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Residual Impact of Integrated Nutrient Management on Yield Attributes, Yields, Nutrient Uptake and Economics in Wheat (*Triticum aestivum*)

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A B S T R A C T

A field experiment was conducted at Deendayal Research Institute Krishi Vigyan Kendra Chitrakoot UPto assess the residual impact of Integrated Nutrient Management and direct effect of inorganic fertilization on Wheat (*Triticum aestivum*) for yield attributes, yields, nutrient uptake and economics during *Rabi* season of 2008-09 and 2009-10. Total 18 treatment included residual effect of 3 different doses of inorganic fertilizers and 3 different manures (FYM, Vermi-compost and Cow Pat Pit) and direct 3 doses of inorganic fertilizers to wheat crop were tested. The yield attributing characters of wheat like Spike length (cm), No. of spikes m^{-1}, No. of spikes $plant^{-1}$, No. of spikelet $spike^{-1}$. No. of seed $spike^{-1}$, Seed weight g $spike^{-1}$, Seed weight g 1000^{-1}had been found significantly higher with application of 100% NPK to wheat + residual effect of 50% NPK and FYM @ 10 tha^{-1}during two years. Seed yield (4.94 and 4.95 tha^{-1}), straw yield (4.95 and 5.04 tha^{-1}) and harvest index (49.95 and 49.54 %) of wheat were also obtained highest with same treatment combination during 2008-09 and 2009-10. The NPK uptake by wheat crop was also found maximum (119.0 and 123.3 kg ha^{-1} N, 20.3 and 20.0 kg ha^{-1} P, 82.0 and 83.6 kg ha^{-1} K) with this treatment. Similarly, residual impact of 50% NPK and FYM @ 10 $tha^{-1}$and 100 recommended dose of fertilizers to wheat also obtained significantly higher values of Gross return (Rs.54372 and 62083 ha^{-1}), Net return (Rs. 42479 and 48213 ha^{-1}) and B:C ratio (4.57 and 4.48) during both years.

Introduction

Wheat (*Triticum aestivum*) occupies the prime position among the food crops in the world. In India, it is the second important food crop being next to rice and contributes to the total food grain production of the country to the extent of about 25%. Wheat has played a vital role in stabilizing the food grain production in the country over the past few years. Wheat production has increased tremendously but is still far below the potential yield (11.2 tha^{-1}) (Singh *et al.*, 2010). Although, India is well placed in meeting its needs for food grains with major objective of food and nutritional security for its entire population has not been achieved. The demand for food grains is expected to rise not only as a function of

population growth but also as more and more people cross the poverty line with economic and social development (Parewa *et al.,* 2019).

On account of continuing world energy crisis and spiraling price of chemical fertilizer, the use of organic manure as a renewable source of plant nutrients is assuming importance. In this endeavor proper blend of organic manure and inorganic fertilizer is important not only for increasing yield but also for sustaining soil health (Kumar *et al.,* 2013).Continuous use of chemical fertilizers has led to problem of soil degradation, which is proving detrimental to crop production (Das *et al.,* 2015). Application of organic material along with inorganic fertilizers into the soils leads to increase in productivity of the cropping system enhance the use efficiency of fertilizer input and sustain n the soil health for longer period (Jat *et al.,* 2015). Fertilizer is one of the costliest inputs of crop production, it is therefore, very important to find out the way of economic use of fertilizer (Dhakal *et al.,* 2016).

Bundelkhand region of Uttar Pradesh has limited irrigation facilities with heavy soils. The scenario of agriculture in this region is suitable for integrated nutrient management which comprises with organic and inorganic fertilizers. Wheat is only important crop of Bundelkhand region in winter season under irrigated condition, which contributes major part of human diet and economy.

The increase in grain yield of wheat due to balanced fertilization is attributed to improvement in growth and yield attributes, which in turn resulted in higher translocation of photosynthates and nutrients, ultimately reflected into higher grain and straw yield (Chandel *et al.,* 2014 and Singh *et al.,* 2018). Hence, the present study was planned and carried out to explore residual impact of organic manures and inorganic fertilizers to succeeding crop of wheat under different level of fertilizer management on yields, nutrient uptake and economics.

