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Standardization of organic cultivation practices on soil NPK status in bitter gourd (*Momordica charantia* L.) var. Pusa Aushadhi

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Abstract
The present investigation entitled "Standardization of organic cultivation practices on soil NPK status in bitter gourd (*Momordica charantia* L.) var. Pusa Aushadhi" was carried out during *rabi* season in the year 2021-2022 at P.G research farm, College of Horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad. The experiment was carried out with twenty (20) treatments in Randomized Block Design with three (3) replications *i.e.* T_1: Farmyard manure (25 t/ha) + AMC (12.5 kg/ha), T_2: Farmyard manure (25 t/ha) + VAM (10 kg/ha), T_3: Farmyard manure (30 t/ha) + AMC (12.5 kg/ha), T_4: Farmyard manure (30 t/ha) + VAM (10 kg/ha), T_5: Vermicompost (10 t/ha) + AMC (12.5 kg/ha), T_6: Vermicompost (10 t/ha) + VAM (10 kg/ha), T_7: Vermicompost (12 t/ha) +AMC (12.5 kg/ha), T_8: Vermicompost (12 t/ha) +VAM (10 kg/ha), T_9: Poultry manure (6 t/ha) + AMC (12.5 kg/ha), T_{10}: Poultry manure (6 t/ha) + VAM (10 kg/ha), T_{11}: Poultry manure (8 t/ha) + AMC (12.5 kg/ha), T_{12}: Poultry manure (8 t/ha) + VAM (10 kg/ha), T_{13}: Neem cake (1 t/ha) + AMC (12.5 kg/ha), T_{14}: Neem cake (1 t/ha) + VAM (10 kg/ha), T_{15}: Neem cake (2 t/ha) + AMC (12.5 kg/ha), T_{16}: Neem cake (2 t/ha) + VAM (10 kg/ha), T_{17}: RDF (40: 80: 50 NPK kg/ha) + AMC (12.5 kg/ha), T_{18}: RDF(40: 80: 50 NPK kg/ha) + VAM (10 kg/ha), T_{19}: RDF (40: 80: 50 NPK kg/ha), T_{20}: Absolute control. Different treatment combinations of RDF and organic manures along with bio fertilizers have a significant influence on soil nutrient status. The results on soil nutrient status showed that among the treatments, T_{11}: Poultry manure (8 t/ha) + AMC (12.5 kg/ha) significantly recorded lowest soil pH after harvest (7.11) and lowest EC after harvest (0.232 dS/m) while, T_3: Farmyard Manure (30 t/ha) + AMC (12.5 kg/ha) recorded the highest organic carbon content after harvest (0.77%). Significantly maximum availability of nitrogen after harvest (251.15 kg/ha), maximum availability of phosphorous after harvest (35.25 kg/ha) and maximum availability of potassium content after harvest (324.56 kg/ha) was recorded by the treatment T_{17}: RDF (40: 80: 50 NPK kg/ha) + AMC (12.5 kg/ha) compared to the other treatments.

Keywords: Bitter gourd, farmyard manure, Vermicompost, poultry manure, Neem cake, AMC, VAM, Pusa Ausadhi

Introduction
Bitter gourd (*Momordica charantia* L.) is diploid in nature (2n=22) and belongs to family Cucurbitaceae. It grows best in well-drained loamy soil with a pH of 6.5-7.0. Although the plant is adaptable to a wide range of climates, it produces best in hot climates (Binder *et al.*, 1989) [5].
Annual production of bitter Gourd in India, cultivated over 114,771 ha and yields about 12,448 kgs / ha. In Telangana, bitter gourd crop occupies 960 ha and 22,660 MT in production (Ministry of Agriculture and Farmers Welfare) [16].
Momordicin, Momordicinin, and Momordicilin are three pentacyclic triterpenes that build over time and induce bitterness in the fruit; the bitterness then diminishes as the fruit ripens [(Begum *et al.*, 1997) [2]; (Cantwell *et al.*, 1996)] [6]. Fruit contains a high concentration of vitamin C (88 mg/100g). It contains antioxidant, antimicrobial, antiviral, antihepatotoxic, antiulcerogenic, and blood sugar-lowering effects (Behera *et al.*, 2011) [3]. It also has a variety of medical characteristics, including a germicidal impact, laxative action, and the ability to treat blood

illnesses such as rheumatism, diabetes, asthma, and AIDS. Bitter gourd possesses hypoglycemic (blood sugar-lowering) properties and is therefore utilized as an anti-diabetic and hypoglycemic agent (Palaniswamy *et al*., 2011) [17]. It has anti-inflammatory, antiviral, anticancer, anti-leukemia, anti-tumour, analgesic, abortifacient, immune suppressive, blood-cleansing, blood sugar-lowering, and hormone-balancing properties that combat free radicals, kill cancer cells, and prevent tumours (Taylor, 2005) [21].

