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ORIGINAL ARTICLE

Effect of nitrogen, wheat residues, and compost rates on the growth and yield of sunflower

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In modern agriculture, precise integrated management of farmlands requires natural, sustainable and environmentally friendly inputs replacing chemical fertilizers application. A two-year (2015-2016) field experiment was conducted to determine the influence of integrated application of wheat (*Triticum aestivum* L.) residues and compost accompanied by nitrogen (N) on growth, seed yield and yield components of sunflower (*Helianthus annuus* L.) at School of Agriculture, Shiraz University, Shiraz, Iran. The experiment was conducted at split plots arranged in randomized complete blocks design with three replications. Treatments included four N (0, 60, 120, and 180 kg N ha^{-1}) two wheat residues (1.5 and 3 t ha^{-1}), two municipal compost (50 and 70 t ha^{-1}) rates and control (no additives). The results showed that higher N rates increased seed yield, whereas it reduced its oil content. Application of wheat residues and compost increased growth, seed yield, and seed oil content compared to control. The effect of compost application on seed yield increase was more pronounced than crop residues. Therefore, for an environmentally and agronomically sound management strategy, high compost application (70 t ha^{-1}) combined with proper N fertilization is recommended for sunflower production in the region.

Key words: chemical fertilizer; conservation farming; organic material; seed oil; sustainable agriculture

Introduction

Sunflower is an important economic crop both for human food and oil industry uses (Chapman et al., 2013). The crop has high climate adaptability, suitability for mechanization and low labor requirements. I is a highly adapted crop to water stress compared to maize (*Zea mays* L.) in southern part of Iran (Shahid et al., 2010; Kazemeini et al., 2009).

Application of chemical fertilizers has been almost a common method for the improvement of crop productivity over the last century. Strong historical association could be found between crop yields and nitrogen fertilizer (Zhang et al., 2015). Nitrogen is one of the major macronutrient leading to increased vegetative and reproductive growth (Hawkesford, 2014). However, high and excessive of N increase the risk of environmental pollution; specifically accumulation of NO^{3-} in underground water reservoirs (Krenkel, 2012) as well as exacerbates greenhouse gasses problem (Patil et al., 2012). Sunflower might easily respond to application of N (De Oliveira et al., 2014). Several studies have shown seed yield increase in response to different N rates (from 16% to 45%) (Kumar & Aryan, 2016; Spinelli et al., 2013; Abdyl-Razak et al., 2014). Recently, due to environmental concerns, numerous attentions have been made on restricted use of high rates of inputs in agriculture. In modern farming, as an alternative management system, sustainability and preservation of the quality of water and soil accompanied by higher crop yield are of great importance. Therefore, many recent researches have focused on management decisions and possibilities to reach these goals (Gholamhoseini et al., 2013; Lampkin et al., 2016).

Organic farming systems maintain and increase soil biological activity, biodiversity, and biological cycles to achieve ideal natural systems being economically and ecologically sustainable (Balasubramanian and Karthickumar, 2017). Municipal derived-composts, as decomposed and recycled additive materials are applied to amend soil properties in modern and organic farming agriculture. Composts are rich in nutrients and can be beneficial for farmland management in several ways, i.e. soil fertilizer conditioner. Moreover, compost is able to maintain microbial biomass in soil (Li et al., 2017).

Wheat (*Triticum aestivum*) is the main crop cultivated in Iran (11.1 million ton in 5.7 million ha) along with roughly 27% of total cereals production in the world (Faostat, 2016). Therefore, wheat residues incorporated into the soil to improve the soil properties and crop yield, would be a challenging method to proper field management (Medina et al., 2015). The great amount of residues produced, particularly in irrigated wheat farms could be a sustainable and potential biomass being used in this purpose (Dietrich et al., 2016). Crop residues, generally are abundant and low-cost materials and without potential confounding with human feeding. Crop residues management enhance productivity of cultivated crops and carbon sequestration in soil, while reduces greenhouse gasses emission (Stagnari et al., 2017). Moreover, a great part of these crops residues is burned in Iran which increases greenhouse gases.

