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Effect of integrated nutrient management on snake gourd (*Trichosanthes anguina* L.) in lateritic soils of Konkan

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Abstract
A field experiment entitled "Effect of Integrated Nutrient Management on Snake gourd (*Trichosanthes anguina* L.) In Lateritic Soils of Konkan" laid out in Randomized Block Design comprising eleven treatment combinations replicated thrice, at Vegetable Improvement Scheme, Central Experiment Station, Wakawali, Dr. B.S.K.K.V., Dapoli, Dist. Ratnagiri during the *kharif* season of 2016. The effect of integrated nutrient management including vermicompost and poultry manure either alone or in combinations with inorganic fertilizers on fruit yield, and nutrient content of snake gourd were studied. The application of 50% N through poultry manure + 50% N through inorganic fertilizers T_6 significantly influenced the growth parameters, fruit yield and total nutrient status *viz.* N, P, K, Ca, Mg, and S. The build-up of fruit quality, the application of 50% N through poultry manure + 50% N through inorganic fertilizer was found to be suitable for snake gourd in lateritic soil of Konkan.

Keywords: Integrated nutrient management, nutrient content, snake gourd, Konkan

1. Introduction
Snake gourd (*Trichosanthes anguina* L.) is an annual vegetable crop, climbing vine, providing both long and short fruits. India is a native home of Snake gourd. Vegetables are important in maintaining satisfactory nutritional level in human diet. There will be increasing demand for this commodity with accelerated industrial growth and increasing urban area. Vegetables are not only important source of vitamins and minerals but they can also help in improving economic condition of farmer. Snake gourd is a popular vegetable crop in southern India grown principally for the immature fruits that can be cooked. The fruit is rich in minerals, calcium, phosphorus and vitamins, riboflavin, thiamine, niacin and carotene.
Lateritic soil is best suited for cultivation of cucurbitaceous family crop (Ghayal, 2016) [7]. The traditional method of farming and less use of organic manure reduces the quality of Snake gourd. For increasing the productivity an economical fertilizer package need to be formulated which can provide all the essential elements through both organic and inorganic sources to get good quality, produce with higher production, keeping the production cost at sustainable level of an average farmer. Intensive use of only chemical fertilizers to achieve high production has created various problems. Continuous application of heavy doses of chemical fertilizers without organic manures has led to deterioration of soil health in terms of physical and chemical properties of soil, decrease in soil microbial activities, and also reduction in soil humus (Anjanappa *et al*., 2011) [1].
Intensive cultivation and improper fertilizer use leads to deficiency of nutrients, thus resulting in lower yield of crops. Therefore, the use of farm input in the form of organic manure has become necessary. Though manures are usually very bulky and the cost of transportation is high but are safe sources of nutrition as they are environmental friendly, release their nutrients in a slow and steady manner to crop in the field thereby activating soil microbial activities (Eifediyi and Remison, 2010) [6]. Organic manure sustains cropping systems through better nutrient recycling and improvement in soil physical, chemical and biological properties. The use of organic manures has been observed to have beneficial effect on soil texture and structure (Hamma *et al*., 2012) [8].

2. Material and methods
A field experiment on effect of integrated nutrient management on snake gourd (*Trichosanthes anguina* L.) in lateritic soils of Konkan Cv. "Kokan shweta" was conducted at Vegetable Improvement Scheme, Central Experiment Station, Wakawali during the *Kharif* 2016.

