ESTIMATE THE IMPACT OF THE COMBINED APPLICATION OF N AND P FERTILIZERS ON THE GROWTH OF WHEAT (*TRITICUM AESTIVUM* L.) UNDER THE DRY ENVIRONMENT OF UTHAL, BALOCHISTAN

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خلاصہ

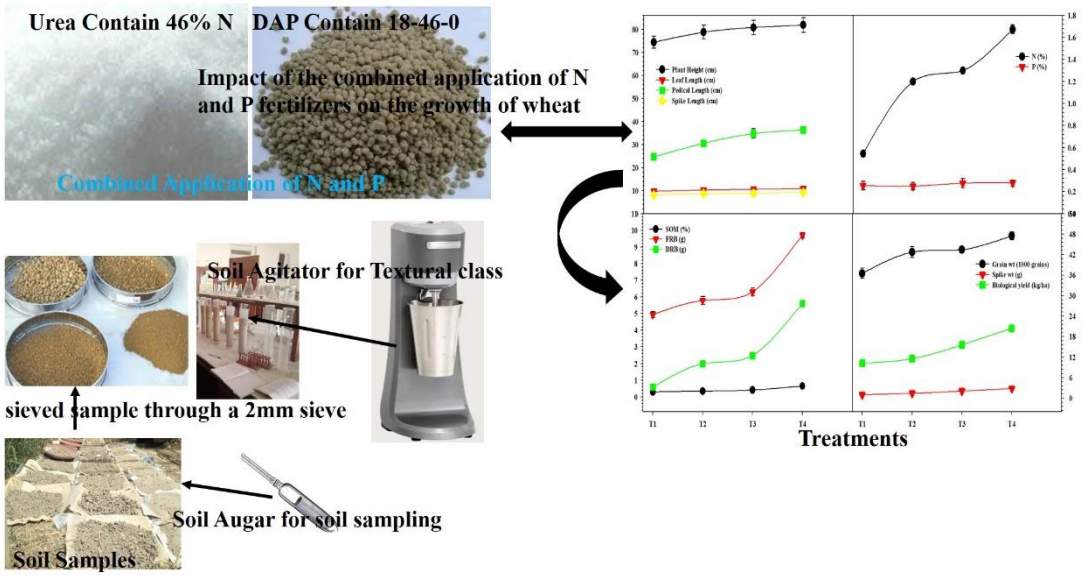
حالیہ تحقیق اوتھل ضلع لسبیلہ کے گرم مرطوب علاقہ میں موسم سرما کے دوران کی گئی تحقیق کا بنیادی مقصد نائڑوجن اور فاسفورس فرٹیلائز کی مدد سے گندم کی فصل پر اسکے مرتب ہونے والے پیدواری اثرات کا جائزہ لیا گیا ہے اسی تجربہ میں تین مختلف مقدار میں نائٹروجن اور فاسفورس سے بنائی گئی فرٹیلائزر یعنی کھاد استعمال کی گئی ہے اور ساتھ میں کنڑول گروپ بھی رکھے گے تاکہ نتائج کی صحیح طریقےسے جانچ کی جاسکے۔

اسکے نتائج سے ہمیں اندازہ ہوا کہ نائٹروجن اور فاسفور س کی کھاد کے گندم کی فصل کی بڑھتی ہوئی پیداور پر گہرے اثرات ہیں. جس تناسب سے ہم نے کھاد میں نائٹروجن اور فاسفورس کا اضافہ کیا تو اسکے اثرات پودے کی لمبائی پتے کے سائز اور اسکے ڈنٹل اور کیلوں پر نوٹ کیے گئے (8-10%). تقسیم شدہ خوراک کے اندر اور استعمال کے بعد آبپاشی کے دونوں کھادوں کے مشترکہ استعمال نے گندم کی نشوونما، حیاتیاتی اور پیداوار کی خصوصیات کے ساتھ نمایاں طور پر متاثر کیا ہے.