It has been demonstrated that high N rates may enhance decomposition of crop residues into additive materials in soil (Buchi et al. 2016; Horton 2014; Muller & Aubert 2014). Zhou *et al.* (2014) also reported the higher N leaching in response to higher N application.

Given the importance of modern management of farms through reduced application of chemical fertilizers in cultivation of crop plants. The current study was conducted to address the effects of integrated application of N, wheat crop residues and municipal compost rates on sunflower growth, seed oil content, seed yield and its components.

Materials and methods

A two-year (2015-2016) field experiment was carried out at the Experimental Research Station, School of Agriculture, Shiraz University (52°46'E, 29°50'N and 1810 m a.s.l.), Shiraz, Iran. Weather data of the study site and soil along with municipal compost and wheat residues properties are presented in Fig. 1 and Table 1, respectively.

Table 1. Soil, compost, and wheat residue physical and chemical properties of the experimental site.

Soil physical properties

Clay (%)	Silt (%)	Sand (%)	Texture class	FC (%)	PWP (%)
41.6	44	14.4	Silty clay	25	8

Soil chemical properties

EC (dS/m)	Ph	CEC ($cmol^+/kg$)	CCE (%)	OM (%)	N (mol kg^{-1})	P (mg kg^{-1})	K (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})
0.44	7.69	19.02	40.05	1.03	0.11	18.25	480	5.79	4.48

Compost chemical properties

EC (dS m^{-1})	pH	OM (%)	N (mg kg^{-1})	P (mg kg^{-1})	K (mg kg^{-1})
11.78	7.41	58	2.04	62.75	2010

Wheat residue chemical properties

EC (dS m^{-1})	pH	OM%	K (mg kg^{-1})	P (mg kg^{-1})	N (mg kg^{-1})
4.03	6.87	73	1320	60.02	0.57

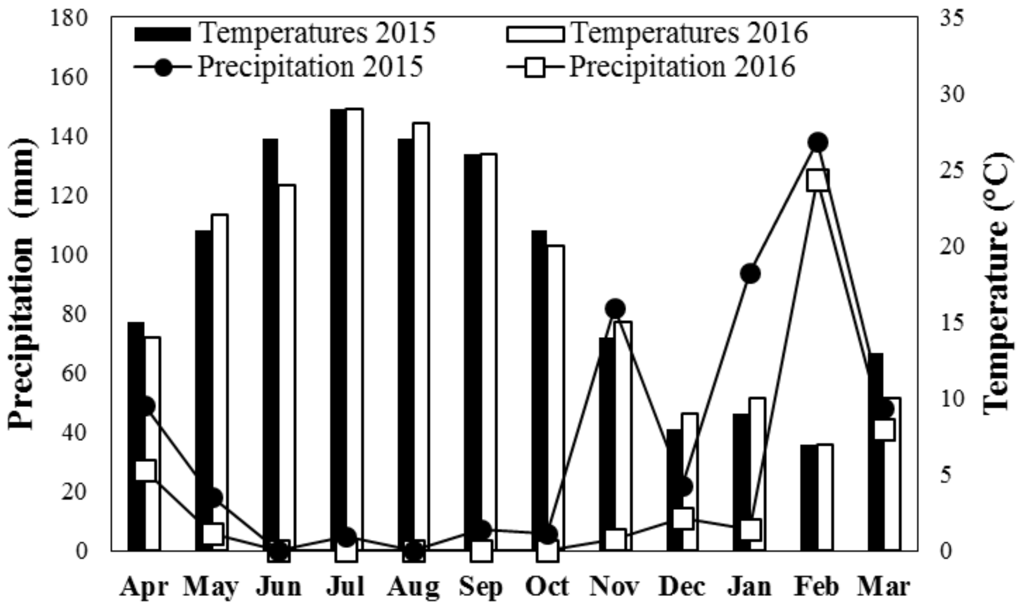

Figure 1. Monthly mean precipitation and temperatures during 2015 and 2016 growing seasons.

The experiment was conducted as split plots arranged in a randomized complete block design with three replications. The treatments consisted of four N rates (0, 60, 120, and 180 kg ha^{-1}) in the main plots, and additive materials including two levels of wheat residues (1.5 and 3 t ha^{-1}), two levels of municipal wastage compost (50 and 70 t ha^{-1}) and control (without additive materials) in the sub plots.