Materials and Methods

Experimental site

Field experiment was conducted at Deendayal Research Institute-Krishi Vigyan Kendra, Chitrakoot UP during *rabi* season in 2008-09 and 2009-10under irrigated condition in clay loam soils. The experiment site is located in semi-arid and subtropical climate with 850 mm mean annual rainfall. Hot waves during month of March create terminal heat stress condition in the area. The soil is clay loam (sand-21%, silt-32% and clay–47%) having 0.31 % organic carbon with a pH of 7.34. The available NPK in the soil were 118.39, 14.96 and 331.50kgha-^{1}, which showed rich in potassium, medium in phosphorus and poor in nitrogen.

Experiment design

Eighteen treatments comprised residual impact of 3 manures (FYM. Vermi-compost and Cow Pat Pit) with two different doses and 3 doses of inorganic fertilizers used in *kharif* crop followed by 3 doses of inorganic fertilizers to main crop of wheat in *Rabi* season. They are:T_1 - Control (No fertilizer) - No fertilizer, T_2 -50% NPK(10:40:20) -100% NPK, T_3 - 75% NPK (15:60:30) - 75% NPK,T_4 - 100% NPK (20:80:40) - 50% NPK, T_5 - 100% NPK (20:80:40) - 75% NPK, T_6 - 100% NPK (20:80:40) - 100% NPK, T_7 - 50% NPK + FYM 10 t ha^{-1}- 50% NPK, T_8- 50% NPK + VC 5 t ha-^{1} - 50% NPK, T_9 -50% NPK + CPP 3.75kgha-^{1} -50% NPK, T_{10} -50% NPK + FYM10 t ha-^{1} -100% NPK, T_{11} - 50% NPK + VC 5 t ha-^{1} - 100% NPK, T_{12} -50% NPK + CPP3.75kgha-^{1}-100% NPK, T_{13} - 75% NPK + FYM 5 t ha-^{1} - 75% NPK, T_{14}- 75% NPK + VC 2.5 t ha-^{1} - 75% NPK, T_{15} -75%

NPK +CPP 1.875kgha-^{1}-75% NPK, T_{16}- 100% NPK + FYM 5tha-^{1} -100%NPK, T_{17} - 100% NPK + VC 2.5 t ha-^{1}-100%NPK, T_{18} - 100%NPK + CPP1.875kgha-^{1} -100% NPK and tested in Randomized Block Design with 3 replications.

Crop culture

The wheat was sown on 29th and 28th Nov.in 2008 and 2009 and harvested on 25th and 26th March in 2009 and 2010, respectively. All necessary production practices *viz.*, weed management, plant protection, irrigation etc. were followed as per standard in whole field during crop growth. Wheat was given 3 irrigations on 18th Dec., 12th Jan. and 9th Feb. during 2008-09and 18th Dec., 10th Jan. and 10th Feb. during 2009-10. No incidence of serious insect or diseases was observed. Crops were harvested manually by sickle from ground level and the total above ground biomass was collected from each plot and seed and straw yield were recorded as per treatments after manually threshing.

Fertilization

The recommended dose of 100% NPK to *kharif* crop and wheat were 20: 80: 40 and 120: 60: 40 kg N: P_2 $O_{5:}$ K_2 Oha^{-1}, respectively. In *kharif*, all amount of NPK were applied as basal in furrows before planting. While, in wheat 1/3 N + full amount of P and K were given as basal in furrows before sowing.

The remaining 2/3 N was applied in two equal split doses after first and second irrigation as top dressing. Urea (46% N), DAP (18%N, 46% P_2 O_5) and Muriate of Potash (K_2O) were used to supply N, P, K, respectively. The amount of N was adjusted with DAP and then urea as per treatments. The FYM (0.43:0.29: 0.73% N:P: K), vermicompost (1.36:0.23: 0.82% N:P: K) and cow pat pit (1.68:0.31: 0.85% N:P: K) were used as organic manures as per treatments.

Yield attributes

All-important yield attributing observations like number of spikes plant^{-1}, spike length (cm), number of spikelet spike^{-1}, number of seeds spike^{-1}, seed weight spike^{-1} (g), seed weight plant^{-1}(g) and seed test weight (g) were recorded from selected 5 plants of wheat crop after harvesting then averaged to calculate specific data required in particular unit.

Yields

The plants harvested from net plot were threshed manually and seed taken out. The seed and straw yield of each net plot was recorded in kg plot^{-1} and converted in to t ha^{-1}.

