Biological Forum – An International Journal **8**(2): 172-180(2016)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of Organic and Mineral Fertilizer on Safflower (*Carthamus tinctorius*) Seed Yield and Yield Components

Mohsen Edalat* and Ruhollah Naderi**
**Department of Crop Production and Plant Breeding, Faculty of Agriculture, Shiraz University, Shiraz, Iran*
***College of Agriculture and Natural Resources of Darab, Shiraz University, Darab, Iran*

(Corresponding author: Mohsen Edalat)
(Received 15 August, 2016, Accepted 20 September, 2016)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Safflower (*Carthamus tinctorius* L.) is an important oil crop which has a favorable production under low input conditions, particularly in organic farming systems. This study was carried out to evaluate the effect of organic and mineral fertilizers including urea nitrogen (N), farmyard manure and municipal waste compost on growth, yield and yield components of safflower. The experiment was conducted at the Experimental Farm of School of Agriculture, Shiraz University, Shiraz, Iran, located at Badjgah in 2014 and 2015 growing seasons. Results showed that maximum seed yield was recorded at 50 tons compost ha^{-1}. Seed yield showed a significant increase by increasing N from 0 to 100 kg ha^{-1} at 50 tons ha^{-1} of compost treatment; however increasing N beyond 100 kg ha^{-1} had no significant effect on safflower seed yield. Results of stepwise regression analysis showed that contribution of yield component of safflower varies with change in N and organic fertilizer application rates. Application of organic fertilizers caused a non-significant increase in soil organic carbon and a significant increase in soil N content.

Keywords: Compost, Farmyard manure, Stepwise regression, Organic carbon.

INTRODUCTION

Recently, increasing of global population has resulted in severe limitation of food resources. Although wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.), bean (*Phaseolus vulgaris*) and corn (*Zea mays* L.) are considered as main food, oil crops are also counted as the second important food resources. In recent years, Iranian farmers have shown an interest in cultivating safflower because it is well adapted to salinity and drought stress (Bye Bourdi, 2007). Several suitable characteristics of safflower including medical, industrial and nutritional use, high quality of oil (more than 80% saturated fatty acids specially linoleic and oleic), high tolerance to salinity and drought stress, low water demand, good compatibility to low and high temperature have made it as a valuable oilseed crop (Ahmadi and Omidi, 1994). Application of organic amendments including cow manure, sewage sludge and municipal waste compost is known as a suitable strategy to increase soil organic matter, and to improve soil structure by increasing aggregate stability (Davari Nezhad *et al.,* 2004). Application of the aforementioned organic amendments can also increase soil water holding capacity and aeration and would improve nutrient availability and soil physical conditions (Viator *et al.,* 2002).

Organic amendments would play a crucial role in improving soil quality, besides their role in crop plant nutrition and soil fertility. However, their effects on soil structure improvement could be more important than their impact on crop nutrient supply (Kamkar and Mahdavi Damghani, 2008). Additionally, organic fertilizers would increase soil organic matter and soil productivity as a result of modifying chemical characteristics of the soil such as, pH, cation exchange capacity, and increment of microorganism's activity and availability of nutrients (Renato, 2003). It has been reported that application of organic amendments could increase yield of various crops including wheat (Kazemeini, 2007), corn (Naderiand Ghadiri, 2010; Sarhadi Sardouyi, 1998), vegetable amaranth (*Amaranthus* sp.) (Onyango *et al.,* 2012), and tomato (*Solanum lycopersicum* L.) (Samavat *et al.,* 2001).

Heckmat (2008) reported that dry matter production in soybean increased by application of organic fertilizers. Composts could aid to water supply as well as to provide a suitable conditions for root growth (Remus, 2000). Patil *et al.* (2006) evaluating the effect of organic fertilizers, manures and chemical fertilizer on sorghum (*Sorghum bicolor* L.), reported that organic amendments particularly compost, caused a significant increase in sorghum yield. Bhattacharya *et al.* (2005) found that municipal waste compost could meet crop nutritional demand and stimulate microbial activity of the soil in short term while it could maintain nutrient resources and soil organic content in long term.

Results from evaluation of organic fertilizer in an experiment on Safflower showed that consumption of 5 tons h^{-1} municipal waste compost produced more seed yield (1813 kg h^{-1}) in comparison with 10 and 15 tons h^{-1} but it had less yield in comparison with chemical fertilizer about 12.5%. Consumption of 50 tons cow manure $ha^{-1}$of also produced the seed yield equivalent to chemical fertilizer in deficit irrigation treatment (Azimzadeh, 2013). The objective of this experiment was to determine the effect of organic and mineral fertilizers on safflower yield and yield components and soil properties.

MATERIALS AND METHODS

Field experiments were carried out in a silty clay loam soil at the Experimental Research Center (Badjgah), Shiraz University (52º 46 E, 29º 50 N and 1810m) in two growing seasons (2014 and 2015).

The experimental design was split plot with three replications. Treatments included mineral fertilizer as urea in four levels (0, 100, 200, and 300 kg N ha^{-1}) as main plots, and organic amendments including farmyard manure in two levels (7.5 and 15tons ha^{-1}), municipal waste compost in two levels (35 and 50 tons ha^{-1}) and control (no fertilizer) as sub plots. Data on monthly average temperature and rainfall for two years of study and 30-years means of the region as well as properties of experimental treatments are shown in Tables 1 and 2.

