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Original Research Article

Nitrogen, Manure and Municipal Waste Compost Effects on Yield and Photosynthetic Characteristics of Corn (*Zea mays* L.) Under Weedy Conditions

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ABSTRACT

A two-year field experiment was carried out to investigate the effects of nitrogen, composted manure, municipal waste compost, and weeds on yield and photosynthetic characteristics of corn. Experimental design was split split plot factorial with 3 replications. Main plots were weedy and weed-free, sub plots were nitrogen fertilizer levels [0 (N_0) and 200 (N_{200}) kg N ha^{-1} as urea], and sub sub plots were factorial application of municipal waste compost [0 (C_0), 25 (C_1) and 50 (C_2) t ha^{-1}] and manure [0 (M_0), 25 (M_1) and 50 (M_2) t ha^{-1}] with all possible combinations. Manure and municipal compost increased photosynthetic rate (A) (27 and 7 %, respectively), stomatal conductance (g_s) (12 and 25 %, respectively) and chlorophyll content of corn leaves same as nitrogen fertilizer. There was no significant difference between C_2+M_2 and C_2+M_2+N_{200} for corn yield. Weed presence significantly decreased A, g_s, chlorophyll content, and yield of corn. Increase in organic or inorganic fertilizers did not decrease the detrimental effect of weeds on corn. Our results showed these organic amendments are valuable potential as nutrient sources for corn production and allow our farmers to recycle livestock and municipal waste products; however, they could also increase weed competition. These findings can use to improve organic fertilization as an essential part of integrated weed management.

Key Words: Crop yield, fertilization, integrated weed management, organic amendments

Abbreviations: Composted manure (M), municipal waste compost (C), nitrogen (N)

INTRODUCTION

Corn (*Zea mays* L.) is one of the three main crops in the world. It is increasingly becoming a very important crop in Iran, especially in Fars province. Nitrogen (N) is a key nutrient element with an essential role in corn production within province. However, the excessive N application by local farmers has raised major concerns. Nitrogen fertilization management is very crucial due to its high environmental risks and cost (Kazemeini 2007).

Increasing soil organic matter content by adding organic amendments has been shown as a worthwhile practice for retaining soil quality (Wander *et al.* 2002). Alternative agricultural practices such as application of organic fertilizers, municipal waste compost and manure have been promoted as environmentally beneficial (Magdoff and Van Es 2009) by reducing agricultural impacts on water quality.

In the world as well as in Iran, municipal waste production is increasing. It is clear that its accumulation and burial is labor-intensive and costly (Kazemeini 2007). Collecting municipal wastes of major cities in Iran and converting them to the compost can provide 2.5 million tons of organic fertilizer which could partially meet soil nutritional demands (Kalbasi 1995). Thus, they can use as potential alternative resources of essential nutrients for crop production. However, unreasonable application of municipal waste compost and/or its low quality can lead to build up of pollutants such as heavy metals in the soil (Weber *et al.* 2007), that would affect the metabolism of living organisms (Watanabe and Suzuki 2002, Lin *et al.* 2007). When applying manures, it is necessary to take account of the potential limitations such as pathogen contamination of crops for direct human consumption, accumulations of toxic metals, and pollution for water, soil and air. It can also be a possible source of weed seeds (Eghbal and Power 1994). Although in recent years, many farmers have shown interest in using municipal waste compost and manure to provide soil nutrient and organic matter in Iran's farming systems, some have been concerned that application of manure to their fields may enhance weed infestation or introduce new weeds, thus compelling them to alter or intensify their weed management programs.

Changes in crop soil fertility levels have a large impact on the competitive interactions with weeds. Nitrogen is generally the most important nutrient in weed competition. Increase in the N supply can enhance

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crop yields (Tollenar *et al.* 1994, Abouzeima *et al.* 2007) or reduce crop yields (Andreasen *et al.* 2006) when weeds exist in crop fields.