The use of expensive commercial fertilizers, which are prohibitively expensive for small and marginal farmers, allowed them to replace chemical fertilizers with a combination of organic manures and bio-fertilizers, increasing soil fertility, crop productivity, and fruit yield. Organic farming makes use of organic manures and naturally occurring compounds like biofertilizers, biopesticides, botanicals, and integrated pest control. To ensure environmental quality and safety. Organically cultivated veggies are nutritious and profitable, with fewer post-harvest losses. Biofertilizers are associations that supplement plant nutrition. Some of the ways that carrier-based microorganisms found in biofertilizers boost productivity include biological nitrogen fixation, solubilization of insoluble phosphate, and manufacture of hormones, vitamins, and other plant growth factors (Bhattacharyya *et al*., 2000) [4].

Farmyard manure increases soil permeability to air and water while also increasing nutrient uptake, improving soil moisture holding capacity, cation exchange capacity (CEC), and soil pH. They also increase soil bulk density and stimulate microbial activity (Subedi, 1998) [20].

Vermicompost has been shown to have a great potential as a soil amendment. It has been determined to be an ideal organic nutrition source due to its high macro- and micronutrient content, which aids in yield enhancement (Hidalgo *et al.,* 1999) [13].

Poultry manure is the best and richest because liquid and solid excreta are released simultaneously, reducing urine loss. It includes growth-promoting chemicals that improve plant development and agricultural yield (Samman *et al.,* 2008) [19]. It enhances soil structure, nutrient retention, aeration, soil moisture holding capacity, water infiltration, and plant P availability (Garg and Bahl, 2008) [11].

Neem cake boosts soil aeration, water holding capacity, soil texture, and organic matter content for better crop development and increase in dry matter.

Arka Microbial Consortium is a carrier-based product that includes N-fixing, P- and Zn-solubilizing, and Plant Growth Promoting Microbes in a single formulation. The peculiarity of this technology is that farmers have no requirement to use nitrogen-fixing, phosphorus-solubilizing, and growth-promoting bacterial inoculants individually. It can be simply applied using seed, soil, water, and nursery medium like coco-peat (Aswathi *et al.,* 2020) [1].

Mycorrhiza forms symbiotic relationships with plant roots and fungal mycelia, facilitating nutrient uptake, particularly phosphorus, zinc, and sulphur, as well as the production of growth hormones such as gibberellic acid, indole acetic acid, and dihydrozeatin, which accelerates plant growth (Ikiz *et al.,* 2009) [14] and crop yield (Dasgan *et al.,* 2008) [9].

Material and Methods

The present investigation was carried out during *rabi* season in the year 2021-2022 at P.G research farm, College of Horticulture, Rajendranagar, Hyderabad. Sri Konda Laxman Telangana State Horticultural University. The experimental site is situated at a latitude of 17º.32’ north, longitude of 78º.40’ East and altitude of 542.3 m above mean sea level. The plots were demarcated into three (3) replications, each replication with twenty (20) treatments and experimental design followed is Randomized Block Design (RBD). The experimental field had sixty (60) plots. The protrays were selected, cleaned and filled with cocopeat: perlite: vermiculite in the ratio of 3:1:1 suitable for rooting media. The seeds were soaked for overnight and imbibed seeds were sown and were kept in shade net for germination purpose. The seedlings at two leaf stage planted into already prepared plots.

The biofertilizers *viz*., Arka Microbial Consortium (AMC) and Vesicular Arbuscular Mycorrhiza (VAM) were added (12.5 kg/ha and 10 kg/ha) respectively to all organic manures for multiplication purpose. Biofertilizers enriched organic manures *viz*., well decomposed farm yard manure (25t/ha and 30t/ha), vermicompost (10t/ha and 12 t/ha), poultry manure (6 t/ha and 8 t/ha) and neem cake (1 t/ha and 2 t/ha) were applied to the respective pits 15 days before transplanting of seedlings and were thoroughly mixed with soil. The recommended doses of Nitrogen, Phosphorous and Potassium @ 60:120:30 kg/ha were applied to the respective pits in the form of Urea, Single Super Phosphate and Muriate of Potash respectively. Half dose of urea and the entire dose of Single Super Phosphate and Muriate of Potash were applied at the time of transplanting as a basal application and the remaining half dose of Urea was divided into two split doses and were applied at 30 and 60 days after transplanting of seedlings. All other cultural and plant protection measures were done as per the recommended package of practices for the healthy crop.

