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Grain yield and NPK uptake of wheat (*Triticum aestivum* L.) as influenced by nitrogen, vermicompost and herbicide (*Clodinafop propargyl*)

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Application of Nitrogen (N) at 150 mg kg^{-1} soil significantly increased the grain and straw yield of wheat from 2.70 to 8.24 and 4.97 to 9.44 g pot^{-1}, respectively over control. Addition of vermicompost at 1% alone increased the grain and straw yield of wheat from 2.70 to 4.81 and 4.97 to 6.60 g pot^{-1} respectively over control and in combination with N at 150 mg kg^{-1} soil further improved from 4.81 to 10.73 and 6.60 to 11.89 g pot^{-1}, respectively. Use of *Clodinafop propargyl* at 60 and 90 g a.i. ha^{-1} significantly decreased the grain yield of wheat from 4.74 to 3.60 and to 2.93 g pot^{-1}, respectively and that of straw yield from 7.16 to 5.87 and to 4.31 g pot^{-1}, respectively over control (without *C. propargyl*). The grain and straw yield of wheat also decreased significantly with the application of *C. propargyl* (60 to 90 g a.i./ha) in presence of both vermicompost and N. Nitrogen, Phosphorus (P) and Potassium (K) uptake by grain and straw increased significantly with the increase in each successive dose of N up to the level of 200 mg kg^{-1} soil and highest uptake of NPK by grain were 149.56, 57.59 and 40.87 mg pot^{-1}, respectively and that of by straw the highest value recorded were 54.72, 18.24 and 143.78 mg pot^{-1}, respectively. Application of vermicompost at 1% significantly increased NPK uptake in both grain and straw over control. Use of *C. propargyl* at 60 and 90 g a.i. ha^{-1} significantly decreased the NPK uptake by grain and straw.

Key words: *Clodinafop propargyl*, Nitrogen, nutrient uptake, pot study, vermicompost and wheat yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is a dominant *rabi* cereal crop of north-western zone of India. India is producing about 92.45 million tons of wheat from an area of 29.64 million hectare with an average productivity of 3119 kg/ha (Anonymous, 2013). Haryana, which is one of the major wheat growing states, produces 111.17 lac tons of wheat from 24.97 lac hectares area with an average productivity of 4452 kg/ha (Anonymous, 2013). N can limit crop yield and its judicious use is essential for sustainable crop production. It represents 28% of the cost of inputs. Mengel et al. (2006) reported that optimum N rate should be explored as too high rates may cause severe N losses and low rates depress the yield. Indiscriminate use of chemical fertilizers to get maximum yields leads to the depletion of inherent soil fertility (Gupta and Nath, 1998). With the improvement in the agricultural technologies and

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release of high yielding dwarf varieties of cereals, demand for fertilizers has increased manifolds and nitrogenous fertilizers in particular. Most soils are far from being ideally fertile and should therefore, be improved not only by adding nutrients, but also by other soil amendments, like organic matter for maintaining the activity of “Soil life”. Since, agriculture becomes more intensive and chemical dependent, therefore soil toxicities and nutrient imbalance threaten sustainable production. So, we have to think about the cheap and easily available alternate source of nutrients. Thus, demand for fertilizers can be lowered by supplementing the nutrients through organic manures. Judicious use of farmyard manure (FYM) with chemical fertilizers improves soil physical, chemical and biological properties and improves the crop productivity (Sharma et al., 2007). Application of organic manures may also improve availability of native nutrients in soil as well as the efficiency of applied fertilizers (Sawrup, 2010). Among different sources of organic manures, vermicompost is most important source and used since long as a nutrients supplement to crop production.

Solid waste generation in India is about 115,000 tons per day with a yearly increase of about 5% (Jain et al., 2014). The estimated annual increase in per capita waste quantity is about 1.33% per year. The large amount of the agro waste generated has created major environmental problems. Vermicomposting is the best biotechnology to reduce the load on the treatment and disposal of biodegradable agro waste. Keeping this in view, the present study was planned to assess the effect of N and vermicompost in presence of herbicide (*C. propargyl*) on wheat yield and nutrients uptake by wheat.

MATERIALS AND METHODS

A pot culture experiment was conducted to study the response of graded levels of N in combination with vermicompost and herbicide on yield and nutrient uptake by wheat (*T. aestivum* L. cv. WH-711) at screen house, Department of Soil Science, CCS HAU, Hisar (29º 05’ N, 75º 38’ E, 222 m elevation). The soil used was sand in texture. Physico-chemical properties of the soil and vermicompost used and their methods of analysis are reported in Table 1. The treatment combinations comprised five levels of N (0, 50, 100, 150 and 200 mg/kg) applied through urea, two levels of vermicompost (0 and 1% on dry wt. basis) and three levels of herbicide (0, 60 and 90 g a.i./ha). Experimental data was statistically analysed by completely randomized design with three replications. Five kilogram air dried soil was spread on a polyethylene sheet and required amount of either fertilizer, vermicompost or in combinations as per above schedule were applied and thoroughly mixed. Half of N was applied through urea solution at the time of sowing and another half was applied 21 days after sowing (DAS). A basal dose of P, K and zinc (Zn) at 60, 75 and 5 mg kg^{-1} soil was added through potassium dihydrogen orthophosphate and $ZnSO_4.7H_2O$ solutions. Herbicide was applied after 35 DAS.

