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Physiological Response and Growth of Wheat Plants (*Triticum aestivum* L.) Variety GURI 6 UNAND with Urea and TSP Fertilizer Doses

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Abstract

Wheat (*Triticum aestivum* L.) is a strategic cereal crop that serves as an important food source and a raw material for the food-processing industry. Wheat production in tropical regions continues to face the challenge of low nutrient-use efficiency, making appropriate fertilization strategies necessary to support plant physiological processes and growth. Nitrogen and phosphorus are essential nutrients that play important roles in chlorophyll formation, energy transfer, vegetative growth, and root development. This study aimed to determine the effects of different combinations of urea and TSP fertilizer doses on the physiological responses and growth of the GURI 6 UNAND wheat variety. The study used a factorial experiment with a completely randomized design and two treatment factors: urea doses (75, 150, and 225 kg/ha) and TSP doses (40, 80, and 120 kg/ha). The parameters measured included total chlorophyll content, nitrogen and phosphorus uptake, flag leaf area, shoot-to-root ratio, and relative growth rate. The results showed a significant interaction between urea and TSP doses for the shoot-to-root ratio and relative growth rate. Applying 225 kg/ha urea resulted in the largest flag leaf area. The highest nitrogen uptake (0.93%) was obtained with the combination of 225 kg/ha urea and 120 kg/ha TSP, while the highest phosphorus uptake (0.85%) was obtained with 150 kg/ha urea and 120 kg/ha TSP. These results indicate that balancing nitrogen and phosphorus not only increases nutrient uptake but also improves the physiological responses of wheat plants under tropical conditions. Based on the results, applying 225 kg/ha urea combined with 120 kg/ha TSP is recommended to improve plant growth and nutrient-use efficiency in the GURI 6 UNAND wheat variety.

Keywords: Chlorophyll, Nitrogen, Phosphorus, Photosynthesis, Plant Metabolism

1. Introduction

Wheat (*Triticum aestivum* L.) is a strategic cereal crop that serves as an important food source and raw material for the food industry. Its gluten content helps provide structure and elasticity to various processed products (Dotto et al., 2025). Wheat consumption in Indonesia continues to increase as people's consumption patterns shift toward wheat-based products such as noodles, bread, and biscuits (H. Sembiring et al., 2016). However, this increase in consumption has not been matched by domestic production, so national wheat needs remain highly dependent on imports. Data from Badan Pusat Statistik (2025) show that Indonesian wheat imports increased from 9.35 million tons

in 2022 to 11.72 million tons in 2024. This trend highlights the importance of developing domestic wheat cultivation to support national food security.

Although wheat is not native to tropical regions, it has been successfully cultivated in several highland areas of Indonesia with agroclimatic conditions suitable for its growth (Nur et al., 2013; Putri et al., 2013). However, wheat production in tropical environments still faces several fundamental challenges, including higher temperatures than those in its native growing areas, limited suitable land, and low nutrient-use efficiency, which can affect plant growth and productivity. In addition to genetic factors, successful wheat production depends greatly on

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appropriate cultivation techniques, particularly fertilizer management that supports optimal physiological processes (Hidayaty et al., 2017). GURI 6 UNAND is a national wheat variety adapted to Indonesia's tropical conditions, with a potential yield of up to 5.3 t/ha (Kementerian Pertanian Republik Indonesia, 2014). Therefore, it has potential for further development through the application of appropriate cultivation technologies.

The growth and development of wheat plants occur through vegetative and generative phases, which are greatly influenced by the availability of essential nutrients, especially nitrogen (N) and phosphorus (P) (Alzain et al., 2023). Nitrogen is a major component of chlorophyll, proteins, and nucleic acids, which play a vital role in photosynthesis, cell division, and vegetative plant growth (Supriatin et al., 2025). Meanwhile, phosphorus plays a role in energy transfer through ATP, root system development, and flower and seed formation (Karpinska et al., 2024). The availability of these two nutrients in the soil is a crucial factor in of effectively plants use them. Therefore, the balance of nitrogen and phosphorus availability is a crucial factor in supporting plant metabolism and growth.

