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Research Article

Effect of Biological Fertilizer on Yield and Yield Components of Sesame under Drought Stress

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ABSTRACT

Water deficit elicits several morphological responses in crop plants. Most of these responses are adaptive mechanisms to withstand water deficit or drought and to ensure both survival and reproduction under conditions of water deficit stress. There are three main aspects of plant morphological behavior in relation to drought: the modulation of root growth. Application of organic manures has various advantages like improving soil physical properties, water holding capacity, and organic carbon content apart from supplying good quality of nutrients. The field experiment was laid out split plot with randomized complete block design with three replications. Treatments included drought stress (a1: control, a2: Irrigation cut in flowering, a3: Irrigation cut in Podding) as main plot and sub plot consisted of biological fertilizer (b0: Conventional chemical fertilizers inside the area, b1: no biological fertilizer, b2: 30 ton/ha manure, b3: 10 ton/ha vermicomposting, b4: 30 ton/ha manure + 100% nitrogen). Analysis of variance showed that the effect of drought stress and biological fertilizer on all characteristics was significant.

Key words: Pant height, Harvest Index, Grain yield, Biological yield

INTRODUCTION

Drought stress is one of the most important environmental factors limits sesame production (Betram *et al*., 2003). The lack of water sources is a main factor preventing the production of agricultural systems in dry and semidry environments limiting the efficient use of other resources (Kenan *et al.,* 2007). Water deficit elicits several morphological responses in crop plants (Jones HG, 2004). Most of these responses are adaptive mechanisms to withstand water deficit or drought and to ensure both survival and reproduction under conditions of water deficit stress. There are three main aspects of plant morphological behavior in relation to drought: the modulation of root growth (Jackson RB *et al*, 2000), the modulation of leaf size and changes in leaf orientation (Chaves *et al* 2003). A fundamental problem with these adaptive responses is that most are aimed at reducing water use and consequently affect plant function and productivity through reduction in photosynthesis (Ribaut J, 2006). Iran is considered as one of the dry and semidry areas in the world, therefore the designation of plant cultivar immune to drought is a key goal in the country's plant correction program (Dane *et al*., 2006). Based on FAO statistics for the year 2011, arable lands in Iran covered about 17 million acres. From this amount, 9 million acres are used for irrigated plantings. 92.2% of Iran's water supply is used for agricultural purposes. Based on the high usage of vegetable oils per person in Iran, up to about 12 kilograms per year, and the import of this product, the farming of this plant is of high importance. Based on the statistics in PGRO (Plant Genetic Resources Center for Conservation Research Center), Iran is 8th on the list for sesame genetic resources. Therefore the analysis and discovery of new and effective methods to achieve high output from these plant cultivars, especially considering each environment's climatic conditions, are researchers' focuses. Sesame (*Sesamum indicum*) is a plant that, because of its high oil capacity (47-52%), has an important role in human health (Kassab *et al*., 2005; Hibasam *et al*., 2000; Miyahara *et al*., 2001). Sesame seed is known as a drought resistant product, but moisture is needed for its growth and for high plant output. This plant has strong, straight, and expanded roots shaped differently based on the stem growth pattern and the amount of moisture in the different layers of the

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rhizosphere (Golestani and Pakniat, 2008). In their research, Mensah *et al*. (1997) showed that lack of water reduces the growth and output of the sesame seed. Karaaslan *et al*. (2007) demonstrated that increasing the irrigation intervals from 6 days interval to 18 and 24 days interval, sesame yield was decreased from 1790-1550 and 1130 kg ha-1. Mensah *et al*. (2006) reported that increasing the irrigation interval from daily to every 15 days, grain yield increased from 5.9 to 6.09 g plant-1. Ucan *et al* (2007) showed that with increasing the irrigation numbers, sesame yield was decreased. Tantawy *et al*. (2007) reported that with decreasing the irrigation, sesame yield was decreased. Kwan *et al*. (2007) found that drought stress caused a large decrease in seed yield per plant but did not affect the mean weight of individual seeds, showing that sesame responds to post-flowering drought by reducing seed numbers, but not seed size. Hassanzadeh *et al*. (2009) studied the effect of water stress on yield and yield components of 27 sesame genotypes. He demonstrated that numbers of capsules per plant and grain yield were affected by irrigation and genotypes. The increasing growth rate of the world population, coupled with climate change and reduction in production resources, are encouraging stimuli for the promotion of sustainable crop production in current and future farming systems. Sustainable agriculture, especially organic agriculture, is a low input system that implies the efficient use of biological resources. Transition from high input to low input agriculture requires information to solve the problems of the transition period. Water and nutrients are the most important factors during plant growth and development. Deficit irrigation and use of biological fertilizers are the critical components to crop production in sustainable farming systems (Canbolat et al. 2006; Sparks 2009). In such a system, fertilizing with organic fertilizers such as vermicompost, farm-yard manure, nitrogenous bio-fertilizer and phosphatic bio-fertilizers (Phosphate Solubilizing Microorganisms) are noticed. However, there are evidences indicating that the yield in organicfarming systems is less than that in conventional production systems, especially in areas with low organic matter in soil (Torstensson *et al*., 2006; Olesen *et al*., 2007; Dawson *et al*., 2007; Ghorbani *et al*., 2008 and Leistrumait_ and Razbadauskien_, 2008). The lower yield in organic production system is attributed to asynchronism of plant need for nutrients especially N and P, and the conversion of nutrients supplied in organic manure to a form available to crops (Kato and Yamagishi, 2011). Although long-term experiments have shown no difference between yield in organic and conventional systems (Kato and Yamagishi, 2011). Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. The natural recycling of farm-waste organic matter through composting is aimed at minimizing nutrient loss, reducing waste accumulation and limiting greenhouse gas emission. Developing inexpensive and nutrient-rich organic media alternatives will not only eliminate environmental impacts but also reduce nursery costs and fertilization and irrigation rates (Wilson et al., 2001). Application of organic manures has various advantages like improving soil physical properties, water holding capacity, and organic carbon content apart from supplying good quality of nutrients (Ayeni and Adetunji, 2010). Furthermore, Nanjappa *et al.* (2001) and Jayanthi *et al*. (2002) suggested that application of vermicompost and manure together showed a positive and meaningful improvement in the maize and oat seed's functioning. Findings of these researches clearly indicated that the use of vermicompost not only causes better plant's growth but also effects the crop functioning. Use of vermicompost in the sustainable agriculture caused significant increases in the population of beneficial microorganism such as mycorrhizal fungi and phosphate dissolving bacteria and fungi in the soil. Production of nutritious elements such as nitrogen, transferable phosphor, magnesium, dissolved potassium required for the plants and causes improvement in the growth and function of the agricultural plants (Jayanthi *et al*., 2002).

