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ORIGINAL RESEARCH

Response of wheat to combined application of nitrogen and phosphorus along with compost

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Abstract
To achieve food security and increase crop productivity in a sustainable way, keeping soil fertile and balanced fertilization is vital. Soil fertility declining and unbalanced fertilization is one of the bottlenecks to sustainable agricultural production. To overcome these problems, a field experiment was investigated, with the aim of exploring the potential of organic and inorganic nutrient sources with their optimal application and integration for sustainable wheat production. The experiment was conducted in a factorial approach with three replications, where one factor was the level of the NP (Nitrogen and Phosphorus) fertilizer and the other compost, set in a randomized complete block design. Four levels of the N:P fertilizer (control, 27.6%:18.4%, 41.4%:32.2% and 55.2%:46%) were combined with three levels of compost (0, 3 ton/ha and 6 ton/ha), giving 12 treatments combination. From the data collected and analyzed, integrated application of the NP fertilizer and compost significantly increased soil organic carbon, total nitrogen, and available phosphorus but had no effect on soil pH and cation exchange capacity (CEC). Application of 6 ton/ha compost was higher with plant height, spike length, number of seeds per spike, 1000 seeds weight, and biological yield. The sole application of the NP (55.2%:46%) produced (6.19 ton/ha) grain yield whereas combined application of the NP (55.2%:46%) along with the compost (6 ton/ha) produced the higher grain yield (8.16 ton/ha). This clearly revealed that application of 75% recommended inorganic NP fertilizers combined with compost resulted in increased wheat yield by 27.45% over sole application of inorganic fertilizer indicated that the integrated approach could enable to save up to 25% of commercial fertilizers and increase the yield of wheat.

Keywords Compost · Nitrogen · Phosphorus · Yield · Soil fertility

Introduction

The main challenges for future scenarios and development are to provide enough food for the increasing world population, mitigate and adapt to climate change, and reduce natural environmental hazards caused by several types of technologies and means of agricultural production (Migliorini and Wezel 2017). Nowadays, agricultural production increasingly relies on technology, such as precision farming, mechanization, and chemical fertilizer. Synthetic fertilizers have higher nutrient contents than organic ones, but they easily result in environmental pollution and soil degradation (Ahmed et al. 2017 Laird et al. 2010). Organic agriculture has been gaining popularity all over the world and traditional family farming, in tins and subtropics, is still the pillar of world food production (Migliorini and Wezel 2017). Moreover, within conventional agriculture, ecological elements and the better use of ecological processes are proposed more often under the paradigm of sustainable or ecological intensification (Wezel et al. 2015). Currently, the level of efficiency of effective agricultural production is determined by how it reduces natural environmental hazards. Organic farming is often proposed as a solution to reduce agriculture's impact on the environment; however, yields in organic agriculture are usually lower than in conventional agriculture (Seufert et al. 2012).

Developing countries produce a large volume of organic solid waste, including food, municipal, and agricultural

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wastes. The treatment of organic solid waste includes composting (Shan et al. 2019), anaerobic digestion (Chen et al. 2020), incineration (Lu et al., 2019), and the landfill (Cappucci et al. 2020); amongst these, composting has reduced the financial burden of purchasing chemical fertilizers and can decrease the environmental impacts associated with the production of chemical fertilizers and their utilization. The application of compost products as organic fertilizers can reduce dependence on fertilizers and improve crop quality (Tubeileh and Stephenson 2020). Furthermore, compost products can be used as soil amendments to improve soil quality and agricultural productivity (Ding et al. 2021; Lerch et al. 2019), control soil pathogens, and promote plant growth (Monda et al. 2017). The authors further reported that the application of compost increase soil aggregate stability, water-holding capacity, high nutritional value, improve organic matter, prevents the leaching of nutrients in the groundwater, and has positive effects on the overall health of the soil (Jain and Kalamdhad 2020; Willekens et al. 2014).

The fertility and quality of soil can be explained by the availability of the major nutrients viz. nitrogen (N), phosphorus (P), and potassium (K) in it. According to past reported studies the chemical fertilizers had provided the above essential nutrients to the soil, but the long-term application had also shown negative impacts on the physical and nutritional properties (Das et al. 2017; Nayak et al. 2012) by increasing the concentration of heavy metals of the soil (Rascio and Navari-Izzo 2011). Therefore, there is a dire need to change the existing practice of using chemical fertilizer to improve overall soil health. Integrated agricultural cultivation is a form of alternative farming, which is to maintain a prominent level of agricultural production while reducing costs resulting from the limited use of chemical and mineral means of production (Szeląg-Sikora et al. 2019). Overall, it can be one of the alternative approaches to maintain soil sustainability as well as to ensure food security for a growing population.

