EVALUATION OF ORGANIC GROWTH PROMOTERS ON YIELD OF DRYLAND VEGETABLE CROPS IN INDIA

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Abstract
A cost-benefit analysis was made of the effect of three organic growth-promoters on yield and quality of two vegetable crops, brinjal (*Solanum melonogena)* and tomato *(Lycopersicon esculentum*), grown under field conditions. Traditional Ayurvedic growth-promoters, Panchagavya and Amrit Pani, were compared with Bokashi made using Effective Microorganisms (EM) technology. The results indicate higher yield and lower glycoalkaloid content in Bokashi-treated crops, followed by Panchagavya. Panchagavya was the most cost-effective growth-promoter followed by Amrit Pani and then Bokashi. We recommend the use of Panchagavya as an organic growth-promoter for small and marginally profitable vegetable-crop farmers.

Keywords: Bokashi, Panchagavya, Amrit Pani, Solanum melongena, Lycopersicon esculentum, glycoalkaloid levels, yield, cost-benefit analysis, dryland marginal farmers, indigenous organic growth-promoters.

Introduction

Reviews of current trends in organic practices have reported improved yield in crops in rainfed areas of India, especially in drought years (Singh et al., 2001, Ramesh et al., 2005). A decrease in yield in the initial years, with no significant yield difference under drought conditions, has been cited in various studies (Ramesh et al., 2005, Kler et al., 2002) as the effect of a transition to organic status.

An estimated 70% of Indian arable land is rainfed. This increases the usefulness of introducing low cost organic farming techniques as a viable alternative to high cost conventional chemical farming. One of the main questions raised with regard to organic farming practices includes the ability of organic methods to meet the nutrient requirements of the crops while increasing yield at low-cost.

I focused on the effectiveness of three different organic growth-promoters, Panchagavya, Amrit Pani and Bokashi on vegetable-crop production. Of the three, Panchagavya and Amrit Pani are traditional to Indian Ayurvedic systems. Bokashi technology or EM (Effective Microorganisms) technology was first developed in Japan. In Panchagavya, as the name suggests, five products of the dairy-cow are used. These are cow dung, cow urine, buttermilk, milk and clarified butter. Amrit Pani is made using cow-dung, cow-urine, buttermilk, leaves of basil or neem, and honey. Other than a few reports on efficacy and use of these traditional organic promoters (Ram and Pathak, 2007), there has been little scientific documentation of yield and nutrient improvement from the use of these growth promoters on vegetable crops.

Effective Microorganisms (EM) is a mixture of live cultures of microorganisms isolated from fertile soils in nature and useful for crop production. E.M. preparations generally contain *Lactobacillus*, photosynthetic bacteria, yeasts and other beneficial microorganisms (Yamada et al., 2003, Zachariah, 2002). Use of EM products and their efficiency in crop yield has been well documented by pioneering work in Japan by the Effective Micro-organism Research Organization (EMRO). E.M. Bokashi is an organic fertilizer produced by the fermentation of organic materials such as rice bran. It contains both decomposed and undecomposed organic matter, microbial

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biomass, and the intermediate and ultimate substances produced by microbes during fermentation (Yamada et al., 2003). I made my own preparations of Bokashi (Appendix 1), Panchagavya (Appendix 2) and Amrit Pani (Appendix 3).
To test the effectiveness of these different organic growth promoters I used two vegetable crops commonly grown in Hosur, South India, namely tomato (*Lycopersicon esculentum*) and brinjal (*Solanum melongena*). I determined yield comparisons, soil nutrient analysis, and the levels of glycoalkaloids in brinjal. In areas where water is a constraining factor, glycoalkaloid levels increase bitterness in vegetable crops (Bose and Som, 1986). This decreases their market value. If organic growth promoters help to also reduce glycoalkaloid levels this would increase the financial returns to these farmers. The treatments employed a randomized block design and the results were analysed using ANOVA. The main purpose of this study was to evaluate the effect of the growth promoters on two vegetable crops, and to recommend the most cost-beneficial solution for small and marginal farmers practicing organic farming in dry land conditions. Crop yield was a consideration, but identifying cost-effectiveness for marginal farmers was the main driving force behind this experiment.

