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Effect of integrated nutrient management on yield of bitter gourd (*Momordica charantia* L.)

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Abstract
A field experiment was conducted to study the effect of integrated nutrient management on yield of bitter gourd (*Momordica charantia* L.) at College farm, College of Horticulture, S. D. Agricultural University, Jagudan, Dist. Mehsana, Gujarat during *Kharif* 2018. The experiment conducted in Randomized Block Design with three replications using cv. Phule Green Gold with fourteen treatments. On the basis of results, the application of 75% RDN through vermicompost + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha to the crop found to be sound integrated practice, where it recorded maximum number of fruits per plant (34.94 g), average weight of fruit (142.90 g), yield per plant (5.08 kg), yield per plot (40.59 kg) and yield per hectare (338.25 q).

Keywords: Bitter gourd, INM, urea, *Azotobacter*, PSB, vermicompost, yield

Introduction
Bitter gourd is important vegetable among cultivated cucurbits, which was identified as a potent vegetable for export purpose by APEDA due to its rich nutritional and hypoglycemic properties. Bitter gourd is a popular and demanded vegetable among cucurbits grown in India. Fruits are considered as a rich source of vitamins and minerals and are rich in vitamin C (88 mg/100 g) (Akter and Rahman 2010) [2]. It contains 0.61 mg iron, 20 mg calcium, 70 mg phosphorous, 126 µg carotene, 25 kcal energy, 92.4 per cent moisture, 1.6 g protein, 0.2 g fat, 4.2 g fiber and carbohydrates per 100 g of edible portion. Fruits have medicinal value and are used for curing diabetes, asthma, blood diseases and rheumatism.

Integrated nutrient supply system has become an accepted strategy to bring about improvement in soil fertility and protecting the environment. It involves the integrated use of mineral fertilizers in combination with organic manures and microbial inoculants to sustain optimum yield to maintain and to improve the soil fertility (Abrol and Katyal, 1990) [1]. Organic farming is the pathway that leads to achieve sustainability in horticultural production. Application of indiscriminate doses of chemical fertilizers without organic manures or biofertilizers causes damage to the soil health in terms of physical and chemical properties of soil, decreasing of soil microbial activities.

The combined use of organic and inorganic sources of plant nutrients not only pushes the production and profitability of field crops, but also helps in maintaining the permanent fertility status of the soil. In the organic sources, organic manures play a vital role for improving soil aeration, water holding capacity, soil structure and crop yield. Among the organic manures, Mustard oil cake is rich in nitrogen, phosphorus and potassium which are essential to maintain soil fertility and growth of plant. Farm yard manure is also a good source of nutrients. Application of farm yard manure resulted in better growth of spider plant as compared to control (Ng *et al*., 2012).

Farm yard manure (FYM) is the principle source of organic matter in our country and its application helps in proper supply of nutrition and maintaining soil health. It supplies all the essential plant nutrients, which improve the physico-chemical properties, increases water holding capacity and encourages the soil microbial activities. Vermicompost is adopted as organic manure produced by use of earthworm. It modifies soil physical, chemical and biochemical properties. Neem cake is the byproduct obtained in the process of cold pressing of neem tree fruits and kernels and the solvent extraction process for neem oil cake.

It is a potential source of organic manure. Neem cake also protects plant roots from nematodes, soil grubs and white ants probably due to its residual limonoid content. It also reduces alkalinity in soil, as it produces organic acids on decomposition. Being totally natural, it is compatible with soil microbes, improves rhizosphere micro flora and hence ensures fertility of soil. Neem cake improves the organic matter content of the soil, helping improve soil texture, water holding capacity and soil aeration for better root development. Biofertilizer is a substance which contains living microorganism which when applied to seeds, plant surface or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Chemical fertilizers directly increase soil fertility by adding nutrients. However, biofertilizer add nutrients through the natural processes of fixing atmospheric nitrogen, solubilizing phosphorus and stimulating plant growth through the synthesis of growth promoting substances.

