

Morphological characteristics of soybean affected by foliar application of Methanol

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ABSTRACT: In order to evaluate effects of drought stress and spraying methanol on some morphological traits of soybean, an experiment was run as split plot in a randomized complete block design with three replications done at Research center in Faculty of Agriculture of Lorestan province, Iran. Treatments included three levels of drought stress, S1= 40percent of available soil moisture depletion (control), S2= 55percent of available soil moisture depletion, S3=70percent of available soil moisture depletion as main plots and four levels of methanol, including M1= without spraying of methanol (control), M2= spraying with 7 volumetric percentage of methanol, M3= spraying with 21 volumetric percentage of methanol and M4= spraying with 35 volumetric percentage of methanol as subplots were. The Results showed that increasing of drought stress, can lead to decreased in soybean length, branches number of leaf, number of pod, pod length and stem diameter. Also the Results showed that the effect of methanol spray there was significantly on soybean length, branches number of leaf, number of pod, pod length and stem diameter. The results showed that the highest values were obtained by 21 volumetric percentage of methanol spray, in this treatment the grain yield was 25.6 percent more than control. With the increasing amount of methanol from 21 to 35 volumetric percentage of methanol was reduced soybean length, branches number of leaf, number of pod, pod length and stem diameter, which is probably due to the negative effects of methanol in the high concentration of methanol.

Key words: Irrigation, methanol, morphology

INTRODUCTION

Soybean (*Glycine max* L.) is one of the most widely adopted grain legumes. Seeds for human consumption is the principal product of the soybean plant. Soybean is also used in the production of oil and protein. Rainfed crops grown in semiarid regions experience unpredictable water deficits during their life cycle. Lack of available water is the main factor limiting chickpea yields in the semiarid regions (Arya et al., 1998). Soil water and nutrients are the two key factors limiting agricultural productivity in the arid to semiarid areas (Ogola et al., 2002; Zhang et al., 2005). However, recent studies have shown that crop yields are not necessarily decreased with a moderate level of water deficit under irrigation conditions (Zhang et al., 1998).

In fact, well-regulated deficit irrigation regimes may increase crop yield compared to the crop grown under conditions of free from water deficit (Kang et al., 2002; Deng et al., 2002). The increased crop yield with regulated irrigation is mainly due to the systems allowing crop plants to grow under certain degrees of water stress at non-critical growth stages. In water-limited environments, the most competitive individuals are likely to gain a disproportionate share of the water in the soil, but partitioning of limited assimilates to the roots to improve water capture requires a reduction in reproductive partitioning to grain. This competitive asymmetry may lead to excessive growth of some resource-foraging organs to such an extent that not only grain production but also total crop production may be lowered (Zhang et al., 1999). Environmental stress is a primary cause of crop loss worldwide, resulting in average yield losses of more than 50% for major crops every year (Brya, 2004). Drought stress causes deceleration of cell enlargement and thus reduces stem length by inhibiting inter nodal elongation and also checks the tillering capacity of plants (Ashraf and O'Leary, 1996). Drought several studies have also shown that optimum yield can be obtained with irrigation at branching, flowering and pod formation stages (Prihar and Sandhu, 1968). In chickpea number of seed per pod has the most stability than other yield components of pulse crop (Singh, 1993). Number of seed per pod, number of seed per plant and number of pod per plant decreased with increasing of drought stress level (Khurgami et al., 2009). Crop production in arid and semi-arid regions is restricted by soil deficiencies in moisture and plant nutrients. It is well known that soil fertility is usually reflected by the status of soil nutrients and water together in an integrated system (Zheng et al., 2002). In chickpea grown primarily for its grain yield, the competition for water in a water-limited environment needs to be balanced by apportioning assimilates to the grain. Known as the game-theory model of root allocation (Gersani et al., 2001; Maina et al., 2002; Laird and Aarssen, 2005), plants competing for a common pool of soil-based resources produce an excess of roots at the expense of above-ground biomass. Therefore, this study was planned to examine effect of irrigation levels and Methanol spray on some morphological traits of soybean Viliams cultivar.

