INFLUENCE OF ORGANIC NUTRIENTS ON YIELD, QUALITY OF BITTER GOURD (*Momordica charantia* L.) CV. LONG GREEN

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ABSTRACT

An investigation was carried out to study the influence of organic nutrients on yield and quality of bitter gourd (*Momordica charantia* L.) cv. Long Green at the Department of Horticulture, Annmalai University, Annamalainagar during July-October, 2012 with 14 organic treatment combinations. The results revealed that the application of vermicompost @ 5 t ha^{-1} and *Azospirillum* @ 5 kg ha^{-1} along with foliar spray of panchakavya spray @ 3 per cent improved yield and quality traits of bitter gourd. This treatment recorded the highest number of fruits per vine (14.60) and fruit yield per vine (6.75 kg). The quality parameters *viz.*, the total soluble solids and ascorbic acid content were significantly influenced by the application of vermicompost 5 t ha^{-1} and *Azospirillum* @ 5 kg ha^{-1} coupled with foliar spray of panchakavya @ 3 per cent with a highest content of 1.42 ^{0}Brix of TSS and 41.21 mg 100 g^{-1}ascorbic acid content. The nutrient uptake by the crop was also favourably influenced by the same treatment. Based on the results, it can be concluded that application of vermicompost @ 5 kg ha^{-1} and *Azospirillum* @ 5 t ha^{-1} along with foliar spray of panchakavya @ 3 per cent has been identified as the best treatment for maximizing the yield and quality in bitter gourd cv. Long Green.

INTRODUCTION

Bitter gourd or balsam pear (*Momordica charantia* L.) is one of the commercially important cucurbitaceous vegetable crops extensively grown throughout India for its nutritive value and medicinal properties. Consumption of its juice has been found useful for diabetic patients due to its potent oxygen free radical scavenging activity of the fruit juice (Sreejayan and Rao, 1991). The leaf extract of bitter gourd has also

showed very good mosquitocidal effect (Murlee Yadav *et al*., 2008). The fruits are prepared for consumption in many ways and are quite commonly used in fried, boiled and stuffed forms.

Organic farming is a crop production system, which favours maximum use of organic matter, keeps the environment healthy and discourages synthetically generated agro-inputs used for maintaining soil fertility and productivity. To get rid of the deleterious effect of chemical fertilizers and pesticides, organic culture is needed as an alternative to provide eco-friendly method of farming (Rana, 2004).

The use of organic manures like FYM, vermicompost, pressmud, *Azospirillum*, panchakavya, EM (effective microorganisms) and humic acid partly substitute chemical fertilizers and also reduce the cost of production. Organically grown horticultural produces are residue free and fetches a high price in the market. FYM promotes favourable soil properties and vermicompost seems to possess an inherent property of acting not only as a fertilizer but also a mild biocide and hence can be referred as "Ferticide" (Pramoth, 1995).

Pressmud is a rich source of carbon (35-37 %), nitrogen (1.0 – 1.5 %), phosphorus (2.5 – 3.5 %) and potassium (0.5 – 0.8 %) and its application to soil increased the organic carbon and total N, P and K content. *Azospirillum* has been found to increase the yield of crops by 5-20 per cent with saving of nitrogen upto 40 per cent. Panchakavya is a single organic input which can act as a growth promoter and immunity booster. It has a significant role in providing resistance against pest and diseases besides increasing the overall yield (Natarajan, 2006).

EM culture to the soil or plant ecosystem can improve soil quantity, soil health and growth, yield and quality of crops (Higa and Wdidana, 1991). Humic acid influences the plant growth through modifying the physiology of plants and by improving the physical, chemical and biological properties of soil.

Not much work has been done on bitter gourd, particularly on the management side, while new varieties are being bred by the public and private sector constantly and hence there is a need to standardise the organic farming practices for this crop. Therefore, the present investigation was carried out to study the influence of organic nutrients in cv. Long Green with an aim to study their influence on fruit yield, quality attributes, dry matter production and nutrient uptake.

MATERIALS AND METHODS

The present investigation was carried out at the vegetable unit of the Department of Horticulture, Annamalai University, Annamalainagar during July-October, 2012.

The seeds of bitter gourd cv. Long Green, a local popular variety was collected from Panruti area near Cuddalore. The fruits are dark green, 25-30 cm long and grown in trellies with a crop duration of 120 days.