Abstract

The present research study was conducted in a cool winter with a hot summer region of Lasbela, Balochistan. The main purpose of this study was to evaluate the effects of the combined application of nitrogen and phosphorus fertilizers on wheat crops, associated with growth and grain yield. Factorial combinations of three of both N and P within the control (T1= control, T2= 30&15kgha-1, T3= 60&30kgha-1, T4= 90&45kgha-1) of three times replicates were laid out in a randomized complete block design. The findings of this study showed that the increased applications of both fertilizers influence wheat's growth and yield attributes. Growth parameter results indicated that plant height (cm), leaf length (cm), pedicel length (cm), and spike length (cm) increased with an increased dose of both fertilizers i.e. 70.66, 7.12, 24.7, 6.12cm; 73, 8.56, 30.53, 7.52cm; 88.312, 11.91, 36.3 and 10.12cm respectively. Mean maximum and significant $p<0.05$ were recorded in T_4 compared to T_1, T_2, and T_3. In the in-comparison of T_1 and T_2, a minor difference was recorded. Additionally, results of biological and grain yield also increased 8-10% more than T_1 and T_2 with increased application of both fertilizers. Conclusively, combined applications of both fertilizations within split doses and after the application irrigation have significantly interacted with the growth, biological, and yield attributes of wheat.

Keywords: Wheat; Growth stag; Nitrogen; Phosphorus; Efficiency



Graphical abstract

Introduction

Wheat (*Triticum Aestivum* L.) is the world's most important cereal crop and a staple food for over 10 billion people in 43 nations worldwide. It accounts for roughly 20 percent of the human race's total calorie consumption in human nutrition. Wheat is the major source of vegetable protein with a greater protein level than most other cereals. It is effectively cultivated in Pakistan on more than 9 million hectares, producing an average yield of 24 million tons. It contains 11-16.5% protein, 1.5-2 % fat, and 1.2-2% Vitamins and inorganic ions (Vitamin E and B-complex). Furthermore, wheat is regarded as the most significant winter crop since its grains are the primary source of nourishment for both urban and rural residents and its straw is an essential fodder for animal feed, particularly during the summer (Arshad *et al.,* 2023; Khan *et al.,* 2023; Asplund *et al.,* 2014; Youssef *et al.,* 2013).

Pakistan's wheat yield is 2.5 times lower than in advanced wheat-producing countries worldwide. Although, the production of wheat from 2022-2023 is 28.18 million tons, which is 7.5% higher than in 2020-2021 in which the production was 26.21 million tons (Ahmed *et al*., 2024). Irrigation covers around 18 million hectares, or 80 percent of its farmed area, with desert farming accounting for the balance (Azmat *et al.,* 2021; Gul *et al.,* 2021; Mahmood *et al.,* 2020; Lal, 2018). Nitrogen has a prominent role in plant metabolism. Nitrogen (N) is a key element involved in all vital plant activities. As a result, nitrogen fertilizer application in the form of chemical fertilizer is necessary to boost crop output. Wheat had the maximum nitrogen utilization efficiency. However, N fertilization still has challenges to improve wheat yield that must be handled to increase wheat production. As a result, the current investigation was conducted to validate current nitrogen application practices. Processes to enhance N fertilizer dosages and determine the most effective N delivery strategy in wheat was studied (Gill *et al.,* 2019; Belete *et al.,* 2018; Asplund *et al.,* 2014). A significant nitrogen loss to the environment could lead to serious environmental issues such as consider groundwater contamination. Reduced levels can help to minimize nitrate seeping from soil (Ecarnot *et al.,* 2013; Boulelouah *et al.,* 2022; Anas *et al.,* 2020).

In agricultural soils, nitrogen deficiency exists due to leaching and volatilization and crops respond to the addition of nitrogen in soil as fertilizer source. Crop response to applied nitrogen fertilizer is influenced depending on the soil type, soil fertility status, soil management and agronomic practices methods, fertilization method, crop variety, etc. In most crops, split nitrogen fertilizer application is more beneficial than basal application of all nitrogen fertilizers. Plants have evolved rapidly when soil phosphorus levels are low specialized adaptation mechanisms such as increased root/shoot ratio, increased root hair quantity, and interaction with carbuncular mycorrhizal fungus (AMF), phosphatase, and organic acid generation and release, as well as increased phosphate transporter expression (Poudel *et al.,* 2023; Lu *et al.,* 2015; Barut *et al.,* 2015).

