



## Research Article

# Growth and Yield Response of Wheat to Organic Manures (Farm Yard Manure, Phospho-Compost (PROM) and Press Mud) Alone and in Combination with Mineral Fertilizer

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**Abstract** | Phosphorus (P) deficiency is the global prime constraint for crop growth including Pakistan. Therefore, the application of phosphatic fertilizers is compulsory. But P availability is low due to its fixation, which is a major constraint in achieving sustainability in crop production. A pot trial was performed to estimate the efficiency of organic manures for P release from rock phosphate by wheat. The fourteen treatments with six replicates were arranged according to completely randomized design (CRD). Treatments of the study were  $T_1$  = Recommended N, K with no P,  $T_2$  = Recommended NPK from mineral fertilizer,  $T_3$  =  $T_1$  + all P from PROM (Phosphorus rich organic manure),  $T_4$  =  $T_1$  + all P from FYM,  $T_5$  =  $T_1$  + all P from compost,  $T_6$  =  $T_1$  + all P from press mud,  $T_7$  =  $T_1$  + half P from mineral fertilizer + half P from PROM,  $T_8$  =  $T_1$  + half P from mineral fertilizer + half P from FYM,  $T_9$  =  $T_1$  + half P from mineral fertilizer + half P from compost,  $T_{10}$  =  $T_1$  + half P from mineral fertilizer + half P from press mud,  $T_{11}$  =  $T_2$  + all P from PROM,  $T_{12}$  =  $T_2$  + all P from FYM,  $T_{13}$  =  $T_2$  + all P from compost and  $T_{14}$  =  $T_2$  + all P from press mud. Pre and post-harvest soil analysis were performed. The growth and yield traits were recorded and data were analyzed using LSD at a 5% level of probability for significance differences. Results of the research intimated that highest height of plant (71.42 cm), shoot dry weight (10.74 g), length of spike (13.33 cm), tiller numbers in a plant (7.16), weight of dry root (0.335 g), root length (11.68 cm), weight of 1000 grains (37.88 g) and wheat biomass (48.63 g) were recorded with  $T_{11}$  ( $T_2$  + all P from PROM). Thus, P application improved the wheat growth and yield traits significantly ( $T_1$ ) and  $T_{11}$  was found more effective for achieving the optimum output.

**Received** | December 15, 2021; **Accepted** | February 09, 2023; **Published** | February 27, 2023

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**Citation** | Shehzad, R.A., G. Sarwar, S.H. Shah, M.A. Tahir, N. Sabah, S. Muhammad, M. Aftab, M.Z. Manzoor, I. Shehzad and U. Saleem. 2023. Growth and yield response of wheat to organic manures (farm yard manure, phospho-compost (PROM) and press mud) alone and in combination with mineral fertilizer. *Pakistan Journal of Agricultural Research*, 36(1): 1-8.

**DOI** | <https://dx.doi.org/10.17582/journal.pjar/2023/36.1.1.8>

**Keywords** | Wheat, Organic manure, Phosphocompost, Press mud and wheat yield



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## Introduction

Wheat is an essential staple crop for majority of the world's population and can be cultivated in rainfed and irrigated conditions (Munir *et al.*, 2007). It is considered a key important staple crop and is the most needed grain around the globe. Within cereals, wheat crop is more significant export and strategic crop in the world in terms of overall growth, production, utilization and growing area around the globe (Ranjana and Kumar, 2013). In Pakistan, wheat is a leading grain crop and its importance is expanding in the light of its food consumption as food and different products (Laghari *et al.*, 2010). Wheat accounts for about 72% of total calories and 125kg/year is the per capita consumption of wheat (Khan *et al.*, 2015). Balanced use of fertilizers and fertilization is always vital to maximize yield and production. Pakistani soils, which are low in nitrogen and phosphorus, need the application of these nutrients in balanced and adequate quantity. An adequate response to nutrient can only be obtained if the nutrients are applied in a balanced proportion (Ghosh *et al.*, 2006).

For plant development, phosphorus is to be considered as chief supplement and nutrient since it is engaged with cell vitality, movement, transfer, photosynthesis and respiration (Brady and Weil, 2005). Phosphorus isn't only necessary for the development and growth of field crops however it is additionally vital for the upgrade of quality of various parameters and characteristics (Chaubey and Kaushik, 2000). Plants facing deficiency of phosphorus may indicate symptoms of deficiency, for example, leaves purpling and stunted growth (Turk *et al.*, 2002). P controls the partitioning of photosynthates with in reproductive organs and source (Cheema *et al.*, 2001). Phosphorus is the least available mineral in most of cropping system (Shenoy and Kalagudi, 2005). In under developing countries and even in developing world productive potential of large area is very low and under-explored due to inadequate management, handling and constrains of nutrition-related matters (Gosh *et al.*, 2006).