Land preparation practices included plowing, disking and ridging of the plots (sized 3 by 5 m). In the first year, organic fertilizers were mixed into the soil by disk harrow. Urea Nwastop-dressed to plots in two times (½ at planting time and ½ at flower bud stage).

Weeds were controlled by Triflouralin (2 liters ha^{-1}) that was applied prior to planting and incorporated into the soil by disking.

Table 1: Monthly average temperature and rainfall values during the years of the experiment and 30-year means at Agricultural Research Center (Badjgah), Shiraz. Iran.

Month	Rainfall (mm)		Temperature (ºC)	
	2014	2015	2014	2015
Sep	0	0	16.7	15.7
Oct	0	0	12.3	11.3
Nov	12	21	8.7	9.1
Dec	34	31	2.6	6.6
Jan	23	76	0.38	1.4
Feb	37	29.5	4.5	3.7
Mar	35	28	7.4	8.9
Apr	78	67	11.5	14
May	3	5	17.3	17.9
Jun	0	0	22	22.4
Jul	2.5	0	25.1	25.8
Aug	0	0	24.1	24.7
Total	224.5	257.5	-	-

Table 2: Physiochemical properties of compost and farmyard manure used in experiment.

Parameters	Compost	Farmyard manure
pH	7.82 ± 0.04	7.81 ± 0.01
C (g kg^{-1})	286.5 ± 1.67	266.3 ± 0.51
N (g kg^{-1})	23.1 ± 1.0	14.4 ± .31
P (g kg^{-1})	9.85 ± 0.10	6.59 ± .03
Organic matter (g kg^{-1})	495.5 ± 2.7	461.2 ± 1.31
C/N ratio	12.3 ± 0.13	18.5 ± 0.13
K (g kg^{-1})	15.2 ± 0.19	8.87 ± 0.05
Ca (g kg^{-1})	23.8 ± 2.91	15.7 ± 1.31
Mg (g kg^{-1})	6.74 ± 0.10	2.59 ± 0.06
Na (g kg^{-1})	6.03 ± 0.06	5.70 ± 0.01
Cu (mg kg^{-})	0.97 ± 0.04	0.77 ± 0.01
Fe (mg kg^{-1})	8.68 ± 0.14	5.59 ± 0.121
Mn (mg kg^{-1})	13.6 ± 0.18	7.72 ± 0.12
Zn (g kg^{-1})	16.9 ± 0.17	8.31 ± 0.10

The seeds of safflower cultivar Faraman (prepared from Iran Dryland Research Institute-Kermanshah) were sown in plots by pneumatic grain drill (model Accord, Germany) on April 5th in both years. Plots were irrigated by tape drip system with 15days intervals. Plants were dried in an oven at 75°C for 72h to determine seed yield. Plants were harvested on August 22nd. Some traits such as seed yield, crop biomass, harvest index (%), capitol number per plant, seed number per capitol, mean kernel weight and branch number were measured by randomly selecting ten plants in each plot. Soil samples of each plot were collected at a soil depth of 0 to 30 cm to determine total N (Bremmer and Mulvaney, 1982), organic C (Nelson and Sommers, 1982), pH and EC (Thomas, 1996) at the end of each growing season. Each soil sample was placed in a plastic bag and transformed to the laboratory. The samples were air-dried at room temperature after removing visible roots and crop residues, and ground to pass through a 2 mm sieve. Potassium contents in both soil extracts and plant digests were determined by flame atomic absorption spectrometry.

The amount of available portion of Phosphorous in soil was measured based on the method developed by Olsen *et al.*, (1954).

Analysis of variance over years indicated that there is no significant (P>0.05) year by N urea and organic amendments for all data. Thus, data of two years were combined. The experimental data were analyzed using SAS (version 9.3) system. Where analysis of variance showed significant treatment effect, LSD Test was used to compare the means at P<0.05.

RESULTS AND DISCUSSION

A. Seed yield

Urea N fertilizer had a significant effect on safflower seed yield. Increasing urea N rate from 0 to 100 kg ha^{-1} and from 100 to 200 kg ha^{-1} increased seed yield significantly; however no significant increase in seed yield was observed when the rate was increased from 200 to 300 kg N ha^{-1} (Table 3). Similar studies reported that application of urea N caused an increase in safflower seed yield (Jehad *et al.*, 2008; Rasti *et al.*, 2015).

Table 3: Effects of nitrogen on growth, yield and yield components of safflower (mean two years data).

Urea (kg ha^{-1})	Seed yield (g m^{-2})	Biomass (g m^{-2})	H.I.	SP	TCP	TSP	MKW (g)	BN
N0	171.9	951.2	18.0	8.9	84.8	848.8	3.9	4.4
N1	284.3	1225.0	20.0	10.0	127.7	1333.8	4.7	6.0
N2	366.5	1314.3	27.8	10.5	146.8	1514.0	5.1	6.8
N3	382.8	1412.0	27.1	10.6	151.4	1536.0	5.3	6.8
LSD (5%)	23.23	80.92	1.97	0.34	6.03	60.55	0.31	0.77

N0=0 kg urea ha^{-1}, N1=100 kg urea ha^{-1}, N2=200 kg urea ha^{-1}, N3=300 kg urea ha^{-1}
H.I.=Harvest Index, SC= seed number per capitol, TCP=total capitol number per plant, TSP= total seed number per plant, MKW= 1000 seed weight, BN=Branch number

