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Composted organic manure replacement probability using chemical fertilizer in organic Safflower farming

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To determine the possibility of composted organic manure being substituted for chemical fertilizer in organic safflower farming, an experiment was performed at Shirvan's Islamic Azad University during the 2018-2019 growing season. Vermicompost, urban waste compost, farmyard manure, and chemical fertilizer were used as treatments in two different irrigated and dryland conditions. The experiment used a split-plot design with three replications based on a randomized full block design. Irrigation treatments are concentrated in the main plot, whereas fertilizer treatments are concentrated in the subplot. Each subplot had a width and length of 2 and 3 meters, respectively. Several unique agronomic characteristics were observed throughout the growing season and after harvest. Even though irrigation had no significant impact on seed production, seed yield was 18% higher in the irrigated treatment than dryland treatment. The highest seed yields in the irrigated treatment were obtained using chemical fertilizer (203 kg/h), 50 tons/h farmyard manure (1883 kg/h), 10 tons/h vermicompost (1860 kg/h), and 5 tons/h urban waste compost (1813 kg/h), which did not differ significantly from each other but produced 35%, 22.5 %, 21%, and 18% more seed yields, respectively when compared to the control. In irrigated conditions, the smallest quantity of urban waste compost (5 tons/h) generated seed yields nearly identical to those produced by 10 tons/h vermicompost and 50 tons/h farmyard manure. In dryland treatment at a rate of 15 tons/h, urban waste compost outperformed control and chemical fertilizer by 35%. As a consequence of the experiment's findings, Safflower demonstrated a superior response to urban waste compost in irrigated and dryland conditions.

Keywords: organic Safflower, composted organic manure, chemical fertilizer

INTRODUCTION

In organic farming, an agroecosystem is analogous to a living body, and all of its components, including soil, crop, microorganisms, and microclimate, exert activity and interactions on one another. To have a sustainable system, all components must be in an acceptable state of environmental health. Increased agricultural output must not be coupled with soil degradation. Natural losses should not accompany provision for human needs, and natural conservation should not be accompanied by agricultural production declines (Mahmoudi, Mahdavi Damghani et al. 2008, Gholamin and Khayatnezhad 2020, Si, Gao et al. 2020, Huang, Wang et al. 2021, Ma, Ji et al. 2021). Despite its substantial and beneficial impact on crop productivity, chemical fertilizers have detrimental effects on natural resources and created ecological issues (Kaviani, Liaghat et al. 2008, Khayatnezhad and Gholamin 2020, Guo, She et al. 2021, Ren and Khayatnezhad 2021). Chemical fertilizers used in Iran, like in other nations, to enhance agricultural output have had a detrimental impact on water and soil resources (Rodríguez 2021, Wan 2021).

Additionally, leakage of chemical solvent fertilizers, including nitrogen, polluted drinking water and resulted in algal blooms in some lakes (Gholamin and Khayatnezhad 2020, Bi, Dan et al. 2021, Xu, Ouyang et al. 2021). Scientists have attempted to determine the likelihood of organic manure being replaced by chemical fertilizer in recent years. Nourihoseini, Khorassani et al. (2016) found that applying farmyard manure, compost, and vermicompost improved seed production, biological yield, umbrella-per-plant, seed-per-umbrella, and plant-height in cumin but did not affect average kernel weight or harvest index. Vermicompost provided all treatments with the greatest biological output (1065 kg/h) and seed yield (477 kg/h). Lellahgani Dazki, Koocheki et al. (2006) found that farmyard manure had a substantial impact on the number of tubers-per-plant, tuber production, and days to emergence of potato. In another research, Kabir, Arefin et al. (2021) showed that when compared to artificial fertilizer, vermicompost, sheep, and cow dung generated the greatest plant height in sweet basil. Huma, Lin et al. (2021)found that cow manure resulted in the greatest plant height (79.3 m) in sesame compared to control.

