Shiraz University

Iran Agricultural Research (2015) **34**(**1**) 1-7

Effects of manure, municipal waste compost and nitrogen on weed communities in corn (*Zea mays* L.)

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ARTICLE INFO

***Article history*:**
Received **13 February 2013**
Accepted **21 September 2013**
Available online **2 June 2015**

***Keywords*:**
Organic amendments
Fertilizer
Weed composition
Corn field

ABSTRACT - A two year field experiment was carried out to evaluate the effects of municipal waste compost (C), composted cattle manure (M), and nitrogen (N) on growth and composition of weeds in a corn field in Shiraz using a split-split plot design with 3 replicates. Visual inspection of the plots showed that the manure treatments neither introduced new weed species nor increased weed density more than the other treatments. In both years of the experiment, redroot pigweed (*Amaranthus retroflexus* L.), field bindweed (*Convolvulus arvensis* L.), high mallow (*Malva sylvestris* L.) were dominant species, respectively. Multivariate analysis showed that wild safflower (*Carthamus* spp.) was associated with control, redroot pigweed with 25 tons (t) compost ha^{-1}, and 50 t compost ha^{-1}, prostrate pigweed (*Amaranthus blioides* L.) with N, and ground cherry (*Physalis alkekengi* L.) with 50 t manure ha^{-1}. Our results showed that contrary to the idea that application of manure might increase the risk of new weed species introduction and/or abundance of certain weed species, no introduction of new weed species or increase in certain weed species was obviously found.

INTRODUCTION

Most agricultural soils of Iran have poor physical conditions due to their low organic matter (OM), usually less than 1% and thus, enhancing OM of these soils is of prime concern. Recently, public concerns have been raised about the potential environmental pollution caused by indiscriminate use of chemical fertilizers as well as the increase in their costs. These accompanied by the concerns over the sustainable agriculture have created an interest in using organic amendments (Maftoun et al., 2004). In Iran, municipal waste (namely, kitchen and yard wastes) and animal manure production are increasing due to urbanization and intensive industrial animal husbandry.

Clearly, their accumulations and burials are labor-intensive and costly (Kazemeiniet et al., 2008). It has been reported that collecting municipal waste of major cities of Iran and converting them to the compost provide 2.5 million t of organic fertilizer per year which could partly meet the soil nutritional demands (Kazemeini, 2007). Therefore, they might be used as potential alternative resources of nutrients for crop production (Kazemeini et al., 2008). When applying manures, it is necessary to take account of its potential limitations such as accumulations of toxic metals. It can also be a possible source of weed seeds (Eghbal and Power, 1994). Additionally, they might increase weed growth (Eghball et al., 2002). It has been reported that organic farming can enhance weed diversity and change weeds composition either via enhancing the seed density of weed species that are already present on a site or through introducing new weed species (Hole et al., 2005; Mt. Pleasant and Schlather, 1994). Therefore, these larger and more diverse weed communities created by organic amendments can cause greater crop yield losses (Davis et al., 2005a; Davis et al., 2001b). Since various weed species have shown to have different patterns in emergence and growth due to the application of composted manure (Liebman et al., 2004; Menalled et al., 2005), manure might have an impact on the spread of weed communities (Cook et al., 2007).

Although in recent years, many farmers have shown interest to use municipal waste compost and manure, some of them are concerned that the application of manure to their fields may enhance weed infestation or introduce new weeds, thus compelling them to change or intensify their weed management programs.However, decayed animal manure has several advantages over fresh manure, such as diminishing the numbers of viable weed seeds, and decreasing the volume and the particle size which can facilitate more uniform application of this organic amendment (Blackshaw et al., 2005). Therefore, the present study was conducted to evaluate the effects of municipal waste compost (C), composted cattle manure (M), and nitrogen (N) on the growth and composition of weeds and to find out whether manure would introduce new weed species.