For these treatments, chemicals of analytical grade were used. Before sowing, about 200 g of soil was removed from each pot. The pot was irrigated with one liter of deionized water. On disappearance of free water from the surface, 10 seeds of wheat were placed eight in circle and two in centre of the pot. Then, these seeds were covered by spreading 200 g of soil. Thereafter, the pots were covered with newspaper to prevent drying out of soil. After 12 days, five plants in each pot were maintained. Intercultural operations and irrigations with deionised water were done as and when required. Crop was harvested at maturity. The plants were thoroughly washed with distilled water. The excess of water was removed by gentle shaking and pressing between two filter papers and then dried in oven at 50°C. The grains and straw were separated and weighed separately from each pot. The grains and straw were ground in a Willey mill using stainless steel sieve. Each sample was mixed thoroughly after grinding and stored in polythene bags. Then these samples were analyzed for total N, P and K in laboratory by following standard procedures. N in plant samples was determined by using Colorimetric (Nessler's reagent) method (Lindner, 1944). P in plant samples was determined by using Vanadomolybdophosphoric yellow color method (Koenig and Johnson, 1942). K in plant samples was determined by using flame photometer (directly).

RESULTS AND DISCUSSION

Grain yield

Data presented in Table 2 revealed that the grain yield of wheat increased significantly with the successive increase in N application up to the level of 150 mg N/kg soil and the extent of increase was from 2.70 to 8.24 g/pot over control. The difference in grain yield was non-significant between 150 mg N/kg soil (8.24 g/pot) and 200 mg N/kg soil (9.29 g/pot). Results are in agreement with Lloveras et al. (2001), Iqtidar et al. (2006), Ali et al. (2011) and Siddiqui et al. (2013). Application of vermicompost alone significantly increased the grain yield over the control (without vermicompost) and the extent of increase in grain yield was from 2.70 to 4.81 g/pot. Similar findings were reported by Ranwa and Singh (1999) and Khandal and Bhardwaj (2000). Similarly, N application in conjugation with vermicompost (150 mg N/kg soil + vermicompost) significantly increased the grain yield of wheat up to the levels of 150 mg N/kg soil and the extent of increase was from 2.70 to 10.73 g/pot. However, the difference between the conjugate use of 150 mg N/kg soil + vermicompost and 200 mg N/kg soil + vermicompost was found non-significant with respect to grain yield. The added beneficial effect of vermicompost was because of vermicompost contains macro and micro nutrients and also improves physico-chemical and biological properties of the soil, which may improves the availability of applied and native nutrients in soil. From the results presented above, it can be revealed that N in combination with vermicompost had more beneficial effect than their individual effect. These findings are similar to that reported by Sujathamma et al. (2001) and Shekhon et al. (2011).

Data presented in Table 2 indicated that application of *C. propargyl* at 60 and 90 g a.i./ha significantly decreased the grain yield from 4.74 to 3.60 and to 2.93 g/pot, respectively over control (without *C. propargyl*). Application of *C. propargyl* at 60 and 90 g a.i./ha also declined the grain yield of wheat from 11.53 to 10.96 and

Table 1. Physico-chemical properties of soil and vermicompost.

Property	Values	Method used
Soil		
Organic carbon (%)	0.15	Walkley and Black Wet oxidation method (Jackson, 1973)
Soil pH	8.10	Glass electrode pH meter (Jackson, 1973)
EC (dS/m at 25ºC)	0.15	Conductivity bridge meter (Richards, 1954)
Available nitrogen (mg/kg)	54.50	Alkaline per magnate method (Subbiah and Asija, 1956)
Available phosphorus (mg/kg)	8.00	Olsen's method (Olsen *et al.*, 1954)
Available potassium (mg/kg)	83.70	Flame photometer method (USDA Hand Book No. 60, Richards, 1954)
Vermicompost (%)		
Total N	1.30	Colorimetric (Nessler's reagent) method (Lindner, 1944)
Total P	0.52	Vanadomolybdophosphoric yellow color method (Koenig and Johnson, 1942)
Total K	1.22	Using flame photometer (directly)
Organic carbon	15.23	Rapid titration method (Walkley and Black, 1934)

Table 2. Effect of Nitrogen, vermicompost and *Clodinafop propargyl* on grain and straw yield (g/pot) in wheat crop.

