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Agronomic Evaluation of Biodynamic preparations and *Panchagavya* for organic cultivation in North Western Indo-Gangetic Plains, India

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ABSTRACT

A field experiment was conducted during 2012-13 to evaluate the effects of biodynamic preparations and Panchgavya in combinations with FYM and vermicompost on productivity, profitability and soil health under different cropping systems. The treatments comprised two cereal based cropping systems and six organic nutrient management practices consisting biodynamic preparations and Panchgavya in combinations with FYM and vermicompost. Results revealed that application of BD- FYM + vermicompost + Panchgavya being at par with BD- FYM + vermicompost recorded significantly higher grain and biological yield of different crops under study. BD-FYM + vermicompost + Panchgavya registered 11.1, 8.80, 10.2, 6.50 and 33.7 % improvement in grain yield and 9.40, 7.10, 11.8, 11.1 and 23.0 % improvement in biological yield of rice, wheat (sole), maize, wheat (intercropped) and mustard, respectively compared to FYM + vermicompost. Maize + cowpea – wheat + mustard cropping system recorded higher system productivity, N, P and K uptake, available N in soil as compared to basmati rice–wheat cropping system. Soil organic carbon, available P and K differed non-significantly among the cropping systems. Irrespective of cropping systems, the application of BD-FYM + vermicompost + Panchgavya recorded the highest system productivity; net return, N, P and K uptake; and organic carbon, available N, P and K in soil.

Key words: Biodynamic farming, basmati rice, cropping system, organic manures, *Panchagavya*

INTRODUCTION

Imbalanced use of chemicals and second generation problems of green revolution in agriculture has weakened the ecological base in addition to degradation of soil, water resources food quality, crop productivity and farm profitability especially in cereal based intensive cropping systems in the country in general and especially North India. Human health hazards and environmental degradation associated with this input intensive cropping systems has renewed the interest in the organic cultivation of crops. Global warming led climate changes are further aggravating the farming situation. Hence, the current scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable food production. Awareness has sprung on the adoption of organic farming as an alternate to modern chemical agriculture (Kannaiyan, 2000). Demand and market for organic produce is growing globally. With increased awareness on organic farming, in addition to the organic manures and biofertilizers as source of nutrients, many organic formulations like *Panchgavya* and biodynamic preparation are being advocated and practiced for increasing the yield and quality of food. *Panchagavya* is a fermented product made from five ingredients obtained from cow, such as milk, urine, dung, curd and clarified butter (Amalraj *et al.,* 2013) and it contains macro and micro nutrients, vitamins, essential amino acids, growth promoting substances like IAA, GA and beneficial microorganisms (Sreenivasa *et al.*, 2010). The use of *Panchagavya* results in higher growth, yield, and quality of crops (Choudhary *et al.,* 2014). Biodynamic farming has recently emerged as an advancement of organic agriculture. In addition to the common tools of organic agriculture, it utilizes specific fermented herbal preparations as compost additives and field sprays. These unique preparations consist of specific minerals or plants treated or fermented with animal organs, water, and/or soil (Steiner, 1974) and they are added to composting organic material in very low doses to stimulate the processes of nutrient and energy cycling, hasten decomposition and to improve soil and crop quality (Koepf, 1993). As a nutrient source, biodynamic FYM has been shown to increase soil organic C and N (Abele, 1978), microbial biomass and biological activity (Mader *et al.*, 1995) as compared to fertilization without biodynamic preparations.

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The positive impact of biodynamic practices and *Panchgavya* alone or in combination with various organic nutrient management practices has been found in various crops (Chandrakala, 2008). However, very scarce literature is available showing the impact of biodynamic preparation and P*anchgavya* either alone/ in combination with various other organic nutrient resources under different cereal-cereal cropping systems. Therefore, the present field trials were undertaken to find the efficacy of the biodynamic preparations and *Panchgavya* along with various organic nutrient management practices on productivity, profitability and soil health under different cropping systems in North Western Indo-Gangetic plains of India.

