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Efficacy of *Parthenium* for Maize Production

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Parthenium hysterophorus L., a plant indigenous to America has become an aggressive weed in India. Now days, it has been a subject of most intensive investigation throughout the world. The aim of the present investigation was to study the influence of different manures prepared from *Parthenium* on the productivity and nutrient uptake of maize.

A field experiment was conducted at Dr. Babasaheb Ambedkar Marathwada University, Aurangabad to evaluate the performance of various manures viz. green manure (GM), compost (CM), vermicompost (VM) and dry leaf manure (DM). For comparison, inorganic fertilizers were also applied at a rate of 120, 80 and 40 kg N, P and K ha^{-1} respectively. The observations were recorded on morph-physiological traits.

On the basis of the results obtained, it is concluded that the application of *Parthenium* foliage as green manure (GM) was more effective in increasing the yield and nutrient contents of maize, which may biologically control ill effects of this weed in agriculture and social life.

Key words: *Parthenium*, Green manure, Compost, Vermicompost, Maize

Introduction

Parthenium hysterophorus (Heliantheae: Asteraceae) is an annual herb of neotropical origin, which has now attained pantropical distribution (Evans, 1997). It is one of the most feared noxious weed species (Rao, 1956). It is widely naturalized in low elevation, dry fields or along roadsides (Wagner *et al*., 1999). In Maharashtra, it was first noted near to Poona in 1951. The weed indeed, no mention is made of it in the classic treatise on the World's Worst Weeds (Holm *et al*., 1977). But within last ten years, it has become one of the seven most dangerous weeds of the world (Singla, 1992).

Reduction in agricultural crops (40%) and forage productivity (90%) has been reported (Khosala and Sobti, 1981; Nath, 1988) due to its infestation in agriculture. Also, in our country 4−7% of human population suffers from familiar clinical symptoms and 42−50% are sensitized devoid of showing symptoms (Towers and Subba Rao, 1992). Now, the weed is considered a major problem in India (Gupta and Sharma, 1977; Shelke, 1984) and is attracting the attention of all. The control of this weed is quite difficult, primarily due to its invasive nature as well as strong reproductive and regenerative potential. One of the beneficial methods for management of *Parthenium* is its use for preparation of various kinds of manures. In this investigation attempts have been made to observe practicability of *Parthenium* manures on growth and yield of maize.

Materials and Methods

Collection of weed and composting process -

The fresh green leafy vegetation of *Parthenium* was collected from different sites of University campus at 10−20% flowering stage and brought to laboratory, chopped into small bits (2−3 cm) by the traditional iron cutter. The amount of vegetation 48 kg/treatment (i.e. 13333 kg ha^{-1}) was used for the preparation of compost (CM), vermicompost (VM) and kept for drying as dry leaf manure (DM). The plant materials were

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evenly spread in the trenches for compost and vermicompost to a thickness of about 5 cm. Above each layer, 5% dung slurry and soil was added alternately, and water was sprinkled in order to maintain the optimal moisture (50−70%). The pits were closed with cow dung slurry and fine clay to prevent loss of heat or exchange of gases. After partial decomposition (18 days), first turning was given for homogeneous decomposition and then the main species of earthworm *Eudrilus eugeniae* Kinberg (90 individuals per pit) were released into the vermicomposting pit. Identification of earthworm was done by Julka (1988). The composting and vermicomposting was completed within 17 days and completely decomposed composts were employed for use in field trials.

Field site, design, treatments and plot size -

A field experiment was conducted in the Research farm of Dr. Babasaheb Ambedkar Marathwada University's Botanical Garden during Oct. 2005 to Jan. 2006. The experimental design was a randomized block design (RBD) with six treatments and four replications. The treatments were green manure (GM-12 kg/plot i.e. fresh weed material only), compost (CM-28 kg/plot i.e. weed material + soil + dung slurry), vermicompost (VM-27 kg/plot i.e. weed material + soil + dung slurry) and dry leaf manure (DM-1.75 kg/plot i.e. dry weed material only) were applied to appropriate plots including fertilized (FE) and unfertilized checks (CO). Samples (100 gm) of each treatment were randomly collected in duplicate before their application to the plots and kept in an oven at 90℃ (48 hours) for dry matter and nutrient analysis. During the application of weed manures, initially four furrows were made with the size 6−8 cm deep and 8−10 cm width in each plot. Then the manures were spread uniformly in the furrows and covered by the soil. Afterward, plots were watered, kept aside for three days and then sowing was done. The fodder maize (*Zea mays* L. cv. African Tall) was sown at a seed rate of 100 kg ha^{-1} in 9 m^2 plots with nine rows spaced 30 cm apart.