Additionally, they found that cow dung had the most seeds-per-pod. Tabrizi, Koocheki et al. (2011) found that farmyard manure applied at a rate of more than 10 tons/h had no meaningful impact on the Thymus. Hewitt (2021) felt that combining chemical fertilizer and biofertilizer had a greater impact on Coriander seed production than their separate application. In another research, Fallahi, Koucheki et al. (2008) found that cow dung generated the greatest seed production (894.30 kg/h) in the German Matricaria medicinal plant, followed by vermicompost at 605 kg/h. Khayatnezhad and Gholamin (2021) found that the number of seeds-per-ear of wheat rose substantially as fungus compost increased.

Additionally, increasing the fungus compost has a substantial impact on the stigma of Saffron (Karasakal, Khayatnezhad et al. 2020). Hewitt (2021) demonstrated that the greatest thousands kernel weight of cumin was generated by compost treatment, followed by vermicompost, sheep dung, and cow manure. Additionally, they found that vermicompost generated the greatest biological (1065 kg/h) and seed production (477 kg/h) yields. Additionally, Yin, Khayatnezhad et al. (2021), (Zhu, Saadati et al. 2021) stated that vermicompost treatment resulted in the greatest branching of the Basil medicinal plant. They demonstrated that vermicompost treatment resulted in the greatest kernel weight compared to cow dung and artificial fertilizer. Vermicompost substantially affected the medicinal plant sweet fennel's height, leaf percentage, and branch number compared to control (Gholamin and Khayatnezhad 2020, Li, Mu et al. 2021, Zhang, Khayatnezhad et al. 2021). Tao, Cui et al. (2021) also found that vermicompost treatment substantially impacted sesame seed production compared to organic manure. This research aimed to determine the impact of organic manure on Safflower production and yield components to determine if organic manure should be substituted for chemical fertilizer in organic Safflower farming. Safflower is environmentally friendly and seems to have a favorable response to organic agricultural techniques.

MATERIALS AND METHODS

An experiment was performed at the Islamic Azad University of Shirvan during the 2018-2019 growing season to determine how composted organic manure could be substituted for chemical fertilizer in Safflower. The treatments include vermicomposting, composting urban trash, applying farmyard manure, and applying chemical fertilizer in two distinct dry land and irrigated conditions. To achieve the appropriate quantity of organic manure, each organic manure was applied in three different amounts. The three vermicomposting rates are 4, 7, and 10 tons/h. Composting rates for urban trash were 5, 10, and 15 tons/h, while farmyard manure treatment rates were 20, 35, and 50 tons/h, 100 kg/h nitrogen, and 100 kg/h phosphorus were used in chemical fertilizer treatment. With nitrogen treatment, the nitrogen content of the second quantity of each organic manure was equal. For instance, the nitrogen content of urban waste compost, vermicompost, and farmyard manure was 1%, 1.4 %, and 0.3 %, respectively. Based on these rates of nitrogen in organic manure, 10 tons/hour of urban waste compost, 7 tons/hour of vermicompost, and 35 tons/hour of farmyard manure release nitrogen equivalent to 100 kg/h nitrogen chemical fertilizer.

The experiment used a split-plot design with three replications based on a randomized full block design. Each plot was 3 m in length and 2 m in width. To begin land preparation, a moldboard plow was used, followed by a disking tow operation and, lastly, ground leveling. Safflower seeds were planted 50 cm apart in rows with a seed spacing of 15 cm and a depth of 5 cm. Seeds were planted by hand. The date of planting was 26 January 2018. To begin treatment, chemical and organic fertilizer are spread across the plot and manually blended into the soil. The first irrigation of the irrigated treatment occurred on 25 February 2018. Three irrigations were carried out in the irrigated treatments, with 50 mm water applied in each irrigation. Due to the low annual precipitation throughout the growth season (235.3 mm), one irrigation equivalent to 32 mm was administered in dryland treatment in June 2019, which is the period of the lowest rainfall in this area. At 50% probability, this month will have no more than 6 mm of rainfall (Azimzadeh and Taliaee, 2004).One irrigation in dryland treatment was carried out to bring the annual precipitation average up to the long-term average (267 mm). Thus, the overall quantity of water receiving in dryland treatment was 267 mm, equal to the long-term average precipitation.