MATERIALS AND METHODS

A field experiment was conducted during rainy and winter season of 2012-13 at research farm of ICAR-IIFSR, Modipuram, Meerut (UP), India (29.4' N latitude, 77.5' E longitude and 230 m amsl). It falls under the North western plain agro-climatic zone. The climate of Modipuram is broadly classified as semi-arid sub-tropical characterized by very hot summers and cold winters. The rainfall during cropping seasons was 237 mm. The soil at site was Typic Ustochrept deep sandy loam with pH 8.0, low in organic carbon (0.44), low in available N (163 kg ha^{-1}), medium in available P (18.7 kg ha^{-1}) and K (185 kg/ha). The experiment was carried out in split plot design with three replications. The treatments comprise two cropping systems i.e. basmati rice – wheat (CS_1) and maize + cowpea – wheat + mustard (CS_2) as main plot treatments and six organic nutrient management practices *viz*., Control (T_1), FYM + vermicompost (T_2), Biodynamic (BD)-FYM (T_3), FYM + vermicompost + *Panchgavya* (T_4), BD- FYM + vermicompost (T_5) and BD- FYM + vermicompost + *Panchgavya* (T_6) in sub plots. The FYM and vermicompost were applied to basmati rice, maize and subsequent wheat equivalent to 70, 80 and 120 kg N ha^{-1}, respectively and the intercrops were raised without additional nutrients. The 50% of N requirement of the crops was met through FYM and remaining 50 % through vermicompost.

Panchgavya was prepared by mixing nine products viz., cow dung, cow urine, cow milk, cow curd, cow ghee (of local breeds of cow), water, tender coconut water, jaggery and well ripened banana in the ratio of 7:10:3:2:1:10:3:3:2. Initially, cow dung and cow ghee was mixed thoroughly both in morning and evening hours and kept for 3 days. After 3 days cow urine and water was mixed and kept for 15 days with regular stirring both in morning and evening hours. After 15 days the remaining ingredients were mixed and *Panchagavya* was ready after 30 days. The biodynamic preparations include specifically fermented six different herbal substances numbered 502-507 obtained from Supa Biotech (P) Ltd., Nainital, (Uttarakhand). The preparations are added in small amounts to composting FYM as per the prescribed procedure. The manure application schedule included incorporation of FYM/BD-FYM in soil at final land preparation (15 days before sowing) and the vermicompost was applied at first irrigation. For spraying *Panchagavya,* 3 % solution was used in 500 liters of water. Spraying rice, maize and wheat was done thrice at 30, 45 and 60 days of sowing/transplanting. The cultural practices of crops raised for experimentation are given in Table 1.

The observations on growth attributes, yield attributes and yield of different crops were recorded through standard procedures. Plant samples (grain and straw) were collected at harvest and analyzed for NPK content based on plant biomass production nutrient uptakes were estimated. Surface soil samples (15 cm depth) were collected at the end of cropping cycle and analyzed for organic carbon, available N, P and K content by following standard laboratory procedures. Production economics of different crops was calculated based on prevailing market prices of different inputs and crop produce. For returns, 20 % premium price was assumed for organic produce. System productivity was estimated in terms of Basmati Rice Equivalent Yield (BREY) as per the formulae; BREY = Yx (Px / Pr), where; Yx is the yield of non-rice crops (q ha^{-1}), Px is the price of non-rice crops (Rs./q), and Pr is the price of rice. The data pertaining to each parameter were subjected to statistical analysis by using the technique of analysis of variance and their significance was tested by “F” test (Gomez and Gomez, 1984). Where significant differences were detected, the means were separated by the least significant difference (LSD) at 5 % probability level.

