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Effect of Integrated Nutrient Management on Yield, Quality Improvement And Nutrient Uptake of Chilli

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ABSTRACT: *A field experiment was conducted at experimental farm at Department Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during kharif season using chilli crop with variety Pusa Jwala. The experiment was laid out in randomized block design with seven treatments T_1 : NPK (80:40:50 kg ha^{-1}) through chemical fertilizer, T_2 : 50 per cent RDF + 2.5 t ha^{-1} vemicompost, T_3 : 50 per cent RDF + 2.5 t ha^{-1} vermicompost + 2 sprays of Vermiwash (1:2 treatment), T_4 : 2.5 t ha^{-1} vermicompost + 2 sprays of cow urine + seeding treatment with Azotobacter + PSB application (1:2), T_5: 5 t ha^{-1} vermicompost + 2 sprays of Vermiwash (1:2 treatment), T_6 : 5 t ha^{-1} vermicompost + 1 sprays of Vermiwash (1:2 treatment) + 1 spray of cow urine + organic booster i.e. fermented slurry, T_7 : 5 t ha^{-1} vermicompost + 2 sprays of EM culture. The recommended dose of fertilizer applied was 80:40:50 kg NPK ha^{-1}. Azotobacter and PSB were applied @ 250 g 10 kg ha^{-1} seed with 100 and 50 per cent RDF, significantly highest total chilli yield (86.85 q ha^{-1}) was recorded in treatment T_3, where 50 per cent RDF + 2.5 t ha^{-1} vermicompost + 2 sprays of Vermiwash was applied, followed by treatment T_6 (81.43 q ha^{-1}) -where 5 t ha^{-1} vermicompost + 1 sprays of Vermiwash + 1 spray of cow urine + organic booster (fermented slurry) was applied followed by treatment T_2 (74.68). The quality parameters like ascorbic acid content, physiological weight loss and rotting percentage in chilli were significantly highest in treatment T_3. However, integrated plant nutrient management system (IPNS) in chilli crop help to increase the crop yield significantly and also improve the quality of chilli crop. The organics in combination with inorganic fertilizer influenced the nitrogen, phosphorus and potassium uptake by chilli. Integrated plant nutrient management system (IPNS) in chilli crop helped to increase the crop yield significantly and also improved the availability of nutrients, physical properties of soil including support to biological life.*

Keywords: *Nutrient uptake, organic nutrition, yield, chilli, vermicompost, vermiwash, cowdung urine slurry, EM culture.*

INTRODUCTION

Chilli (*Capsicum annuum* L.) is one of the important vegetable and commercial spice crop grown throughout tropical and temperate regions of the world. At present, India is the second world's largest producer of chilli, which contributes about one fourth of the world's production. Chilli occupies 102.9 thousand hectares of area in Maharashtra and produces 48.1 thousand tonnes chilli per annum (Anonymous, 2005). Production of chilli in India is dominated by Andhra Pradesh, which accounts for almost 49 per cent of the total production while Karnataka, the second largest producer contributes 11 per cent followed by Orissa (7 per cent), Maharashtra (6 per cent), Madhya Pradesh (4 per cent), Tamil Nadu, Uttar Pradesh and others account for the rest. Nasik, Ahmednagar, Solapur, Aurangabad, Nanded and Amravati are major chilli producing districts of Maharashtra (Peter, 1999). Productivity of chilli in State including Marathwada is below the national average. The production of chilli can be significantly raised by developing high yielding varieties and adopting good management practices which include use of manures and fertilizers to meet the nutrient requirement of crop at various growth stages. The soils are exploited by using high yielding fertilizer responsive hybrids, super seed material and indiscriminate use of chemical input like fertilizers and pesticides.

