Impact of organic and chemical fertilizers on grass species composition and biomass

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Abstract:

A field experiment was carried out at the outdoor nursery of Department of Environmental Science, School of Earth Sciences, Solapur University, Solapur to study the effects of organic and chemical fertilizers on different grass species after harvesting the cluster bean yield. Agricultural solid waste was used for preparation of vermicompost and NADEP compost as well as municipal solid waste was used for preparing pit compost. Five treatments were considered with three replications. The organic and chemical fertilizers were applied to the each plot according to recommended doses of fertilizers. Subsequent to harvesting of cluster bean (*Cyamopsis tetragonolobus*) crop, the soil on plots was ploughed and after 60 days the varieties of grass species were grown in the same plots. Total nine varieties of grass specimens were recorded and identified in overall plots with different fertilizers treatments. Clipped grass species were taken out for estimating average fresh and dry weight of each grass specimens per plot and weights were noted. Composition of grass species was assessed by harvesting individual grass in each plot and was compared for the grass species richness with application of different treatments of organic and chemical fertilizers with control. Results clearly indicate that application of vermicompost had the highest species composition and fresh and dry weights (gm/grass species) as compared to application of remaining fertilizer treatments. Total highest number of verities of grass species observed per plot were recorded in the plots with application of vermicompost as compared to remaining fertilizer treatment plots and then followed by the plot having treatment with chemical fertilizers.

Introduction:

Grassland ecosystems are valuable for conserving the water and soil as these reduce surface runoff, increase infiltrations of water in to soil and reduce soil erosion [1]. Vermicompost has more nutrient contents than the organic fertilizers produced using different methods such as pit composting, heap manure and NADEP method of composting. The application of vermicompost improved the physical and chemical structure of the soil. The growth media are attributed to the increase its plant growth [2]. The species variation in plants from site to site may be due to the

soil type, its composition, elevation of selected site, moisture content of soil, nature of disturbance like grazing pressure, human interference, distance of study site from population area etc. All these factors determine the category of species in which the species belong ecosystems [3]. Grasses, trees and shrubs are keystone plant species in productive grassland. Biodiversity is a key feature of properly functioning grazed ecosystem [4]. Seasonal and annual fluctuations in climate can influence the plant growth and thereby biomass. Major vegetation attributes measured in scientific researches include vegetation cover, density, frequency, structure, and biomass [5]. Productivity and quality of forage is based on the potential soil fertility. Application of fertilizer to soils can also improve the nutritional quality of forage [6, 7]. The plant composition and species richness of permanent grasslands are generally determined by management practices and site characteristics such as topography, water and nutrient availability, and light conditions [8, 9]. Excessive use of chemical fertilizers decrease the quality of soil and food production due to loss of soil organic matter [10, 11]. Coppock (1994) studied that the vegetation in different ecosystems and observed that the vegetation compositions varied depending on topography, climate and soil fertility [12].

MATERIALS AND METHOD:

A field experiment was conducted in nursery of Department of Environmental science, School of Earth Sciences, Solapur University, Solapur. Agricultural solid waste was used for preparation of vermicompost and NADEP compost as well as municipal solid waste was used for preparing pit compost. The process of composting was followed by earlier studies as described by Chavan, Vedpathak and Pirgonde [13]. These organic fertilizers and chemical fertilizers were applied to research plot of size 2m x 1m with three replications for Cluster bean (*Cyamopsis tetragonolobus*) cultivation. The five treatments were taken as compost from vermicomposting (T-1), NADEP method of composting (T-2), pit composting method (T-3), chemical fertilizers was applied in the proportion 40:60:60 Kg of NPK/ha according to recommended dose of fertilizers as T-4 and control (T-5). The vermicompost was applied at the rate of 1 kg (@ 0.5 kg/sq. m) per plot and NADEP compost was used at rate 4 kg (@ 2 kg/sq. m) per plot. A common dose of pit compost was used at rate 1.25 kg (@ 0.625 kg/sq. m) as per usual practice of farmers. Straight chemical fertilizers like Urea @ 17.36gm, single super phosphate @ 75gm and murate of potash @19.92gm combinally used in plot size 2m x 1m and say as treatment T4. [14]. Subsequent to harvesting of cluster bean (*Cyamopsis tetragonolobus*) crop, the soil on plot was ploughed and after 60 days the verities of grass species were grown in same plots. The individual grass species presented in same plot were listed. The number of individual grass species were clipped and counted in each plot after 60 days of harvesting Cluster bean crop. The information include the total number of verities of grass species per plot, their identification and detailed reordering. The fresh weight, dry weight (gm per grass specimens) and species composition of grasses were determined. The main aim was to assess comparative study of different fertilizers treatments on biomass and species composition of different grass species.

