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Effect of integrated nutrient management on productivity and profitability of pointed gourd (*Trichosanthes dioica* Roxb.)

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ABSTRACT

A field experiment was undertaken in the experimental plots of Network Project on Biofertilizer, OUAT, Bhubaneswar during 2012-13 and 2013-14 to evaluate the combined effect of biofertilizers, inorganic fertilizer levels, soil amendment and organic manure on yield and quality improvement in pointed gourd cv. Swarna Alaukik. The experiment was conducted in acidic (pH- 4.62 - 4.73), sandy loam soil imposed with twelve treatment combinations comprising different levels of inorganic fertilizers (Urea, DAP and MOP), organic manure (vermicompost) and bio fertilizers (Azotobacter sp., Azospirillum sp. and Phosphate Solubilising Bacteria [PSB] – Bacillus sp.) and lime (Paper mill sludge). Application of 100 per cent recommended dose (RDF) of NPK in combination with biofertilizer, lime and organic manure to pointed gourd increased the vegetative growth characters (Pooled data) viz; length of vine (234.27 cm), vine girth (3.72 cm) and no. of branches per plant (12.45) as well as yield attributes such as length of fruit (12.50 cm), girth of fruit (8.13 cm) and single fruit weight (24.81 g) over 2012-13 and 2013-14. Integrated application of inorganics with soil amelioration and organic addition enhanced the fruit yield (29.78 t ha^{-1}) and quality attributes (moisture content of fruit, total soluble solid, ascorbic acid, total sugar) of pointed gourd. A net profit of ₹241349 per hectare from the crop over an investment of ₹85961 with a benefit-cost ratio of 2.80: 1 was obtained with combined application of lime, 100 per cent RDF along with biofertilizers and vermicompost. Thus, it can be incurred from the experiment that recommended dose of chemical fertilizer which was applied to pointed gourd in conjunction with biofertilizer and vermicompost in presence of lime, improved the quality of the produce (fruits) without hampering the yield potential of the crop.

Keywords: Amelioration, benefit-cost ratio, bio-fertilizer, INM, pointed gourd

India has made significant progress on the vegetable map of the world and accounts for about 12 per cent share in the world total vegetable production. It occupies an area of 79 million ha with an annual production of 129 m tonne under vegetable crops (Saravaiya *et al.*, 2012). Numbers of vegetables are cultivated in different parts of India as per season. Different vegetables like brinjal, tomato, okra, cauliflower, cabbage, bean, different greens, cucurbits and tropical tuber crops are also being grown in different locations of our state. Among the cucurbits; pumpkin, cucumber, watermelons, pointed gourd, ridge-gourd, bottle gourd etc. are being cultivated in *kharif*, as well as in *rabi* season. Pointed gourd (*Trichosanthes dioica* Roxb.) originally from Indo-Malayan region belongs to the family Cucurbitaceae and grown well under hot or moderately warm and humid climatic regions *viz*; Eastern Uttar Pradesh, Bihar, West Bengal, Assam, Odisha, Madhya Pradesh, in some parts of Maharashtra and Gujarat and some hilly tracts of Andhra Pradesh and Tamil Nadu. In Odisha, it is being cultivated during last part of *rabi* season, where the farmers get substantial profit from marketing in the state as well as outside the state.

Pointed gourd is a tropical vegetable crop known by the name of *parwal*, *palwal*, or *parmal* in different parts of India and Bangladesh and is one of the important vegetables of this region. The fruit is the edible part of the plant. Local varieties of pointed gourd were cultivated since long in our state. Pointed gourd is rich in vitamin and contains 2.6 mg Na, 83.0 mg K, 1.1 mg Cu, and 17.0 mg S per 100 g edible part (Singh, 1989). Of late some new varieties have been developed which are also performing very well in the state. Among them “Swarna Alaukik” is one. It is a high yielding variety developed by ICAR research complex for eastern region, Ranchi, Jharkhand having light green fruits with blunt ends. Approximate average fruit lengths are 5-8 cm long, solid with thin skin. This is good for vegetable as well as preparation of sweets. It gives an average yield of 23 - 28 t ha^{-1} on vertical staking system.

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The present investigation aimed at studying the changes in yield and quality parameters of pointed gourd due to integrated application of vermicompost, biofertilizer and inorganic fertilizer and to evaluate cost effectiveness of sustainable combination of biofertilizer, vermicompost, liming and organic fertilizer for greater economic return from pointed gourd cultivation.

