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Interactive Effect Of Weedicide And Nitrogen Fertilizer Sources On The Growth And Yield Of Wheat

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ABSTRACT

Weedicides play a vital role in modern crop production by controlling weeds and improving yield potential. However, their application may cause environmental concerns and can interfere with soil–plant nutrient interactions, which may reduce nutrient availability and crop performance. Effective management of nitrogen fertilizer sources and appropriate timing of weedicide application are therefore essential to minimize these negative effects while ensuring efficient weed control. A field experiment was conducted at the Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, to evaluate the interactive effects of nitrogen fertilizer sources and weedicide application timing on the growth and yield of wheat. Two nitrogen fertilizer combinations were compared: urea + DAP & SoP and CAN + NP & SoP. The weedicide Atlantis was applied at three stages: before, with, and after

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nitrogen fertilizer application. Recommended doses of N-P-K (120-80-60 kg ha^{-1}) and weedicide (150 g $acre^{-1}$) were applied uniformly. The results indicated that weedicide application after the second dose of CAN in the CAN + NP & SoP combination produced superior results. This treatment significantly enhanced plant height, chlorophyll content, grain yield, and nutrient uptake compared to other treatments. The study concludes that proper selection of nitrogen fertilizer sources along with suitable timing of weedicide application can effectively reduce adverse impacts on crops and help achieve optimum wheat yield and quality.

INTRODUCTION

Wheat (Triticum aestivum L.) is the principal staple food crop of Pakistan and plays a vital role in ensuring national food security and sustaining rural livelihoods. It is cultivated on about 8.5 million hectares with an annual production of nearly 21 million tons. Wheat, along with rice, contributes almost 80 percent of the total cereal production of the country and provides food and employment to a large proportion of the population (Sendhil et al., 2022). Rapid population growth has created continuous pressure to increase agricultural production. Despite increased use of agricultural inputs, the productivity of wheat has not improved substantially in recent years, resulting in higher production costs and reduced profitability (Islam et al., 2023). A significant gap still exists between the potential and actual yield of wheat due to various agronomic, environmental, and management limitations.

Under the present agricultural conditions, further expansion of cultivated land is not feasible. Excessive reliance on synthetic fertilizers, pesticides, and intensive irrigation has begun to negatively affect soil health and environmental quality (Zaib et al., 2023). Continuous and unbalanced use of chemical inputs deteriorates soil physical and chemical properties, reduces biological activity, and threatens the long-term sustainability of crop production systems (Zubair et al., 2023). Therefore, improving input use efficiency and adopting better crop management practices are essential to enhance wheat productivity in an economically and environmentally sustainable manner.

Among the factors responsible for yield reduction in wheat, weed infestation is considered one of the most serious constraints. Weeds compete strongly with wheat for nutrients, water, light, and space, leading to poor crop growth and substantial yield losses (Chaudhary et al., 2022). Depending on weed species, density, and management practices, yield losses in wheat may range from 20 to 40 percent and may be even higher under severe infestation (Minhas et al., 2023). Weeds also reduce the quality of produce, interfere with harvesting operations, and increase the overall cost of production (Zaib et al., 2023). In addition, weeds may exert allelopathic effects, serve as alternate hosts for pests and diseases, and create favorable conditions for the spread of pathogens.

Traditional weed control methods such as hand weeding, hoeing, and cultural practices are labor intensive, time consuming, and often impractical under modern intensive cropping systems. Rising labor costs and difficulty in identifying weeds at early growth stages further limit the effectiveness of these methods. Consequently, chemical weed control through herbicides has become an important and reliable option for timely and efficient weed management in wheat (Zaib et al., 2023). Proper

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use of suitable herbicides can significantly reduce weed competition and improve crop yield. However, inappropriate selection or timing of herbicide application may adversely affect crop growth and soil health (Parven et al., 2025). Therefore, careful selection of herbicide type, dose, and application timing is essential for effective weed management.

Nitrogen fertilization is another critical factor influencing wheat productivity. Nitrogen is a major component of chlorophyll and proteins and is essential for vegetative growth and grain development. Although nitrogen fertilizers are widely used to enhance crop yield, their efficiency is generally low (Zaib et al., 2023). A considerable portion of applied nitrogen is lost through leaching, volatilization, and denitrification, which reduces fertilizer use efficiency and causes environmental problems. Farmers often apply excessive nitrogen with the expectation of higher yields, but this practice increases production costs without proportionate benefits.

