



Vol. 3 No. 8 (August) (2025)

Interactive Effects of Nitrogen and Phosphorus Fertilizer Sources and Weedicide Application with Foliar Urea/CAN on Root Development and Grain Yield of Maize

Muhammad Azim Bezanjo

Cotton Botanist, Directorate of Agriculture

Research cotton Nal khuzdar

Email: azeemshakhsh55@gmail.com

Ammar Ali Khan*(Corresponding author)

Institute of Soil and Environmental sciences,

University of Agriculture Faisalabad.

Email: ammaralikhan009@gmail.com

Muhammad umer fayyaz

Department of Environmental sciences,

Bahauddin Zakariya University Multan.

Email: Umer.fayaz.85@gmail.com

Balach Shakeel

Institute of Soil and Environmental Science

University of Agriculture, Faisalabad.

Email: balachshakeel60@gmail.com

Hafsa Liaquat

Department of Botany, University of Agriculture Faisalabad,

Email: hafsaliaquat56@gmail.com

Muhammad suleman

Department of Plant Breeding and Genetics,

University of Agriculture Faisalabad

Email: sulemanrana7876@gmail.com

Mirza Abdul Raheem

Institute of Plant Protection, Muhammad Nawaz

Shareef University of Agriculture, Multan

Email: mirzaabdulraheem296@gmail.com

Tariq Ahmed Keerio

Department of Agronomy, Faculty Crop Production

Sindh Agriculture University, Tandojam.

Email: tariqahmedkeerio4@gmail.com

ABSTRACT

Maize (*Zea mays* L.) is a major cereal crop with diverse uses in food, feed, and industry, yet its productivity is severely constrained by weed infestation. Weeds compete with maize for nutrients, water, and light, reducing growth and yield, while herbicides, though



Vol. 3 No. 8 (August) (2025)

effective, can impose stress on the crop. Therefore, synchronizing fertilizer application with weedicide use is essential to minimize crop stress and maximize productivity. A field experiment was conducted at the Institute of Soil and Environmental Sciences, University of Agriculture Faisalabad, using a randomized complete block design to assess the interactive effects of nitrogen (N) and phosphorus (P) fertilizer sources, weedicide application timing, and foliar N sprays on maize growth and yield. Fertilizer rates were 175, 125, and 125 kg ha⁻¹ of N, P, and K, respectively, applied as urea + diammonium phosphate (DAP) or calcium ammonium nitrate (CAN) + nitrophos (NP). Weedicide 'Metolachlor' (1 L acre⁻¹) was applied either four days before or after the second N split, combined with a 0.5% foliar spray from the respective N source. Growth and yield attributes, including plant height, cob traits, biological yield, and root development, were recorded at maturity. The treatment involving CAN + NP, with weedicide applied after the second CAN split and supplemented by 0.5% foliar N as CAN, produced the best results, with increases of 4.73% in plant height, 31% in grain yield, 25.97% in biological yield, and 14.21% in root weight compared to urea + DAP with weedicide applied after urea. These findings highlight that integrating CAN + NP fertilization with timely weedicide application and foliar feeding enhances nutrient uptake, reduces herbicide stress, and significantly improves maize productivity.

Introduction

Cereal grains are a fundamental component of the human diet, providing essential nutrients and serving as a primary energy source for populations worldwide. Among cereals, maize (*Zea mays L.*) holds a prominent position due to its high yield potential, wide adaptability, and diverse uses in food, feed, and industry. Globally, more than 900 million people rely on maize as a staple food, benefiting from its rich nutritional profile, which includes carbohydrates, proteins, fats, fibers, and essential minerals (Amanjyoti *et al.*, 2024). Beyond direct consumption, maize is processed into a variety of food products and its by-products serve as valuable feed for livestock and poultry (Khatam *et al.*, 2013). Industrially, maize provides starch for textile dyeing, paper production, biofuels, biodegradable plastics, and various chemical derivatives (Bukhsh *et al.*, 2012), contributing significantly to both agricultural and industrial economies. In Pakistan, maize ranks as the third most important cereal crop after wheat and rice, contributing 0.6% to the gross domestic product (Khan *et al.*, 2012).