Applications of mineral fertilizers -

The fertilizers were supplied as nitrogen (N), phosphorus (P) and potassium (K) through urea, single super phosphate (SSP) and muriate of potash at the rate of 120, 80 and 40 kg ha^{-1}. Entire amount of P and K was applied as basal dose to all the amendments except absolute CO at the time of sowing while N was given in two equal splits at 57 and 89 days after sowing (DAS) to only the FE treatment.

Growth analyses -

The morph-physiological traits of the crop were reported at 100 DAS as plant height, diameter of stem, number of leaves per plant, fresh weight of root, stem, leaves and total plant, upper 4^{th} leaf length, its width and weight, and leaf area per plant (Shahane and Mungikar, 1984; Mungikar, 1986).

Plant sampling -

The green foliage was harvested manually at vegetative stage (102 DAS) early in the morning. The fodder yield obtained per plot was recorded (Davys and Pirie, 1969) and samples of randomly selected three plants from each plot (100 gm $plot^{-1}$) were collected. The samples were oven dried at 80℃ for 2 days to a constant weight and loss in weight was determined. The dried samples were ground, passed through 0.5 mm sieve and stored in sealed polythene bags for nutrient analyses.

Chemical analyses -

Organic matter was determined by rapid titration method (Walkley and Black, 1934). Leaf chlorophyll contents (a, b and total) were estimated following Nanjareddy *et al.* (1990). The dry matter (DM) and calcium (Ca) content was analyzed by AOAC (1995). Nitrogen (N) was estimated by Micro-Kjeldahl Method (Bailey, 1967) and crude protein (CP) was expressed as N x 6.25 by AOAC (1995). Reducing sugar (RS) and phosphorus (P) was determined by colorimetric methods (Oser, 1979) and potassium (K) content was analysed on a flame photometer (Model Mediflame-127) as suggested by Jackson (1973).

Statistical analysis -

The results were statistically analyzed by analysis of variance (ANOVA) and treatment means were compared using the critical difference (CD, $P \leq 0.05$) which allowed determination of significance between different applications (Mungikar, 1997).

Results and Discussion

Growth analyses -

Table 1 gives chemical compositions of various types of manures. Due to the application of manures in combination with fertilizers plant height increased with the GM treatment followed in order by VM, CM, DM and FE over the CO plots where soil available nutrients were not adequate to meet the crop demand. Similar trends were observed with respect to stem diameter, fresh weight of stem, leaves and total plant, leaf parameters and fresh weight of root (Table 2).

Table 1. Analyses of *Parthenium* weed manures.

Treatments	%						C : N ratio
	DM	Ash	N	P	K	OC	
GM	14.75	15.50	2.83	0.59	0.33	8.95	3.16
CM	77.00	87.25	1.45	0.39	0.10	2.40	5.33
VM	66.00	87.50	1.41	0.39	0.18	2.88	7.02
DM	13.54	17.00	2.53	0.67	0.29	9.85	3.89

DM - Dry matter, N - Nitrogen, P - Phosphorus, K - Potassium, OC - Organic carbon

Table 2. Growth analyses of maize plant.

