Changes in the Rate of Soluble and Insoluble Sugars in Roots of Safflower with Using Vermicompost and Nitrogen under Drought Stress

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Abstract: *Current study was carried out in the Faculty of Agriculture, Khoram-abad azad university, Iran in 2012 growing season. . The experiment was laid out Split plot- factorial in Randomized Complete Block Design with 3 replications. Treatments were, Vermicompost rate in 4 levels (V1=0 (control), V2=2, V3=4 and V4=6 ton Vermicompost ha $^{-1}$) and Nitrogen rate, (N1= 0 (control), N2= 84 (30% less from N3), N3= 120 (from the soil analyze lab), N4= 154 (30% more than N3) kg N ha $^{-1}$), and Irrigation as the main factor in two levels, S1= Control and S2=Water Stress (stress from bloom growth stages). The study indicated that V, N and S were significant effect on root soluble and insoluble sugar. As soluble and insoluble sugar increased whit water stress and decreased whit with application of Vermicompost and Nitrogen rate.*

Keywords: *Vermicompost, Nitrogen, drought stress, soluble and insoluble sugar, Safflower.*

1. Introduction

Safflower (Carthamus tinctorius L.) is a member of the family Compositae or Asteraceae, cultivated mainly for its seed, which is used as edible oil and dye production since ancient times. Safflower is an annual winter oil seed crop and it seed content about 20-40 % oil consider one of the alternative oil crops, particularly in the dry and semi dry lands due to tolerance to drought, salinity and cold stress. Safflower oil quality is high due to its fatty acids composition. Standard safflower oil contains about 6-8% palmitic acid, 2-3% stearic acid, 16-20% oleic acid and 71-75% linoleic acid (Anonymous, 1988). Drought stress limits plant growth and productivity more than any other environmental factor in the arid and semi-arid area. Water deficit reduces the economic yield of a crop to different degrees during its growth stage (Villagra and Cavagnaro 2006). A common effect of many environmental stresses is to cause oxidative damage. The imposition of oxidative stress leads to increased production of active oxygen species (AOS) in plant cells, which will affect the regular metabolism by damaging the cellular components (Smirnoff 1998). To alleviate the effects of dryness on regular metabolism and ensure that crops grow and develop normally, plants evolve cellular adaptive responses like oxidative stress protectors (Zhao et al, 2005). The use of organic fertilizers including animal fertilizers and superabsorbent polymer is very effective in reducing drought stress effect and to improve the plants yield and stability in agriculture production. Plant reaction to drought stress is dependent on the intensity of water shortage. Plants have a short term or long term physiological respond to the drought stress (Ahmadi and Ceiocemardeh, 2004). Nitrogen is a nutritive element required by plants in large amounts while its use efficiency is always low in dry land regions, which has become one of the most nutritional-limiting factors for increasing crop yield and improving crop quality (Li, 2007). In addition to supplying a nutrient for plant growth, N application could improve drought tolerance of plants to enhance yields (Xu et al. 2005). Furthermore, nitrogen plays an important role in the antioxidant defence enzyme and lipid peroxidation metabolism of crops under stress (Saneoka et al. 2004). Its deficiency can be considered an abiotic stress factor, resulting in reduced yield of a crop. The increase in production and improvement in drought resistance of crops with increased N supply under water stress are in agreement with previous findings (Zaman and Das, 1991).

2. Materials and methods

Current study was carried out in the Faculty of Agriculture, Khoram-abad azad university, Iran in 2012 growing season ((Longitude=47˚ 40' Latitude=33˚ 36'). Khoram-abad is a moderate climate region and receives average annual rainfall of 530^{mm}. The experimental field was silty clay loam textured soil having a PH value of 7.5 and 0.8% organic carbon. The experiment was laid out Split plot- factorial in Randomized Complete Block Design with 3 replications. Treatments were included three agents: Vermicompost rate in 4 levels (V1=0 (control), V2=2, V3=4 and V4=6 ton Vermicompost ha^{-1}) and Nitrogen rate in 4 levels (N1= 0 (control), N2= 84 (30% less from N3), N3= 120 (from the soil analyze lab), N4= 154 (30% more than N3) kg N ha^{-1}) in the form of Urea which contains 46% N and Irrigation as the main factor in two levels, S1= Control and S2=Water Stress (stress from bloom growth stages). The sugars content were determined by (Irigoyen et al., 1992) method. Statically analysis was conducted using MSTAT-c software. Mean comparison was also conducted with Duncan's Multiple Rang Test (DMRT). And for charts was drawn with Excel software.

3. Result and Discussion

The result of factorial analysis variance (ANOVA) revealed that the effect of variance components (V, N, S) and their interactions were significant at ($P<0.01$) and ($P<0.05$) Soluble and Insoluble Sugar content (Table: 1).

TABLE I: Analysis of variance components Water stress (S) Vermicompost (V), Nitrogen (N), and their interaction for assessed traits.

S.O.V	df	Mean square	
		Soluble Sugar	Insoluble Sugar
Replication	2	0.004	0.003
S	1	0.11^{**}	0.32^{*}
Error S	2	0.004	0.004
V	3	0.10^{*}	0.03^{**}
SV	3	0.01^{*}	0.003^{ns}
N	3	0.06^{**}	0.21^{**}
SN	3	0.009^{ns}	0.004^{ns}
VN	9	0.14^{**}	0.04^{**}
SVN	9	0.009^{ns}	0.003^{ns}
Total Error	60	0.003	0.006
CV(%)		7.5	9.0

*, **: Significantly different at 5 and 1% levels of probability, respectively; ns: non-significant.