Keeping soil fertile and balanced fertilization through the addition of organic and inorganic fertilizer inputs is one of the important actions to confirm food security and sustainably increase crop productivity. Integrated nutrient management has gotten considerable attention in socio-economic conditions due to an increase in fertilizer prices and increased depletion of soil quality. Therefore, it is particularly important to assess and define integrated nutrient management to maintain an adequate supply of nutrients for improved and sustained crop production and soil fertility. This study was designed to initiate analysis of variation of wheat yield and soil properties under different rates of organic and inorganic fertilization in field conditions.

Materials and methods

Experimental design

The study was conducted during the main rain season in Doyogena, Kembata Tembaro Zone, Southern Ethiopia which is located between 7º22′ 26.54"N latitude and 37º47 ′01.78"E longitude. The experiment was conducted in a factorial approach with three replications, where one factor was the level of NP (Nitrogen and Phosphorus) fertilizer and the other compost, set in a randomized complete block design. Four levels of N:P fertilizer (control, 27.6%:18.4%, 41.4%:32.2% and 55.2%:46%) were combined with 3 levels of compost (0, 3 ton/ha and 6 ton/ha), giving 12 treatments combination. The nitrogen and phosphorus fertilizers were applied as Urea (46% *N*) and Triple superphosphate (46% P_2O_5), respectively. Phosphorus (P) fertilizers were applied by soil surface band during the sowing of wheat. Banding was achieved by opening planting furrows approximately 5 cm deep using hoes and dribbling the required fertilizer in along the planting furrow, as evenly as possible, by hand. Half nitrogen was supplied in band application at the time of sowing and the remaining half was applied 35 days after planting.

The bread wheat (*Hidasse*) was used for the experiment. Seeds were sown by uniformly drilling in a depth of 5 cm into rows at the recommended rate of 100 kg/ha. Plot size was 1.8 × 2.5 m, having six rows and 30 cm apart and the distance between the plots and blocks was kept at 0.5 m and 1 m apart, respectively.

Compost preparation

The compost feedstock was prepared from wheat residues, fresh broad leaves of trees, dry manure, wood ash, and forest soil with different ratios to achieve target C:N ratio, between 25 and 30, and pathogen reduction goals. The recommended size of the compost pit (2.5 m in length, 1.2 m in width, and 1.0 m in depth) was dug under shade and in a good drainage area. A 5 cm layer of green material (broad leaves of trees, which are rich in *N*) was added at the bottom of the heap, keeping good ventilation. Immediately on the green material, the wheat residue was added to a thickness of 20 cm. Put on the next layer, animal dry manure 15 cm, and then a thin layer (5 cm) of kitchen ash. Top this with a thin layer (5 cm) of garden soil. Water was added after each layer as required to make the layer moist. Repeat the steps and continue until the compost heap was about 130 cm high. Finally, the pit was covered with a thin layer of soil and Enset (false banana) leaves. Then, the compost heap underwent natural outdoor underground fermentation for 3 months. Compost was added 1 week before the sowing date.

Sampling and analysis

Sampling of plant

At harvest, ten plants were randomly selected from the middle area of each treatment for measuring the plant height, spike length, and the number of seeds per spike. A thousand-grain weight (TGW) was measured randomly from total grain harvest recorded on digital balance expressed in gram (g). Grain and biological yield were measured from the central four rows of each experiment.

Sampling and analysis of soil

Physical and chemical characteristics of the experimental soil before planting were analyzed according to Jones (2001). The characterized physical and chemical properties of the experimental soil sample, collected before planting, are presented in Table 1.

Statistical analysis

The data collected during the season were subjected to analysis of variance using SAS version 9.2 statistical software (SAS 2009) followed by mean separation of treatments using least significant difference (LSD) test at 5% probability level.

