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RESEARCH PAPER

Comparison of organic and inorganic sources of nutrients on the performance of buckwheat (*Fagopyrum esculentum* Moench)

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Abstract : The experiment was conducted during pre-*Kharif* season of 2012 and 2013 at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar on sandy loam soils under sub-tropical par-humid to tropical humid climate of *terai* region of West Bengal, to compare the performance of buckwheat (*Fagopyrum esculentum* Moench) under different sources of organic and inorganic nutrients. The field experiment was laid out in RBD (Randomized Block Design) with fourteen treatments and three replications. Treatments comprised of T_1 = Control, T_2 = RDF (40:20:20), T_3 = Vermicompost @ 2.5 t ha^{-1}, T_4 = Vermicompost @ 5 t ha^{-1}, T_5 = Mustard cake @ 2.5 t ha^{-1}, T_6 = Mustard cake @5 t ha^{-1}, T_7 = Poultry manure @ 2.5 t ha^{-1}, T_8 = Poultry manure @ 5 t ha^{-1}, T_9 = F.Y.M @ 8 t ha^{-1}, T_{10} = RDF +FYM @ 4 t ha^{-1}, T_{11} = Vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1}, T_{12} = Vermicompost @ 2.5 t ha^{-1} + mustard cake @ 5 t ha^{-1}, T_{13} = Vermicompost @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} and T_{14} = Vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1} + poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1}. Poled data revealed that seed yield of buck wheat were increased by 5.2 and 12.8 quintal ha^{-1} through combine application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1} + poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} over 100 % RDF and control. Combined application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1} + poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} (T_{14}) recorded significantly higher percentage of starch (72.1 and 72.1) and protein (14.2 and 14.4) during 2012 and 2013, respectively which was followed by combined application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 5 t ha^{-1} (T_{12}) and poultry manure @ 5 t ha^{-1} (T_8). The highest benefit: cost (2.96) was noticed in T_8 (Poultry manure @ 5 t ha^{-1}) followed by T_2 (2.83).

Key Words : Buckwheat, Vermicompost, Mustard cake, Poultry manure, FYM, Protein

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INTRODUCTION

Heavy use of chemicals in agriculture has weakened the ecological base in addition to degrading the soil, water resources and quality of the food. At this juncture, a keen awareness has sprung on the adoption of "organic farming" as a remedy to cure the ills of modern chemical agriculture (Kunnal, 1997). It is very

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much essential to develop a strong workable and compatible package of nutrient management through organic resources for various crops based on scientific facts, local conditions and economic viability (Kannaiyan, 2000). Organic manures have carry over effect on succeeding crops. The responses of the succeeding crops in a cropping system are influenced greatly by the preceding crops and the inputs applied therein. The organic manure provides the required nutrition to the plants and reduces the environmental pollution. The organic manure provides the required nutrition to the plants and reduces the environmental pollution. Increase the microbial activity, anion and cation exchange capacity, organic matter and carbon content of the soil. Organic manure also improves the yield of crops as well as quality of the products. Organic products of various crops are acceptable in the foreign market because consumers of the foreign countries are preferring products from organic farming, suitable for experiment entitled "composition of organic and inorganic sources of nutrients on performance of buckwheat (*Fagopyrum esculentum* Moench)". Buckwheat is an ancient Asian crop now widely grown around the world. Even though it is an underutilized crop, it remains important for food security in the temperate and hilly regions of countries in East Asia, East Europe and the Himalayan region (Arora, 1995). The crop is not a cereal, but the seeds (strictly achenes) are usually classified among the cereal grains because of their similar usage. The grain is generally used as human food and as animal or poultry feed, with the dehulled goats being cooked as porridge and the flour used in the preparation of pancakes, biscuits, noodles, cereals, etc. Keeping the above facts in mind, present experiment has been conducted to see the, effect of organic and inorganic sources of plant nutrients on performance of buckwheat.

