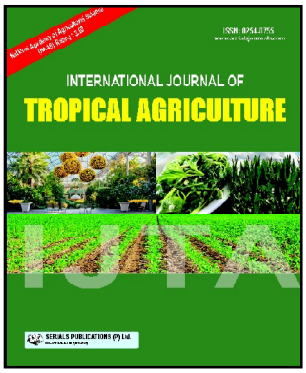

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Effect of liquid manures on the growth and yield of rice through SRI system under organic conditions.

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Abstract: The field experiments were conducted during *kharif* seasons 2011, 2012 and 2013 at the Department of Organic Agriculture at CSKHPKV, Palampur, India, using different organic liquid manures. Rice variety RP 2421 was used in the experiment under SRI system. Liquid manures EM Technology, Himsol, HIMSLURY, Matkakhad , Vermiwash, Compost Tea, and Panchgavya were sprayed four times as per the treatment at an interval of 15 days. Basal dose of Vermicompost @10 t/ha was applied at the time of field preparation. The rice plant height, number of tillers, number of panicles, grain/panicle, 1000grain weight, biological weight and yield were the recorded parameters and all were statistically different from control. Higher yield and yield attributes of rice were recorded with the application of EM technology which were followed by Panchgavya, Himsol, Matkakhad , Himslury, Vermiwash and Compost Tea. The EM Technology increased grain yield by 29.49 %, 23.96% and 33.22% during 2011, 2012 and 2013 respectively over absolute control. Whereas in the pooled data EM technology, Panchgavya and Himslurry produced 28.8%, 23.4% and 19.7% higher yield respectively over control. The findings of the trial suggested that crop productivity improved significantly by the application of various organic manures over control during different periods of study.

Keywords: SRI, Rice, Vermicompost, Organic Liquid Manures

INTRODUCTION

Rice (*Oryza sativa*) is an important ingredient of household food-basket, yet the yield level has been low and uncertain in India. India is one of the world's largest producer of white rice and brown rice, accounting for 20% of all world rice production. The traditional method for cultivating rice is flooding the fields while, or after, setting the young seedlings. This

method requires sound planning and servicing of the water damming and channeling. While flooding is not mandatory for the cultivation of rice, more so ever different methods of irrigation require higher effort in weed and pest control during growth periods and a different approach for fertilizing the soil. At the same time, the operational holding-size is shrinking and land and water resources are being degraded, therefore, some innovative rice production practice is needed to meet its growing demand due to population pressure.

System of Rice Intensification (SRI) may be an appropriate practice to produce more food with less input. SRI developed through empirical method in Madagascar (during 1980s), is seen to be a solution for food security. This system, under most circumstances can significantly increase the productivity of land, water, seeds, capital and labour use for irrigated rice (Bagayoko. 2012; Kassam *et al.*, 2011). Fr. Henry de Laulanie rediscovered this noval small landholdings-oriented practice of SRI. Being a low external input technology, SRI offers an opportunity to create a broad, 'SRI Organic Rice', which has significant market potential (Barah, 2009).

Organic Farming has been advocated as a consequence to the threats posed by the high intensive chemical farming (say Industrial Agriculture) to our soil, water, plants, health, biodiversity and above all, environment. Looking to the present scenario of increasing demand of chemical free produce, there is a vast scope for organic crop production in India and abroad. Under organic conditions, in addition to follow improved agronomic techniques of growing crops and application of different composts application, the role of liquid manures like Vermiwash, Compost tea, Biosol, Matka khad and cow urine etc. is very essential to maintain the activity of microorganisms and other life forms in the soil. They are excellent growth promoters when used as foliar spray. Three to five sprays after 25-30 days of sowing at an interval of fifteen days ensure good productivity. These contain many essential elements such as nitrogen, phosphorus, potassium and calcium in addition to this they also offer additional benefits to plants because they contain plant growth regulators such as auxins, gibberellins as well as other substances that stimulate plant development. These improve soil health, productivity and soil microbial diversity which results in higher crop yields due to enhanced plant nutrients. (Hargreaves *et al.* 2008).