Organic agriculture is an ecological production management system that promote and enhances biodiversity, biological cycles and soil biological activity. Organic farming is a system that excludes the use of synthetic fertilizers, pesticides and growth

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regulators. It is based on minimal use of off-farm inputs and management practices that restore, maintain and enhance ecological harmony. Organic is a lebelling term which denotes products produced under the requirements of the organic food production act. Vegetable responds to addition of nutrients through neem cakes, FYM, green manuring and chemical fertilizers (Sharma and Rana, 1993). Particularly chilli needs heavy manuring for sound plant growth and high yield. The use of judicious combination of organic and inorganic fertilizers source is essential not only to maintain the soil health but also sustain productivity (Malewar *et al.*, 1998). Application of organic sources in chilli crop enhanced plant growth and production. Similarly, fruit quality was improved and pest incidence was also reduced. The replacement of inorganic fertilizers by organic manures like vermicompost is found to be promising in alone or in combination with inorganic sources. This practice enables to curtail the expenditure on inorganic fertilizers and chemical pesticides. Thus, there is a wide scope to use organic manures in vegetable farming and the benefits in respect of healthy produce, human and soil health. Organic chilli cultivation offers one of the most sustainable farming system with recurring benefits to not only long term soil health but provides lasting stability in production by imparting better resistance to various biotic and abiotic stresses.

The importance of organic manure in vegetable cultivation is a well established fact. But the availability of the cattle manure, the major source of organic manure is very much limited. Under this situation the nutrient rich vermicompost produced by the activity of earthworms on biowastes and in situ application of worms in the field along with biowastes can be tried as an alternate source of organic manure and a partial substitute for costly inorganic fertilizers. Use of organic sources of nutrient is a alternative to produce chilli, with least toxic effect besides the advantage of restoring soil health. The recycling of waste through earthworm increases the quality and contents of nutrient resulting in improvement of soil fertility, organic matter content, physical and biological properties of soil.

Thus, the experiment was planned to study the relative efficiency of vermicompost along with other organics on yield and quality of chilli.

MATERIALS AND METHOD

A field experiment was conducted at Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during Kharif season using chilli as test crop on "Effect of integrated nutrient management on yield, quality improvement and nutrient uptake of chilli". Parbhani is situated at 19° 16′ North Latitude and 70° 47′ East Latitude at an altitude of 409 meters (MSL). This area falls under assured rainfall zone. The annual average precipitation is 830 mm. Most of the rain received during June to September from South West monsoon. A field experiment was conducted with seven treatments replicated three times. Details of treatments are T_1-NPK (80:40:50 kg/ha) through chemical fertilizers, T_2-50% RDF + 2.5 t/ha vermicompst, T_3-50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash, T_4-2.5 t/ha vermicompost + 2 sprays of cow urine + seedling treatment of Azotobacter + PSB soil application, T_5-5 t /ha vermicompost + 2 sprays of vermiwash, T_6-5 t/ha vermicompost + 1 sprays of vermiwash + 1 spray of cow urine + CDUS (fermented slurry), T_7-5 t / ha vermicompost + 2 sprays of EM culture. Chilli cultivar Pusa Jwala was used. Recommended dose of inorganic fertilizer viz., N, P, K (80:40:50 kg/ha) were applied through urea, SSP and Muriate of potash containing 46% N, 16% P_2O_5 and 60% K_2O respectively. Vermicompost was used @ 5 t/ha (0.92% N, 0.60% P and 0.83% K) and other organics like vermiwash was used @ 1 lit/m^2, cow urine @ 1 lit/m^2, cow dung urine slurry @ 1 lit/m^2, (0.38% N, 0.42% P and 5.1% K) and E.M. culture @ 1 lit/m^2 were used during application of various treatments. Seedling treatment of Azotobacter and PSB as per treatments were given at the time of transplanting as per the recommended procedure. Nitrogen was applied in two splits i.e. 50% N at the time of transplanting and remaining 50% N was applied at 30 days after transplanting of crop. Recommended dose of P and K were applied at the time of transplanting of crop. Recommended dose of P and K were applied at the time of transplanting as a basal dose. Vermicompost was applied one week after transplanting. Cow dung urine slurry was applied 15 days after transplanting. Cow dung urine slurry was applied 15 days after transplanting. One spray of vermiwash, cow urine and E M culture was given at the time of flowering and second spray of vermiwash, cow urine and EM culture was given at the time of fruit formation. Soil

samples were collected before transplanting of chilli crop and after harvested of chilli crop. These samples were air dried, ground with pestle and morter and passed through 2 mm sieve for general analysis. The plant samples of chilli crop from each plot were collected at harvesting stage. The samples were washed with tap water dried under shade followed by oven drying at 105°C for 15 minutes. These samples were ground with electrically operated grinder. The ground plant samples were stored in ordinary paper bags and used for further analysis. The total green mature fruit yield (g/plant) were harvested from five observational plants in each plot at each picking. The mean number of fruits harvested per plant was determined. Accordingly total green chilli yield (q/ha) was calculated with sum of three pickings. Dry matter of chilli in g per plant at harvest was recorded. The statistical analysis of data collected was done by standard procedure described by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

