Response of Wheat to Bio-compost (BC) along with Inorganic Fertilizer (NPK)

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Abstract: The combined application of organic and inorganic fertilizer improves crop productivity and soil health**.** The field experiments were conducted to determine the effect of bio-compost (BC) and NPK fertilizers on growth, yield and quality of wheat crop at Shakarganj Sugar Research Institute (SSRI) Jhang, Pakistan. The present experiment was conducted under RCBD to determine the plant growth and yield parameters of wheat with integrated management of organic fertilizer Biocompost (BC) with inorganic fertilizers (NPK) at different levels. The experiment was consisted of five levels of Bio-compost (0-0-0, 225, 450, 675 and 900 kg ha^{-1}) with five levels of inorganic fertilizers (0-0-0, 30-25-50, 60-50-30, 90-75-45 and 120-100-60 NPK kg ha^{-1}). The characters understudied like number of plants m^2, plant height (cm), total number of tillers m^2, total number of fertile tillers m^2, spike length (cm), number of spikelet per spike, number of grains per spike, 1000-grain weight (g), grain yield (t ha^{-1}) and harvest index (%) were influenced positively. It is concluded from the present study that integrated use of organic and inorganic sources are good for wheat crop. The plots which received combined (bio-compost and NPK) produced higher yield than of plot receiving only inorganic fertilizer. Moreover, the use of organic sources would reduce reliance on the synthetic fertilizers, with additional benefits of environmental protection.
[Umer Ijaz, Muhammad Faizan Aslam, Malik Ghulam Asghar, Mazhar Ali, Muhammad Jahanzaib Shafi, Muhammad Ahsan Maqbool, Hafiz Muhammad Zaid, Muhammad Dilawaiz Khan. **Response of Wheat to Bio-compost (BC) along with Inorganic Fertilizer (NPK).** *Nat Sci* 2018;16(10):142-147]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 20. doi:10.7537/marsnsj161018.20.

Key words: wheat, bio-compost, NPK

1. Introduction

Wheat (Triticum aestivum L.) is not only the most important cereal crop in the world but also the major source of staple food for the people of Pakistan (Tunio, 2006; Malik, 2006). In Pakistan it contributes 10.1 percent to the value added in agriculture, 2.2 percent to GDP and cultivated in an area of 8693 thousand hectare during 2012 -13 (Anonymous, 2013). Despite its higher yield potential, yield per hectare is very low in Pakistan as compared to other wheat producing countries (Sarwar *et al*., 2010). Different factors affect the wheat crop production. Among them, fertilizer is one of the most important factors in the package of crop production technology (Chaudhary and Thakur, 2007). Many research workers in their field experiments noted significant increase in wheat crop yield with application of nitrogen (N), phosphorus (P) and potash (K) in different combinations (Gill et al., 1993). Despite increased use of the fertilizers, per hectare yield has not been increased proportionally rather stagnation occurs (Ali, 2000). This has been attributed to the imbalanced use of mineral fertilizers and inappropriate method of their application that culminated in low efficiency. According to Zia *et al*. (2000), continuous use of chemical fertilizers even in balanced proportion will not be able to sustain crop productivity due to deterioration in soil health. Application of organic manures or some organic wastes alone was found useful (Alam and Shah, 2003), but integrated use of organic wastes and chemical fertilizer has proved more rewarding (Khanam *et al*.,2001). Compost is a good source for the availability of organic compounds which support plant growth and development. Zheljazkov and Warman (2004) investigated that the addition of compost prepared from municipal waste into agricultural soils has beneficial effects on crop quality and yield by improving soil properties. Composting is a cost effective and environment friendly way of waste disposal (Millner *et al.*, 1998). It is a process in which natural waste materials are biologically transformed into non stable and stable humus like substances (under conditions of optimum moisture, temperature and aeration) that can be controlled, stored and applied without any environmental impacts (Millner *et al.*, 1998: Gallardo-Larva and Nogales, 1987). Finished compost is generally more concentrated in nutrients, narrow in C: N ratio and also effectively free from other un-desirable characteristics (Zia *et al.*, 2003). Limited

availability of additional land for crop production, along with declining yield of major food crops, have heightened concerns about agriculture's ability to feed the growing population expected to exceed 7.5 billion by the year 2020. Future strategies for increasing agricultural productivity will have to focus on using available nutrient resources more efficiently, effectively, and on sustainable basis. Integrated nutrient management are essential for proper plant growth, water use, soil, and land management, that will be critical for the sustaining agriculture productivity over the long term. The overall strategy for increasing crop yields and sustaining them at a high level must include an integrated approach to the management of soil nutrients. An integrated approach recognizes that soils are the storehouse of most of the plant nutrients essential for plant growth and have a major impact on soil fertility, and agricultural sustainability. In addition to farm manures, a huge amount of wastes generated in all big cities, town and villages of Pakistan, which pollute the atmosphere of these cities, and villages, can be used for enhancing soil fertility and crop productivity. Keeping these facts in view, the present investigation was carried out to study the effect of NPK, and bio-compost with various combinations on yield and yield components of wheat.

