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Response of fodder maize to the application of various organic manures prepared from *Ipomoea muricata* weed

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Abstract

Ipomoea muricata (L.) Jacq. is an invasive weed commonly known as morning glory of the family Convolvulaceae. The aim of the present investigation was to study the influence of various manures prepared from *Ipomoea* on the yield and nutrient content of fodder maize. A field experiment was carried out at the research farm located in the Botanical Garden of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, India, to evaluate the performance of various manures, viz. *Ipomoea* NADEP compost (AC), *Ipomoea* Bangalore pit compost (BC), *Ipomoea* vermicompost (IV), *Ipomoea* dry leaf powder (DLP), and garden leaf vermicompost (GLV). These five treatments were compared with chemical fertilizer (FER) and an absolute control (CO) with four replicates each. The root, stem and leaves of maize plants were analyzed for dry matter, N, P, K, Ca, crude protein, and water soluble reducing sugar. The application of all organic manures increased nutrient contents of maize. All the values were statistically significant over the control. *Ipomoea* vermicompost (IV) was the most effective in enhancing fodder maize yield (39861 kg/ha). Compared to chemical fertilizer, organic manures prepared from *Ipomoea* are a better, an effective, and a cheaper source of plant nutrients in maize production for Indian farmers.

Keywords: Compost, green manure, fertilizer, nutrients, vermicompost, yield, India.

Introduction

In the recent past, intensive agriculture has resulted in a reduction in organic matter and plant nutrients in soil. The excess use of chemical fertilizers for enhancing yield not only results in infertility of soil (Alexander et al., 2004) but causes environmental pollution, and social and economic problems which lead to unsustainability in agriculture. Organic manures in agriculture add much needed organic and mineral matter to the soil (Ram, Davari & Sharma, 2014). The organic matter added can be an indispensable component of soil, and plays an important role in maintenance and improvement of soil fertility and productivity (Shah et al., 2007; Choudhary et al., 2010). Organic manures such as compost, vermicompost, farmyard manure, green manure are getting attention worldwide to fulfill the demand for plant nutrients (Shiyam & Binang, 2013; Vlahova & Popov, 2013). Generally, organic agricultural systems depend mainly on organic manure which has limited supply. Therefore, new sources of organic material that supplement the balanced turnover of organic matter should be investigated (Choudhary et al., 2011). A weed in a general sense is a plant that is considered, by the use of the term, to be a nuisance and the term is generally applied to unwanted plants in human made settings. *Ipomoea muricata* L. is a common invasive weed in irrigated and dry areas and is found growing along road sides and on wasteland of Maharashtra, India. Earlier research was carried out regarding the use of weeds such as Parthenium (Chamle et al.,2011, Naikwade, 2012), Trainthema (Naikwade & Jadhav, 2011), Lantana (Ghadge et al., 2013) for preparation of manure and its use for crop improvement. However the study on *Ipomoea* weed as a source of organic manures and the utilization of it has not been done previously by other researchers. So in order to utilize the huge amount of wasteland weed *Ipomoea muricata* (L.) Jacq. as a valuable resource for vermicompost and biocomposts, a study was conducted to investigate the influence on maize yield and nutrient uptake.

Material and methods

A field experiment was carried out in the research farm located in the Botanical Garden of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, India in 2008-2009. The fresh vegetation of *Ipomoea muricata* (L.) Jacq. was collected from the Dr. Babasaheb Ambedkar Marathwada University campus, brought to the laboratory and chopped into small pieces (2 - 3 cm) by iron cutter. Equal amounts (13333 kg/ha) of weed vegetation was used for the preparation of NADEP compost (AC), Bangalore pit compost (BC), Ipomoea vermicompost (IV) and dry leaf powder (DLP). Equal amounts of leaf litter was used for the preparation of garden leaf vermicompost (GLV). The process of composting was done as described by Stoffella & Kahn (2001).