Weed management and nitrogen nutrition are closely interrelated. Higher soil fertility and increased nitrogen availability stimulate the growth of both crop plants and weeds (Li et al., 2025). If weeds are not effectively controlled, they utilize a large share of applied nitrogen, reducing its availability to the crop (Zaib et al., 2023). Research has shown that effective weed control can markedly improve nitrogen use efficiency and enhance wheat performance. Integration of appropriate nitrogen fertilizer sources with timely herbicide application has been reported to reduce weed biomass, improve nutrient uptake, and increase grain yield.

Integrated Weed Management approaches that combine chemical and nutrient management practices are considered sustainable strategies for improving wheat productivity. However, the response of wheat to different combinations of herbicides and nitrogen sources varies under different agro-ecological conditions (Mir et al., 2023). Information regarding the interactive effects of weedicide application and nitrogen management under local conditions of Pakistan is still limited. Understanding these interactions is essential for developing economically viable and environmentally sound recommendations.

Considering the importance of wheat for food security, the growing problem of weed infestation, and the need for efficient nitrogen utilization, the present study was planned with the following objectives: i) To evaluate the interactive effect of nitrogen fertilizer sources and weedicide on the growth and yield of wheat. ii)To determine the appropriate time of application of weedicide and nitrogen fertilizer sources for achieving maximum wheat productivity.

MATERIALS AND METHODS

A field experiment was conducted at the research area of the Institute of Soil and Environmental Sciences, University of Agriculture Faisalabad, to evaluate the interactive effects of nitrogen fertilizer sources and herbicide application timings on the growth and yield of wheat. The study was arranged in a Randomized Complete Block Design with three replications. The experimental field was properly prepared to obtain a uniform seedbed, and initial soil samples were collected from 0–15 cm depth for analysis. Wheat variety Faisalabad-2008 (Triticum aestivum L.) was sown on 15 November 2017 using a hand drill at a seed rate of 40 kg acre^{-1}. Each plot measured 48 × 30 ft, and recommended agronomic practices were followed throughout the

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growing season. Recommended doses of N–P–K (120–90–60 kg ha^{-1}) were applied to all fertilized treatments, while the control plot received no fertilizer or herbicide. Two fertilizer source combinations were used: urea + DAP + SoP and CAN + NP + SoP. Phosphorus and potassium were applied at sowing, whereas nitrogen was applied in two equal splits at 25 and 45 days after germination. The post-emergence herbicide Atlantis was applied at the recommended rate of 150 g $acre^{-1}$ at three different timings in relation to the second nitrogen application: four days before, at the time of, and five days after nitrogen application. Seven treatments were evaluated, including the control and three herbicide application timings under each fertilizer combination. The crop received five irrigations according to requirements. Data on growth parameters such as plant height, spike length, and chlorophyll content were recorded, while yield attributes including tillers per plant, grains per spike, 1000-grain weight, grain yield, straw yield, and biological yield were measured at maturity. The crop was harvested on 19 April 2018, and the recorded data were statistically analyzed to assess the effects of fertilizer sources and herbicide application timings on wheat performance.

Table 1. Physical and Chemical Properties of Soil

Properties	Units	Readings
Silt	%	27.40
Sand	%	49.03
Clay	%	23.57
Texture/Taxonomic class	Sandy loam/ typic haplocambids	
pHs	-	7.87
CEC	$cmol_c/kg$	13.5
Ece	dS m^{-1}	1.94
Soluble Potassium	me/L	0.04
Organic matter	%	0.78
Saturation percentage	%	29.00
Available Phosphorus	mg kg^{-1} soil	6.10

RESULTS

Plant height

Figure 3.1 illustrates the interactive effect of weedicide application timings and nitrogen fertilizer sources on plant height of wheat. Two fertilizer combinations, CAN+NP and urea+DAP, were compared as described in the methodology. Results showed that the CAN+NP combination produced significantly greater plant height than urea+DAP across all weedicide application timings. Maximum plant height (72 cm) was recorded in treatment T7, where weedicide was applied after the second dose of nitrogen as CAN, whereas the corresponding urea+DAP treatment (T4) produced only 57 cm plant height. Similarly, application of weedicide before the second nitrogen dose resulted in better performance under CAN+NP (T5, 66 cm) compared to urea+DAP (T2, 51 cm). When weedicide was applied with the second nitrogen dose, treatment T6 (CAN+NP) produced 62 cm plant height, which was considerably higher than T3 (urea+DAP) with 43 cm. All treatments significantly improved plant

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height compared to the control (T0), which recorded the lowest value of 34 cm. Overall, the results indicate that both nitrogen fertilizer source and timing of weedicide application significantly influenced wheat growth, and the CAN+NP combination consistently produced superior plant height compared to urea+DAP.

