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Safflower Yield Respond to Chemical and Biotic Fertilizer on Water Stress Condition

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Abstract: Due to high dependence of country to supply of plant oil and necessity of using biofertilizers and natural manure to crop plants, instead of chemical fertilizers as the prerequisite to sustainable agriculture, a study was conducted at Khorramabad- Lorestan, Iran, during growing season of 2011. the objective to determine the effect of Vermicompost, N fertilizer and water stress on seed yield and yield component (number of heads per plant, number of seeds per head and 1000 Seed Weight. The experiment was laid out in Randomized Complete Block Design as Split Plats Factorial (RCBD) with 3 replications. Treatments were 4 levels included Vermicompost rates (V1=0, V2=2, V3=4, V4=6 t/ha^{-1}) and Nitrogen rate (N1=0(control), N2=84, N3=120, N4=154 kg N ha^{-1}) and Irrigation as the main factor in two levels, S1=regular irrigation and S2=Non- irrigation (stress from bloom growth stages). The study indicated that V, N and S were significant effect on seed yield and TWG at (P = 0.01). In the interaction effect of Vermicompost with Nitrogen fertilizers, application of V4N4 had the highest seed yield (1655.0 kg/ha^{-1}) ant treatment V3N4 had the highest TWG (39.0 gr). And the interaction of V×N had deferent effect and non- effect on these traits. As a hole the study indicated that seed yield and yield components increased with application of V and N fertilizer and the water stress decrease these traits.

Key words: Safflower yield, Chemical, Biotic, Fertilizer, Water stress

INTRODUCTION

Oil consumption in the country annually is 850,000 ton but only 10% of it is being provided by domestic production. Regarding the important of oil seeds, increasing grain and oil yield of safflower is one of important priorities of agriculture sector [1]. Safflower, (*Carthamus tinctorius L.*), is a member of the family Composite or Asteraceae, cultivated mainly for its seed, which is used as edible oil and as birdseed. Traditionally, the crop was grown for its flowers, used for coloring and flavoring foods and making dyes, especially before cheaper aniline dyes became available and in medicines [2]. And it is a crop species which is well adapted to dry and salty land conditions since it is a strongly tap-rooted annual plant which is resistant to saline conditions, drought stress and can reach the deep-lying water [3]. The direct yield components of safflower are number of plants per plot, number of heads per plant, number of seeds per head and weight of seeds [4]. The relative importance of each yield component is affected by many factors, including genotype, environmental conditions and cultural practices. Nutrient management is one of the critical inputs in achieving high productivity of safflower [5]. Vermicompost and nitrogen availability are important parameters affecting yield and yield components in safflower. The availability of nutrient can be manipulated by adopting suitable package of fertilizer management [6]. Safflower response to nitrogen is generally greater than to other nutrients. Nitrogen increases seed yield primarily through its effect on the number of heads per plant and the increase is greater in tertiary and to a lesser extent in

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secondary heads [2]. The researchers declared that increasing nitrogen cause increase grain yield but grain oil content cause decrease [7]. Taheriasbag *et al*. [8] showed that with increasing drought stress percentage of protein increased significantly. Nitrogen is the most important element that cause increase protein of grain [9]. Flowering is the most sensitive plant stage to water deficit. Moreover, various safflower diseases tend to spread and intensify towards and after flowering. Therefore, plants are subjected to several biotic and abiotic stresses during the seed filling period that diminish photosynthesis and crop nitrogen uptake limiting their production [10]. In recent years, researchers have become progressively interested in using another biological process, termed vermicompost, described as biooxidation and stablilization of organic material involving the joint action of earthworms and mesophilic microorganisms" [3]. However, both composts and vermicomposts have been widely used in traditional agriculture and horticulture and have beneficial effects, on soil structure or soil biota [11-12]. Application of organic manures had significant influence on the plant height, number of leaves per plant, number of primary branches per plant, total dry matter production at harvest and leaf area. Among the different organic manures, application of Vermicompost 2 t ha^{-1} recorded significantly higher growth attributes when compared to FYM and control and was on par with application of poultry manure 2 t ha^{-1} (Hammermeister; 2004). And similar results were reported by (Nakhlawy; 1991) [13]. Vermicomposts have consistently improved seed germination, enhanced seedling growth and development and increased plant productivity much more than would be possible from the mere conversion of mineral nutrients into more plant-available forms (Arancon, 2004) [14]. The objective of the present study was to determine of effect of Vermicompost and Nitrogen levels on yeld and yield components of Safflower under late season drought stress.