In contrast, the total amount of receiving water in irrigated treatment was 385 mm. Several agronomic characteristics, including capitol-per-plant, seed-per-capitol, thousandths kernel weight, seed, and biological yield, were monitored during the growing season. Excel and Mstatc were used to examine the data.

RESULTS AND DISCUSSION

As demonstrated in Table 1, irrigation treatments significantly impacted thousands kernel weight, seed-per-capitol, and capitol-per-plant ($p \leq 1\%$). Organic manure substantially impacted seed production ($p \leq 5\%$) and biological yield, capitol-per-plant, seed-per-capitol, and thousands kernel weight ($p \leq 1\%$). Irrigation with organic manure and chemical fertilizer significantly impacted seed production, biological yield, capitol-per-plant, and average kernel weight ($p \leq 1\%$). Irrigation with organic manure and chemical fertilizer significantly impacted harvest index, plant height, and seed-per-capitol ($p \leq 5\%$).

Irrigation treatment effects on recorded traits

Even though irrigation treatments had no greater impact on seed yield ($p \leq 8\%$), irrigation generated 18% more seed than dry land treatment (table 2). This 18% increase in seed production was achieved in the irrigated treatment due to increased capital-per-plant and seed-per-capitol. The number of capitol-per-plant in the irrigated and dry ground treatments was 7 and 6, respectively, and the number of seeds-per-capitol was 20 and 13, respectively (Table 2).

Deep-rooted safflowers may withstand drought under low moisture conditions by collecting moisture from the soil's deeper layer (Gholamin and Khayatnezhad 2021). Additionally, increased water is detrimental to Safflower (Khayatnezhad and Nasehi 2021). These characteristics of Safflower contribute to its poor reaction to irrigation treatment in this experiment. Due to these features of Safflower and the vast quantity of dry land in Iran, responsible institutions may bring it to the public's notice.

Organic manure effects on recorded traits

As anticipated, the greatest seed production (1746 Kg/h) was achieved with chemical fertilizer treatment. Chemical fertilizer application increased seed production by 14% as compared to control. The nitrogen content of chemical fertilizer was comparable to that of vermicompost at a rate of 7 tons/h, farmyard manure at a rate of 35 tons/h, and urban waste compost at a rate of 10 tons/h. The seed yields in these three treatments were 1505, 1361, and 1491 kg/h in order (fig 1). Seed increments in the chemical fertilizer treatment were 13.8 %, 22 %, and 14.6 %, respectively, compared to the organic manure treatments. The difference between chemical fertilizer and 35 tons/hour farmyard manure was substantial, but not between 10 tons/hour urban waste compost and 7 tons/hour vermicompost. Chemical fertilizer treatment resulted in a 16 %, a 5%, and a 3% increase in seed yield when compared to the highest level of vermicompost (10 tons/h), farmyard manure (50 tons/h), and urban waste compost (15 tons/h), respectively, indicating that the differences with farmyard manure and urban waste compost were very small. Except for vermicompost, increasing the use of farmyard manure and urban waste compost increased seed production.

As previously stated, organic manure treatments had a substantial impact on biological yield (table 1). The difference in chemical fertilizer treatment was considerable in comparison to all other treatments. Chemical fertilizer had the greatest biological output (8778 kg/h). Chemical fertilizer treatment resulted in a 23.5 %, a 15%, and a 15.7 % increase in biological output, respectively, compared to 4, 7, and 10 tons/h vermicompost. Chemical fertilizer increased biological output by 20%, 13%, and 6.5 % compared to 20, 35, and 50 tons/h farmyard manure, respectively. The biological yield difference between chemical fertilizer and 5, 10, and 15 tons/h urban waste compost was 20%, 21.7 %, and 12.8 %, respectively (fig 2). Additionally, increasing the quantity of organic manure improved biological output.