Various studies have shown that nitrogen and phosphorus fertilization can increase the growth and yield of cereal crops. Ibnušina (2013) reported that the application of 150–200 kg/ha of urea increased the weight of 1,000 wheat grains. Yassi et al. (2024) showed that nitrogen fertilization increased chlorophyll content and the number of productive tillers in rice plants. In contrast, Jarallah & Al-Jannaby (2018) reported that TSP application increased straw production and grain number in wheat, while Yusuf (2022) showed that TSP fertilizer increased the growth and yield of rice plants. However, most of these studies evaluated the effects of nitrogen and phosphorus separately or in combination with other types of fertilizers, and focused more on plant growth and yield parameters.

To date, information on the interaction of Urea and TSP fertilizers on the physiological responses of wheat plants remains limited, especially for the GURI 6 UNAND variety developed for tropical conditions in Indonesia. This study aims to determine the effects of various combinations of Urea and TSP fertilizer doses on the physiological responses and growth of wheat plants of the GURI 6 UNAND variety, to provide scientific information on more effective nitrogen and phosphorus management to support the development of wheat cultivation in tropical environments.

2. Material and Methods

This research was conducted from September to December 2025 in Nagari Alahan Panjang, Solok Regency, West Sumatra, located at coordinates of approximately 1°04'22" South Latitude and 100°46'59" East Longitude with an altitude of approximately 1,616 m above sea level. Observations and analyses were conducted at the

Agronomy Laboratory of Andalas University and PT Wiwiadi Bintang Sains, Limau Manis, Padang. The materials used in this research included wheat seeds of the GURI 6 UNAND variety, manure, dolomite, inorganic fertilizers consisting of Urea, TSP, and KCl, fungicides, insecticides, and various laboratory chemicals such as 80% acetone, concentrated H_2SO_4 , and standard solutions of N and P. The equipment used includes cultivation tools in the field and in the laboratory, including a UV-Vis spectrophotometer and an Atomic Absorption Spectrophotometer (AAS) used for the purpose of analyzing plant nutrient content.

This study was a factorial experiment arranged in a Completely Randomized Design with two factors: Urea dosage (75, 150, and 225 kg/ha) and TSP dosage (40, 80, and 120 kg/ha). Nine treatment combinations with three replications resulted in a total of 27 experimental units. Each experimental plot measured 2 m × 1.5 m, consisting of six rows of 1.4 m in length and 30 cm between rows.

The stages of the research implementation included initial soil analysis, land preparation, seed planting, fertilization, and regular plant maintenance. The first stage of fertilization was carried out at 2 WAP by applying $\frac{1}{3}$ of the Urea dose, as well as the entire dose of TSP and KCl. We applied the remaining $\frac{2}{3}$ of the Urea dose at 4 WAP as the second stage of fertilization. We analyzed nutrient absorption data descriptively. In contrast, we analyzed other variables using the F test at a significance level of 5%. If the effect was significant, we continued with Duncan's Multiple Range Test. Data analysis was done using Statistical Tool for Agriculture Research (STAR)® Software. The implementation of the research is presented in the following flow diagram (Figure 1).

3. Results and Discussion

3.1. Total Chlorophyll Content

Analysis of variance showed that the interaction and individual effects of Urea and TSP fertilizer doses did not significantly affect the total chlorophyll content of wheat plants of the GURI 6 UNAND variety. Table 1 presents data on total chlorophyll content in each treatment are presented in Table 1.

