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Effect of organic fertilizers on growth and yield attributes of bitter gourd (*Momordica charantia* L.) CV. Preethi

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Abstract
The work was carried out during the summer 2017 at Fruit Research Station, Madhdi Baug, Department of Horticulture, College of Agriculture, JAU, Junagadh. The present experiment was laid out in Randomized Block Design (RBD) with three replications consist of twelve treatments. Among twelve treatment combinations tested, T_8 (Vermicompost @ 5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha + KSB @ 3 liter/ha) produced best performances in growth parameters like, length of main vine (286.67 cm), length of internodes at (8.03 cm), number of branches per plant (9.72), number of nodes on main vine (67.86) at last harvest. As well as yield parameters like, fruit yield per plant (3.09 kg), fruit yield per plot (20.67 kg), fresh fruit yield (17.21 t/ha). Whatever variations were observed was due to differential nutrient supply, effect of organic sources of nutrients in the form of FYM, VC and Castor cake with the BFs (*Azotobacter*, Phosphorous Solubilizing Bacteria and KSB).

Keywords: Bitter gourd, organic manure, bio fertilizers, growth and yield attributes

Introduction
Vegetables are important source of protective foods and also play an important role in human balanced diet. These are rich source of vitamins, proteins, carbohydrates and minerals. Vegetables make up a significant proportion of the diet of most of the people and the production of vegetables is a significant factor in ensuring that people have an adequate intake of many essential vitamins, minerals and carbohydrates every day. India is positioning second place among the vegetable producing countries of the world after China. According to World Health Organization recommends daily consumption of 300 g of vegetables (125 g leafy vegetables, 100 g roots and tubers and 75 g other vegetables). According to this recommendation, per capita vegetable requirement works out to be 146 kg per year (WHO-2003) [14]. India is bestowed with varied favourable agro-climatic zones and soils. This makes it feasible to grow large number of vegetable crops in the India all the year round and is regarded as a "Horticultural Paradise" (Saravaiya and Patel, 2005) [11].

Cucurbit vegetables are fair source of thiamine and riboflavin. Bitter gourd (*Momordica charantia* L.) is the leading member of the cucurbitaceae family with somatic chromosome number 2n=2X=22. Bitter gourd is usually grown under kitchen garden as a summer vegetable. But at present it is also being grown as commercial crop near the urban areas. Moreover, it can also be grown in any type of soil having good drainage system. Bitter gourd is a highly fertilizer responsive crop. The higher yield and maximum returns make it the most preferred vegetable crop of Indian farmers. The main concept of before India is to increase the production of sufficient quantity of food to feeding the country's large population and increasing income of farmers provide them economic security. At present, Agriculture is highly dependent on the use of chemical fertilizers alone, growth regulators, fungicides and pesticides for obtaining increased yield (Kumar *et al.*, 2012 b) [5]. This dependence is associated with problems such as environmental pollution, health hazards, interruption of natural ecology, nutrient recycling and destruction of biological communities that otherwise support crop production. The use of expensive commercial fertilizers as per the requirement of the crop not much affordable to the small and marginal farmers have given the way for use of combination of organic manures and bio fertilizers instead of chemical fertilizers. Hence, integrated nutrient management is the need of the hour.

This necessitates the use of organic manures and bio fertilizers for maintaining and sustaining a higher level of soil fertility and crop productivity accomplished with high quality fruits. Since vegetables are mostly consumed fresh or only partially cooked, they should be free from the residual effects of chemical fertilizers. Therefore, Integrated nutrient management in vegetables has special relevance (Thriveni *et al*., 2014) [13]

Materials and Methods

The experiment was conducted at Fruit Research Station, Madhdi baug, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh during summer 2017. Junagadh is situated in Saurashtra region of Gujarat state. Geographically, this place is situated at 20.31^0 N Latitude and 70.36^0 E Longitude with an altitude of 60 meters above the mean sea level and 80 km away from Arabian Sea coast on western side at the foothill of mount girnar. The soil of the experimental site was sandy loam with pH 6.2 to 6.8.

