International Journal of Agriculture and Crop Sciences.
Available online at www.ijagcs.com
IJACS/2015/8-3/373-379
ISSN 2227-670X ©2015 IJACS Journal

Effects of municipal waste compost and irrigation regimes on yield and yield components of Safflower (*Carthamus tinctorius* L)

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ABSTRACT: In order to study the effect of municipal waste compost and different irrigation regimes on yield and yield components of Safflower, an experiment was conducted in the Islamic Azad University of Shirvan in 1392-93 growing season. The experiment was conducted as split plot based on randomized complete block design with 3 replications. Main factor was irrigation included one irrigation (simultaneous with planting), two irrigation (simultaneous with planting and shooting), three irrigation (simultaneous with planting, shooting and flowering). Sub factor was fertilizer included, 5, 10, 15, 20 t/h municipal waste compost and 200 kg/h urea chemical fertilizer. Results showed that the most plant height (96.8 cm) was obtained in treatments of two irrigation and application of 15 t/h municipal waste compost which increased by 14% in comparison with chemical fertilizer. The most number of capitol per plant (17) was obtained from the treatments of two irrigation and 5 t/h of municipal waste compost which increased by 20% in comparison with chemical fertilizer. The most seed yield belonged to the treatment of two irrigation during planting and shooting with application of 5 t/h of municipal waste compost which increased by 24% in comparison with chemical fertilizer. So regarding to the result of this experiment, two irrigation during planting and shooting with application of 5 t/h municipal waste compost is recommended for Safflower cultivation.

Key words: Safflower, Organic fertilizer, Nitrogen, Seed yield

INTRODUCTION

Daily increasing of global population in recent years, has resulted to severe limitation of food resources. Although food supplies are discussed about wheat, rice, beans and corn as main food, but oil seeds are counted as the second important food resource. Safflower has been under lots of attentions among oil seed crops which are compatible to Iran's climate and shows an appropriate compatibility in dry regions (Bye bourdi, 2007). Some suitable features of this plant including medical, industrial and nutritional characteristics, high quality oil in aspect of existence of more than 80% saturated fatty acids specially linoleic and oleic, high resistance to salt and drought stresses, low moisture demanding, vast compatibility to low temperature of winter and high temperature of summer have made Safflower as a valuable oil seed crop (Ahmadi and Omidi, 1994).

Evaluations on some of oil seed crops showed that Safflower roots have more capacity in aspect of water extraction from underlying soil (Miller et al,1986). Safflower is the most resistant oil crops to drought (Akhtarbeg and pala, 2001). Sustainable agriculture is an integrated system based on ecological principles. In this system, plant residues, cow manures, organic fertilizers and biological control of pests are used instead of application of external input including chemical fertilizers and pesticides in order to increase the nutrition supplies in the soil, control of weed plants, pest and increasing of biodiversity of farms (rigby, 2001). More than 80% of Iran farmlands are arid and semiarid which are poor in aspect of existence of organic matters. The main sources of supplies of soil organic matter are manures, plant residues and composts resulted from wasted materials which nowadays are under the great attention regarding to importance of organic agriculture (Chudhry et al. 1999). Application of organic wastes including cow manure, sewage sludge and municipal waste compost is a suitable way to preserve soil organic matter, improve the eroded soil and nutrient supply according to plant need (Davari nezhad et al, 2004). Application of organic fertilizers like manures, sewage and municipal waste compost, improves biological and chemical characteristics of soil besides easy penetration of plant root to soil and improved use of air, water and nutrients by plant root through improvement of soil physical characteristics (Malakuti and Khademi, 1994).

Fertilizers and organic matters play and important role in improvement of soil quality, besides their role in crop plant nutrition and soil fertility. Some times their importance in improvement of soil structure is more than their effect in providing of crop plant nutrient (Kamkar and Mahdavi Damghani, 2008). Organic fertilizers increase soil organic matter and soil productivity due to chemical characteristics of the soil like, PH, cation exchange capacity, increment of microorganism's activity and availability of nutrients (Renato, 2003., Phukan, 1993., Goldstein, 1998).