The experiment was laid out in a randomized block design (RBD) with seven treatments:

1. Ipomoea NADEP compost (AC);
2. Ipomoea Bangalore compost (BC);
3. Ipomoea vermicompost (IV);
4. Ipomoea dry leaf powder (DLP);
5. garden leaf vermicompost (GLV);
6. chemical fertilizer (FER); and
7. absolute control (CO),

with four replicates each. The fodder maize (*Zea mays* L.) var. 'African Tall' was cultivated at a seed rate of 100 kg/ha. A plot with the size 9 m^2 and nine rows spaced 30 cm apart was adopted to maintain a uniform population density. The mineral fertilizers N, P_2O_5 and K_2O (120:80:40 kg/ha) were applied through urea, single super phosphate and muriate of potash.

Chemical analysis

The chemical analysis of maize crop was carried out at 87 DAS by adopting standard analytical methods. Ash values were obtained by burning the moisture-free samples in a muffle furnace at 600°C for 2 hours, and calcium (Ca) content was analyzed by titrating the acid soluble ash solution against 0.01 N $KMnO_4$ solution using methyl red as indicator (AOAC, 1995). Nitrogen (N) was estimated by the micro-Kjeldahl method (Bailey, 1967) and crude protein (CP) was then calculated by multiplying N value by 6.25 as specified by AOAC (1995). The dry samples were boiled in distilled water, filtered and the amount of water soluble reducing sugars was determined in the filtrate by using Folin-wu tubes (Oser, 1979). The amount of phosphorus was measured following Fiske & Subba Rau (1972) as described by Oser (1979). Potassium (K) Content was determined on a flame photometer (model Mediflame- 127) as suggested by Jackson (1973).

Statistical analysis

All the results were statistically analyzed using analysis of variance (ANOVA) test and treatment means were compared using the least significant difference (p = 0.05) which allowed determination of significance between different applications (Mungikar, 1997).

Results

Analysis of organic amendments

Table 1 presents details about chemical analysis of organic amendments. The fresh amount of weed used for different manure preparations was constant. Table 1 shows that dry matter (Kg/ha) was found to be highest in the AC treatment, followed by GLV, BC, IV and DLP. The nitrogen (Kg/ha) was found to be highest in the treatment of GLV and lowest in BC. The percent of phosphorus and potassium was found to be highest in the treatment of DLP. The calcium content was found highest in GLV followed by IV, BC, AC and DLP.

Table 1. Analysis of Ipomoea composts produced by different methods.

Treatments	Fresh weight (kg ha^{-1})	DM		N		%		
		%	kg ha^{-1}	%	kg ha^{-1}	Ca	P	K
AC	8333	68.43	5702	0.79	45	1.82	0.13	0.09
BC	7778	69.26	5387	0.75	40	2.02	0.15	0.11
IV	7222	66.64	4813	0.92	44	2.12	0.08	0.10
DLP	13333	14.65	1953	2.25	44	0.52	0.35	0.14
GLV	7778	69.68	5420	0.88	47	2.95	0.12	0.11

Table 2 shows that, the total ash percentage was maximum in IV followed by BC, AC, GLV and DLP. The same pattern was found in the percent of carbon. The elemental composition of the material processed at a composting operation is very much dependent upon the types of feed materials being processed (Choudhary & Thakur, 2012). However, both C and N are essential to the composting process. Carbon provides the primary energy source and N is critical for microbial population growth. For effective, efficient composting the C:N ratio is relevant. In this experiment, the highest C/N ratio was observed in BC and least in DLP.

Table 2. C:N ratio of Ipomoea composts.

	%			
Treatments	Ash	C	N	C:N
AC	46.33	26.87	0.79	33.95
BC	46.95	27.23	0.75	36.32
IV	48.53	28.14	0.92	30.72
DLP	14.90	8.64	2.25	3.84
GLV	41.88	24.29	0.88	27.77

Chemical analysis of maize plant

a) Chemical analysis of root

The fresh weight as well as dry matter of root was higher in IV and other organic manure treatments and minimum in CON (Table 3). The content of nitrogen, crude protein and water soluble reducing sugar were found higher in all organic manure treatments than FER and lowest in the control. The phosphorus, potassium and calcium percent in root was comparatively more in organic manure treated plots as compared to the control treatment.

