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Application of NPK and farmyard manure on biomass production of *Amaranthus palmeri* Wats

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ABSTRACT

The objective of this study was to comparatively evaluate the effects of NPK and farmyard manure on root and shoot growth in terms of biomass and among them farmyard manure have superior response. Fertilizers (Farmyard Manure and NPK) were show uniform increasing impact on biomass.

Key words: *Amaranthus palmeri* Wats., Fertilizers, NPK, Farmyard manure, Pot Culture.

INTRODUCTION

Amaranth is a common name of the genus *Amaranthus* spp., has been consumed throughout history, including by the Inca, Maya and Aztec civilizations, where it was used as a staple food. It is known for its C4 cycle of photosynthesis where the growth rate is optimized by high temperature, bright light and inadequate water and soil minerals.

The vegetable and grains are used in making soup and stew and the cooked leaves are eaten with milk or fat to which salt is added [**1&2].** It has a high nutritional value because of the high level of essential micronutrients like carotene and vitamin C, iron and calcium. Furthermore, it is nutritionally rich in lysine an essential amino acid that lacking in diets based on cereals and tubers.

Recently, an increased interest in amaranth appeared in the 1980s, when the United States National Academy of Science performed research on the grain and described its high nutritional value and agronomic potential [**3]**.

Rajasthan has soil of low fertility. Additional nutrients like NPK and farm-yard manure if supplied to the soil may influence the productivity of plants. The present work is based on the analysis of NPK and farmyard manure for biomass study in pot culture experiment.

MATERIALS AND METHODS

Pot culture experiments were carried out in the Department of Botany, University of Rajasthan, Jaipur. Seeds were collected from different sites of Jaipur district. Study carried out with the seeds of *Amaranthus palmeri* Wats. Which are small and lenticular in shape. The random amount of seeds was used in experiment. Plants were grown under natural environmental conditions in earthen pot of 28×28×16 cm. size. Each pot was filled with seven kilogram. of garden soil. The soil was amended with different concentrations of NPK and farmyard manure nutrients, in ratio of 0.01 g/kg, 0.02 g/kg 0.03g/kg and 0.05g/kg and 1g/kg, 3g/kg 5g/kg and 10g/kg respectively. For each treatment three replicates were used. A set of pots without any additives served as control. Pots were irrigated

manually using watering cans regularly i.e. every day. After every 15 days the data regarding biomass (fresh weight) were recorded up to three and half month (105 days) and statistically analyzed. Every 15 days interval was considered as a period. Vegetative growth and flowering and fruiting were observed in treated plants.

RESULTS

(i) NPK: Increasing concentration of NPK showed enhancing effect in both root and shoot growth. The root and shoot biomass gradually increased in the control, best results were obtained at V^{th} period with all concentrations where root fresh weight was 13.47 and in shoot 6.82 times more than initial fresh weight. Biomass calculated after every period i. e. 15 days. Data were found highly statistically significant (Table 1-2 & Pl.1&2).

(ii) Farmyard manure: Farmyard manure increases soil available levels of nutrients like, nitrogen and phosphorus with increased microbial activity. The root and shoot biomass gradually increased with increased concentration of farmyard manure in different periods. Periodically V^{th} period for treated plants (IV^{th} for control only) gave the best results where increase in biomass was found 24.12 times for root and 18.73 times for shoot than the initial fresh weight. The data were statistically analyzed and found highly significant except among control where the results were not significant. (Table 3-4 &Pl. 1&2).

Table-1: Effect of NPK on root biomass (fresh weight) of *A. palmeri* Wats. in pot culture experiment

Conc.	Biomass (Fresh weight) in gm per plant						
	I	II	III	IV	V	VI	VII
0.00 g/kg	0.04	0.08	0.15	0.85	1.04	1.52	1.67
0.01 g/kg	0.07	0.13	0.20	0.88	1.66	1.85	2.10
0.02 g/kg	0.08	0.15	0.38	0.98	1.79	1.99	2.26
0.03 g/kg	0.08	0.16	0.40	1.05	2.61	2.82	3.24
0.05 g/kg	0.09	0.20	0.48	1.73	3.24	3.64	4.11