Recommended doses of fertilizer (RDF) were shown as bellow

T1- Vermicompost prepared from agricultural solid waste @ 5 t/ha, [14].

T2- NADEP compost prepared from agricultural solid waste @ 20 t/ha, [14].

T3- Pit compost prepared from municipal solid waste @ 6.25 t/ha, [15].

T4- Chemical fertilizer- 40:60:60-NPK Kg/ha, [14].

T5- Soil without fertilizer as control for comparison.

Table 1. Quantity of fertilizers used according to RDF in plot size 2m X 1m:

Treatment No.	Rate of application of fertilizer	Reference No.
T1	@ 1 kg (@ 0.5 kg/sq. m)	14
T2	@ 4 kg (@ 2 kg/sq. m)	14
T3	@ 1.25 kg (@ 0.625 kg/sq. m)	15
T4	Urea @ 17.36gm + single super phosphate @ 75gm + murate of potash @19.92gm	14
T5	Soil without fertilizers	

T-1 indicate compost from vermicomposting, T-2 indicate NADEP method of composting, T3 indicate pit composting method, T-4 indicate chemical fertilizers, T-5 indicate cotrol.

Prior to this experimental study, nutrient status of different fertilizers and soil characteristics of study site were estimated using standard methods [16, 17]. The samples were subjected to chemical analysis. pH value of the soil samples was measured by pH meter. The moisture was determined by loss on drying method. The electrical conductivity values of a soil samples were determined by using digital conductivity meter. Organic carbon of soil sample was determined by using Walkley and Black by rapid dichromate oxidation technique method. Total Nitrogen was determined by using Kjeldahl method. Estimation of available phosphorus was estimated by using method given for acidic soil by Bray and Kurfz method [18]. Potassium in the soils was estimated by flame photometer. Calcium and magnesium forms stable complexes and were determined by EDTA titrimetric method. Sodium was determined by the method of preparation of standard curve for sodium. Phosphorous was determined by Olsen method and Cu, Zn, Fe, Mn was estimated with help of DTPA (diethylene tetramine penta acetic acid) as an extractant method and the micronutrients in the extract were determined by using Atomic Absorption Spectrophotometer. Boron was estimated by Spectrophotometric method. Sulphur content was determined by phosphate extractable SO_4 method [19, 20].

RESULTS AND DISCUSSION:

Table 2 shows the results of chemical composition of soil before the application of fertilizers. The value of pH of soil in overall plot was 8.15 which shows that soil was alkaline in nature, while EC value was 0.18 mS/cm. The NPK contents were 0.26%, 0.20% and 0.09 % respectively. The all other values of nutrients found are represented in Table 1. The results reveal the suitability of soil for the crop growth improvement.

Table 2. Initial physic-chemical characteristics of experimental soil:

Parameter	Soil characteristics	Parameter	Soil characteristics
pH	8.15	Mg (%)	0.44
Moisture %	8.9	Na(ppm)	315
EC (mS/cm)	0.18	B (ppm)	30
Org. matter	1	Fe (ppm)	89
N (%)	0.26	Mn (ppm)	65
P (%)	0.20	Cu (ppm)	15
K (%)	0.09	Zn (ppm)	35
S (%)	0.19	Cl (ppm)	455
Ca (%)	1.09		

Table 3.Nutrients contents of different organic fertilizers.