Table 3. Analysis of root per plant of maize (Age of plant: 87 DAS).

Treatment	Fresh wt. (g)	Dry matter %	Dry matter yield (g)	Nitrogen %	Nitrogen yield (g)	C. protein %	C. protein yield (g)	WSR Sugar %	WSR Sugar yield (g)	% P	% K	% Ca
AC	15.03	31.79	4.69	0.46	0.02	2.86	0.13	2.50	0.12	0.06	0.09	0.20
BC	11.60	33.06	3.68	0.48	0.02	2.99	0.11	2.12	0.08	0.07	0.10	0.15
IV	16.95	37.90	6.37	0.60	0.03	3.77	0.21	1.74	0.09	0.07	0.15	0.17
DLP	14.23	37.54	5.36	0.54	0.03	3.38	0.18	2.05	0.10	0.06	0.09	0.19
GLV	15.20	33.48	4.99	0.58	0.03	3.64	0.17	1.55	0.08	0.07	0.12	0.20
FER	13.25	34.05	4.59	0.50	0.02	3.12	0.14	1.60	0.08	0.06	0.11	0.14
CON	6.90	39.79	2.72	0.40	0.01	2.47	0.07	1.42	0.04	0.05	0.07	0.05
SE	1.24		0.44		0.003		0.02		0.01	0.003	0.01	0.02
CD	3.04		1.09		0.007		0.04		0.02	0.007	0.02	0.05

(AC- Ipomoea NADEP compost, BC- Ipomoea Banglore compost, IV- Ipomoea vermicompost, DLP- Ipomoea dry leaf manure, GLV- garden leaf vermicompost, FER- chemical fertilizer, CON- control, C. protein- Crude protein, WSR.Sugar- Water Soluble Reducing Sugar, SE- Standard error, CD- Critical difference)

b) Chemical analysis of stem

The highest fresh weight of stem was accounted for in DLP treated plots and lowest in CON plots (Table 4). The yield of dry matter, nitrogen, crude protein and reducing sugar was found higher in all organic manure treatments as compared to FER and at a minimum in CON. The P, K, Ca percentage in the root was higher in organic manure treatments and minimum in CON.

Table 4. Analysis of stem per plant of maize (Age of plant: 87 DAS).

Treatment	Fresh wt. (g)	Dry matter %	Dry matter yield (g)	Nitrogen %	Nitrogen yield (g)	C. protein %	C. protein yield	WSR Sugar %	WSR Sugar yield (g)	% P	% K	% Ca
AC	186.65	12.00	22.22	1.04	0.23	6.51	1.47	6.26	1.39	0.15	0.54	0.17
BC	162.13	12.97	19.77	1.06	0.21	6.64	1.29	6.53	1.28	0.17	0.58	0.12
IV	208.48	13.39	28.07	1.12	0.27	7.03	1.66	7.12	1.67	0.16	0.69	0.13
DLP	221.78	13.59	30.14	1.17	0.36	7.29	2.23	7.34	2.22	0.15	0.82	0.16
GLV	175.48	13.04	22.63	1.08	0.25	6.77	1.55	6.90	1.56	0.18	0.79	0.15
FER	150.10	12.84	19.26	1.10	0.21	6.90	1.32	6.13	1.18	0.14	0.59	0.11
CON	49.98	14.41	7.18	0.79	0.06	4.95	0.35	5.65	0.41	0.11	0.45	0.04
SE	21.35		2.81		0.034		0.21		0.21	0.009	0.05	0.02
CD	52.31		6.89		0.083		0.52		0.51	0.022	0.12	0.04

c) Chemical analysis of leaves

The fresh weight of leaves was found higher in IV followed in order by DLP, AC, BC, GLV and FER and lowest in CON (Table 5). The yield of dry matter was found at a maximum in the IV treatment and minimum in the CON. The yield of nitrogen, crude protein and water soluble reducing sugar was found higher in all organic manure treatment as compared to FER and at a minimum in CON. The P, K and Ca content were found higher in all organic manure treatment as compared to FER and at a minimum in CON.