Materials and Methods

The present study was carried out in the field experimental farm of Lasbela University of Agriculture, Water, and Marine Sciences (LUAWMS) Uthal. The study site is accounted as the coastal region of the district Lasbela Balochistan. District Lasbela is 125 km away from Karachi and is famous for its unique geographical structure of mountains and beautiful beaches. The summer is hot with a short winter and the average annual rainfall is 169 mm.

Description of the Research Study

A field experiment was conducted during the winter seasons of 2020-21 to estimate the effects of both N&P fertilizer on wheat growth and yield parameters. The purpose of this study was to compare N&P application with recommended doses and explore the potential for reducing dependency on traditional nitrogen fertilizers. A plot (size 5 m × 4 m) field experiment study was conducted in the winter of 2020 to estimate the effect of various treatments of both N & P applications on soil physico-chemical properties, growth, and yield. TD1 spring wheat variety was sown in line sowing at the rate of 100 kgha-1. Randomized complete block design (RCBD) with three treatments of both N & P application with three replications was performed. Treatments were T_1=control, T_2=30kgha^{-1}, T_3=60kgha^{-1}, T_4=90 kgha$_{-1}$ of N applications, while for phosphorus applicatT_2=15kgha$_{-1}$, T3=30kgha$_{-1}$, T4=45kgha^{-1}. Additionally, P was applied at the time of sowing, and N was applied in three (1st germination of seed, 2nd at second irrigation, and 3rd at booting) split doses. However, all the agronomic observation was carried out at the required period.

Data Compilations

The recorded data were collected for numerous parameters to estimate the effect of both combined applications of N&P fertilization on vegetative growth, productivity, and physiological characteristics of the wheat crop. Parameters include plant height (cm), leaf length (cm), pedicel length (cm), spike length (cm), fresh and dry root biomass (g), thousand-grain weight (g), spike weight (g), and biological yield (kgha^{-1}). At the maturity of the crop, randomly five plants from each plot were selected to estimate plant height (cm), leaf length (cm), pedicel length (cm), spike length (cm), fresh and dry root biomass (g), and Grain yield (thousand-grain weight) of the plants. Though, agronomic practices such as hoeing, plant populations, irrigation, and plant protection measures for each treatment are kept uniform and normal.

Soil Sampling Process and Analysis*:* Before sowing of seed and after harvesting of the crop, composite soil samples in triplicates from both treatments at 0-15 cm of depth were collected. Collected soil samples were packed in well-label polyethylene bags and transported to the lab, all plant root material and stones manually were collected. Initially, soil samples were air-dried and sieved in 2mm for the analysis of Soil EC (dSm-1). pH was analysed by using a digital EC and pH meter within soil and water extraction ratio of 1:2.5. Soil organic matter (%) by wet oxidation of (walkely and black, 1934) available P by spectrophotometer. Available K data were recorded using a flame photometer followed by Jackson and Marion (2005).

Statically Analysis**:** The collected data was subjected to a two-way analysis of variance (ANOVA) suggested by Gomes, 1984. The difference among treatment means was calculated by the Least Significant Difference (LSD) test 5% probability level was used with the help of SPSS Version 20 (IBM.2016).

Results and Discussion

Soil Characteristic of the Experimental Area: Before and after harvesting of the crop, composite soil samples from each replication of the plot and from both treatments of fertilizer at 0-30 cm in triplicates soil samples were collected separately and organized into a composed soil sample of each plot. Table 1 presents the analysis results of soil characteristics before sowing of seed, and generally, there is no significant ($P<0.05$) difference among the treatments. The soil was sandy loam in nature (sand 63.6%, silt 25.7%, and clay 10.7%), low to medium in alkaline, low to medium in SOM%, adequate in exchangeable K, and Low in both N&P nutrients Table 1.

Table-1: Before cultivation soil physico-chemical properties.