Manure and compost may also have effect on weed-crop competitive interactions that could be different from N fertilizer (Davis and Liebman 2002). It may be because of the speed of N release or form of nitrogen. The speed of N release in manure is lower than N fertilizer (Eghbal and Power 1999). Greater knowledge of organic and inorganic fertilizer impacts on weed-crop competitive interactions could aid in improving fertilization strategies as a part of integrated weed management.

This research was carried out to determine the effects of N, composted manure (cattle manure) municipal waste compost (kitchen and yard waste), and weeds on yield and some photosynthetic characteristics of corn. To the best of our knowledge, this is the first experiment that examines the effects of organic and inorganic fertilizer on corn photosynthetic characteristics under weedy conditions.

MATERIALS AND METHODS

Field site

A two-year field experiment was carried out in 2008 and 2009 at the Research Field of Agricultural College of Shiraz University, Shiraz, Iran (53.35°N/29.40°E). Plots were located on a silty loam soil with 0.76 % organic matter, 0.08 % N, 21.8 mg kg^{-1} phosphorus, 600 mg kg^{-1} potassium, pH of 7.85, and EC of 0.52 dSm^{-1}.

Field experiments

Commercial corn seeds, cultivar 370, were sown on June 22, 2008 and 2009 in 3×6 m plots using pneumatic planter at a depth of 5 cm. Each plot consisted of 4 rows spaced 75 cm apart expecting a plant density of 80, 000 plants ha^{-1}. Seedbed preparation consisted of disking and plowing. Experimental design was split split plot factorial with 3 replications. Main plots were weedy and weed-free, sub plots were nitrogen fertilizer [0 (N_0) and 200 (N_{200}) kg N ha^{-1} as urea], and sub sub plots were factorial application of municipal waste compost [0 (C_0), 25 (C_1) and 50 (C_2) t ha^{-1}] and manure [0 (M_0), 25 (M_1) and 50 (M_2) ton ha^{-1}] with all possible combinations.

Nitrogen fertilizer was applied at 200 kg ha^{-1}, a rate considered common among corn farmers of the region. One-third of N fertilizer was hand-broadcasted at planting, one-third top-dressed at six-leaf stage and the remaining was applied at tasseling. Compost and manure were evenly incorporated into the soil. Selected characteristics of compost and manure are given in Tables 1 and 2. Irrigation intervals were 8 days according to the ordinary local practice. All plots were kept free from pests and diseases during the growing season. Weeds in weed-free plots were removed by hand every 2 weeks during first month of the experiment and every week thereafter. No chemical herbicides were used in this experiment.

Table1. Some characteristics of manure that was applied in this experiment.

pH	EC(dS/m)	Total N (%)	C/N	P (mg/kg)	K (mg/kg)
8.7	7.9	2.15	21	8000	341

Table 2. Some characteristics of municipal waste compost that was applied in this experiment.

pH	EC (dS/m)	Total N(%)	C/N	P (%)	K (%)	Cr (mg/kg)	Pb (mg/kg)	Cd (mg/kg)	Ni (mg/kg)	Cu (mg/kg)	Mn (mg/kg)	Zn (mg/kg)
6.9	11.56	1.42	21.41	0.63	0.61	49.03	187.57	6.43	71	281.92	352.64	826.23

Measurements

Net photosynthesis (A) and stomatal conductance (g_s), were taken at 6-leave stage (vegetative stage) and tasseling (reproductive stage) using photosynthesis meter (LCi, UK).Chlorophyll content (SPAD readings value) was also measured on upper leaves of 10 plants per plot using chlorophyll meter (SPAD Model 502, Minolta, Japan) and average values were recorded for each plot. At corn maturity, November 10th , the two middle rows from each plot were sampled for determination of yield and yield components, oven-dried at 75 ºC for 72 h, and weighed. Data were subjected to analysis of variance (ANOVA) and the means were compared (LSD test, $p<0.05$) using SAS (Version 9.1 2002) and M STAT-C (Version 2.4) software.