MATERIALS AND METHODS

A field experiment was carried out with pointed gourd in the research plots of "Network Project on Biofertilizers", College of Agriculture, OUAT, Bhubaneswar located on $22^0 15'$ North latitude, $80^0 22'$ East longitude and 25.5 m above sea level during 2012-13 and 2013-14. The cropping location comes under tropical climatic zone. Bhubaneswar is around 62 kilometres away from Bay of Bengal towards west side. The precipitation during the cropping period was 257.9 mm and 207.9 mm received between November, 2012 to May, 2013 and November, 2013 to May, 2014. The maximum temperature during the period varied between 29.7^0C to 38.8^0C in 2012-2013 and 27.7^0C to 39.0^0C in 2013-2014.

The experiment consisted of twelve treatments with various combinations of nutrient management applied to pointed gourd variety Swarna Alaukik included different level of applications of inorganic fertilizers (Urea, Diammonium Phosphate and Muriate of potash), organic manure (vermicompost), biofertilizers (*Azotobacter sp., Azospirillum sp.* and Phosphate Solubilising Bacteria [PSB] – *Bacillus sp.*) and lime (Paper Mill Sludge) as mentioned in tables 1- 4. The experiment was laid out in randomized block design (R.B.D.) with 3 replications of each treatment. Pointed gourd cuttings were planted in the field at a spacing of 1.2 × 1.2 m in plots of 3.6 × 3.6 m^2 size. Standard cultural practices and plant protection measures were followed to raise a good quality crop. Two plants were selected at random from each plot of each treatment as representative sample for recording the data. The pooled mean values of each treatment in each replication for individual observation were calculated. After collection, data were tabulated and statistically analyzed for interpretation.

The experiment was conducted on sandy loam soil with initial pH 4.62, organic carbon 0.39 per cent, available N, P and K was 272, 27 and 214 kg ha^{-1} respectively. Observations on vegetative characters, yield attributes and quality parameters were recorded in each replication of all the treatments during both the years. Economics of the treatments were calculated as per the prevailing market price of inputs and produce to evaluate the Benefit-cost ratio.

RESULTS AND DISCUSSION

Integrated nutrient management treatments rendered their significant effect on the vegetative characters viz; vine length (cm), vine girth (cm) and number of branches per plant (Table 1). Plots treated with lime, biofertilizers, vermicompost and 100% RDF(T_{12}) recorded significantly best performances for length of vine (234.27 cm), vine girth (3.72 cm) and no. of branches per plant (12.45) over all other treatments, while T_1 where no nutrient was applied from outside was the lowest performer in both the years. Sareedhar *et al.* (2006) reported that higher vine length, number of leaves, and intermodal length of gherkin were registered in the treatment which received recommended dose of inorganic fertilizer along with organic manures, farmyard manure (25 t ha^{-1}), press mud (25 t ha^{-1}) and vermicompost (25 t ha^{-1}). According to Sureshkumar and Karuppaiah (2008) comparatively higher vine length was obtained by application of integrated nutrients in bitter gourd with various sources of nutrients. They obtained best result from the treatment combination of 75 per cent NPK (60:30:20 kg ha^{-1}) + vermicompost at 5 t ha^{-1} + *Azospirillum* at 2 kg ha^{-1}. Both these results are in conformity with the findings of the present experiment.

Significant influences on yield attributing characters (pooled over 2012-2013 and 2013-2014) of pointed gourd were exerted by the nutrient management treatments (Table 2). Length of fruit (12.50 cm), girth of fruit (8.13 cm) and single fruit weight (24.81 g) were recorded maximum in the treatment which received lime, biofertilizers, vermicompost and full (100 per cent) dose of NPK followed by the treatment T_{11} (Lime + Vermicompost @ 5 t ha^{-1} + RDF [75 per cent]). A synergistic interaction between organic manure and bio fertilizers resulted in enhanced fruit length and fruit girth in bitter gourd which ultimately increased average fruit weight (Mulani *et al.* 2007). Further, Anjanappa *et al.* (2012) reported that enhanced yield parameters of cucumber (cv. Hassan Local) like, number of fruits per vine and maximum fruit weight were recorded with application of FYM + *Azotobacter* + Phosphobacteria + Trichoderma. The findings of the present experiment corroborated well with the observations of the above mentioned researchers.