The present research was conducted to study the effect of different liquid manures on growth, yield and yield components in the System of Rice Intensification under organic conditions.

MATERIAL AND METHOD

Field experiment

The field experiments were conducted during *kharif* seasons of 2011, 2012 and 2013 at the experimental area of Department of Organic Agriculture, CSKHPKV, Palampur. The area represents mid-hill wet temperate zone of Himachal Pradesh, situated at an altitude of 1290.8m and is bounded between 32^0 north latitude and 76^0 east longitude. The soil under experimental area was silty clay loam in texture, acidic having pH around 5.5-5.7, organic carbon 0.65%, nitrogen 255kg/ha, phosphorus 6.0 kg/ha and potassium 268 kg/ha.

The experiment was laid out in the first week of June during all the years of experimentation in randomized block design with three replications and eight treatments. The plot size of the experimental plot was 4 x 3m plot. The treatments include seven liquid manures i.e. EM Technology, Himsol, Himslury, Matkakhad , Vermiwash, Compost Tea, Panchgavya and one control. In addition to this all the plots were fertilized with 10 t/ha Vermicompost at the time of field preparation irrespective of treatment. The SRI system of rice was followed which comprised of very young seedling (8-15 days

old), transplanting single seedling of Rice variety RP 2421 (120-125 days maturity) per hill at square pattern of 25cm x 25cm on a well prepared plot. The four sprays of liquid manures were scheduled after every 15 days interval, first spray was done 15 days after transplanting. The liquid manures were diluted 10 times with water prior to the spray except Himslurry (1 kg in 40 lit of water) and Panchgavya (750 ml in 10 lit water). All agronomic operations were kept normal and uniform for all the treatments. Data collected were statistically analyzed using the CPCS programmer.

Composition of different liquid manures

EM technology

EM stands for "Effective Micro-Organisms" and is a liquid culture with basically three genera of microorganisms i.e. lactobacilli, yeast and photosynthetic or phototrophic bacteria. EM solution was activated or extended by mixing one volume part EM with one volume part of jaggery and twenty volume parts of water (1:1:20). This mixture was placed in an airtight container and kept undisturbed in a shaded place of stable temperature to ferment for 5 – 10 days. After about one week i.e. when the pH had dropped to below 4, activated EM solution was used for the spray.

Himsol

It is prepared by using vermicompost (90 kg), cowdung (75kg), cow urine (10 lit), ash (500g), copper shri yantara (1 no), water (200 lit), and these all ingredients were put in a plastic container of 500 lit capacity. The 200 lit water and ash (250 g) were mixed and kept for 24 hrs. To this solution, 90 kg vermicompost, 75 kg cow dung, 10 lit cow urine and remaining 250 g ash were added. This solution was mixed properly and placed inside an airtight plastic container for about 3 months and thereafter the prepared himsol was used for spray.

Matkakhad

It is prepared by mixing one part cow dung (5 kg), one part cow urine (5 lit), one part water (5lit) and jaggery (250 gm) in the earthen pitcher (20 lit capacity) and buried under ground just keeping the mouth of the pitcher above the ground and covered with lid. The pitcher was placed under ground for 7 – 10 days with regular stirring before using it as a one of the liquid manure.

Compost T

Compost T is made by wrapping any prepared or ready to use compost (5 kg) in muslin cloth and dipped in water (15 l) for 7 – 15 days. With regular stirring for 7-10 days, the solution was used for spraying.

Himslury

It is a mixture of cow dung (40 kg), basalt powder (100g), eggshells (200g) and jaggery (50g). The mixture was fermented together with Matka khad (200 ml) for 2 to 3 months. After it's preparation, it was mixed with water at the rate of 1 kg in 40 lit of water. It was stirred for at least 10 minutes for creating oxygen supply to the aerobic microorganisms for their better growth and development.