Because of unequal distribution and management of fertilizers and high cropping systems, there is either extreme exhaustion of nutrients from soil or excessive amount of nutrients in soil that may confer environmental issues (Dong *et al.*, 2006). These factors are responsible for decrease in productivity

of crop and reduction in soil fertility (Gosh *et al.*, 2006). To overcome this situation and want to tackle it by applying mineral P fertilizers, it turns out to be difficult in light of the fact that these are all around expensive and at the same time are not good and favorable for environment (Shenoy and Kalagudi, 2005). Reddy *et al.* (2002) reported that high costs of inorganic manures are making it hard to utilize them effectively and efficiently. On the other hand, organic manures alone can't supply adequate P for ideal growth but have certain attributes that enhance the accessibility of P.

Saleem (1990) documented that use of (FYM) to soils having high pH, supplies more P to the soil and provide acid compounds that enhanced the accessibility of mineral forms of P. Reddy *et al.* (2002) stated that addition of organic materials reacts with the soil and produce natural anions during decomposition, which compete with P for a similar sorption and in this manner enhanced P accessibility in the soil. Gosh *et al.* (2006) revealed that to accomplish high yield and crop production, integrated usage of both organic and inorganic fertilizers must be recommended. Application of both in soil supplies all essential nutrients to soil and crop and enhances the productivity potential of crops.

Similarly, Ibrahim *et al.* (2008) also used mineral fertilizer and FYM in coupled form and individually on wheat crop and concluded that enhanced yield of grain, biological yield and straw yield was recorded when the highest rate of mineral fertilizer and FYM was applied. They suggested that rather than utilizing inorganic and organic manure alone, the integrated use could be increasingly compelling and supportable for agriculture and environment. Therefore, present investigation was performed to explore the role of agro based industry wastes on the P bioavailability from rock phosphate used as phosphocompost (phosphate rich organic manure abbreviated as PROM) and on wheat growth and yield.

## Materials and Methods

A pot experiment was performed to assess the efficacy of organic substrates for growing wheat crop. PROM was prepared to check the solubilization of rock phosphate. For this purpose, cow dung, press mud and rock phosphate were used in 1:2 mixed thoroughly in a container and left for three weeks.

After three weeks, 2% urea solution was sprayed on it and placed it for one week. Later on, mixture was supplied with 2% DAP and again left for one week. After this, mixture was air-dried and sieved for storage and further used. Design of research was completely randomized design (CRD) fourteen treatments and six replications.  $T_1$  = Recommended N, K with no P;  $T_2$  = Recommended NPK from mineral fertilizer N used as urea, P used as TSP and K used as sulfate of potash;  $T_3$  =  $T_1$  + all P from PROM (phosphorus rich organic manure);  $T_4$  =  $T_1$  + all P from FYM;  $T_5$  =  $T_1$  + all P from compost;  $T_6$  =  $T_1$  + all P from press mud;  $T_7$  =  $T_1$  + P half from mineral sources and half from PROM;  $T_8$  =  $T_1$  + P half from mineral sources and half from FYM;  $T_9$  =  $T_1$  + P half from mineral sources and half from compost;  $T_{10}$  =  $T_1$  + P half from mineral sources and half from press mud;  $T_{11}$  =  $T_2$  + all P from PROM;  $T_{12}$  =  $T_2$  + all P from FYM;  $T_{13}$  =  $T_2$  + all P from compost;  $T_{14}$  =  $T_2$  + all P from press mud.

Soil was selected by analyzing it from various sites (Table 1) and into the pots @ 20 kg/pot. In each pot, 05 seeds of wheat cultivar “Punjab-2011” were sown but after plant germination, only 3 plants were maintained. Urea, DAP (diammonium phosphate), PROM and potassium sulphate were applied for NPK sources, respectively.

**Table 1:** Analysis of soil before cultivation.

Parameters	Unit	Value
Soil pH	-	7.7
Soil EC	dSm <sup>-1</sup>	0.81
Soil organic matter	%	0.59
Sodium absorption ratio	-	3.82
Total soil N	%	0.29
Available soil P	ppm	7.8
Extractable soil K	ppm	129.7
Soil Textural Class	-	Clay loam

For analysis of soil, analytical methods mentioned in Hand Book 60 of U.S Salinity Laboratory Staff (1954) were adopted. The procedures other than these methods are also mentioned separately.