MATERIAL AND METHODS

The experiment was conducted during the years of 2012 and 2013 at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, during the early pre-*Kharif* seasons of 2012 and 2013. Cooch Behar is situated in the terai agro climatic zone at $26^0$19'86" N latitude and $89^0$23'53" E longitude and at an elevation of 43 meters above mean sea level. The soil of the experimental site was sandy loam having pH 5.5, organic carbon 0.64 per cent, available nitrogen 107.59 kg ha^{-1}, available phosphorus 15.36 kg ha^{-1} and available potassium 71.78 kg ha^{-1}. The field experiment was laid out in RBD (Randomized Block Design) with three replications. Buckwheat variety VL-7 @ 40 kg ha^{-1} was sown in line by opening furrow with the help of hand tine and ropes on 19th January and 21st January 2012 and 2013, respectively. Seeds were dropped by hand accordingly in the spacing the 30 x 7-10 cm.

The experiment was laid out in Randomized Block Design with three replications having 14 treatments *viz.*, T_1 = Control, T_2 = RDF (40:20:20), T_3 = Vermicompost @ 2.5 t ha^{-1}, T_4 = Vermicompost @ 5 t ha^{-1}, T_5 = Mustard cake @ 2.5 t ha^{-1}, T_6= Mustard cake @5 t ha^{-1}, T_7 = Poultry manure @ 2.5 t ha^{-1}, T_8 = Poultry manure @ 5 t ha^{-1}, T_9 = F.Y.M @ 8 t ha^{-1}, T_{10} = RDF +FYM @ 4 t ha^{-1}, T_{11} = Vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1}, T_{12} = Vermicompost @ 2.5 t ha^{-1} + mustard cake @ 5 t ha^{-1}, T_{13} = Vermicompost @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} and T_{14} = Vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1} + poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1}.

All the organics (well decomposed) were incorporated 20 days before sowing of buckwheat. Field preparation was done by tractor followed by power tiller 3-4 times. There after individual plot of equal size (20 m^{-2}) were prepared and separated by bunds. The plots were leveled using a wooden plank. A pre-sowing irrigation was given to have the fine tilth with optimum moisture condition for even germination of seeds. Two hand weeding were given 1st at 25 DAS and 2nd at 35 DAS. Harvesting was done on 25th April and 26th April, 2012 and 2013, respectively, when most of the clusters are dried. All the agronomic practices were followed as per need of the crop. Data on plant height, leaf area index were recorded from 10 randomly selected plants from each plot at 20, 40, 60 DAS and at harvest. Data on yield attributes were recorded after harvesting of the crop from each plot. Nutrients uptake was calculated after harvesting of the crop by multiplying nutrient content and dry matter. Protein percentage was estimated by Lowry's method (Lowry *et al.*, 1951) and starch content was measured anthrone method as described by Hedge and Hofreiter (1962). A standard statistical method was used for comparing the treatment mean. Economics was calculated with the prevailing market price.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized

under following heads :

Effect of treatments on plant height and leaf area index of buckwheat :

Plant height and leaf area was measured on four occasions starting from 20 DAS (days after sowing) till at harvest. The dates of observations were recorded at 20, 40, 60 days after sowing and at harvest.

Plant height was significantly influenced by the nutrient management treatments at all the dates of observations during both the years of experimentation. It has been seen from the data that the plant height of buckwheat was increasing with increasing rate upto 60 DAS and then it was increasing with decreasing rate irrespective of the treatments. Pooled data revealed that tallest plant was recorded under combined application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1} + poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} (T_{14}) followed by combined application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 5 t ha^{-1} (T_{12}) and it was statistically at par with single application of poultry manure @ 5 t ha^{-1} (T_8) in all the dates of recording observation. At harvest, lowest plant height of 65.9 cm was observed in unfertilized control (T_1) plot while highest plant height of 89.1cm was observed in combined application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1} + poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1}(T_{14}). As soil of terai region is sandy loam with light textured, prevailing with high rainfall, causes leaching down of nutrients, that's why combined application of all the organic manures was added in treatment T_{14}. The higher plant height might be due to synchronous and steady release of plant nutrient throughout the growth period. These results are in conformity with the finding of Inamullah *et al*. (2012).

