ISSN: 0974 - 0376

The Ecoscan : Special issue, Vol. VII: 85-89: 2015
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.in

EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON NUTRIENT UPTAKE AND RECOVERY OF BITTERGOURD (*MOMORDICA CHARANTIA* L.)

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KEYWORDS

Bitter gourd
NPK
Vermicompost
Bio fertilizers
Nutrient uptake and recovery

Proceedings of National Conference on Harmony with Nature in Context of Bioresources and Environmental Health
(HORMONY - 2015)
November 23 - 25, 2015, Aurangabad,
organized by
Department of Zoology,
Dr. Babasaheb Ambedkar Marathwada University
Aurangabad (Maharashtra) 431 004
in association with
National Environmentalists Association, India
www.neaindia.org

The Ecoscan
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES

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ABSTRACT

An experiment was conducted to find out the effect of integrated nutrient management on nutrient uptake and recovery of bitter gourd (*Momordica charantia L.)* during *Kharif*, 2013. Experimental factors includes NPK three levels (50, 75,100% RDF) alone or integration with Vermicompost+Biofertilizers. The results illustrated that the plants treated with 100% NPK+ Vermicompost+ Bio-fertilizers (*Azotobacter, Azospirillum and Phosphate Solubilizing bacteria*) has recorded maximum dry matter production, nutrient concentration and uptake of nitrogen by shoots (34.15kg/ha), by fruit (12.6kg/ha) and recovery percentage (21.3%) and maximum phosphorous uptake by shoots (6.54kg/ha) than by fruit (2.7kg/ha) and highest potassium uptake by vine (65.3kg/ha), by fruits(11.53kg/ha) followed by 75%NPK+VC+BF, respectively Hence, the treatment 100% NPK+ VC+ BF is considered as a best treatment for nutrient uptake.

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INTRODUCTION

Bitter gourd (*Momordica charantia Linn.*) is the leading vegetable member of the cucurbit family, grown for its edible immature tuberculated green fruits, which have unique bitter taste. It has great demand in international market among fresh vegetables due to its hypoglycemic property. Bitter gourd is highly fertilizer responsive crop due to its maximum returns mostly preferred vegetable of India(Naveen Kumar *et al.,* 2012) and it was grown in an area about 9,205M ha with an annual production of 162,187 million tonnes (Annonymous, 2013). However, continues use of the heavy doses of fertilizers leads to damages the natural ecology, nutrient recycling and the biological communities in soil otherwise support the crop production(Prasad *et al.,* 2009). The information on importance of INM on nutrient uptake and recovery by bitter gourd crop was inadequate. Therefore, present experiment was carried out to study the influence of inorganic, organic nutrients along with biofertilizers on nutrient uptake and recovery of bitter gourd cv. Prachi and it was undertaken with a sound data base.

MATERIALS AND METHODS

This experiment was carried out at College of Agriculture under All India Net Work Project on Biodiversity and Bio-fertilizers, OUAT, Bhubaneswar to study the influence of integrated use of in organics, organic manures and bio fertilizers on nutrient uptake and recovery of bitter gourd(*Momordica charantia L.*) cv. Prachi. The field was sandy loam having pH 6.5 and the plot size 2.2X2.5cm with a spacing of 1m X50cm.The experiment was laid out in a randomized block design with three replications involving 10 treatments as fallows. Fertilizer and manural doses were calculated as per the soil test report.