The administration of several doses of Urea fertilizer had no significant effect on the total chlorophyll content of wheat variety GURI 6 UNAND. However, there was a quantitative tendency to increase with increasing doses. This indicates that chlorophyll synthesis depends not only on nitrogen but also on other essential elements such as Mg, C, H, and O, which are components of the chlorophyll molecule (Willstätter and Stoll, 1913). However, nitrogen plays an important role in chlorophyll synthesis because increasing leaf nitrogen levels are positively correlated with chlorophyll content and plant photosynthetic capacity (Lambers et al., 2019). This can be seen from the tendency for increasing chlorophyll levels in line with the increase in

flag leaf area in the Urea dose treatment of 255 kg/ha (Table 2), which indicates that sufficient nitrogen can increase photosynthetic capacity by optimizing leaf area

and physiological quality (Gardner et al., 1985; Zhang et al., 2024).

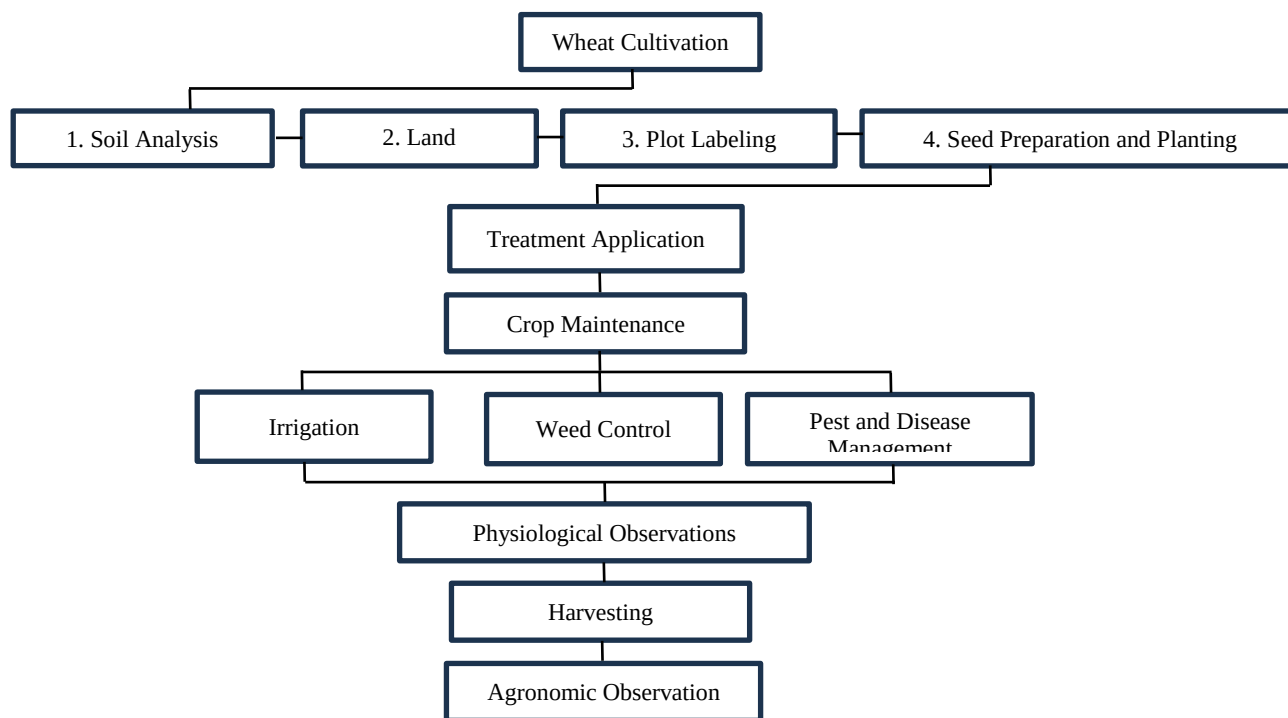


Figure 1. Research flow diagram.

