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J. Nat. Prod. Plant Resour., 2014, 4 (3):82-91
(http://scholarsresearchlibrary.com/archive.html)

ISSN : 2231 – 3184
CODEN (USA): JNPPB7

Evaluation of Inhana rational farming technology as an organic package of practice for effective and economic vegetable cultivation in Farmers' Field

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ABSTRACT

Effectivity of Inhana Rational Farming (IRF) Technology developed by an Indian Scientist, Dr. P. Das Biswas as an effective and economic organic package of practice was evaluated at Farmers' field in the red laterite zone of West Bengal taking tomato (Solanum lycopersicum) as the test crop. The experiment was laid down as per randomized block design (RBD) with 7 treatments replicated 4 times. The treatments included local farming practice with chemical inputs and IRF technology with varying dose of compost. Yield under IRF Package (compost @ 4 ton/ bigha and 10 rounds spraying of solutions for plant management under IRF) was 19.8 percent higher than that of chemical practice. Post harvest analysis of soil samples indicated an increasing trend of soil fertility especially in terms of soil microbial population, in the Novcom compost treated plots as compared to ones receiving chemical treatment. Also higher crop response was obtained from the organic plots as compared to the plots under chemical treatment which might be due to better soil-plant nutrient dynamics under organic management. The study indicated that activation of soil system and plant physiology under comprehensive organic management i.e. quality compost application and effective plant management, can enable better crop performance at a lower economics as compared to conventional chemical practice.

Keywords : Organic, Inhana Rational Farming Technology, Novcom compost, Tomato, Plant development index

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INTRODUCTION

In present day agriculture when soil quality degradation and progressively declining productivity has become a cause of serious concern, there remains little choice but to adopt the organic pathway in order to regain the lost sustainability. Despite application of huge and incremental dose of synthetic fertilizers over a period of years, the soil nutrient reserves today indicate a depleted status [1]. It is evident that low productive, nutrient depleted soils cannot support the desirable crop production targets, which will only depend upon how well and fast soil depletion is checked and the soil nutrient balance shifts towards a positive value. The Herculean task cannot be understandably achieved by the present organic farming methods, which follow the same principle of 'Give in – Take out', only here the chemical inputs are substituted by organic components. This is the reason why no conclusive solution has been achieved till date [2]. In this scenario, Inhana Rational Farming (IRF) Technology has successfully demonstrated its potential as an economically sustainable organic package of practice in two largest certified organic tea estates in Assam. The present study aims to evaluate IRF as an effective organic package of practice for vegetable cultivation, taking tomato as the test crop.

MATERIALS AND METHODS

Crop trial using tomato (*Solanum lycopersicum*; variety : Rituraj) as test crop was conducted at farmers' field at Molebona village, Bankura District of West Bengal; during 2008 – 2009. The experiment was laid down as per randomized block design (RBD) with 7 treatments replicated 4 times. In the chemical farming plots (T_2) N, P_2O_5 and K_2O were applied at the rate of 140 : 70 : 70 kg/ha in form of urea, single super phosphate and muriate of potash, during final land preparation. Novcom compost was applied in experimental plots T_3, T_5, T_6 and T_7 at 4 ton/ bigha, 2 ton/ bigha, 4 ton/ bigha and 6 ton/ bigha, respectively during final land preparation. All the experimental plots received standard cultural practices. Treatment wise crop yield data of various experimental plots were analyzed. Profitability in terms of net return and benefit cost ratio was calculated using prevailing market price for various commodities. IRF package of solutions were applied as per schedule (10 round of spraying with different potentized and energized herbal extracts) in the experimental plots T_4, T_5, T_6 and T_7. Crop was harvested by picking of fruits (3 times); yield and economics were calculated as per standard procedure. Value cost ratio was evaluated as per the methodology of [3].