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within 0.00g/kg	6	8.5707	1.4284	7.24**
Conc. within 0.01 gm/kg	6	10.8429	1.8071	9.16**
Conc. within 0.02 gm/kg	6	12.4127	2.0687	10.49**
Conc. within 0.03 gm/kg	6	14.4995	2.4165	12.25**
Conc. within 0.05 gm/kg	6	20.8401	3.4733	17.62**
Between concentrations	4	10.9454	2.7363	13.88**
Error	70	13.7975	0.1971	-

** *Highly significant*

Table-2: Effect of NPK on shoot biomass (fresh weight) of *A. palmeri* in Wats.pot culture experiment

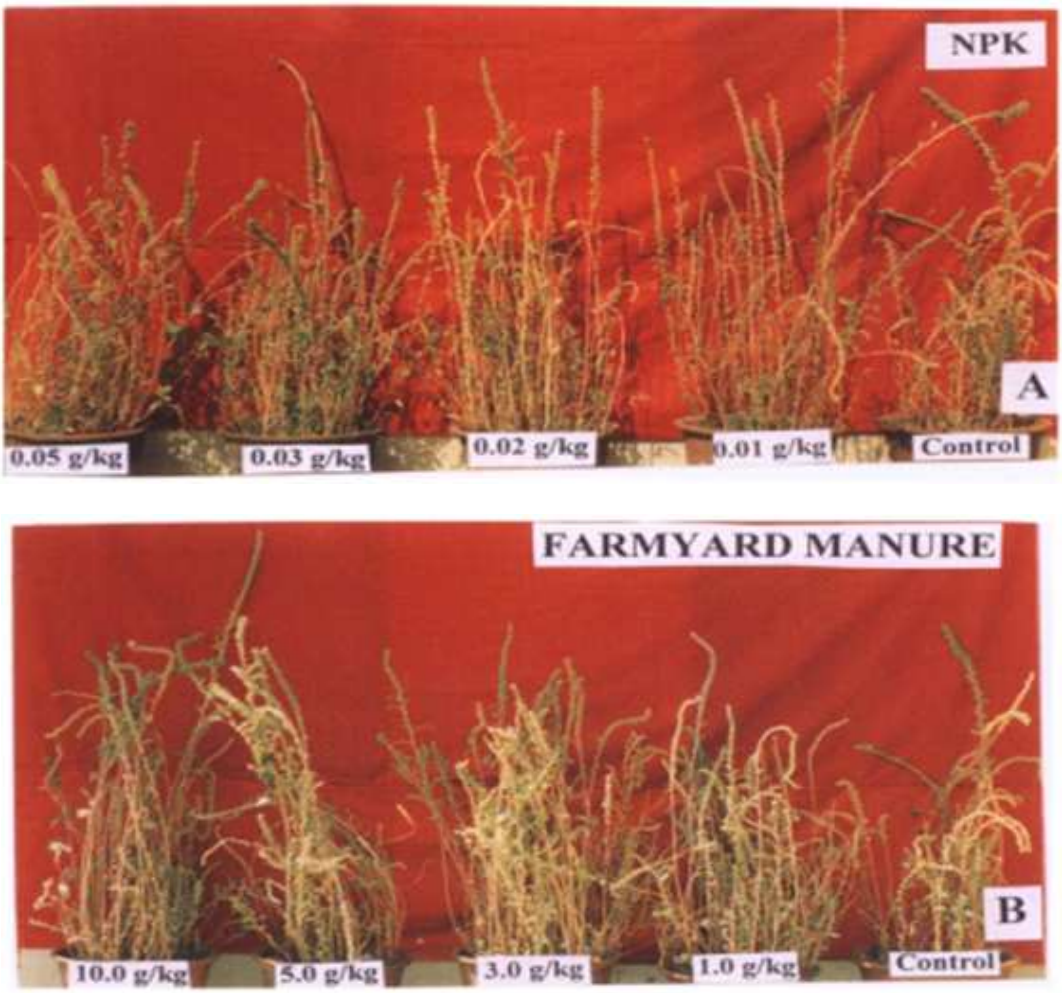
Conc.	Biomass (Fresh weight) in gm per plant						
	I	II	III	IV	V	VI	VII
0.00 g/kg	0.36	0.66	1.32	6.19	7.95	9.13	9.89
0.01 g/kg	0.47	0.95	1.90	5.05	8.17	9.16	9.22
0.02 g/kg	0.55	1.15	3.02	5.50	10.09	12.09	12.24
0.03 g/kg	0.65	1.12	2.42	8.93	14.12	16.25	16.21
0.05 g/kg	1.15	2.06	5.47	9.32	15.37	15.71	16.12