Table 1. Total chlorophyll content of GURI 6 UNAND wheat variety with several doses of Urea and TSP fertilizer at 50 HST

Urea Dosage (kg/ha)	TSP dose (kg/ha)		
	40	80	120
	-----mg/ml-----		
75	5.82 ± 2.32	5.94 ± 0.25	5.96 ± 1.36
150	5.81 ± 1.33	6.09 ± 0.69	6.98 ± 1.12
225	6.45 ± 1.38	7.67 ± 1.26	7.68 ± 1.82
KK	21.53%		

Description: The numbers in the same column and row are not significantly different according to the DMRT test at the $\alpha = 5\%$ level.

TSP fertilizer also showed a trend toward increased chlorophyll levels, although this was not statistically significant. Phosphorus in TSP fertilizer is not directly involved in chlorophyll formation, but in supports energy transfer via ATP, which supports photosynthesis and plant metabolism (Lambers et al., 2019). Therefore, increasing the TSP dose is thought to contribute indirectly to chlorophyll content through increasing the efficiency of energy metabolism.

Soil conditions also influence plant response to fertilization. A relatively low initial soil total N content (0.17%) is thought to limit chlorophyll synthesis in the early growth phase. These results align with reports by Oner (2024) that increasing nitrogen doses up to 100 kg N/ha can improve chlorophyll content and physiological performance of wheat. Furthermore, Fageria et al. (2010) suggest that the efficiency of chlorophyll formation is

determined by nutrient balance and soil reactions, which control plant metabolism.

3.2. Analysis of N and P nutrients in wheat plants

The results of the observations showed variations in the absorption values of nitrogen (N) and phosphorus (P) in various combinations of Urea and TSP fertilizer doses, indicating that the availability of these two macronutrients affected the nutrient absorption capacity of the GURI 6 UNAND wheat variety.

Figure 2 shows that the highest nitrogen uptake was obtained from the combination of 225 kg/ha of Urea and 120 kg/ha of TSP at 0.93%. In general, increasing the dose of Urea is followed by an increase in plant nitrogen uptake, indicating that nitrogen availability in the soil plays an important role in plants' capacity of nitrogen uptake. The higher the nitrogen concentration in the soil solution, the

greater the concentration gradient between the soil and the root tissue, so that nitrogen uptake takes place more optimally (Liu et al., 2025). In addition to being influenced by the availability of nitrogen in the soil, plant N uptake is also determined by the efficiency of the utilization of the given nitrogen fertilizer. Khairuddin et al. (2024) reported that increasing the efficiency of nitrogen fertilization can increase plant N uptake by reducing nitrogen loss and increasing N availability in the soil.

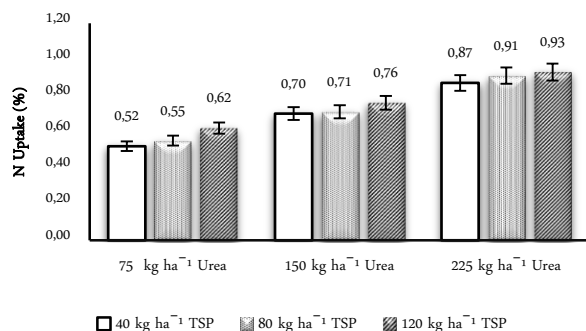


Figure 2. Nitrogen (N) uptake of wheat plants of the GURI 6 UNAND variety in various combinations of Urea and TSP fertilizer doses at 50 days after planting (DAP)

This increased nitrogen uptake further supports vegetative growth and plant photosynthesis. This is in line with reports by Belete et al. (2018) and Pusparini et al. (2018) that increasing nitrogen fertilizer doses can increase nitrogen uptake and plant yields. This is reinforced by the opinion of Damanhuri et al. (2022) reinforce this, reporting that increased nitrogen availability is positively correlated with chlorophyll content and photosynthetic rate, thereby supporting biomass accumulation and plant nutrient uptake.