The experimental soil was moderately acidic is reaction (pH 5.62), high in organic carbon (15.9 g kg^{-1}), medium available nitrogen (266.62 kg ha^{-1}), low available phosphorus (6.87) and high available potassium (289.49 kg ha^{-1}). The experiment was laid out in Randomized block design with three replications. There were eleven treatments comprised of sources of organic and inorganic fertilizers. The treatment details are: control (T_1), RDF (100:50:50 NPK Kg ha^{-1}) through inorganic fertilizers (T_2), 25 % N through VC + 75 % N through inorganic fertilizer (T_3), 25 % N through P.M + 75 % N through inorganic fertilizer (T_4), 50 % N through VC + 50 % N through inorganic fertilizer (T_5), 50 % N through P.M + 50 % N through inorganic fertilizer (T_6), 75 % N through VC + 25 % N through inorganic fertilizer (T_7), 75 % N through P.M + 25 % N through inorganic fertilizer (T_8), 100 % N through VC (T_9), 100 % N through P.M (T_{10}), 50 % N through VC + 50 % N through P.M (T_{11}). The full quantity of poultry manure, vermicompost, P_2O_5 in the form of single super phosphate and K_2O in the form of muriate of potash were applied at time of sowing. The nitrogen was applied in two splits viz. at the sowing and after 30 days of sowing. The seed of snake gourd were dibbled at the rate of 2-3 seed per hill at spacing of 1.5 m × 0.5 m. thinning and gap filling were carried out at 20 days after sowing in order to have one healthy plant per hill. The observations regarding yield, weight of fruit, length of fruit, fruit per vine and nutrient content were taken and data were analyzed statistically as described Panse and Sukhatmate (1967) [12].

3. Results and discussions

3.1 Effect of integrated nutrient management on fruit yield of Snake gourd.

3.1.1 Fruit yield (t ha^{-1})

The data pertaining to the effect of various treatments on fruit yield *i.e.* per plot as well as tons per hector are presented in table 1 fruit yield. It is observed that there was a significant effect of various treatments on fruit yield of snake gourd and ranged from 10.95 to 19.82 t ha^{-1}. The treatment T_6 receiving equal integration of 50 per cent N through poultry manure + 50 per cent N through inorganic fertilizer recorded significantly highest yield of snake gourd (19.82 t ha^{-1}), over rest of all the treatments except treatments T_5, T_7 and T_8 were found to be at par with T_6. This might be due to the presence of more per cent of N in poultry manure than the other organic manures i.e. vermicompost. Haque *et al.* (2014) [9] and Dodake (2015) [5] also reported that the highest fruit yield with 50% RDF + 50% poultry manure in snake gourd, ridge gourd and bitter gourd, respectively.

Table 1: Effect of integrated nutrient management on yield of snake gourd (t ha^{-1})

No.	Treatment No.	Yield (t ha^{-1})
T_1	Control	10.95
T_2	RDF 100:50:50 NPK Kg ha^{-1}	16.78
T_3	25 % N (Vermicompost) + 75 % N Inorganic fertilizer	16.18
T_4	25 % N (Poultry manure) + 75 % N Inorganic fertilizer	16.36
T_5	50 % N (Vermicompost) + 50 % N Inorganic fertilizer	19.58
T_6	50 % N (Poultry manure) + 50% N Inorganic fertilizer	19.82
T_7	75 % N (Vermicompost) + 25 % N Inorganic fertilizer	19.16
T_8	75 % N (Poultry manure) + 25 % N Inorganic fertilizer	19.19
T_9	100 % N (Vermicompost)	17.79
T_{10}	100 % N (Poultry manure)	18.63
T_{11}	50 % N (Vermicompost) + 50 % N(P.M)	16.93
S.E.±		0.390
C.D. at 5%		1.150

3.2 Effect of integrated nutrient management on nutrient content in plant and Snake gourd.

3.2.1 Total nitrogen (N)

The data pertaining to the effect of integrated nutrient management on total nitrogen content in snake gourd plant at 60, 90 days after sowing (DAS) and at harvest are presented in Table 2.

At 60 DAS

The effect of integrated nutrient management showed significant effect on the total nitrogen content in the snake gourd plant at 60 DAS. The total nitrogen of snake gourd ranged from 1.38 to 2.10 per cent. The data further revealed that total nitrogen content in snake gourd was highest (2.10 %) in the treatment T_6 receiving 50 per cent N through Poultry manure + 50 per cent N through inorganic fertilizer and found to be significantly superior over all treatments, while it was minimum (1.38 %) in the control treatment T_1 receiving no fertilizers. Further, it was seen from the data that the total nitrogen content in snake gourd crop at 60 DAS was comparatively higher than that of per cent total nitrogen at 90 DAS and at harvest.