Application of organic matter in Iran increased corn yield (Sarhadi Sardouyi, 1998) and tomato yield (Samavat et al, 2001). Heckmat (2008) reported that production of dry matter in soybean increased through application of organic matter. Composts help to moisture supply and provide a suitable environment for root growth (Remus, 2000). Patil et al (2006) evaluated the effect of organic fertilizers, manures and chemical fertilizer on sorghum and reported that organic fertilizers specially compost, increased sorghum yield significantly. Bhattacharya et al (2005) reported that municipal waste compost provides available nutrients and stimulate microbial activity in short term and maintains nutrient resources and soil organic matter in long term. Results from evaluation of organic fertilizer in an experiment on Safflower in full irrigation showed that consumption of 5 t/h municipal waste compost produced more seed yield (1813 kg/h) in comparison with 10 and 15 t/h but had less yield in comparison with chemical fertilizer about 12.5%. In deficit irrigation condition, consumption of 15 t/h of municipal waste compost produced more yield (1913 kg/h) in comparison with 5 and 10 t/h. Yield increment of 15 t/h municipal waste compost in deficit irrigation condition was 25% more than chemical fertilizer. Consumption of 50 t/h of cow manure also produced the seed yield equivalent to chemical fertilizer in deficit irrigation treatment (Azimzadeh, 2013). In other experiment, effect of organic fertilizer on Rapeseed yield was studied and reported that treatment of 50 t/h cow manures produced the most seed yield (875 kg/h) in deficit irrigation condition. After 50 t/h cow manures, chemical fertilizer and 11 t/h vermicompost produced yield equivalent to 820 and 814 kg/h. In full irrigation condition, variation between treatments of organic manures with chemical fertilizer increased and chemical fertilizer with production of seed yield by 1284 kg/h showed great difference with other treatments (Azimzadeh et al, 2014). Purpose of this experiment was also to evaluate the effect of municipal waste compost and irrigation regime on yield and yield components of Safflower in comparison with urea chemical fertilizer.

MATERIALS AND METHODS

In order to evaluate the effect of municipal waste compost and irrigation regimes on yield and yield components on Safflower, an experiment was conducted at research farm of Islamic Azad University of Shirvan in 37° 26' 20" latitude, 57° 57' 13" longitude 1076 meters height from sea level and average yearly rainfall of 248 mm in 1392-93 growing season. This experiment was conducted as split plot based on randomized complete block design with 3 replications. Length of subplots was 3, width was 2 meters, each plot contained 6 rows, distance between each row was 30 cm. Experiment treatments included one irrigation (simultaneous with planting), two irrigation (simultaneous with planting and shooting) and 3 irrigation (simultaneous with planting, shooting and flowering) which placed on main plot and municipal waste compost including 5, 10, 15, 20 t/h and 200 kg/h urea chemical fertilizer that placed in subplots. Triple super phosphate fertilizer broadcast in all plots based on 150 kg/h. Seed density was based on 100 kg/h. In order to prepare the land, moldboard plowing was used, then discs were applied and leveling was performed eventually. After designing of plots the required rates of different fertilizers were scattered by hand on the plots then mixed with soil by shovel completely. Seeds of Safflower were planted in depth of 5 cm by hand as well. Measured traits included plant height, capitol number per plant, seed number per capitol, branch number, thousand kernel weight, biological and seed yield. Data were analyzed by MSTAT_C software. Duncan multiple test range was used for mean comparison and graphs were drawn by Excel software.

RESULT AND DISCUSSION

Results of the analysis of variance of considered traits are shown in table 1. As shown, irrigation effect on treatments of capitol number per plant, seed number per capitol and seed yield was significant in probability level of 1% and on thousand kernel weight was significant in probability level of 5%. Fertilizer effect on plant height and capitol number per plant was significant in probability level of 5% and on seed number per capitol and seed yield was significant in probability level of 1%. Interaction effect of irrigation and fertilizer on seed number per capitol and seed yield was significant in probability level of 1% and on plant height and capitol number per plant was significant in probability level of 5%.