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within 0.00g/kg	6	305.3924	50.8987	5.02**
Conc. within 0.01 gm/kg	6	312.4777	52.0796	5.13**
Conc. within 0.02 gm/kg	6	439.0000	73.1668	7.21**
Conc. within 0.03 gm/kg	6	602.2080	100.3684	9.89**
Conc. within 0.05 gm/kg	6	759.9804	126.6638	12.48**
Between concentrations	4	178.6074	44.6515	4.39**
Error	70	710.4001	10.148	

** *Highly significant*

Plate: 1A: Showing the effect of different concentration of NPK on biomass at IIIrd period
1B: Showing the effect of different concentration of farmyard manure on biomass at IIIrd period
Note: Flowering observed



Amaranthus palmeri

Plate: 2A: Showing the effect of different concentration of NPK on biomass at VIth period
2B: Showing the effect of different concentration of farmyard manure on biomass at VIth period
Note : Flowering and Fruiting observed

Table-3: Effect of farmyard manure on root biomass (fresh weight) of *A. palmeri* Wats. in pot culture experiment

Conc.	Biomass (Fresh weight) in gm per plant						
	I	II	III	VI	V	VI	VII
0.00 g/kg	0.04	0.08	0.15	0.85	1.04	1.52	1.67
1.00 g/kg	0.05	0.13	0.22	1.53	3.60	3.95	4.65
3.00 g/kg	0.06	0.15	0.29	1.84	3.85	4.01	5.15
5.00 g/kg	0.12	0.25	0.53	2.50	4.91	4.95	6.13
10.00 g/kg	0.13	0.24	0.38	3.78	6.75	7.12	8.29

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within 0.00 gm/kg	6	8.570	1.4284	6.97**
Conc. within 1.0 gm/kg	6	66.213	11.035	53.92**
Conc. within 3.0 gm/kg	6	60.302	10.050	49.10**
Conc. within 5.0 gm/kg	6	93.315	15.552	75.99**
Conc. within 10.0 gm/kg	6	167.520	27.920	136.42**
Between concentrations	4	131.334	32.833	160.43**
Error	70	14.326	0.2046	

*** Highly significant*

Table-4: Effect of farmyard manure on shoot biomass (fresh weight) of *A. palmeri* Wats. in pot culture experiment

Conc.	Biomass (Fresh weight) in gm per plant						
	I	II	III	IV	V	VI	VII
0.00 g/kg	0.36	0.66	1.32	6.60	7.95	9.21	9.89
1.00 g/kg	0.45	0.98	1.78	10.16	21.23	22.35	23.51
3.00 g/kg	0.67	1.49	2.30	15.38	28.65	29.35	30.90
5.00 g/kg	0.85	1.75	3.12	16.51	31.52	32.18	33.91
10.00 g/kg	0.92	1.78	4.54	20.50	40.29	42.29	43.89

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within 0.00 gm/kg	6	305.3922	50.8987	9.53**
Conc. within 1.0 gm/kg	6	2056.5739	342.7623	64.21**
Conc. within 3.0 gm/kg	6	3578.4971	596.4161	11.73**
Conc. within 5.0 gm/kg	6	4224.3899	704.0649	131.90**
Conc. within 10.0 gm/kg	6	7580.4604	1263.4100	236.69**
Between concentrations	4	3738.0299	934.5074	175.07**
Error	70	373.6398	5.3377	

** *Highly significant*

DISCUSSION

Amaranthus is new crop with ancient history. The importance of organic manure in agricultural practice has been recognized from the earliest times. In ancient china, as also, to some extent, in Aryan India, the utilization of different forms of organic waste materials as manure was regarded as an important items of field operation. Most annual crops respond well to the application of organic manure and it can sustain yield under continuous cropping on most soil unlike equivalent amount of NPK fertilizers [**4]**. The potential of organic manure, crop residues and mulches that are decay able for building up soil organic matter and nutrient supply of the soil is particularly important in our today's agriculture, especially in the tropics where chemical fertilizers are no longer as readily and economically available as they were few year ago [**5]**. NPK is commonly used by farmers in the crop field to increase production. Nitrogen, potassium and phosphorus are essential elements for the growth and reproduction of plants. It is reported that low levels of nitrogen, phosphorus and potassium reduced the growth of plants by reducing cytokinin levels in buds and roots of *Helianthus annuus* **[6]**.