The data (Table 1) revealed that leaf area index was low at the early stages of crop growth and went on increasing with the increasing rate till 60th DAS (day after sowing) when it reached at its peak and thereafter, declined towards maturity of the crop, irrespective of treatments applied. This was due to the emergence and enlargement of new branches and leaves during vegetative growth stages of buckwheat which not only stopped at the reproductive stage, but it decreased gradually with the senescence of leaf. Highest leaf area index at 60 DAS was recorded to be 4.46 under the combined application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1} + poultry manure @2.5 t ha^{-1}

Table 1: Effect of treatments on plant height and leaf area index at different growth stages of buck wheat (pooled data over 2 years)

Treatments	Plant height (cm)				Leaf area index (LAI)			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
T_1	16.2	56.8	63.7	65.9	0.17	1.26	2.34	1.53
T_2	22.8	62.9	69.3	71.3	0.22	1.70	2.71	2.13
T_3	18.4	58.2	65.4	67.7	0.20	1.35	2.39	1.57
T_4	27.9	66.2	70.2	73.7	0.26	1.73	3.2	2.26
T_5	20.8	61.4	69.4	69.9	0.23	1.66	2.67	2.20
T_6	34.9	69.5	79.4	80.9	0.27	1.75	3.67	2.29
T_7	19.8	60.2	66.2	69.0	0.22	1.59	2.51	2.08
T_8	36.3	71.5	82.3	84.9	0.29	1.79	4.14	2.78
T_9	25.3	64.3	69.3	72.5	0.24	1.72	2.83	2.68
T_{10}	30.7	67.0	74.4	76.4	0.27	1.73	3.27	2.60
T_{11}	35.9	70.6	80.4	82.8	0.28	1.77	3.88	2.80
T_{12}	36.7	72.8	85.4	87.7	0.31	1.80	4.15	2.86
T_{13}	33.8	68.9	75.2	77.7	0.27	1.74	3.57	2.74
T_{14}	37.1	74.3	86.6	89.1	0.32	1.83	4.46	2.88
S.E.±	2.28	2.10	3.27	2.79	0.013	0.066	0.193	0.108
C.D. (P=0.05)	6.66	6.15	9.57	8.16	NS	0.191	0.564	0.317

T_1 = Control, T_2 = RDF (40:20:20), T_3 = Vermicompost @ 2.5 t ha^{-1}, T_4 = Vermicompost @ 5 t ha^{-1}, T_5 = Mustard cake @ 2.5 t ha^{-1}, T_6= Mustard cake @5 t ha^{-1}, T_7 = Poultry manure @ 2.5 t ha^{-1}, T_8 = Poultry manure @ 5 t ha^{-1}, T_9 = F.Y.M @ 8 t ha^{-1}, T_{10} = RDF +FYM @ 4 t ha^{-1}, T_{11} = Vermicompost @ 2.5 t ha^{-1} + Mustard cake @ 2.5 t ha^{-1}, T_{12} = Vermicompost @ 2.5 t ha^{-1} + Mustard cake @ 5 t ha^{-1}, T_{13} = Vermicompost @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} and T_{14} = Vermicompost @ 2.5 t ha^{-1} + Mustard cake @ 2.5 t ha^{-1} + Poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} NS= Non-significant

+ F.Y.M @ 4 t ha^{-1} (T_{14}) followed by combined application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 5 t ha^{-1} (4.15). Unfertilized control (T_1) recorded significantly lower values leaf area in all the dates of taking observation Inamullah *et al*. (2012) also reported similar observations.