Treatment details :

T_1 : Control
T_2 : Recommended chemical farming practice
T_3 : Only Novcom compost application (@ 4 ton/ bigha)
T_4 : Only 10 round solution spray IRF.
T_5 : Novcom compost application (@ 2 ton/ bigha) and 10 round solution spray under IRF
T_6 : Novcom compost application (@ 4 ton/ bigha) and 10 round solution spray under IRF
T_7 : Novcom compost application (@ 6 ton/ bigha) and 10 round solution spray under IRF

Inhana Rational Farming Technology (IRF) :
Inhana Rational Farming Technology (IRF) developed by a visionary Indian Scientist Dr. P. Das Biswas, Founder Director of Inhana Biosciences is a comprehensive organic package of practice to attending to soil and plant physiology development along with effective pest and disease control through alleviation of the root cause. Objectivity of the practice was (i) Energization of the Soil System i.e., enabling the soil to function naturally and in the most effective way as an effective growth medium for plants and (ii) Energization of the Plant System i.e., the plants become efficient in optimum extraction, utilization and assimilation of nutrients as well as enhancement of the biochemical and structural defense of the plant system through the activation of the plants host defense mechanism. IRF utilizes various In-House solutions for soil and plant energization. Technology specific plants, which store the energy of these five basic elements as well as five basic life forces, are selected in accordance with parameters related to sunset, seasons and various factors. Botanical extracts of these plants are then potentized and energized following Element energy Activation Principle (E.E.A.). Each and every solution individually has one or more function but when applied as a complete package the solutions work in an integrated manner giving a comprehensive result. However, since the situations vary as per crop species and agro-climatic situation hence IRF also ensures need-based solutions for all problems [4].

Process flowchart of IRF solutions under E.E.A principle :

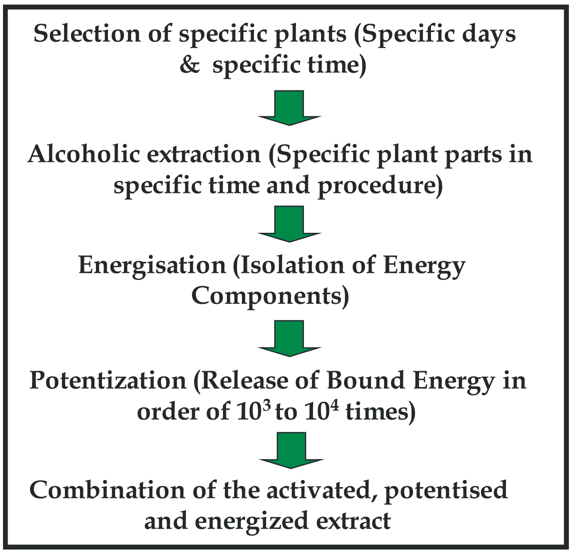

Fig. 1 : Process flow diagram

Selection of specific plants (Specific days and specific time) → Alcoholic extraction (Specific plant parts in specific time and procedure)→ Energisation (Isolation of Energy Components)→Potentization (Release of Bound Energy in order of 10^3 to 10^4 times)→ Combination of the activated, potentised and energized extract.

Guiding philosophy of EEA principle behind development of various IRF solutions :
IRF solutions are developed under the Element Energy Activation (E.E.A.) Principle. Radiant solar energy is stored in plants and the binded stored energy components are extracted from energy rich plant part by a specific extraction procedure and subsequently potentised in the order of 10^3 to 10^4, so that the activated energy forms release the energy components when sprayed in the plant system (matter). Now according to the requirement different extracted energy components are combined in desired proportion to make different solutions which regulate sequential physiological activities to attend the root cause. So a numerous number of solutions can be prepared as per requirement guided by this Element Energy Activation Principle.

Analytical procedures : Analysis of compost was done as per standard International protocol [5]. Soil samples were collected from individual treatment plots, air dried, sieved and analyzed for physico-chemical, fertility and microbial status as per standard procedure [6].

Table 1 : Solution used for organic plant management of tomato under Inhana Rational Farming (IRF) Technology