The objective of the present study was to determine of effect of Vermicompost and Nitrogen rates on yield and yield components of Safflower (*Carthamus tinctorius* L.) under late season drought stress.

MATERIALS AND METHODS

The experiment was carried out at the experimental Khoram-abad azad university farm, Iran (Longitude=47° 40' Latitude=33° 36'). Khoram-abad is a moderate climate region and receives average annual rainfall of 530_{mm}. The soil characteristics were determined before experiment which is presented in Table 1.

The experiment was laid out in Randomized Complete Block Design as Split Plats Factorial (RCBD) with 3 replications. Treatments were included three agents: Vermicompost rate in 4 rates (V1=0 (control), V2=2, V3=4 and V4=6 t/ha^{-1}) and Nitrogen rate in 4 rates (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 (it was broadcasted to the plot meanwhile and Irrigation as the main factor in two levels, S1=regular irrigation and S2=Non- irrigation (stress from bloom growth stages). Each N treatment were applied in three stages: one third in 2-4 leaves stage, one-third in stemming stage and one third in flowering stage. P fertilizer was applied at a rate of 150 kg P_2O_5 ha^{-1} in the form of superphosphate triple in the soil before sowing. Each experimental plot consisted of 6 rows, 4 m long with 30 cm spaced between rows and 10 cm distance between plants on the rows. At harvest stage the four middle rows were used for sampling and measured parameters such as seed yield, number of heads per plant, number of seeds per head and 1000 seed weight. Determination of seed components traits of each experimental plot, 10 plants were randomly selected and their characteristics were measured. Seed yield and number of heads were determined by harvesting 10 plants at random from the four central rows at physiological maturity stage. Seed yield in each plot measured with 14% humidity. Analyses were performed with using the MSTATC software. A factorial analysis of variance (ANOVA) was performed for all parameters. In addition the Duncan's Multiple Range Test (DMRT) (P = 0.05) was used to conduct mean comparison of treatments and find significant differences among means. And for charts was drawn with Excel software.

Table 1: Soil characteristics of the experimental site

Depth (cm)	Available P (ppm)	Exchangeable K (ppm)	Ec (ds m^{-1})	Total N (%)	PH	Organic carbon (%)	Soil Texture
0-30	5	325	1. 39	0.2	7.7	1.1	sandy
30-60	4.4	295	1. 2	0.13	8	1. 06	clay

RESULT AND DISCUSSION

The result of factorial analysis variance (ANOVA) revealed that the effect of variance components (V, N, S) and their interaction were significant at p= 0.01 and p= 0.05 seed yield and yield component (Table 2).

Seed Yield (SY): Analyzing seed yield variance showed that there was a significant different between Vermicompost and N fertilizer rates and water stress at P = 0.01 probability (Table 2). Seed yield was increased with application Vermicompost and N fertilizer but decreased in water stress. The highest amount of seed yield V4(1443.8 kg/ha^{-1}) and N4(1507.0 kg/ha^{-1}) obtained from application of Vermicompost and N fertilizer (Table 3). N fertilizer play a critical role in plant that leads to increased the growth and leaf area index and thereby increased light absorption and increased the amount of dry matter accumulation and economic yield [15-16]. Mündel *et al*. (2004) reported that safflower requires 5 kg/ha of N to produce 100 kg/ha of seed [7]. Dordas and Sioulas (2008) reported that nitrogen fertilization increased seed yield by average of 19%. This study showed that the effect of different amounts of N fertilizers and Vermicompost increased grain yield of safflower, this means that compared with other elements, nitrogen is one of the main essential nutrients for the safflower growth [17]. Atiyeh *et al*. (2000) found that Vermicompost tended to be higher in nitrates, which is the more plant-available form of nitrogen [18]. Hammermeister *et al*. (2004) indicated that Vermicomposted manure has higher N availability than conventionally composted manure on a weight basis. The latter study also showed that the supply rate of several nutrients, including P, K, S and Mg, were increased by Vermicomposting as compared with conventional composting [19]. Many researchers have