Materials and Methods

Hosur (12° 43' 0 N 77° 49' 0 E), India is in a predominantly rain-fed agriculture belt lying in the rain shadow zone of the Deccan plateau. Agriculture that is practiced in this area is predominantly subsistence farming by marginal farmers (< than 1 ha holdings). Mean annual rainfall in this region is 850 mm, and the soil varies between red sandy to laterite soil with a pH range 7.0-8.5. Soil is low-medium in nitrogen, low in phosphorus, very low in organic matter and high in potassium.
Two panchayats (village governing bodies in India), Bethalapalli and Asettipalli, in this area were selected. Ten farmers from each panchayat were selected. I selected tomato (*Lycopersicon esculentum*) and brinjal (*Solanum melongena*) as test crops, as farmers have been growing these main crops locally (>80%) under conventional chemical practices. This made a cost-benefit analysis comparison more effective.
The experiment was carried out over two years (2005 and 2006). Planting was done in the Kharif season (June-Oct 2005), with brinjal (var. MH 10) followed by a legume crop in the Rabi season (Nov 2005- Jan 2006). The following Kharif (June-Oct 2006), tomato (cv. “Natti”) was planted. In 2005, brinjal (var. MH-10) seeds sufficient for 0.4 ha were planted in July in nursery beds; and simultaneously the main field was prepared. Composted farmyard manure was applied in late June 2005 at the rate of 20 tonnes ha^{-1}. Thirty-day-old seedlings were transplanted from nursery beds. The following Kharif, seedlings of tomato (cv. Natti) were transplanted.
Six formulations of growth promoters were tested and these were assigned to each of the 20 farmers, using a randomized block design. Initial soil samples of farmers’ fields were analysed for their nutrient status, namely: inorganic nitrogen (57.6 mg kg^{-1}), inorganic phosphorus (11.3 mg kg^{-1}), inorganic potassium (3.6 mg kg^{-1}) and organic carbon (216.5 mg $kg^{-1}$of soil). Soil analyses were carried out on 0.5 kg composite soil samples collected to a core depth of 0.25 m (the plough depth). Five random soil samples were combined, mixed and, after quartering, a 0.5 kg composite sample was taken for analysis. Samples were tested in a private laboratory. Soil organic matter was determined using the Walkley-Black method (Milne and Heimsath, 2008). The procedure involved the chemical oxidation of the carbon in soil organic matter (SOM) and a measure of the amount of oxidizing agent used gave an indirect measure of the amount of organic matter in the soil sample.
The seeds used in both the control and experimental plots were uniformly treated with *Azotobacter* (1×10^6 cfu L^{-1} suspension in water) and dried in shade before use. Control plots were maintained in the same villages using conventional agricultural practices. In the first year (2005), brinjal (*Solanum melongena*) seeds sufficient for 0.4 ha, were planted in July in nursery beds; and simultaneously the main field was prepared. Compost at the rate of 20×10^3 kg ha^{-1} was applied. The formulations of organic growth promoters being tested were added at this stage by mixing them with the compost. The treatments (T1-T6) applied in the randomized block design were:

T1 – Panchagavya (3%, diluted in water)
T2 – Panchagavya (5%, diluted in water)
T3 – Amrit Pani (3%, diluted in water)
T4 – Amrit Pani (5%, diluted in water)
T5 – Bokashi (750 kg ha^{-1})
T6 – Bokashi (1250 kg ha^{-1})
.
Commercially available biofertilizers (supplied by T. Stannes India Private Limited and International Panacea Limited (India).such as Azotobacter ($1x10^6$ cfu L^{-1}), at an application rate of 5 kg ha^{-1}, Azospirillium ($1x10^5$ cfu L^{-1}), at an application rate of 5 kg ha^{-1}, potassium mobiliser ($2x10^6$ cfu L^{-1}), at an application rate of 5 kg $ha^{-1,}$ and phosphate solubiliser ($2x10^6$ cfu L^{-1}), at an application rate of 5 kg ha^{-1}, neem cake (azadirachtin content 1 mg L^{-1}), at an application rate of 450 kg ha^{-1}, and Trichoderma ($2x10^5$ cfu L^{-1}), at an application rate of 5 g L^{-1} were applied equally in all treatments.

Seedlings were transplanted after 45 days on ridges and furrows in the main field at a spacing of 0.75m X 0.60m. At the time of transplanting, the seedlings were treated with a solution of Asafetida (an indigenous product, showing some fungicidal properties in Indian conditions, obtained as a secretion from the plant *Ferula asafetida*), at an application rate of 0.003 Kg L^{-1}. This is a traditional plant product used as a prophylactic measure against damping-off. To prevent wilt disease attack, the soil was once again drenched with a commercial solution of Trichoderma ($2x10^5$ cfu L^{-1}) at an application rate of 0.003 kg L^{-1}. Plant protection using commercially available foliar sprays of neem oil, and nuclear polyhedrosis virus (NPV) was carried as a prophylactic and, if necessary, as curative sprays. Botanicals (Appendix 4) were made using locally available plant materials and used as curative sprays to control sucking insect pests. Irrigation as per normal cultivation practices was carried out. Harvesting of fruits commenced after about three months (90 days) from transplanting. Two pickings per week over a 10-week period were carried out for both brinjal and tomato.

Observations of plant growth, leaf numbers, number of flowers, flower drop, fruit set, and weight of fruit/plant at each picking were carried out. Fruit were graded visually based on colour lustre, and pest attack. They were also tested for glycoalkaloid content. High-performance liquid chromatography (HPLC) was used for glycoalkaloid analysis (Wahaj et al.,1998).The cost of crop production using the different organic plant growth-promoters was compared. The cost-benefit ratio was also computed. The same procedure was adopted for tomato (*Lycopersicon esculentum*) in the following year (2006).

Studies have shown increased yields where the farmer has used organic practices (Singh et al., 2001, Sharma, 2005, Ramesh et al., 2005, Kler et al., 2002). I tested the hypothesis that organic promoters could increase yield and, at the same time, improve the nutrient status of the soil. Cost-benefit analyses of the different promoters were also compared. It has been shown that EM treatment can increase yield and improve pest resistance (Tuat and Trinh, 2002). My objective was to compare the effect of Indian traditional organic growth promoters with that of Bokashi, which uses live-cultures of soil-derived microorganisms. According to reports in the media, traditional Indian growth-promoters have shown yield improvements, but the paucity of scientific literature has made these comparisons less meaningful. My study was carried out to document the effect of organic promoters in comparison with conventional practices. The data collected were subjected to ANOVA, as per randomized block design. An F-test of significance was computed. Descriptive statistics for different parameters of plant growth and yield have also been carried out as a means of comparison. The data collected for vegetative and reproductive growth in plants were based on 30 plant samples that were taken from each treatment field; the average for each treated field was then compared across treatments.