Treatments	N%	P(mg kg^{-1})	SOM%	C (dSm^{-1})	pH
T_1	0156± 0.003	1533±0.0388	0796±0.007	34±0.015	7.72±0.34
T_2	0184±0.004	1571±0.0329	1338±0.013	39±0.012	7.67±0.39
T_3	0214±0.003	1581±0.0405	0 2063±0.015	36±0.017	7.77± 0.36
T_4	0254±0.003	1577±0.0279	3464±0.016	37± 0.013	7.81±0.37
CV	7.36	3.22	3.74	0.81	5.104

LSD	2.563	0.018	0.025	5.104	0.014
P<0.05	0.0001	0.0000	0.0000	0.0000	0.0000

N (nitrogen), P (phosphorous), SOM (soil organic matter), EC (electrical conductivity) of the soil properties before sowing, mean values with standard errors, the triplicate analysis results indicated the non-significant ($p<0.05$)

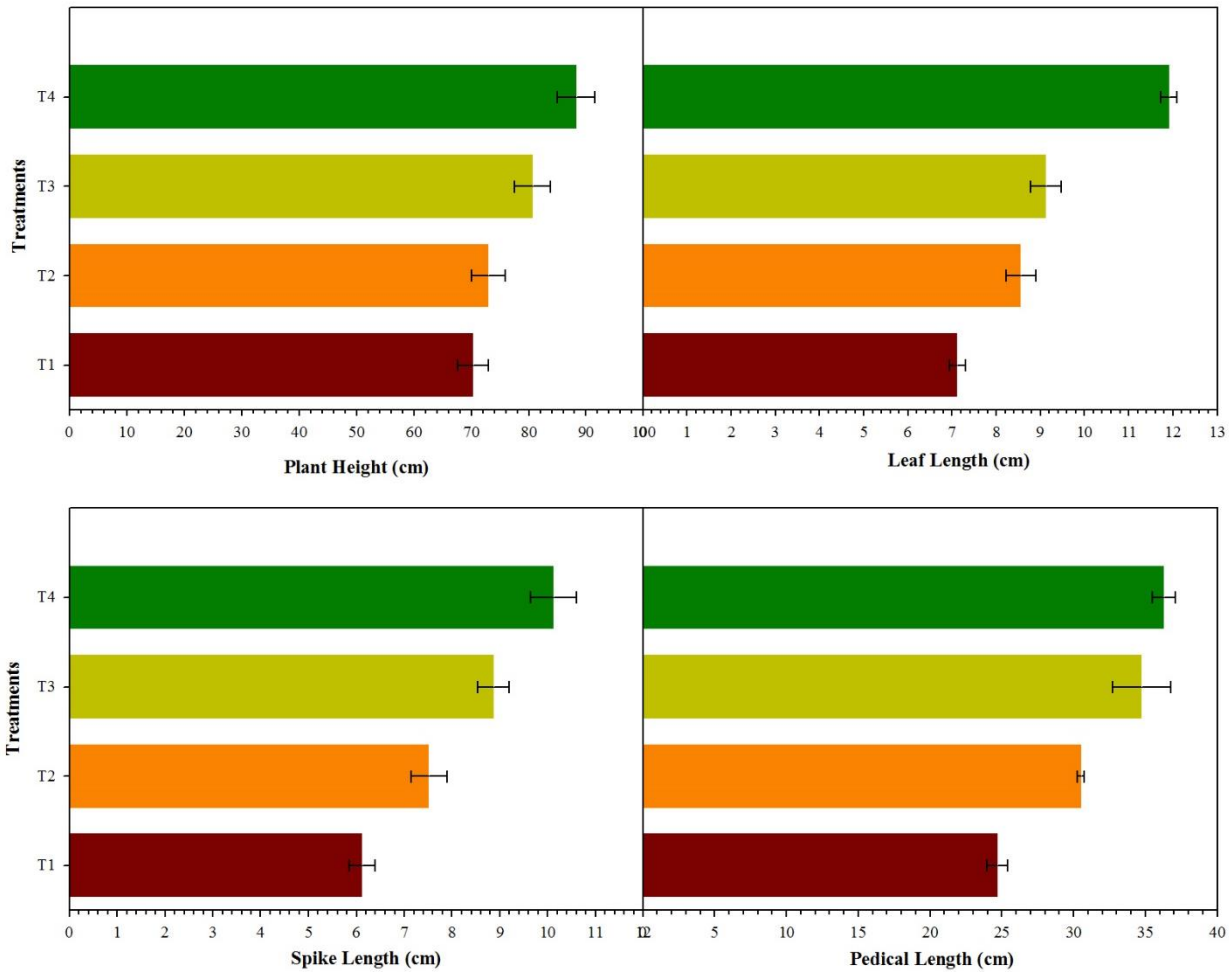


Fig. 1: Estimate the effect of the combined application of both N&P fertilizers on growth parameters of wheat, the mean of triplicates with standard error, results are significant (p<0.05).

Effect of N&P Combined Application on Physiological Growth Parameters: Figure 1 presents the effect of the combined application of N&P on plant height, leaf length, pedicle length, and spike length (cm). Among the all treatments mean maximum plant height (cm), leaf length (cm), pedicle length, and spike length (cm) mean maximum were recorded in T_4 (88.312±3.23cm, 11.91±0.17cm, 36.3±0.80cm and 10.12±0.48cm) respectively and minimum were recorded in T_1 (70.66±2.66cm, 7.12±0.17cm, 24.7±0.70cm and 6.12±0.27cm) respectively, this was followed by the combine application of N&P 90&30kgha^{-1}.