In the first year, additive materials were mixed into the soil 30 cm deep using moldboard plow. Nitrogen was supplied from urea and added to plots at two stages (half at planting time and the remained at the four-leaved stage). Sunflower seeds (Hysun cv) were sown by pneumatic row planter equipped with a row-cleaner at a soil depth of 3-4 cm with a row and within row spacing of 75 and 20 cm, respectively. The field had been kept as fallow in previous year. Seeds were sown in 3 × 4 m plots in April 30 and 29 in 2015 and 2016, respectively. Each plot was separated by two ridges to avoid cross contamination among plots. Weeds were controlled manually throughout the growing season. Each plot was separately and uniformly siphon irrigated in 10-day intervals to reach the 100% field capacity. Soil samples were selected from three depths (30, 60 and 90 cm) before irrigation practice followed by the gravimetric method and subsequently soil moisture content was determined.

Individual samples derived from plants in the middle two rows in each plots were used for assessment of stem diameter, head diameter, seed per head, percentage of unfilled seeds, head weight, thousand seed weight, seed yield, biological yield, harvest index, and seed oil content (AOAC, 1970).

Combined analysis of variance and mean comparison based on least significant difference (LSD) were implemented in Statistical Analysis System (SAS, 1985) software. Prior to combined analysis of variance, the Bartlett's test for homogeneity of error variances was carried out.

Results

Leaf area index (LAI) was significantly affected by year, N, organic materials rates and their interactions (Table 2). In both year, N rates increased LAI and the highest LAI (6.45 and 5.91) were achieved with 180 kg N ha^{-1}. On the other hand, organic materials positively changed LAI in both years, the difference is that varied rates of wheat residue and compost had similarly increased LAI in first year, whereas, in second year compost rates was found to be more effective (Table 4).

Analysis of variance showed that main effects of year, organic materials treatments, and interaction of N, organic materials rates were significant on stem diameter (Table 2). The highest stem diameter (2.51 and 2.39 cm for the first and second year, respectively) was obtained with the highest N rate (Table 3). Among organic additives treatments, both compost rates showed higher stem diameter than other treatments in both years. The higher stem diameter in each N rate was related to the compost application and the highest stem diameter was obtained with 70 t ha^{-1} of compost combined with 120 or 180 kg N ha^{-1}.

Analysis of combined variance showed that the main effect of year, N, and organic materials rates were significant for head diameter, seed per head, percentage of unfilled seed, head weight, thousand seed weight, seed yield, biological yield, and harvest index (Table 2). The interactions between year, N and … organic materials rates were significant for head diameter, seed yield and harvest index. Furthermore, interaction between N and organic materials rates had significant effect on head weight, unfilled seeds, thousand seed weight and biological yield (Table 2).

Table 2. Analysis of variance of morphological traits, seed yield and seed oil content under different rates of chemical and organic materials in sunflower

Source of variation	DF	Mean squares										
		Stem diameter	Leaf area index	Head diameter	seed number/ head	Unfilled seeds	Head weight	Thousand seed weight	seed yield	Biological yield	Harvest index	Seed oil content
Year (Y)	1	1.85**	6.01*	41.42*	29963.85*	7.17*	7.17*	35694.65*	2393396.57**	10101163.53**	986.87*	46.89*
Rep / Y	4	0.101	1.24	8.25	6163.24	0.22	0.22	5054.89	21723.51	282633.8	5.77	3.1
Nitrogen (N)	3	0.08ns	8.24**	75.02**	96403.31**	58.42**	58.42**	468573.26**	3359079.42**	33778391.2**	27.8**	60.93**
Y × N	3	0.03ns	4.58*	47.13**	140.15ns	0.02ns	0.02ns	753.48ns	10825.35ns	90359.5ns	19.93*	0.911**
Error (Rep × N/Y)	12	0.091	0.78	6.28	4866.77	0.07	0.07	4915.24	18770.6	91047.9	4.01	0.14
Organic Materials M)	4	0.94**	4.67**	62.79**	43655.98**	5.07**	5.07**	168111.18**	995381.61**	3222431.7**	24.12**	10.52**
N × M	12	0.058**	0.62ns	51.23**	759.61ns	0.47**	0.47**	18610.18*	38922.73**	233623.7*	0.8ns	0.301*
Y × M	4	0.002ns	1.82*	41.25**	44.02ns	0.003ns	0.003ns	1211.00ns	95346.3**	19822.8ns	23.87**	0.141**
Y × N × M	12	0.003ns	0.25ns	24.53*	12.32ns	0.03ns	0.03ns	1700.34ns	35644.53*	96778.7ns	13.51*	0.138**
Error	64	0.07	0.44	5.27	4710.81	0.029	0.029	4211.47	15044.12	82231.3	3.12	0.021
Coefficient of variation (%)		10.68	12.68	13.34	7.67	4.5	8.17	6.31	5.46	5.19	7.80	10.71