It is found that fertilization of a swale plant community *(Scripus americanus* and *Spartina patens)* with various levels and combinations of nitrogen, phosphorus and potassium resulted in increased plant growth **[7]**. Growth and yield of rice is optimal with chemical fertilizer application of NPK in the ratio of 60:40:40 kg of NPK/ha along with 5 tons of cattle manure, while in another experiment on photosensitive rice culture it was found that NPK in the ratio of 80:40:40 kg/ha showed maximum grain yield per hectare **[8 & 9]**. Schlegel [**10]** observed that poultry manure had highest effect on soil available levels of N and P compared to other animal manures in *Amaranthus.*

The use of compost or manure in agriculture as an organic source of nutrients is common in many tropical, developing countries like Nigeria. One of the drawbacks of such materials is their low nitrogen content. Farmers commonly use chemical N fertilizers such as urea, calcium ammonium nitrate and NPK formulations to obtain better crop growth and yield. These chemical supplements may have a negative impact on the environment through nitrate leaching into water, leading to eutrophication of surface waters that can affect public health. *Gliricidia sepium*, a fast growing, tropical perennial hedge plant was tested as a source of N in organo-mineral fertilizer formulations. Average nutrient content of *Gliricidia* is 3.8% N, 0.32% P, 1.8% K, 0.8% Ca and 0.2% Mg using a sand culture and *Amaranthus caudatus* as a test crop, it was shown that amending commercial compost with 30% *Gliricidia* pruning would benefit many small-scale farmers and control environmental pollution [**11]**. Animal manure *viz.*, dairy cow, goat and poultry to increase the production in amaranths. It was found that poultry manure is superior to goat and dairy cow manure. This was due to mineralization of organic nitrogen and phosphorus **[12]**.

The combined application of inorganic and organic N sources in 75:25 ratio is a superior N-management practice with regards to crop yields as well as improvement of soil fertility **[13]**, but we used separately NPK and farmyard manure for inorganic and organic manures, respectively. In both increased in biomass were observed.

Humic substances tend to increase dry weight of plants. Soil microbes which are in higher concentration in humus might help in a better nutrition of the plants resulting in higher productivity **[14]**. *Rauvolfia serpentina* shows good

growth in pure organic manure whereas maximum growth of *R. serpentina* is exhibited in garden loans mixed with organic manure in the ratio of 1:1 **[15]**. *Cleome viscosa* and *Cleome gynandra* show maximum growth in soil containing organic manure in the ratio of 1: 1 than in garden soil, sand, clay or gravel **[16]**.

The effect of N-fertilizer on *Amaranthus* species grain yield, yield components and growth and development investigated in three Missouri environments with 5-levels of N-fertilizer and 3 cultivars. Averaged across cultivars and environments, N fertilizer act and top rate of 180 kg/ha produced a yield increase of 42% relative to plots receiving no fertilizer. Although amaranth yield is responsive to N -application, high rates of N fertilizer can negatively affect grain harvest in terms of excessive plant height, increased lodging and delayed crop maturity. The root and shoot biomass gradually increased in the control, as well as in the treated plants after every period *i.e.* 15 days. The initial weight (*i.e.* 0.04g) of the roots of control plants is least whereas in the soil amended with 0.05g /kg of urea was just the double. There was fast increase in the growth of root and shoot(7-8 times) up to IV^{th} period in all the treatments and after this growth becomes slow(Table 1,2).In the present studies it has been found that inorganic fertilizer, NPK show uniform increasing effect in root and shoot biomass. In case of organic fertilizers i.e. animal dung reveal a uniform trend of increasing in biomass **[17]**.

In general relative effectiveness of used organic and inorganic manure may sequenced as farmyard manure >NPK were observed for root as well as shoot fresh weight. Increases in biomass were found in the average range in times comparing to initial fresh weight of 9.29 to 29.06g for root; 6.82-18.73g for shoot of *A. palmeri.*

Generally flowering and fruiting time of *A. palmeri* are September and November respectively. In present investigations, flowering is observed in July whereas seed setting (fruiting) take place in month of August. It is found that flowering and fruiting time were changed *i.e.* September-November to July and August. This may be due to fertilizers or regular irrigation.

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