Table 2: Effect of Integrated Nutrient Management on Nutrient Contentin plant at different growth stages of snake gourd

No.	Treatment no.	Nitrogen content (%)			Phosphorus content (%)			Potassium content (%)		
		60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest
T_1	Control	1.38	1.09	0.77	0.19	0.14	0.11	1.47	1.35	1.22
T_2	RDF 100:50:50 NPK Kg ha^{-1}	1.96	1.37	0.95	0.21	0.17	0.14	1.66	1.45	1.34
T_3	25 % N (V.C) + 75 % N (I.F)	1.84	1.19	0.85	0.25	0.20	0.17	1.71	1.54	1.47
T_4	25 % N (P.M) + 75 % N (I.F)	1.86	1.25	0.87	0.30	0.26	0.21	1.79	1.63	1.50
T_5	50 % N (V.C) + 50 % N (I.F)	2.02	1.36	0.88	0.36	0.30	0.26	1.96	1.78	1.55
T_6	50 % N (P.M) + 50% N (I.F)	2.10	1.47	1.07	0.44	0.40	0.36	2.14	1.96	1.62
T_7	75 % N (V.C) + 25% N (I.F)	1.88	1.28	0.84	0.28	0.24	0.20	1.72	1.58	1.34
T_8	75 % N (P.M) + 25% N (I.F)	1.90	1.32	0.82	0.32	0.27	0.19	1.76	1.62	1.38
T_9	100 % N (V.C)	1.86	1.29	0.84	0.38	0.32	0.24	1.82	1.68	1.43
T_{10}	100 % N (P.M)	1.92	1.33	0.83	0.39	0.34	0.26	1.84	1.70	1.58
T_{11}	50 % N (V.C) + 50% N(P.M)	1.94	1.35	0.89	0.40	0.35	0.30	1.88	1.74	1.62
S.E.±		0.017	0.020	0.048	0.010	0.010	0.010	0.052	0.014	0.033
C.D. at 5%		0.051	0.058	0.141	0.030	0.030	0.028	0.154	0.041	0.098

Note: Vermicompost (V.C), Poultry manure (P.M) and Inorganic fertilizer (I.F)

At 90 DAS

The data presented in Table 2 indicated that the effect of various treatments a nitrogen content in plant at 90 DAS was found to be significantly influenced by various treatments. The concentration of total nitrogen in snake gourd ranged from 1.09 to 1.47 per cent was higher than total nitrogen at 60 DAS and harvest. A close scrutiny of the data indicated that the application of 50 per cent N through poultry manure + 50 per cent N through inorganic fertilizer treatment T_6 registered maximum nitrogen (1.47 %), whereas it was found to be minimum (1.09 %) in the treatment T_1 without fertilizer application. The data further indicated that treatment T_6 exhibited significantly higher total nitrogen over rest of all the treatments.

At harvest

The data presented in Table 2 revealed that the total nitrogen content in snake gourd crop at harvest ranged between 0.77 and 1.07 per cent. When data examined critically, it revealed that the integration of 50% N through poultry manure + 50% N through inorganic fertilizer T_6 was recorded maximum nitrogen (1.07 %) and minimum (0.77%) in the control T_1. From the data, it was also observed that the treatment T_6 showed significantly higher total nitrogen over rest of all the treatments. The values of total nitrogen content at harvest were found to be minimum as compared to 60 and 90 DAS.

The decrease in total nitrogen with advancement of growth period might be attributed due to the higher nitrogen requirement of the crop. Narayanamma *et al.* (2009) [11] reported the highest total N content (2.1%) with application of poultry manure @ 2.5 t + ½ RDF ha^{-1} and neem cake @ 1t ha^{-1} in in ridge gourd.

3.2.2 Total phosphorus (P)

The data pertaining to the total P in snake gourd plant as effect of integrated nutrient management at 60, 90 DAS and at harvest are presented in Table 2.