These results show that there is suitable amount and variation in root Soluble and Insoluble Sugar for drought tolerance in safflower. Identifying and developing of drought tolerant cultivars with high yield potential, is the main purpose in any breeding programs especially in those regions that drought stress occurs during reproductive stages of plants (Griffiths and Parry, 2002).

The soluble sugar content decreased with increasing Vermicompost and N fertilizer and increased in water drought stress condition. The highest and lowest soluble sugar in water stress condition obtains S1= 0.73 and S2= 0.90 ($mg.g^{-1}$ root fresh weight) (Figure: 1). As the lowest and highest soluble sugar was obtained V4N3=0.52 and V1N1= 0.87 ($mg.g^{-1}$root fresh weight) respectively (Figure: 2).

The insoluble sugar content also decreased with increasing Vermicompost and N fertilizer and increased in water stress. And the water stress treatment the lowest and highest insoluble sugar content was observed in S1=0.77 and S2=0.89 $mg.g^{-1}$root fresh weight respectively (Figure: 1). The highest insoluble sugar content of 1.43 and the lowest 0.56 $mg.g^{-1}$root fresh weight was observed in V1N1 and V4N4, respectively (Figure: 2). Water stress decreasing plant dry matter via decrease the nutrition menial's suction, transmission and utilization in plant growth. Nitrogen fertilizer increased the plant vegetative growth via increasing the chlorophyll and leaf area in drought stress, and plant escape the drought stress temporary. Hence the soluble sugar content didn’t increase while N access for plant. Abbaszadeh et al., (2008) indicated that proline and soluble sugars increased moderate drought stress (60%FC) in balm (*Melissa officinalis* L.). Aggregation soluble sugars in pigeonpea plant in Water stress condition reported by Subbaro et al., (2000). Ghorbanali and Niakan, (2006) reveals that the roots soluble sugars and proline significantly increased in both moderate and severe water stress but in leaf and stem increased only severe water stress significantly.

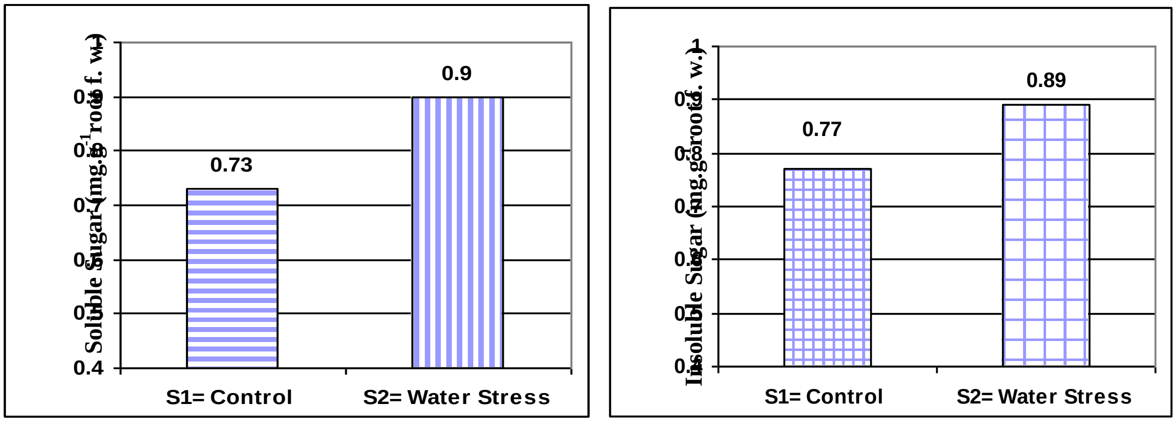

Fig. 1: The effect of water stress on soluble and insoluble sugar (mg.g^{-1}root f. w.)

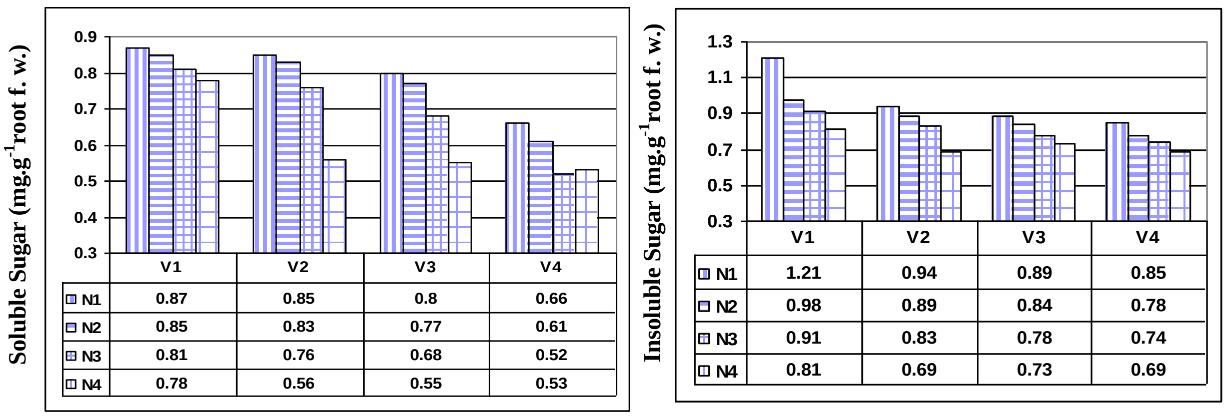

Fig. 2: interaction effect of V and N rate on soluble and insoluble sugar (mg.g^{-1}root f. w.)

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