MATERIALS AND METHODS

This study was conducted in the Research center in Faculty of Agriculture of Lorestan province, Iran. during the growing seasons 2021. Soil of the experiment was clay-silt with pH 7.77, organic matter content 1.07 , total P 3.83% and and 392.9ppm of K and 0.1% nitrogen with EC= 1.239ds/m.. The experiment was laid out in a split-plot design with irrigations in main plots and Methanol spray in subplots with three replications. The experimental treatments consisted of three levels of irrigations [irrigation after 40% water deficit (S1), irrigation after 55% water deficit (S2) irrigation after 70% water deficit (S3)] in the main plots and four Methanol spray [M1 (non spray), M2 (spray with 7% solution), M3 (spray with 21% solution) and M4 (spray with 35% solution)]. Viliams soybean cultivar seeds were sown in rows with 40cm distance. Seeds was planted in a 5 m long and 4-row. Row to row and plant - plant distance was maintained at 40cm and 10cm, respectively. Seeds were placed 5 cm depth in each row. Before sowing seeds were inoculate with (*R. japonicum*) bacteria. Then phenological parameters were determined

The statistical analyses to determine the individual and interactive effects of drought stress, Zinc and K fertilization were conducted using JMP 5.0.1.2 (SAS Institute Inc., 2002). Statistical significance was declared at $P \leq 0.05$ and $P \leq 0.01$. Treatment effects from the two runs of experiments followed a similar trend, and thus the data from the two independent runs were combined in the analysis.

Results

Plant height

The effect of Methanol application and drought stress treatments on plant height was significant (Table 1). The comparison of the mean values of the plant height (Table 2) shows that among the irrigation treatments, the highest plant height (65.15 cm) was belonged at S₁ treatment and the lowest plant height (48cm) was belonged at S₃ treatment. Among the Methanol spray treatments, the highest plant height (62.2 cm) was belonged at M₃ treatment and the lowest plant height (49.8 cm) was belonged at M₄ treatment (Table2).

Number of leaf per plant

The effect of Methanol application and drought stress treatments on number of leaf per plant was significant (Table 1). Among the irrigation treatments, the highest number of leaf per plant (66) was belonged at S₁ treatment and the lowest number of leaf per plant (50) was belonged at S₃ treatment (Table2). Among the Methanol spray treatments, the highest number of leaf per plant (58) was belonged at M₃ treatment and the lowest number of leaf per plant (47) was belonged at M₄ treatment (Table 3).

Table1. Analysis of variance (mean squares) for some morphological traits in soybean under drought stress and Methanol spray

Source of variation	df	Means of square					
		plant height	Number of leaf per plant	stem diameter	Number of branch	Number Of pod	pod length
Repetition	2	22.92	5.25	0.71	0.13	131.49	0.07
Drought stress	2	869**	108*	14**	1.7**	442.5**	1.09**
Error (Ea)	4	155	33	0.18	0.16	104.37	0.04
Methanol Stress*	3	266****	188**	0.11	1.2**	357.51**	0.15**
Methanol	6	10	40.7	0.42	0.16	45.83	0.06
Error (Eb)	18	32.3	29	0.3	0.11	33.51	0.04
CV		10	10.2	8.28	8.6	12.15	4.23

ns: Non-significant, * and **: Significant at 5% and 1% probability levels, respectively

Table2. Mean comparisons for some morphological traits in soybean under drought stress and Methanol spray

	plant Height (cm)	Number of leaf per plant	stem Diameter (mm)	Number of branch	Number Of pod	pod Length (cm)
Irrigation						
After 40%(S1)	65.15a	66.1a	7.7a	3.9ab	54.02a	5.3a
After 55%(S2)	55.9ab	53.4b	6.7b	4.2a	46.92ab	5.1a
After 70%(S3)	48b	50c	5.6c	3.5b	41.94b	4.7b
Methanol spray						
Non spray(M1)	54.3bc	52bc	6.6a	3.8b	48b	5b
With 7%(M2)	59.2ab	55ab	6.7a	3.9b	49.47ab	5.1ab
With 21%(M3)	62.2a	58a	6.8a	4.3a	54.04a	5.28a
With 35%(M4)	49.8c	47c	3.4c	3.4c	39c	4.9b)

Means by the uncommon letter in each column are significantly different (p<0.0

Stem diameter

The effect of Methanol application and drought stress treatments on stem diameter was significant (Table 1). Among the irrigation treatments, the highest stem diameter (7.7mm) was belonged at S₁ treatment and the lowest stem diameter (5.6mm) was belonged at S₃ treatment (Table2). Among the Methanol spray treatments, the highest

stem diameter (6.8mm) was belonged at M₃ treatment and the lowest stem diameter (3.4mm) was belonged at M₄ treatment and the differences were significant (Table 2).

Number of branches per plant

The effect of Methanol application and drought stress treatments on number of branches per plant was significant (Table 1). Among the irrigation treatments, the highest number of branches per plant (4.2) was belonged at S₂ treatment and the lowest number of branches per plant (3.5) was belonged at S₃ treatment (Table 2). Among the Methanol spray treatments, the highest number of branches per plant (4.3) was belonged at M₃ treatment and the lowest number of branches per plant (3.4) was belonged at M₄ treatment (Table 2). Similar results were reported by Mansur et al (2010) Singh and Dixit (1992) and Arya and Khushwa (2000) in chickpea and seghatoleslami et al (2008) in millet and Nabipour et al (2007) in safflower and Mirakhori et al (2009) in soybean Max.