Treatments	Nitrogen levels (mg/kg soil)					
	0	**50**	**100**	**150**	**200**	**Mean**
Grain						
Vermicompost levels						
0	2.70	5.46	6.80	8.24	9.29	6.50
1%	4.81	7.13	9.25	10.73	11.18	8.62
Mean	3.75	6.29	8.02	9.48	10.23	
CD (5%) Nitrogen = 1.21, Vermicompost = 0.76 and Nitrogen × Vermicompost = 1.39						
***Clodinafop propargyl* levels (g a.i./ha)**						
0	4.74	6.82	8.38	10.06	11.53	8.28
60	3.60	6.54	8.10	9.78	10.96	7.79
90	2.93	5.23	6.84	8.01	9.20	6.44
Mean	3.76	6.19	7.77	9.28	10.56	
CD (5%) Nitrogen = 0.27, Herbicide = 0.21 and Nitrogen × Herbicide = 0.47						
Straw						
Vermicompost levels						
0	4.97	6.08	7.73	9.44	10.73	7.79
1%	6.60	8.28	10.35	11.89	12.93	10.01
Mean	5.78	7.18	9.04	10.66	11.83	
CD (5%) Nitrogen = 1.43, Vermicompost = 1.07 and Nitrogen × Vermicompost = 1.16						
***Clodinafop propargyl* levels (g a.i./ha)**						
0	7.16	7.95	9.70	11.22	13.10	9.82
60	5.87	7.43	9.14	10.79	12.02	9.05
90	4.31	6.15	7.88	9.06	10.81	7.64
Mean	5.78	7.17	8.90	10.35	11.97	
CD (5%) Nitrogen = 0.53, Herbicide = 0.41 and Nitrogen × Herbicide = 0.93						

to 9.20 g/pot, respectively in the presence of 200 mg N/kg soil. Data presented in Table 3 revealed that application of *C. propargyl* at 60 and 90 g a.i./ha significantly decreased the grain yield in the presence of

Table 3. Effect of vermicompost and *Clodinafop propargy*l on grain and straw yield (g/pot) in wheat crop.

Vermicompost levels	*Clodinafop propargyl* levels (g a.i./ha)			
	0	60	90	Mean
Grain				
0	7.43	6.51	5.25	6.40
1%	9.08	8.91	7.63	8.54
Mean	8.25	7.71	6.44	
CD (5%) Vermicompost = 0.17, Herbicide = 0.21 and Vermicompost × Herbicide = 0.30				
Straw				
0	9.21	7.88	6.27	7.79
1%	9.93	9.27	8.45	9.21
Mean	9.57	8.57	7.36	
CD (5%) Vermicompost = 0.34, Herbicide = 0.41 and Vermicompost × Herbicide = 0.63				

vermicompost and the extent of decrease was from 9.08 to 8.91 g/pot and 7.63 g/pot, respectively. From the above results, it can be revealed that due to phytotoxic effect of *C. propargyl*, grain yield decreased and this deleterious effect of *C. propargyl* was reduced with the application of N and vermicompost. These results are similar to those reported by Duhan et al. (2006) and Wagner and Nadasy (2009).

Straw yield

It was observed that the straw yield data also followed the similar trend as that of grain yield. There was significant increase in straw yield of wheat with the successive increase in N levels up to the 150 mg kg^{-1} soil (Table 2) and the extent of increase from 4.97 to 9.44 g/pot. These findings are similar to Ali et al. (2011) and Siddiqui et al. (2013). Application of vermicompost alone also significantly increased the straw yield over the control (without vermicompost) and the extent of increase in grain yield was from 4.97 to 6.60 g/pot. Similar findings were reported by Ranwa and Singh (1999) and Khandal and Bhardwaj (2000).

The application of N as well as vermicompost significantly increased the straw yield (150 mg N/kg soil and vermicompost) and the increase was from 9.44 g/pot to 11.89 g/pot over control. Thus, there was significant added effect of vermicompost when applied in conjugation with N fertilizer. These findings were similar to those reported by Billore et al. (2009), Shekhon et al. (2011) and Duhan et al. (2011). The data presented in Table 2 indicated that application of *C. propargyl* at 60 and 90 g a.i./ha significantly decreased the straw yield from 7.16 to 5.87 and to 4.31 g/pot, respectively over control (without *C. propargyl*). Application of *C. propargyl* at 60 and 90 g a.i./ha also declined the straw yield from 13.10 to 12.02 and to 10.81 g/pot, respectively in the presence of 200 mg N kg^{-1} soil. Data presented in Table 3 revealed that application of *C. propargyl* at 60 and 90 g a.i./ha also significantly decreased the straw yield in the presence of vermicompost and the extent of decrease was from 9.93 to 9.27 g/pot and further to 8.45 g/pot, respectively. Wagner and Nadasy (2009) and Kumar (2010) reported that herbicides (2,4-D and IPU) had phyto-depressive effects.

Nutrients uptake

Nitrogen uptake by grain

Uptake of N by wheat grains also increased significantly with the application of N and N + vermicompost (Table 4). It is so because uptake is a mathematical parameter calculated from yield and N content. As both yield and N content increased significantly over control, so uptake of N also increased significantly. A perusal of data (Table 4) indicated that with the increase in successive doses of N the uptake of N by grains increased significantly up to 200 mg N/kg soil and the extent of increase was from 25.92 mg/pot to 149.56 mg/pot over control. Similar, results were reported by Ahmad et al. (2007).

Data further revealed that application of vermicompost alone also significantly increased the N uptake from 25.92 to 63.49 mg/pot over control. Similar, results were reported by Sreenivash et al. (2000) and Davari et al. (2012). Conjugative use of N and vermicompost recorded the highest N uptake by grains and the extent of increase with nitrogen at 200 mg kg^{-1} soil + vermicompost at one percent was from 25.92 to 193.41 mg/pot over control. It is further reported that combined use of N and vermicompost was found superior than their individual use. Our results were in agreement with Jadhav et al. (1997), Khokhar and Nepalia (2010) and Sefidkoohi and Sepanlou (2013).