Vermiwash

It is the liquid spray collected after the passage of water through a column of worm culture. It is a collection of excretory product and excess secretion of earthworms along with micronutrients from soil organic molecules. Earthworm body is long tubular type and celomic fluid is always secreted from earthworm body which keeps the body wet. This celomic fluid along with other liquids from the container were collected and termed as Vermiwash.

Panchgavya

It is prepared by mixing five by products procured from cow. The three direct constituents are cow dung

(4kg), cow urine (3 lit) and cow milk (2 lit). The two derived products are curd (2 lit) and ghee (1 kg). These all were mixed and allowed to ferment for 10-15 days. There after it was used as liquid manures (750 ml in 10 lit water).

Result and discussion

Physicochemical properties of liquid manures

All liquid organic manures were analyzed for pH (digital pH meter), organic carbon (Walkley and Blacks, 1934), nitrogen (Kjeldhal method), phosphorous (molybdenum blue method) and potassium (Flame photometer) (Table 1).

Microbial status: The nutrient status of different organic manures used in this study is given in Figure A. The microbial analysis of different liquid manures showed the presence of Bacteria, Fungi, *Actinomycetes*, *Azotobacter* and *P solubilizers*.

Microbes in the environment significantly influence the biogeochemical cycles of nitrogen and phosphorus. In the ecosystem, a mixed population of microbes such as bacteria, fungi and *actinomycetes* is essential to promote enzymatic degradation of naturally occurring compounds (Trivedi and Bhatt, 2006).

Table 1
Physicochemical properties of liquid manures

Organic manures	*EM Technology*	*Himsol*	*Matkakhad*	*Compost Tea*	*Himslury*	*Verminash*	*Panchgavya*
pH	5.8	7.0	6.0	7.5	6.5	7.5	5.68
OC (%)	5.60	5.04	5.16	—	5.17	—	5.1
Nitrogen (%)	2.62	1.81	1.36	1.39	1.02	1. 62	2.4
Phosphorus (%)	ND	0.079	0.029	0.020	0.022	0.046	0.062
Potassium (%)	ND	0.225	0.054	0.013	0.084	0.106	0.413