MATERIALS AND METHODS

Field site

A two-year field experiment was carried out at the research field in College of Agriculture, Shiraz

University, Shiraz, Iran (53 35°N2940°E) in 2008 and 2009 growing seasons. Soil texture was a silty loam 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 hand-sown on June 22, 2008 and 2009 in 3×6 m plots using pneumatic planter at a depth of 5 cm. Each plot had 4 rows spaced 75 cm apart expecting a plant density of 80, 000 plants ha^{-1}. Seedbed preparation consisted of plowing and disking. Experimental design was split-split plot factorial design with 3 replicates. Main plots were weedy and weed-free, and sub plots were N 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 composted cattle manure [0 (M_0), 25 (M_1) and 50 (M_2)t 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 applied at planting, one-third top-dressed at six-leaf stage and the remaining was applied at tasseling. Compost and manure were uniformly incorporated into the soil. Selected characteristics of compost and manure are given in Tables 1 and 2, respectively. Irrigation intervals were 8 days according to the ordinary local practice. All plots were kept free from pests and diseases during the growing seasons. 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 applied in this experiment. Mean monthly precipitation and temperature data during the experiment period are given in Table 3.

Table 1. Some characteristics of manure that was applied in the experiments of this study.

pH	EC(dSm^{-1})	Total N (%)	C/N	P (mgkg^{-1})	K (mgkg^{-1})
8.7	7.9	2.15	21	8000	341

Table 2. Some characteristics of municipal waste compost that was applied in the experiments of this study.

pH	EC (dS/m)	Total N(%)	C/N	P (%)	K (%)	Cr (mg kg^{-1})	Pb (mg kg^{-1})	Cd (mg kg^{-1})	Ni (mg kg^{-1})	Cu (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})
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

Table 3. Mean monthly precipitation and temperature during the experiment period.

Month	Precipitation (mm)		Temperature(°C)	
	2007-2008	2008-2009	2007-2008	2008-2009
June	0	0	23.6	22
July	0	0	25.4	25.5
August	0	0	23.5	25.7
September	0	0	20.1	20
October	0	0	16.4	15.9

Measurements and statistical analysis

To investigate whether manure, compost and nitrogen can alter the weed community, weed counts were randomly made in 2 m^2 quadrate in each sub-sub plot right after corn tasseling. All weeds present in quadrates were counted, identified by species level,
harvested and oven dried at 75 °C for 72 h before being weighed.

Data were subjected to the analysis of variance (ANOVA) and the means were compared (LSD test, $p \leq 0.05$) using SAS (Version 9.1, 2002) and M STAT-C (Version 2.4, 1989) software. Weed density data were square root transformed so that species that occurred frequently enough to have normal error distributions were analyzed (Swanton et al., 1999). Weed community composition was analyzed using principal components analysis via STATGRAPHIC Plus (version 5.1, 2001). The degree of association between weeds, N fertilizer and organic amendments was evaluated by using a vector diagram. The direction of the vector showed the type of association between a weed species and the treatments, and the strength of the association is proportional to the vector length (Yin et al., 2006).

RESULTS AND DISCUSSION

Weeds number and composition

Overall, fourteen weed species were recorded in this study. In the first year of the experiment, dominant weeds across all the plots were field bindweed (*Convolvulus arvensis* L.), high mallow (*Malva sylvestris* L.), redroot pigweed (*Amaranthus retroflexus* L.), wild safflower (*Carthamus* spp.), prostrate pigweed (*Amaranthus blioides* L.), common lamsquarters (*Chenopodium album* L.), and ground cherry (*Physalis alkekengi* L.). Although the dominant weeds were the same in both years of experiment, their abundance rankings were different in the first (Table 4) and second year (Table 5). Moreover, there were some other weeds, such as camel's thorn (*Alhaji comelorum* L.), common purslane (*Portulaca oleracea* L.), heliotrope (*Heliotropium* spp.), common licorice (*Glycirrhiza glabra* L.), Italian thistle (*Cardus pycnocephalus* L.), shepherd's purse (*Capsella bursa-pastoris* L.), and henbit (*Lamium amplexicaule* L.), that did not occur frequently and thus, we did not consider them for weed abundance measurement (Yin et al., 2004). Principal components analysis (PCA) on the weed community data (represented only by the frequent weed species) are given in Fig 1. Weed community under control, C1, C2, N200, and M2 were separated from M1 along the first component (Fig. 1). This component only explained 31.1 % of the total variation. Control, C1, and C2 were also separated from other treatments by the second component, which explained 24 % of the total variation. Additionally, some weed species associations were shown by the PCA diagram. Particularly, wild safflower was associated with control, redroot pigweed with C1, and C2, prostrate pigweed with N, and ground cherry with M2.