Sources of Organic Manures

The farm yard manure and vermicompost were obtained from the Orchard, Department of Horticulture, Faculty of Agriculture, Annamalai University. The inoculum of *Azospirillum* was obtained from the Department of Microbiology, Faculty of Agriculture, Annamalai Univeristy. Pressumud was obtained from the unit of M/s. M.R. Krishnamoorthy sugar mill, Sethiathoppu. Panchakavya was prepared by a modified method as suggested by Natarajan (2002). Humic acid was obtained both in the crystal and liquid form from M/s. Agro Science Laboratories, Shree Dhanalakshmi Industrial Garden, Santha Vellipet, Vadalur, Cuddalore district. Effective Microorganisms (EM) were obtained from the 'Auroville' at Pondicherry.

The organic manures *viz*., FYM, vermicompost, pressmud and recommended dose of organic fertilizers were given as basal dose and *Azospirillum*, panchakavya, EM (effective microorganisms) and humic acid were given as foliar spray thrice at 15 days interval (30, 45 and 60 DAS). For the treatment T_2, a basal application of 70: 25: 25 kg NPK ha^{-1} was applied. The crop was given irrigation as and when needed. Recommended cultural practices as suggested by Veeraragathatham *et al*. (1988) were followed.

Treatments

There were 14 treatment combinations viz., absolute control (T_1), recommended dose of NPK @ 70: 25: 25 kg ha^{-1} (T_2), FYM @ 25 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} (T_3), vermicompost @ 5 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} (T_4), pressmud @ 2 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} (T_5), FYM @ 25 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} + panchakavya @ 3 per cent ha^{-1} (T_6), vermicompost @ 5 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} + panchakavya @ 3 per cent ha^{-1} (T_7), pressmud @ 25 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} + panchakavya @ 3 per cent ha^{-1} (T_8), FYM @ 25 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} + EM (1: 1000 dilution) (T_9), vermicompost @ 5 t ha^{-1} +

Azospirullum @ 5 kg ha^{-1} + EM (1: 1000 dilution) (T_{10}), pressmud @ 25 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} + EM (1: 1000 dilution) (T_{11}), FYM @ 25 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} + humic acid @ 0.2 per cent ha^{-1} (T_{12}), vermicompost @ 5 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} + humic acid @ 0.2 per cent ha^{-1} (T_{13}) and vermicompost @ 5 t ha^{-1} + humic acid @ 0.2 per cent ha^{-1} (T_{14}).

Observations Recorded

Observations were recorded from ten tagged plants in each treatment per replication on number of fruits per vine, single fruit weight and fruit yield per vine. The dry matter production of plant was estimated using a hot air oven at 80 ± 5 °C for 48 hours and recorded as gram per cent. The quality attributes viz., total soluble solids and (°Brix) and ascorbic acid (mg/100g) in fruits were estimated by a hand refractometer and A.O.A.C method (1975) respectively.

Plant Nutrient Uptake

Five randomly selected plants were dried in an oven at 60 °C, powdered in a wiley mill and analysed for total nutrient content. The total nitrogen uptake was analysed by microkjeldahl method (Yoshida *et al*., 1972) and expressed in kg ha^{-1}. The total phosphorus uptake of plant sample was analyzed calorimetrically from triple acid digestion method as described by Jackson (1973). The total potassium uptake of plant (kg/ha) was estimated using triple acid digestion method as described by Jackson (1973) with flame photometer.

The data recorded were subjected to statistical analysis as per the method suggested by Panse and Sukhatme (1985). Economics of different treatments was worked out in order to compare the efficacy of the treatments and the cost: benefit ratio was worked out from gross return as: B: C ratio = Gross return ha^{-1}/ Cost of cultivation ha^{-1}

RESULTS AND DISCUSSION

Bitter gourd (*Momordica charantia* L.) is one of the most nutritive and commercially important vegetables in India. It is also known for its various medicinal properties with a more recent attention focused on its use as a hypoglycemic agent.

In this modern scientific world, unscrupulous use of chemical fertilizers, pesticides and herbicides have adversely affected the soil productivity and environment. Building up of soil fertility is indispensable for higher productivity of cultivable land. Organic manures and their role in improving the soil fertility and productivity of soil have been acknowledged for decades. However, it is only during the last 10-15 years, awareness for integrated nutrient supply system for enhancing crop yields and quality has increased.

In this context, the present study has brought to light the beneficial effects of different organic manures. The results obtained on yield and quality attributes are discussed below.

As regard to number of fruits per vine, the results revealed that the treatment combination of vermicompost @ 5 t ha^{-1} + *Azospirillus* @ 5 kg ha^{-1} + panchakavya @ 3 per cent foliar spray in the highest number of fruits (14.60) followed by T_{10} (13.68) as compared to the least recorded the control (8.43). The single fruit weight was found to vary significantly among the various treatments. T_7 recorded the maximum weight of fruits (33.97 g) followed by T_{10} (30.58), while the minimum fruit weight (15.06 g) was recorded in T_1 (control). It was observed that the highest yield of fruits per vine (6.75 kg) was registered in T_7 followed by T_{10} (6.69 kg) as against the least (2.90 kg) in the control (T_1) (Table 1).