Table 1: Cultural practices of different crops under experimentation

Particulars	Basmati rice	Maize	Cowpea	Wheat	Mustard
Variety	B-370	Star-56	Pusa Barsati	PBW-343	Pusa bold
Sowing/ transplanting time	Second week of July	First week of July	First week of July	Last week of November	Last week of November
Planting geometry (cm)	20 x 15	60 x 20	intercropped with maize in 1:1 ratio	20 x 5	intercropped with wheat in 4:1 ratio
Seed rate (kg ha^{-1})	25	20	12	100	4
Irrigations	11	4	*Intercrop*	6	*Intercrop*
N:P:K recommendation (kg/ha)	70:50:50	80:60:40	-	120:60:60	-
Weed control	Two hand weedings				

RESULTS AND DISCUSSION

Economic Yield and Biomass production

Application of BD-FYM + vermicompost + *Panchgavya* (T_6) being at par with BD-FYM + vermicompost (T_5) recorded significantly higher grain and biological yield of basmati rice (46.2 and 123 q/ha), maize (53.8 and 133 q ha^{-1}), wheat (sole, 47.0 and 116 q/ha), cowpea (2083 kg/ha pods and 2668 kg/ha stover), wheat (intercropped, 40.8 and 104 q/ha) and mustard (6.39 and 25.1 q/ha) as compared to other treatments and control (Table 2). There are several reasons for increased yield of different crops due to application of BD-FYM and spray of *Panchagavya*. Smaller quantities of IAA and GA present in *Panchagavya* could have created stimuli in the plant system which in turn increased the production of growth regulator in cell system which stimulated the necessary growth and development, leading to better yield (Choudhary *et al.*, 2017). The grain and biological yield of all the crops under trial was also significantly higher under FYM + vermicompost (T_2) as compared to control (T_1) and BD-FYM (T_3) which indicates that BD treated FYM provided the nutrients and plant growth promoting substances but they may not be sufficient to show the early growth and development of the crop which contributes finally to yield. Similarly, although grain and biological yield of all the crops was found higher under BD-FYM + vermicompost (T_5) as compared to FYM + vermicompost (T_2) but it could also not make significant differences which shows that treatment of FYM with BD preparations could not make substantial differences in growth and yield attributes to contribute to yield. These findings are in line with Doring *et al*, (2015) as they also observed no yield differences between the organic and the biodynamic system. However, BD-FYM + vermicompost + *Panchgavya* (T_6) having BD and *Panchgavya* as additional component registered 11.1, 8.80, 10.2, 6.50 and 33.7 % improvement in grain yield and 9.40, 7.10, 11.8, 11.1 and 23.00% improvement in biological yield of rice, wheat (sole), maize, wheat (intercropped) and mustard, respectively over FYM + vermicompost (T_2). This might be ascribed to the increased availability of nutrients at initial stage through BD-FYM in addition to nutritional and other benefits from *Panchgavya* spray which might have created favorable effect on vegetative growth and yield attributes having significant positive correlation with seed and straw yield. The fermented liquid organic manures also contain microbial load and plant growth promoting substances in addition to nutrients that help in improving plant growth, metabolic activities and resistance to pest and diseases (Gore and Sreenivasa, 2011). These findings are in confirmity with those reported by Somasundaram *et al.,* (2003) and Mudigoudra and Balikai (2009).

Further, the same treatment i.e. T_6, having only BD as additional component recorded 5.50, 5.40, 4.30, 4.10 and 16.00% improvement in grain yield and 6.20, 2.30, 8.40, 10.1 and 7.70 % improvement in biological yield of rice, wheat (sole), maize, wheat (intercropped) and mustard, respectively over FYM + vermicompost + *Panchgavya* (T_4). These trends clearly indicates that BD *per se* cannot be substitute for nutrients in soil but it could enhance the growth of the plant due to favorable soil microbial conditions and other growth promoting substances which in combination with

Panchgavya enhanced yield up to the level of statistical significance. Earlier studies also show that BD preparations cause the greatest effect under poor yielding conditions, a small effect under medium yielding conditions, and no, or inhibiting effect under high yielding conditions (Raupp and Konig, 1996).