The experiment was laid out in Randomized Block Design (RBD) with three replications consist of twelve treatments *i.e.* Control without any treatment (T_1), RDF - 60: 60: 60 NPK kg/ha (T_2), FYM @ 10 t/ha + *Azatobacter* @ 3 liter/ha (T_3), FYM @ 10 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha (T_4), FYM @ 10 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha + KSB @ 3 liter/ha (T_5), Vermicompost @ 5 t/ha + *Azatobacter* @ 3 liter/ha (T_6), Vermicompost @ 5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha (T_7), Vermicompost @ 5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha + KSB @ 3 liter/ha (T_8), Castor cake @ 2.5 t/ha + *Azatobacter* @ 3 liter/ha (T_9), Castor cake @ 2.5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha (T_{10}), Castor cake @ 2.5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha + KSB @ 3 liter/ha (T_{11}) and FYM @ 5 t/ha + Vermicompost @ 1.25 t/ha + Castor cake @ 0.5 t/ha (T_{12}). Healthy, bold seeds were graded and sowing was done after the land preparations of the main field pit prepared at 1.5 m x 1.0 m spacing from row to row and plant to plant. Seeds are sown @ 2-3 per pit. FYM, vermicompost and castor cake were applied in a plots as per the treatment specifically selected at the time of sowing. The bio-inoculants namely *Azotobacter,* Phosphate Solubilizing Bacteria (PSB) and Potassium Solubilizing Bacteria (KSB) were applied through drenching at the time of sowing.

Results and Discussion

Length of main vine

The influence of organic fertilizer management practices ultimately reflected in length of main vine at last harvest (Table 1) were found significant during the period of investigation. Among twelve treatment combinations tested, T_8 (Vermicompost @ 5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha + KSB @ 3 liter/ha) produced best performances in length of main vine at last harvest (286.67 cm). These might be due to the application of organic manure along with bio fertilizers is necessary to increase the content of organic matter, maintain the nutrients balance for crops and improve the physical and chemical properties of the soil. The positive effect of organic manure on growth parameters obtained in this study was supported by Kamalakar Reddy (1998) [4], Reddy and Rao (2004) [10], Prasad *et al.* (2009) [9] and Thriveni *et al.* (2014) [13] in bitter gourd.

Length of internodes

The data presented in (Table 1) revealed that Vermicompost @ 5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha + KSB @ 3 liter/ha (T_8) produced best performances in length of internodes at last harvest (8.03 cm). Whereas it was statistically at par T_7, T_5 and T_2 for to length of internodes at last harvest. Similar results were reported by Reddy and Rao (2004) [10], Prasad *et al.* (2009) [9] and Thriveni *et al.* (2014) [13] in bitter gourd. Prabhu *et al.* (2006) [8] also reported similar results while working on cucumber.

Number of branches per plant

The influence of organic fertilizer management practices ultimately reflected in number of branches per plant at last harvest (Table 1) were found significant during the period of investigation. Among twelve treatment combinations tested, T_8 (Vermicompost @ 5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha + KSB @ 3 liter/ha) produced best performances in number of branches per plant at last harvest (9.72). Similar results were reported by Kamalakar Reddy (1998) [4], Reddy and Rao (2004) [10], Prasad *et al.* (2009) [9] and Thriveni *et al.* (2014) [13] in bitter gourd. Bindiya *et al.* (2006) [2] also reported similar results while working on cucumber.

Number of nodes on main vine

The data (Table 1) concluded that number of nodes on main vine at last harvest significantly influenced by different organic fertilizers. Among twelve treatment combinations tested, T_8 (Vermicompost @ 5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha + KSB @ 3 liter/ha) produced best performances in number of nodes on main vine at last harvest (67.86). Enhancement of bitter gourd growth brought about by the application of organic amendments with bio fertilizer can be attributed to their relatively high organic matter content. *Azotobacter* fixed atmospheric nitrogen which enhanced the vegetative growth resulting in higher photosynthetic activity. Besides, PSB converted the soil phosphorus into available form required for the plants and these factors may be reasoned to better results of growth characters (Thriveni *et al.* 2014) [13].