The treatments are as followed. Absolute control (T_1), 50% recommended dose of fertilizers (T_2), - 50% NPK+ Vermicompost @2.5 t ha^{-1}) (T_3), - 50% NPK+ VC+ Bio fertilizers (*Azotobacter, Azospirillum* and PSB @ 4kg ha^{-1})(T_4), -75%NPK (T_5), 75%NPK + VC(T_6),75% NPK+VC+BF(T_7),100% NPK(T_8),100%NPK+ VC(T_9),100% NPK+ VC+BF(T_{10}). Vermicompost (2.5t/ha) and Bio fertilizer mixture were (i.e., *Azotobacter, Azospirillum*, PSB @ 1:1:1 ratio) applied @ 4kg/ha three times i.e., at the time of sowing, at 30 DAS and 45 DAS, respectively. At the time of sowing seed, 1/3 of nitrogen, 1/2 of potassium and full dose of phosphorous applied as per the treatments in basins and mixed well in the soil as a basal application. Half of remaining N (out of ¾ total) of nitrogen and rest part of K, O (1/2) were applied as a first top dressing at 15 days after sowing. The remaining N was applied as second top dressing at 30 days after sowing. The recommended dose of fertilizers N, P, O... , K, O and SO„ @ 150:50:100:50 Kg ha^{-1} were applied in the form of Navrathna (19-19-0-13), Urea and Muriate of Potash (MOP). Cultivar in this study was bejo F1 hybrid Prachi. Regular weeding, earthing up, irrigation and plant protection measures were followed. In each plot five plants were selected randomly and tagged for observations. The total nitrogen, phosphorous, potassium and sulphur content of fruit and vine were analyzed. The plant parts used for dry matter determination and chemical analysis were ground separately into powder by using

mill. The vines of six sampled plants from each treatment were chapped and composite sample of 100g was taken from each treatment .The samples were air dried for three days followed by oven drying at 70°C until constant weight was obtained. The dry matter content was multiplied with the harvested vine weight to get total dry matter production and expressed in Kg ha^{-1}. Nitrogen was estimated by Kjeldahl distillation method (Page et al.1982), Phosphorous and Sulphur by spectrophotometer at 470nm wave length fallowing Vanadomolybdo phosphoric acid method (Jackson,1973) and potassium by Flame photometric method (Jackson,1973). The uptake of nutrients were calculated by multiplying their content with dry matter content expressed in kg/ha and total nutrient uptake obtained by adding uptake through vine, leaf and stem of the crop. The content of nutrients was estimated by Jackson (1973).The uptake of nutrients was calculated by multiplying their content with dry matter content expressed in kg/ha. The observations on uptake and recovery of the nutrients *i.e.*, N, P, K, S were recorded and analyzed individuallyby using RBD statistical method (Gomez and Gomez, 1976).

RESULTS AND DISCUSSION

The results of the mean data of the experiment on dry matter production (Table 1), nutrient concentration (Table 2), nutrient uptake by different parts of the plant (Table 3) and total uptake and nutrient recovery (Table 4) by the plant were presented in as influenced by integrated nutrient management during *Kharif* season 2013.

Dry matter production (kg/ha)

There was significant differences were observed on dry matter production of different parts of bitter gourd among the different integrated treatment combinations. The plants were provided with (T_{10}) 100%RDF+Vermicompost+ bio-fertilizers (*Azotobacter, Azospirillum* and PSB @4kg/ha)(T_{10}) recorded maximum dry matter content through the vine(1900 kg/ha) than through the fruit(361kg/ha) which was on par with T_9(100%NPK+VC) (kg/ha by vine and by fruit kg/ha) while lowest dry matter was recorded in absolute control kg/ha by vine and by fruit kg/ha (T_1-with no fertilization), the total dry matter production ranged from 672 to 2260kg/ha. There was significant increase in DMP with the use of inorganic nutrients with incremental doses for their integration with vermicompost or Vermicompost with BF.The dry matter content of the fruit was also influenced by the INM practices with ranged from 7.2 to 8.9%.

Similar results were observed by InderJeet Sharma, 2013.

Nutrient concentration and uptake by different plant parts

Nitrogen

There was a marked effect of integrated application on N, P, K and S concentration and uptake by bitter gourd. The concentration of N in bitter gourd fruit was more (ranging from2.33 to 3.58%)than in vine (varyingbetween 1.27 and 1.80 %),which have beenpresented in table 2.However highest N conc. was observed with the 100% integration system(T_{10}) in both vine(1.80) and fruit(3.58), while the lowest were recorded in the control(1.27, 2.33 respectively).Plants were applied with 100%RDF+ Vermicompost+ bio-fertilizers (*Azotobacter, Azospirillum* and PSB @4kg/ha) (T_{10}) recorded maximum nitrogen uptake through the vine(34.15 kg/ha) than through the fruit(12.6kg/ha) which was on par with T_9(100%NPK+VC) (32.20kg/ha by vine and by fruit 10.97 kg/ha) while lowest N uptake was recorded in absolute control 7.32kg/ha by vine and by fruit 2.21 kg/ha (T_1-with no fertilization), respectively.

