress conditions (40% PET) in both years of experiments. The average seed yield of two years was high in purslane crop but the mean seed yield loss under WDS was lowest in sesame and highest in hemp crops. These results indicate the superiority of two purslane and sesame crops compared to hemp under WDS. Among the plants tested, purslane had the highest total chlorophyll content. In conclusion, although purslane had the highest grain yield, the reduction in grain yield under severe stress conditions was the lowest in sesame and the highest in hemp. Overall, the results of the germination and field experiments showed that purslane was more tolerant of drought stress due to its morpho-physiological characteristics.

***Keywords*:** Chlorophyll, Germination percentage, Seed priming, Seedling vigor index, Sodium silicate

Table 1. Analysis of variance (Mean of square) for the effect of seeds priming with sodium silicate and drought stress on germination indices and seedling physiological traits of sesame, hemp and purslane

Source of variation	df	Germination percentage	Germination rate	Seedling vigor index (weight)	Total chlorophyll	Proline
Plant species (C)	2	4377.3**	2087.6**	184421719.9**	1728.3**	6.24**
Drought (D)	3	2177.4**	379.3**	5536999.3**	498.0**	0.10**
Sodium silicate (S)	2	3034.3**	191.1**	7258986.9**	29.7*	0.0002^{ns}
C × D	6	210.4**	110.4**	687309.1^{ns}	70.0**	0.32**
C × S	4	112.3*	7.44*	6609461.2**	14.9^{ns}	0.01^{ns}
D × S	6	49.9^{ns}	3.18^{ns}	1363788.9*	139.4**	0.04**
C × D × S	12	59.9^{ns}	3.08^{ns}	573099.4^{ns}	3.52**	0.02**
Error	72	48.3	2.81	622565.1	6.84	0.005
CV (%)	-	*11.43*	*11.26*	*22.78*	*8.27*	*16.7*

ns, * and ** are non-significant, and significant at 5 and 1 percent of probability level, respectively

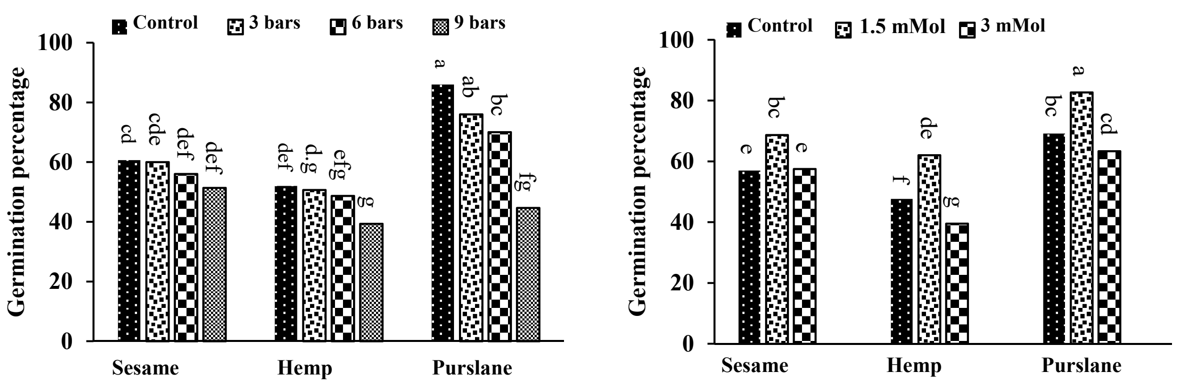

Fig. 1. Germination percentage of sesame, hemp and purslane under different levels of drought stress (left) and sodium silicate (right)