Sl	Solution	Ingredients are biologically activated & potentised extract (as per E.E.A Principle) of following herbs	Spraying schedule
Crop management in Nursery			
1.	Seed solution	*Calotropic procera R. & Tinospora crispa*	Seeds to be soaked for 15-20 minutes in the solution and then sown in the field after air drying (under shade).
2.	NS(Ag) 1	*Ficus hispida Linn.*	2-3 leaf stage.
3.	NS(Ag) 2	*Erythrina Variegate Linn.*	After next 7 days.
Crop management in main field			
1.	IB 1	*Hyoscyamus niger, Ficus benghalensis & Dendrocalamus strictus Nees.*	3 days after transplantation
2.	IB 2 + IB 7	*Ocimum sanctum, Calotropic procera R. & Cynodon dactylon* (IB 2) + *Ocimum sanctum* (IB7)	10 days after 3 days after transplantation
3.	IB 5 + IB 7	*Cynodon dactylon & Calotropic gigantean.* (IB 5) + *Ocimum sanctum* (IB7)	20 days after 3 days after transplantation
4.	IB 3	*Adhatoda vasica Nees, Zingiber officinale Roscoe & Embellia ribs.*	30 days after 3 days after transplantation
5.	IB 10 + IB 7	*Costus specicus sm. & Typhora indica mer* (IB 10) + *Ocimum sanctum* (IB7)	40 days after 3 days after transplantation
6.	IB 11	*Solanum xanthocarpum schard & Aristolochia indica Linn.*	50 days after 3 days after transplantation
7.	IB 2	*Ocimum sanctum, Calotropic procera R. & Cynodon dactylon*	60 days after 3 days after transplantation
8.	IB 6	*Hyoscyamus niger & Solanum Verbascifolium*	70 days after 3 days after transplantation
9.	IB 1 + IB 5	*Hyoscyamus niger, Ficus benghalensis & Dendrocalamus strictus Nees.* (IB 1) + *Cynodon dactylon & Calotropic gigantean.* (IB 5)	80 days after 3 days after transplantation
10.	IB 12	*Sida Cordifolia Linn. & Barberis asiatica Roxb. Ex. De.*	90 days after 3 days after transplantation

RESULTS AND DISCUSSION

The compost was produced within a short period of 21 days using Novcom composting method [7] utilizing the locally available weeds, water hyacinth and farm waste. The better quality and maturity of compost was confirmed through laboratory analysis where different parameters were tested as per U.S. Composting Council, 2002 [8] and [9]. Crop performance under different treatments was evaluated both in nursery and main field. Pre and post experimental soil quality was also analyzed to study the qualitative variation in soil properties especially microbial parameters under different treatments.

Evaluation of quality of Novcom compost :
Compost samples were analyzed as per standard protocol to evaluate the quality and maturity of Novcom compost (Table 2). The results showed that the compost is of high quality. The reasonably high nutrient value of the compost in terms of Total N, P and K content (1.64, 0.39 and 2.27 %, respectively, on dry weight basis) and the standard C/N ratio (15.4:1) indicates faster mineralization potential. But the most important factor is the self- generated microbial population within compost, in the order of 10^{16} c.f.u. (10^4 to 10^6 times higher than any common well decomposed compost), which might be the driving force ensure better post soil application effectivity. Similar results were obtained by [10]. Stability and phytotoxicity test of the compost samples confirmed it as mature and stable compost that is free from any phytotoxic effect [11].

Table 2 : Quality of Novcom Compost prepared at Farmers' Field in Molebona village, Bankura, West Bengal, India

Sl. No.	Parameter	Value	Sl. No.	Parameter	Value
1.	Moisture (%)	68.8	9.	C/N ratio	15.4 : 1
2.	pH_{water} (1 : 5)	8.55	10.	Total bacterial count[2]	140×10^{16}
3.	EC (1 :5) dS/m	5.13	11.	Total fungal count[2]	46×10^{16}
4.	Organic carbon (%)	25.2	12.	Total action count[2]	9.5×10^{16}
5.	CMI[1]	2.17	13.	CO_2 evolution rate *($mgCO_2 – C/g$ OM/day)*	3.94
6.	Total nitrogen (%)	1.64	14.	Seedling emergence *(% of control)*	142
7.	Total phosphorus (%)	0.39	15.	Root elongation *(% of control)*	218
8.	Total potassium (%)	2.27	16.	Germination index *(phytotoxicity bioassay)*	2.83

[1]CMI : Compost mineralization index; [2]Microbial count : c.f.u. per gm moist soil

Figure 2 : Initiation of Novcom Composting Heap under the Project in farmers' field at, Bankura, West Bengal, in the presence of PI - Prof. Kajal Sengupta, Dept. of Agronomy, BCKV.