2. Materials and methods

The proposed study was conducted at the Shakarganj Mills Farm Jhang, Pakistan. The maximum temperature in this area during November ranges from 24 to 29 ^{o}C and minimum temperature ranges from 8 to 14 ^{o}C. This month is ideal for wheat crop sowing and maximum wheat grain yield is obtained when crop is sown during 1st two weeks of November. The experiment was conducted under RCBD) with four replications with a net plot size of 4.5m x 7.5m and row to row distance of 22.5 cm apart. The wheat variety Punjab 2011 was sown during 1st week of November. The seed rate was used @ 50 kg ha^{-1}. All other agronomic and cultural practices i.e. weeding, hoeing, irrigation as when required was adopted uniformly. The treatments were five levels of Biocompost (BC) in combination with NPK 5 levels to see their effect on wheat crop as regards plant growth and yield parameters. The data were recorded on following characters like germination count (m^2), number of plants m^2, plant height (cm), total number of tillers m^2, total number of fertile tillers m^2, spike length (cm), number of spikelet per spike, number of grains per spike, 1000-grain weight (g), grain yield (t ha^{-1}), biological yield (t ha^{-1}), harvest index (%). The data were analyzed through the appropriate statistical techniques. Pre- sowing soil sample were collected up to 40cm depth for analysis of the experimental soil. Soil analysis indicated that the experimental soil was sandy loam. The soil is productive without any problem for wheat crop production. The soil was deficient in NPK and organic matter

Treatments:

A: Biocompost (BC) = 5 Levels

B_1 = Control (0% BC), B_2 = BC 25% @ 225kg ha^{-1}, B_3 = BC 50% @ 450kg ha^{-1}, B_4 = BC 75% @ 675kg ha^{-1}, B_5 = BC 100% @ 900kg ha^{-1}.

B: Inorganic Fertilizer (NPK) = 5 Levels

F_1 = Control (0% NPK), F_2 = NPK 25% @ 30-25-15 NPK kg ha^{-1}, F_3 = NPK 50% @ 60-50-30 NPK kg ha^{-1}, F_4 = NPK 75% @ 90-75-45 NPK kg ha^{-1}, F_5 = NPK 100 % @ 120-100-60 NPK kg ha^{-1}

3. Results and discussion

Germination Count m^2

Germination count is an important yield contributing factor in wheat plant. It is an important feature of BC which determines the grain yield. Data on germination count as affected by different treatments of NPK application and Biocompost in wheat is presented in table 4.1. Maximum Germination count was produced by BC3 (BC3 = BC 50% @ 64 m^3 ha^{-1}) and minimum in D1 (0% BC). According to levels of NPK highest Germination count was depicted in F3 (F_3 = NPK 50% @ 60-50-30 NPK kg ha^{-1}) and lowest was observed in F1 Control (0% NPK). Interaction effect of levels of BC and NPK was found significant to Germination count.

Table 4.1 Germination count m^2

Bio-compost	Mean Fertilizer (NPK)				
	F1	F2	F3	F4	F5
BC1	204.00	204.13	204.63	203.88	203.50
BC2	204.63	203.50	203.63	204.13	203.25
BC3	204.13	204.00	204.38	204.00	204.25
BC4	203.75	204.13	204.63	204.13	204.88
BC5	204.25	204.13	204.25	204.38	204.50

Plant height (cm)

Plant height is an important morphological trait of combined effects of genetic makeup of a plant,

environmental conditions and nutrient status of soil in which the plant is grown. Plant height reflects the vegetative growth behavior of crop plant in response to applied inputs. Data regarding plant height of wheat plant as affected by application of Biocompost and NPK at different levels is presented in (Table 4.2). According to Biocompost levels maximum plant height was observed at BC3 (BC3 = BC 50% @ 64 m^3 ha^{-1}) and minimum was observed in control (0% BC). According to different levels of NPK maximum wheat plant height was reported at F3 (F_3 = NPK 50% @ 60-50-30 NPK kg ha^{-1}). Interaction between BC and NPK was found significant to plant height at maturity.