Treatments	Plant height (cm)	Stem diameter (cm)	No. of leaves (plant^{-1})	Fresh weight (gm plant^{-1})				4^{th} upper leaf			Leaf area (cm^2 plant^{-1})
				Root	Stem	Leaves	Total	Length (cm)	Width (cm)	Weight (gm)	
GM	226.32	1.54	10.75	7.25	160.97	48.95	217.17	77.55	4.87	2.67	210.75
CM	184.65	1.32	9.75	3.60	132.67	41.37	177.64	70.40	4.47	1.95	187.50
VM	208.65	1.41	10.25	3.45	135.52	45.80	184.77	76.10	4.52	2.25	202.00
DM	177.47	1.29	10.00	3.42	98.45	36.62	138.50	67.97	4.17	1.92	172.50
FE	172.45	1.20	9.50	3.27	69.82	31.07	104.16	64.10	3.67	2.25	153.75^{ns}
CO	132.12	1.00	8.50	2.02	34.60	12.80	49.42	58.10	3.15	1.55	131.50
S.E.	12.09	0.06					22.78				11.18
C.D.	27.32	0.13					51.48				25.26

GM - Green manure, CM - Compost, VM - Vermicompost, DM - Dry leaf manure, FE - Inorganic fertilizers, CO - Control

Chlorophyll contents -

The mean values for chlorophyll contents (a, b and total) of maize ranged from 0.58−2.17, 0.30−1.14 and 0.89−3.31 mg gm^{-1} respectively. Chlorophyll content was maximum due to the application of manures. Among them, chlorophyll a, b and total chlorophyll were highest in GM received plots (Fig. 1). The chlorophyll contents play a significant role in the production of total biomass and productivity of the crops.

Analyses of maize plant and crop -

a) *Analyses of root*:

The fresh weight of root was highest in the plots that received GM followed in order by CM, VM, DM and FE treatments in comparison with CO plots (Table 3). However, analogous results were obtained for dry matter, nitrogen (N) and reducing sugars (RS). The crude proteins (CP) were maximum with GM and CM amendments followed by VM and DM applications and minimum in CO when compared to the fertilized plots. The phosphorus (P) and calcium (Ca) contents were more in all the weed manure and FE treatments as compared to absolute controls where as potassium (K) content was high with the VM and CM treatments (Table 3).

b) *Analyses of stem*:

The highest fresh weight of stems was accounted for GM treated soil followed in order by VM, CM and DM treatments and lowest in the FE and CO plots (Table 4). A similar trend was observed with respect to dry matter and RS content. N and CP were maximum in GM followed by CM, VM and DM amendments. The P content was higher in the plots treated with CM and FE applications. The K and Ca contents were superior in all the amendments apart from the unfertilized plots with the exception of K where the VM treated plots showed lower values (Table 4).

c) *Analyses of leaves*:

The fresh weight of leaves was higher in the GM amended plots followed in order by VM, CM, DM and FE treatments and lower in un-amended soil (Table 5). The dry matter and RS behaved in a similar manner in

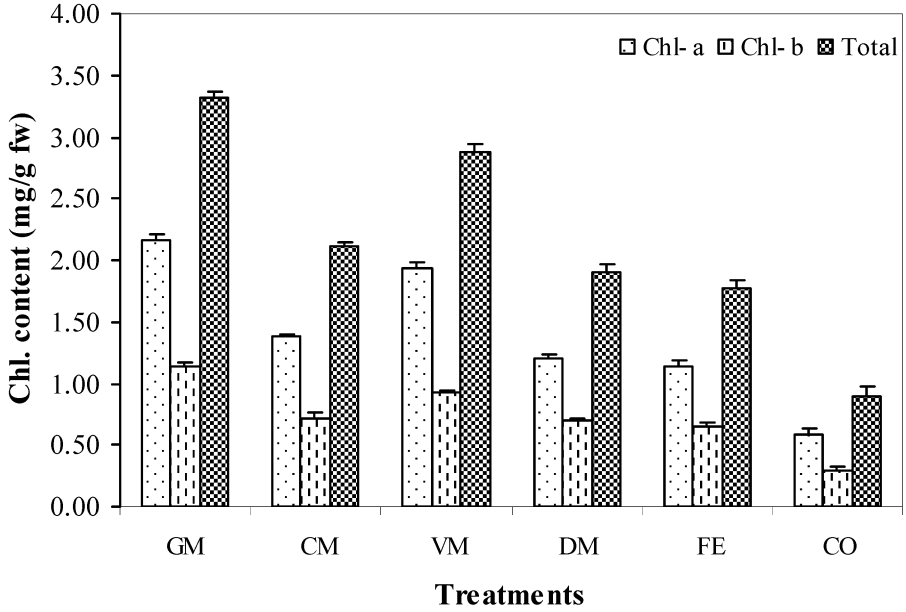

Fig. 1. Leaf chlorophyll contents of maize as influenced by *Parthenium* weed manures at 101 DAS (n=4±SE).