Organic fertilizers significantly enhanced safflower seed yield. Application of 7.5 and 15 tons ha^{-1} of farmyard manure and 35 and 50 tons ha^{-1} of municipal waste compost resulted in 15.5, 16, 40.7, and 46.4% increase in safflower seed yield, respectively. However, maximum seed yield was found at 50 tons compost ha^{-1}. There was no significant difference between 7.5 and 15 tons farmyard manure ha^{-1} for seed yield. There was also no significant difference between 35 and 50 tons municipal waste compost ha^{-1}. Municipal waste compost increased safflower seed yield more than farmyard manure (Table 4). These results are in agreement with those of Naderi and Bijanzadeh (2014) who found that in greenhouse study municipal waste compost and farmyard cattle manure was able to increase safflower seed yield but municipal waste compost increased safflower seed yield more than farmyard cattle manure. There was a significant interaction between urea N and organic fertilizer (Table 5). Application of 50 tons municipal waste compost combined with 200 kg urea N ha^{-1} produced maximum seed yield (469 g m^{-2}) which it was significantly higher than both 35 and 50 tones municipal waste compost ha^{-1} combined with 300 kg N ha^{-1} (Table 5). Although application of 7.5 and 15 tons farm yard manure ha^{-1} combined with 300 kg N ha^{-1} caused an increase in seed yield, they were not significantly different from 7.5 and 15 tons farm yard manure ha^{-1} combined with 200 kg N ha^{-1} (Table 5). Minimum seed yield was observed at control (no use of urea N and organic amendments) (120 g m^{-2}). These findings suggest that application of organic amendments can increase safflower seed yield and simultaneously reduce safflower N requirement, possibly through improvement of soil physical, chemical and biological characteristics (Mantovi *et al.*, 2005; Cherif *et al.*, 2009) which may be considered a step toward sustainable agriculture.

Table 4: Effect of organic fertilizers on growth, yield and yield components of safflower (mean data of two years).

Treatments	Biomass (g m^{-2})	Seed yield (g m^{-2})	HI	SC	TCP	TSP	MKW (g)	BN
Cont.	1098.3	243.5	22.1	9.2	105.1	1026.0	4.3	5.2
FM1	1166.2	281.4	24.1	9.6	124.2	1261.5	4.6	5.7
FM2	1187.1	282.7	23.8	9.8	125.5	1273.7	4.7	5.7
C1	1328.7	342.7	25.7	10.4	140.7	1483.7	5.0	6.5
C2	1347.8	356.6	26.4	10.9	143.0	1485.5	5.1	6.9
LSD (5%)	48.64	15.8	1.67	0.285	5.01	63.35	0.281	0.47

Cont.= Control, FM1=7.5 tons farmyard manure ha^{-1}, FM2=15 tons farmyard manure ha^{-1}, C1=35 tons compost ha^{-1}, C2=50 tons compost ha^{-1}

HI=Harvest Index, SC= seed number per capitol, TCP=total capitol number per plant, TSP= total seed number per plant, MKW= 1000 seed weight, BN=Branch number

Table 5: Interaction effects of mineral and organic fertilizers on growth, yield and yield components of safflower (mean data of two years).

Treatments		Biomass (g m^{-2})	Seed yield (g m^{-2})	HI	SC	TCP	TSP	MKW (g)	BN
N0	Cont.	786	120	15.27	7.2	64.5	513	3.5	3.4
	FM1	941	150	17.34	8.8	83.7	825	3.9	4.0
	FM2	855	160	17.57	8.1	79.9	723	3.7	3.6
	C1	1061	208	19.63	9.5	91	996	4.3	5.0
	C2	1111	221	20.13	10.6	105	1147	4.4	5.8
N1	Cont.	1096	220	20.06	9.4	105	1102	4.3	5.0
	FM1	1200	246	21.89	9.7	122	1285	4.6	5.9
	FM2	1110	260	22.24	9.5	117	1234	4.3	5.4
	C1	1341	340	25.44	10.5	147	1584	5.0	6.3
	C2	1376	355	25.80	10.7	147	1464	5.2	6.9
N2	Cont.	1183	289	24.43	9.9	119	1171	4.4	6.0
	FM1	1231	346	28.14	10.3	139	1397	5.1	6.4
	FM2	1250	350	23.03	10.4	147	1578	5.3	6.8
	C1	1383	387	28.10	10.5	152	1664	5.2	7.0
	C2	1528	469	30.18	11.5	177	1760	5.6	8.0
N3	Cont.	1326	345	26.05	10.3	132	1318	5.1	6.0
	FM1	1375	365	26.55	10.3	152	1540	5.1	6.5
	FM2	1450	379	26.15	10.5	158	1560	5.3	6.8
	C1	1523	435	28.48	11.1	172	1698	5.4	7.4
	C2	1380	390	28.27	10.5	143	1564	5.2	7.1
LSD (5%)		97.3	29.4	3.35	0.5711	10.03	126.7	0.5625	0.95

N0=0 kg urea ha^{-1}, N1=100 kg urea ha^{-1}, N2=200 kg urea ha^{-1}, N3=300 kg urea ha^{-1}, Cont.= Control, FM1=7.5 ton farmyard manure ha^{-1}, FM2=15 ton farmyard manure ha^{-1}, C1=35 ton compost ha^{-1}, C2=50 ton compost ha^{-1}
HI=Harvest Index, SC= seed number per capitol, TCP=total capitol number per plant, TSP= total seed number per plant, MKW= 1000 seed weight, BN=Branch number

Naderi and Ghadiri (2013) also showed that application of organic amendments combined with appropriate N fertilizer led to an increase in corn yield. Barzegar *et al.* (2002) in a study on the effect of various organic amendments including farmyard manure and composted sugarcane bagasse residue showed that application of organic materials increased wheat yield, aggregate stability, and soil infiltration rate. However, they reported that effectiveness of different organic materials on improving the soil physical properties did not show any difference.