**, *, and ns are representing significance rates of 0.01, 0.05, and not-significant. DF: degree of freedom

The highest head diameter, seeds per head, the percentage of unfilled seeds, head weight, seeds weight, thousand seed weight, and harvest index were obtained with the highest N rate (Tables 3-5).

There was no significant difference between 120 and 180 kg urea ha^{-1} for percentage of unfilled seeds and thousand seed weight in the first year. Control treatment had the lowest yield related components in both years (Tables 3-4).

We did not register significant difference between 120 kg urea ha^{-1} and control treatment for thousand seed weight in first year, and between 0, 60, and 120 kg urea ha^{-1} for unfilled seeds percentage in both years.

The highest head diameter, seeds number per head, percentage of unfilled seeds, head weight, thousand seed weight, and harvest index were obtained with the highest compost rate in both years (Tables 3-5). We aslo did not observe significant difference between 70 and 50 t ha^{-1} compost rate for some of traits in both years. Application of 70 t ha^{-1} of compost had the highest biological and seed yields (Tables 3 and 5), whereas control treatment had the lowest seed yield in both years. Application of 3 t ha^{-1} of wheat residue and 50 t ha^{-1} compost showed significant differences for biological yield in both years and seed yield in first year (Tables 3 and 5).

Combined analysis of variance showed that the effect of year, N, organic materials rates and their interactions were significant on seed oil content (Table 2). There was a negative interaction between seed oil content and increased urea rates in both years (Table 5).

The highest and lowest seed oil content were obtained with control and the highest N rate, respectively. On contrary, organic materials treatments showed that higher application of compost or crop residues produced higher seed oil content. The highest seed oil content was achieved with the highest compost rate in both years.

At all N rates, compost treated plants had higher stem diameter, head weight and biological yield (Table 3). There was no significant difference between different organic fertilizers for 0 and 180 kg N ha^{-1} in terms of thousand seed weight; however, in low and moderate N rates (e.g. 60 and 120 kg ha^{-1}) the highest seed weight were obtained in compost treatments (Table 3). Overall, organic materials had more positive effect on low and moderate N rate.

In N control plots, application of 30% residue, 50% residue, 50 t ha^{-1} compost and 70 t ha^{-1} of compost increased biological yield by 2.8%, 4.9%, 8.7% and 15.7%, respectively, however these values intensified to 2.9%, 7.1%, 6.5% and 13.0% in 60 kg N ha^{-1}, and to 8.0%, 20.6%, 23.5% and 25.8% in 120 kg N ha^{-1}. This indicated that increased biological yield due to organic materials application was higher in 60 and 120 kg N ha^{-1} (Table 3).