Results and Discussion

Growth-promoter treatments:

1) Brinjal (*Solanum melongena*)

As indicated by the flowering data (Tables 1 and 2)., treatments T1, T2, T5 and T6 gave similar results. There is a significant variance from the control ($\alpha=0.05$), but between treatments it is not significant. Treatment with Bokashi (T5 and T6) gives the largest growth-effect, followed by the treatment with Panchagavya (T1 and T2). Similarly, in terms of fruit yield (Table 3), T5 and T6 treatments gave the largest yield, followed by T2 and T3.

Table 1. Plant growth of brinjal under different organic plant growth promoter treatments

Treatments	Plant height (cm) (Mean±S.E)	No. of branches /plant (Mean±S.E)	No. of leaves/ plant (Mean±S.E)
Control	56.8±0.3	4.6±0.1	49.3±0.1
T1-Panchagavya (3%)	68.8±0.3	6.0±0.0	70.6±0.1
T2-Panchagavya (5%)	67.1±0.2	4.9±0.1	74.8±0.1
T3-Amrit Pani (3%))	60.9±0.2	6.0±0.0	49.7±0.1
T4-Amrit Pani (5%)	61.9±0.2	6.0±0.0	53.9±0.1
T5-Bokashi (750 Kg Ha^{-1})	64.7±0.1	6.0±0.0	97.7±0.1
T6-Bokashi (1250 Kg Ha^{-1})	70.9±0.1	6.0±0.0	114.5±0.1

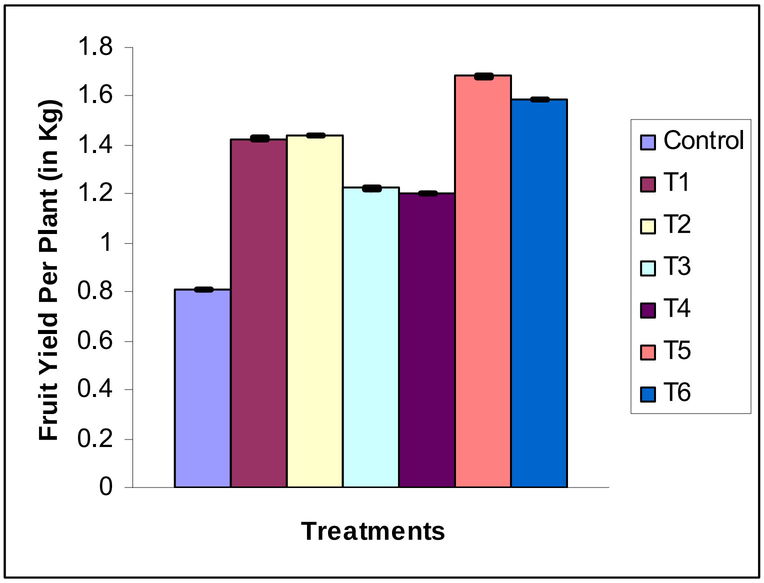
Table 2. Flowering of brinjal under different organic plant growth promoter treatments

Treatments	Days to flowering (Mean±S.E)	Days to 50 percent flowering (Mean±S.E)	No of flowers per plant (Mean±S.E)	Flower drop (Mean±S.E)
Control	34.2±0.2	50.6±0.1	50.2±0.1	27.5±0.1
T1-Panchagavya (3%)	40.5±0.1	54.4±0.1	65.3±0.1	18.3±0.1
T2-Panchagavya (5%)	40.0±0.0	58.0±0.0	62.4±0.1	16.0±0.0
T3-Amrit Pani (3%)	38.5±0.1	53.5±0.1	50.8±0.1	27.2±0.1
T4-Amrit Pani (5%)	38.4±0.1	54.2±0.1	50.7±0.1	24.7±0.1
T5-Bokashi (750 Kg Ha^{-1})	40.7±0.1	60.4±0.1	69.5±0.1	17.4±0.1
T6-Bokashi (1250 Kg Ha^{-1})	39.1±0.1	60.5±0.1	71.9±0.1	15.2±0.1

Table 3. Fruit yield of brinjal under different organic plant growth promoter treatments