Table 2: Yield (q ha^{-1}) of component crops of different cropping systems as affected by various nutrient management practices

Treatment	Basmati rice - wheat cropping system				Maize + cowpea – wheat + mustard							
	Rice		Wheat		Maize		Cowpea		Wheat		Mustard	
	Grain yield	Biological yield	Grain yield	Biological yield	Grain yield	Biological yield	Pod yield	Stover yield	Grain yield	Biological yield	Grain yield	Biological yield
T_1	32.7	91.7	27.4	80.1	37.7	97.4	1444	1806	25.4	72.2	3.90	17.1
T_2	41.6	112	43.2	109	48.8	119	1629	2236	38.3	94.0	4.78	20.4
T_3	38.8	103	36.0	99.6	45.7	113	1595	2212	32.2	81.5	4.48	19.3
T_4	43.8	115	44.6	114	51.6	123	1875	2481	39.2	94.8	5.51	23.3
T_5	45.6	119	44.6	114	52.4	126	1881	2560	40.7	100.7	6.20	24.3
T_6	46.2	123	47.0	116	53.8	133	2083	2668	40.8	104.4	6.39	25.1
SEm±	0.74	1.4	1.76	2.97	1.15	1.20	90.0	88.0	1.63	2.76	0.098	0.52
LSD (P=0.05)	2.30	4.30	5.50	9.40	3.60	3.80	283	279	5.10	8.70	0.31	1.60

System productivity and economics

The better utilization of favorable plant nutrition regime in soil by diverse crops and yield contribution of intercrops like cowpea and mustard without any substantial yield loss in main crop resulted in 27.6% higher system productivity under maize + cowpea – wheat + mustard cropping system (CS_2) as compared to basmati rice–wheat cropping system (CS_1). Irrespective of cropping systems, the application of BD-FYM + vermicompost + *Panchgavya* (T_6) recorded the highest system productivity in terms of BREY (93.5 and 133.7 q/ha in CS_1 and CS_2, respectively) (Fig. 1). Enhanced soil microbial activities provided ease in supplying available nutrients to plants due to BD-FYM coupled with plant growth stimulus imparted by *Panchgavya* spray resulted in yield improvement in all the crops.