The observations were recorded on soil NPK status like soil pH, EC, organic carbon, available nitrogen, available phosphorus and available potassium. The data collected were analyzed statistically by following the analysis of variance (ANOVA) technique (Panse and Sukhatme 1985) [18]. Statistical significance was tested with 'F' value at 5 per cent level of significance and whenever the F value was found significant, critical difference was worked out at five per cent level of significance.

Results and Discussion

Soil nutrient status

The data recorded on soil nutrient status after harvest viz., soil pH, electric conductivity, organic carbon, available nitrogen, available phosphorus and available potassium are presented in the Table 1

Soil pH

The data pertaining to soil pH after harvest as influenced by different treatment combinations of RDF and organic manures along with bio fertilizers are presented in the Table 1

The initial soil pH of soil was recorded as 7.44. The results revealed that among different combinations of RDF and organic manures along with biofertilizers had shown non-significant results on soil pH after harvest in bitter gourd

Electric conductivity (dS/m)

The data pertaining to electric conductivity after harvest as influenced by different treatment combinations of RDF and organic manures along with bio fertilizers are presented in the

Table 1

The initial electric conductivity of soil was recorded as 0.293 dS/m. The results indicated that there was a significant difference among the treatments with respect to the electric conductivity of soil after harvest of crop. The least electric conductivity of soil (0.232 dS/m) was recorded significantly in T_{11}: Poultry manure (8 t/ha) + AMC (12.5 kg/ha) which was on par with T_{12}: Poultry manure (8 t/ha) + VAM (10 kg/ha) (0.238 dS/m), T_7: Vermicompost (12 t/ha) + AMC (12.5 kg/ha) (0.241 dS/m) and it was followed by T_8: Vermicompost (12 t/ha) + VAM (12.5 kg/ha) (0.243 dS/m). However, the highest electric conductivity of soil was significantly recorded inT_{20}: Absolute control (0.289 dS/m).

The results revealed that among different combinations of RDF and organic manures along with biofertilizers had shown significant results on electric conductivity after harvest in bitter gourd. Electric conductivity was lower at the end of the season in all organic matter applications, but higher in conventional chemical fertilizer applications which might be attributed to increased salt permeability.

Similar results were reported by Kameswari *et al.* (2011) [15] in ridge gourd; Ghayal (2016) [12] in cucumber.

Organic carbon (%)

The data pertaining to organic carbon of soil after harvest as influenced by different treatment combinations of RDF and organic manures along with bio fertilizers are presented in the Table 1

The initial organic carbon of soil was recorded as 0.49%. There were significant differences observed among the treatments with respect to organic carbon of soil after harvesting of bitter gourd. Significantly the highest organic carbon (0.77%) recorded in T_3: Farmyard Manure (30 t/ha) + AMC (12.5 kg/ha) which was on par with T_4: Farmyard Manure (30 t/ha) + VAM (10 kg/ha) (0.76%), T_1: Farmyard Manure (25 t/ha) + AMC (12.5 kg/ha) (0.75%), T_2: Farmyard Manure (25 t/ha) + VAM (10 kg/ha) (0.74%) and it was followed by T_7: Vermicompost (12 t/ha) + AMC (12.5 kg/ha) (0.73%). However, lowest organic carbon was significantly recorded in T_{20}: Absolute control (0.46%).

The results revealed that among different combinations of RDF and organic manures along with biofertilizers had shown significant results on organic carbon after harvest in bitter gourd. Soil organic carbon serves as a sink and source of nutrients for microbial population, which regulates the availability of various nutrients via microbial transformation. Organic manures and fertilizers combined with biofertilizers resulted in a much higher net increase in organic carbon than 100% NPK alone. This could be due to increased microbial activity in the root zone, which decomposed the organic manures and also fixed unavailable forms of mineral nutrients into available forms in soil, thereby substantiated crop requirements hence improved organic carbon level and stabilized soil pH.