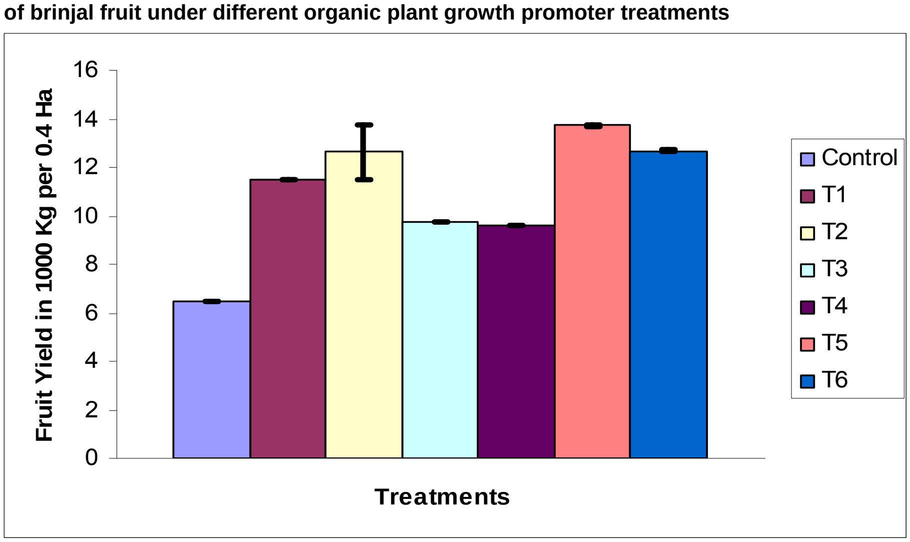
Treatments	No. of fruits /plant (Mean±S.E)	Yield /plant (kg) (Mean±S.E)	Equivalent yield (t ha^{-1})
Control	22.5±0.1	0.8±0.0	14.5
T1-Panchagavya (3%)	37.3±0.1	1.4±0.0	25.8
T2-Panchagavya (5%)	37.0±0.0	1.4±0.0	28.2
T3-Amrit Pani (3%)	23.1±0.1	1.2±0.0	21.7
T4-Amrit Pani (5%)	26.2±0.1	1.2±0.0	21.5
T5-Bokashi (750 Kg Ha^{-1})	52.7±0.1	1.7±0.0	30.7
T6-Bokashi (1250 Kg Ha^{-1})	45.9±0.2	1.6±0.0	28.4

Fig 1. Brinjal fruit per plant (in Kg) under different organic plant growth promoter treatments



Key: T1- Panchagavya (3% in water); T2-Panchagavya (5% in water); T3-Amrit Pani (3% in water); T4-Amrit Pani (5% in water); T5-Bokashi (750 kg ha^{-1}); T6-Bokashi (1250 kg ha^{-1});

Fig 2. Yield of brinjal fruit under different organic plant growth promoter treatments



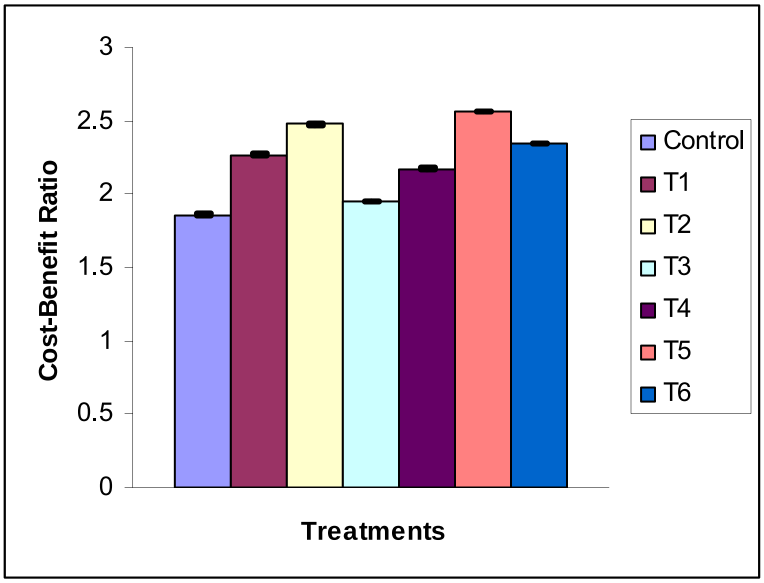
Key: T1- Panchagavya (3% in water); T2-Panchagavya (5% in water); T3-Amrit Pani (3% in water); T4-Amrit Pani (5% in water); T5-Bokashi (750 Kg ha^{-1}); T6-Bokashi (1250 kg ha^{-1});

A cost-benefit analysis of the growth-factor treatments was carried out using the formula:

$$\textbf{Cost- Benefit Ratio} = \frac{\textbf{Gross Income}}{\textbf{Expenses}}$$

The use of organic growth promoters increased crop yield, and provided a better return than conventional methods used in the control treatments (Fig. 3). The largest cost-benefit ratio was produced in T5 and T6 treatments using Bokashi formulations, followed by T1 and T2 for Panchagavya treatments.

Fig 3. Cost-benefit ratio of brinjal fruit yield (2005) under different organic plant growth promoter treatments



Key: T1- Panchgavya (3% in water); T2-Panchgavya (5% in water); T3-Amrit Pani (3% in water); T4-Amrit Pani (5% in water); T5-Bokashi (750 kg ha^{-1}); T6-Bokashi (1250 kg ha^{-1}).

2) Tomato (*Lycopersicon esculentum*)

The descriptive statistics for plant-growth, flowering, and yield data for tomato are presented in Tables 4, 5 and 6. All treatments with growth promoters have a significant variance from the control ($F_{\alpha=0.05}$), but there is no significance between treatments. Bokashi gives the highest growth, followed closely by Amrit Pani and Panchagavya. In terms of fruit yield (Table 6), T5 and T6 treatments gave the highest yield, followed by the other treatments. There is no significant difference in terms of yield for the different treatments.