Growth performance of tomato seedlings in experimental sub plots of nursery :

Growth performance of tomato seedlings (in terms of germination percent 7 days after showing) and periodical measurement of plant height, number of leaves and number of branches per plant were observed during the study (Table 2). Maximum germination percent was observed in T_7 plots closely followed by T_6 and T_5 plots in the study area. The germination percent in these experimental plots were 44 percent higher with respect to control in all the cases.

However, germination percent in chemically treated plot was only 6 to 7 percent higher than control and significantly lower than organically treated plots of T_5, T_6 and T_7 in both the areas (Figure 3). Plant height, number of leaves and branches per plant under different treatments, studied at periodical interval of 7 days i.e. on 7th, 14th and 21st day revealed that the plots receiving organic treatments under IRF performed better than the chemically treated plots. The findings indicated that along with Novcom compost, Inhana nursery solution played a vital role in the growth of tomato seedlings.

Development of Plant Development Index (PDI) to assess seedling quality :

Different agronomic parameters viz. plant height, girth, number of leaves etc., which indicate bush health also reflect the effect of management undertaken that ultimately influence the bush yield potential. However, to understand comparative plant development by a single value, plant development index calculated as per the methodology of [12].

Plant Development Index (PDI)

$$= \frac{1}{n}\left\{\sum_{n=1}^{n} \frac{100(X_1 - C_1)}{C_1} + \frac{100(X_2 - C_2)}{C_2} + \cdot\cdot\cdot\cdot\cdot + \frac{100(X_n - C_n)}{C_n}\right\}$$

Where X = Agronomic Parameter; C = Control

In the present study three parameters *viz.* plant height, number of leaves and number of branches were considered and cumulative impact of these parameters were measured through plant development index (fig. 2) which was significantly higher in the seedlings under organic management in comparison to their chemical counterparts.

Growth performance of tomato in experimental field :

Comparative growth performance of tomato *viz.* height of the plant, branches per plant, initiation of flowers and fruits were periodically observed at 30 days interval and 30^{th}, 60^{th}, 90^{th} and 120^{th} days observation were documented (Table 3). In case of all the treatments plant height steadily increased up to 90 days after which it some what slowed down. Number of branches in each plant also increased with time, where the organically treated plants showed comparatively higher numbers than the chemically treated ones. But the most significant fact noted was the early initiation of flowers as well as fruits in organically treated plants as compared to the chemically treated ones.

The findings indicate that organic solutions under IRF might activate the desired physiological functions of the plants. Another major differences observed during the study was that the organically treated tomato plants showed comparatively longer fruit bearing stage than their chemical counter parts. The findings indicated superior plant functioning under organic cultivation and in this case solutions under IRF definitely played an important role towards enhancing the plants fruit bearing stage. Similar observation in terms of effectivity of IRF plant management solution on plant functioning was observed by [13].

Table 3 : Growth performance of tomato seedlings in different treatments.

Treatments	Germination %	Plant's height (cm)			No. of leaves / plant			No. of branches / plant		
	< ------------------------*Days after showing* ------------------------------ >									
	7	7	14	21	7	14	21	7	14	21
Experimental Location : BCKV Research Farm, W.B										
T_1	74	2.72	4.21	7.58	4	10	13	1	2	3
T_2	78	3.23	6.08	8.93	5	12	16	2	2	3
T_3	87	3.24	5.94	8.12	5	11	15	1	2	3
T_4	81	2.88	4.89	8.59	4	12	17	1	2	3
T_5	92	3.14	6.18	8.97	5	14	21	2	2	3
T_6	94	3.60	6.19	8.98	6	15	24	2	3	4
T_7	94	3.53	6.29	9.04	6	16	25	2	3	5
C.D (P = 0.05)		NS	1.34	1.06	NS	2.09	6.84	NS	NS	0.76
Experimental Location : Farmers' Field at Molebona village, Bankura, W.B.										
T_1	68	2.13	4.57	7.57	4	9	12	1	2	3
T_2	66	2.79	6.12	8.91	5	11	16	2	3	3
T_3	77	2.83	5.64	8.10	4	10	16	2	2	3
T_4	72	2.20	4.79	8.57	4	11	18	1	2	3
T_5	82	3.04	6.07	8.87	5	12	20	2	3	4
T_6	83	3.10	6.11	8.89	6	12	22	2	3	4
T_7	83	3.27	6.27	9.00	6	13	23	2	3	5
C.D (P = 0.05)		0.89	1.72	1.07	NS	2.47	6.87	NS	0.75	1.03