Phosphorous

Data pertaining to phosphorous concentration and uptake (kg/ha) by different plant parts of bitter gourd as influenced by integrated nutrient management differed significantly among treatments. Phosphorous content of fruit was greater than vine. Significantly the highestper cent of fruit 0.75 was observed in T_{10}which was significantly increased by 50% integration to optimum integration, however least content was observed without nutrition. During Kharif plants treated with 100%RDF+VC+BF(T_{10}) recorded maximum phosphorus uptake by vine (6.54)kg/ha) which was at par with 100%RDF +VC+BF(T_7) (6.30kg/ha and T_9 (5.70kg/ha), where as lowest phosphorus uptake(2.60kg/ha) was recorded in treatment without fertilization (T_1), with regard to fruit T_{10} recorded the maximum phosphorus uptake (2.70 kg/ha) which was at par T_7 (2.40kg/ha). However, the lowest phosphorus uptake (0.42 kg/ha) was registered with unfertilized treatment (T_1). Similar results was observed in greengram (Patel *et al.*, 2013).

Table 1: Total Dry matter production (kg/ha) and fruit dry matter content (%) of Bitter gourd under the influence of graded doses of inorganic nutrients integrated with Vermicompost and bio-fertilizers

Treatments	Dry matter Production(Kg/ha)			RAE (%)	Dry matter content of fruit(%)
	Fruit	Vine	Total		
Absolute control (T_1)	94	577	674	-	7.2
50%NPK (T_2)	205	854	1057	27	7.4
50%NPK+VC (T_3)	234	1264	1497	57	7.9
50%NPK+VC+BF (T_4)	268	1464	1740	74	8.0
75%NPK (T_5)	270	1610	1877	83	8.0
75%NPK+VC (T_6)	275	1737	2014	93	7.9
75%NPK+VC+BF (T_7)	303	1870	2170	104	8.0
100%NPK (T_8)	303	1810	2114	100	8.6
100%NPK+VC (T_9)	317	1904	2220	107	8.7
100%NPK+VC+BF (T_{10})	361	1900	2260	110	8.9
LSD(0.05)	0.51	4.32	4.08		1.02*
CV(%)	11.38	16.83	13.53		7.38*

Table 2: Nutrient concentration (%) of Bitter gourd under the influence of graded doses of inorganic nutrients integrated with Vermicompost and bio-fertilizers

Treatments	Nutrient concentration (%)							
	N		P		K		S	
	Fruit	Vine	Fruit	Vine	Fruit	Vine	Fruit	Vine
Absolute control (T_1)	2.33	1.27	0.43	0.45	2.22	3.7	0.30	0.12
50%NPK (T_2)	2.57	1.28	0.69	0.31	2.44	3.5	0.35	0.074
50%NPK+VC (T_3)	3.55	1.33	0.72	0.32	2.54	3.4	0.37	0.096
50%NPK+VC+BF (T_4)	3.59	1.37	0.74	0.38	2.87	3.8	0.38	0.120
75%NPK (T_5)	2.54	1.29	0.65	0.34	2.60	3.3	0.34	0.070
75%NPK+VC (T_6)	3.34	1.33	0.68	0.33	2.70	3.5	0.40	0.075
75%NPK+VC+BF (T_7)	3.48	1.39	0.71	0.35	2.86	3.5	0.40	0.110
100%NPK (T_8)	3.42	1.49	0.68	0.24	2.67	3.0	0.45	0.070
100%NPK+VC (T_9)	3.48	1.69	0.74	0.30	2.76	3.3	0.46	0.073
100%NPK+VC+BF (T_{10})	3.58	1.80	0.75	0.33	3.20	3.3	0.47	0.100
LSD(0.05)	0.71	0.54	0.17	0.14	0.68	0.77	0.04	0.046
CV(%)	13.0	22.8	14.8	24.4	14.7	13.1	21.5	30.2