Leaf length and spike length an important parameter in wheat crop growth and yield. Because leaves play a major role in the formation of chlorophyll during the process of photosynthesis. At maturity of the crop (120days after sowing) analysis results of both leaf length and spike length of both combined applications of fertilizers were recorded and results showed that with increasing doses of N&P applications in both parameters leaf length and spike length were also improved Figure 1 mean maximum were recorded in T_4 whereas the minimum was recorded in control T_1. In contrast to T_2 and T_1, non-significant results were recorded; however, in comparison to T_1 and T_4, a significant difference was recorded ($p<0.05$) Figure 1.

Combine Application of N&P Effect on the Availability of N and P (%): The results of the N&P content of plant leaves are presented in Figure 2. Results showed the mean maximum up take of both applications of fertilizers by the plant in T_4 (1.673±0.038% and 0.278±0.059%) in comparison to other treatments Figure 2; Moreover in comparison

of T_1 and T_2 (0.54±0.021, 0.25±0.038%, 1.2003±0.025% 0.249±0.0329% and 1.3±0.0251, 0.276±0.0405%) a minor difference were recorded, whereas as in comparison of T_1 and T_3 a significant difference was recorded ($P<0.05$).

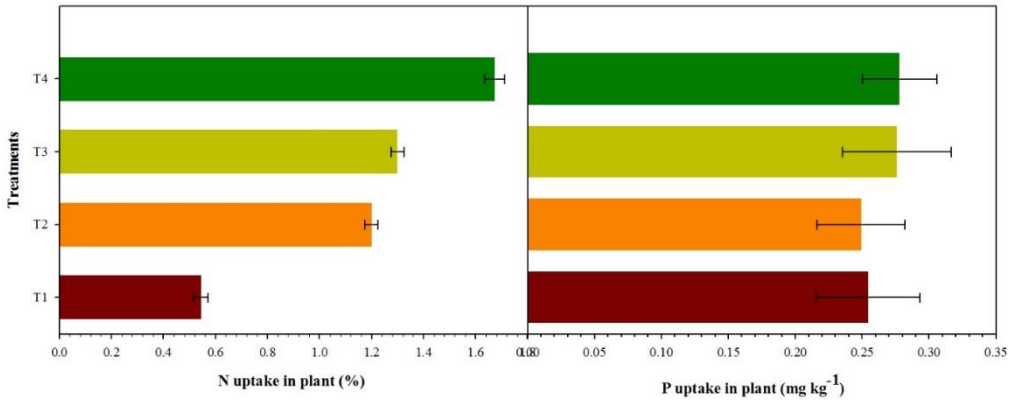


Fig. 2: Estimate the effect of combined application of both N&P fertilizers on nitrogen and phosphorous up taken by plant, the mean of triplicates with standard error, results are significant ($p<0.05$)