Yield performance and economics of tomato in different treatment :

Total number of fruits (tomato) per plant and average mass of fruit (tomato) under different treatments were taken and total yield was determined. The yield was highest in case of T_7 followed by T_6, T_5, T_2, T_3, T_4 and T_1 (table 4). Tomato yield in organically treated plots of T_7 and T_6 were significantly higher than their chemical counter parts. The higher yield was basically contributed from higher number of fruits per plant as well as average fruit mass. The higher number of fruits per plant may be due to comparatively longer fruit bearing stage of organically treated plants which again indicated that the organic solutions used under IRF has a direct influence on plant functioning leading to enhancement of crop yield potentials.

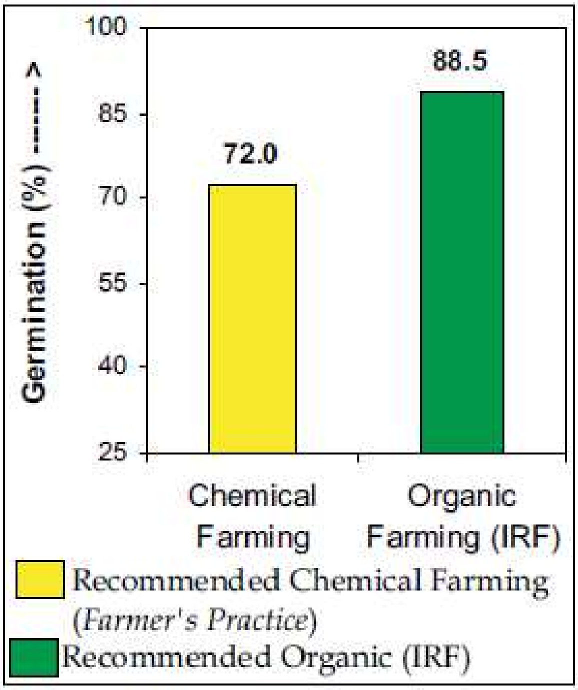

Fig. 3 : Comparative Study of Germination Percent (GP) of Mature Tomato Seedlings.

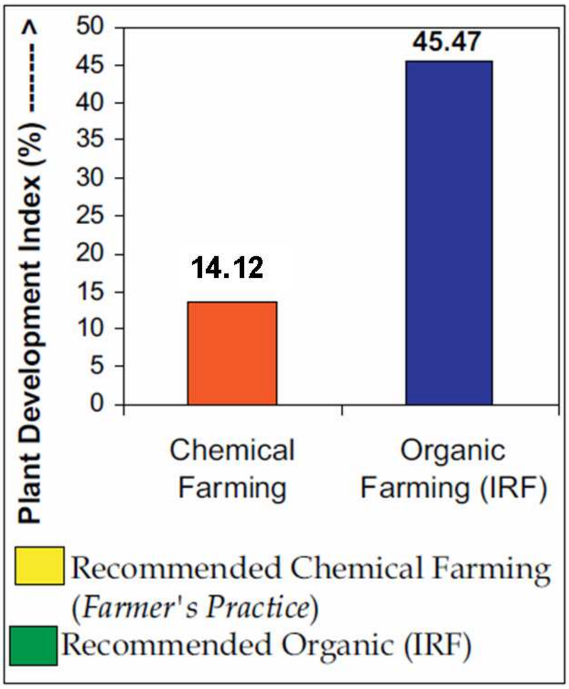

Fig. 4 : Comparative Study of Plant Development Index (PDI) of Mature Tomato Seedlings.