Table 3: Uptake of different nutrients in different parts of bitter gourd under the influence of graded doses of inorganics integrated with Vermicompost and biofertilizers

Treatments	N Uptake		P uptake		K uptake		S uptake	
	Fruit	Vine	Fruit	Vine	Fruit	Vine	Fruit	Vine
Absolute control (T_1)	2.21	7.32	0.42	2.60	2.11	21.3	0.28	0.72
50%NPK (T_2)	5.25	10.93	1.42	2.65	5.02	29.9	0.72	0.63
50%NPK+VC (T_3)	8.31	16.80	1.68	4.10	6.00	43.0	0.86	1.22
50%NPK+VC+BF (T_4)	9.70	20.05	1.90	5.60	7.68	55.6	1.03	1.76
75%NPK (T_5)	6.85	20.73	1.80	5.50	7.01	53.0	0.92	1.20
75%NPK+VC (T_6)	9.20	23.14	1.86	4.70	7.45	60.7	1.10	1.31
75%NPK+VC+BF (T_7)	10.6	25.95	2.40	6.30	8.65	62.8	1.22	2.00
100%NPK (T_8)	10.84	26.93	2.10	4.40	8.11	54.2	1.47	1.30
100%NPK+VC (T_9)	10.87	32.20	2.15	5.70	8.76	62.6	1.46	1.40
100%NPK+VC+BF (T_{10})	12.6	34.15	2.70	6.54	11.53	65.3	1.69	2.06
CD(0.05)	1.66	5.92	0.36	1.4	1.38	15.1	0.21	0.40
CV (%)	11.3	15.8	11.4	16.6	11.2	17.3	11.6	17.7

Table 4: Total nutrient uptake and apparent recovery (%) of different parts of bitter gourd under the influence of graded doses of inorganics integrated with vermicompost and biofertilizers

Treatments	Total uptake(kg/ha)				Apparent recovery (%)			
	N	P	K	S	N	P	K	S
Absolute control (T_1)	9.54	3.02	23.4	1.00				-
50%NPK (T_2)	16.20	4.08	35.5	1.35	8.8	9.6	18.1	2.2
50%NPK+VC (T_3)	25.12	5.75	48.8	2.06	15.7	14.7	30.4	5.2
50%NPK+VC+BF (T_4)	29.71	7.56	63.3	2.78	18.3	24.5	47.7	8.6
75%NPK (T_5)	27.60	7.30	60.0	2.10	15.9	26.1	36.6	4.5
75%NPK+VC (T_6)	32.30	6.50	68.2	2.40	16.6	14.6	38.5	4.8
75%NPK+VC+BF (T_7)	36.51	8.45	71.9	3.30	19.7	22.4	40.5	7.9
100%NPK (T_8)	37.76	6.45	62.3	2.65	18.8	15.6	29.3	5.1
100%NPK+VC (T_9)	43.04	7.85	71.4	2.85	19.2	17.3	32.3	5.0
100%NPK+VC+BF (T_{10})	46.70	12.24	76.8	4.25	21.3	20.1	40.0	8.8
LSD(0.05)	5.3	1.21	14.4	.68				
CV(%)	10.08	10.7	14.5	16.2				

Potassium

Plants fertilized with 100% RDF integration with Vermicompost and Bio-Fertilizers (T_{10}) was observed maximum concentration of potassium inbitter gourd fruit ranged from 2.22 to 3.20 percent, which was less than the vine concentration ranged from3.3 to 3.7 percent. However, K uptake throughvine (65.3kg/ha) highest recorded with the same treatment followed by T_7 (62.8 kg/ha) and T_9 (62.6 kg/ha), whereas the lowest uptake of potassium (21.3 kg/ha) was recorded without fertilization(T_1) .potassium uptake through the fruit ranging from 2.11 to 11.53 kg/ha while the maximum potassium uptake by fruit was recorded in T_{10} (11.53 kg/ha) is due to integration of optimum dose of inorganic fertilizers with VC and BF.This was significantly differing among the treatment combinations.However, lowest uptake was due to without fertilization (Control).The uptake of Potassium through the vine greater than through the fruit.