Effect on yield attributes and seed yield :

The data pertaining to yield attributes *viz.*, number of cluster plant^{-1}, number of seed cluster^{-1}, test weight, seed yield and stem yield are represented in Table 2. Combined application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1} + poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} (T_{14}) recorded significantly highest number of cluster plant^{-1} (8.75 and 8.82) and seed cluster^{-1} (19.5 and 20.1), higher values of test weight (26.3 and 26.9 g), seed yield (16.5 and 17.7 quintal ha^{-1}) and stem yield (28.3 and 29.7 quintal ha^{-1}) of buck wheat during both the year of experimentation, followed by the combined application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 5 t ha^{-1} (T_{12}). Poled data revealed that seed yield of buck wheat were increased by 5.2 and 12.8 quintal ha^{-1} through combine application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1} + poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} over 100 per cent RDF and control, respectively. The higher yield attributes and seed yield of buckwheat due to different organic sources could be ascribed to the overall improvement in crop growth, vigour, production and translocation of sufficient photosynthate. The results corroborates the experimental findings of Dietrych *et al*. (2008) and Inamullah *et al*. (2012). Unfertilized control (T_1) plot recorded significantly lowest values of all the yield attributes and finally produced lowest seed yield of buck wheat during both the year of experimentation. Pooled analysis also showed the similar trend as the individual years. Among the sole application of organic manures, poultry manure @ 5 t ha^{-1} (14.6 quintal ha^{-1}) proved superiority in producing seed yield of buck wheat followed by mustard cake @5 t ha^{-1} (14.1 quintal ha^{-1}), vermicompost @5 t ha^{-1} (12.9 quintal ha^{-1}) and FYM @ 8 t ha^{-1} (12.2) over 100 per cent chemically fertilized plot, simply due to addition of more organic matter and nutrients, while lower doses of all these organics recorded lower pod yield.

It would further be seen from the Table 2 that the yield attributes and seed yield was higher in second year of experimentation irrespective of treatments except

Table 2: Effect of treatments on yield attributes and seed yield of buckwheat

Treatments	No. of cluster plant^{-1}			No. of seeds cluster^{-1}			Test weight (g)			Seed yield (q ha^{-1})			Stem yield (q ha^{-1})			Harvest index (%)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T_1	2.71	3.13	2.92	6.30	7.20	6.70	20.3	21.4	20.8	3.70	4.80	4.30	12.0	14.1	13.1	23.3	25.3	24.3
T_2	4.13	4.31	4.22	11.9	12.3	12.1	22.6	22.9	22.7	11.4	12.4	11.9	25.9	27.2	26.6	30.9	31.2	30.8
T_3	3.25	3.55	3.40	9.40	9.50	9.40	22.2	22.6	22.4	10.0	11.1	10.6	25.4	26.8	26.1	28.2	29.3	28.7
T_4	5.26	5.51	5.39	13.1	13.5	13.3	22.9	23.3	23.1	12.4	13.3	12.9	26.3	27.2	26.7	32.0	32.8	32.4
T_5	3.81	4.23	4.02	11.5	12.1	11.8	22.5	22.8	22.6	11.3	12.3	11.8	26.0	27.0	26.5	30.2	31.2	30.7
T_6	6.25	6.51	6.38	14.4	15.2	14.8	23.8	24.4	24.1	13.5	14.7	14.1	28.4	27.9	28.1	32.1	34.5	33.4
T_7	3.67	3.91	3.79	10.5	10.9	10.7	22.3	22.8	22.6	11.2	12.2	11.7	25.9	26.9	26.4	30.1	31.1	30.6
T_8	7.43	7.82	7.63	16.5	16.9	16.7	24.3	25.1	24.7	14.1	15.2	14.6	27.9	28.3	28.1	33.3	34.9	34.2
T_9	4.41	4.81	4.61	12.3	12.6	12.5	22.8	23.1	22.9	11.7	12.6	12.2	25.7	27.6	26.6	31.1	31.3	31.2
T_{10}	5.33	5.64	5.49	13.6	14.3	13.9	23.2	23.8	23.5	12.7	13.9	13.3	27.0	27.9	27.5	32.0	33.1	32.6
T_{11}	6.65	6.83	6.74	15.3	16.4	15.8	24.2	24.6	24.4	13.9	14.8	14.3	28.2	27.9	28.0	32.1	34.8	33.7
T_{12}	7.81	8.25	8.20	17.4	17.6	17.5	25.1	25.3	25.2	14.6	15.8	15.2	28.1	29.0	28.6	34.1	35.2	34.7
T_{13}	5.62	5.86	5.74	14.3	15.2	14.7	23.3	24.1	23.7	13.1	14.2	13.6	27.6	27.8	27.7	32.1	33.7	32.9
T_{14}	8.75	8.82	8.79	19.5	20.1	19.8	26.3	26.9	26.6	16.5	17.7	17.1	28.3	29.7	29.0	36.8	37.3	37.0
S.E.±	0.465	0.513	0.468	0.92	1.01	1.11	1.53	1.45	1.49	7.82	9.71	8.65	8.29	9.92	8.37	0.94	0.94	0.94
C.D.(P=0.05)	1.360	1.500	1.367	2.69	2.96	2.76	NS	NS	NS	22.87	28.37	25.30	24.22	29.01	24.46	2.75	2.75	2.74