Table 4. Tomato plant growth under different organic plant growth promoter treatments

Treatments	Plant Height (cm) (Mean ±S.E)	No. of branches per plant (Mean ±S.E)	No. of leaves per branch (Mean ±S.E)
Control	72.5±0.8	3.4±0.1	10.3±0.1
T1-Panchagavya (3%)	90.2±0.4	4.9±0.1	11.7±0.1
T2-Panchagavya (5%)	89.8±0.1	5.1±0.1	11.6±0.1
T3-Amrit Pani (3%)	81.1±0.2	4.6±0.1	12.0±0.1
T4-Amrit Pani (5%)	84.0±0.2	5.2±0.1	11.9±0.1
T5-Bokashi (750 Kg Ha^{-1})	97.2±0.2	6.0±0.1	13.3±0.1
T6-Bokashi (1250 Kg Ha^{-1})	94.8±0.1	6.1±0.1	13.1±0.1

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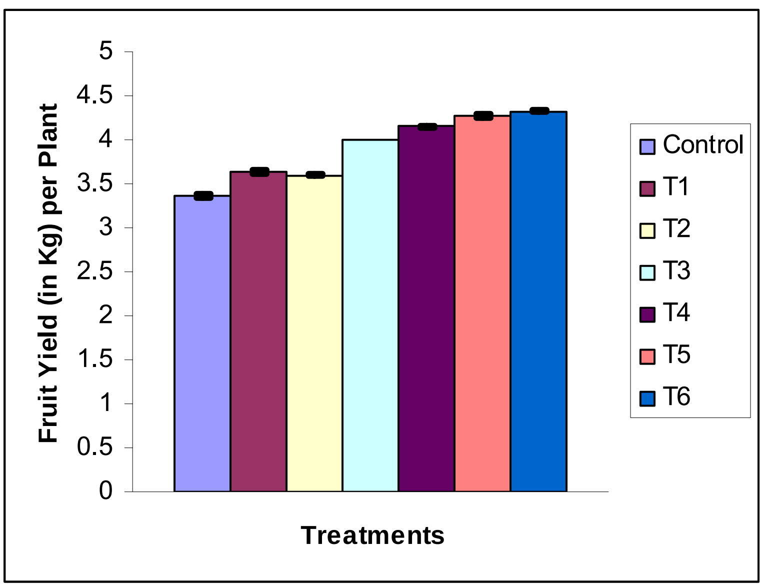
Table 5. Flowering of tomato plants under different organic plant growth promoter treatments

Treatments	Number of flowers/plant (Mean ±S.E)	Flower drop (Mean ±S.E)	Days to flower initiation (Mean ±S.E)	Days to 50 percent flower (Mean ±S.E)
Control	144.6±0.3	44.4±0.1	41.6±0.2	59.8±0.2
T1-Panchagavya (3%)	153.2±0.2	39.1±0.6	45.2±0.1	62.2±0.1
T2-Panchagavya (5%)	153.3±0.2	40.4±0.1	45.4±0.1	62.1±0.1
T3-Amrit Pani (3%)	155.9±0.1	38.8±0.1	45.6±0.1	63.0±0.2
T4-Amrit Pani (5%)	155.5±0.2	38.6±0.1	45.7±0.1	62.5±0.1
T5-Bokashi (750 Kg Ha^{-1})	157.6±0.1	35.4±0.1	46.5±0.1	62.8±0.1
T6-Bokashi (1250 Kg Ha^{-1})	158.5±0.1	35.2±0.1	46.6±0.1	63.0±0.0

Table 6. Yields of tomatoes under different organic plant growth promoter treatments

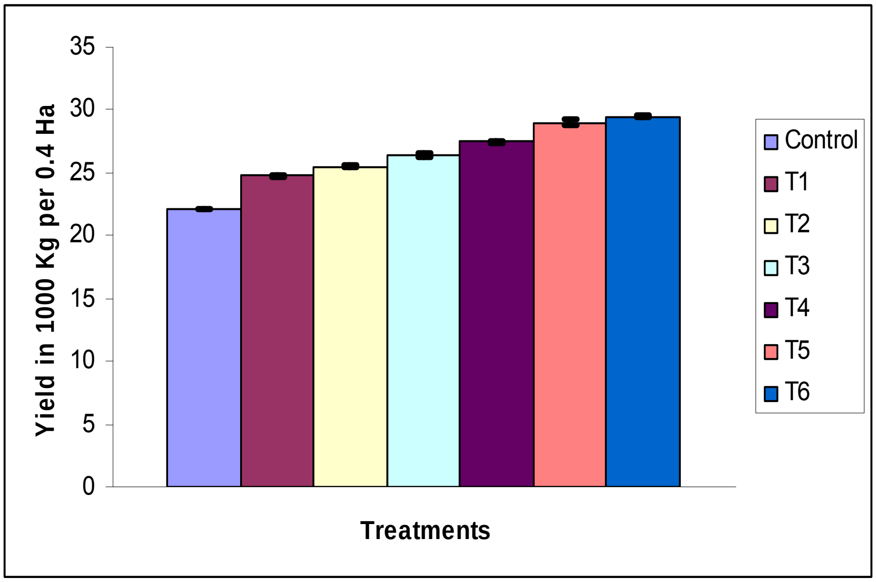
Treatments	No. of fruits/ plant (Mean ±S.E)	Yield/ plant (kg) (Mean ±S.E)	Equivalent yield (t ha^{-1})
Control	111.4±0.3	3.4±0.0	49.5
T1-Panchagavya (3%)	113.6±0.1	3.6±0.0	55.3
T2-Panchagavya (5%)	116.1±0.1	3.6±0.0	57.1
T3-Amrit Pani (3%)	115.6±0.1	4.0±0.0	59.1
T4-Amrit Pani (5%)	116.0±0.0	4.2±0.0	61.4
T5-Bokashi (750 Kg Ha^{-1})	119.8±0.1	4.3±0.0	65.0
T6-Bokashi (1250 Kg Ha^{-1})	121.0±0.3	4.3±0.0	66.1