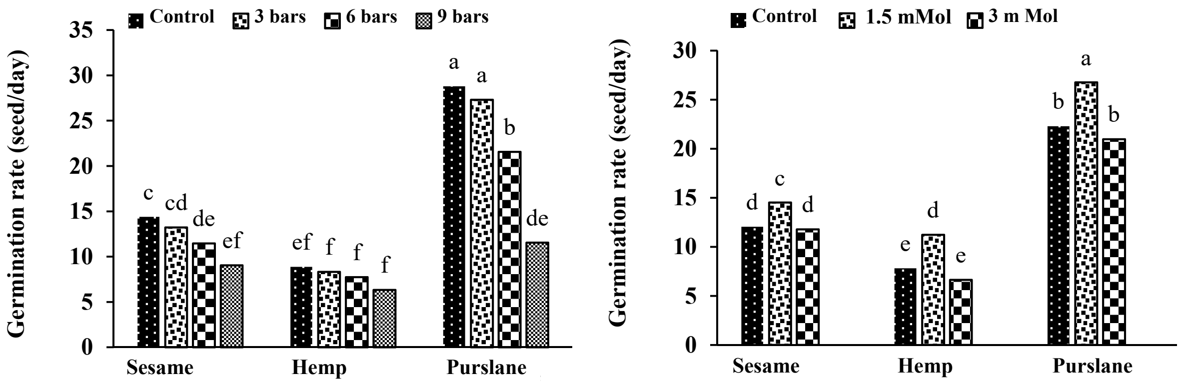

Fig. 2. Germination rate of sesame, hemp and purslane under different levels of drought stress (left) and sodium silicate (right)

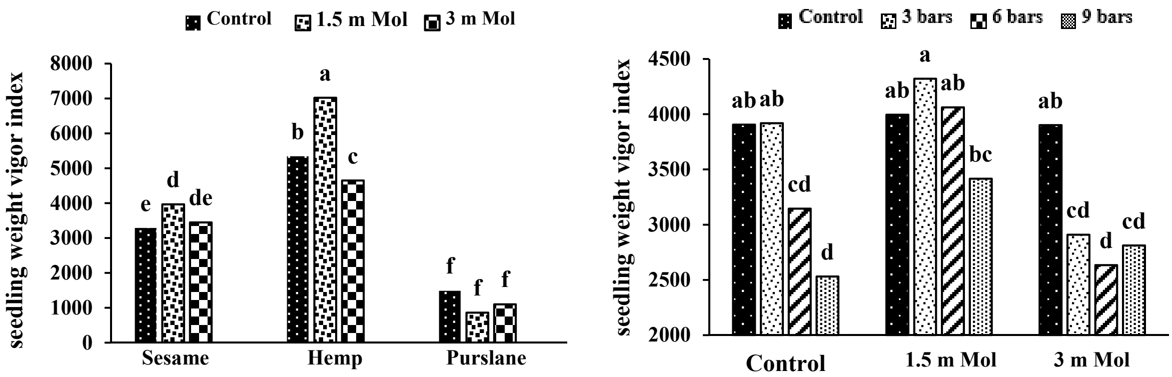

Fig. 3. Interaction of plant species and sodium silicate (left) and drought stress and sodium silicate (right) on seedling weight vigor index

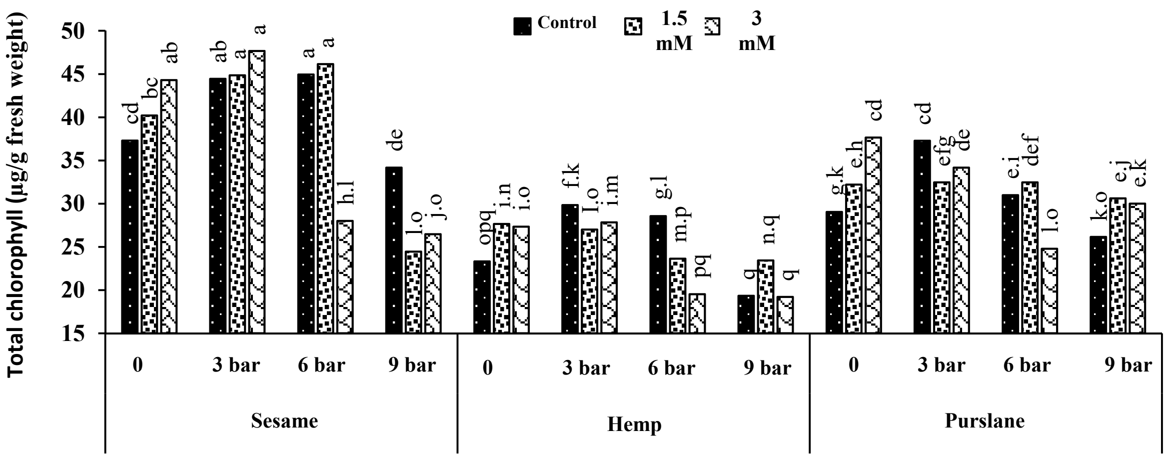

Fig. 4. Interaction of drought stress and sodium silicate on total chlorophyll content of sesame, hemp and purslane seedlings