Nutrient uptake

The available nitrogen, phosphorus and potassium content in seed and straw were analyzed by modified Kjeldahl method (Bremner and Mulvaney, 1982), Vanado-molybdo-phosphoric yellow colour method (Koenig and Johnson, 1942) and Ammonium acetate method (Jackson, 1971) and their uptake were calculated in kgha^{-1} according to biological yield of respective plots.

Economics

Cost of cultivation of each treatment was calculated accordingly inputs used and other cost involved during crop period. Gross return was calculated on market rate of produce and subtracting cost of cultivation, the net return was noted. The B: C ratio was calculated by dividing gross return by cost of cultivation. All monetary parameters were finally converted in to Rs ha^{-1}.

Results and Discussion

Residual effect of INM and direct effect of Inorganic fertilizers on Wheat

Yield attributing parameters

Application of 100% NPK through fertilizer to wheat and residual effect of FYM 10 tha^{-1}+ 50 % NPK to *Kharif* crop (T_{10}) recorded significantly higher values of all yield attributing characters *i.e.* number of spikes plant^{-1} (2.3 and 2.4), spike length (10.3 and 10.4 cm), spikelet spike^{-1} (20.7 and 20.6), seeds spike^{-1} (60.20 and 60.33), seed weight spike^{-1} (2.42 and 2.24 g), seed weight plant^{-1} (5.37 and 5.38 g), and seed test weight (40.53 and 40.54 g) during 2008-09 and 2009-10 (Table 1 and 2).

The possible reasons of higher yield attributing parameters may be ascribed due to balanced dose of NPK supply and sufficient accumulation of N element and organic content through FYM that obviously increases primary vegetative growth and other growth parameters of wheat.

Table.1 Residual impact of INM and direct application of inorganic fertilizers on Yield attributes of Wheat

Treatments Kharif - Rabi (Wheat)	Yield attributes							
	2008-09				2009-10			
	Spike length (cm)	No. of spikes m^{-1}	No. of spikes plant^{-1}	No. of spikelet spike^{-1}	Spike length (cm)	No. of spikes m^{-1}	No. of spikes plant^{-1}	No. of spikelet spike^{-1}
T_1- Control (No fertilizer) - No fertilizer	5.9	29.0	1.5	12.6	5.9	27.0	1.3	13.8
T_2- 50% NPK (10:40:20) - 100% NPK	9.9	44.3	2.2	18.3	9.9	44.6	2.2	18.6
T_3- 75% NPK (15:60:30) - 75% NPK	9.2	39.6	1.9	16.3	9.2	39.6	1.8	16.4
T_4- 100% NPK (20:80:40) - 50% NPK	8.3	35.0	1.7	14.4	8.4	35.3	1.7	14.3
T_5- 100% NPK (20:80:40) - 75% NPK	9.3	40.6	1.8	16.4	9.2	40.0	1.9	16.4
T_6- 100% NPK (20:80:40) - 100% NPK	9.9	44.6	2.2	18.4	9.9	45.0	2.2	18.6
T_7 - 50% NPK + FYM 10 t ha^{-1}- 50% NPK	8.9	38.3	1.8	15.5	8.9	38.6	1.8	15.5
T_8- 50% NPK + VC 5 t ha^{-1} - 50% NPK	8.8	38.0	1.7	15.3	8.8	38.0	1.7	15.3
T_9 -50% NPK+CPP 3.75kgha^{-1} -50% NPK	8.6	35.0	1.7	14.6	8.5	35.6	1.7	14.5
T_{10} -50% NPK+FYM10 t ha^{-1} -100% NPK	**10.3**	**48.0**	**2.3**	**20.7**	**10.4**	**49.7**	**2.4**	**20.6**
T_{11} - 50% NPK + VC 5 t ha^{-1} - 100% NPK	10.0	47.3	2.2	20.2	10.3	48.0	2.3	20.1
T_{12} -50% NPK+CPP3.75kgha^{-1}-100% NPK	9.8	45.3	2.1	19.0	9.9	45.3	2.2	18.8
T_{13} - 75% NPK + FYM 5 t ha^{-1} - 75% NPK	9.5	42.0	1.9	17.4	9.5	42.3	2.1	17.4
T_{14} - 75% NPK + VC 2.5 t ha^{-1} - 75% NPK	9.4	40.6	1.9	17.4	9.4	42.0	2.0	17.4
T_{15} -75% NPK +CPP1.875kgha^{-1}-75% NPK	9.3	40.3	1.8	16.7	9.3	40.6	1.9	16.5
T_{16} - 100% NPK + FYM 5 t ha^{-1} -100% NPK	10.0	46.0	2.2	19.8	10.0	46.6	2.3	20.0
T_{17} -100% NPK+VC 2.5 t ha^{-1} -100% NPK	9.9	46.0	2.2	19.3	9.9	46.0	2.2	19.8
T_{18} -100%NPK+CPP1.875kgha^{-1} -100% NPK	9.8	45.3	2.2	18.6	9.9	45.3	2.2	18.7
SEm±	0.19	0.95	0.11	0.22	0.04	0.25	0.06	0.18
CD (P=0.05)	0.56	2.75	0.31	0.63	0.09	0.73	0.17	0.50