The data presented in Table 4 indicated that application of *C. propargyl* at 60 and 90 g a.i./ha significantly

Table 4. Effect of Nitrogen, vermicompost and *Clodinafop propargyl* on nitrogen uptake by grain and straw (mg/pot) in wheat crop.

Treatments	Nitrogen levels (mg/kg soil)					
	0	**50**	**100**	**150**	**200**	**Mean**
Grain						
Vermicompost levels						
0	25.92	74.25	103.36	127.72	149.56	96.16
1%	63.49	113.36	150.77	179.19	193.41	140.04
Mean	44.70	93.80	127.06	153.45	171.48	
CD (5%) Nitrogen = 1.59, Vermicompost = 1.01 and Nitrogen × Vermicompost = 2.26						
***Clodinafop propargy*l levels (g a.i./ha)**						
0	58.30	105.71	138.27	169.00	199.46	134.14
60	40.68	94.83	127.17	157.45	181.93	120.41
90	31.35	74.78	103.28	122.55	148.12	96.01
Mean	43.45	91.77	122.90	149.66	176.50	
CD (5%) Nitrogen = 1.59, Herbicide = 1.23 and Nitrogen × Herbicide = 2.76						
Straw						
Vermicompost levels						
0	15.40	21.88	32.46	47.20	54.72	34.33
1%	27.06	36.43	50.71	66.41	73.70	50.86
Mean	21.23	29.15	41.58	56.80	64.21	
CD (5%) Nitrogen = 1.93, Vermicompost = 1.22 and Nitrogen × Vermicompost = 3.10						
Clodinafop propargyl Levels (g a.i./ha)						
0	29.35	34.98	47.53	61.72	73.36	49.38
60	20.54	30.46	41.13	57.18	64.90	42.84
90	13.79	22.75	33.09	46.20	56.21	34.40
Mean	21.23	29.40	40.58	55.03	64.82	
CD (5%) Nitrogen = 1.93, Herbicide = 1.49 and Nitrogen × Herbicide = 3.34						

decreased the N uptake by grains from 58.30 mg/pot to 40.68 and to 31.35 mg/pot, respectively over control (without *C. propargyl*). Application of *C. propargyl* at 60 and 90 g a.i./ha also declined the N uptake by wheat grains from 199.46 to 181.93 and to 148.12 mg/pot, respectively in the presence of nitrogen at 200 mg kg^{-1} soil. Data presented in Table 5 further revealed that application of *C. propargyl* at 60 and 90 g a.i./ha also significantly decreased the N uptake by grains in the presence of vermicompost and the extent of decrease was from 149.82 to 138.99 mg/pot and to 116.73 mg/pot, respectively. Wagner and Nadasy (2009) and Majumdar et al. (2010) also reported similar findings.

Nitrogen uptake by straw

N uptake by wheat straw also increased significantly with the application of N and N + vermicompost (Table 4). A perusal of data (Table 4) indicated that application of N significantly increased the uptake of N by straw up to 200 mg N/kg soil and the extent of increase was from 15.40 mg/pot to 54.72 mg/pot over control. Similar, results were reported by Ahmad et al. (2007). Data further revealed that application of vermicompost alone also increased significantly the N uptake from 15.40 to 27.06 mg/pot over control. Similar, results were reported by Gupta et al. (1996) and Sreenivash et al. (2000). Conjugative use of N at 200 mg/kg soil and vermicompost at 1% recorded the highest N uptake (73.70 mg/pot) by straw over control. It is further reported that combined use of N and vermicompost was found superior than their individual use. Results are in agreement with those reported by Khokhar and Nepalia (2010) and Sefidkoohi and Sepanlou (2013). The data presented in Table 4 indicated that application of *C. propargyl* at 60 and 90 g a.i./ha significantly decreased the N uptake by straw from 29.35 mg/pot to 20.54 and to 13.79 mg/pot, respectively over control (without *C. propargyl*). Application of *C. propargyl* at 60 and 90 g a.i./ha also decreased the N

Table 5. Effect of vermicompost and *Clodinafop propargyl* on nitrogen uptake by grain and straw (mg/pot) in wheat crop.

Vermicompost levels	*Clodinafop propargyl* levels (g a.i./ha)			
	0	60	90	Mean
Grain				
0	109.96	90.48	69.82	90.08
1%	149.82	138.99	116.73	135.18
Mean	129.89	114.73	93.27	
CD (5%) Vermicompost = 1.01, Herbicide = 1.23 and Vermicompost × Herbicide = 1.75				
Straw				
0	40.52	33.09	24.45	32.68
1%	51.63	44.49	38.87	44.98
Mean	46.07	38.79	31.66	
CD (5%) Vermicompos t = 1.22, Herbicide = 1.49 and Vermicompost × Herbicide = 2.11				

uptake by straw from 73.36 to 64.90 and to 56.21 mg/pot, respectively in the presence of 200 mg N kg^{-1}soil. Table 5 revealed that application of *C. propargyl* at 60 and 90 g a.i./ha significantly decreased the N uptake by straw in the presence of vermicompost and the extent of decrease was from 51.63 to 44.49 mg/pot and further to 38.87 mg/pot, respectively. Majumdar et al. (2010) and Sarmamy and Khidir (2013) also reported similar results.

