



# Evaluation of Different Enriched Composts under Protected Organic Farming in Capsicum-pea based Cropping System

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## ABSTRACT

**Background:** For the successful adoption of organic farming especially under protected cultivation conditions there is a dire need to enrich and fortify the different composts for meeting out the requirements of crops. Experiments were conducted at Model Organic Farm, Department of Organic Agriculture and Natural Farming, CSKHPKV, Palampur and at farmers field in Akrot, Una and Rajol Kangra of HP with an objective to evaluate different enriched composts under protected organic farming conditions.

**Methods:** The experiments were conducted with 9 treatments viz. Matka khad (M) + Rock phosphate (RP), Matka khad + Gypsum (G), Matka khad + Patent kali (PK), Matka khad + Lime (L), Matka khad + control, Matka khad + Combination of RP,G,PK,L + *Tricoderma* + *Rhi/Azoto* + PSB, Panchgavya + Combination of RP,G,PK,L + *Tricoderma* + *Rhi/Azoto* + PSB, Jeevamrit + Combination of RP,G,PK,L + *Tricoderma* + *Rhi/Azoto* + PSB and Vermicompost. These treatments were selected after preparation of enriched and fortified FYM and its evaluation by microbial and nutrient analysis. Pea crop variety Pb-89 and Capsicum crop variety California wonder were selected for the experiments under polyhouse at research farm and at farmer's field.

**Result:** Results showed that inoculation of biomass with matka khad along with additives i.e. rock phosphate, gypsum, patent kali and lime @ of 1% and fortification with *Tricoderma*, suitable biofertilizer (*Rhizobium/Azotobacter*) along with PSB increased the yield of Pea crop more than 40% at organic farm and farmers fields, whereas in case of capsicum the increase in yield was to the tune of 14% at model organic farm and more than 40% at two different sites of farmers field.

**Key words:** Bio-fertilizers, Enriched, FYM, Liquid manure, Organic, Permitted additives.

## INTRODUCTION

Agricultural soil has been adversely affected by chemical fertilizers, pesticides and heavy machinery and it has been observed that most of the soils are not responding towards productivity. On the other hand growing awareness of health and environmental issues in agriculture has demanded production of organic food which is emerging as an attractive source of rural income generation. Various organic manures like farm yard manure, vermicompost, green manure etc., that are added to the soil from time to time further add to the store of organic matter (Palaniappan and Annadurai, 1999). But the main problem usually farmers faced is that all organic manures are low in nutrient status which is insufficient to meet the basic requirement of crop so the need for the fortification or enrichment of compost with different natural substrates and microbes arises which will improve the quality of the compost in terms of nutrient status and microbial population. Nyamangara *et al.* (2003) reported that the organic waste composted manure application even enhanced the use efficiency of mineral nitrogen fertilizer by crops when the two were applied in combination. Under such circumstances, enrichment of organic manures and composts with permitted additives like rock phosphate, patent kali, bone manure, gypsum, lime, oil seed cake/cotton cake, sheep droppings and neem cake is a feasible option for nutrient supplementation in organic food production. Composting is one of the biological processes for recycling of organic waste and can be handled, stored and applied to land without any environmental impact (Eghball *et al.*, 2004). Considering the above mentioned challenges the green

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biomass to be used for composting was treated with different liquid preparations viz; Matka khad, Panchgavya, Jeevamrit along with water considered as control with the objective of decreasing the period of its preparation and it was enriched with the different additives and microbes to form the enriched fortified compost. The objective of the present study was to evaluate the effect of fortified enriched compost under protected organic farming at Research farm and at farmers' field.