Parameters	T1	T2	T3
pH	8.10	7.67	7.20
Moisture (%)	29.24	18.45	02.47
Org. matter (%)	17.55	11.85	12.32
N (%)	1.30	0.98	0.63
P (%)	1.50	1.09	0.11
K (%)	1.05	1.90	0.81

Where; *T-1 indicate compost from vermicomposting, T-2 indicate NADEP method of composting, T-3 indicate pit composting method.*

Present investigations was carried out to study and compare effects of organic and chemical fertilizers on average fresh and dry weights (gm/grass species) and composition on different varieties of grasses in study plots. Table 4, 5 and 6 shows average fresh and dry weights (gm/grass species) and composition of grass species in different plots as influenced by organic and chemical fertilizer applications in comparison with control. Total nine grass species which grown with application of different fertilizers were identified using relevant literature. Maximum number of grass species showed good performance under the application of vermicompost. It was observed that the biomass was significantly highest in terms of fresh and dry weights (gm/ grass species) and grass species composition was also highest with application of vermicompost and then followed by chemical fertilizers treatment.

Table 4. Effects of fertilizers treatment on grass species grown on first replication

Fertilizer Treatment →	Avg. Biomass wt. with application of VC (gm/grass species)		Avg. Biomass wt. with application with of NDP (gm/grass species)		Avg. Biomass wt. with application of PC (gm/)grass species		Avg. Biomass wt. with application of CF (gm/species)		Avg. Biomass wt. in control (gm/grass species)	
Scientific name of grass species↓	Fresh Wt. gm	Dry Wt. gm	Fresh Wt. gm	Dry Wt. gm	Fresh Wt. gm	Dry Wt. gm	Fresh Wt. gm	Dry Wt. gm	Fresh Wt. gm	Dry Wt. gm
Phyllanthus amarus	1.12	0.56	2.00	0.83	×	×	1.71	0.85	0.65	0.28
Alternanthera bettzickiana	6.19	1.57	×	×	×	×	×	×	×	×
Parthenium hysterophorus L	4.40	1.00	3.00	1.00	0.38	0.15	×	×	2.00	0.59
Desmodium alysicarpoides.	×	×	5.00	1.19	×	×	×	×	×	×
Tridax procumbens L	16.2	1.26	2.16	0.44	1.62	0.30	1.20	0.25	3.00	0.42
Crysanthenum	2.23	0.81	×	×	×	×	×	×	×	×
Oxalis debilis	×	×	2.05	0.73	×	×	8.31	3.31	×	×
Commelina diffusa	2.22	0.55	×	×	×	×	×	×	×	×
Hyptis suaveolens (L.)	1.87	0.60	×	×	×	×	×	×	×	×

*VC stands for vermicompost, NDP stands for NADEP compost, PC stand for pit compost, and Cf stands for chemical fertilizers and * × indicate grass species was absent in given study area.*

Table 5 . Effects of fertilizers treatment on grass species grown on second replication.

Fertilizer Treatments →	Avg. Biomass wt. with application of VC (gm/grass species)		Avg. Biomass wt. with application with of NDP (gm/grass species)		Avg. Biomass wt. with application of PC (gm/) grass species		Avg. Biomass wt. with application of CF (gm/species)		Avg. Biomass wt. in control (gm/grass species)	
Scientific name of grass species↓	Fresh Wt. gm	Dry Wt. gm	Fresh Wt. gm	Dry Wt. gm	Fresh Wt. gm	Dry Wt. gm	Fresh Wt. gm	Dry Wt. gm	Fresh Wt. gm	Dry Wt. gm
Phyllanthus amarus	2.12	0.88	1.00	0.43	0.78	0.35	1.71	0.85	×	×
Alternanthera bettzickiana	4.20	1.80	×	×	×	×	5.45	1.75	×	×
Parthenium hysterophorus L	5.64	1.00	×	×	×	×	0.90	0.35	2.00	0.59

Desmodium alysicarpoides.	3.68	1.10	2.15	0.90	×	×	×	×	×	×
Tridax procumbens L	8.2	1.65	×	×	1.30	0.25	1.20	0.25	3.00	0.42
Crysanthenum	2.23	0.81	×	×	×	×	×	×	×	×
Oxalis debilis	×	×	2.05	0.73	×	×	8.31	3.31	×	×
Commelina diffusa	2.22	0.55	×	×	×	×	×	×	×	×
Hyptis suaveolens (L.)	2.30	0.90	×	×	×	×	1.60	0.45	×	×