Phosphorus uptake by grain

A perusal of data (Table 6) indicated that with the increase in successive doses of N the uptake of phosphorus by wheat grains increased significantly up to 200 mg N/kg soil and the extent of increase was from 11.07 mg/pot to 57.59 mg/pot over control. Similar results reported by Nedelciuc et al. (1995) and Gupta et al. (1992). Data further revealed that application of vermicompost alone significantly increased the P uptake from 11.07 to 26.45 mg/pot over control. Similar, results were reported by Sreenivash et al. (2000) and Davari et al. (2012). Conjugative use of N and vermicompost (200 mg N/kg soil + vermicompost at 1%) recorded the highest P uptake (71.55 mg/pot) by grains over control. It is further reported that combined use of N and vermicompost was found superior than their individual use. Results are in agreement with Khokhar and Nepalia (2010) and Goel and Duhan (2011). The data presented in Table 6 indicated that application of *C. propargyl* at 60 and 90 g a.i./ha significantly decreased the P uptake by grains from 25.59 mg/pot to 17.28 and to 12.30 mg/pot, respectively over control (without *C. propargyl*). Application of *C. propargyl* at 60 and 90 g a.i./ha also declined the P uptake by grains from 74.94 mg/pot to 69.04 and to 56.12 mg/pot, respectively in the presence of 200 mg N kg^{-1} soil. Data presented in Table 7 revealed that application of *C. propargyl* at 60 and 90 g a.i./ha also significantly decreased the P uptake by grains in the presence of vermicompost and the extent of decrease was from 57.20 to 54.35 mg/pot and further to 43.49 mg/pot, respectively. This decrease in P uptake by grains with the application of *C. propargyl* at both levels may be due to phytotoxic effect of herbicide. Osborne et al. (1993) and Sarmamy and Khidir (2013) also reported similar type of results.

Phosphorus uptake by straw

A perusal of data (Table 6) indicated that with the increase in successive doses of N the uptake of P by wheat straw increased significantly up to 200 mg N/kg soil and the extent of increase was from 3.74 mg/pot to 18.24 mg/pot over control. Similar, results were reported by Ahmad et al. (2007). Data further revealed that application of vermicompost significantly increased the P uptake from 3.74 to 6.60 mg/pot over control. Similar, results were reported by Sreenivash et al. (2000) and Bhardwaj et al. (2000). Conjugative use of N and vermicompost recorded the highest P uptake by wheat straw and the extent of increase with 200 mg N/kg soil + vermicompost at 1 % was from 3.74 to 25.86 mg/pot over control.

It is further reported that combined use of N and vermicompost was found superior than their individual use. Our results were in agreement with those reported by Benbi et al. (1998) and Sefidkoohi and Sepanlou (2013).

The data presented in Table 6 indicated that application of *C. propargyl* at 60 and 90 g a.i./ha significantly decreased the P uptake by straw from 7.16 mg/pot to5.28 and to 2.58 mg/pot, respectively over control (no *C. propargyl*). Application of *C. propargyl* at 60 and 90 g a.i./ha also declined the P uptake by straw from 28.82 to 22.83 and to 17.29 mg/pot, respectively in the presence

Table 6. Effect of Nitrogen, vermicompost and *Clodinafop propargyl* on phosphorus uptake by grain and straw (mg/pot) in wheat crop.

Treatments	Nitrogen levels (mg/kg soil)					
	0	50	100	150	200	Mean
Grain						
Vermicompost levels						
0	11.07	29.48	38.08	49.44	57.59	37.13
1%	26.45	42.06	58.27	68.66	71.55	53.39
Mean	18.76	35.77	48.17	59.05	64.57	
CD (5%) Nitrogen = 1.26, Vermicompost = 0.79 and Nitrogen × Vermicompost = 1.78						
***Clodinafop propargyl* levels (g a.i./ha)**						
0	25.59	40.23	52.79	64.38	74.94	51.59
60	17.28	37.93	49.41	60.63	69.04	46.85
90	12.30	27.71	37.62	47.25	56.12	36.20
Mean	18.39	35.29	40.60	57.42	66.70	
CD (5%) Nitrogen = 1.26, Herbicide = 0.97 and Nitrogen × Herbicide = 2.18						
Straw						
Vermicompost levels						
0	3.74	4.86	10.05	15.10	18.24	10.39
1%	6.60	9.10	14.49	21.34	25.86	15.47
Mean	5.17	6.98	12.27	18.22	22.05	
CD (5%) Nitrogen = 0.72, Vermicompost = 0.46 and Nitrogen × Vermicompost = 1.02						
***Clodinafop propargyl* levels (g a.i./ha)**						
0	7.16	8.74	13.58	21.32	28.82	15.92
60	5.28	7.43	11.88	19.42	22.83	13.36
90	2.58	4.92	8.66	13.59	17.29	9.40
Mean	5.06	7.03	11.37	18.11	22.98	
CD (5%) Nitrogen = 0.72, Herbicide = 0.56 and Nitrogen × Herbicide = 1.26						

Table 7. Effect of vermicompost and *Clodinafop propargyl* on phosphorus uptake by grain and straw (mg/pot) in wheat crop.