Nitrogen uptake is also influenced by the availability of phosphorus through the application of TSP fertilizer. At each level of Urea dosage, increasing the TSP dosage tends to increase nitrogen uptake, which reflects the synergistic relationship between nitrogen and phosphorus in increasing the efficiency of nutrient uptake (Kabato et al., 2022). Physiologically, nitrogen uptake is an active process that requires energy in the form of ATP. At the same time, phosphorus is a major component of ATP, supporting the activity of transport proteins in the root membrane in enabling more efficient nitrogen absorption (Marschner, 2012). In addition, phosphorus stimulates the development of the root system, thereby expanding the root absorption area and increasing the plant's nutrient uptake capacity (Damanhuri et al., 2022; Choi et al., 2025).

The high nitrogen uptake of the combination of 225 kg/ha of urea and 120 kg/ha of TSP indicates that the optimum response is achieved when nitrogen and phosphorus are available in high amounts. The synergistic interaction of these two elements increases the efficiency of nutrient uptake and overall plant metabolism. The results of

this study are in line with findings by Xia et al. (2023) that reported that the addition of phosphorus can increase plant nitrogen uptake by an average of 18% in various ecosystems through increased soil microbial activity. In this study, increasing the TSP dose from 40 to 120 kg/ha at a dose of 225 kg/ha of urea increased nitrogen uptake from 0.78% to 0.93%, or an increase of approximately 19.2%, thus indicating a similar response pattern. In addition, Xue et al. (2014) reported that proper nitrogen management can improve root system development and nutrient uptake efficiency in wheat. The results of this study indicate that the combination of nitrogen and phosphorus fertilization provides a better response than single applications because the two elements work synergistically to support plant growth and metabolism.

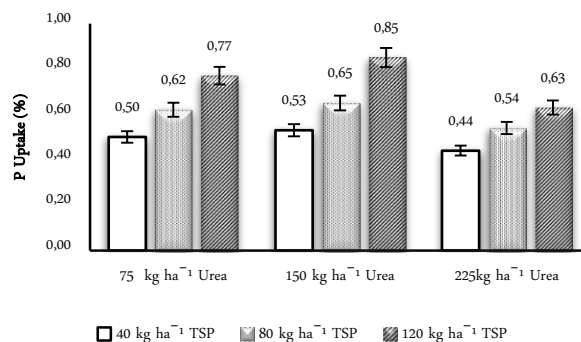


Figure 3. Phosphorus (P) absorption of wheat variety GURI 6 UNAND at various doses of Urea and TSP fertilizer at 50 days after planting (DAP)

Figure 3 shows that phosphorus (P) uptake by wheat plants of the GURI 6 UNAND variety increased with the addition of TSP doses, at Urea levels of 75 and 150 kg/ha. This indicates that the availability of phosphorus in the soil is a determining factor in the capacity of P absorption by plants. Phosphorus plays an important role in the formation of ATP, nucleic acids, and cell membrane phospholipids that support metabolism and plant root development (Taiz et al., 2015). Phosphorus availability encourages root system proliferation, increasing root absorption area and nutrient absorption efficiency. These results are in line with Sembiring et al. (2020), who showed that increasing nutrient availability through the application of dolomite and slow-release NPK fertilizer can improve root growth and plant physiological responses, thereby supporting more efficient nutrient utilization.

Nitrogen also contributes to increased phosphorus uptake by stimulating vegetative growth and expanding the root system, which expands the root exploration zone in absorbing nutrients (Hawkesford et al., 2012; Senevirathna et al., 2024). The synergistic relationship between nitrogen and phosphorus is reflected in increased P uptake under conditions of nitrogen sufficiency, because adequate nitrogen availability can optimize plant metabolic activity

so that phosphorus absorption takes place more efficiently (Asrijal dan Upe, 2018).

In contrast, at the highest nitrogen dose (225 kg/ha), phosphorus uptake tends to decrease even though the TSP dose increases. This condition is thought to be the impact of nutrient imbalance that causes nutrient dilution (*nutrient dilution effect*), namely when the rate of biomass accumulation exceeds the rate of phosphorus absorption so that the P concentration in plant tissue decreases (Marschner, 2012). In addition, the application of Urea through the nitrification process produces H^+ ions, which have the potential to lower soil pH, thereby stimulating phosphorus fixation by Al and Fe, which form insoluble compounds that are not available to plants (Wang et al., 2024; Farooqi et al., 2025). In these conditions, the accumulation of nitrate (NO_3^-) in high concentrations can also trigger ion competition in the root membrane, which inhibits phosphate absorption (Chen et al., 2023; Hao et al., 2023).