Table 1. Results of analysis of variance of recorded traits of Safflower under the effect of municipal waste compost and irrigation

S.O.S	D.F	Height	Capitol/plant	Seed/capitol	T.K.W	Biological yield	Seed yield
Rep	2	492.579	11.521	1.736	31.975	101232106.4	135978.022
Factor A	2	166.019	83.974**	117.698**	20.187*	330802720.467	28985018.289**
Error	4	88.017	2.409	1.165	3.122	106442233.167	535947.622
Factor B	4	100.686*	7.106*	34.755**	1.968	76671280.578	2079126.478**
AB	8	79.163*	8.253*	19.462**	9.858	51814718.828	1367129.011**
Error	24	38.490	2.574	1.797	6.398	44232321.161	172263.45
CV	%	%7.05	%12.4	%8.92	%8.40	%16.94	%7.19

* ,** - Significant at 5% and 1% levels of probability respectively

Interaction effect of irrigation and fertilizers on plant height

As shown in Fig 1, the most plant height observed in the treatment of one irrigation and application of 10 t/h municipal waste compost. Treatment of 10 t/h per hectare municipal waste compost increased plant height by 17% and 14% in comparison with treatments of 15 t/h municipal waste compost and 200 kg/h urea chemical fertilizer which the difference was significant. The most plant height in treatment of two irrigation belonged to 15 t/h municipal waste compost which didn't show any significant difference with other level of municipal waste compost but showed significant difference in comparison with chemical fertilizer and caused increment in plant height by 13%.

In the treatment of three irrigation, there were no significant difference among all fertilizer treatments. Generally and regarding to Fig 1 the most plant height belonged to the treatment of, two irrigation and application of 15t/h municipal waste compost.Application of 10 t/h municipal waste compost with one irrigation and 15 t/h municipal waste compost with two irrigation caused increasing in plant height which was significant in comparison with chemical fertilizer. The reason for plant height increment in the treatment of municipal waste compost compared with nitrogen fertilizer may was providing balance nutrients and accessibility of nutrients by plant during growing season by gradual releasing from municipal waste compost. Phukan (1993) also reported positive effect of gradual releasing of nutrient on crop production. Azimzadeh, (2014) conducted an experiment on Safflower and reported that increasing the application of municipal waste compost from 5 to 10 t/h caused plant height increment and its increasing to 15 t/h, decreased plant height. In another experiment, it was reported that increasing the application of municipal waste compost from 7 to 11 tons per hectare, increased rapeseed height and its increasing to 15 t/h decreased rapeseed height. Increasing the plant height of fennel through application of municipal waste compost reported by Mahfouzi (2007) as well.