Table 1: Effect of integrated nutrient management on vegetative characters of pointed gourd (pooled)

Treatments	Vine length (cm)	Vine girth (cm)	Number of branches plant^{-1}
T_1- Control (only FYM)	183.12	2.43	4.22
T_2- LIME as PMS @ 5 t ha^{-1}	213.35	2.64	5.35
T_3- Biofertilizers (*Azotobacter* sp. + *Azospirillum* sp. + *Bacillus* sp.)	202.78	2.54	4.18
T_4- Vermicompost @ 5 t ha^{-1}	213.30	2.47	4.45
T_5- Recommended dose of fertilizer (75%)	222.03	2.85	8.63
T_6- Lime + Biofertilizer	214.02	2.71	6.63
T_7- Lime + Vermicompost @ 2.5 t ha^{-1}	221.60	2.74	7.82
T_8- Lime + RDF (75%)	225.43	3.52	9.77
T_9- Lime + Biofertilizer + Vermicompost @ 2.5 t ha^{-1}	222.93	3.47	9.70
T_{10}- Lime + Biofertilizer + RDF (75%)	230.40	3.55	10.99
T_{11}- Lime + Vermicompost @ 5 t ha^{-1} + RDF (75%)	231.17	3.68	11.93
T_{12}- Lime + Biofertilizer + Vermicompost @ 5 t ha^{-1} + RDF (100%)	234.27	3.72	12.45
SEm (±)	**0.11**	**0.02**	**0.05**
LSD (0.05)	**0.33**	**0.05**	**0.14**

Table 2: Effect of integrated nutrient management on yield attributes of pointed gourd (pooled)

Treatments	Length of fruit (cm)	Girth of fruit (cm)	Single fruit weight (g)
T_1- Control (only FYM)	7.32	5.25	21.09
T_2- LIME as PMS @ 5 t ha^{-1}	9.62	5.86	22.34
T_3- Biofertilizers (*Azotobacter* sp. + *Azospirillum* sp. + *Bacillus* sp.)	7.59	5.55	21.76
T_4- Vermicompost @ 5 t ha^{-1}	8.68	5.74	22.18
T_5- Recommended dose of fertilizer (75%)	11.13	6.72	23.62
T_6- Lime + Biofertilizer	9.88	6.45	22.42
T_7- Lime + Vermicompost @ 2.5 t ha^{-1}	10.95	6.24	23.13
T_8- Lime + RDF (75%)	11.77	7.42	24.23
T_9- Lime + Biofertilizer + Vermicompost @ 2.5 t ha^{-1}	11.34	6.97	23.92
T_{10}- Lime + Biofertilizer + RDF (75%)	11.81	7.64	24.48
T_{11}- Lime + Vermicompost @ 5 t ha^{-1} + RDF (75%)	12.09	7.99	24.69
T_{12}- Lime + Biofertilizer + Vermicompost @ 5 t ha^{-1} + RDF (100%)	12.50	8.13	24.81
SEm (±)	**0.06**	**0.03**	**0.03**
LSD (0.05)	**0.17**	**0.08**	**0.10**

The economic yield is dependent on the magnitude of the dry matter production as well as the distribution of dry matter within various parts of the plant. Nitrogen supply however affects both dry matter production as well as its distribution. Optimum level of nitrogen supply is essential for effective partitioning of the accumulated dry matter to the economic sink. Conjugative application of different levels of nitrogen, phosphorus and potassium in combination with biofertilizer and vermicompost in presence of lime increase the yield of fruits per plant and ultimately the yield per hectare in an increasing order up to the recommended dose of chemical fertilizers. Maximum yield of 29.51t ha^{-1} and 30.05t ha^{-1} were obtained with the use of 100 per cent NPK with biofertilizer and vermicompost in presence of lime which was

Table 3: Effect of integrated nutrient management on fruit yield and quality of pointed gourd (pooled)

Treatments	Fruit yield (t ha^{-1})	Moisture content of fruit (%)	Total soluble solid (TSS ^{o}brix)	Ascorbic acid (mg/100 g)	Total sugar (%)
T_1- Control (only FYM)	15.49	90.04	2.08	27.97	0.61
T_2- LIME as PMS @ 5 t ha^{-1}	20.70	90.38	2.70	28.14	0.87
T_3- Biofertilizers (*Azotobacter* sp. + *Azospirillum* sp. + *Bacillus* sp.)	16.95	90.23	2.55	28.02	0.75
T_4- Vermicompost @ 5 t ha^{-1}	19.84	90.21	2.68	28.07	0.80
T_5- Recommended dose of fertilizer (75%)	22.53	91.91	3.10	28.34	1.29
T_6- Lime + Biofertilizer	22.22	91.09	3.02	28.18	0.94
T_7- Lime + Vermicompost @ 2.5 t ha^{-1}	22.42	91.15	2.83	28.32	1.21
T_8- Lime + RDF (75%)	25.05	92.45	3.17	28.57	1.56
T_9- Lime + Biofertilizer + Vermicompost @ 2.5 t ha^{-1}	24.32	92.21	2.82	28.40	1.39
T_{10}- Lime + Biofertilizer + RDF (75%)	25.50	92.60	3.08	28.72	1.77
T_{11}- Lime + Vermicompost @ 5 t ha^{-1} + RDF (75%)	29.03	92.68	3.18	28.91	1.81
T_{12}- Lime + Biofertilizer + Vermicompost @ 5 t ha^{-1} + RDF (100%)	29.78	92.83	3.30	29.02	1.89
SEm (±)	**0.03**	**0.04**	**0.03**	**0.03**	**0.01**
LSD (0.05)	**0.10**	**0.13**	**0.09**	**0.11**	**0.03**