As regard to dry matter production, all the treatments proved superior to the control in increasing the dry matter production. Among them, T_7 registered maximum dry matter production (220.44 g $plant^{-1}$) followed by T_{10} (212.01 g $plant^{-1}$) as against the least (94.63 g $plant^{-1}$) recorded in control (Table 2).

Higher yields due to application of vermicompost in this study may be attributed to the higher level of nutrients along with growth stimulating substances exerted by earthworms into their casts. Tomati *et al.* (1983) emphasized the influence of microbial, hormone like substances on the plant metabolism, growth and development by vermicompost.

The favourable effect of panchakavya on fruit yield may be due to the fact that it acts as growth promoter and immunity booster. Panchakavya stock solution creates a depression, which facilitates a cosmic ray link. The basic elements for the growth are harmonized by this energy which refreshes the growth process.

The results of the present study are in accordance with those of Sridhar (2003) and Sivakumar (2004) in black nightshade and Bharathi (2004) in *Coleus forskohilii* and Kalaipoovizhi (2007) in cucumber.

The dry matter production which is an important trait in deciding the productivity of a crop was found to be significantly higher in the treatment which received combined application of vermicompost @ 5 t ha^{-1} + *Azospirillum* 5 kg ha^{-1} + panchakavya 3 per cent as foliar spray. The results of this study are in accordance with the reports of Kanimozhi (2003) and Bharathi (2004) in medicinal coleus.

As suggested by Krishnamoorthy and Ravikumar (1973), higher production of dry matter by the plant could be attributed to the fact that organic manures having high amount of humus, facilitate N-fixation by microbes, regulate the nitrogen supply to the plants and also helps in the production of plant growth promoters.

Quality Attributes

As regard to the total soluble solids in the fruits, the treatment T_7 (vermicompost @ 5 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} + panchakavya @ 3 per cent) registered he maximum total soluble solids (1.42 °Brix) followed by T_{10} (1.31 °Brix) whereas the control (T_1) registered the least (0.61 °Brix). The ascorbic acid content of the fruit also showed similar trend with T_7 recording the maximum content (41.21 mg 100 g^{-1}) followed by T_{10} (40.07 mg 100 g^{-1}) whereas the control recorded the least (29.83 mg 100 g^{-1}) (Table 3).

These favourable quality traits may be attributed to the capability of organic manures in supplying adequate macro and micro plant nutrients which play a major role in quality improvement through desirable enzymatic changes (Kalabandi *et al*., 2007).

The results of the present study which envisaged increased quality attributes are in agreement with the findings of Prabakaran and James Pitchai (2003) and Kannan (2004) in tomato and Kalaipoovizhi (2007) in cucumber.

Uptake of Nutrients

In the present study, uptake of nitrogen (31.11 kg ha^{-1}), phosphorus (6.97 kg ha^{-1}) and potassium (27.92 kg ha^{-1}) were highest in the treatment of T_7 (vermicompost @ 5 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} + panchakavya @ 3 per cent) as against the least in control (Table 4).

Organic manures when applied to the soil result in the breakdown of complex nitrogen compounds by the action of microorganisms and increase its availability to the soil in the form of nitrate nitrogen as observed by Chavan *et al*., (1997) in tomato. Earlier reports by Subbaiah *et al*. (1982) also revealed increased uptake of NPK with the application of vermicompost could be attributed to the solubilisation effect of plant nutrients by the addition of vermicompost.

Further, Budhawant (1994) reported out that the phosphorus uptake was increased with the application of organic manures especially vermicompost which may be attributed to the greater solubilisation of native phosphorus from the soil due to the action of various organic acids liberated during the decomposition of vermicompost.

The use of combined application organic manures might have increased the potassium content, which may be ascribed to its role in improving the soil properties, leading to better penetration of roots, thereby resulting in greater uptake of potassium from native source (Budhawant, 1994).

Cost: Benefit Ratio

In the present experiment, the economic analysis indicated that the benefit: cost ratio was is higher for the treatment, vermicompost @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + panchakavya @ 3 per cent spray, followed by recommended dose of fertilizers.

Thus, it can be concluded that application of vermicompost @ 5 t ha^{-1} + *Azospirullum* @ 5 kg ha^{-1} + panchakavya @ 3 per cent as foliar spray as the best treatment to get higher fruit yield coupled with quality in bitter gourd cv. Long Green.