B. Crop Biomass

Urea N fertilizer had a significant effect on biomass of safflower per unit area with an optimal level of 300 kg N ha^{-1} (Table 3). Application of organic amendments generally increased the biomass over control at all levels of urea fertilizer, however the magnitude of increase of biomass was higher at lower levels of urea.

For instance, the highest increment in biomass over control was 26.2% which was observed at 0 kg N ha^{-1} whereas the lowest (8.04%) was observed at 300 kg urea ha^{-1}. The highest increase in biomass occurred at 50 tons compost ha^{-1}combined with 200 kg N ha^{-1} that was not significantly different from 35 compost tons ha^{-1}combined with300 kg N ha^{-1} level (Table 5). Naderi and Bijanzadeh (2014) also showed that both urea N and organic amendments increase safflower biomass significantly. Kazemeni (2007) studying the effects of municipal waste compost and nitrogen on dry-land wheat found similar results.

C. Harvest index (HI)

Harvest index (HI) of safflower was significantly affected by urea N application. Increasing N application rate resulted in increased HI, however beyond 200 kg N ha^{-1} rate the increase was not significant (Table 3). Increasing the rate of fertilizer application was shown to increase HI in other studies (Faramarzi *et al.,* 2009; Cheema *et al.,* 2001), but some studies reported negligible effect of N application rate on HI (Hocking and Stapper, 2001; Hocking *et al.,* 1997). The HI reached its peak at 50 tons compost ha^{-1} combined with200 kg ha^{-1} of N fertilizer. The lowest value of HI was achieved at control (no organic matter, no urea fertilizer). Both compost and farmyard manure increased HI; however compost caused 20% increase in HI over control while farmyard manure caused 10% HI increase over control (Table 4). The HI increase pattern was consistent across organic material treatments at all levels of N fertilizer and across N-fertilizer at all levels of organic matter (Table 5). Naderi (2011) in corn and Kazemeini (2007) in wheat also reported that organic amendments caused and increase in HI and the increment was higher for municipal waste compost compared to animal manure.

D. Seeds number per capitol (SC)

Increasing mineral fertilizer application rate up to 200 kg ha^{-1} increased seeds number per capitol significantly but the increase was not statistically significant thereafter (Table 3). Maximum SC was found at 50 tons compost ha^{-1} showing a significant difference with farmyard manure regardless of the rate applied. Generally compost had a better effect on SC so that the increase in SC over control was 18.5% at 35 tons compost ha^{-1} while it was 6.5% at 15 tons ha^{-1} farmyard manure (Table 5). The optimal SC was recorded at 50 tons compost ha^{-1}combined with200 kg N ha^{-1}, however the lowest value of SC was recorded at control (no-organic matter and no N-fertilizer treatment) (Table 5). Naik *et al*. (2007) in a study on organic amendments on yield and yield components reported similar results.

E. Total number of capitol per plant (TCP)

The total number of capitols per plant (TCP) peaked at 300 kg N ha^{-1} and it was lowest at 0 kg N ha^{-1} while the difference between TCP at 200 and 300 kg N ha^{-1} was not significant (Table 3). The TCP reached its peak at 50 tons compost ha^{-1} that did not show a significant difference with 35 tons compost ha^{-1} (Table 4). Application of organic amendments increased the TCP over control at all levels of urea. TCP increasing trend was decreased with application of mineral fertilizer at all levels of organic amendments (Table 5). These results are in agreement with those of Naik *et al.* (2007). Sharma *et al.* (2009) studying organic manure and N on safflower reported similar results.

F. Total seed number per plant (TSP)

The total number of seeds per plant (TSP) responded to both mineral and organic fertilizer (Tables 3 and 4). Maximum TSP was found at 50 tons compost ha^{-1} which was significantly higher than that farmyard manure at all levels of the application rate (Table 4). The maximum TSP occurred at 50 tons compost ha^{-1}combined with200 kg N ha^{-1}. Compared to farmyard manure, application of compost had a better effect on TSP. Increasing trend of TSP over control at 50 tons compost ha^{-1} was 44.5% but only 24% at 15 tons farmyard manure ha^{-1} (Table 4). These results are similar to findings of Naik *et al.* (2007) and Sharma *et al.* (2009).