Combined Applications of N&P Effect on Yield Attributes: Biological ($kgha^{-1}$), 1000 grain weight (g), and spike yield results are present in Figure 3. Results showed that there was a significant difference in the combined application of both fertilizers among the treatments ($P<0.05$). Mean maximum were recorded in T_4 (20.441±0.9226, 47.5045±1.1443 and 2.8±0.0155) compared to all other treatments T_1, T_2 and T_3 (10.2313±0.319, 36.5163±1.4948, 1.0167±0.0458, 11.5627±0.3233, 42.7349±1.5913, 1.83±0.0644, 15.62±1.1087, 43.4405±0.5628 and 2.05±0.0456) Biological, grain and spike yield respectively Figure 3. Moreover, mean minimum was recorded in T_1 (10.2313±0.319, 36.5163±1.4948 and 1.0167±0.0458) in all three parameters; Biological, 10000 grain weight, and spike yield respectively (Figure 3). Agronomic observations are significant ($P<0.05$) under maximum applications of both fertilizers T_4 compared to other treatments.

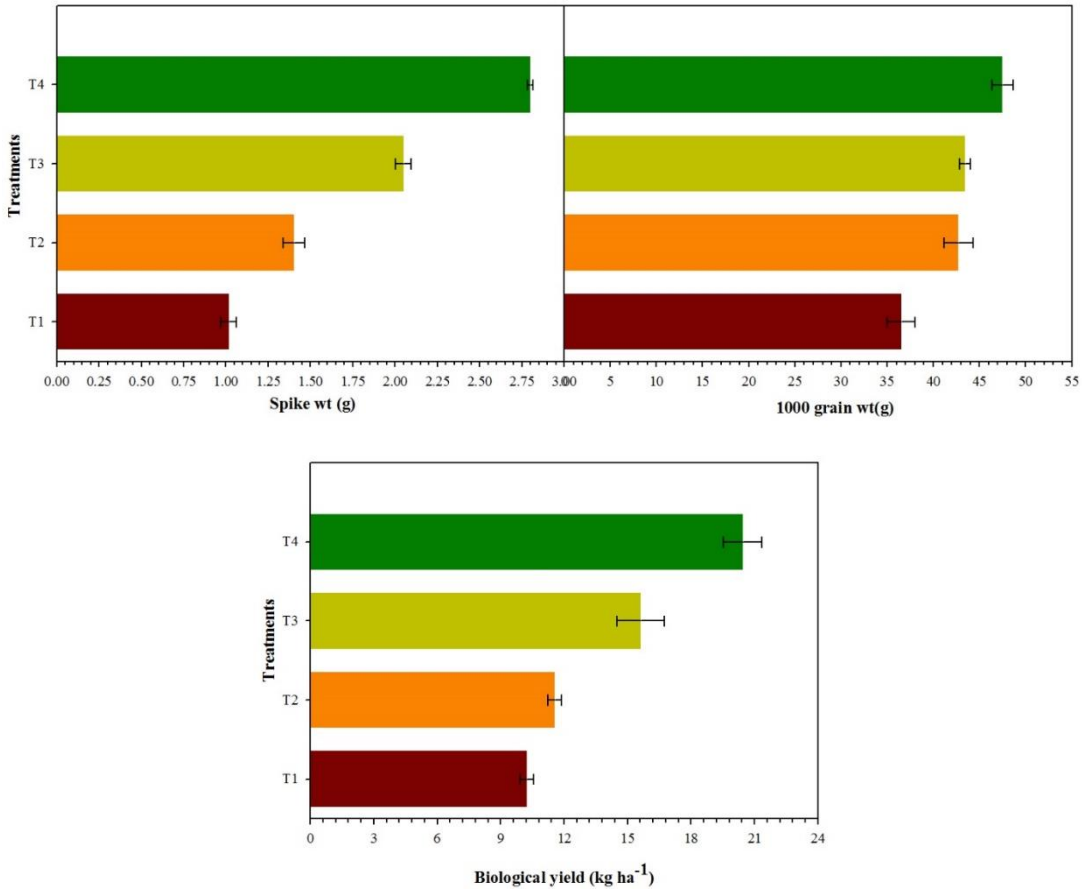


Fig. 3: Combined application of both N&P fertilizers effect on biological and grain yield of wheat, presented results are in the mean of triplicates with standard error, results are significant ($p<0.05$).

Effect of Combine Application of N&P Fertilizer on Root Biomass: Plant roots are the main sources of water and nutrients from the soil. The analysis results of soil organic matter (%) root biomass (g) fresh and dry root biomass are present in Figure 4. Results showed that the mean maximum was recorded in T_4 (0.8464±0.0156, 10.7±0.1528, and 6.611±0.0511) of both the combined application of N&P fertilizers (Figure 4). Compared to others in both parameters root biomass and soil organic matter, whereas the minimum was recorded in control T_1 (0.2961±0.015, 4.9349±0.1823 and 0.581±0.0757) Figure 4. Furthermore, in comparing T_2 and T_3 (0.3378±0.013, 5.782±0.2467, 1.9903±0.011, 0.4063±0.0155, 6.3±0.2241 and 2.4747±0.1008) a minor difference was also recorded Figure 4. Also, in comparison of both fertilizer applications, the findings of this study are significant ($P<0.05$) under different applications of both fertilizers (Figure 4).