Fig 4. Yield of tomatoes per plant (Kg) under different organic plant growth promoter treatment



Key: T1-Panchgavya (3% in water); T2-Panchgavya (5% in water); T3-Amrit Pani (3% in water); T4-Amrit Pani (5% in water); T5-Bokashi (750 kg ha^{-1}); T6-Bokashi (1250 kg ha^{-1});

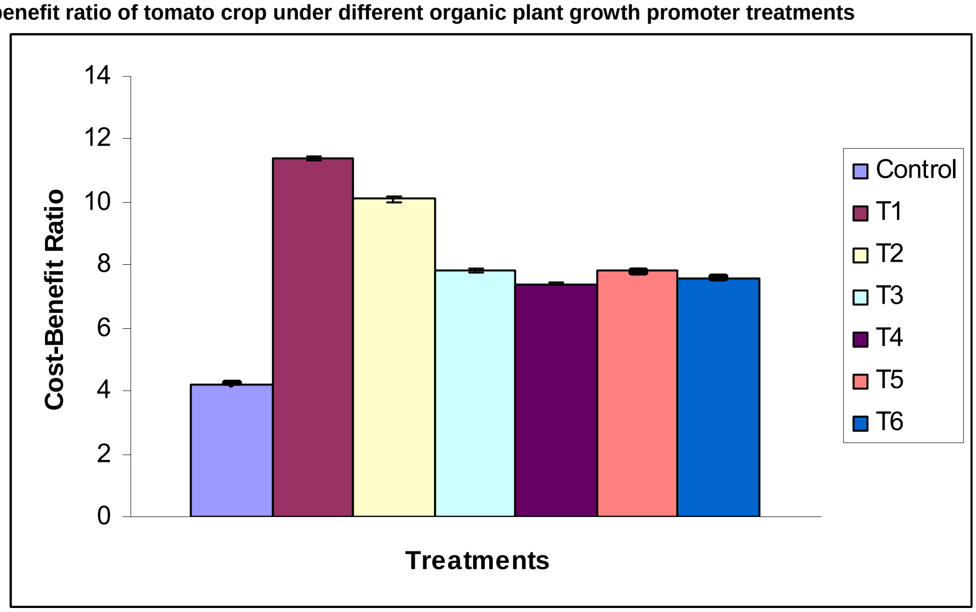
Fig 5. Yield of tomatoes under different organic plant growth promoter treatments



Key: T1-Panchgavya (3% in water); T2-Panchgavya (5% in water); T3-Amrit Pani (3% in water); T4-Amrit Pani (5% in water); T5-Bokashi (750 kg ha^{-1}); T6-Bokashi (1250 kg ha^{-1});

With respect to cost-benefit ratios, the results indicate Panchagavya as the most cost-effective, followed by Amrit Pani and then Bokashi (Fig.6).

Fig 6. Cost-benefit ratio of tomato crop under different organic plant growth promoter treatments



Key: T1-Panchgavya (3% in water); T2-Panchgavya (5% in water); T3-Amrit Pani (3% in water); T4-Amrit Pani (5% in water); T5-Bokashi (750 Kg ha^{-1}); T6-Bokashi (1250 Kg ha^{-1}).

