Oryza Vol. 48. No. 4, 2011 (343-346)

# Effect of organic farming on productivity, soil fertility and economics of scented rice-tomato–bottle gourd cropping system.

**S. K. Singh**

*ICAR Research Complex For Eastern Region, ICAR- Parisar, PO-Bihar Veterinary College, Patna - 800014 (Bihar)*

## ABSTRACT

*Field experiments were conducted during 2006-2009 to study the effect of various organic sources (computed on 150 kg ha$^{-1}$ N-equivalent basis) forming seven treatments, viz. Azotobacter + FYM, FYM, Goat manure, Vermicompost, Azolla + FYM and cow urine along with no application (control) in rice(cv Sugandha) and their residual effect on productivity of tomato (Swarna Lalima) and bottle gourd(Arka Bahar) crops, soil fertility and economics of the cropping system. The highest rice grain yield of 2.68 t ha$^{-1}$ was recorded with Azolla + FYM which was at par with vermicompost (2.55 t ha$^{-1}$), Azotobacter + FYM (2.41 t ha$^{-1}$) and FYM (2.37 t ha$^{-1}$). Among different organic sources the rice grain yield was significantly lower under goat manure and cow urine. However, vermicompost recorded significantly highest yield of tomato as well as bottle gourd which was at par with Azotobacter + FYM and FYM treatment. Maximum net return of Rs. 3, 11, 958 ha$^{-1}$ with 3.59 benefit: cost ratio was obtained by vermicompost. It was followed by net return of Rs.2, 98, 628/- and B: C ratio of 3.42 by Azotobacter + FYM and net return of Rs.2, 77298/- and B: C ratio of 3.25 by FYM alone treatment. The continuous application of all the organic sources to rice for three years significantly improved the soil-organic carbon, available N, P and K status at the end of the cropping system.*

***Key words :*** *rice based cropping system, organic farming, manures, soil fertility*

In the anxiety of increasing food production to meet the needs of ever-increasing population of the country, there had been excessive use of agrochemicals for the last 50 years, and least attention was given to ecological agriculture. Consequently danger signals have started coming sooner than expected. Many of our highly productive soil have started showing signs of declining productivity. Dawe *et al.* (2003) have reported that deterioration in soil health and crop productivity is associated with decline in soil – organic carbon under such farming systems. It is necessary to device nutrient management – practice that help improve or maintain the organic carbon content of the soil. Enough organic sources like Cow dung, Cow urine, Goat manure, Crop residues, Vermicompost, Biofertilizer etc. are available with us. Thus, organic farming has a good potential under Indian context and this approach will conserve natural resources also. One half of the nitrogen and one-fifth of phosphorus may be recovered from organic manures in first season of application (Brady, 1996). One of the important aspects is organic farming is the soil fertility/ nutrient management of crops/cropping system to optimize crop productivity. Information regarding the influence of various organic manures on the crop productivity & soil fertility is very important to the farmers engaged in organic farming. There is very little research work on total use of organic sources and that too is limited to horticultural and vegetable crops. No attempt has been made to assess the sustainability of rice-tomato-bottle gourd cropping system under organic sources of nutrients. Hence, the present study was conducted to compare the performance of different organic sources on the productivity and nutrient availability in rice-tomato-bottle gourd cropping system under organic farming in subtropical conditions.

## MATERIALS AND METHODS

Field experiments were conducted for three years (2006-2009) at ICAR- Research Complex for Eastern Region, Patna with rice-tomato-bottle gourd cropping system during rainy, winter and summer seasons. The experimental soil was silty clay loam with pH 6.2, low