An experiment was conducted to "effect of integrated nutrient management on yield, quality improvement and nutrient uptake of chilli" during the kharif season at Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Soil samples were analysed before and after harvest of the crop for chemical and biological properties. Similarly, biometric observations were recorded at various stages of the crop. The yield was recorded plotwise and expressed on hectare basis. The results of the experiment are subjected for statistical analysis and are presented under following heads.

Effect of organic sources of nutrients on yield of green chilli (q/ha) and dry matter yield (q/ha)

The total fruit yield per plant was converted into total green pod yield per hectare and also dry matter yield after harvest of third picking was observed. The relevant data was statistically analyzed and-presented in Table 1. The green chilli yield and dry matter yield of chilli were ranged from 51.83 to 86.85 q/ha and 11.99 to 16.86 q/ha with the mean value of 70.27 q/ha and 14.44 q/ha respectively. This data clearly brought out the fact that the treatment T_3 proved to be significantly superior over the rest of the treatments in green chilli and dry matter yield followed by the treatment T_6 consisting of application of 5 t/ha vermicompost + 1 spray of vermiwash + 1 spray of cow urine + use of organic booster which could be the next second highest.

Use of vermicompost alongwith organic booster with a fermented mixture of cow dung urine slurry (CDUS) is better for enhancing the yield of chilli crop considerably. Sharma and Bhalla (1995) also reported the higher yield of vegetable. Santhakumar (1993) also reported application of biogas digested slurry in combination with chemical fertilizer to crop okra.

Table 1
Effect of organic sources of nutrients on yield of chilli (q/ha) and dry matter yield (q/ha)

Treatment	*Yield of green chilli (sum of 3 picking) (q/ha)*	*Dry matter yield (q/ha)*
T_1	61.74	13.40
T_2	74.68	14.05
T_3	86.85	16.86
T_4	51.83	11.99
T_5	69.67	14.81
T_6	81.43	15.63
T_7	65.69	14.39
Mean	70.27	14.44
SE +	0.52	0.27
CD at 5%	1.62	0.85

The beneficial effect of application of organics on physical, chemical and biological properties influencing soil structure favourably for root growth which ultimately influence better plant growth and dry matter accumulation. The results revealed that vermicompost when applied combinely with some supplement may be through chemical fertilizers or through organics always fulfil the nutrient requirement of crop like chilli. Manna and Hajara (1996) also studied the comparative performance of cow dung urine slurry and inorganic fertilizer on maize and reported that the dry matter yield obtained due to application of slurry along with inorganic fertilizer was more.

Effect of organic sources of nutrients on pH, electrical conductivity and calcium carbonate

The data presented in Table 2 indicated that pH of soil decreased considerably with application of vermicompost and other organic sources. After harvesting of chilli soil pH was found to at 7.48 in treatment T_1, while it was reduced to 7.10 in T_4. There was significant decline in pH with the use of vermicompost in combination with other organics over control (recommended dose of NPK).

The use of vermicompost and other organics like cow dung urine slurry, are preferred in agriculture as input for improvement of physico-chemical properties of soil besides as a source of plant nutrients. The attempts were made during the present investigation to record the changes in chemical properties of soil. The data presented in Table 2 indicated that the pH of soil was decreased due to application of organic sources. The pH was reduced from 8.26 to 7.10. Similar results were obtained by Saravanan and Baskar (1996). Vermicompost treated plots were also decreased pH of the soil maintained nearer to neutrality because of earthworm activity as reported by Springett (1983).

However, in case of EC non-significant results were obtained. Electrical conductivity was reduced from 0.31 to 0.26 dsm^{-1} from initial to harvest. Basak *et. al.* (1990) observed that application of vermicompost decreased EC value in presence of earthworms.