Materials and Methods

The entire investigation was planned and executed at the College farm, College of Horticulture, S. D. Agricultural University, Jagudan, Dist. Mehsana, Gujarat in *Kharif* season 2018 to study the effect of integrated nutrient management on yield of bitter gourd (*Momordica charantia* L.). The field was sandy loam having pH 6.5 and the plot size 3.0 x 4.0 cm with the experiment was laid out in a randomized block design with three replications involving 14 treatments as fallows. T_1 : 100% RDF (100 : 50: 50: NPK kg/ha), T_2 : 100% RDN through urea, T_3 : 75% RDN through FYM + 25% N through urea, T_4 : 50% RDN through FYM + 50% N through urea, T_5 : 75% RDN through vermicompost + 25% N through urea, T_6 : 50% RDN through vermicompost + 50% N through urea, T_7 : 75% RDN through neem cake + 25% N through urea, T_8 : 50% RDN through neem cake + 50% N through urea, T_9 : 75% RDN through FYM + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha, T_{10} : 50% RDN through FYM + 50% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha, T_{11} : 75% RDN through vermicompost + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha, T_{12} : 50% RDN through vermicompost + 50% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha, T_{13} : 75% RDN through neem cake + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha, T_{14} : 50% RDN through neem cake + 50% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha. Fertilizer and manure doses were calculated as per the soil test report and apply as a recommended dose. The cultivar used for the trials was Phule Green Gold. Regular weeding, irrigation and plant protection measures were followed. In each plot five plants were selected randomly and tagged for observations.

Results and Discussion

Yield Parameters

Effect of integrated nutrient management on number of fruits per plant

The data pertaining to effect of integrated nutrient management on number of fruits per plant are presented in Table. Maximum number of fruits per plant (34.94) was observed with treatment 75% RDN through vermicompost + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha (T_{11}) which was statistically at par with treatment T_{12}, whereas the minimum number of fruits per plant (24.33) was recorded with the treatment 100% RDN through urea (T_2).

This may be attributed to the environment including temperature, relative humidity and light intensity played significant role in significant plant growth, enhance flowering, fruit set and development. These results are in conformity with the finding of Mousa *et al.* (2017) [7] in summer squash. The increase in number of fruit might be due to availability of better nutrients. Variation in number of fruits per plant due to application of different organic manures and biofertilizers were previously reported by Mulani *et al.* (2007) [8] in bitter gourd, Karuppaiah and Kathiravan (2008) [6] in cucumber and Anjanappa *et al.* (2012) [3] in cucumber.

Effect of integrated nutrient management on average weight of fruit (g)

Effect of integrated nutrient management on average weight of fruit (g) is presented in Table. Maximum average weight of fruit (142.90 g) was observed with treatment 75% RDN through vermicompost + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha (T_{11}) which was statistically at par with treatment $T_{12,}$ T_5 and T_6, whereas the minimum average weight of fruit (91.86 g) was recorded with the treatment 100% RDN through urea (T_2).

It might be due to availability of essential plant nutrients and more balanced C/N ratio from vermicompost and bio fertilizers which might have increased the synthesis of carbohydrates, resulted in increase of average fruit weight. The increase in weight of fruit might be due to improving soil conditions; released adequate nutrient element for yield enhancement might have increased the synthesis of carbohydrates resulted in increase of the fruit weight. These results are in conformity with the findings of Mulani *et al*. (2007) [8] and Thriveni *et al*. (2015) [17] in bitter gourd, Karuppaiah and Kathiravan (2008) [6] and Anjanappa *et al*. (2012) [3] in cucumber.

Table 1: Effect of integrated nutrient management on yield parameters

Tr. No.	Treatments detail	Number of fruits per plant	Average weight of fruit (g)	Yield per plant (kg)	Yield per plot (kg)	Yield per hectare (q)
T_1	100% RDF (100 : 50: 50: NPK kg/ha)	25.01	94.41	2.38	19.10	159.19
T_2	100% RDN through urea	24.33	91.86	2.24	18.02	150.20
T_3	75% RDN through FYM + 25% N through urea	25.71	96.47	2.47	19.82	165.14
T_4	50% RDN through FYM + 50% N through urea	25.34	95.83	2.42	19.44	162.00
T_5	75% RDN through vermicompost + 25% N through urea	29.43	134.81	3.99	32.05	267.08
T_6	50% RDN through vermicompost + 50% N through urea	27.67	127.43	3.49	28.08	234.03
T_7	75% RDN through neem cake + 25% N through urea	26.55	114.45	3.02	24.23	201.94
T_8	50% RDN through neem cake + 50% N through urea	26.08	112.58	2.94	23.61	196.73
T_9	75% RDN through FYM + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha	26.03	107.30	2.77	22.27	185.58
T_{10}	50% RDN through FYM + 50% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha	25.77	98.12	2.53	20.32	169.33
T_{11}	75% RDN through vermicompost + 25% N through urea + *Azotobacter*@ 2.5 lit/ha + PSB @ 2.5 lit/ha	34.94	142.90	5.08	40.59	338.25