in organic carbon (0.35 %), low in N (240 kg ha$^{-1}$), high in P (26.10 kg ha$^{-1}$) and medium in K (160 kg ha$^{-1}$). Various organic sources (computed on 150 kg ha$^{-1}$ N-equivalent basis) forming seven treatments, viz., Azotobacter + FYM, FYM, Goat manure, Vermicompost, Azolla + FYM and Cow urine along with control were imposed to rice during rainy season and their residual effect was studied on subsequent crops of tomato and bottle gourd during winter and summer seasons under randomized complete block with three replications. The N content in FYM, goat manure, Vermicompost, *Azolla* and cow urine was 0.5, 0.7, 1.5, 3.5 and 1.0 %, respectively. Organic manures were incorporated at the time of final land preparation, whereas bio-fertilizers were applied at the time of planting. *Azotobacter* was applied @ 1.0 kgha$^{-1}$. Under the treatment of Azolla + FYM, Azolla was applied @ 55.5 kg N ha$^{-1}$ along with FYM @ 94.5 kg N ha$^{-1}$ (altogether @ 150 kg N ha$^{-1}$ on N-equivalent basis). The row to row and plant to plant distance in rice, tomato and bottle gourd were 20 X 15, 60 X 45 and 200 X 200 cm respectively. The varieties used for scented rice, tomato and bottle gourd were 'Sugandha', 'Swarna Lalima' and 'Arka Bahar', respectively. Chemical properties of the soil were taken before planting and harvest of each crop with standard laboratory procedures. Data was analyzed following analysis of variance technique and then pooled over the years for rainy, winter and summer crops separately.

## RESULTS AND DISCUSSION

All the organic sources significantly increased the yield over those of control for all crops (Table1). Under absolute control rice recorded drastic decline in grain yield over the years. The highest rice grain yield of 2.68 t ha$^{-1}$ was recorded with Azolla + FYM which was at par with vermicompost (2.55 t ha$^{-1}$), Azotobacter + FYM (2.41 t ha$^{-1}$) and FYM (2.37 t ha$^{-1}$). Positive effect of use of Azolla + FYM has also been reported by Singh & Dhar (2011) in rice-wheat-greengram cropping sequence. Das *et al.* ((2001) also reported that biofertilizers have added advantage in rice and wheat production. Among different organic sources the rice grain yield was significantly lower under goat manure and cow urine. This was attributed to early release of mineral nitrogen by these two sources which contained narrow C: N ratios >10 (6:1 and 3:1 respectively). However, vermicompost recorded significantly highest yield of tomato as well as bottle gourd which was at par with Azotobacter + FYM and FYM treatment. Thus, these sources favourably influenced plant growth and development characters which ultimately resulted in higher yields. While, Meena *et al.* (2010) from their study of two years on FYM, vermicompost and poultry manure in Varanasi, found highest rice equivalent yield by Poultry manure which was followed by vermicompost and FYM from rice-table pea-onion sequence with the application of 150 % recommended nitrogen dose. This may be attributed

**Table 1.** Direct effect of organic sources on the productivity of rice and their residual effect on the productivity of tomato and bottle gourd, rice equivalent yield (REY) and economics of rice-tomato-bottle gourd cropping system (pooled data over 3 years).

| Treatments | Yields (t ha$^{-1}$) | | | | Net Returns (Rs ha$^{-1}$) | Cost of cultivation (Rs ha$^{-1}$) | Benefit : cost ratio |
|---|---|---|---|---|---|---|---|
| | Rice grain | Tomato fruits | Bottle gourd fruits | Rice equivalent | | | |
| Control | 1.20 | 11.61 | 7.72 | 14.08 | 68438 | 100522 | 1.68 |
| Azotobacter + FYM | 2.41 | 26.45 | 22.66 | 35.15 | 298628 | 123172 | 3.42 |
| FYM | 2.37 | 26.16 | 20.33 | 33.36 | 277298 | 123022 | 3.25 |
| Goat manure | 2.23 | 24.21 | 18.97 | 31.01 | 256598 | 115522 | 3.22 |
| Vermicompost | 2.55 | 29.16 | 24.83 | 38.54 | 311958 | 120418 | 3.59 |
| Azoll + FYM | 2.68 | 22.94 | 17.73 | 29.79 | 241990 | 115490 | 3.09 |
| Cow urine | 2.27 | 23.49 | 18.69 | 30.39 | 241658 | 123022 | 2.96 |
| CD (0.05) | 0.23 | 2.26 | 1.90 | | | | |

Charges of input used (Rs Kg$^{-1}$): FYM 0.75, Azotobacter 150, Goat manure 0.70, Vermi compost 4.00, Azolla 0.50 and Cow urine @ 1.5 litre$^{-1}$.
Selling price (Rs Kg$^{-1}$) of organic produce: rice grain 12.00, tomato 8.00 and bottle gourd 8.00.