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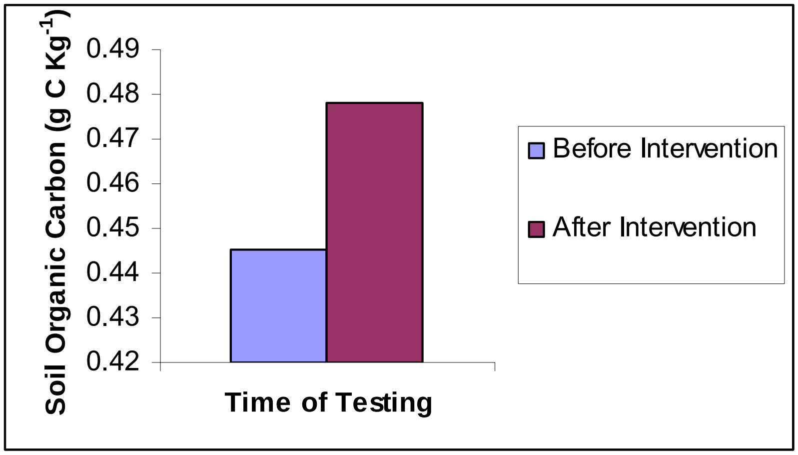
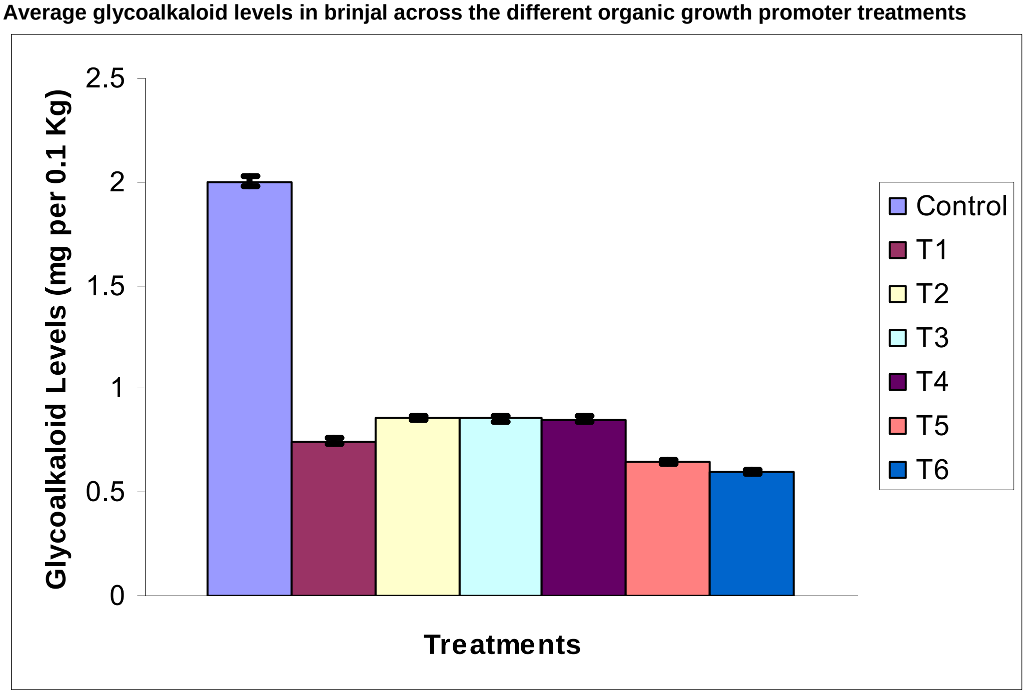
I also compared the organic carbon and organic matter content of the soil at beginning of the first year and the end of the second year for the 20 farmers; and also the glycoalkaloid content of the fruit in brinjal (Fig 7 and Fig 8**)**

Fig 7. Average soil organic carbon content (SOC) in twenty farmer fields before and after intervention



The small increase in organic carbon was not statistically significant (Fig 7). To detect a significant difference, additional amounts of supplementary organic matter would be essential. The levels of soil N, P, and K and pH also showed marginal changes.

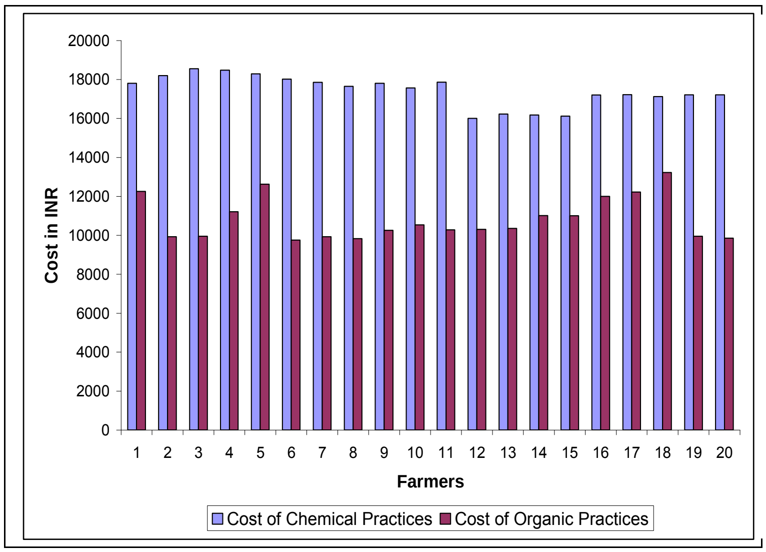
Fig 8. Average glycoalkaloid levels in brinjal across the different organic growth promoter treatments



Key: T1-Panchgavya (3% in water); T2-Panchgavya (5% in water); T3-Amrit Pani (3% in water); T4-Amrit Pani (5% in water); T5-Bokashi (750 kg ha^{-1}); T6-Bokashi (1250 Kg ha^{-1});

The glycoalkaloid levels were lower under organic growth promoter treatments when compared to the control treatment (Fig 8). Treatments with Bokashi (T5 and T6) showed the lowest glycoalkaloid contents. When water becomes a constraining factor, glycoalkaloid levels increase thereby making the brinjal fruits bitter (Bose and Som, 1986). However, in such water-limiting situations use of organic growth promoters did reduce bitterness in the fruits.
I also compared the cost of cultivation for the 20 farmers before and after the introduction of organic inputs (Fig 9). The costs are given in Indian Rupees (INR).

Fig 9. Comparison of input-costs in conventional and organic agricultural practices for the twenty farmer group



There was a reduction in the input costs for the organic farmers (Fig 9). A further reduction in input costs would be expected if farmers possessed cattle and were able to produce their own compost.