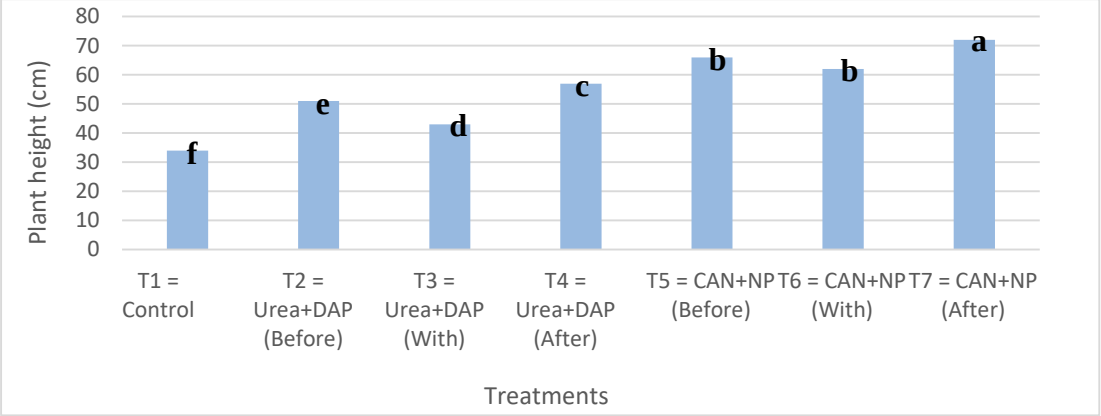

Figure 3.1 Interactive effect of weedicide and N-fertilizer sources on the plant-height (cm) of wheat.

Chlorophyll content

Photosynthesis is the fundamental process through which plants produce food, making them natural food factories. In the presence of chlorophyll, plants synthesize glucose ($C_6H_{12}O_6$) from water and carbon dioxide using light energy, which ultimately enhances plant growth and crop yield. In the present study, chlorophyll content of wheat ranged from 28 to 51. Data presented in Figure 3.2 showed that nitrogen application through the CAN+NP fertilizer combination produced higher chlorophyll content compared to the urea+DAP combination. The highest chlorophyll values were recorded when weedicide was applied after the second dose of nitrogen as CAN. Application of weedicide at different timings in relation to the second nitrogen dose before, with, and after consistently resulted in better chlorophyll content under the CAN+NP combination than under urea+DAP. The results further indicated that applying weedicide after the second nitrogen application was more effective for achieving improved weed control, higher chlorophyll content, and better overall wheat performance**.**

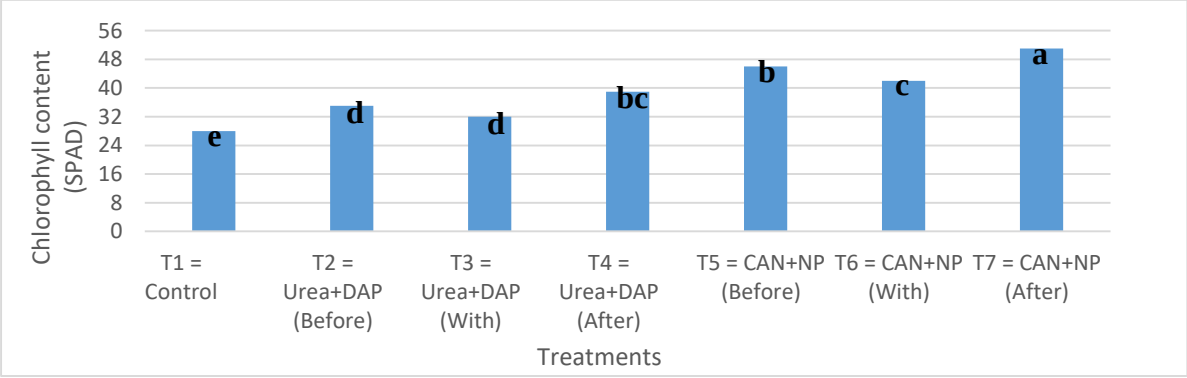

Figure 3.2 Interactive effect of weedicide and nitrogen fertilizer sources on the chlorophyll content of wheat.

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Grain yield

Enhancing wheat grain yield through the interaction of different nitrogen fertilizer sources and weedicide application timings was the main objective of this study. Data presented in Figure 3.3 showed that grain yield was significantly influenced by both fertilizer combination and timing of weedicide application. The highest grain yield (5325 kg ha^{-1}) was recorded in treatment T7, where CAN+NP was used and weedicide was applied after the second nitrogen application. This was followed by treatments T5 and T6 with grain yields of 4912 and 4626 kg ha^{-1}, respectively. Under the urea+DAP combination, the maximum grain yield was obtained in treatment T4 (4507 kg ha^{-1}), followed by T2 and T3 with yields of 4265 and 4193 kg ha^{-1}, respectively. The lowest grain yield (1729 kg ha^{-1}) was observed in the control treatment (T1), where no fertilizer or weedicide was applied. Overall results indicated that the CAN+NP fertilizer combination produced consistently higher grain yield than urea+DAP across all weedicide application timings. Among the timings, application of weedicide after the second dose of nitrogen resulted in better weed control and superior grain yield. These findings suggest that proper selection of nitrogen source along with appropriate timing of weedicide application plays a crucial role in maximizing wheat productivity.