Table 4.2 Plant height (cm)

Bio-compost	Means				
	Fertilizer (NPK)				
	F1	F2	F3	F4	F5
BC1	74.63	80.25	89.50	108.63	111.25
BC2	79.38	83.50	101.25	111.63	109.88
BC3	89.00	100.50	103.25	109.88	112.75
BC4	98.50	105.50	105.25	111.25	113.50
BC5	103.25	108.50	110.75	113.50	114.00

Number of grains per spike (cm)

Number of grains per spike had great effect on the grain yield of wheat. The data pertaining to number of grains per spike is presented in the table 4.3. Biocompost levels showed the significant difference in number of grains per spike. Maximum number of grains per spike was produced by BC3 (BC3 = BC 50% @ 64 m^3 ha^{-1}) and minimum in D1 (0% BC). According to levels of NPK highest number of grains were depicted in F3 (F_3 = NPK 50% @ 60-50-30 NPK kg ha^{-1}) and lowest was observed in F1 Control (0% NPK). Interaction effect of levels of BC and NPK was found significant to number of grains per spike.

Table 4.3 Number of grains per spike (cm)

Bio-compost	Means				
	Fertilizer (NPK)				
	F1	F2	F3	F4	F5
BC1	28.25	39.63	42.88	45.13	47.38
BC2	37.13	41.75	44.88	46.88	47.75
BC3	42.13	43.68	46.38	47.63	48.38
BC4	42.63	45.63	46.13	48.13	48.50
BC5	45.13	46.63	47.50	48.30	48.75

Spikelets per spike

Number of spikelets per spike is also an important yield contributing factor in wheat. It directly affects the grain yield of wheat. The data presented in table 4.5 revealed that Biocompost and NPK levels have significant difference in number of spikelets per spike. Maximum number of spikelets per spike was given by BC3 (BC3 = BC 50% @ 64 m^3 ha^{-1}) and F3 (F_3 = NPK 50% @ 60-50-30 NPK kg ha^{-1}) and minimum were reported in D1(0% BC) and F1 (0% NPK). Interaction between BC and NPK was found significant to number of spikelets per spike.

Table 4.4 Spikelets per spike

Bio-compost	Means				
	Fertilizer (NPK)				
	F1	F2	F3	F4	F5
BC1	12.50	14.13	14.75	17.00	17.50
BC2	12.88	14.25	15.50	17.50	17.80
BC3	13.28	14.38	16.63	17.75	17.98
BC4	13.63	15.13	17.13	17.80	18.13
BC5	14.63	16.80	17.50	17.81	18.38

Spike length (cm)

Spike length is a very important yield determining factor of wheat. Larger the size of spike more would be the number of grains per spike and consequently higher grain yield. The data presented in table 4.6 revealed that NPK and Biocompost levels significantly differ in spike length (cm). According to Biocompos tlevels maximum spike length was

observed at BC3 (BC3 = BC 50% @ 64 m^3 ha^{-1}) and minimum was observed in control (0% BC). According to different levels of NPK maximum spike length was reported at F3 (F_3 = NPK 50% @ 60-50-30 NPK kg ha^{-1}). Interaction between BC and NPK was found significant to spike length.

Table 4.6 Spike length (cm)

Bio-compost	Means				
	Fertilizer (NPK)				
	F1	F2	F3	F4	F5
BC1	9.00	11.30	12.15	12.95	13.20
BC2	10.75	11.85	12.23	13.18	13.33
BC3	11.28	11.98	12.55	13.18	13.36
BC4	11.65	12.08	12.83	13.27	13.33
BC5	12.00	12.33	13.25	13.39	13.44

Number of tillers per m^2

Number of tillers/m^2 is also an imperative factor, which contribute significantly towar BC grain yield of the wheat crop. The data presented of both year experiments in table 4.38 revealed that Biocompostlevels have significant difference in number tillers/m^2. Maximum number of tillers/m^2 were recoreded in BC3 (BC3 = BC 50% @ 64 m^3 ha^{-1}) and statistically minimum was observed in control (0% BC). Data table 4.9 showed that at F3 (F_3 = NPK 50% @ 60-50-30 NPK kg ha^{-1}) highest number of tiller per m^2 were noted and lowest in F1 (0% NPK). Interaction between BC and NPK was found significant to number of tiller per m^2

Number of fertile tiller per m^2

Number of fertile tiller per m^2 is also an important yield contributing factor in wheat. It directly affects the grain yield of wheat. The data presented in table 4.7 revealed that Biocompostand NPK levels have significant difference in number of fertile tiller per m^2. Maximum number of fertile tiller per m^2 were given by BC3 (BC3 = BC 50% @ 64 m^3 ha^{-1}) and F3 (F_3 = NPK 50% @ 60-50-30 NPK kg ha^{-1}) and minimum were reported in D1(0% BC) and F1 (0% NPK). Interaction effect of levels of BC and NPK was found significant to number of fertile tiller per m^2.