Table 2: Analysis of variance components Vermicompost (V), Nitrogen (N), Water stress (S) and their interaction for assessed traits

		Mean square			
S.O.V	df	Seed yield	NH/P	NS/H	TSW
Replication	2	28422926.0	5.37	261.93	11.23
V	3	449822.9 **	0.75 ns	35.77 *	22.55 **
Error V	6	46995.4	2.16	5.73	2.51
N	3	510224.1 **	150.25 **	16.91 *	54.28 **
V.N	9	37665.1 ns	2.81 ns	5.65 ns	19.71 **
S	1	14489496.0 **	737.04 **	69.87 **	144.55 **
V.S	3	10292.1 ns	36.12 **	8.55 ns	2.35 ns
N.S	3	64341.6 ns	6.73 ns	2.53 ns	26.32 **
V.N.S	9	39751.5 ns	3.11 ns	3.94 ns	2.18 ns
Error	56	29284.0	2.64	5.43	5.78
C.V%		12.75	13.85	12.00	6.82

V= Vermicompost, N= Nitrogen and S= water Stress NH/P= Number Head per Plant, NS/H= Number Seed/ Head, TSW= 1000 Seed Weight

Table 3: Effect and means comparisons (simple effect) of V, N and S on assessed traits.

Treatments	Mean			
Vermicompost (t/ha^{-1})	S Y (kg/ha^{-1})	NH/P	NS/H	TSW (gr)
V1	1143.3 b	11.0 a	18.8 a	33.9 b
V2	1368.4 a	11.2 a	18.9 a	36.2 a
V3	1416.5 a	10.5 a	18.8 a	35.3 a
V4	1443.8 a	11.0 a	21.2 a	35.5 a
Nitrogen (kg/ha^{-1})				
N1	1168.3 d	8.3 c	18.5 a	34.3 b
N2	1291.5 c	11.4 b	19.0 a	34.2 b
N3	1403.4 b	13.4 a	19.7 a	34.9 b
N4	1507.6 a	13.8 a	20.4 a	37.4 a
Water stress				
S1	1730.5 a	14.5 a	20.2 a	36.4 a
S2	953.4 b	8.9 b	18.5 b	34.0 b

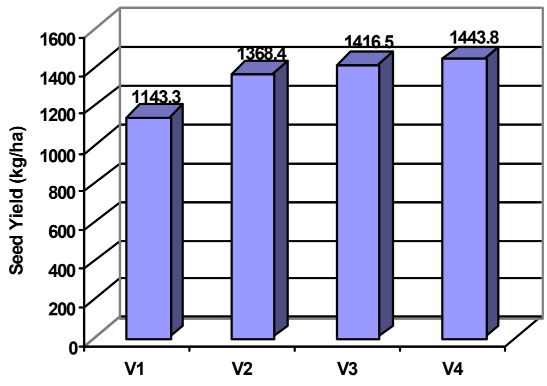

Fig. 1: Effect of Vermicompost rate on seed yield (kg/ha)

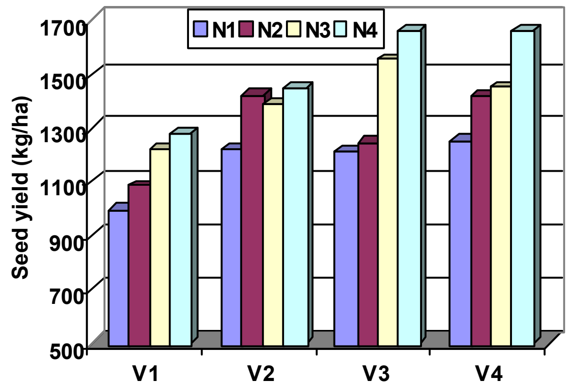

Fig. 3: Interaction of N and V rate on seed yield (kg/ha)

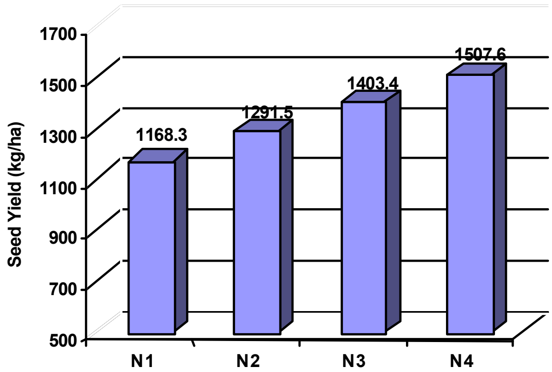

Fig. 2: Effect og Nitrogenrate on seed yield (kg/ha)