RESULTS AND DISCUSSION

Dominant weeds

In both years of the experiment, dominant weeds across all the plots were field bindweed (*Convolvulus arvensis*), high mallow (*Malva sylvestris*), redroot pigweed (*Amaranthus retroflexux*), wild safflower (*Carthamus* spp.), prostrate pigweed (*Amaranthu sblioides*), common lamsquarters (*Chenopodium* album), and ground cherry (*Physalis alkekengi*).

Photosynthesis rate (A)

In both years and at both vegetative (A1) and reproductive sampling (A2), A was affected by weed ($p<0.05$), N ($p<0.05$), compost ($p<0.05$) and manure ($p<0.05$) (Tables 3 and 4). Weed pressure caused 32 % and 45 % reduction in A1, and 45 % and 50 % in A2 in 2008 and 2009, respectively. The greater reduction in A in the second year of the experiment could be explained by the greater weed density, primarily redroot pigweed (*Amaranthus retroflexus*). The lower values of A in the weedy treatment than those of weed-free were not due to irradiance because when A was measured, care was taken so that leaves were unshaded. Giovani *et al.* (2008) also found that infection of branched broomrape (*Orobanche ramosa*) in tomato could significantly decrease the photosynthesis rate of the crop. Our results are in accordance with Iqbal and Wright (1999) who have found that competition of *Phalaris minor*, *Chenopodium album* and *Sinapis arvensis* led to decrease in flag leaf photosynthesis of spring wheat. It is unlikely that weeds competed with corn for height at the vegetative growth stage since their height was lower than corn at that time.

Table 3. Main effects of weeds (W), compost (C), manure (M), and nitrogen (N) on photosynthesis (A), stomatal conductance (g_s) at vegetative (1) and reproductive (2) stage of corn growth and corn grain yield in 2008.

Source of variation	A1 (µmol m^{-2} s^{-1})	gs1 (mol m^{-2} s^{-1})	Grain Yield (kg)	SPAD readings 1	A2 (µmol m^{-2} s^{-1})	gs2 (mol m^{-2} s^{-1})	SPAD readings 2
W0	35.6	0.4	12569.64	46	30.8	0.29	52.6
W1	24.2	0.24	8685.51	42	17	0.17	43.5
LSD value(p<0.5)	3.6	0.02	319.8	0.8	5.4	0.02	2.5
N0	28.9	0.28	10450.9	42.9	22.3	0.21	45.5
N200	31.01	0.35	10804.3	45.1	25.5	0.26	50.7
LSD value(p<0.5)	0.5	0.01	86	0.2	2	0.01	0.18
C1	28.9	0.29	10177.3	45.6	21.9	0.21	50
C2	29.1	0.30	10041.3	43.3	22.3	0.22	47
C3	31.4	0.33	11064.1	43	25.5	0.24	46.9
LSD value(p<0.5)	0.7	0.01	105.27	0.2	3	0.01	0.2
M1	24.8	0.27	9298.92	40.8	19.6	0.19	46.2
M2	30.3	0.30	10933.5	45.3	23.1	0.20	47.8
M3	34.7	0.34	11650.4	45.7	28.1	0.24	50.23
LSD value(p<0.5)	0.7	0.01	105.27	0.2	4	0.01	0.2

Table 4. Main effects of weeds (W), compost (C), manure (M), and nitrogen (N) on photosynthesis (A), stomatal conductance (g_s) at vegetative (1) and reproductive (2) stage of corn growth and corn grain yield in 2009.