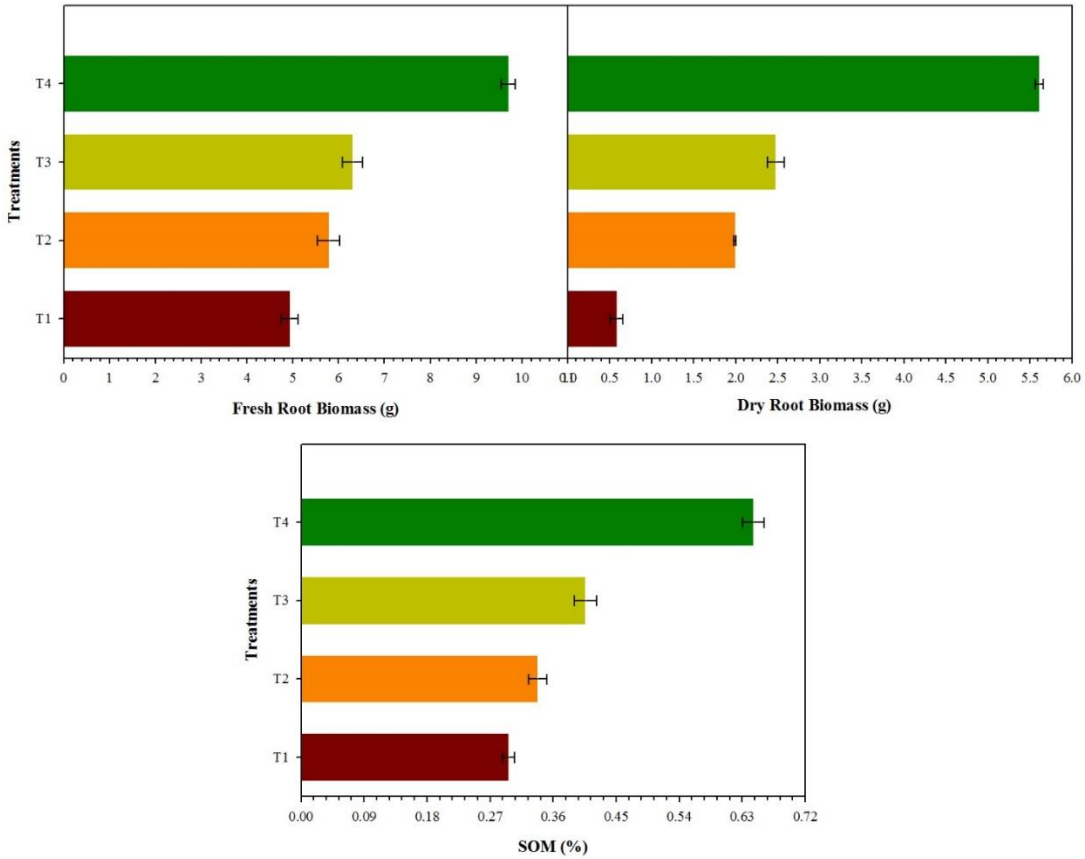


Fig. 4: Combined application of both N&P fertilizers affects fresh and dry root biomass of wheat, presented results are in the mean of triplicates with standard error, results are significant ($p<0.05$).

The soil of district Lasbela commonly are sandy loam in nature wind and water is a common factor of the district. Due to sandy loam in nature, such soil requires an adequate amount of N&P fertilizers to get optimum crop yield and avoid losses. An adequate supply of both N&P applications presents the taller plant, more dry matter due to proper application applications of both fertilizers (N&P) ultimate effect on the biochemical process of crop growth Figure 1. Nitrogen is one of the most essential nutrients for the overall growth of plants and particularly an important component of chlorophyll present on plant leaves, which helps to improve the vertical and lateral growth of crop plants and finally improve plant height, number of leaves, the stem of the plant, spike length, biological and grain yield. On the other side, such type of soil (sandy loam) with minimum application of N&P fertilizers has been recorded as limited height of plant, growth, number of leaves, biological and grain yield Figure 1, the findings of our study are in line with (Kumar *et al*., 2023a; Wang *et al*., 2022; Kubar *et al*., 2021; Yousaf *et al*., 2014; Barthwal *et al*., 2013). Although the observations of biological and grain yield have more effect of combined application of N&P fertilizer in T_4 compared to others T_1, T_2, and T_3 Figure 2, similar findings were also recorded by (Kumar *et al*., 2023a; Kubar *et al*., 2021; Wang *et al*., 2015) that sandy loam soils more N&P, may be due to more drainage and poor to retain soil moisture. Various agronomic observations were conducted to estimate the grain and biological parameters related to yield. The more effective tillers, plant height, and spike/grain were recorded in the T_4 with increased doses of both combined applications