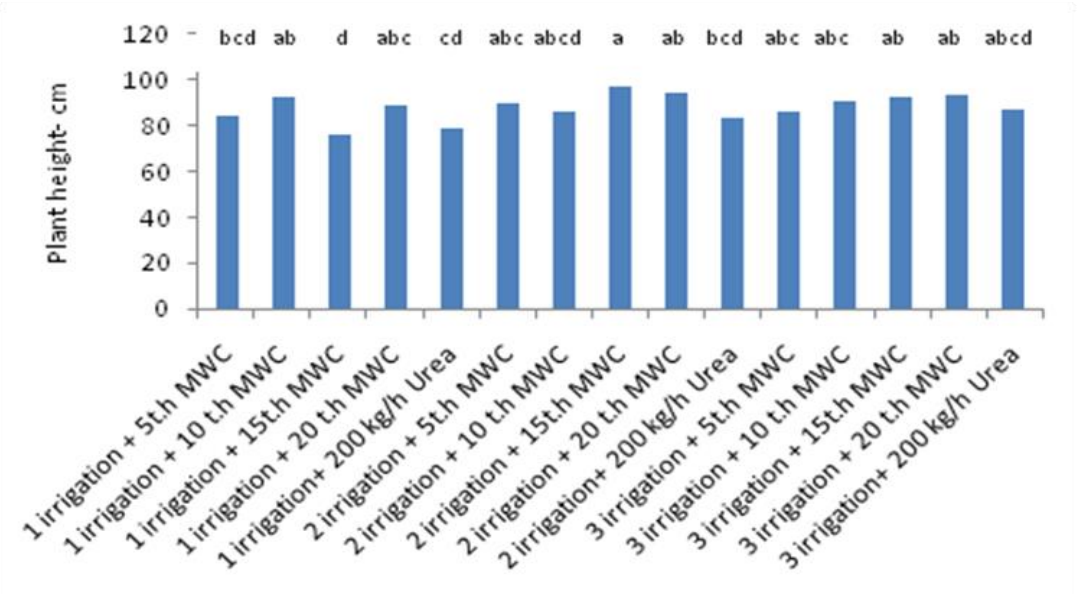

Figure 1. Interaction effect of irrigation and fertilizers on Safflower height

Interaction effect of irrigation and fertilizers on capitol number per plant

The most capitol number per plant in the treatment of one irrigation observed in application of 5 t/h municipal waste compost (12.6). Application of 5 t/h municipal waste compost with one irrigation compared with application of one irrigation and 20 t/h, 15 t/h 10/h and 200 kg/h urea chemical fertilizer produced 33%, 32%, 33% and 24% more capitol per plant respectively(Fig 2). In 2 irrigation, there were no significant difference among all levels of municipal waste compost but the highest capitol number per plant belonged to 5 t/h municipal waste compost that was significantly 20% more than urea fertilizer. In three irrigation there were no significant difference among all fertilizer treatments. Irrigation increment from one to two times, caused increasing in capitol number per plant in all of the treatment of municipal waste compost and chemical fertilizer but 3 times irrigation not only showed increment effect on capitol number per plant in fertilizer treatments but also showed a little decrement in capitol number per plant in all fertilizer treatments. The reason for decreasing of capitol per plant is the sensitivity of Safflower to moisture increment (Khajapoor, 2004., Naraki, 2001). Generally regarding to Fig 2, it is obvious that the most capitol number per plant was obtained in the treatment of two irrigation and application of 5 t/h municipal waste compost. This is due to the fact that Safflower responds well to two-times irrigation at the stages of planting and shooting. So two-times irrigation in the mentioned stages is sufficient for Safflower cultivation. The best fertilizer treatment among total fertilizer treatments in two irrigation is application of 5 t/h municipal waste compost which produced the most number of capitol per plant compared to all other treatments. Of course capitol number decreased by increasing the application of municipal waste compost in one-time and two-times irrigation which can be due to the limitations of overdose effect of municipal waste compost. Decreasing of capitol number per plant under the higher levels of municipal waste compost also reported by Azimzadeh (2013) as well.

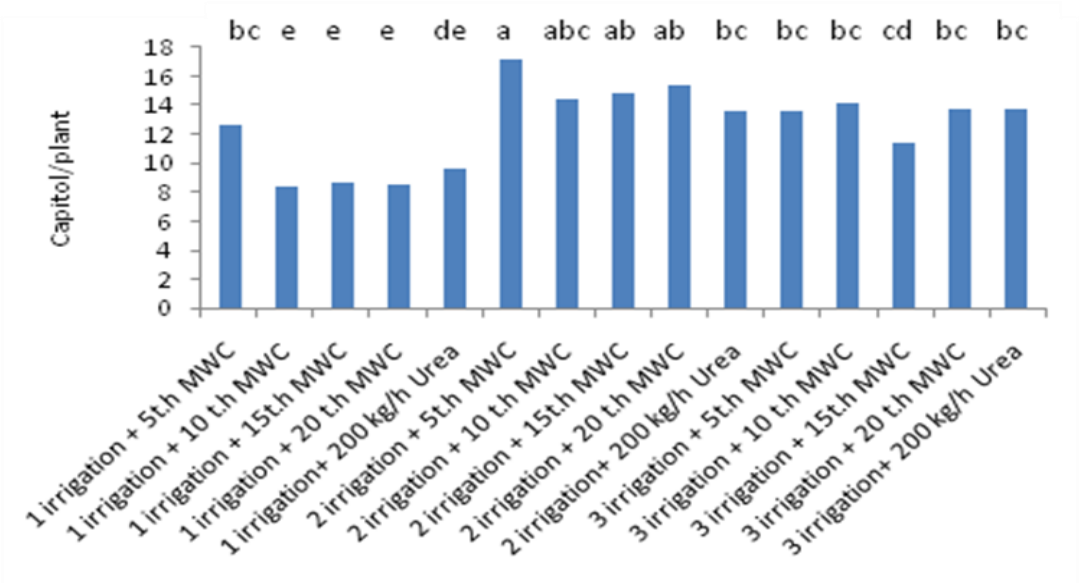

Figure 2. Interaction effect of irrigation and fertilizers on number of capitol per plant

Interaction effect of irrigation and fertilizers on seed number per capitol.