Results

Effects of soil properties

Data on (Table 1) initial soil characteristics (0–15 cm depth) measured revealed that the soil were slightly acidic (pH 6.5), cation exchange capacity (CEC) 6.5 cmol/kg, available phosphorus 0.85 g/ha, and available potassium 40.12 g/kg. The soil texture of the experimental field before sowing was clay 47%, and 30% and silt 25%, well drained and flat (1.5% slop) topography (Table 1). The recorded total *N* and organic carbon before treatment of the experimental field were low and medium, respectively, according to Gachene and Kimaru (2003).

Table 2 reveals that integrated application of organic compost and chemical fertilizer was significantly influenced ($p \leq 0.05$) the soil organic carbon, total nitrogen content, and available phosphorus. Soil pH and cation exchange capacity (CEC) was not affected by the treatments. The highest value of total nitrogen content was measured at (55.2%:46%) NP along with 3 and 6 ton/ha compost application, while the lowest was measured at control treatment. The highest value of soil organic carbon content was measured at the application of (55.2%:46%) NP along with 3 and 6 ton/ha and at the application of (41.4%:32.2%) NP along with 6 ton/ha compost which was statistically at par, whereas the lowest was measured at control treatment.

Table 1 Initial characteristics of experimental field soils before treatment application

Parameters	Unit	Result
pH		6.5
Soil organic carbon	%	2.21
Total nitrogen	%	0.19
Available phosphorus	g/kg	0.85
Cation exchange capacity	(c mol/kg)	6.5
Available potassium	g/kg	40.12
Sand	%	30
Silt	%	25
Clay	%	47

Phenological and growth parameters

The days to maturity of the compost application were statistically significant ($P \leq 0.05$). The result showed that late maturing (103.58 days) was observed at 6 ton/ha compost application treatment, whereas early maturing (99.00 days) was observed at control levels (Table 3). The differences between maturities of the treatments were due to their level of nutrients available in the soil.

Table 4 result reveals that the levels of nitrogen and phosphorus significantly ($P \leq 0.05$) affected the maturity days. The application of (55.2%:46%) NP fertilizer was observed to delay the maturity days (105.22), while control levels were showed early maturity days (97.44). Table 5 shows that there is a significant difference in the interaction effect of compost applied along with nitrogen and phosphorus.

The plant height was statistically significant by compost and NP application (Table 3). The tallest plants 81.97 cm were observed at 6 ton/ha application of compost, while the shortest plant 76.33 cm was recorded with control levels compost application. The combined application of nitrogen and phosphorus had a noticeable effect on plant height. At (55.2%:46%) NP application, the tallest plant 100.4 cm was observed while at control levels the shortest plant 58.06 cm was observed. The data showed that interaction between compost and NP fertilization significantly affects the plant height (Table 5). The tallest plant 102.83 cm and 100.6 cm recorded at (55.2%:46%) NP interacts with 6 ton/ha compost and (41.4%:32.2%) NP interacts with 3 ton/ha compost, respectively, whereas the shortest plant height recorded at the control level.

Table 2 Final chemical properties of experimental field soil after harvesting

Treatment* (NP + C)	pH	CEC (meq 100 g $^{-1}$)	Soil organic carbon (%)	Total Nitrogen (%)	Available phosphorus (g/kg)
$N:P_0 + 0$	6.51	21.56	1.79c	0.11c	0.21c
$N:P_0 + 3$	6.56	22.01	2.6bc	0.18bc	0.36c
$N:P_0 + 6$	6.51	22.15	2.61bc	0.28bc	0.5c
$N:P_1 + 0$	6.53	21.78	1.92c	0.32bc	0.92bc
$N:P_1 + 3$	6.56	21.9	3.08ab	0.59bc	0.92bc
$N:P_1 + 6$	6.51	22.51	3.08ab	0.52bc	1.21b
$N:P_2 + 0$	6.54	22.6	2.55bc	0.26bc	1.12b
$N:P_2 + 3$	6.54	23.01	3.53ab	0.78ab	1.61ab
$N:P_2 + 6$	6.53	22.9	3.82a	0.86ab	1.79a
$N:P_3 + 0$	6.56	22.2	2.59bc	0.68b	1.86a
$N:P_3 + 3$	6.54	23.21	4.15a	1.02a	2.03a
$N:P_3 + 6$	6.57	22.08	4.52a	1.02a	2.01a
p value	0.32*	0.42*	0.04	0.006	0.015

Means with the same letter in each row are not significantly different at ($p \leq 0.05$), according to Duncan's test