G. Mean kernel weight (MKW)

N-fertilizer and organic amendment had positive effects on MKW. Application of compost also caused a significant increase in the MKW over both farmyard manure and control (Table 4). Application of 200 kg N ha^{-1} caused an increase in MKW compared to 0 and 100 kg N ha^{-1}. However, no significant difference was found between 200 and 300 kg N ha^{-1} (Table 3). An increase in the MKW was observed with increase in urea fertilizer however at higher rates of mineral fertilizer this effect was not significant (Table 3). Ahmadi and Bahrani, (2009) reported no significant effect for increased N levels on 1000-seed weight. However, Naderi and Ghadiri (2013) reported that urea N caused an increase in 1000-seeds weight. Maximum MKW were obtained 50 tons compost ha^{-1} combined with 200 kg N ha^{-1} (Table 6). An enhancement in 1000-seeds weight of sunflower (*Helianthus annuus*) has been also reported by Maiorana *et al.* (2005). In contrast, Rezvantalab *et al.* (2008) growing corn with municipal waste compost found that compost did not affect the 1000-kernels weight of the corn.

H. Branch number (BN)

The number of branches of safflower was increased significantly following increase in urea N application rate. Municipal waste compost caused a 29% increase in BN over control, while the increase was only 9.6 % for farmyard manure (Table 4).

Maximum number of branches was observed at 50 tons compost ha^{-1} combined with 200 kg N ha^{-1} and minimum was obtained at control (no urea N and no organic amendments) (Table 5). Similar results were found by Naik *et al.* (2007).

Stepwise selection of yield components

Results showed that contribution of yield components of safflower varied with change in mineral and organic fertilizer application rates. The mean kernel weight explained 97.8% of the variations in seed yield when no N-fertilizer applied. Nitrogen deficiency causes a reduction in vegetative growth and accumulation of non-structural carbohydrates in stem tissues of the plant. It appears that remobilization of assimilates is impaired in vegetative growth stage but recommences in final stages of seed development and contributes in seed weight through re-translocation of non-structural sugars making MKW a critical component of seed yield under poor nitrogen condition (Table 6). Increasing urea N fertilizer to 100 kg ha^{-1} changed the role of the number of seeds per capitol as the main contributing component in seed yield (partial R-square=0.985) and diminished the contribution of MKW (Table 6).

Safflower is an indeterminate plant and its reproductive growth is also followed by any flash of vegetative growth, so an increase in N fertilizer rate proceeds with increased vegetative growth and consequently with higher number of capitols per plant. This may explain the reason that application of 100 kg N ha^{-1} increased the contribution of the number of capitols per plant in seed yield up to 97.6 % (Table 6). Increasing the rate of N fertilizer to 300 kg ha^{-1} caused a significant increase in the number of secondary branches and improved the contribution of this component in seed yield to 93.1% (Table 6). With increasing N application rate as a vegetative growth stimulant, the number of secondary branches and accordingly the number of capitols per plant increased.

When no organic amendments was applied, the number of capitols per plant explained 97.2% of variation in seed yield and the proportion of explained variance approached 99.6% after adding farmyard manure to soil (Table 7). Most of the nutrient content of farmyard manure might be converted into a readily available form for plant nutrition not before several years of manure decomposition in soil.

Table 6: Summary of Stepwise Selection for nitrogen treatments (mean two years data).

Nitrogen (kg ha^{-1})	Variable entered	Partial R^2	Model R^2	F Value	Pr >F
N0	Mean kernel weight	0.978	0.978	365.93	<0.0001
	Capitol no. per plant	0.016	0.994	23.27	0.0019
	Seed no. per plant	0.004	0.999	35.37	0.001
N1	Seed no. per capitol	0.985	0.985	554.64	<0.0001
	Mean kernel weight	0.012	0.997	31.94	0.0008
	Seed no. per plant	0.003	1.00	1190.68	<0.0001
N2	Capitol no. per plant	0.976	0.976	333.4	<0.0001
	Branch no.	0.931	0.931	109.5	<0.0001
N3	Seed no. per capitol	0.063	0.994	88.77	<0.0001
	Seed no. per plant	0.005	0.999	101.92	<0.0001

N0=0 kg urea ha^{-1}, N1=100 kg urea ha^{-1}, N2=200 kg urea ha^{-1}, N3=300 kg urea ha^{-1}

Table 7: Summary of Stepwise Selection for organic fertilizer treatments (mean two years data).

Organic Matter (ton ha-1)	Variable entered	Partial R^2	Model R^2	F Value	Pr >F
Cont.	Capitol no. per plant	0.972	0.97	211.88	<0.0001
	Seed no. per capitol	0.026	1.00	91.97	0.0002
FM1	Capitol no. per plant	0.979	0.98	291.27	<0.0001
	Branch no.	0.02	1.00	2030.49	<0.0001
FM2	Capitol no. per plant	0.996	1.00	1515.25	<0.0001
	Mean kernel weight	0.004	1.00	52.44	0.0122
C1	Mean kernel weight	0.979	0.98	291.78	<0.0001
	Seed no. per plant	0.015	0.99	16.17	0.0101
C2	Seed no. per plant	0.997	1.00	2370.39	<0.0001
	Mean kernel weight	0.003	1.00	223.65	<0.0001

Cont.= Control, FM1=7.5 ton farmyard manure ha^{-1}, FM2=15 ton farmyard manure ha^{-1}, C1=35 ton compost ha^{-1}, C2=50 ton compost ha^{-1}

Therefore application of manure to soil will not possibly have a significant advantage to the crop planted immediately in the next season. This may give an explanation why no significant difference between organic amendments treatment and control (no organic matter) was found. However, Municipal waste compost contains more available minerals and organic matter, thus application of 35 tons compost ha^{-1} improved the contribution of MKW in seed yield (partial R-square 97.9 %) (Table 7). As the rate of application of compost was increased to 50 tons ha^{-1}, the contribution of number of seeds per plant in seed yield replaced the MKW and became the most important component with a partial R-square of 99.7 %. Application of more compost led to a nutritional surplus in soil which improved utilization of soil nutrient by roots and enabled producing more seeds per capitol.