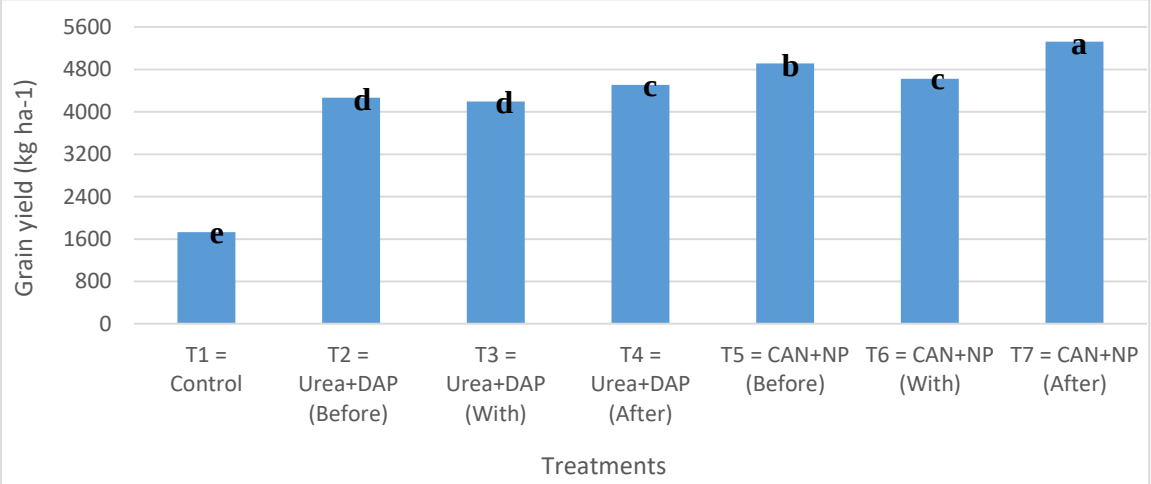

Figure 3.3 Interactive effect of weedicide and nitrogen fertilizer sources on the grain yield of wheat.

Nitrogen concentration in grain

The effect of weedicide application timings and different nitrogen fertilizer sources on nitrogen concentration in wheat grain was evaluated to assess nutrient utilization efficiency. Results indicated that both fertilizer source and timing of weedicide application significantly influenced nitrogen uptake by the crop. The highest nitrogen concentration in grain (2.50%) was recorded in treatment T7, where CAN+NP was applied and weedicide was sprayed after the second nitrogen application. This was followed by treatments T5 and T6 with nitrogen concentrations of 2.10% and 1.70%, respectively. Under the urea+DAP combination, maximum nitrogen concentration (1.47%) was observed in treatment T4, where weedicide was applied after the second

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nitrogen dose. Treatments T2 and T3 produced lower values of 1.25% and 1.16%, respectively. Statistical analysis showed that T4 resulted in significantly higher nitrogen concentration than T2 and T3. The control treatment (T1), where no fertilizer or weedicide was applied, recorded the lowest nitrogen concentration (0.86%). Overall findings demonstrated that the CAN+NP fertilizer combination was more effective in improving nitrogen uptake compared to urea+DAP, particularly when weedicide was applied after the second nitrogen application. All fertilized treatments showed significantly higher nitrogen concentration than the control.