Table 4.7 Number of fertile tiller per m^2

Bio-compost	Mean (2012-13 and 2013-14)				
	Fertilizer (NPK)				
	F1	F2	F3	F4	F5
BC1	292.00	353.00	375.25	386.00	426.25
BC2	352.00	374.25	387.75	411.25	434.25
BC3	364.25	383.50	412.75	421.75	444.00
BC4	374.00	421.50	423.75	436.50	445.25
BC5	397.00	427.27	440.50	447.25	457.50

1000 grain weight (g)

The yield potential of crop is determined by the mean grain weight. Grain weight is the most important yield contributing factor for deciding the potential of wheat crop. Data regarding 1000 grain weight of wheat plant as affected by application of Biocompostand NPK at different levels is presented in (Table 4.8). According to Biocompostlevels maximum 1000 grain weight was observed at BC3 (BC3 = BC 50% @ 64 m^3 ha^{-1}) and minimum in control (0% BC). According to different levels of NPK maximum 1000 grain weight was reported at F3(F_3 = NPK 50% @ 60-50-30 NPK kg ha^{-1}). Interaction between BC and NPK was found significant to 1000 grain weight.

Table 4.8 1000 grain weight (g)

Bio-compost	Means				
	Fertilizer (NPK)				
	F1	F2	F3	F4	F5
BC1	28.88	30.13	34.00	36.13	38.00
BC2	30.88	35.13	36.50	36.75	38.13
BC3	32.88	36.50	37.75	38.00	38.25
BC4	34.25	36.25	38.00	38.25	38.50
BC5	36.13	38.00	38.25	38.25	38.63

Grain yield (t ha^{-1})

Grain yield is an ultimate end product of many components, physiological and morphological processes taking place in plants during growth and development. Data presented in the table 4.9 showed that grain yield in different Bio-compost and NPK treatments was found significant. Maximum grain yield was recoreded in BC3 (BC3 = BC 50% @ 64 m^3 ha^{-1}) and statistically minimum was observed in control (0% BC). Data table 4.42 showed that at F3 (F_3 = NPK 50% @ 60-50-30 NPK kg ha^{-1}) highest grain yield was noted and lowest in F1 (0% NPK). Interaction between BC and NPK was found significant to grain yield.

Table 4.9 Grain yield (t ha^{-1})

Bio-compost	Means				
	Fertilizer (NPK)				
	F1	F2	F3	F4	F5
BC1	2.28	2.93	3.27	4.58	5.34
BC2	2.88	3.21	4.06	4.84	5.35
BC3	3.26	4.06	5.31	5.33	5.34
BC4	4.52	4.85	5.32	5.34	5.36
BC5	4.84	5.32	5.32	5.34	5.36

Harvest index (%)

Harvest index showed the physiological efficiency of plants to convert the fraction of photo-assimilates to grain yield. Higher the harvest index is, greater will be the grain yield of crop. Table 4.10 showed that harvest index differed significantly among the Bio-compost levels. Maximum harvest index was found in BC3 (BC3 = BC 50% @ 64 m^3 ha^{-1}). Considering the effect of different NPK treatments maximum value of harvest index was found under F3 (F_3 = NPK 50% @ 60-50-30 NPK kg ha^{-1}). The interactive effects of Biocompostand NPK treatments were found significant for harvest index.

Bio-compost	Means				
	Fertilizer (NPK)				
	F1	F2	F3	F4	F5
BC1	0.34	0.37	0.37	0.45	0.51
BC2	0.37	0.38	0.43	0.47	0.51
BC3	0.38	0.43	0.50	0.50	0.50
BC4	0.45	0.47	0.51	0.51	0.51
BC5	0.47	0.50	0.51	0.51	0.51

4. Conclusion

It is concluded from the present study that integrated use of organic and inorganic sources are good for wheat crop. The plots which received combined (bio-compost and NPK) N produced higher yield than of plot receiving only inorganic fertilizer. The best results were obtained from plots, which receive BC3 and F3.

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10/13/2018