Vermicomposting at a rate of 4 to 10 tons/h improved biological yield by 10%. Increased utilization of farmyard manure from 20 to 50 tons/h resulted in a 15% increase in biological output, whereas increasing urban waste compost from 5 to 15 tons/h resulted in an 8% increase in biological production. Other scientists have found similar findings on other crops. Sun, Lin et al. (2021)found that farmyard manure, urban compost, and vermicompost substantially impacted most cumin's agronomic characteristics. Organic manure improved seed and biological output, the number of umbrellas-per-plant, the number of seeds-per-umbrella, and the height of the Cumin plant. Khayatnezhad and Gholamin (2020), (Peng, Khayatnezhad et al. 2021) also shown that farmyard manure had a substantial impact on the number of tubers-per-plant and production of potatoes.

The greatest capitol-per-plant was recorded after chemical fertilizer treatment (8.5). The difference in capitol-per-plant between chemical fertilizer and 7 tons/h vermicompost was not significant, while the difference between chemical fertilizer and other treatments was. The lowest capitol-per-plant was found in vermicomposting at a rate of 10 tons/h and urban waste composting at 5 tons/h. Using 10 tons/h instead of 4 or 7 tons/h seemed to negatively impact the number of capitol-per-plant (fig 3).

Variation in the number of seeds-per-capitol followed the same pattern as the number of capitol-per-plant. When compared to 4 and 10 tons/h vermicompost, 7 tons/h vermicompost generated more seed-per-capitol. The seed-per-capitol was 16, 18, and 14 in 4, 7, and 10 tons/h vermicompost, respectively (fig 4). The seed-per-capitol was 15 in the chemical fertilizer treatment, which was less than in the other treatments. This is because chemical fertilizer treatment requires a larger capitol-per-plant. The seed-per-capitol was greater in the 5 tons/h urban waste compost compared to other treatments. Reduced capitol-per-plant (fig 3) may account for the greater seed-per-capitol in this treatment, which often results from yield component compensating effects.

The lowest and greatest kernel weights were recorded in both check and 10 tons/h vermicompost (fig 5). The thousands kernel weights in the treatments mentioned above were 27 and 35 gr, respectively. Thousands kernel weight increases in 10 tons/h vermicompost may be due to a reduction in seed-per-capitol in this treatment. On thousands kernel weights, there were no substantial differences between treatments.

Interaction effects of organic manure and irrigation on recorded traits

As anticipated, most organic manure and chemical fertilizers increased seed production in irrigated treatments compared to dry land treatments (table 3), although urban waste compost responded differently. In irrigated conditions, the response of urbane waste compost was the inverse of that in dryland conditions. Improved vermicompost use from 4 to 10 tons/h increased seed production from 1643 to 1860 kg/h, or 11.5 %. Increases in farmyard manure application from 20 to 50 tons/h improved seed output by 22%, while increases in urban waste compost application from 5 to 15 tons/h reduced seed yield from 1813 to 1470 kg/h, or 19% under irrigated conditions. Despite the lack of a significant difference, increasing vermicompost from 4 to 7 tons/h improved seed production by 29 %, whereas increasing vermicompost to 10 tons/h reduced seed yield by 31%. While increasing farmyard manure did not make a meaningful difference in dryland treatment, increasing urbane waste compost from 5 to 15 tons/h resulted in a 34% increase in seed production. This tendency was found in biological yields after treatments with organic manure and chemical fertilizers. The decrease in seed yield with increasing urbane waste compost in irrigated conditions is due to the lower thousands kernel weight and seed-per-capitol (table 3). In contrast, the increase in seed yield with increasing urbane waste compost in dryland treatment is due to the increased seed-per-capitol and capitol-per-plant. Increased seed production in dry ground treatment with 7 tons/h vermicompost may be ascribed to a greater capitol-per-plant in this treatment.

Organic manure has a higher water content, which is an essential feature. According to Gholamin and Khayatnezhad (2020), organic compounds may retain up to 90% of their weight in water. According to Radmanesh (2021), compost reduces soil bulk density while improving soil porosity, thus conserving more water in the soil. Additionally, Hou, Li et al. (2021) found a substantial increase in the capacity for soil water saving due to compost application. Jia, Khayatnezhad et al. (2020), (Khayatnezhad and Gholamin 2021) ascribed the increase in Millet dry matter to the improved soil physical condition and water content due to organic manure use (Sun and Khayatnezhad 2021).