At 60 DAS

The data presented in Table 2 revealed that the total phosphorus varied from 0.19 to 0.44 per cent. When the data examined critically, it was indicated that the higher (0.44%) and lower (0.19%) content of total phosphorus was recorded in treatment T_6 receiving integration of 50 per cent N through poultry manure + 50 per cent N through inorganic fertilizer and control T_1, respectively. It was seen that the total phosphorus at 60 DAS was found to be higher as compared to 90 DAS and at harvest. The treatment T_6 receiving 50 per cent N through poultry manure + 50 per cent N through inorganic fertilizer had showed significantly higher concentration of total phosphorus content than the rest of the all treatments.

At 90 DAS

Total phosphorus content in snake gourd crop varied from 0.14 to 0.40 per cent. It was found to be maximum in treatment T_6 and minimum in control treatment T_1. A close scrutiny of the data indicated that application of 50 per cent N through poultry manure + 50 per cent N through inorganic fertilizer was recorded significantly higher total phosphorous content (0.40 %) in snake gourd crop. It was also seen that there was a decrease in total phosphorous content as compared to 60 DAS to at harvest.

At harvest

The data presented in Table 2 indicated that the total phosphorous content varied from 0.11 to 0.36 per cent in snake gourd crop. Further, it was found to be maximum (0.36 %) and minimum (0.22 %) in treatment T_6 and control T_1, respectively. A close scrutiny of data revealed that the treatment T_6 receiving integration of 50 per cent N through poultry manure + 50 per cent N through inorganic fertilizer showed significantly higher total phosphorus content (0.36%) in snake gourd crop. The values of total phosphorus content in snake gourd at harvest were found to be minimum as compared 60 and 90 DAS.

Narayanamma *et al.* (2009) [11] reported the highest total P content (0.28 %) with application of poultry manure @ 2.5 t + ½ RDF ha^{-1} and neem cake @ 1t.

3.2.3 Total potassium (K)

The data pertaining to the total potassium content in snake gourd plant as affected by integrated nutrient management are presented in Table 2.

At 60 DAS

The data presented in Table 2 indicated that the effect of various treatments on potassium content in plant at 60 DAS was found to be significantly influenced. The concentration of total potassium in snake gourd varied from 1.47 to 2.14 per cent. The treatment T_6 receiving 50 per cent N through poultry manure + 50 per cent N through inorganic fertilizer had shown the maximum content of total potassium (2.14%), while it was minimum (1.47%) in the treatment T_1 receiving no fertilizer. The treatment T_6 showed significantly higher total potassium content over rest of all the treatments. Further, it is seen that total potassium content at 60 DAS was higher as compared to total potassium at 90 DAS and at harvest.

At 90 DAS

The data presented in Table 2 revealed that the total potassium content in snake gourd crop varied from 1.35 to 1.96 per cent. The treatment T_6 receiving 50 per cent N through poultry manure + 50 per cent N through inorganic fertilizer exhibited the maximum content of total potassium (1.96 %), while it was minimum (1.35%) in the control T_1. The treatment T_6 recorded significantly higher total potassium content over rest of all the treatments. Further it was seen that total potassium content at 90 DAS was higher as compared to total potassium at after harvest.

At harvest

The total potassium content in snake gourd crop at harvest ranged from 1.22 to 1.62 per cent. Integration of 50 per cent N through poultry manure + 50 per cent N through inorganic fertilizer T_6 showed higher potassium, while it was minimum in control T_1. A critical look on data further indicated that treatment T_6 showed significantly higher total potassium content over rest of all other treatments. Total potassium content at harvest stage was observed to be minimum as compared to 60 and 90 DAS.

Further, it was noticed that the total potassium at all the growth stages was found to be maximum in the treatment receiving 50 per cent N through P. M + 50 per cent N through inorganic fertilizer T_6. This might be attributed due to the higher content of N, P, K in poultry manure and its slow mineralization.

Narayanamma *et al.* (2009) [11] reported the highest total K content (2.39%) with application of poultry manure @ 2.5 t + ½ RDF ha^{-1} and neem cake @ 1t.

3.2.4 Calcium content (Ca)

The data pertaining to the calcium content in snake gourd plant as affected by various treatments at 60, 90 DAS and at harvest are presented in Table 3.