## MATERIALS AND METHODS

The experiment was conducted at Research Farm of Department of Organic Agriculture and Natural Farming, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur at an altitude of 1290.8 metre

a.m.s.l with latitude 32°6' N and longitude 76°3' E and at two different farmers' sites at Akrot in Una at an altitude of 369 metre a.m.s.l with latitude 31°4' N and longitude 76°3' E and Rajol in Kangra at an altitude of 733 metre a.m.s.l with latitude 32°1' N and longitude 76°3' E. The Research farm area represents the mid-hill wet temperate zone of Himachal Pradesh. Different organic inputs like Matka khad, Panchgavya, Jeevamrit etc were used for preparation of enriched compost (Table 1). After the preparation of enriched compost and its evaluation, shortlisted treatments were tested under protected conditions at Research farm and at farmers' field. Capsicum crop variety California wonder was transplanted on 20<sup>th</sup> May with spacing of 50x30 cm and first picking was taken on 2<sup>nd</sup> July which continued up to 20<sup>th</sup> August. Pea crop variety PB-89 was sown with spacing of 50 × 5 cm on 12<sup>th</sup> November and its first pick was taken on 4<sup>th</sup> April which continued up to 25<sup>th</sup> May.

#### Preparation of enriched compost

#### Collection of green biomass and its inoculation with liquid manure

Two to three days old green biomass was collected and

placed in the form of heaps on 1 m<sup>3</sup> area. Three inoculants namely matka khad, panchgavya, jeevamrit and water (control) were sprinkled over biomass layer by layer at the rate of 2 lt. liquid manure per quintal biomass. This treated biomass was kept for 15 days for decomposition.

#### Enrichment of main material (cow dung)

After the partial decomposition of green material, it was enriched with different enrichments namely rock phosphate, gypsum, patent kali, combination of three (rock phosphate, gypsum, patent kali) along with control as per treatment. Other inputs such as bone manure, sheep droppings and oilseed cakes were also added as common in all the treatments. In order to upgrade nutrient content of the compost, nitrogen fixing bacteria, rock phosphate and phosphate solubilising microorganisms has been documented (Singh *et al.*, 1992; Pazhanivelan *et al.*, 2006). Five treatments per liquid manure were experimented.

#### Fortification of enriched manures

After the preparation of the enriched compost, this compost was further fortified with biofertilizers *viz*; *Rhizobium*,

**Table 1:** Different organic inputs and method of preparation.

Name of the inputs	Ingredients	Method of preparation
Matka khad	Cow dung = 5 kg Cow urine = 5 lt. Water = 5 lt. Jaggary = 250 gm Earthen Pitcher = 1 no. of 20 lt. capacity	Thoroughly mix 5kg of cow dung, 5lt. cow urine, 5lt. water and 250gm of jiggery and put in a pitcher of 20 lt. capacity. The pitcher is filled up to ¾ level only, for effective fermentation. A lid is placed over the pitcher and buried in the soil for 7 to 10 days with its neck outside the soil.
Panchgavya	Cow dung = 5 kg Cow urine = 3 lt Cow dung slurry = 4 kg Cow milk = 2 lt. Cow curd = 2 kg Cow butter oil = 1 kg (ghee)	It is a blend of 5 product obtained from cow mainly its dung, urine, milk, ghee and curd. For making Panchgavya, thoroughly mix the required quantities of the ingredients and allow to ferment for 7 days with twice stirring per day.
Jeevamrit	Cow dung = 5 kg Cow urine = 5 lt. Water = 50 lt. Jaggary = 1 kg Pulse flour = 1 kg Fertile soil = 1/2 kg	Mix all the ingredients in a drum with the help of a wooden stick. Shake the mixture 2-3 times per day regularly for 5-7 days for proper fermentation.
Vermiwash	Pitchers = 3 Earthworms ( <i>Eisenia foetida</i> ) = 200-300 (No) Dung = 4-5 Kg Dry Biomass = 3-5 Kg Pebbles = few Rubber Pipe = 1m Rope = 1-2 m	Vermiwash was prepared by using three pitchers. In one of the pitcher a hole was made at base and rubber pipe was fitted to it. In this pitcher few pebbles were placed and 2-3 inches layer of sand was spread at the bottom of the pitcher. Above this, a layer (5cm) of dry biomass was also spread which was further covered by a layer (5 cm) of cow dung. Then repeat these two layers. As the material was filled up to 2/3 of pitcher, 200-300 adult earthworms ( <i>Eisenia foetida</i> ) were added to it. A little biomass along with water was added to it and the pitcher was hanged with the help of plastic rope under a shady area. Another pitcher with a hole at the bottom and filled with water was placed above the pitcher mentioned above so that water got trickled drop wise in the pitcher having earthworms. Another empty pitcher was placed below it to collect the vermiwash.