Table.2 Residual impact of INM and direct application of inorganic fertilizers on Yield attributes of Wheat

Treatments	Yield attributes					
	2008-09			2009-10		
	No. of seed spike^{-1}	Seed weight g spike^{-1}	Seed weight g 1000^{-1}	No. of seed spike^{-1}	Seed weight g spike^{-1}	Seed weight g 1000^{-1}
T_1- Control (No fertilizer) - No fertilizer	39.86	1.21	30.32	38.93	1.24	30.35
T_2- 50% NPK (10:40:20) - 100% NPK	55.0	2.16	39.26	55.06	2.18	39.29
T_3- 75% NPK (15:60:30) - 75% NPK	48.73	1.81	37.13	48.60	1.78	37.43
T_4- 100% NPK (20:80:40) - 50% NPK	42.20	1.51	35.76	41.26	1.45	35.98
T_5- 100% NPK (20:80:40) - 75% NPK	48.93	1.82	37.19	48.46	1.78	37.41
T_6- 100% NPK (20:80:40) - 100% NPK	55.33	2.17	39.21	55.13	2.18	39.30
T_7- 50% NPK + FYM 10 t ha^{-1} - 50% NPK	47.00	1.87	39.81	47.06	1.88	39.82
T_8- 50% NPK + VC 5 t ha-^{1} - 50% NPK	46.00	1.86	39.76	46.93	1.85	39.76
T_9- 50% NPK + CPP 3.75 kgha-^{1} - 50% NPK	42.73	1.56	36.50	41.40	1.56	36.51
T_{10} - 50% NPK + FYM 10 t ha-^{1} - 100% NPK	**60.20**	**2.42**	**40.53**	**60.33**	**2.24**	**40.54**
T_{11} - 50% NPK + VC 5 t ha-^{1} - 100% NPK	59.73	2.40	40.51	59.86	2.23	40.51
T_{12} - 50% NPK + CPP 3.75 kgha-^{1}- 100% NPK	55.80	2.22	39.75	55.60	2.19	39.75
T_{13} - 75% NPK + FYM 5 t ha-^{1} - 75% NPK	51.60	2.00	38.78	52.33	2.05	38.78
T_{14} - 75% NPK + VC 2.5 t ha-^{1} - 75% NPK	51.26	2.00	39.00	51.93	2.02	38.77
T_{15} - 75% NPK + CPP 1.875 kgha^{-} - 75% NPK	47.26	1.80	38.08	48.86	1.82	38.08
T_{16} - 100% NPK + FYM 5 t ha-^{1} - 100% NPK	55.73	2.23	40.00	55.86	2.19	40.04
T_{17} - 100% NPK + VC 2.5 t ha-^{1}- 100% NPK	55.33	2.20	39.76	55.53	2.19	39.93
T_{18} - 100%NPK+CPP1.875 kgha-^{1} - 100% NPK	54.80	2.18	39.75	55.40	2.16	39.80
SEm±	0.64	0.06	2.72	0.33	0.04	0.16

Table.3 Residual impact of INM and direct application of inorganic fertilizers on Yields of Wheat