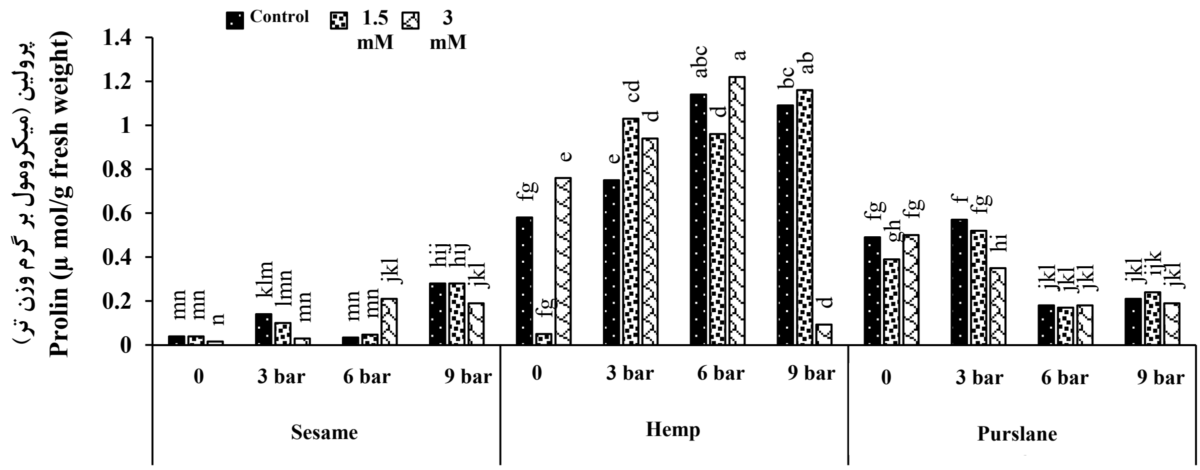

Fig. 5. Interaction of drought stress and sodium silicate on seedling proline content of sesame, hemp and purslane

Table 2. Analysis of variance (Mean of square) for the effect of deficit irrigation stress on some morpho- physiological traits of sesame, hemp and purslane in two years

S.O.V	df	Plant height	Seed yield	Biomass yield	Harvest index	Total chlorophyll	Proline
Year (Y)	1	1055.1*	285614ns	6284017.1*	10.9ns	6392.5**	0.11**
Error a	4	39.41	15404.9	1512367.4	3.35	4.98	0.005
Deficit irrigation (D)	2	4624.7**	371184.8**	32485436.7**	7.07ns	274.4**	0.38**
Y × D	2	61.9ns	5993.8ns	935480.6ns	2.11ns	86.4**	0.12**
Error b	8	143.4	16467.3	923060.7	6.72	9.44	0.0009
Plant species (C)	2	74058.0**	431168.0**	26126963.7**	155.5**	63.5*	0.007**
Y × C	2	80.8ns	14501.8ns	2139525.5ns	26.9**	2.62ns	0.003*
D × C	4	487.7*	5980.1ns	4938670.9**	3.99ns	25.9ns	0.001ns
Y × D × C	4	45.6ns	19686.6*	770657.7ns	2.20ns	16.7ns	0.004**
Error c	24	142.1	9978.7	1054726.9	4.33	11.7	0.0009
CV (%)	-	*10.03*	*11.41*	*12.08*	*15.42*	*13.91*	*16.94*

ns, * and ** are non-significant, and significant at 5 and 1 percent of probability level, respectively