Vermicompost levels	*Clodinafop propargyl* levels (g a.i./ha)			
	0	60	90	Mean
Grain				
0	43.09	35.80	26.25	35.04
1%	57.20	54.35	43.49	51.68
Mean	50.14	45.07	34.87	
CD (5%) Vermicompost = 0.79, Herbicide = 0.97 and Vermicompost × Herbicide = 1.38				
Straw				
0	12.89	9.45	6.27	9.53
1%	16.88	13.90	10.14	13.64
Mean	14.88	11.67	8.22	
CD (5%) Vermicompost = 0.46, Herbicide = 0.56 and Vermicompost × Herbicide = 0.80				

of nitrogen at 200 mg kg^{-1}soil. Data presented in Table 7 further revealed that application of *C. propargyl* at 60 and 90 g a.i./ha also significantly decreased the P uptake by straw in the presence of vermicompost and the extent of decrease was from 16.88 to 13.90 mg/pot and further to 10.14 mg/pot, respectively. Results are in agreement with

Table 8. Effect of Nitrogen, vermicompost and *Clodinafop propargyl* on Potassium uptake by grain and straw (mg/pot) in wheat crop.

Treatments	Nitrogen Levels (mg/kg soil)					
	0	50	100	150	200	Mean
Grain						
Vermicompost levels						
0	13.23	25.66	31.28	37.08	40.87	29.62
1%	25.97	37.07	46.25	49.35	51.42	42.01
Mean	19.60	31.36	38.76	43.21	46.14	
CD (5%) Nitrogen = 1.06, Vermicompost = 0.67 and Nitrogen × Vermicompost = 1.50						
***Clodinafop propargyl* levels (g a.i./ha)**						
0	27.96	38.87	45.25	51.30	55.34	43.74
60	20.16	35.31	40.50	45.96	48.22	38.03
90	15.23	25.62	31.46	35.24	37.72	29.05
Mean	21.12	33.27	39.07	44.17	47.09	
CD (5%) Nitrogen = 1.06, Herbicide = 0.82 and Nitrogen × Herbicide = 1.84						
Straw						
Vermicompost levels						
0	46.71	62.60	114.22	122.72	143.78	98.06
1%	65.34	98.53	150.28	162.48	178.43	131.01
Mean	56.02	80.56	132.25	142.60	161.10	
CD (5%) Nitrogen = 1.81, Vermicompost = 1.14 and Nitrogen × Vermicompost = 2.56						
***Clodinafop propargyl* levels (g a.i./ha)**						
0	73.03	92.22	126.10	150.34	182.09	124.75
60	56.93	82.43	115.17	143.50	163.47	112.30
90	39.22	65.80	95.34	118.68	143.77	92.56
Mean	56.39	80.15	112.20	137.50	163.11	
CD (5%) Nitrogen = 1.81, Herbicide = 1.40 and Nitrogen × Herbicide = 3.13						

those reported by Majumdar et al. (2010) and Sarmamy and Khidir (2013).

Potassium uptake by grain

It was observed from the data that uptake of K by wheat grains increased significantly with the application of N up to 200 mg N/kg soil (Table 8) and increase was from 13.23 mg/pot to 40.87 mg/pot over control. Similar, results were reported by Gupta et al. (1992). Data further revealed that application of vermicompost alone significantly increased the K uptake from 13.23 to 25.97 mg/pot over control. Results are similar to those reported by Sreenivash et al. (2000) and Davari et al. (2012). Conjugative use of N and vermicompost recorded the highest K uptake (51.42 mg/pot) by grains over control. Our results were in agreement with Duhan et al. (2006), Khokhar and Nepalia (2010) and Sefidkoohi and Sepanlou (2013).

The data presented in Table 8 indicated that application of *C. propargyl* at 60 and 90 g a.i./ha significantly decreased the K uptake by grains from 27.96 mg/pot to 20.16 and to 15.23 mg/pot, respectively over control (without *C. propargyl*). Application of *C. propargyl* at 60 and 90 g a.i./ha decreased the K uptake by grains from 55.34 to 48.22 and to 37.72 mg/pot, respectively in the presence of 200 mg N kg^{-1} soil. Data presented in Table 9 indicated that application of *C. propargyl* at 60 and 90 g a.i./ha also significantly decreased the K uptake by grains from 49.94 to 44.56 mg/pot and to 35.09 mg/pot, respectively in the presence of vermicompost. Similar findings were reported by Majumdar et al. (2010) and Sarmamy and Khidir (2013).

Potassium uptake by straw

A perusal of data (Table 8) indicated that with the increase in N doses, the uptake of K by wheat straw also increased significantly up to 200 mg N/kg soil and increase was from 46.71 to 143.78 mg/pot over control. Similar, results were reported by Ahmad et al. (2007).

Table 9. Effect of vermicompost and herbicide (*Clodinafop propargyl*) on potassium uptake by grain and straw (mg/pot) in wheat crop.