Table 3. Interaction of N rates and organic materials on some sunflower traits

N rate (kg ha^{-1})	Organic materials	Stem diameter (cm)	Unfilled seeds (%)	Head diameter (cm)	Thousand seed weight (g)	Biological yield (kg ha^{-1})
	Control	2.10^{e}	8.29^{b-d}	543.95^{k}	49.25^{g}	4179.0^{j}
	Residue (30%)	2.19^{de}	7.93^{d-f}	572.80^{k}	50.36^{fg}	4295.4^{j}
0	Residue (50%)	2.22^{c-e}	7.99^{c-f}	667.86^{j}	53.39^{e-g}	4383.5^{ij}
	Compost (50 t ha^{-1})	2.43^{ab}	8.16^{b-e}	763.92^{fg}	55.91^{c-g}	4542.0^{h-j}
	Compost (70 ha^{-1})	2.49^{ab}	8.29^{b-d}	839.48^{cd}	59.71^{b-e}	4833.6^{f-i}
	Control	2.10^{e}	7.67^{f}	664.77^{j}	51.05^{fg}	4677.3^{g-j}
	Residue (30%)	2.19^{de}	7.64^{f}	752.93^{gh}	52.49^{e-g}	4812.4^{f-i}
60	Residue (50%)	2.22^{c-e}	7.99^{c-f}	693.62^{ij}	58.10^{b-f}	5006.9^{e-h}
	Compost (50 t ha^{-1})	2.42^{a-c}	8.41^{a-c}	725.53^{hi}	62.29^{a-d}	4982.6^{e-h}
	Compost (70 t ha^{-1})	2.49^{ab}	8.48^{ab}	823.28^{de}	62.15^{a-d}	5283.6^{ef}
	Control	2.05^{e}	8.15^{b-e}	822.06^{de}	54.33^{d-g}	5071.3^{e-g}
	Residue (30%)	2.21^{de}	7.79^{ef}	790.09^{ef}	57.37^{b-g}	5475.5^{e}
120	Residue (50%)	2.33^{b-d}	7.89^{d-f}	852.72^{cd}	60.67^{b-e}	6118.1^{d}
	Compost (50 t ha^{-1})	2.53^{ab}	7.91^{d-f}	911.00^{b}	61.65^{b-d}	6263.1^{cd}
	Compost (70 t ha^{-1})	2.63^{a}	8.84^{a}	910.72^{b}	63.52^{a-c}	6379.5^{cd}
	Control	2.05^{e}	8.10^{b-f}	832.19^{cd}	63.26^{a-c}	6146.0^{d}
	Residue (30%)	2.20^{de}	8.23^{b-e}	861.15^{c}	63.89^{a-c}	6748.7^{bc}
180	Residue (50%)	2.34^{b-d}	8.48^{ab}	834.14^{cd}	65.07^{ab}	7043.4^{ab}
	Compost (50 t ha^{-1})	2.52^{ab}	8.54^{ab}	946.82^{b}	70.28^{a}	6920.3^{ab}
	Compost (70 t ha^{-1})	2.63^{a}	8.52^{ab}	1117.80^{a}	69.97^{a}	7426.6^{a}

Means with similar letter(s) in each column are not significantly differed (LSD 5%).

Table 4. Influence of N rates and organic materials on seeds number per head and leaf area index of sunflower in two years

N Rate (kg ha^{-1})	Seed number per head		Organic materials	Seed number per head	
	2015	2016		2015	2016
0	835.61c	802.19c	Control	857.15d	822.87d
60	909.70b	873.31b	Wheat residue (1.5 t ha^{-1})	893.76c	858.01c
120	930.38b	893.16b	Wheat residue (3 t ha^{-1})	917.45b	880.76b
180	974.14a	935.17a	Compost (50 t ha^{-1})	943.3a	905.57a
			Compost (70 t ha^{-1})	950.62a	912.59a
N Rate (kg ha^{-1})	Leaf area index		Organic materials	Leaf area index	
	2015	2016		2015	2016
0	3.79c	3.43c	Control	4.58b	4.31d
60	4.99b	5.35b	Wheat residue (1.5 t ha^{-1})	5.39a	4.79c
120	6.39a	5.55b	Wheat residue (3 t ha^{-1})	5.58a	5.26b
180	6.45a	5.91a	Compost (50 t ha^{-1})	5.69a	5.51a
			Compost (70 t ha^{-1})	5.78a	5.43a

Means with similar letter(s) for each trait and in each column are not significantly differed (LSD 5%).