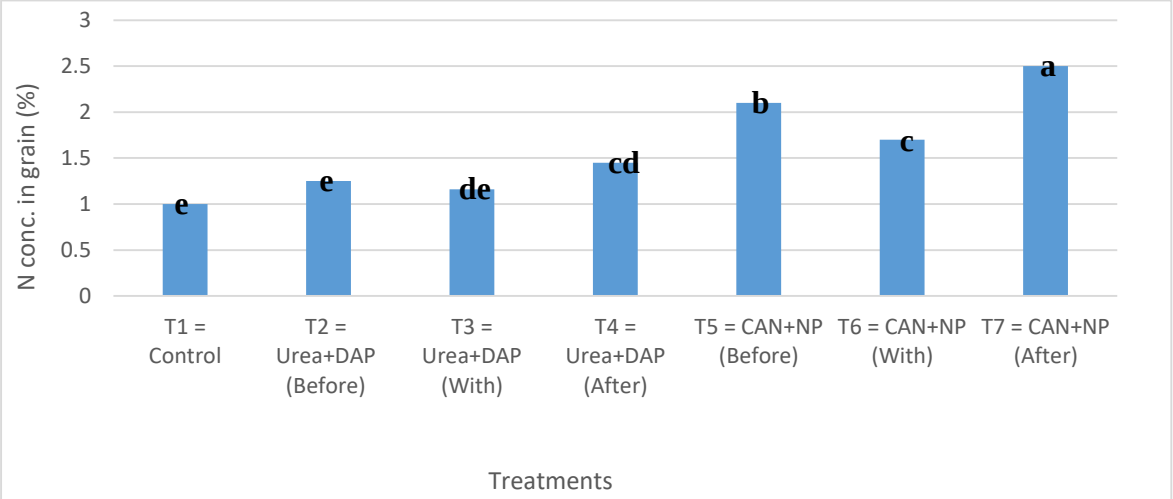

Figure 3.4 Interactive effect of weedicide and N-fertilizer sources on the N concentration in grain (%) of wheat.

Phosphorus concentration in grain

Figure 3.5 showed the phosphorus concentration in grains. Maximum results were found in those treatments where weedicide was applied after nitrogen application in both combinations but more significant results were found in combination of N fertilizer CAN+NP. Minimum results were found in control (T_1). Poor phosphorus percentage in grains was observed in treatments T_3, T_2 and T_4 0.14, 0.18 and 0.22 % P respectively. Maximum results of phosphorus concentration were found in treatment T_7 then in T_5 and after that in T_6 that were 0.33, 0.29 and 0.26 % P in grains respectively. All the treatments had statistically significant results as compared to control which gave minimum percentage of phosphorus in grains of wheat (0.11 %), but treatment (T_7) of CAN+NP where weedicide was applied after application of 2nd dose of N fertilizer as CAN, showed statistically highly significant results.

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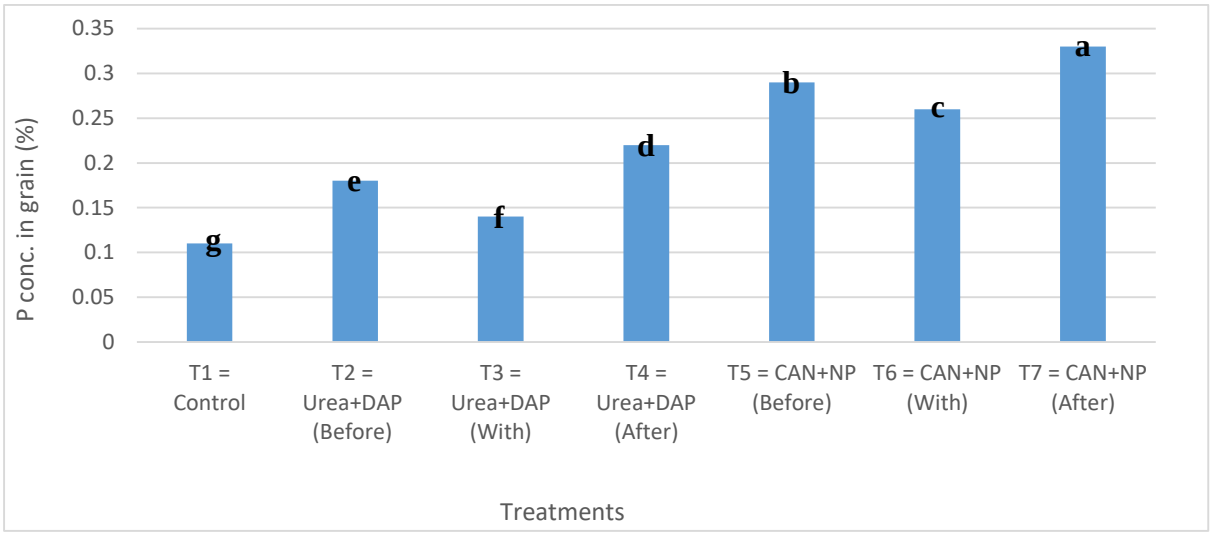

Figure 3.5. Interactive effect of weedicide & N-fertilizer sources on the phosphorus Conc. in grains (%) of wheat

Potassium concentration in grain

Figure 3.6 consisted of K conc. in the wheat grain. Two combination of N fertilizer sources were used as mentioned in materials and methods. It was clearly demonstrated that enhancement of potassium concentration was observed in the treatment T_7 which consisted of CAN+NP and weedicide application after 2nd dose of N application as CAN, then treatment T_5 that was CAN+NP and weedicide application before application of 2nd dose of nitrogen application as CAN and at third potassium concentration was found in treatment (T_6) here also fertilizer sources were same but weedicide was applied with application of 2nd dose of N fertilizer as CAN. Potassium percentage in grains of the both combination of fertilizer starting from maximum to minimum are given as: T_7, T_5 and T_6 (1.7, 1.54 and 1.41 % respectively) and T4, T2 and T3 having potassium percentage in grain (1.35, 1.24 and 1.15% respectively). Control treatment in which no fertilizer and weedicide application take place, showed low concentration of potassium in grains (0.89 %).