NP Nitroge and Phosphorus, *C* Compost, $N{:}P_0$ = Control, $N{:}P_1$ = 27.6%:18.4%, $N{:}P_2$ = 41.4%:32.2%, $N{:}P_3$ = 55.2%:46%

* non-significant at ($p \leq 0.05$)

Table 3 Means value of wheat yield and its components affected by compost application

Variable	Compost (ton/ha)			LSD	CV (%)	EMS
	0	3	6			
Physiological maturity days	99.00c	102.58b	103.58a	0.76	0.88	0.81
Plant height (cm)	76.33c	77.83b	81.97a	0.81	1.22	0.92
Spike length (cm)	7.36c	7.60b	7.93a	0.16	2.23	0.04
Number of Grain per spike	56.17c	62.50b	64.50a	1.41	2.74	2.81
Thousand seed weight (g)	43.33c	45.50b	48.42a	1.33	3.45	2.5
Grain yield (ton/ha)	4.19b	4.98a	5.32a	0.37	9.05	0.19
Biological yield (ton/ha)	8.37c	8.99abc	9.75a	0.95	12.47	1.27
Harvest index (%)	50.06a	55.39a	54.56a	6.12	14.06	52.52

Means with the same letter in each row are not significantly different at ($p \leq 0.05$), according to Duncan's test

Table 4 Means value of wheat yield and its components affected by nitrogen and phosphorus fertilizer

Variable	NP				LSD (0.05)	CV (%)	MSE
	$N:P_0$	$N:P_1$	$N:P_2$	$N:P_3$			
Physiological maturity day	97.44d	101.56c	102.67b	105.22a	0.87	0.88	0.81
Plant height (cm)	58.08d	72.02c	84.35b	100.40a	0.93	1.22	0.92
Spike length (cm)	6.37d	7.26c	7.78b	9.10a	0.19	2.23	0.04
Number of seeds per spike	42.56d	65.44c	69.00b	67.22a	1.63	2.74	2.81
Thousand seed weight (g)	38.11d	43.67c	49.00b	52.22a	1.54	3.45	2.5
Grain yield (ton/ha)	2.24d	3.83c	5.96b	7.28a	0.43	9.05	0.19
Biological yield (ton/ha)	6.21c	8.06b	10.45a	11.43a	1.10	12.4	1.27
Harvest index (%)	36.07c	47.52b	57.03a	63.69a	7.05	14.0	52.54

Means with the same letter in each row are not significantly different at ($p \leq 0.05$), according to Duncan's test

Table 5 Effect of the interaction between NP and compost on yield and its components

Treatment (NP + C)	Physiological maturity (day)	Plant height (cm)	Spike length (cm)	Number of seed per spike	Thousand seed weight (g)	Grain yield (ton/ha)	Biological yield (ton/ha)	Harvest index (%)
$N:P_0+0$	96.33e	56.60i	6.12f	38.33f	36.00 h	1.86 g	5.74f	32.40
$N:P_0+3$	97.00de	57.33i	6.25f	39.33f	40.33fgh	2.58 fg	5.97f	43.21
$N:P_0+6$	99.00d	60.30 h	6.54f	50.00e	38.00gh	2.29 fg	6.91ef	33.1
$N:P_1+0$	98.00de	70.37 g	6.82ef	62.00d	44.00ef	3.53ef	8.08cdef	43.68
$N:P_1+3$	104.67b	72.30 fg	7.72d	69.00abc	41.33efg	3.41ef	7.45def	45.77
$N:P_1+6$	102.00c	73.40f	7.25de	65.33 cd	45.67de	4.55de	8.64bcde	52.66
$N:P_2+0$	98.67de	80.60d	7.13e	67.33bc	43.67ef	5.17 cd	9.81abcde	52.70
$N:P_2+3$	104.00bc	81.10d	7.77d	69.33abc	49.33 cd	6.43bc	10.74abcd	59.86
$N:P_2+6$	105.33b	91.37c	8.44c	70.33ab	54.00ab	6.29bc	10.80abc	58.24
$N:P_3+0$	103.00bc	97.76b	9.19ab	67.00bc	49.67bcd	6.19c	9.84abcde	62.91
$N:P_3+3$	104.67b	100.60a	9.04ab	72.33a	51.00bc	7.49ab	11.79ab	63.53
$N:P_3+6$	108.00a	102.83a	9.48a	72.33a	56.00a	8.16a	12.66a	64.45
P value	<0.001	<0.001	<0.001	<0.001	<0.001	0.014	0.02	0.648*