Source of variation	A1 (µmol m^{-2} s^{-1})	gs1 (mol m^{-2} s^{-1})	Grain Yield (kg)	SPAD readings 1	A2 (µmol m^{-2} s^{-1})	gs2 (mol m^{-2} s^{-1})	SPAD readings 2
W0	18.5	0.19	11757.7	41.6	28.9	0.28	48.9
W1	33.5	0.3	5202	37.9	14.5	0.24	40.5
LSD value(p<0.5)	4.3	0.03	3547	3	6.14	0.01	1.8
N0	23.6	0.21	7953.8	40.7	20.8	0.23	42
N200	28.4	0.28	9006	38.8	22.7	0.29	47.3
LSD value(p<0.5)	3	0.02	715.19	2	0.3	0.01	1
C1	24.8	0.23	7215.4	37	20.4	0.24	43.6
C2	25.1	0.24	9042.5	39.5	21.1	0.25	43.86
C3	27.3	0.26	9881.8	41.19	22.9	0.27	46.7
LSD value(p<0.5)	1	0.01	875.93	2	1	0.01	2
M1	21.7	0.21	7180	36.9	17.8	0.21	43
M2	26.8	0.25	8226.5	41.05	21.6	0.22	44
M3	29.6	0.27	10033	41.3	25.7	0.36	46
LSD value(p<0.5)	0.4	0.01	870	3	0.4	0.1	1

Nitrogen could cause 41 % and 52 % increase in A1 and 51 % and 53 % in A2 in 2008 and 2009, respectively. It has been reported that N could increase photosynthesis and plant growth of different crops (Cechin and Fumis 2004, Dordas and Sioulas 2008, Vos *et al.* 2005). However, other researchers have found no effect of N on photosynthesis, especially under dry conditions (Shangguan *et al.* 2000). It is noted that up to 75% of leaf N content exists in chloroplasts and most of it only constitutes ribulose bisphosphate carboxylase (Rubisco). The lower photosynthesis rate that has been seen under conditions of N limitation is often known to be due to the reduction in chlorophyll content and Rubisco activity (Toth *et al.* 2002).

Although compost could increase A in both years, no significant difference between 0 and 25 t ha^{-1} was found. This shows that 50 t compost ha^{-1} was able to increase A therefore, it is an appropriate rate to increase corn yield. These results are in agreement with those of others who have stressed that municipal waste compost can stimulate photosynthesis (Gurrero *et al.* 2001, Lakhdar *et al.* 2008). The enhancement in photosynthesis in our experiment might be because of improvement in Rubisco capacity (Arena *et al.* 2005, Lakhdar *et al.* 2008) which might be associated with an improvement of the soil with humic substances (Delfine *et al.* 2005). These substances seem to have hormone-like activities via their participation in photosynthesis and different enzymatic reactions (Muscolo *et al.* 1999) and can eventually have a positive impact on plant growth and productivity.

Indiscriminate additions of composts and/or their low quality might accumulate heavy (e.g. Pb and Cd) metals in soil (Weber *et al.* 2007) and consequently could have a detrimental effect on living organisms' metabolism (Watanabe and Suzuki 2002, Lin *et al.* 2007). For instance, it can cause a decrease in plants growth. Based on our results, it could be concluded that the municipal waste compost used in this experiment had a good quality (include no excessive amount of heavy metals) with the appropriate application rate which caused no deleterious impact on A.

All levels of manure had a significant positive effect on A at both measurements, in both years. Manure application even at a low rate, 25 t ha^{-1}, could increase 40 % and 39 % in A1 and 48 % and 35 % in A2 in 2008 and 2009, respectively. Studying the effects of manure Liu *et al.* (2004) reported that application of manure significantly increased photosynthetic rates of maize, soybean, and wheat. Several workers have also demonstrated that application of manure could promote nutrient availability (Eghbal and Power 1999, Butler *et al.* 2008). Our results revealed that composted manure can increase soil nutrients availability and satisfy crop demands.

The lowest A1 and A2 values were obtained at the weedy and unfertilized treatment, in both years. There were no significant difference among A1 and A2 at high rates of manure, compost and nitrogen, in both years (Tables 5 and 6).

Stomatal conductance (g_s)

In both years weed pressure caused a decrease in g_s (Tables 3 and 4). This is consistent with Iqbal and Wright (1999) who found that interference of some weeds species could significantly diminish g_s of wheat. Competition of weed species with corn for water could be considered to be likely explanation for the decrease in g_s at weedy treatment. It is obvious that weeds compete for water and could diminish water availability and lead to crop water stress. They have either as much or often more water requirement than crops and are often more successful to gain it (Zimdhal 2007).