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Table 1. Influence of organic nutrients on single fruit weight (g) and fruit yield per vine (kg) of bitter gourd cv. Long Green

Tr. No.	Treatment Details	Single fruit weight (g)	Fruit yield per vine (kg)
T_1	Absolute control	15.06	2.90
T_2	Recommended dose of NPK @ 70: 25: 25 kg ha^{-1}	20.59	3.43
T_3	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	23.19	3.98
T_4	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	26.58	4.02
T_5	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	25.91	4.71
T_6	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	26.17	5.03
T_7	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	33.97	6.75
T_8	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	23.10	5.02
T_9	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	27.09	4.99
T_{10}	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	30.58	6.69
T_{11}	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	24.57	4.21
T_{12}	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + HA @ 0.2 % ha^{-1}	29.54	5.37
T_{13}	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + + HA @ 0.2 % ha^{-1}	27.17	5.01
T_{14}	VC @ 25 t ha^{-1} + HA @ 0.2 % ha^{-1}	28.56	4.97
	SE(d)	**0.4903**	**0.0186**
	CD (p=0.05)	**1.0101**	**0.0383**

Table 2. Influence of organic nutrients on dry matter production (g plant^{-1}) of bitter gourd cv. Long Green

Tr. No.	Treatment Details	Dry Matter Production (g plant^{-1})
T_1	Absolute control	94.63
T_2	Recommended dose of NPK @ 70: 25: 25 kg ha^{-1}	101.54
T_3	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	143.07
T_4	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	101.39
T_5	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	129.35
T_6	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	133.57
T_7	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	220.44
T_8	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	177.54
T_9	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	158.70
T_{10}	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	212.01
T_{11}	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	146.86
T_{12}	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + HA @ 0.2 % ha^{-1}	186.55
T_{13}	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + + HA @ 0.2 % ha^{-1}	174.35
T_{14}	VC @ 25 t ha^{-1} + HA @ 0.2 % ha^{-1}	166.76
	SE(d)	**0.1328**
	CD (p=0.05)	**0.2735**

Table 3. Influence of organic nutrients on total soluble solids (°Brix) and ascorbic acid content (mg 100 g^{-1}) of bitter gourd cv. Long Green

Tr. No.	Treatment Details	Total Soluble Solids (°Brix)	Ascorbic Acid Content (mg $100g^{-1}$)
T_1	Absolute control	0.61	29.83
T_2	Recommended dose of NPK @ 70: 25: 25 kg ha^{-1}	0.99	32.56
T_3	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	0.74	29.97
T_4	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	1.01	30.03
T_5	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	1.19	30.67
T_6	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	1.07	33.64
T_7	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	1.42	41.21
T_8	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	1.02	34.12
T_9	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	1.16	35.63
T_{10}	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	1.31	40.07
T_{11}	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	1.13	37.11
T_{12}	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + HA @ 0.2 % ha^{-1}	1.22	37.28
T_{13}	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + + HA @ 0.2 % ha^{-1}	1.21	36.88
T_{14}	VC @ 25 t ha^{-1} + HA @ 0.2 % ha^{-1}	1,11	31.95
	SE(d)	**0.0343**	**0.5449**
	CD (p=0.05)	**0.0707**	**1.1226**

Table 4. Influence of organic nutrients on total nitrogen, phosphorus and potassium (kg ha^{-1}) of bitter gourd cv. Long Green

Tr. No.	Treatment Details	Total Nitrogen Uptake (kg ha^{-1})	Total Phosphorus Uptake (kg ha^{-1})	Total Potassium Uptake (kg ha^{-1})
T_1	Absolute control	23.22	5.41	20.02
T_2	Recommended dose of NPK @ 70: 25: 25 kg ha^{-1}	27.84	5.94	21.16
T_3	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	30.01	6.03	24.54
T_4	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	30.00	5.76	21.53
T_5	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}	26.91	5.91	22.86
T_6	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	25.52	6.24	22.62
T_7	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	31.11	6.97	27.92
T_8	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PK @ 3 % ha^{-1}	29.01	5.66	23.71
T_9	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	24.18	5.99	24.98
T_{10}	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	30.07	6.67	27.60
T_{11}	PM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + EM (1: 1000 dilution)	29.58	5.65	26.03
T_{12}	FYM @ 25 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + HA @ 0.2 % ha^{-1}	30.04	6.28	26.46
T_{13}	VC @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + + HA @ 0.2 % ha^{-1}	26.97	6.00	24.60
T_{14}	VC @ 25 t ha^{-1} + HA @ 0.2 % ha^{-1}	27.63	6.11	25.98
	SE(d)	**0.0102**	**0.0986**	**0.1328**
	CD (p=0.05)	**0.0210**	**0.2031**	**0.2735**