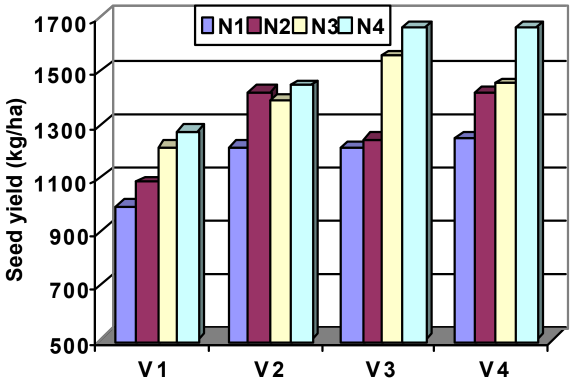

Fig. 4: Interaction of N and V rate on seed yield (kg/ha)

found that Vermicompost stimulates further plant growth even when the plants are already receiving optimal nutrition [18]. Vermicomposts have consistently improved seed germination, enhanced seedling growth and development and increased plant productivity much more than would be possible from the mere conversion of mineral nutrients into more plant-available forms [11].

Number of Heads per Plant (NH/P): Analyzing seed yield variance showed that there was a significant effect on (NH/P) at different N fertilizer rates and water stress at P = 0.01 level of probability and the Vermicompost didn't had effect on (NH/P) (Table 2). There was an increase in number of heads on plant with increasing N from 0 to 156 kg N ha^{-1}. The highest number of heads on plant (13.8) obtained from application of N156 (kg/ha^{-1}). The lowest number of number of heads on plant (8.3) were recorded from N control treatments (Table 3). N and other elements in Vermicompost play an important role in different metabolic processes in plant. And this may be attributed to improving water absorption and plant nourishing due to nitrogen and other elements in Vermicompost. This result was agreement by (Naseri; 2010) who indicated that application of N fertilizer increased number of heads on plant [20]. (Dordas and Sioulas; 2008) reported that nitrogen fertilization increased number of heads per plant by average of 32% [17]. Strasil and Vorlicek (2002) reported that N fertilization didn't have affect at number of heads per plant [21].

Number of Seed per Head (NS/H): Number of seed per head influenced by Vermicompost, Nitrogen rate at P = 0.05, water stress at P = 0.01 levels of probability and their interactions didn't influenced the Number of Seed per Head (Table 2). This trait was increased by increasing Vermicompost and Nitrogen rate but decreased in water stress treatment. The highest and lowest (NS/H) belonged to V4 and N4 with 21.2 and 20.4 (NS/H) respectively (Table 3). As the Vermicompost and Nitrogen had positive effect on heads per plant therefore the (NS/H) increased. In other word, using Vermicompost and Nitrogen appropriate levels provide better nutrient and water uptake and plant photosynthesis through improving roots expansion, Vermicompost's elements and microorganism activity which results in better flowering and heading.

The results were consistent with (Naseri and Mirzaei; 2010, Bitarafan; 2011 and Galavi *et al*., 2012) reports [20-23].

1000 Seed Weight (TSW): The analysis of variance (Table 2) revealed that 1000 Seed Weight significantly in response to Vermicompost, Nitrogen, Water stress and N×S interactions. The V, N and S head influenced 1000 Seed Weight at P = 0.01 levels of probability. The levels of V and N increased the (TSW) but water stress decreased the (TSW). According to the interactions means comparisons the highest (TSW) were V2 and N4 with 36.2 and 37.4 (gr) respectively (Table 3). And the interaction of V×N the highest of (TSW) was V3N4 with 39.0 (gr) (Figure: 4). Applying Vermicompost and Nitrogen providing better nourishment and element to plant roots and this have positive effect to plant growth thereby increased the 1000 seed weight. This results were agreement by (Naseri and Mirzaei; 2010), Bitarafan; 2011) and (Galavi *et al*., 2012) but wasn't agreement with (Strasil and Vorlicek; 2002) [20-23].

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