The phosphorus uptake response in this study is thought to be influenced by the initial soil characteristics at the study site. The soil's relatively low total N content (0.17%) indicates a need to increase in the Urea dose to optimize nitrogen availability for plants. Meanwhile, the available P content is in the moderate category (9.51 ppm) with a slightly acidic soil pH (5.78), which has the potential to cause some phosphorus to be fixed by Al and Fe, so that

the efficiency of phosphorus uptake is limited and an increase in the TSP dose is needed to maintain phosphorus availability in the soil. The combination of Urea 150 kg/ha and TSP 120 kg/ha in this study resulted in the highest phosphorus uptake (0.85%), indicating that the availability of balanced nitrogen and phosphorus can increase the efficiency of nutrient utilization by plants. These results are in line with Kabato et al. (2022), who report that the application of a combination of nitrogen and phosphorus increases phosphorus uptake in wheat plants by 22.8% compared to no fertilization, and increases the efficiency of nutrient utilization through improved root growth. Senevirathna et al. (2024) reported similar findings, showing that increased nitrogen availability increased phosphorus uptake by up to 18.6% by stimulating root growth and nutrient transport activity. Thus, the balance of nitrogen and phosphorus plays a crucial role in increasing phosphorus uptake efficiency by optimizing root activity and plant nutrient uptake mechanisms.

3.3. Flag Leaf Area

Analysis of variance showed no significant interaction. A single dose of urea fertilizer significantly affected flag leaf area, while TSP fertilizer did not significantly affect flag leaf area. Table 2 presents flag leaf area for each treatment.

Table 2. Flag leaf area of wheat variety GURI 6 UNAND with several doses of Urea and TSP fertilizer at 8 Weeks After Planting (MST)

Urea Dosage (kg/ha)	TSP dose (kg/ha)			Average
	40	80	120	
	-----cm ² -----			
75	23.11	23.17	26.59	24.29 ± 5.22 c
150	34.12	34.86	35.37	34.79 ± 3.00 b
225	38.72	40.81	46.39	41.98 ± 5.06 a
Average	31.98 ± 7.29	32.95 ± 8.42	36.12 ± 10.26	
KK	13.53%			

Description: Numbers in the same column followed by the same lowercase letter are not significantly different according to the DMRT test at the $\alpha = 5\%$ level.

Table 2 shows that a urea dose of 225 kg/ha produced the highest flag leaf area (41.98 cm²), significantly different from other doses. Adequate nitrogen stimulates vegetative growth by increasing chlorophyll synthesis, which optimizes photosynthetic capacity and encourages plant cell division, enlargement, and elongation. (Hakim et al., 1986; Taiz et al., 2015). Flag leaves are the main photosynthetic organs that contribute about 50–60% to the daily photosynthesis of plants, and their loss can reduce yields by up to 40% depending on the variety. (Towfiq et al., 2015; Racz et al., 2022) Although nitrogen is the dominant factor, phosphorus still plays a role in supporting photosynthesis through the formation of ATP and NADPH for energy transfer, carbohydrate synthesis, and enzyme activity that supports cell division. (Mahendra et al., 2020; Kayoumu et al., 2023) Phosphorus also maintains the stability of

photosynthesis by regulating electron transport and CO₂ fixation. (Fathi dan Afra, 2023).