Soil characteristics

Electro-conductivity and pH. Application of N-fertilizer increased soil electro-conductivity (EC) (Table 8). Neither compost nor farmyard manure caused significant changes in EC over control. Although an increase in EC was observed at compost treatments, this increase did not show a significant difference with control which may be owing to the effect of higher EC of the compost used (Table 9). Similar effect of compost or manure on soil EC was also reported by Eghbal *et al.* (2004). Application of urea fertilizer resulted in a decrease in pH, though the decrease was only significant between 300 and 0 kg N ha^{-1} treatments (Table 8). Biological nitrification of N sources that are mainly in the form of urea may cause reduction in soil pH. Naderi *et al*. (2016) in a study on N and organic manure on corn reported similar results. Amending of soil with organic amendments did not cause any significant change in pH (Table 9). However, Lee (2012) and Naderi *et al*. (2016) and Naderi (2011) found that increased cattle manure rates caused an increase in soil pH.

Potassium and phosphorus. Neither mineral nor farmyard manure caused a significant change in soil potassium level; however compared to farmyard manure, application of municipal waste compost increased soil potassium level significantly (Tables 8 and 9).

Available phosphorus in soil responded to the application of organic amendments. Application of farmyard manure and municipal waste compost increased available phosphorus significantly, but the increase was not significant (Table 9). In contrast, Eghbal (2002) reported a significant increase of available phosphorus in soil after application of animal manure and compost.

Soil nitrogen content. Application of N fertilizer had no significant effect on total soil nitrogen content (Table 8). These results are in agreement with Maltas *et al.* (2013) and Dai et al. (2013) who have reported that N fertilizer had no effect on soil nitrogen content. However, Naderi *et al.* (2016) and Alijani *et al.* (2012) found an increase in soil nitrogen content by application of N fertilizer. Municipal waste compost increased the total nitrogen content of soil significantly (Table 9).

Table 8: Effects of nitrogen on some soil nutrient concentration (mean two years data).

Nitrogen (kg ha^{-1})	K (ppm)	P (ppm)	N (%)	OC (%)	EC (dSm^{-1})	pH
N0	589	13.9	0.058	0.561	0.345	7.86
N1	575	13.8	0.058	0.573	0.346	7.81
N2	573	13.4	0.062	0.577	0.395	7.81
N3	569	13.2	0.066	0.581	0.401	7.80
LSD (5%)	23	0.75	0.009	0.23	0.065	0.052

N0=0 kg urea ha^{-1}, N1=100 kg urea ha^{-1}, N2=200 kg urea ha^{-1}, N3=300 kg urea ha^{-1}

Table 9: Effects of additive organic matters on some soil nutrient concentration (mean two years data).

Treatments	K (ppm)	P (ppm)	N (%)	OC (%)	EC (dS m^{-1})	pH
Cont.	550	13.5	0.059	0.55	0.415	7.88
FM1	560	13.4	0.061	0.61	0.418	7.86
FM2	557	14.0	0.063	0.64	0.412	7.88
C1	560	13.6	0.062	0.60	0.444	7.87
C2	580	14.0	0.069	0.69	0.468	7.86
LSD (5%)	32	0.65	0.002	0.165	0.058	0.03

Cont.= Control, FM1=7.5 tons farmyard manure ha^{-1}, FM2=15 tons farmyard manure ha^{-1}, C1=35 tons compost ha^{-1}, C2=50 tons compost ha^{-1}

Increased soil nitrogen content after adding compost or farmyard manure to the soil has also been reported by Eghball *et al.* (2004). In another study Beraud *et al.* (2005) also found that cropping condition may change mineral nitrogen uptake and carbon and nitrogen mobilization in soil through its effects on soil temperature and liberation of organic carbon from root seepage. Since mineralization rate of manure is slower than compost, it can be concluded that manure left over has a residual effect on soil fertility and nitrogen availability in long term.

Organic carbon (OC). Urea N increased soil OC content over control, but the increase was not significant (Table 8). Halvorson et al. (2002) found that regardless of increasing of plant residue after applying nitrogen to soil, this treatment did not cause any significant change in organic carbon content of the soil. Soil organic carbon was increased due to application of organic amendments but it was not significant (Table 9). Naderi *et al,* (2016) found a significant increase in soil OC by application of organic amendments.

CONCLUSION

Our results showed a beneficial effect of municipal waste compost to reduce application of mineral nitrogen fertilizer. The optimal rate of application to guarantee the maximum safflower seed yield was50 tons compost ha^{-1} combined with 200 kg urea ha^{-1}. It appears that 50% of the required N-fertilizer could be replaced by compost application. Stepwise regression results showed that contribution of yield components of safflower varies with change in urea N and organic fertilizer application rates. Compared to the control (no use of urea N and organic amendments), application of organic amendments had no effect on soil pH or EC. Application of 50 tons compost ha^{-1} increased total soil nitrogen. Organic amendments increased soil organic carbon, even though this increase was not significant.