Nitrogen had also a significant effect on g_s, in both years (Tables 3 and 4). Reports on the effect of N on g_s are contradictory. Some researchers have found higher rates of g_s in high N-grown plants (Broadly *et al.* 2000, Shanggun *et al.* 2000, Tadayon 2006). In contrast, others have reported opposite impact (Ciompi *et al.* 1996) or no effect (Grassi *et al.* 2002) of nitrogen on g_s.

In both years and at both samplings, compost only at the rate of 50 t ha^{-1} resulted in a significant increase in g_s. No significant difference was found between 0 and 25 t manure and compost ha^{-1}. However, all levels of manure could significantly increase g_s. A number of researchers have shown that manure and compost application caused an increase in crop growth and yield as much as inorganic fertilizers do (Kato and Yamagishi 2011, Montemurro *et al.* 2006, Zheljazkov *et al.* 2006).

At both samplings, the highest rates of g_s were obtained with mixture of organic and inorganic fertilizer and the lowest rate was achieved at the weedy and unfertilized treatment, in both 2008 and 2009 (Tables 5 and 6). Our results are in accordance with those of Iqbal and Wright (1999).

Leaf chlorophyll content

Corn leaf chlorophyll content was higher in both organic (8%) and inorganic (8%) fertilized treatments than in unfertilized treatments, and also higher in the weed free (13%) treatments than weedy treatments (Tables 3 and 4). This indicated that organic materials (manure and compost) like chemical fertilizers could increase soil fertility and satisfy the nutrient demands of crops. These results also revealed that organic fertilizers can provide sufficient nutrient supply for crop growth and development. Studying response of corn genotypes to weed interference and nitrogen in Nigeria, Chikoye *et al.* (2008) reported that in both low and high weed pressure, leaf chlorophyll content were lower than weed free treatments. In fact, weeds could exploit both organic and inorganic fertilizers more than corn and it led to nutrient deficiency for corn.

Table 5. Interaction effects of Weeds (W), compost (C), manure (M) and nitrogen (N) on photosynthesis (A), stomatal conductance (g_s) at vegetative (1) and reproductive (2) stage of corn growth and corn grain yield in 2008.

			A1 (μmol m^{-2} s^{-1})		gs1 (mol m^{-2} s^{-1})		SPAD readings 1		A2 (μmol m^{-2} s^{-1})		gs2 (mol m^{-2} s^{-1})		SPAD readings 2		Kernel yield (kg)	
W	M	C	N0	N200	N0	N200	N0	N200	N0	N200	N0	N200	N0	N200	N0	N200
1	1	1	13.86	37.62	0.17	0.33	30.5	42.5	13.32	31.5	0.14	0.26	30.5	42.5	8916	11450
		2	21.98	37.62	0.23	0.34	30.5	41.5	19.72	32.5	0.19	0.28	30.5	41.5	9173	11560
		3	25.74	37.22	0.23	0.34	42.5	42.5	22.67	30.5	0.2	0.25	42.5	42.5	9723	12110
	2	1	25.9	36.4	0.23	0.34	41.5	41.58	22.77	30.4	0.2	0.25	41.5	41.58	10830	12230
		2	27.13	37.6	0.3	0.35	41.5	42.5	23.38	33.65	0	0.26	41.5	42.5	11240	13390
		3	38.71	36.1	0.3	0.35	42.5	44.35	32.53	33.35	0.25	0.27	42.5	44.35	13380	13680
	3	1	38.61	37.6	0.31	0.37	42.5	42.5	32.64	32.53	0.26	0.26	42.5	42.5	13490	13800
		2	38.61	38.5	0.32	0.36	44.3	43.4	32.43	33.55	0.25	0.28	44.3	43.4	15210	15350
		3	37.6	38.6	0.33	0.37	44.35	44.3	29.9	33.86	0.25	0.28	44.35	44.3	15210	15510
2	1	1	9.5	15.84	0.06	0.22	27.9	38.8	9.35	12	0.09	0.18	27.9	38.8	6710	9284
		2	14.85	17.82	0.14	0.22	27	38	12.2	11.18	0.096	0.2	27	38	7949	8409
		3	15.15	16.83	0.13	0.23	38.8	39	12.2	11.18	0.1	0.2	38.8	39	8465	7254
	2	1	17.82	19.8	0.14	0.23	39.7	38.8	14.13	12.2	0.11	0.2	39.7	38.8	8316	8255
		2	18.71	19.8	0.2	0.24	39	39	14.4	12.6	0.12	0.2	39	39	9386	9719
		3	21.78	21.8	0.2	0.23	40	37	16.27	14.6	0.13	0.2	40	37	10450	10320
	3	1	22.77	22.77	0.2	0.2	39	39	21.35	16.5	0.16	0.2	39	39	8807	7750
		2	20.79	20.79	0.2	0.2	40	38	22.37	15.8	0.17	0.2	40	38	9385	8622
		3	21.78	18.81	0.21	0.2	40	36	22.37	15.5	0.18	0.2	40	36	9189	7478
LSD value ($p<0.05$)			1.85		0.04		3		1.2		0.03		10		364.7	