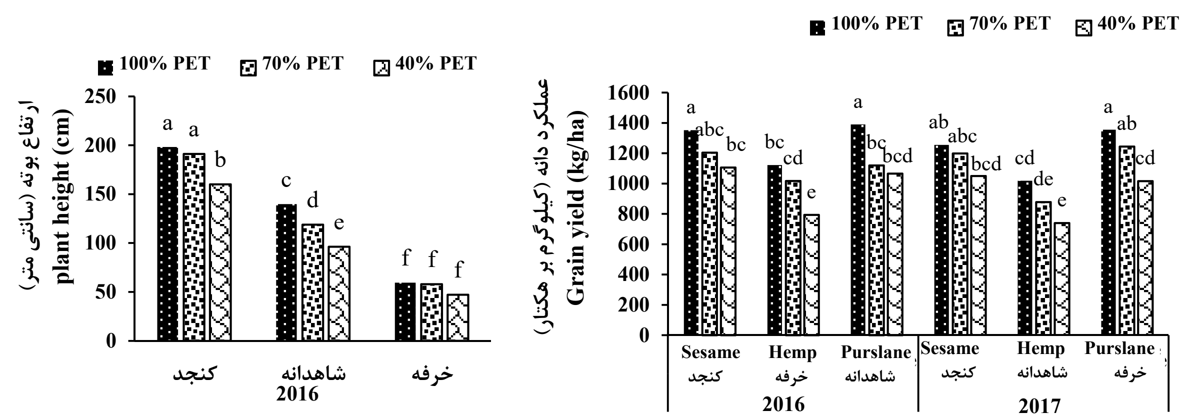

Fig. 6. Effect of different irrigation levels on plant height of sesame, hemp and purslane (right) and on their seed yield in two years experiment (left)

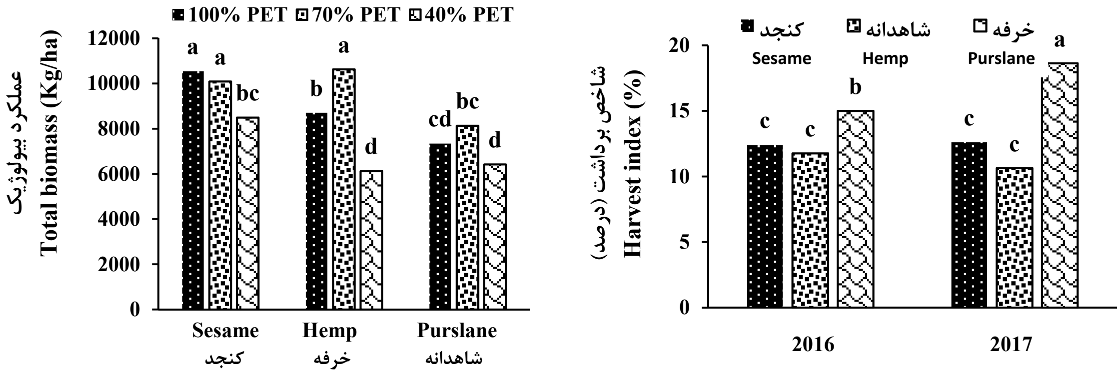

Fig. 7. Total biomass of sesame, hemp and purslane under different irrigation levels (right) and their harvest index in two years experiment (left)

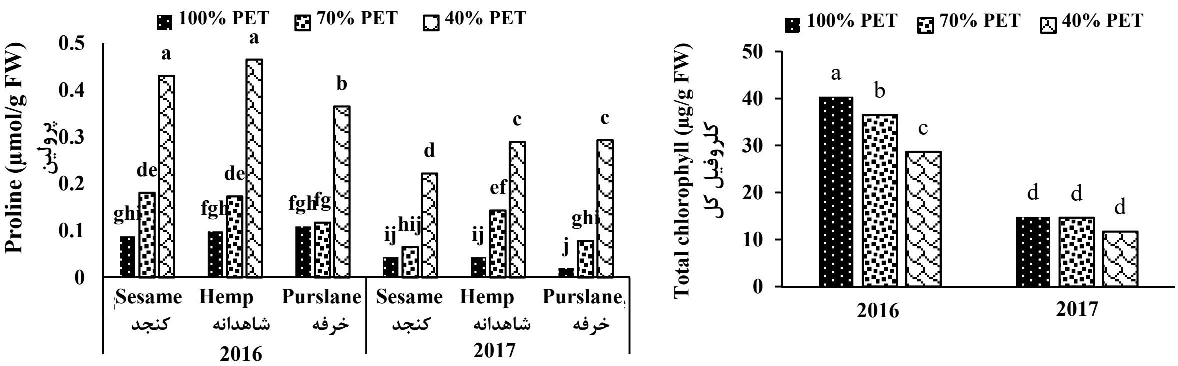

Fig. 8. Interaction of year, plant species and irrigation levels on leaf proline (left) and year and irrigation levels on total leaf chlorophyll (right)