As shown in Fig 3, in one irrigation, Increasing the application of municipal waste compost from 5 to 10, 15 and 20 t/h, decreased seed number per capitol by 37%, 30% and 50% respectively. Reason for this decrement was due to the limitation that generated by higher levels of municipal waste compost (mamo at al., 1998). Application of 5 t/h of municipal waste compost with one irrigation, increased seed number per capitol by 35% compared to chemical fertilizer.

In two irrigation, in spite of no significant difference among fertilizer treatments, the lowest seed number per capitol observed in 200 kg/h urea chemical fertilizer. application of 5 and 10 t/h municipal waste compost with tow irrigation produced more seed number per capitol compared with other treatments.

The most seed number per capitol in tree irrigation belonged to 5 t/h municipal waste compost which produced more seed per capitol compared with all other treatments and increased seed number per capitol by 34% compared to chemical fertilizer treatment.

As observed in Fig 3, in three times irrigation, increasing the application of municipal waste compost, decreased seed number per capitol as in one and two times irrigation. Positive effect of municipal waste compost

on seed number per capitol in Safflower and it's decreasing effect by increasing application of municipal waste compost reported by Azimzadeh (2010) as well.

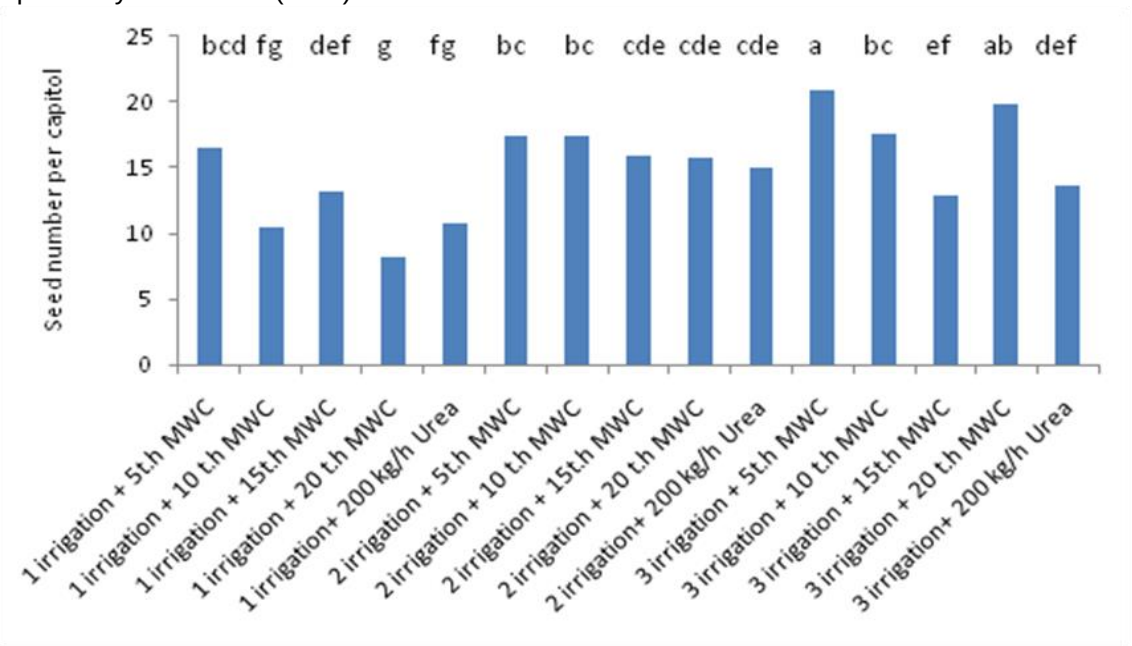

Figure 3. Interaction effect of irrigation and fertilizers on seed number per capitol

Interaction effect of irrigation and fertilizers on seed yield

The most seed yield in one-time irrigation treatment belonged to 5 t/h municipal waste compost which increased seed yield by 32%, 29%, 36% and 23% in comparison with treatments of 10, 15, 20 t/h municipal waste compost and 200 kg/h urea chemical fertilizer, respectively. In two irrigation treatment, the most seed yield belonged to 5 t/h municipal waste compost which was more by 24% compared to the treatment of 200 kg/h chemical fertilizer. Application of 5 t/h municipal waste compost accompanied with two irrigation produced more seed yield compared with the treatments of 10, 15 and 20 t/h municipal waste compost. Seed yield increment in Safflower in the treatment of 5 t/h municipal waste compost accompanied with one irrigation can be due to increasing capitol number per plant and seed number per capitol (Figs 2 and 3) and also seed yield increment in application of 10 t/h municipal waste compost accompanied with two irrigation can be due to increasing in capitol number per plant (Fig 2).