to the higher enzyme activity of soil in terms of dehydrogenase and phoshatase with the application of organic manures, especially with poultry manure treatment. Enzymes play key role in the transformation, recycling and availability of plant nutrients in soil and they are likely to be influenced by manures (Singaram and Kamalakumari, 1995). Sharma *et al.* (2009) also noticed higher efficacy of vermicompost over FYM in okra-onion sequence. Significant improvement in crop yield due to residual soil fertility under organic sources has also been observed by Kharub and Chander (2008) and Ramesh *et al*. (2008). Azolla + FYM recorded the lowest fruit yield among all the sources. This was due to early release of mineral nitrogen by the Azolla having narrow C: N ratio (10:1). About less than 30% of N and small fraction of P and K in organic manures may become available to immediate crop and rest to subsequent crops (Sharma and Vyas, 2001).

The continuous application of all the organic sources for three years significantly improved soil organic carbon (O.C.) content compared to control (Table 2). Among the organic sources, vermicompost recorded highest soil O.C. The maximum O.C. buildup was accrued (0.60%) in case of vermicompost which was closely followed by Azotobacter + FYM (0.59 %) and FYM (0.58 %), while least value (0.40 %) was noticed with no application (control). The increase of O.C. content may be attributed to addition of organic materials and better root growth. These observations are in agreement with the findings of Sharma *et al.* (2005). The difference in the O.C. content with the application of different source of nutrients might be due to the result of differential rate of oxidation of organic matter by microbes (Trehan, 1997). Increased O.C. of soil due to application of manure was also reported by Babhulkar *et al.* (2000)**.** Higher availability of nutrient was mainly due to slow mineralization of organic matter with gradual release of nutrients in soil and solublization of the nutrients from native source during the process of decomposition. Soil available N, P and K were increased with the application of all the organic sources as compared to control. Vermicompost maintained highest available nitrogen contents (265 kg $ha^{-1}$) at the completion of the experiment (Table 2). This treatment increased available N content by 7.7 % over control. While Azotobacter + FYM and FYM alone increased available N by 6.50 and 5.69 % respectively over control. Increase in available N with organic sources might be attributed to the direct addition of nitrogen through organic sources to the available pool of the soil. Sharma *et al*. (2005) also noticed enhancement in available N content of soil with the use of organics in Entisols of Himachal Pradesh. Different treatments maintained slightly higher available P status than control. Among the organic sources, vermicompost continued to maintain highest available P in the soil which was 19 % higher over control, while Azotobacter + FYM and FYM alone increased available P by 14.03 and 13.67 % respectively over control. Like available N and P, highest available K content (200 kg$ha^{-1}$) was recorded in case of vermicompost. This treatment registered an increase in available K content by 21 % over control, while Azotobacter + FYM and FYM alone increased available K by 18.18 and 13.33 % respectively over control. The beneficial effect of organic sources on available K status may be ascribed to direct K addition in the K pool of the soil. Results clearly indicated improved fertility status of soil due to increased values of available N, P and K in all organic treatments over its initial value as well as control.

**Table 2.** Effect of continuous use of organic sources on soil fertility status after three years of experimentation in rice-tomato-bottle gourd cropping system.

| Treatments | O.C. (%) | Available N (kg $ha^{-1}$) | Available P (kg $ha^{-1}$) | Available K (kg $ha^{-1}$) |
|---|---|---|---|---|
| Control | 0.40 | 246 | 28.15 | 165 |
| Azotobacter + FYM | 0.59 | 262 | 32.10 | 195 |
| FYM | 0.58 | 260 | 32.00 | 187 |
| Goat manure | 0.57 | 258 | 31.50 | 183 |
| Vermicompost | 0.60 | 265 | 33.50 | 200 |
| Azolla + FYM | 0.54 | 253 | 30.20 | 176 |
| Cow urine | 0.56 | 255 | 30.30 | 179 |
| Initial soil fertility | 0.35 | 240 | 26.10 | 160 |

Pooled economic evaluation in terms of monetary returns showed that all the organic sources gave higher net returns and benefit: cost ratio than control (Table 1), indicating that organic nitrogen management is a productive and remunerative practice while no application of manure (control) was found least economical. The highest rice equivalent yield (REY) was recorded by vermicompost which was followed

by Azotobacter + FYM, FYM, goat manure, cow urine and Azolla + FYM. This is due to greater and balanced availability of nutrients besides improvement in soil health.(Table 2). Maximum net return of Rs. 3, 11, 958 $ha^{-1}$ with 3.59 benefit: cost ratio was obtained when rice crops was manured with 150% recommended N dose through vermicompost. It was followed by Rs.2, 98,628 and 3.42 B: C ratio by Azotobacter + FYM and Rs. 2, 77, 298 and 3.25 B: C ratio by FYM alone treatment.