Table 2
Effect of organic sources of nutrient on pH, EC and content of soil

Treatment	*pH*	*EC (dsm^{-1})*	*$CaCO_3$ (%)*
T_1	7.48	0.29	6.20
T_2	7.17	0.28	6.66
T_3	7.37	0.27	6.50
T_4	7.10	0.27	6.36
T_5	7.37	0.27	6.13
T_6	7.37	0.26	6.46
T_7	7.34	0.26	6.16
Mean	7.31	0.27	6.35
SE ±	0.01	0.0078	0.06
CD at 5%	0.05	NS	0.20
Initial value	8.26	0.31	6.0

The $CaCO_3$ content of the experimental soil was recorded from 6.13 to 6.66 per cent with a mean value of 6.35. After the harvest of chilli crop the significant changes in the $CaCO_3$ content was estimated from 6.13 to 6.66 per cent. The significant increase in the $CaCO_3$ was observed when vermicompost was used along with other organics.

The $CaCO_3$ status of soil was increased due to application of vermicompost after harvest of chilli over the initial values of calcium content of soil. The increase in the calcium carbonate due to application of vermicompost, might be due to presence of calciferous glands in earthworm. Wiecek and Messenger (1972) stated that it was function of calcite spheroids in caliciferous glands.

Effect of organic sources of nutrients on organic carbon content (%) in soil after harvest

The organic carbon content in soil was significantly increased when vermicompost was applied in combination with chemical fertilizer, cow-dung urine slurry and other organic (Table 3). After harvest of chilli crop organic carbon content was increased from 0.37 to 0.63 per cent.

Table 3
Effect of organic sources of nutrients on organic carbon content (%) in soil

Treatment	*At flowering*	*After harvest*
T_1	0.57	0.63
T_2	0.45	0.47
T_3	0.46	0.54
T_4	0.49	0.57
T_5	0.55	0.58
T_6	0.55	0.58
T_7	0.62	0.37
Mean	0.52	0.53
SE±	0.009	0.01
CD at 5%	0.02	0.03
Initial value : 0.32		

The organic carbon content was influenced by vermicompost along with other organic sources and inorganic fertilizers. All the treatments showed increase in organic carbon content after harvest of chilli. The differential effect of various organic sources on carbon content was obvious because of varied nature of organic material incorporated in soil. The enhancement of organic carbon status of soil was more or less dependent on the type of organic material. The earthworms excret cast which is having higher carbon content. These results are in conformity with those of Biswas *et al.* (1971) and Manna and Hajara (1996). Saravanan and Baskar (1996) who also observed similar increase in organic carbon during experimentation. This increase could be attributed to better plant growth including root biomass under treatments of organic and chemical combinations.

Effect of organic sources of nutrients on the uptake of nutrient by chilli (on dry matter basis)

The data presented in Table 4 indicated that use of organic sources along with chemical fertilizers influenced the concentration and uptake of nitrogen, phosphorus and potassium.

Nitrogen uptake

The concentration and uptake of nitrogen ranged from 1.61 to 2.49 per cent and 19.30 to 41.98 kg/ha with the mean value of 1.93% and 28.26 kg/ha

respectively, at harvest of the chilli (Pusa Jwala). The highest concentration and uptake was recorded in the treatment T_3 (50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash) which was significantly more over other treatments. The treatment T_6 receiving vermicompost + 1 spray of vermiwash + 1 spray of cow-urine + organic booster (cow dung urine slurry) was also increased the concentration and uptake of nitrogen.

Phosphorus uptake

The concentration and uptake of phosphorus was ranged from 0.12 to 0.23 per cent and 1.43 to 3.87 kg/ha with the mean value of 0.17% and 2.54 kg/ha respectively. The treatment T_3 (application of 50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash) has enhanced the phosphorus uptake significantly and which was at par to the treatment T_6 (vermicompost @ 5 t/ha + 1 spray of vermiwash + 1 spray of cow urine + cow dung urine slurry). Comparatively less uptake was observed in the treatment T_4 (2.5 t/ha vermicompost + 2 sprays of cow urine + seedling treatment of *Azotobactor* + PSB soil application) which was at par to the treatment T_1 (recommended dose of NPK). In general, the performance of vermicompost in combination with other organic sources and inorganic fertilizer enhanced the uptake of phosphorus by chilli.