Wheat growth and yield parameters were noted at maturity. Height of plants (cm) was recorded at maturity. The shoot of sampled plant was oven dried at 70°C for 24 hours then the dry weight of shoot was noted using electrical balance for each treatment separately. Then the average shoot dry weight (g) was measured. The length of spike (cm) of all wheat plants

was measured with a scale. Tiller numbers in a plant were counted manually from wheat plant from each treatment. Weight of dry root (g) was calculated from previously separated roots. These roots were dried for 24 hours at 70 °C in oven. When the roots were completely dried then weighed on electric balance. For taking 1000-grain weight (g), number of grains were taken from each treatment and calculated by using grain counter and then assessed its weight using electronic balance. The plants were harvested from each treatment separately and then electric balance was used to measure its biomass (g).

### Statistical analysis

The data were collected analyzed statistically by employing Statistix 8.1 software analysis of variance (ANOVA) technique and significance of treatments means were compared using LSD test at 5% level of probability (Steel *et al.*, 1997).

## Results and Discussion

### Plant height (cm)

Height of plant is the main indicator of green area, as tallness of plant will create a larger green area that increases photosynthesis and contributes to grains productivity. Impact of different mineral fertilizers alone or in mixture with organic manures on tallness of plant of wheat was found significant. Figure 1 exposed that application of mineral fertilizer sole or in mixture with organic manures considerably boosted the tallness of wheat plants. However, among all the treatments the maximum tallness of plant (71.42 cm) of wheat was measured under the application of  $T_2$  + all P from PROM ( $T_{11}$ ) which was followed by  $T_2$  + all P from compost ( $T_{13}$ ) that produced 67.13 cm of tallness of plant (Figure 1). The treatments,  $T_2$  + all P from FYM ( $T_{12}$ ) and  $T_2$  + all P from press mud ( $T_{14}$ ) produced 66.13 cm of tallness of plant which were statistically similar to each other. Similarly, the  $T_8$  ( $T_1$  + half P from mineral fertilizer + half P from FYM) and  $T_9$  ( $T_1$  + half P from mineral fertilizer + half P from compost) indicated statistically similar results. The minimum tallness of plants (52.91 cm) of wheat was observed with  $T_1$  (Recommended N, K, and P = 0). It was indicated that phosphorus plays an essential role to improve the tallness of wheat plants.

### Shoot dry weight (g)

It is also an important trait that improves or reduces plant growth and development. As the weight of dry

shoots increases, the accumulation of solids in the shoots increases that helps to enhance the biomass of crop plant. Data in Figure 2 showed that application of mineral fertilizer and organic manures exaggerated the shoot dry weight expressively. The highest shoot dry weight (10.74 g) of wheat was noted in the treatment grown under T<sub>11</sub> (T<sub>2</sub> + all P from PROM) which was statistically similar to T<sub>13</sub> (T<sub>2</sub> + all P from compost) that produced 10.62 g of shoot dry weight. However, the lowest shoot dry weight (7.22 g) of wheat was noted under T<sub>1</sub> (Recommended N, K, and P = 0). Results indicated that T<sub>11</sub> and T<sub>13</sub> showed superiority over all other treatments.

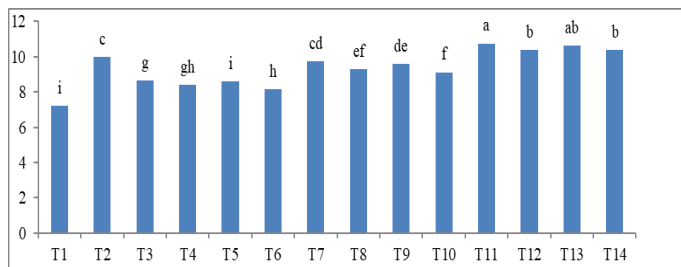


Figure 1: Impact of organic and inorganic sources of nutrients on height of wheat plants.