On the basis of these findings, it can be concluded that to achieve maximum productivity, vermicompost when applied @ 150 kg N $ha^{-1}$ to rice crop, could meet the nutrient requirement of scented rice–tomato–bottle-gourd cropping system to yield >2.5 > 29 and > 24 t $ha^{-1}$ of scented rice, tomato and bottle-gourd respectively, besides enhancing soil fertility under organic farming.

## REFERENCES

Babhulkar PS, Wandile RM, Badole WP and Balpande, SS 2000. Residual effect of long-term application of FYM and fertilizers on soil properties (vertisols) and yield of soybean**.** Journal of Indian Society of Soil Science 48: 89-92.

Brady NC 1996. The Nature and properties of Soil. Prentice Hall of India Pvt. Ltd., New Delhi: 501-502.

Das K, Medhi DN and Guha B 2001. Recycling effect of crop residues with chemical fertilizers on physico-chemical properties of soil and rice yield. Indian Journal of Agronomy 46: 642-653.

Dawe D, Dobbermann A, Ladha JK, Yadav RL, Lin B, Gupta RK, Lal P, Panaullah G, Sariam O, Singh Y, Swarup A and Ahem QK 2003. Do organic amendment improve yield trends in intensive rice systems? Field Crops Research 83: 191-213.

Kharub AS, and Chander S 2008. Effect of organic farming on yield, quality and soil- fertility status under basmati rice (*Oryza sativa*)–Wheat (*Triticum aestivum*) cropping system. Indian Journal of Agronomy 53 (3): 172-177.

Meena RN, Singh SP and Singh K 2010. Effect of organic nitrogen nutrition on yield, quality, nutrient uptake and economics of rice (*Oryza sativa*) - table pea (*Pisum sativum* var. *hortense*)- onion (*Allium cepa*) cropping sequence. Indian Journal of Agricultural Sciences 80 (11): 1003-06.

Ramesh P, Panwar NR, Singh AB and Ramana S 2008. Effect of organic manures on productivity, soil fertility and economics of soybean (*Glycine max*) – durum wheat (*Triticum durum*) cropping system under organic farming in Vertisols. Indian Journal of Agricultural Sciences 78 (12): 1033-37.

Sharma RP, Datt N and Chander G 2009. Effect of vermicompost, Farmyard Manure and Chemical fertilizers on yield, nutrient uptake and soil fertility in Okra (*Abelmoschus esculentus*)-onion (*Allium cepa*) sequence in wet temperate zone of Himachal Pradesh. Journal of Indian Society of Soil Science 57 (3):357-361.

Sharma RP, Sharma Akhilesh and Sharma JK 2005. Productivity, nutrient uptake, soil fertility and economics as affected by chemical fertilizers and farm yard manure in broccoli (*Brassica oleracea* var *italica*) in an Entisol. Indian Journal of Agricultural Sciences 75 (9): 576-579.

Sharma, SC and Vyas, AK 2001. Residual effect of phosphorus fertilization and farmyard manure on productivity of succeeding wheat (*Triticum aestivum*) after soybean (*Glycine max*). Indian journal of Agronomy 46 (3): 416-420.

Singaram, P and Kamalakumari K 1995. Long-term effect of FYM and fertilizers on enzyme dynamics of soil. Journal of Indian Society of Soil Science 43: 378-81.

Singh YV and Dhar DW 2011. Influence of organic farming on soil microbial diversity and grain yield under rice-wheat-green gram cropping sequence. Oryza 48 (1): 40-46.

Trehan SP 1997. A rapid method for the estimation of potential immobilization of N after the addition of cattle slurry to soil. Journal of Indian Society of Soil Science 45:14-9.