Table 3. Analyses of root per plant of maize.

Treatments	Fresh weight (gm)	Dry matter		N		CP (gm)	Total RS		%		
		%	Yield (gm)	%	Yield (gm)		%	Yield (gm)	P	K	Ca
GM	7.25	32.62	2.350	0.68	0.016	0.10	3.25	0.077	0.08	0.09	0.44
CM	3.60	59.39	2.125	0.74	0.015	0.10	3.21	0.067	0.07	0.12	0.44
VM	3.45	60.39	2.050	0.55	0.011	0.07	3.17	0.064	0.07	0.15	0.44
DM	3.42	43.85	1.475	0.49	0.007	0.04	2.90	0.042	0.07	0.09	0.43
FE	3.27^{ns}	46.19	1.450	0.39	0.005	0.03^{ns}	2.50	0.036	0.07	0.05	0.39
CO	2.02	49.98	1.025	0.30	0.003	0.02	1.51	0.015	0.05	0.03	0.33
S.E.	0.65		0.18		0.001	0.01		0.008			
C.D.	1.40		0.40		0.002	0.02		0.018			

N - Nitrogen, CP - Crude protein, RS - Reducing sugar, P - Phosphorus, K - Potassium, Ca - Calcium

this regard. N and CP content were more for GM followed by CM, VM and DM amendments when compared to FE alone and CO treatment. The same patterns were observed in respect to Ca content. The percent of P and K were high in plots based with DM treatment and least in absolute CO (Table 5).

d) *Analyses of maize crop*:

The average yield of fresh aerial biomass and dry matter of maize was highest in the plots receiving GM amendment followed in order by VM, CM DM, FE and lowest in the unfertilized treatment (Table 6). Green manure is more effective, because application of *Parthenium* green manure enhances organic matter to the soil. Organic matter increases the availability of plant nutrients such as N, P, K, Ca, Mg etc. due to increased biochemical activities of microorganisms. CP content was maximum in the VM followed by CM, GM, DM and FE treatments over the CO plots. Similar trends were observed with respect to total RS. The P content was greater for CM based application followed in order

Table 4. Analyses of stem per plant of maize.

Treatments	Fresh weight (gm)	Dry matter		N		CP (gm)	Total RS		%		
		%	Yield (gm)	%	Yield (gm)		%	Yield (gm)	P	K	Ca
GM	160.97	14.37	22.925	1.05	0.240	1.50	7.09	1.631	0.17	0.83	0.35
CM	132.67	13.45	17.875	1.11	0.198	1.24	7.12	1.273	0.21	0.79	0.34
VM	135.52	14.27	19.375	0.95	0.186	1.16	7.03	1.360	0.17	0.49^{ns}	0.33
DM	98.45	12.73	12.550	0.97	0.119	0.74	6.93	0.873	0.16^{ns}	0.86	0.35
FE	69.82^{ns}	13.80	9.575^{ns}	0.89	0.084	0.53	6.90	0.658	0.19	0.83	0.34
CO	34.60	17.80	6.125	0.57	0.034	0.21	6.29	0.385	0.16	0.57	0.25
S.E.	17.53		2.38		0.02	0.17		0.17			
C.D.	39.61		5.37		0.04	0.31		0.38			

GM - Green manure, CM - Compost, VM - Vermicompost, DM - Dry leaf manure, FE - Inorganic fertilizers, CO - Control

Table 5. Analyses of leaves per plant of maize.