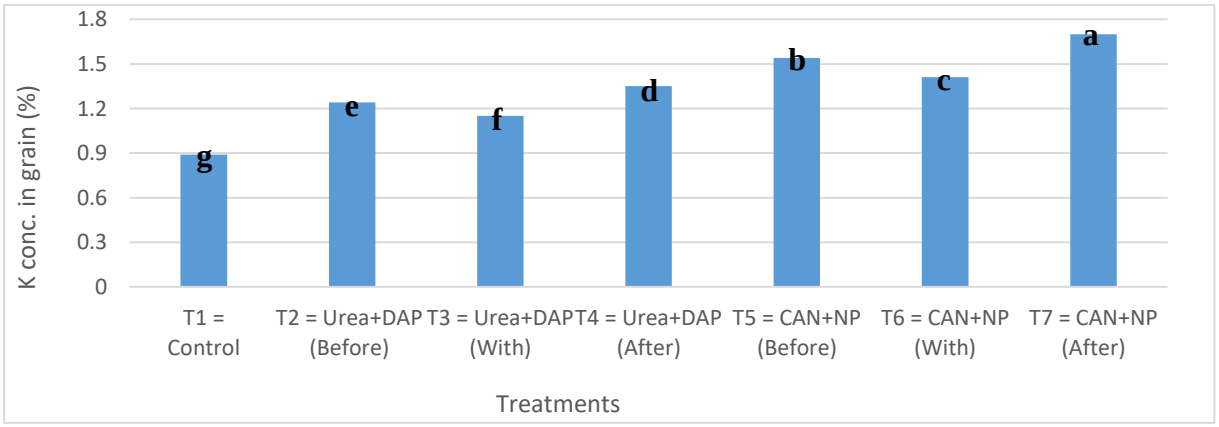

Figure 3.6 Interactive effect of weedicide & N-fertilizer sources on the potassium conc. in grain (%) of wheat.

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Nitrogen concentration in straw

The effect of nitrogen fertilizer sources and weedicide application timings on nitrogen concentration in wheat straw was evaluated to assess nutrient distribution within the plant. Results indicated that treatment T7 (CAN+NP with weedicide applied after the second nitrogen dose) showed the highest nitrogen concentration in straw (1.9%), followed by T5 and T6 with 1.6% and 1.4%, respectively, as shown in Figure 3.7. Among the urea+DAP treatments, the highest straw nitrogen was recorded in T4 (1.2%), followed by T2 (0.99%) and T3 (0.96%). The control treatment (T1) had the lowest nitrogen concentration (0.86%). These results demonstrate that both the choice of nitrogen source and the timing of weedicide application significantly influenced nitrogen accumulation in wheat straw, indicating more balanced nutrient utilization in treatments receiving CAN+NP, particularly when weedicide was applied after the second nitrogen dose.