Table 5. Analysis of leaves per plant of maize (Age of plant: 87 DAS).

Treatment	Fresh wt.	Dry matter		Nitrogen		C. protein		WSR Sugar		%		
	(g)	%	(g)	%	(g)	%	(g)	%	(g)	P	K	Ca
AC	72.30	23.81	17.36	2.10	0.37	13.15	2.32	3.73	0.64	0.13	0.49	0.28
BC	71.10	23.26	16.58	2.25	0.37	14.06	2.33	3.60	0.60	0.16	0.52	0.23
IV	81.83	26.79	21.6	2.46	0.49	15.36	3.07	3.91	0.77	0.15	0.60	0.26
DLP	78.53	26.13	20.14	2.50	0.51	15.62	3.16	4.04	0.82	0.13	0.69	0.29
GLV	70.93	24.07	16.95	2.23	0.38	13.93	2.36	3.45	0.58	0.17	0.72	0.29
FER	64.28	22.98	14.45	2.04	0.29	12.76	1.84	3.21	0.47	0.12	0.51	0.21
CON	43.73	27.46	11.96	1.40	0.16	8.72	1.02	2.62	0.31	0.10	0.40	0.08
SE	4.72		1.23		0.04		0.28		0.07	0.008	0.04	0.03
CD	11.56		3.01		0.11		0.67		0.16	0.021	0.1	0.07

d) Total yield of fodder maize

Table 6 gives details of analysis of total aerial biomass of maize plant at final harvesting (85 DAS). The average yield of fresh aerial biomass (kg/ha) of maize was highest (39861 kg/ha) in the plots receiving the IV treatment (39862 kg/ha) followed in order by DLP, AC, BC, GLV, FER and lowest in CON (20556 kg/ha). The dry matter and water soluble reducing sugar content (kg/ha) of maize was found at a maximum in the IV treatment f and minimum in CON plots. The nitrogen (kg/ha) as well as crude protein content was found greater in all organic manured plots and minimum in the control. All the results are calculated on the dry matter basis and the values are the means of four replicates. All the values were statistically significant over control (p = 0.05).

Table 6. Total yield of maize plant (Age of crop: 87 DAS).

Treatment	Fresh wt.		Dry matter		Nitrogen		Crude Protein		WSR Sugar	
	kg/plot	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha
AC	34.00	37778	19.27	7281	1.60	117	10.02	730	5.69	414
BC	32.88	36528	18.88	6896	1.42	98	8.85	610	5.09	351
IV	35.88	39861	19.78	7886	1.37	108	8.59	677	6.35	501
DLP	34.50	38333	18.67	7158	1.69	121	10.54	755	6.04	432
GLV	32.00	35556	19.33	6872	1.46	100	9.11	626	5.88	404
FER	30.13	33472	20.35	6810	1.33	91	8.33	567	5.13	349
CON	18.50	20556	20.48	4210	1.00	42	6.25	263	4.01	169
SE		2463		443		9.94		62.11		39.39
CD		6035		1084		24.34		152.17		96.51

Discussion

Based on the results, it is evident that the combined application of organic manures prepared from *Ipomoea* weed is one of the best sources of nutrients for fodder maize crop as reflected by increased crop growth yield relative to the sole application of inorganic fertilizers and absolute control. In support of this, earlier there are results of increased maize yield by application of organic manure (Adekayode & Olojugba, 2010). Accumulation of dry matter and its distribution into different plant components is an important consideration in achieving desirable economic yield from crop plants (Singh & Yadav, 1989). Application of organic manures positively affects the growth and development of plant roots and shoots (Choudhary et al., 2006). Patra et al. (2000) proved that organic manure contains high content of nitrogen and phosphorus and a slow and sustainable availability of the nutrients can occur in various crops.