Fruit yield per plant

The results of the present investigation showed that (Table 1) the maximum fruit yield per plant (3.09 kg) was recorded under treatment T_8 (Vermicompost @ 5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha + KSB @ 3 liter/ha) which was at par with T_7 and T_5. These might be due to the organic nutrient favor increase in yield per plant because of favourable soil condition which increase uptake of NPK nutrients due to the influence of bio fertilizers which provide favourable conditions around the root rhizosphere resulted in better absorption of nutrients. The results obtained are in line with the findings of Anjanappa *et.al* (2012) [1] in cucumber.

Fruit yield per plot

The results of the present investigation showed that (Table 1) the maximum fruit yield per plot (20.67 kg) was recorded under treatment T_8 (Vermicompost @ 5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha + KSB @ 3 liter/ha) which was at par with T_7 and T_5. Similar results were reported by Prasad *et al.* (2009) [9], Ghosh *et al.* (2011) [3] and Thriveni *et al.* (2014) [13] in bitter gourd, Nirmala (1999) [6], Parmar *et al.* (2011) [7] in cucumber and Sreenivas *et al.* (2000) [12] in ridge gourd. This may be due to synthesis of auxin, growth substances, and anti fungal due to inoculation of Azotobacter and conversion of insoluble phosphate to soluble form by PSB perhaps helped to increase fruit yield of bitter gourd.

Table 1: Effect of different organic fertilizers on growth and yield parameters

Treatments	Length of vine (cm)	Length of internodes (cm)	Number of branches/ plant	Number of nodes on main vine	Fruit yield per plant (kg)	Fruit yield per plot (kg)	Fruit yield (t/ha)
T_1	221.67	6.23	7.42	51.13	2.28	12.67	10.54
T_2	259.00	7.62	9.41	65.37	2.50	15.14	12.60
T_3	245.67	6.79	7.99	54.45	2.55	15.72	13.09
T_4	250.33	6.78	8.18	56.67	2.67	16.00	13.32
T_5	275.33	7.75	9.58	67.73	2.94	19.18	15.52
T_6	251.00	7.10	8.02	56.09	2.63	17.64	14.69
T_7	284.00	7.83	9.53	66.56	3.04	19.54	16.27
T_8	286.67	8.03	9.72	67.86	3.09	20.67	17.21
T_9	246.67	7.03	8.01	57.88	2.67	16.48	13.72
T_{10}	248.00	6.70	7.62	58.36	2.45	16.45	13.69
T_{11}	241.00	7.10	8.14	58.68	2.52	17.00	14.15
T_{12}	250.00	6.96	7.81	58.66	2.54	16.55	13.78
S.Em. ±	11.87	0.30	0.48	3.12	0.14	0.54	0.60
CD at 5%	34.82	0.89	1.41	9.14	0.41	1.59	1.75
C.V. %	8.06	7.32	9.83	9.01	9.06	5.54	7.36

Fruit yield (t/ha)

The assessment of data showed that (Table 1) the maximum fresh fruit yield (17.21 t/ha) was recorded under treatment T_8 (Vermicompost @ 5 t/ha + *Azatobacter* @ 3 liter/ha + PSB @ 3 liter/ha + KSB @ 3 liter/ha) which was at par with T_7 and T_5. Similar results were reported by Prasad *et al.* (2009) [9], Ghosh *et al.* (2011) [3] and Thriveni *et al.* (2014) [13] in bitter gourd, Nirmala (1999) [6], Parmar *et al.* (2011) [7] in cucumber and Sreenivas *et al.* (2000) [12] in ridge gourd.

This might be due to the facts that combined effect of *Azotobacter*, PSB and KSB with organic fertilizer. It may be increased the availability of nutrients to the plant from different organic sources. It plays important role in increase the solubility micro nutrients in root rhizosphere, essentially required for the formation and development of the fruits. Thus, it increased the number of fruits per plant and per hectare. It influenced the rate of photosynthesis, protein synthesis and more absorbance capacity of nutrients from root zone. It may be mentioned that no single source of nutrient supply be it bio fertilizer is in position to meet the increasing nutrient demand and yield.

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