At 60 DAS

The data presented in Table 3 revealed that the calcium content in plant varied from 1.11 to 1.42 per cent. A close scrutiny of data indicated that Ca content found to be maximum (1.42 %) and minimum (1.11 %) in the treatment T_{10} and T_1, respectively. The data further indicated that treatment T_{10} receiving 100 per cent N through poultry manure exhibited significantly higher on Ca content over the all treatments, except the treatments T_9, T_8, T_7, and T_6 which were found to be at par with T_{10}.

Table 3: Effect of Integrated Nutrient Management on Ca, Mg and S. Content in Plant at Different Growth Stages of Snake gourd

No.	Treatment no.	Calcium (%)			Magnesium (%)			Sulphur (%)		
		60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest
T_1	Control	1.11	1.05	0.93	0.26	0.21	0.14	0.22	0.20	0.20
T_2	RDF 100:50:50 NPK Kg ha^{-1}	1.19	1.12	1.03	0.32	0.26	0.20	0.26	0.24	0.21
T_3	25 % N (V.C) + 75 % N (I.F)	1.24	1.14	1.07	0.38	0.30	0.25	0.35	0.32	0.28
T_4	25 % N (P.M) + 75 % N (I.F)	1.28	1.16	1.10	0.41	0.32	0.27	0.37	0.35	0.30
T_5	50 % N (V.C) + 50 % N (I.F)	1.23	1.28	1.12	0.45	0.34	0.31	0.47	0.45	0.40
T_6	50 % N (P.M) + 50% N (I.F)	1.38	1.30	1.18	0.48	0.33	0.29	0.53	0.50	0.45
T_7	75 % N (V.C) + 25% N (I.F)	1.35	1.26	1.12	0.52	0.36	0.22	0.47	0.44	0.40
T_8	75 % N (P.M) + 25% N (I.F)	1.33	1.22	1.09	0.54	0.35	0.26	0.50	0.47	0.42
T_9	100 % N (V.C)	1.34	1.26	1.10	0.56	0.36	0.29	0.52	0.50	0.46
T_{10}	100 % N (P.M)	1.42	1.32	1.20	0.64	0.40	0.34	0.54	0.52	0.49
T_{11}	50 % N (V.C) + 50% N (P.M)	1.21	1.14	1.09	0.62	0.36	0.31	0.46	0.44	0.40
S.E.±		0.054	0.016	0.022	0.012	0.012	0.017	0.015	0.014	0.012
C.D. at 5%		0.160	0.047	0.066	0.037	0.037	0.051	0.043	0.040	0.034

Note: Vermicompost (V.C), Poultry manure (P.M) and Inorganic fertilizer (I.F)

At 90 DAS

The Ca content in snake gourd plant at 90 DAS varied from 1.05 to 1.32 per cent with minimum value of (1.05 %) in the control T_1 while it was observed to be maximum (1.32%) in treatment T_{10}. Further, it is the observed that the Ca content at 90 DAS was maximum as compared to 60 DAS and at harvest. Treatment receiving 100 per cent N through poultry manure T_{10} had recorded significantly higher Ca content over rest the all treatments with T_5 and T_6 which remained at par with T_{10}.

At harvest

The data pertaining in Table 3 revealed that the Ca content in snake gourd at harvest varied between 0.93 and 1.20 per cent. A close look on data indicated that treatment T_{10} receiving 100 per cent N through poultry manure had exhibited significantly higher Ca content over all the treatments except T_6 which was observed to be at par with T_{10}. The Ca content was found to be maximum (1.20 %) and minimum (0.93 %) in the treatment T_{10} and T_1, respectively.

In general, Ca content in snake gourd plant was maximum at 60 DAS followed by 90 DAS and minimum at harvest. The declining pattern of Ca content from 90 DAS to at harvest irrespective of different treatments might be due to dilution effect caused by higher dry matter production.

It is also seen from the data that the treatment (T_{10}) i.e. application of 100 per cent N through poultry manure registered higher Ca content at all growth stages. It might be due to poultry manure as a rich source of plant nutrient and mineralization takes place slowly as compared to vermicompost.

The higher content and uptake of Ca by the plant due to application of poultry manure over vermicompost was also reported by Diwale (2012) [3] in lateritic soils. Similar finding were also reported by Boateng *et al.* (2006) [2] and Ewulo *et al.* (2008) [5] in maize.