The improved performance of maize as a result of added *Ipomoea* manures is due to the supply of nutrient elements to the plants. Maize is a crop that has exhausting effects on the soil, and it needs a supply of the necessary nutrients in the correct proportions to produce a satisfactory yield (Ristanovic, 2001). The application of *Ipomoea* manures showed increases in the nitrogen, phosphorus, potassium, and calcium in maize plants which have physiological importance in the formation of chlorophyll, nucleotides, alkaloids as well as in many enzymes, hormones and vitamins for optimum crop yield (Mohamed et al., 2008). Application of weed manures has been shown to enhance chlorophyll and nutrients in spinach (Naikwade et al., 2011) The application of organic manures would have helped in the plant metabolic activity in the early vigorous growth of crop plants (Muthukumaravel et al., 2008). Shah & Ahmad (2006) reported profitable increases in crop and N yields of wheat with the integrated use of organic manures and urea. In the present research, vermicompost prepared from *Ipomoea* gave excellent results which were superior to other *Ipomoea* organic manures. Choudhary et al (2006) verified that vermicompost gives higher yields than compost and other manures.

Conclusion

The current study indicates that the various manures prepared from *Ipomoea muricata* (L.) Jacq. have superior effects on the yield, water soluble reducing sugar and other nutrient content of maize crop compared to chemical fertilizer and the control. The application of *Ipomoea* vermicompost (IV) was the most effective treatment in increasing the nutrient quality of the crop and also the total yield as compared to the other treatments. The vermicompost, compost and the dry leaf powder prepared from *Ipomoea* are better and cheaper sources of plant nutrients for farmers and work with high efficiency and are superior to chemical fertilizer treatments. As the cost of inorganic fertilizers is increasing it is important to consider organic manures prepared from weeds, such as *Ipomoea* vermicompost, compost, and *Ipomoea* dry leaf manure. The production of compost offers the opportunity of recycling nutrients. The use of inorganic fertilizers can be reduced by replacement with organic manures to obtain more profitable maize production for the economic emancipation of Indian maize farmers.

References

Adekayode, F.O. & Olojugba, M.R. (2010). The utilization of wood ash as manure to reduce the use of mineral fertilizer for improved performance of maize (Zea mays L.) as measured in the chlorophyll content and grain yield. Journal of Soil Science and Environmental Management, 3: 40-45.

Alexander, R. Tyler, R. & Goldstein, N. (2004). Increasing dollar value for compost products. Biocycle, 45 (10), 48–54.

AOAC. (1995). Official Methods of Analytical Chemistry. 16th Ed., Association of Official Analytical Chemists, Washington, DC.

Bailey, R.L. (1967). Techniques in Protein Chemistry. II Ed., Elsevier Publishing Co., Amsterdam.

Chamle, D.R., Dhale, D.A. & Mogle, U.P. (2011). Effect of Parthenium weed manures on rhizosphere mycoflora of maize. Current Botany, 2(4): 31-33.

Choudhary, A.K., Thakur, S.K., Singh, A., Yadav, D.S., Sood, P. & Rahi, S. (2011). Utility of obnoxious weed flora of wet temperate North-Western Himalayas as vermi-compost. In Proc. National symposium cum brainstorming workshop on organic agriculture" w.e.f. April 19-20, 2011 at CSK HPKV, Palampur, India. OASI National Symposium Abstracts Vol. I, p125.

Choudhary, A.K. & Thakur, S.K. (2012). Low cost vermi-compost production technology – A boon to hill farmers. In Proc: National seminar on indian agriculture: Present situation, challenges, remedies and road map held at CSK HPKV, Palampur, India. CSK HPKV Publication, ISBN No. 978-81-85430-23-2, pp 94–95.

Choudhary, A.K., Kumar, R., Rana, V., Punam & Atul. (2006). Cultivation of Matricaria chamomilla through farmyard manure. Journal of Tropical Medicinal Plants, 7(1): 87-90.