The results of the present study are in close confirmity with the findings of Chaudhary *et al.* (2005) [7] and Chumyani *et al.* (2012) [8] in tomato

Available nitrogen (kg/ha)

The data pertaining to available nitrogen after harvest as influenced by different treatment combinations of RDF and organic manures along with bio fertilizers are presented in the Table 1

It was recorded that initial nitrogen content in the soil was recorded as 212.83 kg/ha. From the data it is clear that there was significant increase in availability of nitrogen in soil after harvest of bitter gourd in all treatments as compared to before sowing of crop except absolute control. Significant differences were observed among the treatments for available nitrogen. The maximum available nitrogen in soil (251.15 kg/ha) was recorded significantly in T_{17}: RDF (40 : 80 : 50 NPK kg/ha) + AMC (12.5 kg/ha) which was on par with T_{18}: RDF (40 : 80 : 50 NPK kg/ha) + VAM (10 kg/ha) (250.01 kg/ha), T_{19}: RDF (40 : 80 : 50 NPK kg/ha) (247.45 kg/ha), T_{11}: Poultry manure (8 t/ha) + AMC (12.5 kg/ha) (245.33 kg/ha), T_{12}: Poultry manure (8 t/ha) + VAM (243.76 kg/ha) and it was followed by T_7: Vermicompost (12 t/ha) + AMC (12.5 kg/ha) (241.52 kg/ha). However, significantly minimum available nitrogen was recorded in T_{20}: Absolute control (210.80 kg/ha).

The results revealed that among different combinations of RDF and organic manures along with biofertilizers had shown significant results on maximum availability of nitrogen after harvest in bitter gourd. The significant increase in available nitrogen in soil after harvest of bitter gourd crop as compared to before sowing of crop may be due to the ability of bio fertilizers to fix atmospheric nitrogen in the rhizosphere throughout the cropping period, soil inoculated with microorganism has great biological activity and ability to fix nitrogen. By application of chemical fertilizers, the available nitrogen was found high in NPK treated soil which might be due to mineralization, solubilization, chelating action in ions available and slow down the leaching of nutrients making it readily available.

The results of the present study are in close confirmity with the findings of Kameswari *et al.* (2011) [15] in ridge gourd; Dodake *et al.* (2015) [10] in bitter gourd

Available phosphorus (kg/ha)

The data pertaining to available phosphorus after harvest as influenced by different treatment combinations of RDF and organic manures along with bio fertilizers are presented in Table 1

It was observed that initial phosphorus content in the soil was recorded as 23.47 kg/ha. From the data it is clear that there were significant differences in availability of phosphorous in soil after harvest of bitter gourd in all treatments as compared to before sowing of crop except absolute control. Significant differences were observed among the treatments for available phosphorus. The maximum available phosphorus in soil (35.25 kg/ha) was recorded significantly in T_{17}: RDF (40: 80: 50 NPK kg/ha) + AMC (12.5 kg/ha) which was on par with T_{18}: RDF (40: 80: 50 NPK kg/ha) + VAM (10 kg/ha) (34.16 kg/ha) and it was followed by T_{19}: RDF (40: 80: 50 NPK kg/ha) (33.77 kg/ha). However, significantly minimum available phosphorus was recorded in T_{20}: Absolute control (22.12 kg/ha).

The results revealed that among different combinations of RDF and organic manures along with biofertilizers had shown significant results on maximum availability of phosphorus after harvest in bitter gourd. Normally, phosphorus is said to be in fixed form, and its absorption is slow or non-existent. The increase in available phosphorus with the biofertilizers in inoculated plot may be due to reduction in fixation of water-soluble P, better mobilization, better solubility and maintaining soil physical condition by inoculation with AMC might have contributed organic acids, growth hormone like auxins and cytokinins that resulted in transformation of the complex form of phosphate into a more soluble and simple form of phosphorus, resulting in increased phosphorus availability in the rhizosphere soil.