Vermicompost levels	*Clodinafop propargyl* levels (g a.i./ha)			
	0	60	90	Mean
Grain				
0	37.89	29.30	21.52	29.57
1%	49.94	44.56	35.09	43.19
Mean	43.91	36.93	28.30	
CD (5%) Vermicompost = 0.67, Herbicide = 0.82 and Vermicompost × Herbicide = 1.16				
Straw				
0	111.45	92.19	69.60	91.08
1%	126.11	115.87	102.24	114.74
Mean	118.78	104.03	85.92	
CD (5%) Vermicompost = 1.14, Herbicide = 1.40 and Vermicompost × Herbicide = 1.98				

Data further revealed that application of vermicompost alone significantly increased the K uptake from 46.71 to 65.34 mg/pot over control. Rathore et al. (1995) and Sreenivash et al. (2000) reported similar results. Conjugative use of N and vermicompost recorded the highest K uptake by straw and the extent of increase with nitrogen at 200 mg/kg soil + vermicompost at 1% was from 46.71 to 178.43 mg/pot over control. It is further reported that combined use of N and vermicompost was found superior than their individual use. Our results were in agreement with Thakral et al. (2003) and Sefidkoohi and Sepanlou (2013).

The data presented in Table 8 indicated that application of *C. propargyl* at 60 and 90 g a.i./ha significantly decreased the K uptake by straw from 73.03 to 56.93 and to 39.22 mg/pot, respectively over control (without *C. propargyl*). Application of *C. propargyl* at both the levels significantly decreased the K uptake by straw from 182.09 to 163.47 and to 143.77 mg/pot, respectively in the presence of 200 mg N/kg soil. Data presented in Table 9 further revealed that application of *C. propargyl* at 60 and 90 g a.i./ha also significantly decreased the K uptake by straw in the presence of vermicompost and the extent of decrease was from 126.11 to 115.87 mg/pot and to 102.24 mg/pot, respectively. Similar findings were reported by Duhan et al. (2006) and Majumdar et al. (2010).

Conclusion

Grain and straw yield of wheat increased significantly with the increasing levels of N up to 150 mg/kg soil over control as well as vermicompost thereafter no significant increase in yield was observed. Application of vermicompost also increased the grain and straw yield over control. Application of *C. propargyl* significantly decreased the grain and straw yield at both the levels (60 and 90 g a.i./ha) either alone or in combination with N and vermicompost. Application of N as well as vermicompost subsides/lower down the phytotoxic effect of *C. propargyl*. NPK uptake by grain and straw increased significantly with increasing levels of N alone as well as in combination with vermicompost (at 1%). Application of *C. propargyl* significantly decreased the NPK uptake in grain and straw at both the levels.

Conflict of Interest

The authors have not declared any conflict of interest.

REFERENCES

Ahmad RS, Khan SM, Arshad MA, Mamood MH (2007). Growth and yield response of wheat (*Triticum aestivum L*.) and maize (*Zea-mays* L.) to nitrogen and *L-Ttryptophan* enriched compost. Pakistan. J. Bot. 39(2):541-549.

Ali A, Syed A, Khaliq WH, Asif M, Aziz M, Mubeen M (2011). Effects of nitrogen on growth and yield components of wheat. (Report), Sci. Int. (Lahore). 23(4):331-332.

Anonymous (2013). Dept. of Economics and Statistics. Govt. of India.

Benbi DK, Biswas CR, Bawa SS, Kumar K (1998). Influence of farm yard manure, inorganic fertilizers and weed control practices on some soil physical properties in a long-term experiment. Soil use manage. Oxford: CAB International. 14(1):52-54.

Bhardwaj B, Khandal DK, Nagendra B, Bhardwaj N (2000). Effect of vermicompost of *Echhornia* on two cultivars of wheat. J. Eco-Physiol. 5(3-4):143-148.

Billore SD, Joshi OP, Ramesh A, Vyas AK (2009). Enhancing wheat production through tillage and integrated nutrient management. Indian J. Agric. Fertil. 5(11):25-27.

Davari MR, Sharma SN, Mirzakhani M (2012). The Effect of combinations of organic materials and biofertilisers on productivity, grain quality, nutrient uptake and economics in organic farming of wheat. J. Org. Syst. 7(2):26-35.

Duhan BS, Goel V, Arya VS, Devraj, Ramparkash (2011). Response of different organic manures on yield and micronutrients uptake by wheat. Ann. Biol. 27(2):135-142.