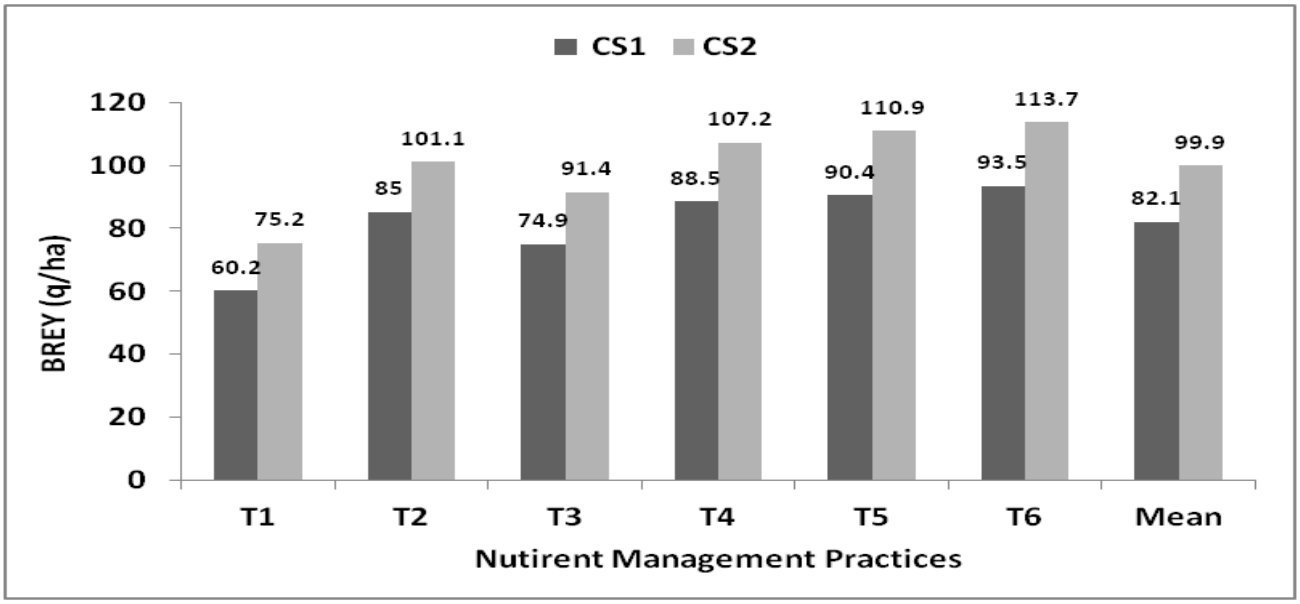

Fig. 1: Basmati Rice Equivalent Yield (BREY) of different cropping systems under different nutrient management practices

The application of BD and *Panchagavya* increased the net return in both the cropping systems (Table 3). Results further reveal that maximum net return in both the cropping systems (Rs. 1,05,719 and 1,24,223/ha in CS1 and CS2, respectively) was observed with the combined application of application of BD- FYM + vermicompost + Panchgavya (T_6) as compared to either application of only FYM + vermicompost (T_2) and FYM + vermicompost + *Panchgavya* (T_4). The higher net return due to application of *Panchagavya* could be explained on the basis of increased seed and straw yield under the application of *Panchagavya* in the present investigation. Similar findings were also observed in groundnut (Choudhary *et al.,* 2014). Further irrespective of the cropping systems, the highest B: C ratio (2.26 and 2.54 in CS_1 and CS_2, respectively) was observed under BD-FYM (T_3). The B: C ratio was decreased due to application of *Panchagavya* (T_4 and T_6) because effectiveness of *Panchagavya* was less in enhancing yield as compared to cost incurred.

Table 3: Economics of different cropping systems as affected by various nutrient management practices

Treatment	Basmati rice – wheat (CS_1)		Maize + cowpea – wheat + mustard (CS_2)	
	Net returns (Rs ha^{-1})	B:C ratio	Net returns (Rs ha^{-1})	B:C ratio
T_1	97,521	3.55	1,12,270	4.05
T_2	1,03,537	1.61	1,19,316	1.79
T_3	1,04,237	2.26	1,20,846	2.54
T_4	1,04,845	1.52	1,25,208	1.76
T_5	1,11,990	1.67	1,32,489	1.91
T_6	1,12,187	1.56	1,35,211	1.83
Mean	1,05,719	2.00	1,24,223	2.30

Nutrient (NPK) uptake

Data on total nutrient uptake by cropping systems under different nutrient management practices (Table 4) reveals that total N, P and K uptake was significantly influenced by cropping systems and significantly highest N, P and K uptake was recorded in maize + cowpea – wheat + mustard cropping system (CS_2) as compared to basmati rice - wheat cropping (CS_1). A total of 18.9, 22.3 and 20.8 % higher N, P and K uptake, respectively was recorded under CS_2 as compared to CS_1. The supply of N, P and K in more readily available form from organic manures to the crop during active growth period of crop, resulted in increased the nutrient content and uptake in grain and straw.