The results of the present study are in close confirmity with the findings of Kameswari *et al.* (2011) [15] in ridge gourd; Dodake *et al.* (2015) [10] in bitter gourd

4.5.6 Available potassium (kg/ha)

The data pertaining to available potassium content after harvest in the soil as influenced by different treatment combinations of RDF and organic manures along with bio fertilizers are presented in the Table 1

It was recorded that initial potassium content in the soil was recorded as 284.16 kg/ha. From the data it is clear that there was significant increase in availability of potassium in the soil after harvest of bitter gourd in all treatments as compared to before sowing of crop except absolute control. Significant differences were observed among the treatments for available potassium. The maximum available potassium in soil (324.56 kg/ha) was recorded significantly in T_{17}: RDF (40 : 80 : 50 NPK kg/ha) + AMC (12.5 kg/ha) which was on par with T_{18}: RDF (40 : 80 : 50 NPK kg/ha) + VAM (10 kg/ha) (321.14 kg/ha), T_{19}: RDF (40 : 80 : 50 NPK kg/ha) (320.12 kg/ha), T_{11}: Poultry manure (8 t/ha) + AMC (12.5 kg/ha) (319.98 kg/ha), T_{12}: Poultry manure (8 t/ha) + VAM (317.87 kg/ha), T_9: Poultry manure (6 t/ha) + AMC (12.5 kg/ha) (314.56 kg/ha), T_{10}: Poultry manure (6 t/ha) + VAM (10 kg/ha) (311.35 kg/ha) and it was followed by T_7: Vermicompost (12 t/ha) + AMC (12.5 kg/ha) (309.15 kg/ha). However, significantly minimum available potassium was recorded in T_{20}: Absolute control (281.34 kg/ha).

The results revealed that among different combinations of RDF and organic manures along with biofertilizers had shown significant results on maximum availability of potassium after harvest in bitter gourd. The increase in available potassium in soil after harvest of bitter gourd as compared to before sowing of crop, could be due to the mineralization of insoluble compounds through the action of organic acids released by bio-fertilizers. The beneficial effect of combined fertilizer and manure application on available soil potassium. Nitrogen might have influenced potassium availability by virtue of its complementary action with potassium.

The results of the present study are in close confirmity with the findings of Kameswari *et al.* (2011) [15] in ridge gourd; Dodake *et al.* (2015) [10] in bitter gourd

Table 1: Effect of different treatment combinations of RDF and organic manures along with biofertilizers on soil pH, electric conductivity (dS/m), organic carbon (%) and available N, P_2O_5 and K_2O (kg/ha) in soil after harvest in bitter gourd

Treatments	Soil pH	Electric conductivity (dS/m)	Organic carbon (%)	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)
T_1	7.28	0.263	0.75	227.54	26.87	301.15
T_2	7.21	0.271	0.74	225.32	26.25	299.87
T_3	7.18	0.258	0.77	232.28	27.75	297.32
T_4	7.19	0.262	0.76	229.87	27.32	294.56
T_5	7.17	0.255	0.70	235.23	28.68	304.56
T_6	7.18	0.257	0.69	234.12	28.42	302.33
T_7	7.13	0.241	0.73	241.52	29.78	309.15
T_8	7.14	0.243	0.71	240.12	29.25	307.34
T_9	7.15	0.246	0.62	238.79	31.65	314.56
T_{10}	7.16	0.252	0.60	236.17	30.41	311.35
T_{11}	7.11	0.232	0.67	245.33	32.34	319.98
T_{12}	7.12	0.238	0.64	243.76	31.96	317.87
T_{13}	7.34	0.277	0.56	219.16	24.86	292.34
T_{14}	7.34	0.280	0.53	216.33	24.45	290.12
T_{15}	7.31	0.272	0.58	223.43	25.66	288.56
T_{16}	7.31	0.275	0.57	220.14	25.32	287.12
T_{17}	7.35	0.280	0.50	251.15	35.25	324.56
T_{18}	7.37	0.281	0.49	250.01	34.16	321.14
T_{19}	7.38	0.283	0.48	247.45	33.77	320.12
T_{20}	7.40	0.289	0.46	210.80	22.12	281.34
S.E (m) ±	0.11	0.003	0.01	3.32	0.46	4.76
CD at 5%	N.S	0.010	0.03	9.51	1.31	13.61

Conclusion

Based on the study, it was concluded that, different treatment combinations of RDF and organic manures along with bio fertilizers have a significant influence on quality in bitter gourd. The experimental results revealed that application of T_{11}: Poultry manure (8 t/ha) + AMC (12.5 kg/ha) recorded significantly lowest pH and lowest EC while, T_3: Farmyard Manure (30 t/ha) + AMC (12.5 kg/ha) recorded the highest organic carbon content. Significantly maximum availability of nitrogen, maximum availability of phosphorous and maximum availability of potassium content was recorded by the treatment T_{17}: RDF (40: 80: 50 NPK kg/ha) + AMC (12.5 kg/ha) was proved to be the best treatment in bitter gourd (*Momordica charantia*. L) var. Pusa Aushadhi.

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