MATERIALS AND METHODS

Location of experiment

The experiment was conducted at the zabol which is situated between 31° North latitude and 61° East longitude.

Composite soil sampling

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 split plot with randomized complete block design with three replications.

Treatments

Treatments included drought stress (a1: control, a2: Irrigation cut in flowering, a3: Irrigation cut in Podding) as main plot and sub plot consisted of biological fertilizer (b0: Conventional chemical fertilizers inside the area, b1: no biological fertilizer, b2: 30 ton/ha manure, b3: 10 ton/ha vermicompost, b4: 30 ton/ha manure + 100% nitrogen).

Data collect

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

RESULTS AND DISCUSSION

Plant height

Analysis of variance showed that the effect of drought stress on plant height was significant (Table 1). The maximum of plant height of treatments A1B3 was obtained (Table 2). The minimum of plant height of treatments A2B1was obtained (Table 2). Analysis of variance showed that the effect of biological fertilizer on plant height was significant (Table 1). The maximum of plant height of treatments A1B3 was obtained (Table 2). The minimum of plant height of treatments A2B1was obtained (Table 2).

Table 1: Anova analysis of the sesame affected by biological fertilizer and drought stress

S.O.V	df	Pant height	Harvest Index	Grain yield	Biological yield
R	2	70.19 n.s	18.08 n.s	1898.1 n.s	138572.5 n.s
a (drough)	2	527.04*	108.6 *	41393.7*	851790.5**
Error a	4	83.8	2.2	4009.7	123315.1
b (biological fertilizer)	3	497.7*	396.7 **	239109.5**	123315.1*
A*b	6	375.7*	843.7 **	253890.7**	1684672.3**
Error b	18	107.9	29.15	10548.2	120398.7
Total Error	35	-	-	-	-
C.V	-	7.5	14.1	8.7	10.8

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

Table 2: Comparison of interaction between different traits affected by biological fertilizer and drought stress

Treatments	Pant height (cm)	Harvest Index	Grain yield (kg/ha)	Biological yield(kg/ha)
A1B1	125.3 ghi	34 defg	1239.1 cdef	3088.6 fg
A1B2	138.3 bcd	34.05 def	983.3 fgh	2677.3 fghi
A1B3	158.20 a	68.96 a	1505.3 a	4304.9 a
A1B4	153.3 ab	57.29 b	1472.6 ab	4013.3 a
A2B1	124 ijk	21.7 ijk	722 ijk	2457.6 ghijk
A2B2	133 cdef	51.46 b	1371.6 abc	2534.3 fghijk
A2B3	135.3 bcde	34.7 de	1277 bcde	3718 abc
A2B4	130.3 fgh	31.1 defgh	915 hi	2854.6 fgh
A3B1	132 efg	24.6 defghij	813.4 ij	3074.3 fg
A3B2	124.80 hij	28.1 defghi	1103.6 defg	3149.3 bce
A3B3	153 ab	34.9 d	1318.3 bcd	2594.6 fghij
A3B4	146.6 abc	35.1 c	1415.4 ab	3823.6 ab

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

Harvest index

Analysis of variance showed that the effect of drought stress on harvest index was significant (Table 1). The maximum of harvest index of treatments A1B3 was obtained (Table 2). The minimum of harvest index of treatments A2B1was obtained (Table 2). Analysis of variance showed that the effect of biological fertilizer on harvest index was significant (Table 1). The maximum of harvest index of treatments A1B3 was obtained (Table 2). The minimum of harvest index of treatments A2B1was obtained (Table 2).

Grain yield

Analysis of variance showed that the effect of drought stress on grain yield was significant (Table 1). The maximum of grain yield of treatments A1B3 was obtained (Table 2). The minimum of grain yield of treatments A2B1was obtained (Table 2). Analysis of variance showed that the effect of biological fertilizer on grain yield was significant (Table 1). The maximum of grain yield of treatments A1B3 was obtained (Table 2). The minimum of grain yield of treatments A2B1was obtained (Table 2).

Biological yield

Analysis of variance showed that the effect of drought stress on biological yield was significant (Table 1). The maximum of biological yield of treatments A1B3 was obtained (Table 2). The minimum of biological yield of treatments A2B1was obtained (Table 2). Analysis of variance showed that the effect of biological fertilizer on biological yield was significant (Table 1). The maximum of biological yield of treatments A1B3 was obtained (Table 2). The minimum of biological yield of treatments A2B1was obtained (Table 2).

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