Treatment Kharif - Rabi (Wheat)	Yield				Harvest Index (%)	
	Seed (t ha^{-1})		Straw (t ha^{-1})			
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
T_1- Control (No fertilizer) - No fertilizer	1.55	1.49	1.56	1.57	49.25	48.72
T_2- 50% NPK (10:40:20) - 100% NPK	4.29	4.32	4.40	4.47	49.37	49.14
T_3- 75% NPK (15:60:30) - 75% NPK	3.09	3.13	3.23	3.36	48.69	48.19
T_4- 100% NPK (20:80:40) - 50% NPK	2.23	2.248	2.32	2.34	49.80	48.94
T_5- 100% NPK (20:80:40) - 75% NPK	3.11	3.17	3.26	3.34	48.84	48.72
T_6- 100% NPK (20:80:40) - 100% NPK	4.31	4.34	4.49	4.52	48.93	49.02
T_7- 50% NPK + FYM 10 t ha^{-1} - 50% NPK	3.12	3.22	3.48	3.51	47.26	48.34
T_8- 50% NPK + VC 5 t ha-1 - 50% NPK	3.08	3.11	3.39	3.42	47.57	47.66
T_9- 50% NPK + CPP 3.75 kgha-1 - 50% NPK	2.42	2.48	2.55	2.66	48.66	48.41
T_{10} - 50% NPK + FYM 10 t ha-1 - 100% NPK	**4.94**	**4.95**	**4.95**	**5.04**	**49.95**	**49.54**
T_{11} - 50% NPK + VC 5 t ha-1 - 100% NPK	4.88	4.76	4.93	4.93	49.73	49.14
T_{12} - 50% NPK + CPP 3.75 kgha-1 - 100% NPK	4.38	4.41	4.57	4.58	49.04	49.02
T_{13} - 75% NPK + FYM 5 t ha-1 - 75% NPK	4.18	3.86	4.59	4.21	47.65	47.87
T_{14} - 75% NPK + VC 2.5 t ha-1 - 75% NPK	4.09	3.82	4.52	4.16	47.50	47.86
T_{15} - 75% NPK + CPP 1.875 kgha-1 - 75% NPK	3.26	3.24	3.60	3.59	47.51	47.40
T_{16} - 100% NPK + FYM 5 t ha-1 - 100% NPK	4.51	4.53	4.55	4.68	49.73	49.17
T_{17} - 100% NPK + VC 2.5 t ha-1 - 100% NPK	4.41	4.46	4.48	4.63	49.64	49.05
T_{18} - 100%NPK+CPP1.875 kgha-1 - 100% NPK	4.36	4.36	4.45	4.58	49.46	48.78
SEm±	0.25	0.35	0.22	0.21	0.39	0.25
CD(P=0.05)	0.73	0.72	0.63	0.59	1.12	0.74

Table.4 Residual impact of INM and direct application of inorganic fertilizers on Nutrient uptake of Wheat

Treatment Kharif - Wheat	Nutrient uptake (kgha-1)					
	Nitrogen		Phosphorus		Potassium	
	2008-09	2009- 10	2008-09	2009- 10	2008-09	2009- 10
T_1- Control (No fertilizer) - No fertilizer	32.6	31.3	4.6	4.3	13.6	13.0
T_2- 50% NPK (10:40:20)- 100% NPK	108.0	107.6	15.3	15.6	64.3	66.0
T_3- 75% NPK (15:60:30) - 75% NPK	67.0	67.6	12.0	12.0	42.6	44.3
T_4- 100% NPK (20:80:40) - 50% NPK	55.6	57.0	7.3	8.0	27.6	27.3
T_5- 100% NPK (20:80:40) - 75% NPK	70.3	71.6	12.3	12.6	45.3	45.0
T_6- 100% NPK (20:80:40) - 100% NPK	107.6	111.6	16.3	16.3	68.6	69.3
T_7- 50% NPK + FYM 10 t ha-1 - 50% NPK	81.3	82.6	11.0	11.6	49.6	51.3
T_8- 50% NPK + VC 5 t ha-1 - 50% NPK	77.0	77.3	11.0	11.0	44.6	48.3
T_9- 50% NPK + CPP 3.75 kgha-1 - 50% NPK	60.3	61.6	10.0	9.6	31.0	33.3
T_{10} - 50% NPK + FYM 10 t ha-1 - 100% NPK	**119.0**	**123.3**	**20.3**	**20.0**	**82.0**	**83.6**
T_{11} - 50% NPK + VC 5 t ha-1 - 100% NPK	114.3	116.0	**20.0**	**19.6**	78.6	80.6
T_{12} - 50% NPK + CPP 3.75 kgha-1 - 100% NPK	103.3	106.0	16.0	17.0	69.3	69.6
T_{13} - 75% NPK + FYM 5 t ha-1 - 75% NPK	94.6	95.0	16.0	16.0	63.0	65.6
T_{14} - 75% NPK + VC 2.5 t ha-1 - 75% NPK	94.0	94.6	15.3	15.6	60.0	63.0
T_{15} - 75% NPK + CPP 1.875 kgha-1- 75% NPK	71.3	72.0	13.0	13.0	47.6	50.0
T_{16} - 100% NPK + FYM 5 t ha-1 - 100% NPK	114.3	114.6	19.0	19.3	71.6	78.0
T_{17} - 100% NPK + VC 2.5 t ha-1 - 100% NPK	109.3	110.0	18.0	18.0	68.6	75.3
T_{18} - 100%NPK+CPP1.875 kgha-1 - 100% NPK	106.3	108.3	16.3	16.0	66.3	71.6
SEm±	0.55	0.62	0.33	0.42	0.56	0.67
CD(P=0.05)	1.58	1.78	0.94	1.22	1.63	1.93