T_1 = Control, T_2 = RDF (40:20:20), T_3 = Vermicompost @ 2.5 t ha^{-1}, T_4 = Vermicompost @ 5 t ha^{-1}, T_5 = Mustard cake @ 2.5 t ha^{-1},
T_6= Mustard cake @5 t ha^{-1}, T_7 = Poultry manure @ 2.5 t ha^{-1}, T_8 = Poultry manure @ 5 t ha^{-1}, T_9 = F.Y.M @ 8 t ha^{-1}, T_{10} = RDF +FYM @ 4 t ha^{-1},
T_{11} = Vermicompost @ 2.5 t ha^{-1} + Mustard cake @ 2.5 t ha^{-1}, T_{12} = Vermicompost @ 2.5 t ha^{-1} + Mustard cake @ 5 t ha^{-1},
T_{13} = Vermicompost @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} and T_{14} = Vermicompost @ 2.5 t ha^{-1} + Mustard cake @ 2.5 t ha^{-1} + Poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} NS= Non-significant

control plot might be due to higher availability of plant nutrients.

Effect on quality of buck wheat and nutrient uptake:

The starch and protein content of buckwheat was influenced significantly by the organic sources of nutrients (Table 3). Polled data revealed that starch content of buck wheat varied from 53.7 to 72.1 per cent while protein content was varied from 11.0 to 14.3 per cent. Combined application of vermicompost @ 2.5 t

Table 3: Effect of treatments on starch and protein content and NPK uptake of buckwheat

Treatments	Starch (%)			Protein (%)			Nitrogen uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Potassium uptake (kg ha^{-1})		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T_1	54.3	53.0	53.7	11.0	11.5	11.0	16.6	20.2	18.4	6.70	9.00	7.80	37.7	39.8	38.7
T_2	66.5	67.3	66.9	12.8	12.6	12.7	64.9	76.9	70.9	22.2	24.7	23.4	47.7	48.8	48.2
T_3	64.9	64.1	64.5	12.6	12.0	12.3	55.9	68.5	62.2	20.5	23.4	22.0	74.5	76.3	75.4
T_4	67.1	67.4	67.3	13.1	13.2	13.1	78.4	88.8	83.6	21.8	23.8	22.8	76.7	83.3	80.0
T_5	66.3	66.9	66.6	12.6	12.6	12.6	91.3	101.9	96.6	21.0	22.5	21.8	57.0	59.3	58.1
T_6	69.0	69.6	69.3	13.2	13.3	13.2	108.4	79.2	93.8	27.5	28.9	28.2	63.5	65.4	64.4
T_7	66.2	66.4	66.3	12.6	12.3	12.5	81.9	100.0	91.0	25.8	28.0	26.9	78.9	84.6	81.8
T_8	70.0	69.9	70.0	13.5	13.7	13.6	100.3	112.7	106.5	27.3	29.2	28.3	71.9	77.2	74.5
T_9	66.7	67.4	67.0	13.0	13.0	13.0	64.8	82.0	73.4	22.6	24.7	23.7	67.1	69.7	68.4
T_{10}	67.2	67.5	67.3	13.1	13.2	13.2	86.2	99.3	92.7	24.9	26.5	25.7	59.3	64.5	61.9
T_{11}	69.6	69.6	69.6	13.5	13.4	13.4	100.0	109.3	104.6	26.6	27.8	27.2	77.0	84.0	80.5
T_{12}	71.2	70.2	70.7	13.6	14.0	13.8	121.4	133.7	127.6	26.6	28.9	27.7	89.0	78.3	83.6
T_{13}	68.3	69.3	68.8	13.2	13.3	13.2	78.7	91.2	84.9	24.1	25.3	24.7	67.9	74.3	71.1
T_{14}	72.1	72.1	72.1	14.2	14.4	14.3	123.6	134.0	128.8	32.5	35.6	34.0	82.6	85.5	84.0
S.E.±	1.43	1.62	0.96	0.38	0.53	0.31	2.15	2.64	1.96	1.26	1.07	0.95	2.22	2.28	1.54
C.D.(P=0.05)	4.17	4.74	2.80	1.12	1.55	0.90	6.27	7.72	5.74	3.68	3.13	2.78	6.49	6.65	4.49