Table 4 : Growth performance of Tomato under different treatments

Treatments	Plant height (cm)				No. of branches/plant (cm)				Flower initiation (%)				Fruit Initiation (%)			
	30	60	90	120	30	60	90	120	30	60	90	120	30	60	90	120
	< -------------------------- *Days after planting* -------------------------- >															
Experimental Location : Farmers' Field at Molebona village, Bankura, W.B.																
T_1	8.7	32.5	50.2	51.9	3	5	8	10	-	51.2	100	100	-	-	60.7	100
T_2	11.5	37.4	59.8	61.4	5	8	10	11	-	69.3	100	100	-	5.6	81.6	100
T_3	10.2	36.1	58.2	59.3	5	6	10	12	-	62.3	100	100	-	4.2	81.2	100
T_4	9.9	35.4	56.1	58.3	5	6	12	12	-	60.2	100	100	-	4.7	82.9	100
T_5	10.9	37.6	58.0	60.8	6	7	13	14	-	71.6	100	100	-	7.7	91.3	100
T_6	11.2	37.3	60.1	63.6	6	9	14	15	-	82.5	100	100	-	10.4	100	100
T_7	11.9	38.0	60.3	64.1	6	9	13	15	-	85.4	100	100	-	12.6	100	100
C.D (P=0.05)	1.02	3.79	6.49	8.56	1.25	3.01	4.08	3.17	-	-	-	-	-	-	-	-

Table 5 : Crop performance and economics of tomato in different treatments

Treatments	No. of fruit per plant	Av. mass of mature fruit (g)	Total Yield (ton)	B : C	Value Cost Ratio (VCR)
Experimental Location : Farmers' Field, Molebona village, Bankura, W.B.					
T_1	26.4	45.05	21.53	2.87	-
T_2	38.1	54.80	31.46	3.23	4.41
T_3	36.5	52.50	30.16	2.51	1.92
T_4	38.2	53.25	31.30	3.48	6.51
T_5	44.0	56.84	35.28	3.14	3.67
T_6	48.6	58.51	37.67	2.79	2.69
T_7	52.1	60.83	42.23	2.68	2.51
C.D (P =0.05)	6.01	2.03	7.18	-	-

Fig. 5 : Growth of tomato plants under different treatments in farmers' field at Bankura, West Bengal, India

But the most significant fact is that the average mass of fruits (tomato) at harvestable stage was significantly higher in case of organically treated plants in both the study areas. It indicates that soil-plant nutrient dynamics were more active in organically treated plots irrespective of the agro-climatic zone. The increase in tomato yield under organic treatment might be due to better mineralization of soil nutrients *vis-à-vis* their plant uptake and utilization in the presence of higher soil microbial population.

Evaluation of the economics of tomato cultivation in terms of benefit-cost ratio revealed that organic treatments were compatible to their chemical counterparts and even higher in some cases, which indicated the economic viability of IRF for organic vegetable cultivation. Value cost ratio (VCR) which indicated extra crop grain per rupee invested for organic inputs should be at least 2.0 or higher, to stimulate usage of the input in high risk environments [14], [15]. Value cost ratio higher than 2.0 in all the organic plots indicates that it may economically viable for large scale adoption [16].

Change in soil quality under different treatments :
In order to evaluate any qualitative improvement in soil status in relation to organic soil management, soil samples from all individual plots were tested twice [*i.e.*, before initiation of experiment and after harvesting]. The soils in the experimental plots were slightly acidic to neutral in reaction with moderate to high organic carbon (0.62 to 0.70 %), low to medium soil available nitrogen (278 to 285 kg ha^{-1}), low to moderate in available phosphate (28 to 37 kg ha^{-1}) and medium in available potash (204 to 214 kg ha^{-1}) (Table 5A). Soil analysis after crop harvesting showed that the plots receiving Novcom compost showed increasing trend of soil fertility as compared to their chemical counter parts. The soil pH also increased in the compost treated plots, indicating its positive effect on acid soils, which might influence better soil-plant nutrient dynamics.