**Table 2: Details of enrichments and fortification.**

I.D	Main material	Treated biomass	Enrichment	Other inputs	Fortification
MK+RP	1. Partial decomposed biomass-30 kg 2. Cow dung- 450 kg	MK treated grass-20 kg	RP-2 kg	1. Bone manure-2kg 2. Sheep droppings -6 kg 3. Oil seed cake-6 kg	1. Tricoderma 2. Rhizobium/Azotobacter 3. PSB 4. Comb (Tricoderma + Rhizobium/Azotobacter + PSB) 5. Control
MK+Gyp.	-do-	-do-	Gyp - 2kg	-do-	(As per treatment)
MK+PK	-do-	-do-	PK - 2kg	-do-	
MK+(RP+Gyp+PK).	-do-	-do-	Comb.( RP + Gyp + PK)-2kg	-do-	
MK+C	-do-	-do-	Nil	-do-	
P+RP	-do-	P treated grass- 20 kg	RP-2kg	-do-	
P+Gyp.	-do-	-do-	Gyp.-2kg	-do-	
P+PK	-do-	-do-	PK- 2kg	-do-	
P+(RP+Gyp+PK).	-do-	-do-	Comb.( RP + Gyp + PK)-2kg	-do-	
P+C	-do-	-do-	Nil	-do-	
J+RP	-do-	Jeevamrit treated grass- 20 kg	RP-2kg	-do-	
J+Gyp.	-do-	-do-	Gyp.-2kg	-do-	
J+PK	-do-	-do-	PK- 2kg	-do-	
J+(RP+Gyp+PK).	-do-	-do-	Comb.( RP + Gyp + PK)-2kg	-do-	
J+C	-do-	-do-	Nil	-do-	
W+RP	-do-	Water treated grass- 20 kg	RP-2kg	-do-	
W+Gyp	-do-	-do-	Gyp.-2kg	-do-	
W+PK	-do-	-do-	PK- 2kg	-do-	
W+(RP+Gyp+PK)	-do-	-do-	Comb.( RP + Gyp + PK)-2kg	-do-	
W+C	-do-	-do-	Nil	-do-	

\*MK-Matka khad, P- Panchgavya, J- Jeevamrit, W- Water, RP- Rock phosphate, Gyp- Gypsum, PK- Patent kali, Comb.- Combination, C- Control, PSB- Phosphate solubilisers bacteria.

*Trichoderma*, phosphate solubilizers, combination of three [*Rhizobium*, *Trichoderma*, phosphate solubilizers (PSB)] and control in case of peas, whereas in case of capsicum *Azotobacter* was used. Fortification was done in pots containing 3 kg compost at the rate of 1 kg *Trichoderma* and 250g *Rhizobium*/*Azotobacter* and PSB per 25 kg compost. This fortified compost was used for conducting trials. The addition of compost or organic manure is an important way to improve the soil in degraded areas since nitrogen and other nutrients, as well as organic matter which improves soil structure, was added with the organic material (Caravaca *et al.* 2002; Muthukumar and Udaiyan, 2000, Nziguheba *et al.* 2000; Shrestha Vaidya *et al.* 2008). Polyhouse trial was conducted in 250 m<sup>2</sup> area and best nine treatments were short listed on the basis of basic study and were further evaluated in the field conditions. Enriched and fortified compost was amended in the soil in separate plots according to treatments.

To manage different insect pest and diseases following spray schedule was followed.

Spray schedule: After 15 days of germination at 15 days interval.

- Milk (1 lt.) + heeng (50g) in 10 lt. water spray.
- Neem oil (5 ml in 1 lt. water).
- Vermiwash (2 lt.) + panchgavya (1 lt.) in 15 lt. water.
- Milk (1 lt.) + heeng (50g) in 10 lt. water spray.