of fertilizers Figure 1. Moreover, the Lengthier spike/plant was recorded in higher doses of N&P application Figure 1, this may be due to more uptake of N&P occurring in such treatments compared to others. The findings of our study are also in line with the observations of (Kumar *et al*., 2023a; Rawate *et al*., 2022; kalhoro *et al*., 2019; and Mehta and Bharat, 2019).

SOM and root biomass are the bases for the dynamic of soil. This will improve the health of the standing crop and supply adequate resources of soil micro-organisms that regulate the supply of water, air, and plant nutrients. Organic matter carries ½ half of the N quarter P crops requirement and thus strongly influences fertilizer requirement). Mostly fine root biomass is highly concentrated in the uppermost soil layer where the availability of nutrients (soil fertility), nitrogen, and organic matter, as well as the activity of soil microbial communities, are higher, and fine root biomass decreases with depth, 90% of fine root biomass occurred in the top 30 cm surface layers (kalhoro *et al*., 2018; kalhoro *et al*., 2017; Yuan and Chen, 2012).

Conclusion

Based on present study observations, it is concluded that experimental soil of sandy loam in nature requires more amount of nutrients to achieve an optimum yield of the cultivated crop. Increased application of both N&P fertilizers (@rate of 90 & 45kgha^{-1}) just after the application of irrigation and into three split doses is better compared to traditional and unbalanced application of fertilizer in terms of wheat growth, morphological characteristic and grain and straw yield. This type of application of fertilizers also improves N use efficiency and minimizes losses of nitrogen. The increase in N and P availability in the soil was primarily responsible for the improvement in wheat growth. Thus, nitrogen and phosphorous fertilizers could improve the soil properties and enhance nutrient availability and crop productivity.

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