significantly higher than other treatments including control (Table 3). This increase may be due to the solubilisation effect of nutrients as well as chelating effect of biofertilizer and vermicompost as organic source in presence of lime on metals, thereby, the availability of nutrients to the plants get increased. Further the favourable nutritional environment in the root zone created by addition of organic manures and biofertilizers resulted in increased absorption of nutrients from soil solution and uptake responsible for increased fruit growth and yield attributing characters. Similar findings have been reported by earlier researchers Mondal and Roy (2001) in potato, Jyotishi and Pandey (1969) in onion and Luzzati *et al*. (1980) in carrot. The soil application of biofertilizers (*Azospirillum* and PSB) was effective in nitrogen fixation, synthesis of plant growth promoting hormones and enzyme activation which might have helped in yield maximization.

The present investigation revealed that the moisture content of the fruit (per cent) was significant with respect to the combined effect of 100 per cent NPK (RDF) along with biofertilizers and vermicompost in presence of lime (Table 3). The increase in the moisture content of the fruit might be due to increased absorption of nutrients including water, utilization as well as accumulation of the same in the fruits. The result is in confirmation with the findings of Sreenivas *et al*. (2000) in ridge gourd, Ansary *et al*. (2004) in pumpkin and Kameswari *et al*. (2011) in ridge gourd.

The present investigation revealed (Table 3) that the total soluble solid (^{o}brix) was significantly higher in the treatment T_{12} (lime + biofertilizer + vermicompost @ 5 t ha^{-1} + RDF [100 per cent]) followed by T_{11} (lime + vermicompost @ 5 t ha^{-1} + RDF [75 per cent]). Application of biofertilizers along with N, P and K could be attributed to higher metabolic activities, which helps in synthesis of higher amount of acids and might have contributed to total soluble solid per cent. Anuja and Archana (2012) in bitter gourd, Yadav and Mangal (1984) in muskmelon, Sreenivas *et al*. (2000) in ridge gourd, Kumaran and Natarajan (2001) in tomato, Adam *et al*. (2003) in cantaloupe and Ansary *et al*. (2004) in Pumpkin, had also reported similar results.

The ascorbic acid content in pointed gourd was recorded significantly higher in the treatment imposed with lime, biofertilizers, vermicompost and 100 per cent RDF over all other treatments (Table 3). According to Worthington (2001) improving soil quality by applying vermicompost and biofertilizers could able to increase the ascorbic acid content of the treatments in crops. Increased ascorbic acid content in the pointed gourd fruits with the application of vermicompost as an organic source might be due to slow but continuous supply of all major and micronutrients which might have helped in the assimilation of carbohydrates and in turn synthesis of ascorbic acid. Significantly higher vitamin-C (ascorbic acid) content in lettuce was recorded in the treatments receiving organic manure combined with

Azotobacter (Bahadur *et al*. 2006, 2009 and 2003). Further the result is in agreement with the findings of Anuja and Archana (2012) in bitter gourd, Kumaran and Natarajan (2001) in tomato and Kameswari *et al*. (2011) in ridge gourd.

Appreciable positive variation in the quality character of pointed gourd was observed due to integrated application inorganics with biofertilizers, vermicompost and lime. The sugar content was found maximum in the plots receiving 100 per cent NPK (RDF), biofertilizer, vermicompost and lime followed by the treatment T_{11} (Lime + Vermicompost @ 5 t ha^{-1} + RDF [75 per cent]) where as lowest sugar content was observed in control (Table 3). The increased nutrient contents of soil due to application of biofertilizer and vermicompost along with lime enhanced the carbon nitrogen ratio in the soil which might have increased the sugar content in the fruits. The result is in conformity with the observations of Ansary *et al*. (2004) in pumpkin and Kameswari *et al*. (2011) in ridge gourd.