In addition to this vermiwash drip was followed at weekly interval to meet out the nutrient requirements of the crops and initially at sowing or transplanting vermicompost was added in soil @ 10t/ha.

## RESULTS AND DISCUSSION

### Trial conducted at Research Farm

#### Evaluation of different enriched composts in peas under polyhouse

It was found that, different enriched composts improved plant population, most of the yield attributes and significantly produced higher yield as compared to vermicompost except MK + control which was significantly at par with vermicompost treatment. Yield from the treatments of MK + (RP+Gyp+PK) + (Tri+PSB+Rhi) and MK + Lime were the highest among all the treatments and was 39 % higher than the vermicompost treatment followed by MK+ Gypsum 35% higher (Table 3).

#### Evaluation of different enriched composts in capsicum under polyhouse

The different enriched composts significantly increased the height of plants as compared to vermicompost treatment except in MK + RP treatments where the plant height did not vary significantly. Tallest plants were recorded in MK + Gypsum treatment, significantly at par with the MK + PK treatment. Different enriched composts significantly increased the number of fruits/m<sup>2</sup> in some of the treatments as compared to vermicompost treatment. Significantly higher number of fruits/m<sup>2</sup> were recorded in MK + Gypsum

Table 3: Effect of different enriched composts on yield and yield attributes of peas.

Treatments	No of days to (50%) flowering	No. of plants/treat.	Plant height (cm)	No. of pods/m <sup>2</sup>	Length of pods (cm)	Grains/ pod	Shelling % (q/ha)	Yield (q/ha)
Matkakhad (MK) +(RP+Gyp+PK)+(Tri+PSB+Rhi)	102.0	96.0	80.94	462.2	9.44	8.25	43.51	170.00
Panchgavya (P) +(RP+Gyp+PK)+(Tri+PSB+Rhi)	103.5	95.5	96.21	322.6	8.80	6.86	41.89	138.30
Jeevamrit (J) +(RP+Gyp+PK)+(Tri+PSB+Rhi)	103.5	91.5	80.99	347.4	9.37	7.46	37.46	148.48
MK+RP	104.5	88.5	97.73	360.7	9.06	7.97	43.80	154.23
MK+ Gyp	102.0	94.0	97.16	382.8	9.29	8.05	41.07	165.41
MK+control	103.5	89.0	90.48	304.7	8.06	8.17	37.69	113.56
MK+ PK	102.0	94.0	79.52	339.4	8.86	7.92	39.67	146.53
MK+ Lime	100.0	90.0	93.83	461.3	9.88	8.50	43.28	170.05
Vermicompost	102.0	87.5	96.19	452.9	8.42	7.82	42.54	122.05
CD (P = 0.05).	4.0	6.3	7.60	90.7	0.50	1.25	3.84	9.45

RP- Rock phosphate, Gyp- Gypsum, PK-Patent kali, Tri- Trichoderma PSB-Phosphate solubilisers Bacteria, Rhi-Rhizobium.

**Table 4:** Effect of different enriched composts on yield and yield attributes of Capsicum.

Treatments	Plant height (cm)	No. of fruits/m <sup>2</sup>	Yield (q/ha)
Matka khad (MK) + (RP+Gyp+PK) + (Tri+PSB+Azo.)	136.2	13.6	143.8
Panchgavya (P) + (RP+Gyp+PK) + (Tri+PSB+Azo.)	127.6	12.4	140.0
Jeevamrit (J) + (RP+Gyp+PK) + (Tri+PSB+Azo.)	135.0	13.4	145.7
MK+RP	111.5	12.0	138.0
MK+Gyp	204.4	15.4	149.5
MK+control	165.1	10.0	120.2
MK+PK	192.2	13.8	138.1
MK+Lime	184.2	12.8	125.7
Vermicompost	116.3	11.4	126.2
CD ( $\rho = 0.05$ )	12.2	1.0	8.1

RP- Rock phosphate, Gyp- Gypsum, PK- Patent kali, Tri- Trichoderma PSB- Phosphate solubilisers bacteria, Azo-Azotobacter.