Treatments	Fresh weight (gm)	Dry matter		N		CP (gm)	Total RS		%		
		%	Yield (gm)	%	Yield (gm)		%	Yield (gm)	P	K	Ca
GM	48.95	28.27	13.825	2.55	0.349	2.18	3.84	0.519	0.17	0.74	0.68
CM	41.37	28.00	11.525	2.38	0.274	1.71	3.75	0.432	0.18	0.77	0.64
VM	45.80	27.06	12.350	2.32	0.272	1.70	3.69	0.459	0.18	0.69	0.62
DM	36.62	26.44	9.725	2.22	0.224	1.40	3.42	0.331	0.19	0.79	0.50
FE	31.07	22.32	6.875^{ns}	2.14	0.145	0.91	2.60	0.175	0.16	0.68	0.44
CO	12.80	31.59	3.925	1.43	0.056	0.35	1.48	0.057	0.14	0.52	0.34
S.E.	4.87		1.38		0.03	0.24		0.06			
C.D.	11.00		3.11		0.06	0.54		0.13			

N - Nitrogen, CP - Crude protein, RS - Reducing sugar, P - Phosphorus, K - Potassium, Ca - Calcium

Table 6. Analyses of total aerial biomass of maize plants.

Treatments	Fresh weight		Dry matter		N		Total CP	Total RS		%		
	kg $plot^{-1}$	kg ha^{-1}	%	kg ha^{-1}	%	kg ha^{-1}	(kg ha^{-1})	%	kg ha^{-1}	P	K	Ca
GM	32.000	35555	12.50	4444	1.32	58.25	364.07	6.04	269.53	0.20	1.03	0.45
CM	30.275	33638	12.37	4158	1.57	65.85	411.59	6.23	259.40	0.26	1.06	0.48
VM	30.325	33694	12.75	4293	1.55	66.70	416.87	5.94	254.58	0.23	0.89	0.57
DM	29.425	32694	12.07	3936	1.26	50.00	312.37	5.90	233.29	0.17	0.81	0.57
FE	28.050	31166	12.42	3887	1.20	46.45	290.32	5.52	217.37	0.22	0.86	0.48
CO	9.600	10666	13.77	1478	0.80	12.03	75.21	4.57	67.87	0.11	0.53	0.39
S.E.	3.14	3492		412		7.54	47.19		28.12			
C.D.	7.10	7891		932		17.04	106.6		63.55			

by VM, FE, GM and least in un-manured plots than that of DM. The percent of K was more in the CM amendment and afterward in GM where as the Ca was higher with VM and DM fertilized plots as compared to all the other treatments and less in total CO (Table 6).

All the results are calculated on dry matter basis and the values are the means of four replicates. These results are statistically significant over controls. With the exceptions of leaf area, fresh weight and CP in root, fresh weight and dry matter in stem and dry matter of leaves in case of FE application. Also, P and K content in stem with respect to DM and VM treatments.

Based on the results, it is clear that the growth and yield of maize increased significantly due to the application of organic manures in combination with inorganic fertilizers because of better uptake of nutrients from the soil. Organic manuring along with application of fertilizers helps to release nutrient elements slowly and steadily during the period of crop growth.

Conclusion

From the above results, it can be concluded that the combined application of green manure (GM) and chemical fertilizers was more effective in increasing the growth, nutrient uptake and yield without any detrimental effect on maize crop. As compared to other manuring methods, green manure is the best and cheapest source of plant nutrients working with high efficiency because fresh plant material especially leaves contains more nutrients, which latter on decompose and gradually release nutrients into the soil in readily available form. They are not only fully utilized by crop but also useful in the reclamation of soil. Also, this method is economically viable and there is no loss of nutrient contents during the preparation. The maximum utilization of *Parthenium* weed as manure will reduce its population. Then it will certainly lower the menace and ill effects in agriculture and social life. Atkar *et al.* (1993) find out that after green manuring, application of 30 kg N ha^{-1} given more yield when compared to sole use of 90 kg N ha^{-1}. Similarly, on the basis of three years data Kolhe and Bhambri (2005) concluded that the application of *P. hysterophorus* as green manure along with 25% recommended dose of fertilizer (RDF-80:50:30) can be utilized. Hence, the present results are in agreement with the findings of earlier workers.

On the basis of studies, it is obvious that *P. hysterophorus* can be exploited as green manure in combination with inorganic fertilizers (25% RDF) for rice and maize crops. Finally, author feels that the integrated management of *Parthenium* as manure will enhance agricultural productivity with minimum input of mineral fertilizers and maximum utilization of noxious weed. Hence, further attempts of similar studies are advocated for other crops individually or along with different dosage of chemical fertilizers.

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