Means with the same letter in each column are not significantly different at $p \leq 0.05$

* nonsignificant at ($p \leq 0.05$)

Spike length and number of seeds per spike

The spike length of the compost treatment was significantly greater than an untreated trail (Table 3). The longer spike length (7.93 cm) was observed with 6 ton/ha application of compost while the shortest spike length (7.36 cm) was observed with the control level of compost (Table 3). Spike length was significantly influenced by the combined application of nitrogen and phosphorus fertilizer (Table 4). The longer spike (9.10 cm) was achieved at (55.2%:46%) NP application level, while shorter spikes (6.37 cm) were recorded at zero (control) level of nitrogen and phosphorus. The result shows that there is an increasing trend in spike length with increasing NP levels. The interaction effect of the application of compost with NP had a significant effect on spike length (Table 5). The spike length resulted longer (9.48 cm) when (55.2%:46%) of NP interacted with 6 ton/ha of compost whereas the shortest spike length recorded control levels.

The number of seeds per spike is an important yield component to determine the potential of grain yield. Data shown in Table 3 indicated that the application of compost differed significantly ($P \leq 0.05$) for the number of grains per spike. A different application of NP levels had significantly ($P \leq 0.05$) affected the total number of seeds per spike (Table 4). It is clear from the data that the number of seeds per spike increased with increasing NP levels. The interaction effect between compost and NP fertilizer shows that there was a significant difference in the number of seeds per spike (Table 5). The maximum number of seeds per spike (72.33 and 72.33) was recorded at (55.2%:46%) NP interacts with 6 ton/ha and (41.4%:32.2%) NP interact with 3 ton/ha compost, respectively, which is statistically par, whereas the minimum number of seed per spike recorded at the control level.

Grain yield and thousand seeds weight

The statistically analyzed data of grain yield are presented in Tables 3, 4, and 5, which shows grain yield was significantly ($P \leq 0.05$) affected by combined application of nitrogen and phosphorus levels along with compost. Mean comparison of grain yield in compost which is applied at the rate of 6 and 3 ton/ha produced the yield of 5.32 and 4.98 ton/ha had the highest grain yield, respectively, which are statistically at par, and control level of compost which produced with the yields of 4.19 ton/ha, had the lowest grain yield (Table 3). Among mean grain yield of nitrogen and phosphorus levels, applied at the highest rate produced maximum grain yield (7.28 ton/ha), while lower grain yield (2.24 ton/ha) was recorded with control treatment (Table 4). The combined application of the NP along with compost produced the highest grain yields (8.16 ton/ha), whereas the lowest grain yield (1.86 ton/ha) was recorded at an untreated level (Table 5). At any level of combined application of nitrogen and phosphorus along with compost, seed yield response was highest over the other treatment. As a result of combined application of nitrogen and phosphorus with compost increases grain yield to four-fold over an untreated or control trail. However, the result showed that there is still an increment of grain yield with increasing NP along with compost application. Thousand seeds weight positively responded to the combined application of NP along with compost levels as well (Table 5).

Biological yield and harvest index

Mean biological yield was positively responded to the application of the NP and compost levels as well (Tables 3 and 4). The mean higher biological yield (9.75 ton/ha) was obtained from the 6 ton/ha compost application, while the lower mean biological yield (8.37ton/ha) was obtained from the control level. The highest biological yield (12.66 ton/ha) was achieved combined application of the NP along with compost applied at the maximum level while the lower yield (5.74 ton/ha) was recorded at control level (Table 5).

The mean value of the harvest index of the compost and interaction effect of the NP along with compost was statistically insignificant (Tables 3 and 5), while the mean value of the NP harvest index was statistically significant (Table 4).