Table 4. Weed species abundance under different main treatments in 2008

Weed species	Weed abundance (%)					
	C	C1	C2	M1	M2	N200
Chenopodium album	12	2	10	2	9	2
Amaranthus retroflexus	19	25	20	22	23	25
Carthamus spp.	23	20	12	18	2	11
Amaranthus blioides	9	8	8	4	13	15
Convolvulus arvensis	13	12	22	34	22	11
Physalis alkekengi	2	2	2	2	13	9
Malva sylvestris	22	31	26	18	18	27

Table 5. Weed species abundance under different main treatments in 2009.

Weed species	Weed abundance (%)					
	C	C1	C2	M1	M2	N200
Chenopodium album	2	1	3	2	2	2
Amaranthus retroflexus	39	43	40	41	47	47
Carthamus spp.	22	7	6	1	4	2
Amaranthus blioides	1	5	1	3	4	1
Convolvulus arvensis	16	18	26	34	23	42
Physalis alkekengi	3	1	1	-	4	1
Malva sylvestris	17	25	23	19	16	5

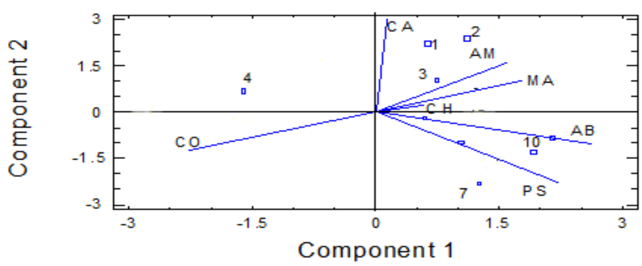

Fig. 1. PCA ordination diagram of weed species under different treatments

+common lamsquarters (CH), redroot pigweed (AM), wild safflower (CA), prostrate pigweed(AB), field bindweed (CO), ground cherry(PS), and high mallow (MA). 1, 2, 3, 4, 7 and 10 refer to as control, 25 t compost ha^{-1}, 50 t compost ha^{-1}, 25 t manure ha^{-1}, 50 t manure and 200 kg N ha^{-1}.

The total weed density means are given in Fig. 2. Surprisingly, there were no significant differences between plots that received cattle manure and the other treatments ($p \leq 0.05$). These results were in accordance with Cook et al. (2007) reported no significant differences between manured and non-manured plots for weed density. Stevenson et al. (1997) also noted that liquid manure treated plots did not have greater weed density than those received N fertilizer. In contrast, Miyazawa et al. (2004) reported that weed density and size enhanced under composted manure application which might be attributed to the introduction of weed seed by manure. Thus, contrary to this idea that the application of manure could increase the risk of new weed species introduction and/or abundance of certain weed species, no introduction of new weed species or increase in certain weed species was obviously found in this study.

A worthy benefit of using decayed manure would be reduced numbers of viable weed seeds. However, it should be considered that frequent addition of manure in the same field might have an impact on weed community overlong period of time (Cook et al., 2007).