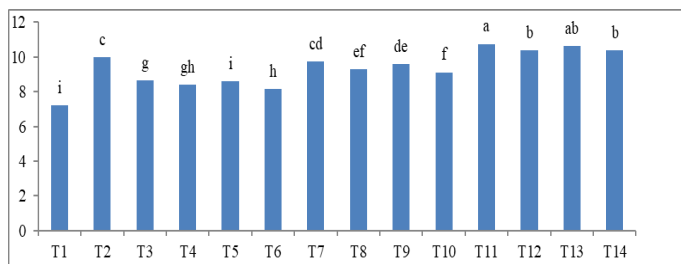


Figure 2: Impact organic and inorganic sources of nutrients on shoot dry weight of wheat.

### Spike length (cm)

Length of spike of wheat crop is an imperative factor to determine crop performance. The wheat productive competency was also governed. A significant impact of mineral fertilizer and organic manures was imparted on wheat length of spikes (Figure 3). Data concerning wheat length of spike was displayed that application of mineral fertilizer alone or in mixture with organic manures improved the length of spikes of wheat. The application of T<sub>2</sub> + all P from PROM (T<sub>11</sub>) recorded the highest length of spikes (13.33 cm) of wheat which was followed by T<sub>2</sub> + all P from compost (T<sub>13</sub>). The minimum values of wheat length of spikes (10.0 cm) were measured with T<sub>1</sub> (Recommended N, K, and P = 0). It was revealed from the data that among all the treatments, T<sub>11</sub> proved superior to others in term of length of spikes of wheat.

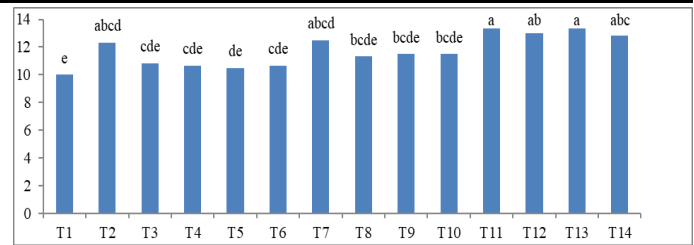


Figure 3: Impact of organic and inorganic sources of nutrients on length of spikes of wheat

### Number of tillers in a plant

The yield capability of wheat is mainly subjected to the tiller numbers in a plant. It plays a vital role to produce the more crop yield. It is observed that greater the tillers of wheat per plant higher will be the grain productivity. Effect of different mineral fertilizer alone or in mixture with organic manures on tallness of plant of wheat was found non-significant (Figure 4). Data depicted that application of mineral fertilizer alone or in mixture with organic manures increase the tiller numbers in a plant. However, between all the treatments the highest tiller numbers in a plant (7.16) of wheat were measured under the application of T<sub>2</sub> + all P from PROM (T<sub>11</sub>) which was followed by T<sub>2</sub> + all P from FYM (T<sub>12</sub>). The minimum tiller numbers in a plant (5.33) of wheat were observed with T<sub>1</sub> (Recommended N, K and P = 0) and T<sub>6</sub> (T<sub>1</sub> + all P from press mud).

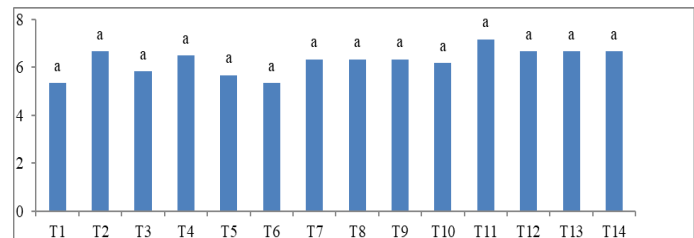
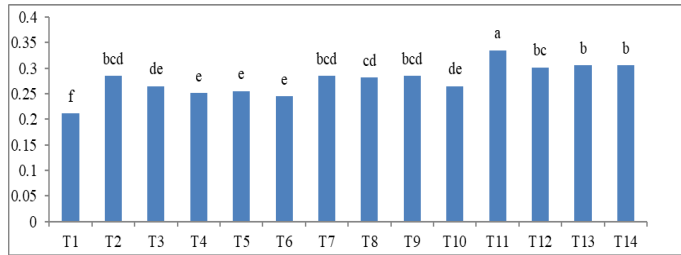


Figure 4: Impact of organic and inorganic sources of nutrients on tiller numbers in a plant of wheat.