Table 6. Interaction effects of compost (C), manure (M) and nitrogen (N) on photosynthesis (A), stomatal conductance (g_s) at vegetative (1) and reproductive (2) stage of corn growth and corn grain yield in 2009.

			A1 (μmol m^{-2} s^{-1})		gs1 (mol m^{-2} s^{-1})		SPAD readings 1		A2 (μmol m^{-2} s^{-1})		gs2 (mol m^{-2} s^{-1})		SPAD readings 2		Kernel yield (kg)	
W	M	C	N0	N200	N0	N200	N0	N200	N0	N200	N0	N200	N0	N200	N0	N200
1	1	1	13.86	37.62	0.17	0.33	30.5	42.5	13.32	31.5	0.14	0.26	30.5	42.5	5074	12290
		2	21.98	37.62	0.23	0.34	30.5	41.5	19.72	32.5	0.19	0.28	30.5	41.5	8386	13140
		3	25.74	37.22	0.23	0.34	42.5	42.5	22.67	30.5	0.2	0.25	42.5	42.5	9177	11790
	2	1	25.9	36.4	0.23	0.34	41.5	41.58	22.77	30.4	0.2	0.25	41.5	41.58	10970	10120
		2	27.13	37.6	0.3	0.35	41.5	42.5	23.38	33.65	0	0.26	41.5	42.5	12000	12330
		3	38.71	36.1	0.3	0.35	42.5	44.35	32.53	33.35	0.25	0.27	42.5	44.35	13100	13400
	3	1	38.61	37.6	0.31	0.37	42.5	42.5	32.64	32.53	0.26	0.26	42.5	42.5	13800	14100
		2	38.61	38.5	0.32	0.36	44.3	43.4	32.43	33.55	0.25	0.28	44.3	43.4	15400	15550
		3	37.6	38.6	0.33	0.37	44.35	44.3	29.9	33.86	0.25	0.28	44.35	44.3	15570	15620
2	1	1	9.5	15.84	0.06	0.22	27.9	38.8	9.35	12	0.09	0.18	27.9	38.8	2039	2942
		2	14.85	17.82	0.14	0.22	27	38	12.2	11.18	0.096	0.2	27	38	6588	4369
		3	15.15	16.83	0.13	0.23	38.8	39	12.2	11.18	0.1	0.2	38.8	39	5406	4969
	2	1	17.82	19.8	0.14	0.23	39.7	38.8	14.13	12.2	0.11	0.2	39.7	38.8	4607	4691
		2	18.71	19.8	0.2	0.24	39	39	14.4	12.6	0.12	0.2	39	39	5042	4466
		3	21.78	21.8	0.2	0.23	40	37	16.27	14.6	0.13	0.2	40	37	4757	4932
	3	1	22.77	22.77	0.2	0.2	39	39	21.35	16.5	0.16	0.2	39	39	5793	4529
		2	20.79	20.79	0.2	0.2	40	38	22.37	15.8	0.17	0.2	40	38	7130	6420
		3	21.78	18.81	0.21	0.2	40	36	22.37	15.5	0.18	0.2	40	36	6505	5456
LSD value ($p<0.05$)			1.85		0.04		3		1.2		0.03		10		303.4	

Grain yield

In both 2008 and 2009, weed-free corn grain yield was significantly higher than weedy treatments (Tables 3 and 4). The yield losses caused by weed competition were 30 % and 56 % in 2008 and 2009, respectively. Nitrogen, compost and manure also significantly affected corn grain yield in both years (Tables 3 and 4).