Weeds biomass

Weed biomass was affected by N fertilizer in both 2008 and 2009 (Table 6) ($p \leq 0.05$). The unfertilized plot had the lowest weed biomass (Table 6), indicating that the growth of the weeds responded positively to higher N levels of the soil (Blackshaw et al., 2003; Blackshaw et al., 2005). Therefore, indiscriminate N application might benefit weeds at the expense of crops (Blackshaw, 2005). Many researchers found that N fertilizers had an increasing effect on competitive ability of weeds (Carlson and hill, 1985; Dhima and Eleftherohorinos, 2001; Andreasen et al., 2006; Naderi and Ghadiri, 2011). However, some scholars documented that N increased competitive ability of crops (Abouzeima et al., 2007; Cathcart and Swanton, 2004). Interestingly, Blackshaw and Brandt (2008), after studying the effects of nitrogen fertilizer on various weed species, reported that this impact was species dependent.

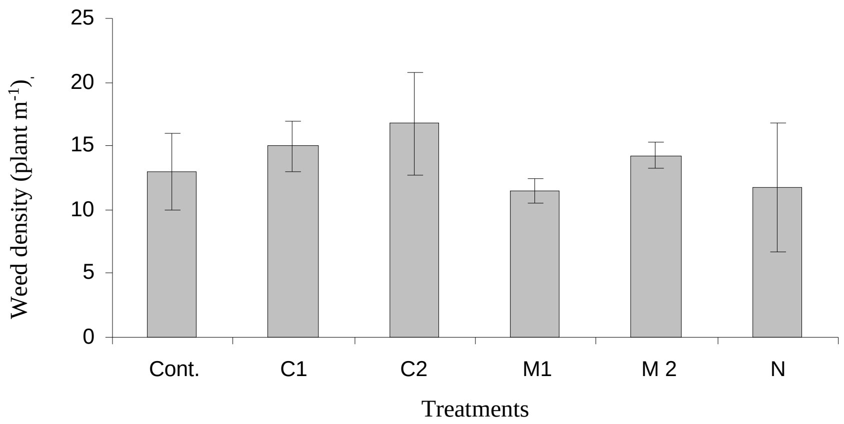

Fig. 2. Effects of main treatments on weed density. Vertical bars show standard deviations. Cont, C1, C2, M1, M2 and N refer to as control, 25 t compost ha^{-1}, 50 t compost ha^{-1}, 25 t manure ha^{-1}, 50 t manure and 200 kg N ha^{-1}

In both 2008 and 2009, composted manure had a significant impact on weed biomass ($p \leq 0.05$) (Table 6). The growth of the weeds in plots treated with manure was greater in the second year than that of in the first year. This was likely because of gradual release of nitrogen from manure over years (Eghbal et al., 2004; Blackshaw et al., 2005). Composted manure altered the abundance and diversity of soil- borne pathogens and mycorrhizal fungi (Menalled et al., 2005). Thus, this modification in the microbial community was probably the underlying reason for increasing growth rates of weeds (Klironomos, 2002).

Similar to the impact of manure on weed biomass, municipal waste compost had also an increasing impact on weed biomass so that all levels of compost increased the trait significantly ($p \leq 0.05$) (Table 6). It was reported that municipal waste compost decreases weeds germination in agricultural fields (Jakobsen, 1995). However, it can also change the weed-crop interaction. In our study, these organic amendments not only increased corn yield (data not shown) but also had an increasing effect on weed biomass. In addition, it was documented that N and organic fertilizers produced the same amount of weed biomass (Eghbal and Power, 1999). Therefore, farmers who use these types of organic fertilizers should carefully consider the detrimental effect of them through increasing weeds competitive ability over crops. Lowest weed biomass was obtained at unfertilized control, while the highest amount of weed biomass was obtained at 200 kg N ha^{-1}, 50 t manure and compost ha^{-1} in both years of the experiment (Tables 6 and 7) ($p \leq 0.05$). This showed that indiscriminate application of nutrients would increase competitive ability of weeds over crops. These results were in agreement with those of Blackshaw et al. (2005). Among the treatments, 50 t manure + 25 t compost ha^{-1} as well as 50 t manure and 50 t compost ha^{-1}produced reasonable corn yield (data not shown) and also the least weed biomass (Table 7).