Number of pods per plant

The effect of Methanol application and drought stress treatments on number of pods per plant was significant (Table1). Among the irrigation treatments, the highest number of pods per plant (54) was belonged at S₁ treatment and the lowest number of pods per plant (42) was belonged at M₃ treatment (Table2). Among the Methanol spray treatments, the highest number of pods per plant (54) was belonged at M₃ treatment and the lowest number of pods per plant (39) was belonged at M₄ treatment and differences were significant (Table 2). Similar results were reported by Mansur et al (2010) and Singh and Dixit (1992) in chickpea and Kenan and Cafer (2004) in sugar beet and Penuelas et al (1993) in pepper and beans.

Pod length

The effect of Methanol application and drought stress treatments on pod length was significant (Table 1). Among the irrigation treatments, the highest pod length (5.3cm) was belonged at S₁ treatment and the lowest pod length (4.7cm) was belonged at S₃ treatment although the differences were significant (Table2). Among the Methanol spray treatments, the highest pod length (5.3cm) was belonged at M₃ treatment and the lowest pod length (4.9) was belonged at M₁ treatment and the differences were not significant (Table1). Similar results were reported by Mansur et al (2010) and Arya and Khushwa (2000) in chickpea and Mirakhori et al (2009) in soybean Max.

DISCUSSION

This study has showed that soybean length, branches number of leaf, number of pod, pod length and stem diameter were decreased significantly in water deficit condition and Methanol spray has a positive effect on them. The reduction in number of pod per plant in non irrigation treatment may be attributed to the limitation of dry matter partitioning to the reproductive sink or even grain formation factors as has been reported by Turk et al (1980). Similar results were reported by khurgami et al (2009) and Arya and Khushwa (2000) in chickpea and Mirakhori et al (2009) in soybean Max. In a water-limited environment, there is an inevitable trade-off between investment in roots to increase water supply and reproductive growth (Manuela et al., 2003).

The reduction in plant length, pod length and number of leaf per plant under non irrigation condition may be attributed to the abscission of the reproductive structures but the difference was not significant. Ziska and Hall (1983) and Gwathmey and Hall (1992) reported similar results.

Water deficit occurrence in relation to anthesis stage causes a drastic reduction in some yield components (Seghatoleslami et al., 2008). However, the effect of methanol spray there was significantly on number of pods per plant. The results showed that the highest values were obtained by 21 volumetric percentage of methanol spray, in this treatment the grain yield was 25.6 percent more than control. With the increasing amount of methanol from 21

to 35 volumetric percentage of methanol was reduced length, branches number of leaf, number of pod, pod length and stem diameter, which is probably due to the negative effects of methanol in the high concentration of methanol. In this study the plant length, branches number of leaf, number of pod, pod length and stem diameter in soybean under uses methanol increased. Mahalakshmi and Bidinger (1985) reported that drought stress at grain filling stage reduced yield up to 50%. Boutraa and Sanders (2001) previously reported that the reduction in yield and growth parameters differed in two bean cultivars imposed to water stress during flowering and pod filling stages. In different irrigation treatments indicate in early irrigation period condition increased the number of branches per plant and pod length significantly. Decrease biomass yield under lower soil moisture might be due to reduction of number of leaf per plant and leaf area and photosynthesis rate (Sinaki et al., 2007). Latiri-Soki et al (1998) reported that, irrigation and fertilizers increased biomass yield and grain yield. They suggested the increase might be due to increased leaf area index (LAI) and an increase in the period for which the crop remained green, which resulted in increased capture efficiency of radiation energy and consequently more dry matter production.

CONCLUSION

Low soil moisture during the early stages of the soybean growth decreases nodule formation and low moisture during late vegetative to early flowering period decreases efficiency of N₂ fixation and decreased soybean length, branches number of leaf, number of pod, pod length and stem diameter of it. The present study concluded that the increasing of drought stress, can lead to decreased in soybean length, branches number of leaf, number of pod, pod length and stem diameter. Also the Results showed that the effect of methanol spray there was significantly on soybean length, branches number of leaf, number of pod, pod length and stem diameter. The results showed that the highest values were obtained by 21 volumetric percentage of methanol spray, in this treatment the grain yield was 25.6 percent more than control. With the increasing amount of methanol from 21 to 35 volumetric percentage of methanol was reduced soybean length, branches number of leaf, number of pod, pod length and stem diameter, which is probably due to the negative effects of methanol in the high concentration of methanol.

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