Table 1: The results of analysis of variance of recorded traits of Safflower under the effect of organic manure treatments and irrigation

S. O. V	D. F	Seed yield	Biological yield	Capitol /plant	Seed /capitol	T.K.W	Height	Hi
Rep	2	282986.36	781019.69	36.07	5.401	11.133	202.365	37.7
Irrigation	1	1585650	567490.90	101.081**	802.21**	34.186**	44.510	253.7
Organic manure	10	101266.06*	2517181.21**	12.324**	19.438**	33.046**	29.772	9.38
Irrigation and Organic manure interaction	10	195513.33**	2731004.24**	5.058**	8.108*	45.651**	56.816*	14.27*
C.V%		14.10	8.6	11.39	11.94	9.21	6.17	11.81

**,*, In order significant at 1 and 5% level of probability

Table 2: Effect of irrigation treatments on recorded traits in Safflower

Treatment	Seed yield (Kg/h)	Biological yield (Kg/h)	Capitol/plant	Seed/capitol	T. K. W (gr)	Height (cm)	Hi (%)
Irrigation	1673a	7488a	7a	20a	30a	84a	22.5a*
Dry land	1363a	7303a	6b	13b	31b	82a	18.6a

*, In each column the means that showed with common letter are not significant at 5% level of probability

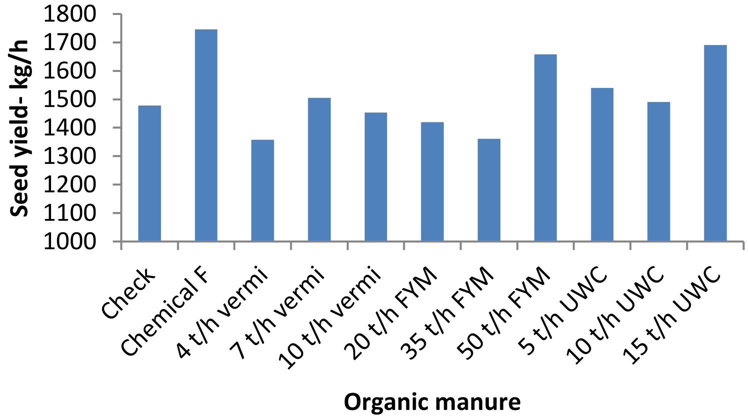

Figure 1: Effect of organic manure on Safflower seed yield

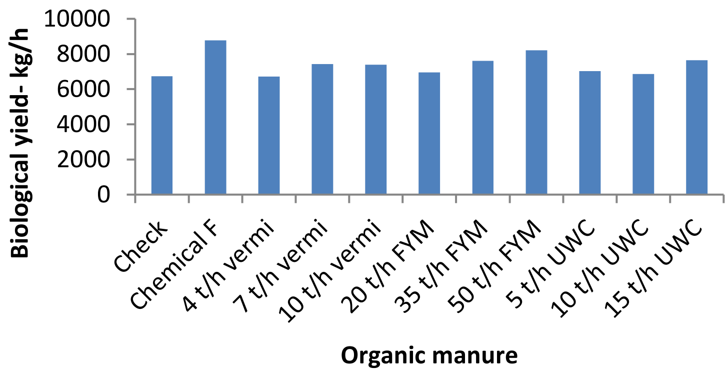

Figure 2: Effect of organic manure on Safflower biological yield

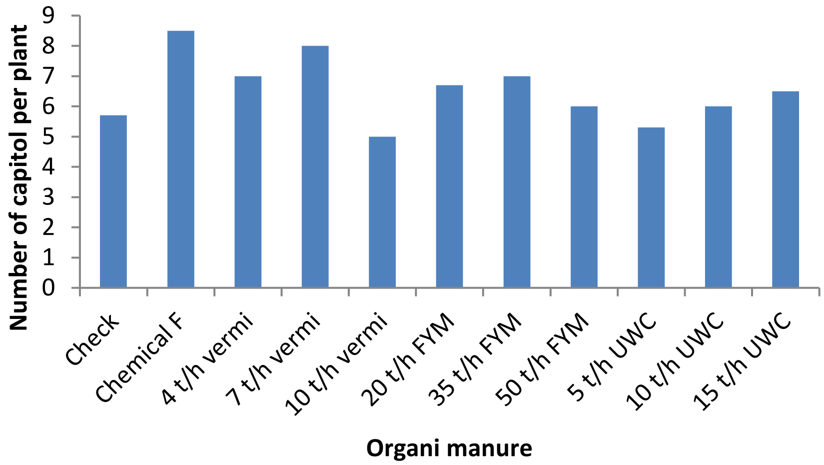

Figure 3: Effect of organic manure on number of capitol per plant

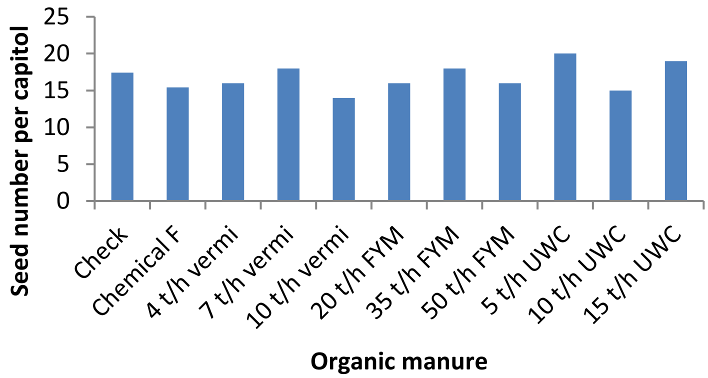

Figure 4: Effect of organic manure on seed number per capitl

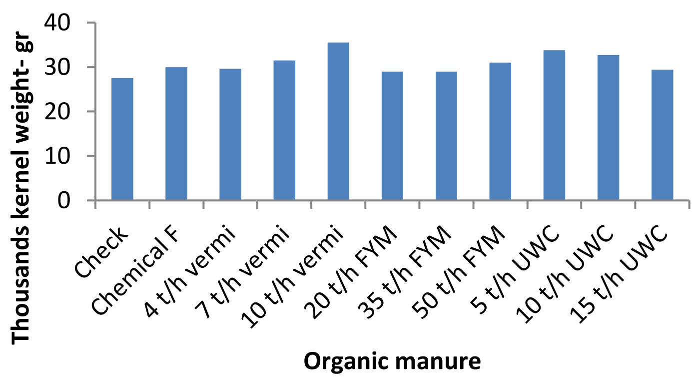

Figure 5: Effect of organic manure on thousands kernel weight

Table 3: Irrigation and organic manure interaction on yield and yield components of Safflower