Table.5 Residual impact of INM and direct application of inorganic fertilizers on economics of Wheat

Treatments	Economics							
	Cost of cultivation (Rs ha^{-1})		Gross Return (Rs ha^{-1})		Net Return (Rs ha^{-1})		B:C Ratio	
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
T_1- Control (No fertilizer) - No fertilizer	9214	11195	17061	18827	7847	7632	1.85	1.68
T_2- 50% NPK (10:40:20) - 100% NPK	11893	13870	47428	54417	35535	40547	3.99	3.92
T_3- 75% NPK (15:60:30) - 75% NPK	11205	13186	34360	39720	23155	26534	3.06	3.01
T_4- 100% NPK (20:80:40) - 50% NPK	10520	12507	24721	28225	14201	15718	2.35	2.25
T_5- 100% NPK (20:80:40) - 75% NPK	11205	12852	34506	40027	23301	27175	3.08	3.04
T_6- 100% NPK (20:80:40) - 100% NPK	11993	13870	47744	54721	35851	40851	4.01	3.94
T_7- 50% NPK + FYM 10 t ha^{-1} - 50% NPK	10520	12507	35055	41004	24535	28497	3.33	3.28
T_8- 50% NPK + VC 5 t ha^{-1} - 50% NPK	10520	12507	34491	39668	23971	27161	3.28	3.17
T_9- 50% NPK + CPP 3.75 kgha-^{1} - 50% NPK	10520	12507	26899	31631	16379	19124	2.56	2.53
T_{10} - 50% NPK + FYM 10 t ha^{-1} - 100% NPK	11893	13870	**54372**	**62083**	**42479**	**48213**	**4.57**	**4.48**
T_{11} - 50% NPK + VC 5 t ha^{-1} - 100% NPK	11893	13870	53756	59921	41863	46.51	4.52	4.30
T_{12} - 50% NPK + CPP 3.75 kgha-^{1}- 100% NPK	11893	13870	48559	55525	36666	41655	4.08	4.00
T_{13} - 75% NPK + FYM 5 t ha^{-1} - 75% NPK	11205	13186	46794	49171	35589	35985	4.18	3.73
T_{14} - 75% NPK + VC 2.5 t ha^{-1} - 75% NPK	11205	13186	45899	48604	34694	35418	4.10	3.69
T_{15} - 75% NPK + CPP 1.875 kgha^{-} - 75% NPK	11205	13186	36531	41383	25326	28197	3.26	3.14
T_{16} - 100% NPK + FYM 5 t ha^{-1} - 100% NPK	11893	13870	49673	57025	37780	43155	4.18	4.11
T_{17} - 100% NPK + VC 2.5 t ha^{-1}- 100% NPK	11893	13870	48658	56141	36765	42271	4.09	4.05
T_{18} - 100%NPK+CPP1.875 kgha-^{1} - 100% NPK	11893	13870	48131	55062	36238	41192	4.05	3.97
SEm±	-	-	511.0	3518.0	533.4	834.4	0.03	0.06
CD (P=0.05)	-	-	1469	10117	1533	2410	0.13	0.18

Balanced application of fertilizers and credited macro and micronutrients through organic manures, used in preceding *kharif* crop enhanced the root and shoot development. Since adequate supply of N promotes the physiological process of growth and development of wheat crop and ultimately gave higher values of yield attributing characters (Table 1 and 2). These results have also reported bySingh *et al.*, (2011), Thakur *et al.,* (2011), Meena *et al.*, (2013), Usadadiya *et al*., (2013), Vinay Singh (2016) and Parewa *et al.*, (2019).