3.2.5 Magnesium content (Mg)

The data pertaining to the magnesium content in snake gourd plant as influenced various treatmentsat 60, 90 DAS and at harvest are presented in Table 3.

At 60 DAS

The data presented in Table 3 showed that the Mg content in plant ranged between 0.26 and 0.64 per cent. The treatment T_{10} registered maximum Mg content and minimum in control T_1. A critical look on data further indicated that treatment T_{10} receiving 100 per cent N through poultry manure exhibited significantly higher Mg content over all the treatments except T_{11} which remained at par with T_{10}.

At 90 DAS

The data presented in Table 3 showed that the Mg content in plant ranged from 0.21 to 0.40 per cent. It was maximum (0.40 %) and minimum (0.21%) in the treatment T_{10} and T_1, respectively. A close scrutiny of data indicated that application 100 per cent N through poultry manurehad showed significantly higher Mg content over all the treatments except the treatments T_7, T_9 and T_{11} which were at par with T_{10}.

At harvest

The Mg content ranged between 0.14 to 0.34 per cent. The treatment (T_{10}) receiving application of 100 per cent N through poultry manure exhibited significantly higher Mg content over all the treatments except T_5, T_6, T_9 and T_{11} which remained at par with T_{10}.

The values Mg content was observed minimum at harvest and it was maximum at 60 DAS. It might be due to demand of Mg by crop and high content of Mg in poultry manure and its slow mineralization. The content of magnesium decreased from 90 DAS to at harvest irrespective of different treatments, which may also be due to dilution effect.

The higher content and uptake of Mg by the plant due to poultry manures over vermicompost application was also reported by Diwale (2012) [3] in lateritic soils. Increased

content of magnesium in poultry manure applied plots were also reported by Boateng *et al.* (2006) [2] and Ewulo *et al.* (2008) [5].

3.2.6 Sulphur content (S)

The data pertaining to the sulphur content in snake gourd plant as influenced various treatmentsat 60, 90 DAS and at harvest are presented in Table 3.

At 60 DAS

The data presented in Table 3 revealed that the S content ranged between 0.22 to 0.54 per cent. The treatment T_{10} registered maximum S content and minimum in treatment T_1 control. A critical look on data further indicated that treatment T_{10} receiving 100 per cent N through poultry manure recorded significantly higher S content over rest all the treatments except treatments T_6, T_8 and T_9 which were found to be at par with T_{10}.

At 90 DAS

The data presented in Table 3 revealed that the sulphur content in plant varied from 0.20 to 0.52 per cent. The sulphur content was maximum 0.52 and minimum 0.20 per cent in the treatment T_{10} and T_1 respectively. A close scrutiny of data indicated that application 100 per cent N through poultry manure exhibited significantly higher S content over all the treatments except T_6 and T_9 which were found to be at par with T_{10}.

At harvest

The sulphur content in snake gourd plant at harvest varied from 0.12 to 0.34 per cent. The treatment T_{10} receiving application of 100 per cent N through poultry manure exhibited significantly higher S content over rest the all treatments except treatment T_6 and T_9which remained at par with T_{10}.

The values sulphur content was found to be minimum at harvest and maximum at 60 DAS. It might be due to demand of S by crop and high content of S contain in poultry manure and its slow mineralization. The content of sulphur decreased from 90 DAS to at harvest irrespective of different treatments, which might also be due to dilution effect.

Further, scrutiny of the data of S content at 60 DAS and at harvest of the fruits, falling trend of S concentration was observed and it might be due to the sulphur taken up by the plants and utilized for its metabolic activities.

The higher content and uptake of S by the plant due to poultry manure over and vermicompost application was also reported by Theriveni (2015) [13] and Kapase (2016) [10] in chilli.

4. Conclusion

The nutrient content in plant at various stages was also influenced due to various treatments. Application of 50 % N through poultry manure + 50 % N through inorganic fertilizer *i.e.* treatment T_6 was recorded the higher nutrient concentration however remained at par with treatment T_{10}.

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