Irrigation treatment	Fertilizer treatment	Seed yield (Kg/h)	Biological yield (Kg/h)	Harvest index (%)	T.K.W (gr)	Height (cm)	Seed/capitol	Capitol/plant
Irrigation	Check	1536abcd*	6170j	24.9a	26d	82abcd	21.6ab	6.5cdef
	Chemical fertilizer	2073a	10233a	20.3abcd	27.4d	91.8a	19.8abcd	8.8a
	4 ton/h vermicompost	1643abc	6900ghi	23.8ab	26.7d	84.4abcd	17.6bcdef	7.2abcde
	7 ton/ vermicompost	1496bcd	6900ghi	21.8abc	33.5bcd	86abcd	20.8abc	8.6ab
	10 ton/h vermicompost	1860ab	7783de	23.8ab	41a	82abcd	18bcde	4.4g
	20 ton/h farmyard manure	1466bcd	6505ij	22.5abc	27d	77.5cd	21ab	7.6abcd
	35 ton/h farmyard manure	1456bcd	7686de	19bcde	27.6d	87.6abc	22ab	7.4abcde
	50 ton/h farmyard manure	1883ab	7953cd	23.7ab	32.5bcd	82.5abcd	19.9abcd	5fg
	5 ton/h urban waste compost	1813abc	7936cd	23abc	30.6bcd	83.7abcd	24a	6.4cdef
	10 ton/h urban waste compost	1710abc	7306efg	23.5ab	29.9bcd	78bcd	18bcde	6.5cdef
	15 ton/h urban waste compost	1470bcd	7000fgh	20.9abcd	28.5cd	86.8abcd	20.7abc	6.6cdef
Low irrigation	Check	1420bcd	7300efg	19.5bcde	29cd	76.8d	13efgh	5fg
	Chemical fertilizer	1420bcd	7323efg	19.4bde	32.8bcd	83abcd	11gh	8abc
	4 ton/h vermicompost	1073d	6520hij	16.4de	32.5bcd	7bcd	15defgh	7abcde
	7 ton/ vermicompost	1513bcd	7966cd	19bcde	29.4cd	82.4abcd	15.7cdefg	7.9abc
	10 ton/h vermicompost	1046d	7003fgh	15e	29.6bcd	83.6abcd	10h	6defg
	20 ton/h farmyard manure	1373bcd	7410ef	18.4cde	31bcd	85.8abcd	11gh	5.7defg
	35 ton/h farmyard manure	1266cd	7526de	16.8de	30bcd	84.4abcd	14efgh	6.8bcdef
	50 ton/h farmyard manure	1433bcd	8450b	17de	29.8bcd	81bcd	12.6fgh	7abcde
	5 ton/h urban waste compost	1266cd	6100j	20.7abcd	40ab	82abcd	15.6defg	4c
	10 ton/h urban waste compost	1273cd	6426ij	19.4bcde	35.5abc	88a	11.7gh	5.efg6
	15 ton/h urban waste compost	1913ab	8306bc	22.7abc	30bcd	78.8bcd	17bcdef	6.4cdef

*, In each column the means that have a common letter are not significant at 5% of probability

According to Safflower's sensitivity to increased water in the soil's surface layer (Aletor 2021) and the higher water content of organic manure, particularly urban waste compost, it appears that this organic manure stifled Safflower plant growth and ultimately resulted in a decrease in seed and biological yield under irrigated conditions. For this reason, seed production improved with higher organic manure application in dry soil conditions due to enhanced moisture availability in urban waste compost treatment (Karasakal, Khayatnezhad et al. 2020, Barth 2021, Ma, Khayatnezhad et al. 2021).

As a consequence of the findings of this experiment, utilizing 15 tons of urban waste compost per hour in a restricted moisture environment produced the greatest Safflower seed production outcomes. The seed yield in this treatment was comparable to that in the irrigated treatment with chemical fertilizer. In the irrigated condition, employing 10 tons/h vermicompost, 50 tons/h farmyard manure, and 5 tons/h urban waste compost resulted in the same seed production and did not demonstrate significant differences. The smallest quantity of urban waste compost (5 tons/h) generated seed yields comparable to the largest amounts of vermicompost (10 tons/h) and farmyard manure (50 tons/h). Safflower seems to have a superior response to urban waste compost in irrigated and dryland conditions. Of course, more research is necessary to determine the optimal response of Safflower to urban waste compost.

CONCLUSION

As a consequence of the findings of this experiment, utilizing 15 tons of urban waste compost per hour in a restricted moisture environment produced the greatest Safflower seed production outcomes. The seed yield in this treatment was comparable to that in the irrigated treatment with chemical fertilizer. In the irrigated condition, employing 10 tons/h vermicompost, 50 tons/h farmyard manure, and 5 tons/h urban waste compost resulted in the same seed production and did not demonstrate significant differences. The smallest quantity of urban waste compost (5 tons/h) generated seed yields comparable to the largest amounts of vermicompost (10 tons/h) and farmyard manure (50 tons/h). Safflower seems to have a superior response to urban waste compost in irrigated and dryland conditions. Of course, more research is necessary to determine the optimal response of Safflower to urban waste compost.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Arda Karasakal conducted, planned, Analyzed the data, wrote manuscript and interpreted the results and involved in manuscript preparation. All authors read and approved the final version.

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