Integrated nutrient management practices with organics and biofertilizers exhibited noticeable influence in the economics of pointed gourd cultivation comprising cost of cultivation, gross income, net income and B: C ratio during both the years of experimentation (2012-13 and 2013-14). Maximum involvement of cost was marked when 100 per cent recommended dose of inorganic fertilizers along with vermicompost and biofertilizers were applied in limed plot (₹85961.00) and the lowest was in control (₹71045.00) receiving neither chemical fertilizer nor organics (Table 4).

Combined use of 100 per cent NPK with vermicompost as organic source with biofertilizers in limed plot recorded the highest gross return of (₹327310/-) whereas, the lowest gross return (₹170400/-) was obtained where no nutrient were applied (Table 4). The higher gross return is mainly due to higher total fruit yield. The highest net return of ₹241349/- (mean of two years) was calculated by applying 100 per cent NPK with vermicompost and biofertilizers in presence of lime as compared to other treatments tried in the experiments. However, the lowest net return for both the years 2012-13 and 2013-14 was calculated to be ₹99355/- (mean of two years in control). This might be due to application of chemical fertilizer alone and it can be implied that application of 100 per cent RDF with inoculation of bio-fertilizers and vermicompost recorded significantly higher yield, which resulted in higher economic return. Highest B: C ratio (2.80) averaged over two years was observed with integrated use of inorganic fertilizers (100 per cent RDF) with biofertilizers and vermicompost as organic source and limed whereas the lowest B: C ratio of 1.39 (mean of two years) was observed where no nutrient was applied (control) during both the years. The increase in B: C ratio and other crop growth parameters might be due to increase in yield which fetched more prices in the market. Similar results were also reported by Alom *et al*. (2013), Ram *et al*. (2013) and Saravaiya *et al*. (2012) in pointed gourd.

Table 4: Economics of different treatments on pointed gourd cultivation (pooled)

Treatments	Total expenditure (Rs. ha^{-1})*	Gross income (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit –cost ratio
T_1- Control (only FYM)	71045.00	170400.00	99355.00	1.39
T_2- LIME as PMS @ 5 t ha^{-1}	73545.00	227710.00	154165.00	2.09
T_3- Biofertilizers (*Azotobacter* sp. + *Azospirillum* sp. + *Bacillus* sp.)	71205.00	185870.00	114665.00	1.60
T_4- Vermicompost @ 5 t ha^{-1}	81045.00	217530.00	136485.00	1.68
T_5- Recommended Dose of Fertilizer (75%)	72737.00	247360.00	174623.00	2.39
T_6- Lime + Biofertilizer	73705.00	243980.00	170275.00	2.30
T_7- Lime + Vermicompost @ 2.5 t ha^{-1}	73545.00	246230.00	172685.00	2.34
T_8- Lime + RDF (75%)	75237.00	275070.00	199833.00	2.65
T_9- Lime + Biofertilizer + Vermicompost @ 2.5 t ha^{-1}	73705.00	267120.00	193415.00	2.62
T_{10}- Lime + Biofertilizer + RDF (75%)	75397.00	280340.00	203843.00	2.71
T_{11}- Lime + Vermicompost @ 5 t ha^{-1} + RDF (75%)	85397.00	319770.00	234373.00	2.74
T_{12}- Lime + Biofertilizer + Vermicompost @ 5 t ha^{-1} + RDF (100%)	85961.00	327310.00	241349.00	2.80

Integrated nutrient management treatments rendered their significant effect on the vegetative growth characters as well as yield attributing characters and fruit quality parameters of pointed gourd cv. Swarna Alaukik. Treatment receiving combined application of lime, biofertilizer, vermicompost (5 t ha^{-1}) and 100 per cent recommended dose recorded maximum performances with respect to the vegetative growth characters (vine length, vine girth and number of branches per plant) as well as yield attributes (length of fruit, girth of fruit, single fruit weight, fruit yield) and fruit quality (moisture content of fruit, total soluble solid, ascorbic acid, total sugar). Control treatment where no nutrient was applied from external source was the lowest performer with regard to all the above characters. Investigations carried out for two years on the integrated use of fertilizers for pointed gourd revealed that the cultivar "Swarna Alaukik" could be profitably grown under Bhubaneswar agro-climatic condition with 100 per cent of recommended dose of NPK *i.e.,* 90:60:60 kg ha^{-1} NPK along with vermicompost and biofertilizers.

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