Table 6. Main effects of weeds (W1), compost (C) manure (M) and nitrogen (N) on weed biomass, in 2008 and 2009.

	2008	2009
Treatments	weed biomass	
N0	276.9	294.70
N200	501.10	530.60
LSD value(p<0.5)	41.684	14.032
C1	334.30	358.00
C2	399.90	384.50
C3	432.70	495.60
LSD value(p<0.5)	23.39	8.56
M1	332.20	344.10
M2	381.60	392.70
M3	453.10	501.40
LSD value(p<0.5)	23.39	9.00

Table 7. Interaction effects of compost (C), manure (M) and nitrogen (N) on weed biomass in 2008 and 2009.

		2008		2009	
M	C	N0	N200	N0	N200
1	1	128.1	289.3	72.55	405.2
	2	196	422.7	170	409.2
	3	356.7	601.2	410.9	634.3
2	1	207.5	310.3	230.4	376.5
	2	330.6	463.2	393.5	390
	3	495	483	404.6	570
3	1	232.5	378.4	283	423.8
	2	261.5	670.3	347	582.5
	3	285.2	891.1	378.5	993.5
LSD value(p<0.5)		57		21	

CONCLUSIONS

The results of the present study showed that application of cattle manure and compost had no effect on weed density. Additionally, manure did not introduce new weeds species. However, long term effects of repeated application of organic amendments should be carefully considered, especially when huge amount of them are used in the same field. Generally, to have less weed competition and, as a result, to gain highest corn grain yield, application of 50 t manure + 25 t compost ha^{-1} as well as 50 t manure and 50 t compost ha^{-1} are recommended to the farmers.

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تحقیقات کشاورزی ایران (۱۳۹۴) ۳۴(۱) ۱-۷

اثر کود دامی، کمپوست زباله شهری و نیتروژن برجوامع علف های هرز مزرعه ذرت (*Zea mays* L.)

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اطلاعات مقاله

تاریخچه مقاله:
تاریخ دریافت: ۱۳۹۱/۱۱/۲۵
تاریخ پذیرش: ۱۳۹۲/۶/۳۰
تاریخ دسترسی: ۱۳۹۴/۳/۱۲

واژه های کلیدی:
افزودنی های آلی
ترکیب علف های هرز
کود شیمیایی
مزرعه ذرت

چکیده - آزمایش مزرعه ای دو ساله به منظور بررسی اثرات کمپوست زباله شهری، کود دامی ، و نیتروژن بر رشد و ترکیب علف های هرز مزرعه ذرت انجام شد. طرح آزمایشی اسپلیت اسپلیت پلات با ۳ تکرار بود. بازرسی چشمی از پلاتها نشان دادکه تیمارهای کود دامی باعث شیوع گونه های علف هرز جدید نشد و همچنین تراکم علف‌های هرز را بیشتر از تیمارهای دیگر افزایش نداد. در هر دو سال آزمایش علف‌های هرز غالب به ترتیب عبارت بودند از تاج خروس ریشه قرمز (*Amaranthu sretroflexus* L.)، پیچک صحرایی (*Convolvulus arvensis* L.) و پنیرک (*Malva sylvestris* L.). تجزیه چند متغیره نیز نشان داد گلرنگ وحشی (*Carthamus* spp.) با تیمار بدون کود، تاج خروس ریشه قرمز با ۲۵ و ۵۰ تن کمپوست در هکتار، تاج خروس خوابیده (*Amaranthus blioides* L.) با نیتروژن و عروسک پشت پرده (*Physalis alkekengi* L.) با ۵۰ تن کود دامی در هکتار رابطه داشت. به طور کلی نتایج نشان داد بر خلاف این ایده که استفاده ازکود دامی ممکن است باعث افزایش خطرمعرفی گونه های جدیدعلف هرز و یا باعث افزایش فراوانی برخی ازگونه های خاص علف هرز شود، در پژوهش حاضر گونه علف هرز جدید و یا افزایش فراوانی گونه خاص علف هرز مشاهده نشد.