T_1 = Control, T_2 = RDF (40:20:20), T_3 = Vermicompost @ 2.5 t ha^{-1}, T_4 = Vermicompost @ 5 t ha^{-1}, T_5 = Mustard cake @ 2.5 t ha^{-1}, T_6= Mustard cake @5 t ha^{-1}, T_7 = Poultry manure @ 2.5 t ha^{-1}, T_8 = Poultry manure @ 5 t ha^{-1}, T_9 = F.Y.M @ 8 t ha^{-1}, T_{10} = RDF +FYM @ 4 t ha^{-1}, T_{11} = Vermicompost @ 2.5 t ha^{-1} + Mustard cake @ 2.5 t ha^{-1}, T_{12} = Vermicompost @ 2.5 t ha^{-1} + Mustard cake @ 5 t ha^{-1}, T_{13} = Vermicompost @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} and T_{14} = Vermicompost @ 2.5 t ha^{-1} + Mustard cake @ 2.5 t ha^{-1} + Poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1}

Table 4: Effect of treatments on economics of buckwheat

Treatments	Cost of cultivation (Rs.)	Cost of treatment (Rs.)	Total cost of treatment (Rs.)	Yield	Gross return (Rs./ha)	Net return (Rs./ha)	B:C
T_1 = Control	13436.00	0.00	13436	4.30	21250	7814	0.58
T_2 = RDF (Buckwheat=40:20:20)	13436.00	2044.00	15480	11.9	59250	43770	2.83
T_3 = Vermi compost (2.5 t/ha.)	13436.00	10000.00	23436	10.6	52750	29314	1.25
T_4 = Vermi compost (5.0 t/ha.)	13436.00	20000.00	33436	12.9	64250	30814	0.92
T_5 = Mustard cake (2.5 t/ha.)	13436.00	20000.00	33436	11.8	59000	25564	0.76
T_6 = Mustard cake (5.0 t/ha.)	13436.00	40000.00	53436	14.1	70500	17064	0.32
T_7 = Poultry manure (2.5 t/ha.)	13436.00	2500.00	15936	11.7	58500	42564	2.67
T_8 = Poultry manure (5.0 t/ha.)	13436.00	5000.00	18436	14.6	73000	54564	2.96
T_9 =F.Y.M (8.0 t/ha.)	13436.00	8000.00	21436	12.2	60750	39314	1.83
T_{10} = RDF +FYM (4.0 t/ha.)	13436.00	6044.00	19480	13.3	66500	47020	2.41
T_{11} = [T_3 + T_5]	13436.00	30000.00	43436	14.3	71500	28064	0.65
T_{12} = [T_3 + T_6]	13436.00	50000.00	63436	15.2	76000	12564	0.20
T_{13} = [T_3 + (F.Y.M. 4 t/ha.)	13436.00	14000.00	27436	13.6	68000	40564	1.48
T_{14} = (T_{3+} T_{5+} T_{7+} F.Y.M. 4 t/ha.)	13436.00	36500.00	49936	17.1	85500	35564	0.71