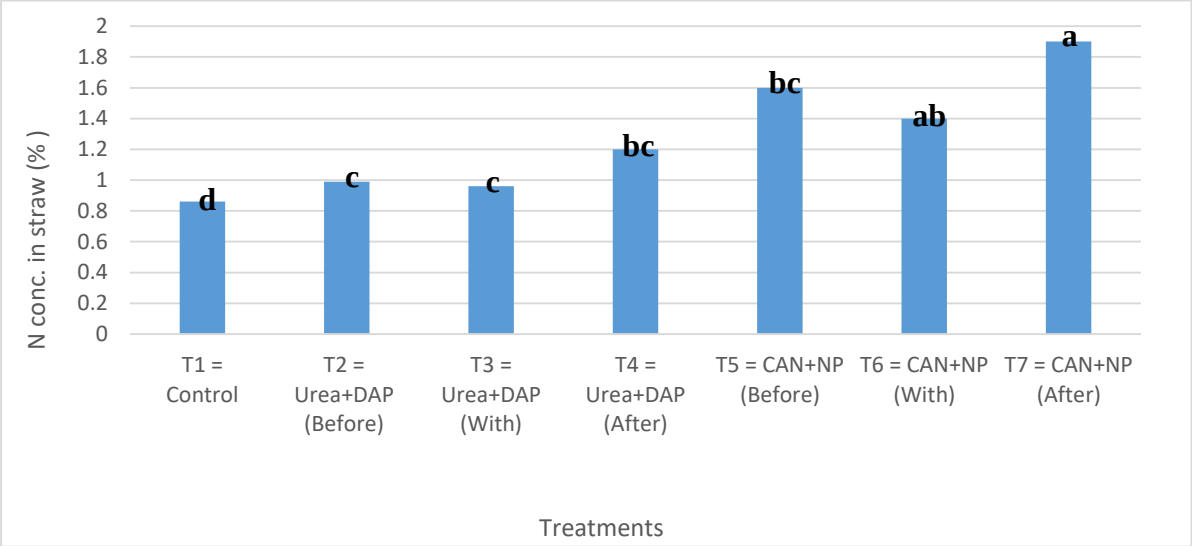

Figure 3.7 Interactive effect of weedicide & N-fertilizer sources on the N-conc. in straw (%) of wheat.

Phosphorus concentration in straw

Phosphorus is the most limiting nutrient for the growth and development of wheat. Two combinations of fertilizer along with weedicide application at the different timings with respect to the recommended doses of N-P-K were applied. Phosphorus concentration in the straw was determined to check the utilization of phosphorus in different parts of the plant. Table 4.15 revealed that the phosphorus concentration in the treatment (T_7) of CAN+NP and application of weedicide after 2nd dose of N application as CAN was 0.19 %, in treatment (T_5) of CAN+NP and application of weedicide before the 2nd dose of N application as CAN it was 0.17 % and in treatment (T_6) of CAN+NP and application of weedicide with the 2nd dose of N application as CAN gave P percentage 0.15 %. Similarly, in the combination of urea+DAP best results were found in T_4 (0.13 %) where weedicide was applied after 2nd dose of N application as urea, then in T_2 (0.11 %) where weedicide was applied before the application of 2nd dose of N application as urea and after that low percentage was observed in T_3 (0.09 %) where weedicide was applied with the 2nd dose of nitrogen as

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urea. Overall results showed that all the treatments gave significantly higher phosphorus concentration in comparison to control (0.06 %).

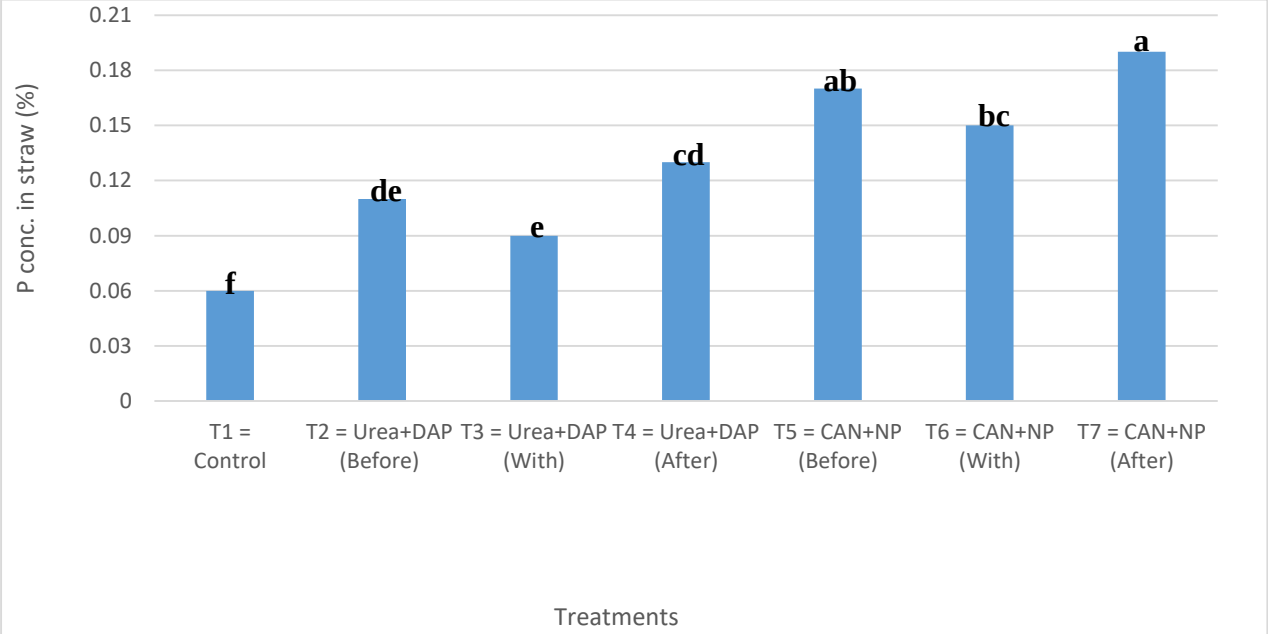

Figure 3.8 Interactive effect of weedicide & N-fertilizer sources on the phosphorus conc. in straw (%) of wheat.