Yield and Harvest Index

Application of 100% NPK to wheat and residual effect of FYM @ 10 tha^{-1}+ 50% NPK to previous *kharif* crop (T_{10}) recorded significantly higher seed (4.94 and 4.95 t ha^{-1}), straw yield (4.95 and 5.04 t ha^{-1}) and Harvest index (49.95 and 49.54 %) of wheat over rest of the treatments except 100% NPK with residual impact of vermicompost @ 5 tha^{-1} and 50% NPK (T_{11}) which was statistically at par with T_{10} during 2008-09 and 2009-10 (Table 3). This was obtained due to accumulated C: N ratio at primary stage of the crop (Pratap *et al.,* 2006). Nitrogen directly influenced plant growth and development of crop canopy through better utilization of photosynthates. Moreover, at maturity stage of crop more photosynthates are diverted and accumulated in spike resulted to maximum grain yield. Further optimum dose of phosphorus and potassium played their role for development of vigorous seed and a greater number of seeds in spike. This was because the N omission strongly depressed the grain and straw production of wheat (Hussain and Kumar, 2013). The residual N also helped to sustain yield improvement in wheat and sustained the productivity Aulakh *et al.,* (2012). Residual impact of manures in wheat crop exerted significant effect on grain and straw yield over 100% NPK alone (Pandey and Kumar 2017). Residual macro and microelement through FYM provided better soil environment and physical condition for better root development, which able to supply addition demand of mineral and water for maximum photosynthesis process. These findings are similar those of Usadadiya *et al.*, (2013), Das *et al.,* (2015), Singh *et al*., (2015), Nawale *et al.,* (2018) and Parewa *et al.,* (2019).

Nutrient uptake

Nitrogen (119.0 and 123.3 kg ha^{-1}) and potassium (82.0 and 83.6 kg ha^{-1}) uptake of wheat were found significantly higher with residual impact of 100% NPK + FYM @ 10 $tha^{-1}$and 100 % NPK to wheat (T_{10}) over other treatments during 2008-09 and 2009-10. While, phosphorus uptake (20.3 and 20.0 kg ha^{-1}) was recorded significantly greater under same treatment but it was statistically at par with T_{11} (residual effect of 100% NPK + vermicompost @ 5 tha^{-1} and 100% NPK to wheat) in both the years (Table 4). It might be due to use of balanced dose of NPK to wheat with residual response of organic manures and inorganic N & P. Consequently, higher soil microbial activity with the presence of organic matter, which ensured higher availability of NPK thus it, increased root cation exchange capacity. Jointly these owing to increase supply of nutrient to the crop, as well as reduced the loss of organically supplied nutrients. Das *et al.,* (2015), Sharma *et.al.* (2015), Singh *et al.,* (2015), Vinay Singh (2016), Dwivedi *et al.,* (2016), Singh and Patra (2017), Nawale*et.al.,* (2018), Bairwa *et al.,* (2019) and Paramesh *et al.,* (2020) also reported similar findings.

Economics

Cost of cultivation of wheat was recorded maximum Rs. 11893 and 13870 ha^{-1} during

2008-09 and 2009-10 in those treatment having 100% RDF with inorganic fertilization followed by 75% and 50% NPK of RDF. The gross return (Rs 54372 and 62.083 ha^{-1}), net return (Rs. 42479 and 48213 ha^{-1}) and B:C ratio (4.57 and 4.48) were recorded significantly higher under treatment T_{10} (residual effect of 100% NPK+FYM @ 5 t ha^{-1} in *kharif* crop) in compare to all other treatments during 2008-09 and 2009-10 (Table 5).

The economic output of wheat influenced significantly with doses of Fertilizers (50, 75 and 100%) and residual effect of inorganic fertilizers and Manures (FYM, Vermi-compost and CPP) which were used in preceding crop. Certainly, the higher values of economic return were directly related to higher values of grain and straw yield and cost of cultivation are higher side due to higher cost of vermi-compost and FYM in compare to other treatment. Earlier findings in this regard reported by Hussain *et al.,* (2013) Das *et al.,* (2015, Sharma *et al.,* (2015), Vinay Singh (2016), Singh and Singh (2018), Bairwa *et al.,* (2019) and Kumar *et al.,* (2020) had also showed conformity.

In conclusion the study provides information that residual effect of FYM 5 $tha^{-1}$with 100% recommended dose of inorganic fertilizer to previous crop and 100 % RDF to wheat was found as a best combination of organic manure and inorganic fertilizers in term of yield attributes, yield, nutrient uptake and economics of wheat.

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