ha^{-1} + mustard cake @ 2.5 t ha^{-1} + poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} (T_{14}) recorded significantly higher percentage of starch (72.1 and 72.1) and protein (14.2 and 14.4) during 2012 and 2013, respectively which was followed by combined application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 5 t ha^{-1} (T_{12}) and poultry manure @ 5 t ha^{-1} (T_8). Unfertilized control (T_1) recorded the lowest starch (54.3 and 53%) and protein content (11 and 11.5%) during both the years of experimentation. Similar results were also recorded by Popovic *et al*. (2013); Chai *et al*. (1989); Constantinescupop *et al*. (2011) and Eggum (1980). It was noticed that all organically treated plots proved superiority in terms of quality of buck wheat than chemically treated plot.

Organic sources of nutrients significantly influenced the nutrients uptake by buck wheat during both the years of experimentation (Table 3). Combined application of vermicompost @ 2.5 t ha^{-1} + mustard cake @ 2.5 t ha^{-1} + poultry manure @ 2.5 t ha^{-1} + F.Y.M @ 4 t ha^{-1} (T_{14}) recorded maximum uptake of nitrogen (123.6 and 134.0 kg ha^{-1}), phosphorus (32.5 and 35.6 kg ha^{-1}) and potassium (82.6 and 85.5 kg ha^{-1}) followed by vermicompost @ 2.5 t ha^{-1} + mustard cake @ 5 t ha^{-1} and poultry manure @ 5 t ha^{-1} (T_8) during both years of experimentation. Increased nutrients uptake might be due to consistent supply of nutrients and reduced nutrients loss during the process of decomposition of organic manure. This was due to the increased growth, nutrient influx and photosynthetic rate which resulted in more absorption and translocation of these nutrients to the seed and stem. The result of the present investigation is in conformity with the findings of Singh *et al*. (1996) and Mohamed *et al*. (2007). The lowest nutrients uptake was recorded under unfertilized control (T_1).

Economics of buck wheat cultivation :

The data on economics of buck wheat in relation to organic manures and chemical fertilizers have been presented in (Table 4). The analysis on economics revealed that maximum gross return of Rs. 85500 ha^{-1} were obtained with combined application (VC @ 2.5 t ha^{-1}+ MC @ 2.5 t ha^{-1}+ PM@ 2.5t ha^{-1}+ FYM @ 4.0 t ha^{-1}) *i.e.* T_{14} closely followed by Rs. 76000 ha^{-1} with VC @ 2.5 t ha^{-1}+ MC @ 5.0 t ha^{-1} *i.e.* T_{12}. Higher gross return was simply due to higher yield. The results showed that all the organic treatments recorded higher gross returns as compared to chemically treated and control plots. Among all treatments T_8 (Poultry manure @ 5 t ha^{-1}) registered the maximum net return to the tune of Rs. 54564 ha^{-1}, respectively in both the year. This was followed by T_{10} (Rs. 47020 ha^{-1}). The net returns were less in first year of experiment as compared to the second year simply due to lesser yield. Among the organic manures vermicompost recorded comparatively lower net returns in both the years might be due to higher unit price. The highest benefit: cost (2.96) was noticed in T_8 (Poultry manure @ 5 t ha^{-1}) followed by T_2 (2.83). This was owing to the less cost incurred by these treatments. However, lowest benefit: cost (0.20) was obtained from T_{12} (VC@2.5 t/ha. + (MC @ 5.0 t/ha.) during both the years. Though all the organically treated plots recorded higher yield and gross return than chemically treated plot but due to their higher treatment cost, 100 per cent RDF fetched higher benefit: cost ratio than the organic treatments. The results corroborate with the earlier findings of Panwar and Munda (2007).

REFERENCES

Agbede, T.M., Ojeniyi, S.O. and Adeyemo A.J. (2008). Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in South west, Nigeria. *American Eurasian J. Sustain. Agric*. **2**(1): 72-77.