**Table 5:** Microbial status of different organic manures.

Treatments	Microbial count (log CFU)				
	Bacteria	Fungi	Actinomycetes	Azotobacter	PSB
Matka khad (MK) + (RP+Gyp+PK) + (Tri+PSB+Rhi)	9.61	3.60	4.43	4	2.28
Panchgavya (P) + (RP+Gyp+PK) + (Tri+PSB+Rhi)	8.47	3.25	5.62	4.99	2.41
Jeevamrit (J) + (RP+Gyp+PK) + (Tri+PSB+Rhi)	8.51	2.30	4.56	4.82	ND
MK+RP	9.10	3.48	5.02	4.74	2.03
MK+Gyp	9.37	3.69	5.24	4.94	ND
MK+control	9.34	2.60	5.91	4.93	ND
MK+PK	9.54	3.30	ND	4.69	2.17
MK+Lime	9.34	3.74	5.03	4.82	ND
Vermicompost	7.74	5.54	7.15	6.26	5.57

RP- Rock phosphate, Gyp- Gypsum, PK- Patent kali, Tri- Trichoderma PSB- Phosphate solubilisers bacteria, Rhi- Rhizobium.

treatment followed MK + (RP+Gyp+PK) + (Tri. + PSB + Azo.). Maximum capsicum yield was obtained with the treatment MK + Gypsum which was 18.5 % higher than the application of vermicompost treatment. Although MK + (RP+Gyp+PK) + (Tri. + PSB + Azo.), P + (RP+Gyp+PK) + (Tri. + PSB + Azo.) and J + (RP+Gyp+PK) + (Tri. + PSB + Azo.) treatments were significantly at par with the treatment MK + Gypsum (Table 4).

#### Microbial status of different organic manures

Among various treatments bacteria count ranged from 7.74-9.61, maximum values of bacteria were recorded in Matka khad + (RP+Gyp+PK) + (Tri. + PSB + Rhi.) treatment and minimum in vermicompost. Fungi values varied from 2.30-5.54, maximum in vermicompost and minimum values were recorded in Jeevamrit + (RP+Gyp+PK) + (Tri. + PSB + Rhi.) treatments. Values of Actinomycetes were maximum in vermicompost 7.15 and minimum in MK + (RP+Gyp+PK) + (Tri. + PSB + Rhi.) 4.43. Similar results were recorded for *Azotobacter*. For most of the treatments PSB were not detected and maximum values was recorded in vermicompost treatment (Table 5).

#### Nutrient status of different organic manures

The pH of the treatments ranged from 5.6-7.4 and the highest value in MK + (RP+Gyp+PK) + (Tri. + PSB + Rhi.) and lower value in vermicompost was recorded (Fig 1). Nitrogen

content ranged from 1.05-1.97 and found maximum content in MK + Lime followed by MK + RP and MK + gypsum. Phosphorus percentage found maximum in MK + (RP+Gyp+PK) + (Tri. + PSB + Rhi.) and minimum in MK + lime, whereas, Potassium varies from 0.34-1.04 with maximum value MK + (RP+Gyp+PK) + (Tri. + PSB + Rhi.) followed by P + (RP+Gyp+PK) + (Tri. + PSB + Rhi.). Other elements like Ca, Mg and S also shows similar results with higher values in MK + (RP+Gyp+PK) + (Tri. + PSB + Rhi.) followed by MK + Lime.