Choudhary, A.K., Kumar, R., Punam & Atul. (2010). Cultivation of Celery (Apium graveolens) in north-western Himalayas. Journal of Tropical Medicinal Plants, 11(2): 211-214.

Fiske, C.H. & Subba Rau, Y. (1972). The calorimetric method for the estimation of phosphorus. Journal of Biological Chemistry, 66:375.

Ghadge,S. Naikwade P.V. & Jadhav, B.B. (2013). Utilization of problematic weed for improved yield of fenugreek, Indian Stream Research Journal, 3(4): 1-8.

Hornick, S.B., Sikora, L.J., Sterrett, S.B., Murray, J.J., Millner, P.D., Burge, W.D., Colacicco, D., Parr, J.F., Chaney, R.L. & Willson, G.B. (1983). Application of sewage sludge compost as a soil conditioner and fertilizer for plant growth. USDA Agricultural Information Bulletin, 464: 1-32.

Jackson, M.L. (1973). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Mohamed, S.A., Ewees, S.A., Sawsan, A., Seaf, E.Y. & Dalia, M.S. (2008). Improving maize grain yield and its quality grown on a newly reclaimed sandy soil by applying micronutrients, organic manure and biological inoculation. Res. J. Agric. Biol. Sci., 4:537-544.

Mungikar, A.M. (1997). An Introduction to Biometry. Sarawati Printing Press, Aurangabad.

Muthukumaravel, K., Amsath, A. & Sukumaran, M. (2008). Vermicomposting of vegetable wastes using cow dung, e-Journal of Chemistry 5(4):810-813.

Naikwade P.V. & Jadhav, B.B. (2011). Effect of Trianthema weed manures on fodder, Bioinfolet, 8(2):174-176.

Naikwade, P.V. (2012). Conversion of Parthenium hysterophorus L. weed to nutrient resource by composting. NeBio, 3(4): 171-179.

Naikwade, P.V. Mogle U.P. & Jadhav, B.B. (2011). Improving Total chlorophyll, ascorbic acid and β - carotene in spinach by applying weed manures, Bioscience Discovery, 2(2):251-255.

Oser, B.L. (1979). Hawk's Physiological Chemistry. XIV Ed., Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Patra, D.D., Anwar, M. & Chand, S. (2000). Integrated Nutrient Management and Waste Recycling for Restoring Soil Fertility and Productivity in Japanese and Mustard Sequence in Utter Pradesh, India. Agriculture, Ecosystem and Environment, 80:267–275.

Ram, M., Davari, M. R., & Sharma, S. N. (2014). Direct, residual and cumulative effects of organic manures and biofertilizers on yields, NPK uptake, grain quality and economics of wheat (Triticum aestivum L.) under organic farming of rice-wheat cropping system. Journal of Organic Systems, 9(1), 16-30.

Ristanovic, D. (2001). Maize. p. 23-45. In: R.H. Raemaekers (Editor) Crop Production in Tropical Africa. Goekint Graphics nv. Belgium.

Schertz, D.L. (1988). Conservation tillage: an analysis of acreage projections in the United States. Journal of Soil and Water Conservation, 43: 256-263.

Shah, Z., Tariq, M. & Afzal, M. (2007). Response of maize to integrated use of compost and urea fertilizers. Sarhad Journal of Agriculture, 23(3): 200-204.

Shiyam, J. O., & Binang, W. B. (2013). Effect of poultry manure and plant population on productivity of fluted pumpkin (Telfaiaria occidentalis Hook F.) in Calabar, Nigeria. Journal of Organic Systems, 8(2), 29-35.

Singh, A. & Yadav, D.S. (1989). Effect of sowing date and plant density on dwarf field peas. Indian Journal of Agronomy, 34: 92-95.

Vlahova, V., & Popov, V. (2013). Influence of the biofertiliser Seasol on yield of pepper (Capsicum annuum L.) cultivated under organic agriculture conditions. Journal of Organic Systems, 8(2), 6-17.