In both years of the experiment, highest corn grain yield was obtained at weed-free, 200 kg N ha^{-1}, 50 t compost and manure ha^{-1}, which was not significantly different from weed free, 0 kg N ha^{-1}, 50 t compost and manure ha^{-1} and weed free, 0 kg N ha^{-1}, 50 t compost and 25 manure ha^{-1} (Tables 5 and 6). A possible reason for this increase in yield would be adequate nutrients supplied by manure and compost for maximum corn grain yield. Our results are in accordance with others who have found that municipal waste compost (Kazemeini 2007, Zheljazkov *et al.* 2006, Montemurro *et al.* 2006, Lakhdar *et al.* 2008) and manure (Singer *et al.* 2010, Prabhakar *et al.* 2011, Kato and yamagishi 2011, Meade *et al.* 2011) could increase crops yield. Other contributing factors might be greater soil water use efficiency and improved soil quality caused by these organic fertilizers. Increasing composted manure rates resulted in an increase in water infiltration rate and soil water retention (Butler and Muir 2006, Kazemeini 2007). The lowest corn grain yield was obtained at weedy, 0 kg N, 0 t compost and manure ha^{-1}. In contrast, a number of investigators have also reported no effect of manure and compost on some crops yield (Liebman *et al.* 2004, Menalled *et al.* 2005, Mkhabela and Warman 2005).

Nitrogen fertilizer, manure and compost did not increase corn yield in weedy plots compared to unfertilized control (weed-free). However, some incorporated fertilizer treatments (25 t manure and 25 t compost, 25 t manure and 50 t compost, 50 t manure and 25 t compost, 50 t manure and 50 t compost, 25 t manure, 25 t compost and 200kg N ha^{-1}, 25 t manure, 50 t compost and 200kg N ha^{-1}) in the first year of the experiment and only one (50 t manure and 25 t compost) in the second year had slightly higher yields compared with the unfertilized control treatment.

In the first year of the study, the corn yields in weedy plots which were treated by compost and manure were higher than those in the second year. Interestingly, this could provide some evidences that weeds sometimes benefited equally or more from manure and compost than from nitrogen fertilizers. It is likely attributed to gradual release of nitrogen from manure and compost (Eghbal and Power 1999). These results are in agreement with those of Blackshaw (2005) and Blackshaw *et al.* (2005) on spring and winter wheat under conditions of weed competition. Liebman *et al.* (2004) have similarly documented that composted swine manure increased the competitive ability of velvetleaf (*Abutilon theopherasti*) and common waterhemp, while it had no effect on corn yield. It has also been reported that composted swine manure increased common waterhemp competitive ability with no increase in soybean grain yield. Crop fertilization manipulation is known as an important feature of long-term integrated weed management systems (Blackshaw *et al.* 2005). Thus, when these types of organic fertilizers are applied, besides their benefits for crops, their beneficial impact on weeds should be taken into account.

CONCLUSION

The results of the present study showed that compost and manure did not have detrimental effects on corn leaf photosynthesis rate. We also found that, although manure and compost showed valuable potential as N sources and increased corn grain yield and also allows our farmers to recycle livestock and municipal waste products, they could also increase the level of weed competition. Future works should investigate the effects of both organic and inorganic fertilizers on leaching of nitrate as its excess in the ground water could be very harmful for human health. Moreover, it is worthy to study whether different methods of organic fertilization could affect corn grain yield and/or weeds growth and as a results weed-crop interaction.

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