Conclusions

In a two-year experiment that involved 20 farmers using alternative inputs, increased yields of brinjal (*Solanum melongena*) and tomatoes (*Lycopersicon esculentum*) were recorded when compared to their production under conventional agricultural practices. The increased yield in the transition years reported in other studies (Ramesh et al., 2005) has similarly been observed here. The increased yield may be a result of a combination of effects of using just the required quantities of biofertilizers and growth-promoters, along with the judicious use of bio-pesticides. The soil organic matter content has marginally increased, due possibly to the use of organic inputs, but this change was not statistically significant.
Compared with the controls, the levels of glycoalkaloids in brinjal fruit from the organic growth promoter soil treatments were considerably lower, with the lowest levels in fruit from the Bokashi treatments. Low soil-water availability increases the glycoalkaloid levels; this was a governing factor in addressing glycoalkaloid level testing using organic growth promoters.
Overall, the organic growth-promoter treatments showed considerable improvement over the control plants in terms of yield ($F_{\alpha= 0.05}$), and especially in fruit quality, but there were no significant differences between treatments. The selection of the most effective organic growth promoter was determined by calculating the cost-benefit ratio. The cost-benefit to farmers was greatest when Panchagavya was used as a growth promoter (Figs 3 and 5). For farmers with access to cattle, the other growth promoters, namely Panchagavya and Amrit Pani that use mostly milk-cow by-products, become cheaper as well as easier to obtain. Panchagavya is the cheapest to use, followed by Amrit Pani, and Bokashi is the costliest alternative input. When farmers prepare

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Panchagavya or Amrit Pani and use products available from the farm itself the cost of production becomes nominal. The cost of Panchagavya is Rs. 12-13 L^{-1}, Amrit Pani about Rs.15 per litre and Bokashi Rs. 20-25 kg^{-1}. For farmers with only access to Bokashi, its use is advocated as an effective growth promoter for their crops; however, my recommendation is to use Panchagavya as the preferred organic growth promoter.

When it comes to traditional organic growth promoters, and preparations of Bokashi, the farmer should have patience and diligence to make sure the solution/mixture is made correctly. Once the formula is prepared correctly, and applied in the right proportion and at the correct time, greater yields should not be difficult to obtain. Preliminary studies in a pilot study (personal communication N. Natarajan, Erode, India) indicate presence of gibberelic acid in Panchagavya, though a comprehensive study is yet to be undertaken.

For the years 2005-2006, the average cost-benefit ratio obtained by these farmers for their tomato crop was around 10 and for brinjal around 2.5. This increased cost-benefit ratio has helped expand our organic farmer community in the area; with other marginal farmers making the transition to organic vegetable cultivation. The next phase of this experiment involves testing the effectiveness of these organic growth promoters in reducing pests of vegetable crops.

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APPENDIX 1

***Preparation of Bokashi*:** The method of Bokashi preparation was based on the parameters set by the EMRO (EM Research Organization, 1996). Our procedure to prepare 300 Kg of Bokashi involved a ratio of 2:1 plant to animal matter.

Materials required:

125 Kg Rice bran
100 Kg Rice husk
25 Kg Oil-cake
100 Kg Cow dung (instead of fish/bone meal)

Method:

a)The dry material is thoroughly mixed.
b)An EM solution is made mixing 3 L of 1% EM (weight per volume), 30 L of 10% EM (weight per volume), and 3 L of molasses (1% volume per volume).
c) This is sprinkled on the dry material mixture and mixed thoroughly to avoid lumping. The colour of the mixture is brown.

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d) This is placed in an airtight plastic container (anaerobic fermentation) in the dark for 5-8 days without stirring.

e) A good Bokashi preparation at this stage has a pleasant fruity odour, there is no excess water in the mixture when it is pressed by hand, and it should form into a ball when pressed together and crumble when disturbed.

APPENDIX 2

Preparation of Panchagavya

Materials required:
5 Kg Cow dung
4 L Cow urine
3 L Milk
2 L Curd
1 Kg Ghee

Method:

a) Mix cow dung and ghee into a smooth pliable mixture and set aside for three days.
b) Simultaneously mix milk, curds together and set aside for three days.
c) Set aside cow urine for three days.
d) On the third day mix all the above ingredients together in the same bowl. Set aside for four days.
e) The mixture has to be blended clockwise and anticlockwise about 12 times, both in the morning and the evening. On the seventh day, Panchagavya is ready.
f) Panchagavya can be used as a spray (3% dilution) and as a soil drench (5% dilution).

APPENDIX 3

Preparation of Amrit Pani

Materials required:
2 Kg Ghee
2 Kg Honey
1.5 Kg *Vitex negundo* leaves
1.5 Kg Neem leaves
1 L Cow Urine

Method:

a) Mix the ghee and honey and keep aside.
b) Crush roughly the neem and *Vitex negundo* leaves and mix with 2 L of water.
c) Keep cow urine in a separate pot.
d) Set the above aside for two days, mixing the solution thoroughly.
e) On third day, mix all solutions into one bowl and mix thoroughly.
f) Set aside for another two days.
g) On fifth day, filter the solution and the filtrate is ready for spraying (3% solution) and as a soil drench (5% solution).

APPENDIX 4

Botanical Spray Preparations:

a) *Asafetida foliar spray* at 5% (volume per volume) was used to prevent damping-off.

b) *Botanical Spray* I: 250 g each of crushed leaves of *Vitex negundo*, tobacco (dried), *Carica papaya* and *Adathoda vasicosa* were ground to a rough paste. This was dissolved in 3 L of water and set aside for two days. The filtrate was diluted with water (3ml per L) and used as a preventive spray against sucking pests.

c) *Botanical Spray* II: 300 g each of pods of *Alium sativa* and green chillies were roughly ground into a paste and then mixed in 3L of water and set aside for two days. The filtrate was then diluted with water (3ml per L) and used as a pest preventive spray.

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