REFERENCES

Ahmadi, M. & Bahrani, M.J. (2009). Yield and yield components of rapeseed as influenced by water stress at different growth stages and nitrogen levels. *American-Eurasian Journal of Agriculture and Environmental Sciences*, **5**: 755-761.

Ahmadi, M.R. & Omidi, A.H. (1994). Study on seed yield and effect of harvesting time on facultative varieties of safflower. *Iranian Journal of Agriculture,* **27**: 28-35.

Alijani, K., Bahrani, M. & Kazemeini, A. (2012). Short-term responses of soil and wheat yield to tillage, corn residue management and nitrogen fertilization. *Soil and Tillage Research*, **124**: 78-82.

Azimzadeh, S.M., Kocheki, A.R. & Pala, M. (2013). Effect of different tillage systems on some soil physical and chemical characteristics. *Research in Agricultural Sciences*, **2**: 51-63.

Bar-Tal, A., Yermiyahu, U., Beraud, J., Keinan, M., Rosenberg, R., Zohar, D., Rosen, V. & Fine, P. (2004). Nitrogen, phosphorus, and potassium uptake by wheat and their distribution in soil following successive, annual compost applications. *Journal of Environmental Quality*, **33**: 1855-65.

Barzegar, A.R., Yousefi, A. & Daryashenas, A. (2002). The effect of addition of different amounts and types of organic materials on soil physical properties and yield of wheat. *Soil and Tillage Research*, **247**: 295 - 301.

Baybordi, A. (2007). Plant nutrition. Parivar publication. 80 pp.

Beraud, J., Fine, P., Yermiyahu, U., Keinan, M., Rosenberg, R., Hadas, A. & Bar-Tal, A. (2005). Modeling carbon and nitrogen transformations for adjustment of compost application with nitrogen uptake by wheat. *Journal of Environmental Quality*, **34**: 664-675

Bhattacharyya, P., Chakrabarti, K., Chakraborty, A. & Nayak D.C. (2005). Effect of municipal solid waste compost on phosphorous content of rice straw and grain under submerged condition. *Journal of Agronomy and Soil Science*, **51**: 363-370.

Cheema, M.A., Malik, M.A., Hussain, A., Shah, S.H. & Basra S.M.A. (2001). Effects of time and rate of nitrogen and phosphorus application on the growth and the seed and oil yields of safflower (*Brassica napus* L.). *Journal of Agronomy and Crop Science,* **186**: 103-110.

Cherif, H., Ayari, F., Ouzari, H., Marzorati, M., Brusetti, L., Jedidi, N., Hassen, A. & Daffonchio, D. (2009). Effects of municipal solid waste compost, farmyard manure and chemical fertilizers on wheat growth, soil composition and soil bacterial characteristics under Tunisian arid climate. *European Journal of Soil Biology*, **45**: 138-154.

Dai, X., Li, Y., Ouyang, Z., Wang, H. & Wilson, G.V. (2013). Organic manure as an alternative to crop residues for no-tillage wheat-maize systems in North China Plain. *Field Crops Research*, **149**: 141-148.

Davarinejad, G.H., Haghnia, G.H., Shahbazi, H.A. & Mohamadian, R. (2002). Effect of municipal compost on growth and yield of sugar beet. *Agricultural Science and Technology*, **16**: 75-84.

Davarinrjad, G., Haghnia, G. & Lakzian, A. (2004). Effect of enrichment manure and compost on wheat yield. *Agricultural Industrial Science Journal*, **18**: 75-83

Diepenbrock, W. (2000). Yield analysis of winter oilseed rape (*Brassica napus* L.): a review. *Field Crops Research*, **67**: 35-49.

Eghball, B. (2002). Soil properties as influenced by phosphorus and nitrogen-based manure and compost applications. *Agronomy Journal*, **94**: 128-135.

Eghball, B., Ginting, D. & Gilley, J.E. (2004). Residual effects of manure and compost application on corn production and soil properties. *Agronomy Journal,* **96**: 442-447.

Faramarzi, A., Barzegar, A., Zolleh, H.H., Mohammadi, H., Ardakani, M.R. & Normohammadi, G. (2009).Response of safflower (*Brassics napus*) cultivars to rate and split application of nitrogen fertilizer. *Australian Journal of Basic and Applied Science*, **3**: 2030-2037.

Halvorson, A.D., Wienhold, B.J. & Black, A.L. (2002). Tillage, nitrogen, and cropping system effects on soil carbon sequestration. *Soil Science Society of America Journal*, **66**: 906-912.

Heckman, S.R. & Angle, J.S. (2008). Residual effect of sewage sludge on Soybean. *Journal of Environment Quality*, **16**: 113-117.

Hocking, P.J., Randall, P.J. & MeMarco, D. (1997). The response of dryland safflower to nitrogen fertilizer: Partitioning and mobilization of dry matter and nitrogen, and nitrogen effects on yield components. *Field Crops Research*, **54**: 201-220.

Hocking, P.J., Stapper, M. (2001). Effects of sowing time and nitrogen fertilizer on safflower and wheat, and nitrogen fertilizer on Indian mustard. II. Nitrogen concentrations, N accumulation, and N fertiliser use efficiency. *Australian Journal of Agricultural Research*, **52**: 635-644.

Jackson, G.D. (2000). Effects of nitrogen and sulphur on safflower yield and nutrient uptake. *Agronomy Journal*, **92**: 644-649.