Sulphur

The concentration of sulphur in fruit was ranging from 0.30 to

0.47 percent, which was higher than the vine concentration ranging from 0.070 to 0.120 percent and uptake in fruit was ranged from 0.28 to 1.69 kg/ha, lower than through the vine (0.72 to 2.06 kg/ha). In all these cases highest value was observed in T_{10} which was significantly higher than rest of the treatments. However, lowest was registered with unfertilized treatment absolute control (T_1). By increasing the level of inorganic nutrients from 50 to 100% integrated with VC and BF showed nutrient uptake in increasing trend. Data recorded to total Nitrogen, Phosphorus, potassium and sulphur uptake as influenced by integrated nutrient management grown under Bhubaneswar conditions during *Khareif* presented in Table 3. The plants provided with optimum dose of inorganic integration with organic and bio-Fertilizers (T_{10}) recorded maximum Nitrogen (46.70 kg/ha) which was followed by T_9 (43.04 kg/ha). Total phosphorus and potassium uptake by the plant ranged from 3.02 to 8.95 kg/ha, (23.4to 76.8 kg/ha, respectively. However in all the cases T_{10} had highest total uptake of specific nutrients followed by T_7. The quantity of K uptake by the crop was maximum than N, P and S uptake (Table 4).

Nutrient recovery (%)

N, P, K and S recovery by bitter gourd crop was significantly influenced by the various combinations of inorganic fertilizers, Vermicompost and biofertilizers. The highest recovery of nitrogen (21.3%) wasrecorded when 100% inorganic dose integrated with Vermicompost and biofertilizers (T_{10})were applied. However, highest Percent recovery ofP andK were registered in T4 treatment26.1,47.7% followed by T_7 and T_{10}, based on control but sulphur recovery maximum recorded in T_{10}(8.8%) followed by T_4(8.6%). Where plants treated inorganic alone have N recovery 23% response but with Vermicompost recovery improved by 34% and with biofertilizers integration by 44.7%,respectively. Similarly P and K also with chemical fertilizers alone gave 29.5, 46.3, integrated with VC 38.1, 50.7 and with BF 58.5 and 63.4% response over control, respectively.

Total uptake of NPKS by different parts of the bitter gourd plants fertilized with 100%RDF + VC + BF recorded maximum uptake of nutrients, this could be attributed due to maximum application of optimum dose integration with Vermicompost and biofertilizers which helps in quick availability of nutrients to the plant. Integration of inorganic nutrients with organic input source and bio fertilizers through their impact on physical, chemical and biological properties of soil, nutrient supplying capacity has influences the biomass production, yield, quality and nutrient use efficiency. Vermicompost is organicmanure; it is not only improves the aeration, water holding capacity, CEC but also provides food for the soil microbes. Application of biofertilizers not only enhances the crop growth, yield and quality but also improves soil fertility through nutrient fixation, solubilization and in addition also releases GRs like IAA, GA, cytokinins and other growth promoting substances, which influences cell elongation in ordered to givegood root growth, root density, root volume, root cat ion exchanging capacity, there by enhances the dry matter production of the crop. Hence it was directly influence the nutrient uptake and apparent recovery of specific nutrients by the bitter gourd crop.The increasing of N due todiazotrops (*Azotobacter and Azospirillum*) they were fixing atmospheric nitrogen in soil. Maximum uptake of phosphorous due to better sloubilization by phosphobacteria (PSB) with solubilizes the insoluble form of P into available form.The apparent recovery of N, P, K and S increased from a level 9 to 21%, 10 to 20%, 18 to 20%, 2to 9%, respectively from non integrated condition to optimum integration condition. These finds were confirmed with results of Anjanappa *et al*. (2012) in cucumber at GKVK, Bangalore, Bindya *et al*. (2012) in Gherkin at Hyderabad, Pattanayak *et al*. (2008) in potato.

All the above findings supported integrated nutrient management including application of optimum soil test based fertilizer application correcting deficient of soil nutrients, sufficient organics and consortia of micro-organisms, like *Aztobacter, Azospirillum* and PSM for increased dry matter production with quality produce as well as nutrient uptake and recovery percent of the crop.

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