Table 5. Effect of N rates and organic materials on some sunflower traits in two years

N rate (kg ha^{-1})	Organic materials	Head diameter (cm)		Seed yield (kg ha^{-1})		Seed oil content (%)	
		2015	2016	2015	2016	2015	2016
0	Control	15.33 k	13.33 l	1620.90 l	1846.20 l	45.6 g	47.9 g
	Residue (30%)	15.83 jk	13.70 kl	1643.47 kl	1928.13 kl	45.9 f	48.2 f
	Residue (50%)	16.33 ij	14.00 j-l	1672.13 j-l	2020.00 jk	46.3 d	48.6 d
	Compost (50 t ha^{-1})	16.67 h-j	14.33 i-k	1828.20 ij	2150.67 g-i	46.8 b	49.1 b
	Compost (70 t ha^{-1})	16.67 h-j	14.67 ij	1930.70 hi	2304.87 ef	47.7 a	50.1 a
60	Control	16.67 h-j	14.17 j-l	1809.00 i-k	1988.23 jk	44.8 i	47.0 i
	Residue (30%)	17.33 f-h	15.17 hi	1841.53 i	2074.00 h-j	45.3 h	47.6 h
	Residue (50%)	17.67 e-g	16.50 fg	1969.83 g-i	2154.27 gh	46.1 e	48.4 e
	Compost (50 t ha^{-1})	18.00 d-f	16.67 ef	2013.37 gh	2257.03 fg	46.3 d	48.6 d
	Compost (70 t ha^{-1})	18.33 c-e	16.67 ef	2121.73 fg	2414.17 e	46.5 c	48.8 c
120	Control	17.00 g-i	15.67 gh	1967.83 g-i	2031.03 i-k	42.6 n	44.7 n
	Residue (30%)	17.67 e-g	16.83 ef	2087.63 f-h	2234.57 fg	42.7 m	44.8 m
	Residue (50%)	18.00 d-f	16.67 ef	2310.43 de	2578.30 d	43.1 l	45.3 l
	Compost (50 t ha^{-1})	18.67 cd	18.67 c	2362.60 cd	2853.33 b	43.3 k	45.5 k
	Compost (70 t ha^{-1})	18.67 cd	18.33 cd	2399.17 cd	2919.20 b	43.8 j	46.0 j
180	Control	17.33 f-h	16.67 ef	2195.20 ef	2425.67 e	40.8 s	42.8 s
	Residue (30%)	18.33 c-e	17.50 de	2385.47 cd	2701.83 c	41.3 r	43.4 r
	Residue (50%)	19.00 cb	18.37 c	2503.30 bc	2876.93 b	41.8 q	43.9 q
	Compost (50 t ha^{-1})	19.67 ab	20.00 b	2568.07 b	2931.50 ab	42.1 p	44.2 p
	Compost (70 t ha^{-1})	19.90 a	21.67 a	2859.07 a	3048.77 a	42.3 o	44.4 o

Means with similar letter(s) in each column are not significantly differed (LSD 5%).

There was no significant difference between head diameter for wheat residue treatments with control at all N rate in first year and in 0 and 60 kg N ha^{-1} in second year. In other wheat residue as well as in all compost rates, a significant increase in head diameter was obtained with organic materials application (Table 5).

Application of wheat residue significantly increased seed yield only with 180 kg N ha^{-1} in first and in 120 and 180 kg N ha^{-1} in second year. Compost at all N rates significantly increased seed yield in both years, however there were no significant difference between 50 and 70 t ha^{-1}.

The higher positive impact of 50 t ha^{-1} compost on seed yield (20.1% compared to control) was obtained with 120 kg N ha^{-1}, while 70 t ha^{-1} of compost had more effect on seed yield (20.1% compared to control) with 180 kg N ha^{-1}. The highest seed yield (3048.8 kg ha^{-1}) was achieved with 70 t ha^{-1} compost combined with 180 kg N ha^{-1} (Table 5).

Seed yield had positive and significant correlation with its components (Table 6), with the highest correlation (+0.968**) identified for seeds number per head and thousand seed weight (+0.942**).

Biological yield also positively and significantly correlated with all components and head weight had the highest correlation (+0.926**) with biological yield (Table 6).