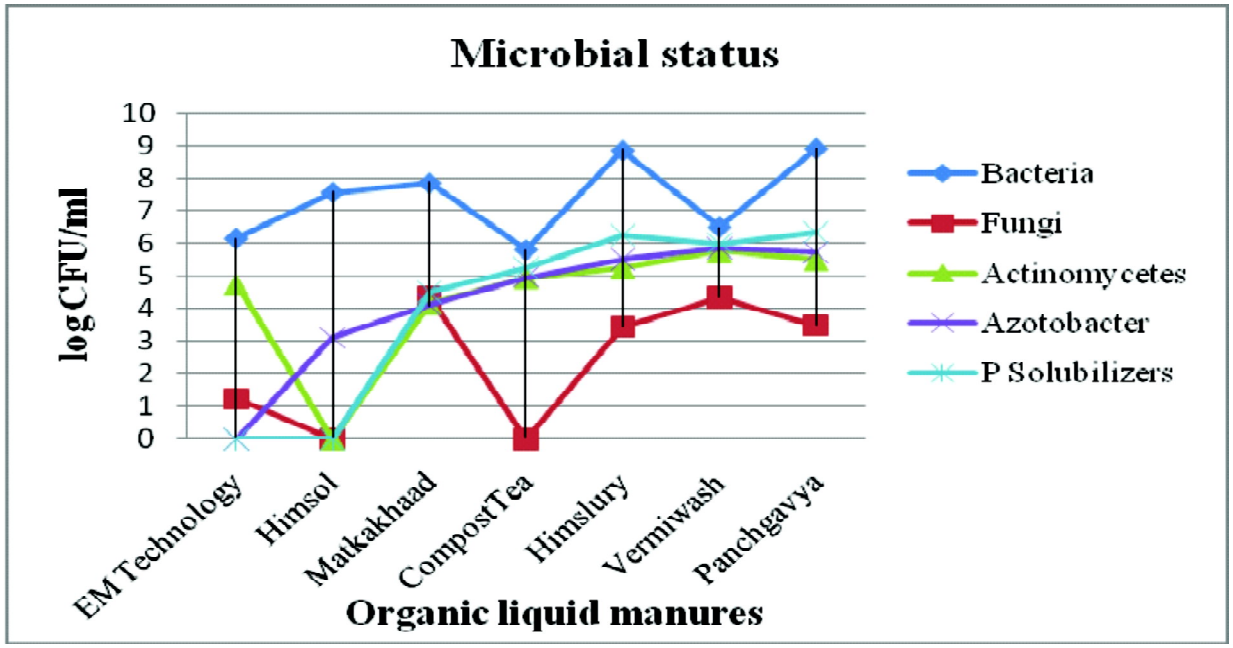

Figure A: Microbial status of liquid organic manures

The effect of different beneficial microbial population of liquid manures has been presented in Fig A. The pH of liquid manures ranged from 5.68 - 7.5 (Table 1) in which Himsol, Compost Tea and Vermiwash is nearer to neutral (7–7.5) and optimum for the growth of maximum microbes as stated by various workers (Selvakumar *et al.* 2008; Kalra *et al.* 2010). Himslury, Matkakhad , EM Technology and Panchgavya found to be acidic (5.68 – 6.5). Among liquid manures greater microbial loads for bacteria was found in Panchgavya (8.91 log cfu/ml), actinomycetes in Vermiwash (5.75 log cfu/ml), fungi in Matkakhad and Vermiwash (4.35 log cfu/ml), azotobacter in Vermiwash (5.85 log cfu/ml) and PSB in Panchgavya (6.34 log cfu/ml).

Rice yield and yield attributes

During the three years of study, yield attributing characters viz., plant height, tillers per meter row length, panicles per meter row length, 1000 grain weight, biological weight and yield of rice were influenced significantly by the application of EM Technology, Panchgavya, Himsol, Vermiwash, Matkakhad , Compost Tea and Himslury. The EM Technology increased grain yield by 29.49 %, 23.96 % and 33.22% during 2011, 2012 and 2013 respectably over absolute control. During 2012 Panchgavya produced 22.36% and Matkakhad produced 14.21% higher grain yield over the control. Similarly during the year 2013 Himsol produced 25.40% and Panchgavya produced 23.06% higher grain yield over absolute control. The pooled data for three years showed that EM Technology increased grain yield by 28.88 %, Panchgavya 23.44% and himsol 19.68% over the absolute control. (Table 3).

Plant height: Maximum plant height of rice plants in the year 2011 was observed in plots where Himslury was added and was statistically at par with Compost Tea and Matkakhad followed by Himsol and Panchgavya treatments. In 2012 maximum plant height was recorded in Himsol treatment which was at par with Matkakhad followed by Himslury. In 2013 Panchgavya treatment showed maximum plant height which was at par with Himslury, EM Technology, Himsol, and Matkakhad and followed by Vermiwash and Compost Tea. Pooled data for the three year showed maximum plant height in the treatment of Matkakhad which was at par with Himslury, Himsol, Compost Tea, EM Technology, Panchgavya, Vermiwash and the lowest value was recorded in control.

Number of Tillers/Plant: Data for total number of tillers for the first year were found to be not significant however the maximum value was found in Himslury treatment (Table 3). During the second year of study maximum tillers were found in Matkakhad which were statistically at par with EM Technology, Himsol, Himslury, Vermiwash and Panchgavya where as Vermiwash and Panchgavya found to be at par with Compost Tea followed by control. In case of third year the maximum tiller were found in the treatment EM Technology statistically at par with Panchgavya whereas Panchgavya treatment was at par with Himsol and Himslury treatments. The pooled data for the three year showed maximum panicles/plant in the treatment of EM Technology which was at par with Himsol, Himslury, Matkakhad , panchgavya, Vermiwash and Compost Tea and the lowest value was recorded in control. The enhanced and continuous supply of nutrients by the enriched organics lead to better tiller production and filled grain of rice (Sangeetha *et al*, 2013).