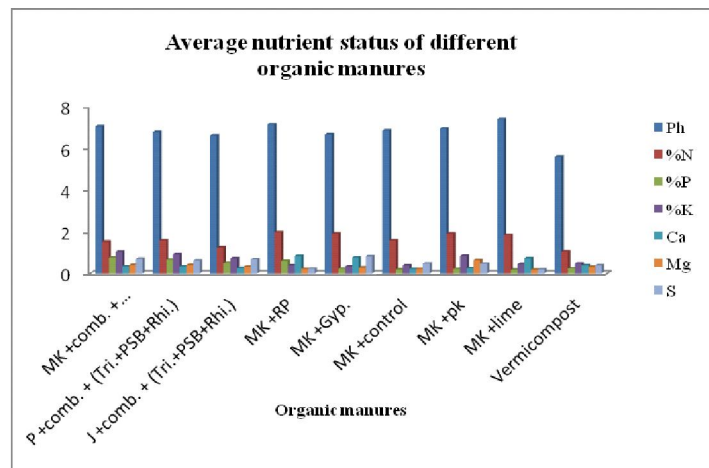
#### Trial conducted at farmer's fields

##### In Akrot (Una)

Capsicum and pea crops were tested under polyhouse conditions. The different enriched composts significantly increased yield of both crops as compared to vermicompost except MK + Gypsum, MK + control, MK + PK, MK + Lime treatments where the yield in case of capsicum was significantly at par with each other. In capsicum and Pea crops maximum yield was recorded in MK + (RP+Gyp+PK) + (Tri. + PSB + Azb.) which was 45 % and 61% higher than application of vermicompost (Table 6).

##### In Rajol (Kangra)

The different enriched composts significantly increased the capsicum and pea yield as compared to application of vermicompost. In case of pea crop MK + Lime treatment



**Fig 1:** Average nutrient status of different organic manures.

\*MK- Matka khad, P- Panchgavya, J- Jeevamrit, Comb. - (RP+Gyp+PK), RP- Rock phosphate, Gyp- Gypsum, PK- Patent kali, Tri- Trichoderma, PSB- Phosphate solubilisers bacteria, Rhi- Rhizobium.

**Table 6:** Effect of different enriched composts on yield of capsicum and peas crops under farmers' fields under polyhouse conditions.

Treatments	Akrot Una		Rajol Kangra	
	Capsicum yield (q/ha)	Pea yield (q/ha)	Capsicum yield (q/ha)	Pea yield (q/ha)
Matka khad (MK) + (RP+Gyp+PK) + (Tri+PSB+Rhi/Azo)	140.23	178.20	135.32	130.25
Panchgavya (P) + (RP+Gyp+PK) + (Tri+PSB+Rhi/Azo)	108.58	120.54	110.12	122.59
Jeevamrit (J) + (RP+Gyp+PK) + (Tri+PSB+Rhi/Azo)	135.25	168.35	125.85	122.54
MK+RP	115.08	167.42	110.25	128.25
MK+Gyp	100.25	145.30	100.58	125.45
MK+control	98.50	125.45	106.18	100.25
MK+PK	95.52	140.25	116.35	100.24
MK+Lime	91.25	135.20	100.74	92.45
Vermicompost	97.04	110.36	91.65	90.47
CD ( $\rho = 0.05$ )	6.52	8.25	8.20	7.10

RP- Rock phosphate, Gyp- Gypsum, PK- Patent kali, Tri- Trichoderma, PSB- Phosphate solubilisers bacteria, Rhi- Rhizobium, Azo- Azotobacter.

produced yield significantly at par with vermicompost. In capsicum and pea maximum yield was recorded in MK + (RP+Gyp+PK) + (Tri. + PSB + Rhi/Azb.) which was 48% and 44% higher than application of vermicompost respectively. In capsicum application of J + (RP+Gyp+PK) + (Tri. + PSB +Azb.) was the second best treatment which produced 37% higher production as compared to application of vermicompost, whereas in case of peas MK + RP treatments was significantly at par with J + (RP+Gyp+PK) + (Tri. + PSB +Rhi.) (Table 6).

## CONCLUSION

It was found that the inoculation of biomass with matka khad and use of additives *i.e.* rock phosphate, gypsum, patent kali and lime @ of 1% and fortification with *Tricoderma*, suitable biofertilizer (*Rhizobium/Azotobacter*) along with PSB improved the microbial count, increased yield of pea crop

(40 to 61%) and capsicum crop (14 to 48%) both at organic farm and farmers' fields as compared to application of vermicompost alone.

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