Seed yield in three irrigation treatment, in 15 t/h municipal waste compost was less than other treatments. Generally, regarding to Fig 4, it is obvious that the most seed yield obtained in the treatment of two irrigation simultaneous with planting and shooting with application of 5 t/h municipal waste compost. One of the reasons for seed yield increment in municipal waste compost was providing balance nutrients for plants. Although all of the levels of fertilizer of municipal waste compost in two irrigation treatment produced more seed yield than fertilizer levels in one irrigation treatment, but seed yield decreased by increasing the application of municipal waste compost. Lal, (1995) reported that organic matters are able to absorb moisture to 90% of their weight. Joodi (2007) reported that organic fertilizers increased soil porosity and moisture supply in the soil. Regarding to sensitivity of Safflower to moisture (khajehpoor, 2004) and according to increasing of water holding capacity in organic fertilizers, it seems that municipal waste compost caused Safflower growth limitation in this way. It has also been reported that negative effect of immature compost or some heavy metal in organic fertilizers or increasing of electrical conductivity may restrict plant growth and development (Mamo et al,1998 and summer ,2000)

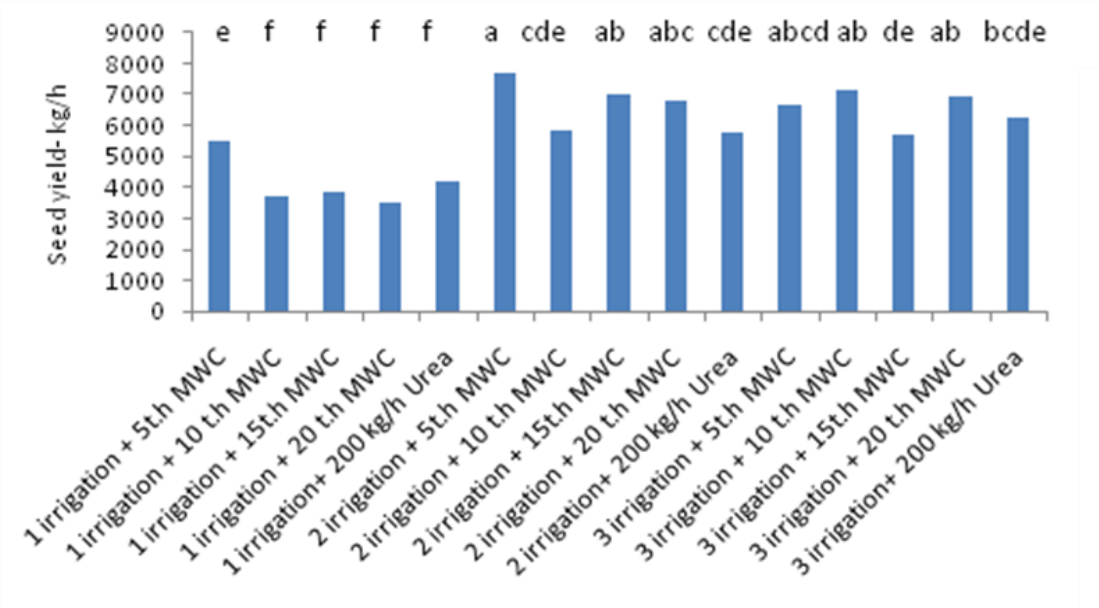

Figure 4. Interaction effect of irrigation and fertilizers on seed yield

So as a general conclusion, application of 5 t/h municipal waste compost with two irrigation during the planting and shooting is the best treatment for Safflower production. Seed yield increment in this treatment is due increasing the capitol number per plant. Regarding to positive response of Safflower to municipal waste compost, it seems that application of this fertilizer can easily replaced with chemical fertilizer in organic farming.

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