T_{12}	50% RDN through vermicompost + 50% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha	31.01	138.47	4.27	34.25	285.44
T_{13}	75% RDN through neem cake + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha	27.40	121.39	3.33	26.77	223.08
T_{14}	50% RDN through neem cake + 50% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha	27.06	117.20	3.17	25.48	212.36
	S.Em. ±	1.80	7.29	0.19	1.57	13.09
	C.D. (P = 0.05)	5.22	21.20	0.55	4.56	38.03
	C.V.%	11.40	11.10	10.41	10.76	10.76

Effect of integrated nutrient management on yield per plant (kg)

The effect of integrated nutrient management on yield per plant (kg) is presented in Table. Maximum yield per plant (5.08 kg) was observed with treatment 75% RDN through vermicompost + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha (T_{11}) whereas, the minimum yield per plant (2.24 kg) was recorded with the treatment 100% RDN through urea (T_2).

These might be due to the organic manures favor increase in yield per plant because of favorable soil condition which increase uptake of N, P and K nutrients due to the influence of biofertilizers which provide favorable conditions around the root rhizosphere. The increasing yield per plant in bitter gourd might be due to better nutrient supply by specific combination of integrated nutrient management treatments. Use of vermicompost improves the soil aeration, nutrient status and biological properties. Sureshkumar *et al.* (2016) [5] and Thriveni (2017) [16] in bitter gourd, Singh *et al.* (2018) [12, 14] in cucumber, Ghosh *et al.* (2016) [5] in water melon and Das *et al.* (2015) [4] in bottle gourd had also recorded similar pattern of results.

Effect of integrated nutrient management on yield per plot (kg)

The effect of integrated nutrient management on yield per plot (kg) are presented in Table. Data pertaining to yield per plot (kg) was found significant.

Maximum yield per plot (40.59 kg) was observed with treatment 75% RDN through vermicompost + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha (T_{11}), whereas the minimum yield per plot (18.02 kg) was recorded with the treatment 100% RDN through urea (T_2).

The increasing yield per plant in bitter gourd might be due to better nutrient supply by specific combination of integrated nutrient management treatments. Use of vermicompost improves the soil aeration, nutrient status and biological properties. Singh *et al.* (2018) [12, 14] in cucumber and Singh *et al.* (2017) [13] in bottle gourd.

Effect of integrated nutrient management on yield per hectare (q)

Data regarding effect of integrated nutrient management on yield per hectare (q) are presented in Table. Maximum yield per hectare (338.25 q) was observed with treatment (T_{11}) 75% RDN through vermicompost + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha whereas, the minimum yield per hectare (150.20 q) was recorded with the treatment T_2 (100% RDN through urea). The increasing yield per plant in bitter gourd might be due to better nutrient supply by specific combination of integrated nutrient management treatments. Use of vermicompost improves the soil aeration, nutrient status and biological properties Thriveni *et al.* (2017) [16]. This is in accordance with the findings of Singh *et al.* (2018) [12, 14] in cucumber, Singh *et al.* (2017) [13] and Patle *et al.* (2018) [11] in bottle gourd and Nayak *et al.* (2016) in pointed gourd.

Conclusion

From the foregoing discussion, it could be concluded that application of 75% RDN through vermicompost + 25% N through urea + *Azotobacter* @ 2.5 lit/ha + PSB @ 2.5 lit/ha (T_{11}) in *Kharif* bitter gourd is beneficial for obtaining higher yield and improvement of nutrient status of the soil.

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