Duhan BS, Kataria D, Singh JP, Dahiya SS, Yadav HD (2006). Effect of

nitrogen, FYM and metribuzin on yield and nitrogen content of wheat (*Triticum aestivum* L.). Haryana agric. Univ. J. Res. 36:35-39.
Goel V, Duhan BS (2011). Kinetics of nitrogen mineralization of some organic manures in a typichaplustept. Ann. Biol. 27(2):129-134.
Gupta AP, Nath J (1998). Effect of FYM on the crop yield and nutrient uptake. Experimental Report. CCS Haryana Agricultural University, Hisar.
Gupta AP, Antil RS, Narwal RP (1996). Effect of various organic manure and fertilizer nitrogen on the performance of wheat. Ann. Biol. Ludhiana. 12(2):188-194.
Gupta AP, Narwal RP, Antil RS, Dev SC (1992). Sustaining soil fertility with organic- N, P and K by using farm yard manure and fertilizer- N in a semi arid zone. A long term study Arid. Soil Res. Rehab. 6:243-251.
Iqtidar H, Ayyaz KM, Ahmad KE (2006). Bread wheat varieties as influenced by different nitrogen levels. J. Zhejiang Univer. Sci. 7:70-78.
Jadhav AD, Talashilkar SC, Power AG (1997). Influence of conjunctive use of FYM, vermicompost and urea on growth and nutrient uptake in rice. J. Maharastra Agric. Uni. 22:249-250.
Jain P, Handa K, Paul A (2014). Studies on waste-to-energy technologies in India and a detailed study of waste-to-energy plants in Delhi. Int. J. Adv. Res. 2(1):109-116.
Khandal DK, Bhardwaj N (2000). Effect of vermicompost of typha on two cultivars of wheat. J. Phytological Res. 13(1):91-94.
Khokhar AK, Nepalia V (2010). Effect of herbicides and nutrient management on weed flora, nutrient uptake and yield of wheat (*Triticum aestivum*) under irrigated conditions. Indian J. Weed Sci. 42(1&2):14-18.
Koenig RA, Johnson CR (1942). Colorimetric determination of P in biological materials. Ind. Eng. Chem. Anal. 14:155-56.
Kumar S (2010). Effect of herbicides on cytoskeleton microtubules in wheat. Unpublished Ph.D. Thesis, Department of Botany, Banaras Hindu University, Varanasi (India). pp. 1-200.
Lindner RC (1944). Rapid analytical method for some of the more common inorganic constituents of plant tissues. Plant Physiol. 19:76-89.
Lloveras J, Lopez A, Ferran J, Espachs S, Solsona J (2001). Bread-making wheat and soil nitrate as affected by nitrogen fertilization in irrigated Mediterranean conditions. Agron. J. 93:1183-1190.
Majumdar B, Saha AR, Sarkar S, Maji B, Mahapatra BS (2010). Effect of herbicides and fungicides application on fibre yield and nutrient uptake by jute (*Corchorus olitorius*), residual nutrient status and soil quality. Indian J. Agric. Sci. 80:10-17.
Mengel K, Hutsch B, Kane Y (2006). Nitrogen fertilizer application rates on cereal crops according to available mineral and organic soil nitrogen. Eur. J. Agron. 24:343-348.
Nedelciuc M, Nedeloiuc C, Toma M (1995). Protein content and NPK consumption in wheat. Romanian Agric. Res. 3:93-100.
Osborne LD, Robson AD, Bowran DG (1993). The impact of chlorsulfuron and diclofop-methyl on nutrient uptake by wheat. *Aust.* J. Agric. Res. 44(8):1757-1766.
Ranwa RS, Singh KP (1999). Effect of integrated nutrient management with vermicompost on productivity of wheat (*Triticum aestivum* L.). Indian J. Agron. 44(3):554-559.
Rathore AL, Chipde SJ, Pal AR (1995). Direct and residual effects of bio-organic and inorganic fertilizers in rice (*Oryza sativa*) – wheat (*Triticum aestivum*) cropping system. Indian J. Agron. 40(1):14-19.
Sarmamy OI, Khidir M (2013). Effects of some soil treated pesticides on growth characteristics of faba bean and wheat Plants. Int. J. Emerg. Technol. Comput. Appl. Sci. 5(1):07-20.
Sawrup A (2010). Integrated plant nutrient supply and management strategies for enhancing soil fertility, input use efficiency and crop productivity. J. Indian Soc. Soil Sci. 58:25-30.
Sefidkoohi AA, Sepanlou MG (2013). Effects of multi-period application of two types of composts on some chemical properties of soil and
uptake of phosphorous by Wheat. Inter. J. Agric. Res. Rev. 3(2):254-262.
Sekhon KS, Singh JP, Mehla DS (2011). Long-term effect of manure and mineral fertilizer application on the distribution of organic nitrogen fractions in soil under a rice–wheat cropping system. Arch Agro. Soil Sci. 57(7):705-714.
Sharma A, Singh H, Nanwal RK (2007). Effect of nutrient management on productivity of wheat (*Triticum aestivum* L.) under limited and adequate irrigation supply. Indian J. Agron. 52:120-123.
Siddiqui AN, Akhter MN, Hossain MA, Sultana M, Ahmed B (2013). Effect of nitrogen levels on yield parameters of wheat. Bangladesh Res. Pub. J. 8(1):01-06.
Sreenivash CH, Muralidhar S, Singh R (2000). Yield and quality of ridge guard fruit as influenced by different levels of inorganic fertilizers and vermicompost. Annu. Agric. Res. 21:262-266.
Sujathamma P, Gopala RP, Rajasekhar D (2001). Nitrogen dynamics in rice groundnut cropping system. The Andhra Agric. J. 48:223-226.
Thakaral SK, Kadian VS, Kumar S (2003). Effect of different organic and fertilizer levels on yield and yield attributes of wheat. Haryana J. Agron. 19(1):60-62.
Wagner G, Nadasy E (2009). Interaction between nutrition and herbicide application in pea culture. Commu. Soil Sci. Pl. Anal. 40:435-444.