### Weight of dry root (g)

It is a key feature of crop plants that showed crop improvement and development. Higher the weight of dry root more will be the root length which provides food storage and translocation of solutes to crop plant that enhanced the wheat growth. Figure 5 revealed that application of mineral fertilizer and organic manures affected the weight of dry root of wheat significantly. The maximum weight of dry root (0.335 g) of wheat was recorded in the treatment grown under T<sub>11</sub> (T<sub>2</sub> + all P from PROM). However, the lowest weight of dry root (0.211 g) of wheat was noted under T<sub>1</sub> (Recommended N, K, and P = 0). Results of the study exposed that among all tested

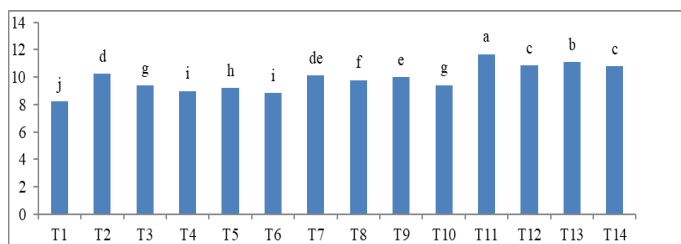
combinations  $T_{11}$  showed superiority over all other treatments.



**Figure 5:** Impact of organic and inorganic sources of nutrients on weight of dry root (g) of wheat.

### Root length (cm)

A significant impact of mineral fertilizer and organic manures was imparted on root length of wheat (Figure 6). Data concerning to root length of wheat was displayed in Figure 6 which showed that application of mineral fertilizer alone or in mixture with organic manures enhanced the root length of wheat. The application of  $T_2$  + all P from PROM ( $T_{11}$ ) resulted in highest root length (11.68 cm) of wheat which was followed by  $T_2$  + all P from compost ( $T_{13}$ ). The application of  $T_2$  + all P from FYM ( $T_{12}$ ) and  $T_2$  + all P from press mud ( $T_{14}$ ) produced 10.86 and 10.79 cm of root length of wheat respectively. The minimum values of wheat root length (8.22 cm) were observed with  $T_1$  (Recommended N, K and P = 0). It was noticed that between all tested treatments,  $T_{11}$  performed well as compared to other treatments in term of root length of wheat.

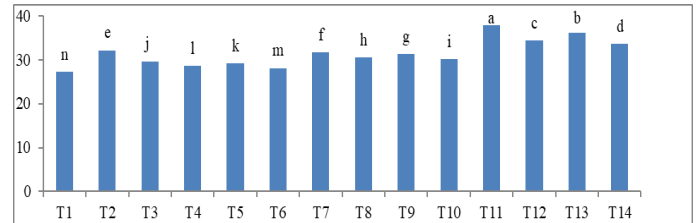


**Figure 6:** Impact of organic and inorganic sources of nutrients on root length (cm) of wheat.

### 1000 grain weight (g)

Effect of different mineral fertilizer alone or in mixture with organic manures on wheat weight of 1000 grains was found substantial (Figure 7). Data exhibited that application of mineral fertilizer alone or in mixture with organic manures extensively improved the weight of 1000 grains of wheat. However, the highest weight of 1000 grains (37.88 g) of wheat were noted under the application of  $T_2$  + all P from PROM ( $T_{11}$ ) which was followed by  $T_2$  + all P from compost ( $T_{13}$ ) that produced 36.08 g of Weight of 1000 grains. The

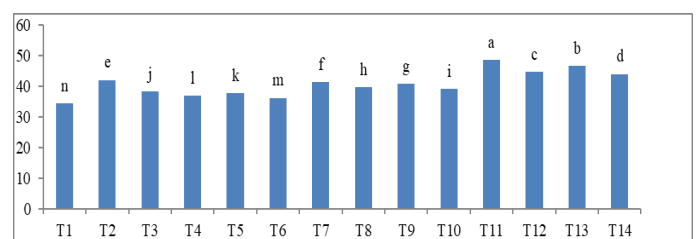
treatments,  $T_2$  + all P from FYM ( $T_{12}$ ) and  $T_2$  + all P from press mud ( $T_{14}$ ) produced 34.28 and 33.58 g weight of 1000 grains respectively. The lowest Weight of 1000 grains (27.18 g) of wheat was observed with  $T_1$  (Recommended N, K, and P = 0) (Figure 7). Overall outcome revealed that weight of 1000 grains of wheat improved significantly with phosphorus application than no phosphorus application.