Panicles/plant: During the first year of study Himsol showed maximum number of panicles per plant which was statistically at par with Vermiwash and Panchgavya whereas Vermiwash treatment was statistically similar, during the second year of study all the spray treatments were at par with each other but significantly higher than the control. During the third year of study maximum panicles/ plant were

recorded in EM Technology treatment which were at par with Himsol, Panchgavya and Vermiwash whereas Vermiwash treatment was at par with Himslury. Significantly lower values were recorded in control. Pooled data showed that maximum panicles/plant were recorded in the treatment of himsol which was statistically at par with Vermiwash, Panchgavya and EM Technology whereas EM Technology was at par with Matkakhad , Himslury and compost tea. The lowest value was recorded in control that was found to be differing significantly with all the treatments.

1000 grains weight: Maximum numerical value of grain weight for the first year was found in EM Technology treatment however data was not significant. During the second year Vermiwash treatment showed maximum grain weight followed by Panchgavya which was at par with EM Technology and Matkakhad. Himslury treatment was found to be statistically at par with Compost Tea and Himsol. In the third year maximum grain weight was found with the application of EM Technology which was at par with Himsol, Panchgavya, Vermiwash and Matkakhad . The pooled value for the three years data showed maximum value of 1000 grain weight in the treatment of Vermiwash which was at par with EM Technology, Panchgavya, Matkakhad and himsol, whereas Himsol was statistically at par with Himslury followed by Compost Tea and control with minimum value.

Biological weight: During the three years of study maximum biological weight was recorded in EM Technology however the biological weight during 2011 was not significant among different treatments (Table 4). During the year 2012 EM Technology treatment was at par with Matkakhad and Himsol, whereas Matka khad and Himsol were significantly at par with Compost Tea and Panchgavya. In the year 2013 maximum biological weight (93.96 q/ha) was recorded in EM Technology followed by Himsol, which was significantly at par with Panchgavya, Vermiwash, Matkakhad and Himslury followed by Compost Tea. In the pooled values for the three years, maximum value was recorded in the treatment of EM Technology followed by himsol which was significantly at par with Matkakhad , Panchgavya, Compost Tea and Vermiwash followed by Himslury and minimum biological weight was recorded in absolute control. The application of EM technology, Himsol, Panchgavya and Matkakhad increased the microbial balance and diversity of agriculture soils and improved growth, yield attributes and yield of crop (Pairintra and Pakdee, 1994) It might be due to adequate supply of essential nutrient elements by liquid manure application which also increased the availability and uptake of other essential nutrients resulted in increased metabolic activities.

Yield: The application of EM Technology treatment recorded the highest yield during all the years of experimentation might be due to better supply of nutrients and microibes. During first year, maximum yield in the treatment of EM Technology was recorded being at par with Panchgavya, Himsol, Matkakhad treatments, whereas Panchgavya treatment was also at par with Compost Tea. Least grain yield of rice was obtained in control which was statistically at par with the yield obtained in the treatment of Himslurry and Vermiwash. In the second year, EM Technology treatment being at par grain yield with Panchgavya, Matkakhad , Himsol. Similarly Matkakhad treatment was at par with Himsol, Vermiwash, Compost Tea and Himslury. During the third year of study EM Technology produced significantly higher grain yield and was followed by himsol which was at par with Panchgavya and Vermiwash. Vermiwash was at par with Matkakhad whereas Matkakhad was statistically at par with Himslury followed by Compost Tea. In the pooled data of three years maximum yield was found in EM Technology which was significantly at par with Panchgavya which was at par with Himsol and Matkakhad where as Matka khad was significantly at