Table 6. Correlation coefficients between traits in sunflower (means of two years)

	SD	HD	SN	US	HW	TSW	SY	BY	SOC
Stem diameter (SD)	1.000								
Head diameter (HD)	0.535*	1.000							
Seed number (SN)	0.351	0.986**	1.000						
Unfilled seeds (US)	0.221	0.502*	0.485*	1.000					
Head weight (HW)	0.604*	0.882**	0.862**	0.455*	1.000				
Thousand seed weight (TSW)	0.362	0.918**	0.912**	0.640**	0.858**	1.000			
Seed yield (SY)	0.659**	0.915**	0.968**	0.553*	0.929*	0.942**	1.000		
Biological yield (GY)	0.472*	0.855**	0.901**	0.268	0.926**	0.891**	0.973**	1.000	
Seed oil content (SOC)	0.101	-0.613**	-0.557*	-0.115	-0.553*	-0.527*	-0.649*	0.792**	1.000

** and * are representing significance rates of 0.01, 0.05, respectively.

Discussion

The minimum use of chemical fertilizers in agricultural practices is of the main concerns worldwide and promote global low use of chemicals. Distribution of natural and organic materials in agricultural lands leading to both high productivity and soil stability (Gholamhoseini et al., 2013). In this research, the two rates of compost had higher positive effect on sunflower growth parameters and seed yield than wheat crop residues. Incorporation if crop residues into the soil increased these parameters more than control treatment as well. Municipal compost contains humic acid, additive material necessary for plant growth, and also nutritional elements vital for plant growth; therefore, its application probably increased growth rate of sunflower.

On the other hand, application of combined N fertilizer and compost increased crop productivity showing the superiority of integrated managements in farming practices. Meanwhile, maintaining wheat crop residues as in-site accompanied by reduced tillage practices might assist higher soil water contents and its availability, which was reported by others (Abdyl-Razak et al., 2014; Kumar & Aryan, 2016).

Our results are in agreement with Adebayo et al. (2012) and Zhao et al. (2016). Adebayo et al., (2012) reported that leaves number per plant and plant height of sunflower increased with increased compost rate.

Zhao et al. (2016) reported that incorporation of maize (*Zea mays* L.) straw into the soil significantly increased yield and production of sunflower.

Application of both compost and wheat crop residues significantly enhanced yield components compared to control treatment. However, compost accompanied by N fertilizer application profoundly increased yield and yield components (with the rate from 20 to 55%). On the contrary, satisfactory availability of soil N (Table 1) is essential to achieve high seed yield and production of sunflower (Montemurro et al., 2005). Leaf area index was the lowest with the no N and increased with higher N rate and was higher with compost and residue application in the first and with compost application in the second year.

Better effect of organic matters in the first year might be due to lower temperatures during summer and a little more precipitation throughout the growing season in this year (Fig. 1).

Similarly, several authors have reported higher availability of nutrients, such as N and P as well as water under organic materials application compared to conventional systems (Robacer et al., 2016; Tesfai et al., 2016).

Subsequently, proper rate of N fertilizer applied along with organic farming systems could lead to acceptable yield and sustainability of farmlands. The positive effects of organic materials application on some other crops have shown that application of compost, alone or in combination with chemical fertilizers, significantly enhanced crop yield and yield components (Montemurro et al., 2005; Marchesini et al., 1988; Havlin et al., 1990; Khatik & Dikshit, 2001; Jones et al., 2016; Litaor et al., 2017).

Higher N rates decreased seed oil content due to higher vegetative growth of plant, however seed oil contents increased with compost application and increase the rate. This shows that higher compost (70 t ha^{-1}) rate might induce higher seed oil content with acceptable seed yield. It seems that higher oil content in compost treated plants was related to supply essential nutrient in soil for plants. The result of Otie et al. (2016) suggested that the adequate plant nutrition increased amino acids synthesis in maize and enhanced oil content.

Conclusions

The overall results of this study showed that higher N rates increased growth, yield, and yield components of sunflower. Application of organic materials integrated with low chemical inputs could result in an economical and sustainable approach for improve growth and yield, however, N application alone decreased organic materials led to higher seed oil content. Application of organic matters, either as municipal compost or crop residue increased growth, yield, and seed oil content. Furthermore, the influence of compost was more pronounced than wheat residues application in higher seed yield production. Higher compost (70 t h^{-1}) and lower N fertilizer (60 kg ha^{-1}) application rates could be an optimum combination to achieve acceptable seed yield and ecological sustainability.

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