Arora, R.K. (1995). Buckwheat genetic resources in the Himalayas: their diversity, conservation and use. *Curr. Adv. Buckwheat Res*., **1** (3) : 39-46.

Chai, Y., Liu, R. and Feng, S. (1989). Nutritive components and nutritive values of buckwheat. *Scientific treaties on buckwheat in China*. Academic Periodical Press, Beijing. pp 198-202.

Constantinescupop, G., Dabija, A. and Buculei, A. (2011). Study regarding the possibilities to obtain functional food from wheat flour: bread with exogenous buckwheat. Food and Environment Safety. *J. Faculty Food Engg*., **10**(4):1-12.

Dietrych, S.D., Podolska, G. and Maj, L. (2008). The effect of N fertilization doses on buckwheat yield and content of protein and flavonoids in buckwheat nuts. Czartoryskich, Poland: Polish Society for Agronomy. *Fragmenta Agronomica*., **25**(1): 101-109.

Eggum, B.O. (1980). The protein quality of buckwheat in comparison with other protein source of plant or animal origin. *J. Biol. Chem*., **252**: 1102-1106.

Hedge, J.E. and Hofreiter, B. T. (1962). In: *Carbohydrate chemistry* (Eds Whistler, R. L. and Be Miller, J. N.) Academic Press, NEW YORK, U.S.A.

Inamullah, G., Hulamullah, S., Muhammad, A., Khan, A.A.,

Shazma, A. and Khan, S.A. (2012). Response of common buckwheat to nitrogen and phophorus fertilization. Peshawar, Pakistan: Agricultural University Peshawar.*Sarhad J. Agric.*, **28** (2) : 171-178.

Kannaiyan (2000). *Bio-fertilizers – Key factor in organic farming*. The Hindu Survey of Indian Agriculture, pp.165-173.

Kunnal, L.B. (1997). *Economics of organic farming.* In: Abstracts of the scientific conference and general assembly on food security in harmony with nature organized by IFOAM Asia (Eds. Shivsankar, K.) at UAS, Hebbal, Bangalore, pp. 108.

Lowry, O. H., Rosebrough, N. J., Farr, A. L. and Randall, R. J. (1951). Protein measurement with the Folin phenol reagent. *J. Biol. Chem.*, **193** : 265.

Mohamed, A.M., Alagesan, A., Vaiyapuri, K., Pazhanivelan, S. and Sathyamoorthi, K. (2007). Nutrient uptake, tuber yield of cassava (*Manihot esculenta* Crantz.) and soil fertility as influenced by organic manures. *J. Agron.*, **6**(1): 183-187.

Panwar, A.S. and Munda, G.C. (2007). Response of groundnut (*Arachis hypogaea*) to organic and inorganic sources of nutrient supply under mid-hill altitude conditions. *Indian J. Agril. Sci.*, **77** (12) : 814-818.

Popovic,V., Sikora,V., Berenji, J., Glamoclija, D. and Maric,V., (2013a). Effect of agroecological factors on buckwheat yield in convential and organic cropping systems. *Institute of PKB Agroeconomic, Belgrade*, **19**(1-2) : 155-165.

Popovic,V., Sikora,V., Ikanovic, J., Rajicic,V., Maksimovic, L. and Katanski, S. (2013b). Production, productivity and quality of buckwheat in organic growing systems in course environmental protection, XVII Eco-Conference, Novi Sad, 25- 28 Sept. pp.395-404.

Qian J. and Kuhn, M. (1999). Physical properties of buckwheat starches from various origins. *Starch/Starke*, **51**: 81-85.

Singh, B., Singh,Y., Maskina, M. S. and Meelu, O.P. (1996). The value of poultry manure for wetland rice grown in rotation with wheat. *Nutr. Cycl. Agroecosyst.*, **47**(3): 243-250.

Stempinska K. and Soral, S.M. (2006). Skladniki chemiczne i ocena fizykochemiczna ziarniakow gryki porównanie trzech polskich odmian. *Zywnosc Nauka Technologia Jakosc, Supplement*, **13** (2/47): 348-357.