*VC stand for vermicompost, NDP stand for NADEP compost, PC stand for pit compost and Cf stand for chemical fertilizer and. * × indicate grass species was absent in given study area.*

Table 6. Effects of fertilizers treatment on grass species grown on third replication

Fertilizers treatments →	**Avg. Biomass wt. with application of VC (gm/grass species)**		**Avg. Biomass wt. with application with of NDP (gm/grass species).**		**Avg. Biomass wt. with application of PC (gm/) grass species**		**Avg. Biomass wt. with application of CF (gm/species)**		**Avg. Biomass wt. in control (gm/grass species)**	
Scientific name of grass species ↓	**Fresh Wt. gm**	**Dry Wt. gm**	**Fresh Wt. gm**	**Dry Wt. gm**	**Fresh Wt. gm**	**Dry Wt. gm**	**Fresh Wt. gm**	**Dry Wt. gm**	**Fresh Wt. gm**	**Dry Wt. gm**
Phyllanthus amarus	×	×	2.00	0.85	1.90	0.65	2.71	1.20	×	×
Alternanthera bettzickiana	×	×	×	×	×	×	×	×	×	×
Parthenium hysterophorus L	4.90	1.65	3.54	1.25	×	×	×	×	1.75	0.35
Desmodium alysicarpoides.	2.35	1.00	1.15	0.45	×	×	×	×	1.00	0.35
Tridax procumbens L	6.35	1.90	×	×	×	×	1.50	0.90	×	×
Crysanthenum	2.80	0.90	×	×	×	×	4.65	1.30	×	×
Oxalis debilis	3.12	1.10	1.65	0.54	×	×	7.85	2.98	×	×
Commelina diffusa	4.25	1.32	×	×	×	×	×	×	×	×
Hyptis suaveolens (L.)	×	×	×	×	×	×	×	×	×	×

*VC stands for vermicompost, PC for pit compost, NDP stands for NADEP compost and Cf stands for chemical fertilizers. * × indicate grass species was absent in given study area.*

The number of samples from each plot shows the plot composition. From Table 4, 5 and 6 it is clear that, the average number of verities of grass species found were 07, 04, 1.67, 4.33 and 2.34

with application of VC, NDP, PC, CF and control respectively. Results of present investigation indicate that maximum number of verities of grass species are observed with treatment of vermicompost and then followed by chemical fertilizers and its ascending order with respect to fertilizer response to different varieties of grasses was as bellow

T-1 > T-4 > T-2 > T-5 > T-3.

The lowest value was 1.67 observed with application of pit compost. The obsevations presented in Table 4, 5, 6, and 7 indicate that maximum fresh-dry weight and number of verities grass species was observed with application of vermicompost than remaining fertilizer treatment. This shows that the vermicompost is not only useful as effective organic fertilizers but also is a good soil conditioner for sustainable land practices.

Table 7. Effects of fertilizers treatment on average no. of grass species per plot.

Treatments.	Average number of verities of grass species per plot.
T-1	07
T-2	04
T-3	1.67
T-4	4.33
T-5	2.3

T-1 indicate compost from vermicomposting, T-2 indicate NADEP method of composting, T3 indicate pit composting method, T-4 indicate chemical fertilizers, T-5 indicate cotrol

The following photos shows total nine varieties of grass specimens collected from the study area.

Phyllanthus amarus

Alternanthera bettzickiana

Parthenium hysterophorus L

Desmodium alysicarpoides. Tridax procumbens L. Crysanthenum.

Oxalis debilis

commelina diffusa

Hyptis suaveolens (L.)

Conclusion:

All grass species had significantly higher average fresh and dry weights (gm/grass species) with application of vermicompost as compared to other remaining fertilizer treatments. Total number of verieties of grass species found per plot was maximum with application with vermicompost then followed by chemical fertilizer.

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