Discussion

Optimum crop yield cannot be attained without ensuring that plants have an adequate and balanced supply of nutrients. Effective and efficient approaches are required to maintain and increase soil quality and crop productivity in a sustainable way. Farmers in the study area are not getting optimum yield, because of the low soil fertility and unproper soil management practices. To mitigate the problem, farmers commonly use a blanket recommendation of inorganic fertilizers. Currently, most farmers are not applying inorganic fertilizers at recommended rates, because of the high price of inorganic fertilizers. The data (Table 2) revealed that there is a direct relationship between the integrated application of the compost and NP on the soil organic carbon, total nitrogen, and available phosphorus content. Application of organic fertilizer along with chemical fertilizer increase microbial activity, promotes efficiency in the use of nutrients and increases accessibility of the surrounding nutrients (Moharana et al., 2012), resulting in adequate nutrient uptake by plants. Therefore, to increase the soil productivity by providing all the plant nutrients in available form, sustain good soil condition, and reduced the use of chemical fertilizer, it is required to use organic fertilizer in combination with inorganic fertilizers to achieve optimum yields. The application of organic fertilizer alone might not meet the plant needs because of the relatively low nutrient content.

Increasing the application of the NP and compost was increasing the content of organic carbon, total nitrogen, and available phosphorus but had no effect on pH and cation exchange capacity. Different studies reported that combined use of inorganic as well as organic fertilizers could be the best alternative strategy for maintaining the fertility of soil and productivity of crops on a sustainable basis (Güereña et al., 2016). Moreover, the result showed that integrated application of the compost and NP fertilizer was high soil organic and total nitrogen content compared to control and a single application of the NP. Similarly, several studies reported that integrated application would have a significant impact on the amount of soil organic carbon, total nitrogen, and other essential nutrients (Bhardwaj et al., 2019; Kukal et al., 2009; Padbhushan et al., 2021).

The yield benefits were higher when NP and compost fertilizers were used together, due to the positive interactions between the two sources of nutrients, which increased nutrient supply. In the present study, the highest grain yield at the sole application of the NP produced 6.19 ton/ha (Table 4), whereas combined application of NP along with compost produced the higher grain yield of 8.16 ton/ha (Table 5). This data clearly revealed that the combined application of NP and compost increased wheat yield by 27.45% over the sole application of NP. This result indicated that the contribution of the total chemical fertilizer consumption in the soil to crop yield has been unable to meet the requirement of farmers. Integrated application of NP and compost significantly and positively affected the grain yield of wheat might have been due to the availability of nutrients throughout the growth period and the synergistic impact of microorganisms, which could have enhanced the chemical fertilizers to quickly supply the immediately required nutrients to crop plants. These results are also in accordance with previous findings that organic addition is of major significance for maintaining soil quality and crop production sustainably, and should be advocated in the nutrient management strategies of intensive water- and nutrient-demanding cropping systems (Abid et al., 2020; Padbhushan et al., 2021).

Additionally, the improved yields and its component of wheat due to combined application of NP along with compost resulted from positive effects to the soil pH, soil structure, available P, and total N, and might be other nutrients. There is enough evidence that the application of organic fertilizer also enhances the effectiveness of chemical fertilizer through beneficial soil microbial activity and improvement of soil fertility levels (Xin et al., 2017). The results of this study show that increasing crop yields and sustaining them at a prominent level must include an integrated nutrient management approach. The addition of organic compost in this study demonstrated a significant improvement in crop productivity through improving soil physical properties associated with the structural stability of the soil.

Conclusion

It is clear from the results of the present study that the sole application of the NP fertilizers that were used has not fulfilled the actual need for wheat growth. The combined application of the NP fertilizer (55.2%:46%) along with 6 ton/ha of compost produced the highest (8.16 ton/ha) grain yield, which increases wheat yield by 27.45% over sole application of the chemical fertilizer by improving the soil organic carbon, total nitrogen, available phosphorus and might be other nutrients. Hence, application of 75% recommended inorganic NP fertilizers mixed with compost resulted in the highest yield production in wheat indicating that the integrated approach can enable to save up to 25% of commercial fertilizers. The results have indicated that either inorganic fertilizer or organic fertilizer alone cannot sustainably improve productivity of wheat. Using the combined application of organic and inorganic fertilizer enhances crop productivity, increases the effectiveness of chemical fertilizer, and decreased the amount of chemical fertilizer use. The declining soil fertility is due to the high cost of inorganic fertilizer, imbalance in fertilizer use, and the continuous use of inorganic fertilizers. To reach higher yield targets in wheat production, balanced soil nutrition is necessary, which supply of nutrients in adequate quantities of organic and inorganic fertilizer as appropriate soil fertility management practices.

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Declarations

Conflict of interest The authors declares that they have no known competing financial interests that could have appeared to influence the work reported in this paper.

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