Table 4
Effect of organic sources of nutrients on concentration and uptake of nitrogen, phosphorus and potassium after harvest of chilli

Treatment	*Nitrogen*		*Phosphorus*		*Potassium*	
	Cone. (%)	*Uptake (kg/ha)*	*Cone. (%)*	*Uptake (kg/ha)*	*Cone. (%)*	*Uptake (kg/ha)*
T_1	1.77	23.71	0.13	1.74	1.66	22.24
T_2	1.92	26.97	0.19	2.66	1.72	24.16
T_3	2.49	41.98	0.23	3.87	1.91	32.20
T_4	1.61	19.30	0.12	1.43	1.52	18.22
T_5	1.88	27.84	0.17	2.51	1.71	25.32
T_6	2.02	31.57	0.21	3.28	1.78	27.82
T_7	1.84	26.47	0.16	2.30	1.69	24.31
Mean	1.93	28.26	0.17	2.54	1.71	24.89
SE +	0.006	0.62	0.002	0.26	0.002	0.44
CD at 5%	0.01	1.91	0.008	0.82	0.007	1.37

Potassium Uptake

The concentration and uptake of potassium ranged from 1.52 to 1.91 per cent and 18.22 to 32.20 kg/ha with the mean value of 1.71% and 24.89 kg/ha respectively. The highest uptake of potassium was recorded in the treatment T_3 (50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash). Comparatively less uptake was observed in the treatment T_4 (vermicompost @ 2.5 t/ha + 2 sprays of cow urine + seedling treatment of *Azotobactor* + PSB soil application followed by treatment T_1 (RDF).

Uptake of nitrogen, phosphorus and potassium by chilli as influenced by application of different sources of nutrients *viz.* chemical, organic and biological alone and in combination revealed that organic sources in combination with chemical sources has resulted into better uptake of nitrogen over their application through individual sources. This could be attributed to the fact that there is synergistic effect of different sources in making the nutrients available and also the prevention of losses of applied chemical nitrogen through leaching and volatilization. Besides this priming effect of applied chemical sources of nitrogen on enhancing the rate of decomposition of native and applied organic sources and thereby making more nitrogen availability is a common phenomenon. Similar effect of inorganic fertilizer and FYM was noticed by Nair and Peter (1990). Manna and Hajara (1996) also observed uptake of nitrogen increased due to application of cow dung urine slurry. Phosphorus uptake was also increased with the application of vermicompost in combination with other organics and inorganic fertilizer. This may be attributed to more solubilization of native phosphorus from the soil due to action of various microorganisms and enzymes liberated during the process of decomposition of vermicompost. Further, vermicompost, cow dung urine slurry application may also enhance better biological yields which definitely reflects on their content and uptake. The beneficial effects of organics on improving soil physical properties in terms of better penetration of the roots, better aeration, moisture availability might have resulted into more uptake from native as well as applied source of plant nutrient. Increased uptake of N, P and K by chilli with the addition of organics also recorded by Nair and Peter (1990) and Manna and Hajra (1996). Kale *et al*. (1992) also observed more uptake of nitrogen and phosphorus due to application of vermicompost + 505 recommended dose of NPK.

CONCLUSIONS

The screening of various organic and inorganic combination and their individual effects on yield and yield attributes, quality of produce, availability of nutrients, effect on physical and biological properties

revealed that combined effect of organics with other organic sources and inorganic fertilizers proved to be better. Among the various combinations overall performance of treatment T_3 (50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash) was superior and followed by treatment T_6 receiving 5 t/ha vermicompost + 1 spray of vermiwash + 1 spray of cow urine + organic booster (cow dung urine slurry).

Integrated plant nutrient management system (IPNS) in chilli crop helped to increase the crop yield significantly and also improved the availability of nutrients, physical properties of soil including support to biological life.

The treatment T_6 in which application of 5 t/ha vermicompost + 1 spray of vermiwash + 1 spray of cow urine + use of fermented cow dung urine slurry could proved to be the next best option for chilli crop.

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