Jehad, A., Gerendás, J. & Sattelmacher, B. (2008). Effects of nitrogen supply on growth, yield and yield components of safflower and sunflower. *Plant and Soil*, **306**: 167-180.

Kamkar, B. & Mahdavi Damghani, A. (2008). Principles of sustainable agriculture. Jihad of Mashhad University Press.

Kazemeini, S.A. (2007). Interaction effects of organic matter types, nitrogen, and weeds on dryland wheat growth and yield. Doctoral Dissertation. Shiraz, Iran: Shiraz University.

Lee, J. (2012). Evaluation of composted cattle manure rate on bulb onion grown with reduced rates of chemical fertilizer. *Horticultural Science and Technology*, **22**: 798-803.

Malakooti, M.J. & Khademi, Z. (2006). Increasing irrigation wheat yield and nutrition with iron and compost and microelements in Iran. Karaj Agricultural education publication. Iran

Maltas, A., Charles, R., Jeangros, B. & Sinaj, S. (2013). Effect of organic fertilizers and reduced-tillage on soil properties, crop nitrogen response and crop yield: results of a 12-year experiment in Changins, Switzerland. *Soil and Tillage Research*, **126**: 11-18.

Mantovi, P., Baldoni, G. & Toderi, G. (2005). Reuse of liquid, dewatered, and composted sewage sludge on agricultural land: effects of long-term application on soil and crop. *Water Research*, **39**: 289-296.

Marinoa, S., Tognettib, R & Alvinoa, A. (2011). Effects of varying nitrogen fertilization on crop yield and grain quality of emmer grown in a typical Mediterranean environment in central Italy. *European Journal of Agronomy*, **34**: 172-180.

Naderi,. R (2011). Nitrogen, manure and compost effects on growth and competition of weeds with corn (*Zea mays* L.). Doctoral Dissertation. Shiraz, Iran: Shiraz University.

Naderi, R., Edalat, M. & Kazemeini, S.A. (2016). Short term responses of soil nutrients and corn yield to tillage and organic amendment. *Archives of Agronomy and Soil Science*, **62**: 570-579.

Naderi, R. & Ghadiri, H. (2010). Urban waste compost, manure and nitrogen fertilizer effects on the initial growth of corn (*Zea mays* L.). Desert, **15**: 159-165.

Naderi R. & Ghadiri, H. (2013). Nitrogen, manure and municipal waste compost effects on yield and photosynthetic characteristics of corn (*Zea mays* L.) under weedy conditions. Journal of Biology and Environmental Sciences, **7**: 141-151.

Naik, R., Halepyati, A.S. & Pujar, B.T. (2007). Effect of organic manures and fertilizer levels on growth, yield components and yield of safflower (*Carthamus tinctorius* L.). *Karnataka Journal of Agricultural Science*, **20**: 835-836.

Olsen, S.R., Cole, C.V., Watanabe, F.S. & Dean, L.A. (1954). Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate. U. S. Department of Agriculture Circular No. 939. Banderis, A. D., D. H. Barter and K. Anderson. Agricultural and Advisor.

Onyango, C.M., Harbinson, J., Imungi, J.K., Shibairo, S.S. & Kooten, O. (2012). Influence of organic and mineral fertilization on germination, leaf nitrogen, nitrate accumulation and yield of vegetable amaranth. *Journal of Plant Nutrition*, **35**: 342-365.

Patil, S.L.& Sheelavantar, M.N. (2006). Soil water conservation and yield of winter sorghum as influenced by tillage, organic materials and nitrogen fertilizer in semi-arid tropical India. *Soil and Tillage Research*, **89**: 246-257.

Rasti, E., Saffari, M. & Maghsoudi Moud, A.A. (2015). The effects of organic and chemical fertilizers on yield and yield components of safflower (*Carthamus tinctorius* L.) under water stress conditions. *Irrigation Water Engineering Journal*, **18**: 69-80.

Remus, R., Ruppel, S., Jacob, H.J., Hecht-Buchholz, C.H. & Merbach, W. (2000). Colonization behavior of two entero-bacterial strains on cereals. *Biology and Fertility of Soils*, **30**: 550-557.

Renato, Y., Ferreira, M.E., Cruz, M.C. & Barbosa, J.C. (2003). Organic matter fractions and soil fertility under influence of liming, vermicompost and cattie manure. *Bioresource Technology*, **60**: 56-63.

Rezvantalab, N., Pirdashti, H., Bahmanyar, M., Abbasian, A. (2009). Evaluation of application of municipal waste compost and chemical fertilizers on yield and yield components of corn cultivar SC 704. *Iranian Journal of Crops Production*, **2**: 75-87.

Samavat, S., Lakzian, A. & Zamirpoor, A. (2001) Effect of vermicompost on tomato growth indices. *Agricultural Industrial Science Journal*, **5**: 83- 88.

Sarhadi Sardooiy, J. (1998). Effect of phosphorous and organic matter on corn growth and chemical compound in 3 kind of soil of Kahnooj. M.Sc. Thesis (soil science). Agricultural faculty. Shiraz University.

SAS Institute (1996) SAS user's guide. 3rd ed. SAS Inst., Cary, NC. **70**: 835-839.

Sharma,A., Kumar, A., Dharmaraj P.S. & Basavaraj, K. (2009). Response of safflower to organic manure, inorganic fertilizer and micronutrients. *Karnataka Journal of Agricultural Science*, **4**: 883-886.