The apparent response to Urea fertilization in this study was related to the initial soil fertility conditions, where the relatively low total N content (0.17%) made nitrogen the main limiting factor for vegetative growth. In contrast, the available P content in the moderate category (9.51 ppm) was not yet a significant limiting factor for leaf growth. This is in line with Houlton et al. (2018), who asserted that nitrogen limitation is the main factor controlling plant productivity—in this study, increasing the Urea dose from 75 kg/ha to 225 kg/ha increased flag leaf area from 24.29 cm² to 41.98 cm², an increase of 72.8%. This increase indicates that higher nitrogen availability encourages the formation and expansion of leaf tissue through increased chlorophyll synthesis and photosynthetic

activity. This result is in line with research by Oner (2024), which reported that increasing the nitrogen dose from 0 to 100 kg N/ha increased the flag leaf area of wheat from 25.31 cm² to 30.75 cm² or an increase of 21.5%, where the increase in flag leaf area contributed to increasing photosynthetic efficiency and wheat grain yield, thus indicating that nitrogen sufficiency is an important factor in supporting vegetative growth and productivity of wheat

plants.

3.4. Root Crown Ratio

Analysis of variance showed a significant interaction between the doses of urea and TSP fertilizers on the shoot-root ratio of wheat plants of the GURI 6 UNAND variety. Table 3 presents the shoot-root ratio for each treatment combination.

Table 3. Shoot-root ratio of wheat plants of the GURI 6 UNAND variety in various combinations of Urea and TSP fertilizer doses at 8 weeks after planting (MST)

Urea Dosage (kg/ha)	TSP dose (kg/ha)		
	40	80	120
	-----g/week-----		
75	5.23 ± 0.02 A c	5.16 ± 0.02 B c	5.1 ± 70.01 AB c
150	6.06 ± 0.01 A b	5.46 ± 0.08 B b	5.27 ± 0.06 C b
225	7.04 ± 0.02 A a	6.69 ± 0.03 B a	6.41 ± 0.03 C a
KK	10.66%		

Description: Numbers in the same row followed by capital letters and numbers in the same column followed by the same lowercase letters are not significantly different according to the DMRT test at the $\alpha = 5\%$ level.

Table 3 shows that increasing the urea dose at each TSP level tends to increase the shoot-root ratio of GURI 6 UNAND wheat variety at 8 WAP. Conversely, increasing the TSP dose at each Urea level tends to decrease the shoot-root ratio. Physiologically, nitrogen plays an important role in supporting shoot growth of forming chlorophyll, amino acids, and proteins that support photosynthesis and the accumulation of vegetative tissue (Xu et al., 2012). Thus increasing leaf area and biomass allocation to the crown (Chen et al., 2024; Zhang et al., 2024). In line with the concept of biomass allocation proposed by Poorter *et al.* (2012), that plants allocate assimilates to organs that are most responsive to nutrient availability. Conversely, increasing TSP doses tend to decrease the shoot-root ratio because phosphorus stimulates the development of root meristem tissue (Ajmera et al., 2019). Optimal phosphorus availability allows for an increase in length, surface area, volume, and number of root tips so that the proportion of root biomass increases (He et al., 2019; Liu et al., 2024). Xue et al. (2014) reinforced this, finding that increasing nitrogen in wheat increases shoot biomass and the shoot-root ratio.

The interaction of nitrogen and phosphorus shows a synergistic relationship with different directions of influence on plant biomass distribution. Under conditions of high nitrogen and relatively low phosphorus, biomass allocation is more dominant to the crown, resulting in an increased crown-root ratio. Whereas under conditions of high phosphorus, root growth is more stimulated to optimize nutrient absorption, resulting in a decreased crown-root ratio. These results are consistent with Lv et al. (2025), who reported that increasing nitrogen doses in winter wheat increased nitrogen accumulation in the crown

by 31.7–39.4% compared to l-nitrogen treatments, followed by an increase in biomass allocation to the crown. Conversely, Shen et al. (2018) showed that increasing plant phosphorus status to a crown P concentration of approximately 3.0 mg g⁻¹ increased root biomass from 0.15 g to 0.45 g per pot and total root length from 26.3 m to over 60 m per pot. These findings indicate that high nitrogen availability tends to direct biomass accumulation to the crown. In contrast, increased phosphorus availability stimulates root system development, resulting in a higher crown-to-root ratio under high nitrogen conditions and a lower one under high phosphorus conditions.