Table 3
Effect of liquid manures on different growth parameters of Rice

Treatments	*Plant Height(cm)*				*No of Tillers/plant*				*Panicles/Plant*			
	2011	*2012*	*2013*	*Pooled*	*2011*	*2012*	*2013*	*Pooled*	*2011*	*2012*	*2013*	*Pooled*
T1(EM)	93.8	117.2	103.3	**104.8**	22.20	18.86	18.82	**20.0**	13.96	11.00	16.27	**13.74**
T2(HMSL)	97.5	121.0	103.3	**107.3**	22.39	18.86	17.53	**19.6**	16.46	11.16	16.20	**14.61**
T3(MK)	100.8	119.4	103.3	**107.8**	22.26	19.13	17.07	**19.5**	14.30	11.33	14.40	**13.34**
T4(C-T)	100.9	115.9	101.5	**106.1**	22.04	16.60	16.40	**18.3**	14.01	10.33	14.00	**12.78**
T5(HMSLRY)	101.9	117.5	103.5	**107.6**	23.27	18.40	17.27	**19.6**	14.20	10.66	14.87	**13.24**
T6(VW)	91.4	112.3	101.5	**101.7**	21.72	17.86	17.13	**18.9**	15.34	10.33	15.93	**13.87**
T7(PNCH)	94.1	115.1	103.6	**104.3**	21.55	17.86	18.40	**19.3**	14.80	10.33	16.13	**13.75**
T8(C)	87.6	110.7	100.0	**99.43**	21.94	14.60	14.80	**17.1**	12.13	9.33	13.07	**11.51**
CD(P=0.05)	2.42	2.22	1.53	**4.43**	NS	1.51	1.2	**1.52**	1.75	1.04	1.06	**1.16**

Table 4
Effect of liquid manures on 1000 grain weight, biological and seed yield of rice.

Treatments	*1000 Grains Weight (g)*				*Biological Yield (q/ha)*				*Yield (q/ha)*			
	2011	*2012*	*2013*	*Pooled*	*2011*	*2012*	*2013*	*Pooled*	*2011*	*2012*	*2013*	*Pooled*
T1(EM)	25.27	24.19	26.92	**25.46**	70.64	106.9	104.35	**93.96**	30.56	31.04	33.04	**31.55**
T2(HMSL)	24.97	21.59	26.72	**24.43**	66.48	101.9	96.96	**88.45**	28.48	28.32	31.1	**29.30**
T3(MK)	24.17	24.17	26.24	**24.86**	64.7	103.84	94.93	**87.82**	28.32	28.6	29.35	**28.76**
T4(C-T)	23.97	21.6	25.54	**23.70**	63.75	99.79	90.05	**84.53**	27.23	26.54	26.18	**26.65**
T5(HMSLRY)	24.33	22.07	25.73	**24.04**	63.09	94.13	94.77	**84.00**	26.15	26.09	28.82	**27.02**
T6(VW)	23.73	26.73	26.25	**25.57**	63.97	93.57	95.49	**84.34**	24.7	26.66	30.43	**27.26**
T7(PNCH)	24.63	24.37	26.66	**25.22**	64.7	97.47	96.02	**86.06**	29.51	30.64	30.52	**30.22**
T8(C)	23.27	21.4	25.27	**23.31**	63.03	92.63	88.33	**81.33**	23.6	25.04	24.8	**24.48**
CD(P=0.05)	NS	2.19	1.03	**1.15**	NS	6.87	3.47	**4.40**	3.31	4.19	1.44	**1.92**

EM= Effective microbes, HMSL= Himsol, MK= Matka khad, C-T= Compost tea, HMSLRY= Himslurry, VW= Vermiwash, PNCH= Panchgavya, C= Control

par with Vermiwash and Himslury followed by Compost Tea and control was having minimum yield. The EM Technology increased grain yield by 28.88%, Panchgavya 23.44% and himsol 19.68% over the absolute control.

CONCLUSION

The use of organic liquid manures (EM Technology, Himsol, Matkakhad, Compost Tea, Himslury, Vermiwash and Panchgavya) with the use of solid compost basal dose (vermicompost) increased the yield and yield attribute in treatment over control. There is a great scope of improving crop production with the help of organic liquid manures in SRI system of rice cultivation.

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