**Figure 7:** Impact of organic and inorganic sources of nutrients on weight of 1000 grains (g) of wheat.

### Wheat biomass (g)

Data in Figure 8 indicated that application of mineral fertilizer and organic manures affected the biomass of wheat significantly in terms of statistics. A great increment in wheat biomass was observed with chemical and organic fertilizers application. The maximum biomass of wheat (48.63 g) of wheat was recorded in the treatment grown under  $T_{11}$  ( $T_2$  + all P from PROM) which was followed by  $T_{13}$  ( $T_2$  + all P from compost) that produced 46.70 g of wheat biomass (Figure 8). However, the lowest shoot dry weight (7.22 g) of wheat was noted under  $T_1$  (Recommended N, K, and P= 0). It was observed that all treatments enhanced the wheat biomass significantly but  $T_{11}$  was found more effective among all tested treatments.



**Figure 8:** Impact of organic and inorganic sources of nutrients on biomass of wheat.

For plant development, phosphorus is to be considered as chief supplement and nutrient since it is engaged with cell vitality, movement, transfer, photosynthesis and respiration (Brady and Weil, 2005). It helps in expanding the area of leaf, P of shoot and root, weight of shoot dry of plants and crops as well and its inadequacy may lessen crop growth, development, blooming delaying maturity and flower development. It is a basic segment of nucleic acids, phospho-

proteins, numerous co-compounds of enzymes and phospho-lipids (Chaubey and Kaushik, 2000). Plants facing deficiency of phosphorus may indicate symptoms of deficiency, for example, leaves purpling and stunted growth (Turk and Tawaha, 2002). During the process of photosynthesis, reproductive growth, and carbohydrate metabolism role of P is of primary importance and its lack during this point restrains the yield. Phosphorus controls the partitioning of photosynthates with in reproductive organs and sources (Cheema *et al.*, 2001).

The results of the previous researcher Turk and Tawaha (2002) also documented that most of the measured traits such as seed weight per plant, tallness of plant and pod length were significantly affected by phosphorus application than control. Our findings are further reinforced by the outcomes of Chand *et al.* (2006) who indicated that integrated application of organic (FYM) and mineral fertilizers (NPK) along with manuring of sesbania green manure that enhanced the crop productivity by improving the crop growth attributes e.g., plant height, shoot and root weight. Our results are further supported by Chaubey and Kaushik (2000) who stated that application of organic manures which release phosphorus proved helpful in increasing the leaf area and shoot dry weight of crop plants and its deficiency may reduce crop growth. Ghosh *et al.* (2006) described that the nutrients status as well as crop efficiency has been observed highest under the application of organic manures in soil with added inorganic or mineral fertilizers. The results of the Ibrahim *et al.* (2008) and Abbas *et al.* (2012) also implied that organic manures had a significant impact on various growth and yield attributes of wheat and highest values of wheat tallness of plant as well as length of spikes were achieved where compost was applied than that of control. Meena *et al.* (2013) also stated that the combined use of organic and mineral nutritional sources impart a substantial impact on number of tillers of wheat and highest tillers was noted with both inorganic and organic sources of nutrients application than applied alone or separately. The work of Singh *et al.* (2001), Mohanty *et al.* (2006), Sarwar *et al.* (2009) and Sabah *et al.* (2014, 2020) was also in accordance with our outcomes. They reported that a substantial increase in the grain weight of wheat and rice was observed in plots where mixture of NPK and FYM was applied.

## Conclusions and Recommendation

Incorporation of nutritional sources (organic or inorganic) either applied alone or in combination boosted the growth and growth parameters of wheat. Among all tested treatments, highest plant height, shoot and root dry weight, 1000-grain weight, biomass of wheat was recorded with  $T_{11}$  ( $T_2$  + all P from PROM). It is concluded that all treatments improved the wheat growth and yield characteristics significantly except  $T_1$  but  $T_{11}$  was found more effective for attaining the best results.

## Acknowledgement

Authors are highly grateful to ORIC, University of Sargodha for providing funds to accomplish this research work.

## Novelty Statement

Incorporation of nutritional sources (organic or inorganic) either applied alone or in combination boosted the growth and growth parameters of wheat. Role of PROM proved superior to all other sources.

## Author's Contribution

**Rana Amir Shahzad:** Conducted the research trial.

**Ghulam Sarwar:** Supervised the trail.

**Sabir Hussain Shah and Sher Muhammad:** Technical assistance at every step for write up.

**Mukkram Ali Tahir:** Co-supervised the trial.

**Noor-us-Sabah and Usman Saleem:** Statistical analysis.

**Muhammad Aftab:** Proof reading and final editing.

**Muhammad Zeeshan Manzoor and Imran Shehzad:** Helped in all field and Lab work.

## Conflict of interest

The authors have declared no conflict of interest.

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