3.5. Relative Growth Rate

Analysis of variance showed a significant interaction between the doses of Urea and TSP fertilizers on the relative growth rate of wheat plants of the GURI 6 UNAND variety. Table 4 presents the relative growth rate for each treatment combination.

Table 4 shows that increasing the urea dose at each TSP level tends to increase the relative growth rate of wheat variety GURI 6 UNAND at 8 WAP. Conversely, increasing the TSP dose at each urea level tends to decrease the relative growth rate. The increase in LTR due to nitrogen application is related to its role in increasing chlorophyll formation, leaf area, and photosynthetic capacity of plants. These results are in line with research by Guo et al. (2019) reporting that increasing the availability of nitrogen in the form of nitrate significantly increases the biomass of roots, stems, leaves, and panicles of wheat, while nitrogen deficiency causes a decrease in leaf biomass of up to 53% and stem biomass of up to 54% compared to optimum nitrogen conditions. In addition, Noor et al. (2023)

reported that increasing the nitrogen dose from 0 to 210 kg ha⁻¹ significantly increased the photosynthetic capacity of flag leaves and wheat yield. Phosphorus also supports the effectiveness of nitrogen utilization by providing energy in the form of ATP, which is needed for the process of nitrogen assimilation, protein synthesis, and new tissue growth, so that the balance of nitrogen and phosphorus

availability is an important factor in determining the growth rate of wheat plants (Taiz et al., 2015; Grant et al., 2000). However, increasing the TSP dose from 40 to 120 kg/ha at the level of Urea 225 kg/ha actually reduces the LTR from 0.66 to 0.57 g/week, which indicates a nutrient imbalance that inhibits the efficiency of nitrogen absorption and relative plant growth (Arzu et al., 2024).

Table 16 UNAND variety in various combinations of Urea and TSP fertilizer doses at 8 weeks after planting (MST)

Urea Dosage (kg/ha)	TSP dose (kg/ha)		
	40	80	120
	-----g/g/week-----		
75	0.57 ± 0.04 A b	0.53 ± 0.02 A c	0.45 ± 0.01 B c
150	0.62 ± 0.01 A ab	0.57 ± 0.04 AB b	0.51 ± 0.03 B b
225	0.66 ± 0.02 A a	0.62 ± 0.01 A a	0.57 ± 0.04 A a
KK	5.68%		

Description: Numbers in the same row followed by capital letters and numbers in the same column followed by the same lowercase letters are not significantly different according to the DMRT test at the $\alpha = 5\%$ level.

The decrease in LTR at higher phosphorus doses relates to biomass allocation, whereby plants allocate carbon to the organs most responsive to nutrient availability (Poorter et al., 2012). Under conditions of high nitrogen and low phosphorus, assimilates are predominantly allocated to the shoot, increasing photosynthetic capacity and LTR. In contrast, higher phosphorus promotes biomass investment in the root system, reducing the proportion allocated of shoot growth. Thus, nitrogen plays a role in accelerating biomass accumulation by optimizing photosynthesis, while phosphorus supports energy metabolism and root development. The balance between these two nutrients is therefore a determining factor in

optimizing wheat plant growth.

4. Conclusion

Urea and TSP fertilizer applications affected the physiological responses and growth of wheat plants of the GURI 6 UNAND variety. The interaction between the two fertilizers significantly affected the shoot-to-root ratio and relative growth rate. A urea dose of 225 kg ha⁻¹ produced the best response, as indicated by increases in flag leaf area, total chlorophyll content, and nitrogen and phosphorus uptake. Therefore, this dose is recommended to support the growth of the GURI 6 UNAND wheat variety under similar agroecological conditions.

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