DISCUSSION and Conclusion

Weeds are a serious biological constraint to wheat production because they compete directly with the crop for nutrients, water, light, and space. This competition reduces nutrient use efficiency, restricts crop growth, and ultimately results in considerable yield losses. Heavy weed infestation also creates favorable conditions for pests and diseases, further limiting crop performance. Therefore, timely and effective weed management is essential for achieving optimum wheat productivity. Among different control strategies, chemical weed control through herbicides is widely regarded as a practical and efficient approach for minimizing weed competition in modern wheat production systems.

Nitrogen is a fundamental nutrient that regulates several physiological and biochemical processes in wheat. Adequate nitrogen supply enhances chlorophyll formation, leaf area development, and photosynthetic activity, which collectively contribute to improved vegetative growth and higher grain yield. However, the effectiveness of applied nitrogen largely depends on the level of weed pressure in the field. When weeds are properly controlled, the crop is able to utilize nitrogen more efficiently, leading to better growth and yield formation. Proper nitrogen fertilization also promotes rapid canopy development, which further suppresses weed emergence through shading and resource competition.

The present study investigated the interactive effects of nitrogen fertilizer sources and herbicide application timings on wheat growth and yield. The results clearly demonstrated that both factors significantly influenced important agronomic and physiological traits. Maximum plant height was recorded in treatments where

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herbicide was applied either before or after nitrogen application using CAN + NP as fertilizer sources. The better performance of CAN compared to urea can be attributed to the immediate availability of nitrate nitrogen, which supports rapid vegetative growth. In addition, herbicide application after nitrogen fertilization effectively controlled weeds that had become more vigorous due to nitrogen uptake, allowing the crop to utilize available nutrients more effectively. These findings are consistent with earlier studies that reported improved crop growth under integrated nitrogen and weed management practices.

Physiological parameters such as chlorophyll content and leaf area index were also enhanced through combined application of nitrogen fertilizers and herbicide. Reduction in weed competition provided greater access to light, nutrients, and space, which improved photosynthetic efficiency and overall crop vigor. Increased nitrogen availability promoted chloroplast development and chlorophyll synthesis, resulting in better leaf expansion and canopy growth. These results confirm previous research indicating that effective weed control along with adequate nitrogen supply significantly improves the physiological performance of wheat.

Tiller production, an important determinant of final yield, was positively affected by the integrated use of nitrogen fertilizers and herbicide. Higher tiller numbers were observed in treatments where weeds were effectively controlled and nitrogen was supplied at critical growth stages. Reduced weed interference enabled the crop to make better use of applied nutrients, leading to more productive tillers. This response supports earlier findings that proper weed management combined with balanced nitrogen application plays a key role in enhancing tillering capacity in wheat.

Grain yield and thousand-grain weight were markedly improved by the combined application of nitrogen fertilizers and herbicide. Higher grain yield was mainly associated with improved crop growth, longer spikes, increased grain number per spike, and better nutrient availability. The results confirmed that nitrogen fertilization can express its full potential only when weed competition is effectively minimized. Treatments involving CAN + NP in combination with appropriate herbicide timing produced higher grain yield than the urea + DAP combination, highlighting the importance of selecting suitable fertilizer sources along with proper weed control strategies.

Straw yield also showed a general increase in fertilized and herbicide-treated plots, although the interaction between nitrogen source and herbicide timing had comparatively less influence on straw production than on grain yield. This suggests that grain yield is more responsive to improvements in weed management and nitrogen availability, while straw yield shows relatively limited variation under different treatment combinations.

Overall, the findings of this study demonstrated that integrated management of nitrogen fertilizers and herbicide significantly improved wheat growth and productivity. The combination of CAN + NP with timely application of Atlantis herbicide proved more effective than the conventional urea + DAP approach. Application of herbicide either before or after nitrogen fertilization with CAN + NP resulted in superior agronomic performance and higher grain yield. Comparative analysis indicated that applying CAN and NP after herbicide application enhanced grain yield by 18.15 percent over the traditional practice of simultaneous fertilizer and

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herbicide application. The study emphasizes that appropriate selection of nitrogen fertilizer sources together with suitable herbicide application timing is essential for maximizing wheat yield and improving nitrogen use efficiency under local agro-climatic conditions.

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