Table 6 : Temporal variation of soil physicochemical properties and fertility status in the experimental plots in Farmers' Field

Treatments	Before initiation of Field Experiment (After Harvesting Tomato) Farmers' Field, Molebona village, Bankura					
	pH (H_2O)	EC (dSm^{-1})	Org. C (%)	N	P_2O_5 < --- (kg ha^{-1}) --- >	K_2O
T_1	5.27	0.04	0.63	276	32	205
	(5.29)	(0.04)	(0.61)	(265)	(30)	(202)
T_2	5.25	0.04	0.66	272	33	218
	(5.21)	(0.06)	(0.65)	(279)	(35)	(225)
T_3	5.32	0.04	0.62	266	30	211
	(5.48)	(0.05)	(0.66)	(273)	(32)	(223)
T_4	5.29	0.04	0.65	270	30	212
	(5.31)	(0.04)	(0.69)	(273)	(34)	(218)
T_5	5.38	0.05	0.67	255	35	209
	(5.46)	(0.05)	(0.70)	(260)	(39)	(214)
T_6	5.36	0.04	0.70	260	30	212
	(5.42)	(0.06)	(0.75)	(271)	(37)	(219)
T_7	5.27	0.04	0.65	258	36	202
	(5.60)	(0.06)	(0.73)	(274)	(39)	(216)
C.D(P =0.05)	0.10	0.02	0.31	10.11	10.01	5.51

**CD (P=0.05) values are meant for soil analysis data after harvesting.*

In red laterite soils of Bankura with low organic matter content, soil microbial status is generally poor and this was reflected by the values obtained from the samples of different experimental plots (Table 5B). Microbial analysis of the soil samples collected from farmers' field revealed total count of bacteria, fungi and actinomycetes in the order of 10^3 (primary value varied from 11 to 36), which was found to increase up to the order of 10^5 in the Novcom compost treated plots as revealed from post-harvest analysis of soil samples. Simmilar observation with application of organic manure in red lateriate soils was observed by [17]. Improvement of soil quality under application of Novcom compost was also noticed by many workers [18, 19, 20]

Table 7 : Temporal variation of soil microbial population in the experimental plots

Treatments	Before initiation of Field Experiment (After Harvesting Tomato) Farmers' Field, Molebona village, Bankura		
	Bacteria	Fungi	Actinomycetes
	< ---- Total microbial count in c.f.u. (per g moist soil) ----- >		
T_1	39 x 10^3 (27 x 10^3)	21 x 10^3 (19 x 10^3)	26 x 10^3 (19 x 10^3)
T_2	36 x 10^3 (22 x 10^3)	19 x 10^3 (16 x 10^3)	32 x 10^3 (20 x 10^3)
T_3	31 x 10^3 (38 x 10^5)	24 x 10^3 (22 x 10^5)	38 x 10^3 (26 x 10^5)
T_4	38 x 10^3 (28 x 10^3)	20 x 10^3 (29 x 10^3)	26 x 10^3 (35 x 10^3)
T_5	36 x 10^3 (28 x 10^5)	38 x 10^3 (42 x 10^5)	11 x 10^3 (21 x 10^5)
T_6	31 x 10^3 (57 x 10^5)	21 x 10^3 (32 x 10^5)	14 x 10^3 (27 x 10^5)
T_7	22x 10^3 (69 x 10^5)	24 x 10^3 (39x 10^5)	14 x 10^3 (29 x 10^5)
C.D(P =0.05)	3124.5	8321.9	5861.3

**CD (P=0.05) values are meant for soil analysis data after harvesting.*

Fig. 6 : Spraying operation on tomato plants in farmers' field at Bankura, W.B.

Fig. 7 : Initiation of fruits under different treatments in farmers' field at Bankura, W.B.

CONCLUSION

Utilization of Rational farming Technology for organic tomato cultivation encompassed three significant criteria viz. organic soil management, organic nursery management and organic crop management. Organic crop production in terms of soil, nursery besides crop management from sowing to harvesting stage is still considered a difficult proposition. However, this study revealed that Rational Farming Technology can be successfully used for organic vegetable cultivation. The technology enables effective organic soil management using Novcom compost, provides Nursery Management Package besides providing guidelines and solutions for crop production from sowing till harvest, at the same time ensuring affordability for the poor/marginal farmers. Under this study the technology demonstrated better effectivity not only in terms of crop response but especially in terms of soil quality development, over conventional management practices. This study in the red laterite zone of West Bengal also pointed out that the technology can be adopted in the problematic and less productive soils or not only for successful organic crop production even under stressed conditions but specifically to bring about soil quality regeneration that too at an affordable cost.

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