Table 4: Nutrient uptake (kg ha^{-1}) under different cropping systems as affected by various organic nutrient management practices

Treatment	Nitrogen	Phosphorus	Potassium
Cropping System (A)			
CS_1	188	53.4	253
CS_2	224	65.3	306
SEm±	1.34	0.61	1.62
LSD (P=0.05)	8.20	3.70	9.90
Nutrient management (B)			
T_1	147	37.7	212
T_2	210	58.2	281
T_3	181	47.4	251
T_4	221	63.8	295
T_5	233	71.3	312
T_6	244	77.7	327
SEm±	2.31	0.64	3.33
LSD (P=0.05)	6.84	1.94	9.84
Interaction (A x B)			
SEm±	3.27	0.90	4.71
LSD (P=0.05)	NS	2.65	NS

It is further inferred from the results that total N, P and K uptake by various crops under different nutrient management practices found significantly highest under BD-FYM + vermicompost + *Panchgavya* (T_6), which being statistically at par to BD-FYM + vermicompost (T_5) recorded 16.2, 33.5 and 16.3% higher N, P and K uptake, respectively over FYM + vermicompost (T_2). It is evident that interaction for nutrient uptake between cropping systems and nutrient management practices was found significant only for total P uptake. Due to adequate supply of required nutrients through organic manures at an early stage of plant growth and also due to overall improvement in soil physico-chemical and biological properties due to combined application of organic and liquid manures might have increased the nutrient uptake of crop (Gore and Sreenivasa, 2011).

Soil fertility status

Available N in soil under maize + cowpea – wheat + mustard cropping system (CS_2) was significantly higher compared to basmati rice - wheat cropping (CS_1)., while SOC, available P and K in soil under CS_2 were non- significantly higher compared to CS_1 (Table 5). Further, the nutrient management practices significantly affected the SOC and availability of N, P and K into the soil and BD-FYM + vermicompost + Panchgavya (T_6), being statistically at par to BD-FYM + vermicompost (T_5) and FYM + vermicompost + *Panchgavya* (T_4) except available P recorded 5.93 and 19.8% higher available N and P content, respectively over FYM + vermicompost (T_2) showing added advantage of BD preparation and Panchgavya. However, available K and SOC under application of BD-FYM + vermicompost + *Panchgavya* (T_6) and FYM + vermicompost (T_2) were found at par. Interaction between cropping systems and nutrient management practices was found significant for available N, P and SOC content in soil. Higher SOC has been owing to addition of FYM and vermicompost with greater biological activity brought about by BD and Panchagavya spray resulting higher available nutrients (Rudragouda *et al.*, 2015).

Table 5: SOC, available N, P and K in soil (0 – 15 cm depth) as affected by different cropping systems and organic nutrient management practices after completion of crop cycle

Treatment	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	SOC (g kg^{-1})
Cropping System				
CS_1	204	19.3	233	5.68
CS_2	218	23.3	237	6.13
SEm±	2.17	0.67	3.60	0.08
LSD (P=0.05)	13.2	NS	NS	NS
Nutrient management				
T_1	166	17.7	185	4.64
T_2	219	20.7	243	6.16
T_3	202	19.6	236	5.15
T_4	222	22.1	245	6.46
T_5	225	23.2	247	6.48
T_6	232	24.8	251	6.52
SEm±	4.32	0.52	3.05	0.17
LSD (P=0.05)	12.7	1.50	9.00	0.51
Interaction (A x B)				
SEm±	6.10	0.74	4.31	0.20
LSD(P=0.05)	18.0	2.20	NS	0.70

Under the present and future scenario of climate change and consumer preference for organic food products, it is imperative to explore the possibilities of alternative sources of nutrients. Efficacy of FYM as an alternative nutrient source for organic cultivation of crops was found increased culminating into higher productivity of crops. Productivity of crops was found further enhanced by application of *Panchgavya*. From the present study, it is revealed that irrespective of cropping system, application of FYM treated with biodynamic preparations before sowing of crops, application of vermicompost in standing crops and spray of *Panchgavya* produced highest yield of different crops and net return by creating favourable soil

environment for nutrient uptake. It is concluded that maize + cowpea – wheat + mustard can be raised organically by combined application of BD treated FYM, verimicompost equivalent to N requirement of main crop and spray of *Panchgavya* fetching higher profitability and improving soil fertility.

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