Despite its potential, maize production is constrained by multiple biotic and abiotic stresses, including unfavorable climatic conditions, suboptimal soil fertility, and pest pressures. Among these, weed infestation represents one of the most severe threats to maize productivity. Weeds compete vigorously with crop plants for light, water, and nutrients, often resulting in substantial yield losses, sometimes reaching up to 40% (Tsfay *et al.*, 2014). Their competitive advantage is partly due to higher nutrient demands compared to crop plants (Patel *et al.*, 2006), and they often serve as hosts for insect pests and plant pathogens (Kumar *et al.*, 2018). Prolonged weed crop competition reduces kernel weight, ear number per plant, and overall crop vigor, while also impeding harvesting operations and increasing production costs (Imoloame and Omolaiye, 2017). Consequently, effective weed management is crucial to bridging the gap between potential and actual maize yields.

Weed control in maize can be achieved through cultural, mechanical, biological, or chemical methods, each with its advantages and limitations. Cultural practices are labor-intensive and often insufficient for high weed pressure, while mechanical control is effective but costly and increasingly impractical due to labor shortages (Behera *et al.*,



Vol. 3 No. 8 (August) (2025)

2024). Chemical control using herbicides has proven to be one of the most efficient approaches, with reported weed control efficiencies of 85–95% in maize (Tanveer *et al.*, 2011). However, the success of herbicide application depends on several factors, including the crop growth stage, weed emergence pattern, and timing of application (Tahir *et al.*, 2009). Inappropriate use can lead to reduced efficacy, crop injury, environmental contamination, and health risks. Furthermore, herbicides may induce phytotoxic effects in maize, causing oxidative stress, reduced chlorophyll content, impaired photosynthesis, and lower grain yields (Varshney *et al.*, 2012; Brankov *et al.*, 2020). Such stress effects highlight the need for integrated management strategies that mitigate potential crop damage while ensuring effective weed suppression.

Nutrient management is another cornerstone of high-yield maize production, with nitrogen (N) and phosphorus (P) being the two most limiting macronutrients. Nitrogen is essential for chlorophyll synthesis, photosynthesis, protein formation, and overall vegetative growth, while phosphorus supports root development, energy transfer, and reproductive success. Adequate N application can increase maize grain yield by 43–68% and biomass by 25–42% (Begam *et al.*, 2018). However, nitrogen losses through leaching and volatilization are common, reducing fertilizer use efficiency and contributing to environmental pollution (Khan *et al.*, 2012). Judicious N management not only improves yield and nitrogen use efficiency but also minimizes leaching risks (Zaib *et al.*, 2023). Similarly, optimal P fertilization enhances plant height, leaf number, disease resistance, and grain quality, while deficiency can delay silking and ear formation (Iftikhar-ud-Din *et al.*, 2011).

One promising approach to mitigating herbicide-induced stress is the use of foliar nutrient sprays during critical growth stages. Foliar application of nitrogen, particularly in the form of urea or calcium ammonium nitrate (CAN), allows for rapid nutrient absorption and can help sustain photosynthesis and growth when root uptake is compromised (Zaib *et al.*, 2023). By directly supplying essential nutrients to foliage, foliar feeding may offset the temporary growth suppression caused by herbicides and improve recovery, ultimately enhancing grain yield (Zubair *et al.*, 2023). The combined use of soil-applied N and P fertilizers with foliar N sprays and effective weed control represents an integrated management strategy with the potential to improve maize productivity under field conditions.

Despite extensive research on individual aspects of nutrient management, weed control, and foliar feeding, limited studies have addressed their interactive effects on maize root development and yield, particularly under local agro-climatic conditions. Understanding how different N and P fertilizer sources interact with weedicides and foliar N sprays can provide valuable insights for developing efficient, sustainable maize production systems. Therefore, this study was designed to investigate the interactive effects of nitrogen and phosphorus fertilizer sources, weedicide application, and foliar nitrogen sprays (urea/CAN) on root growth and grain yield of maize. The specific objectives of the study were: i) To determine the optimum timing of herbicide application in combination with different N and P fertilizer sources and its effect on maize growth and yield. ii) To evaluate the role of foliar nitrogen application in reducing herbicide-induced stress and improving maize productivity.

MATERIALS AND METHODS

Experimental design

A field experiment was conducted at the Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, using a randomized complete block design (RCBD)



Vol. 3 No. 8 (August) (2025)

with five treatments and three replications to evaluate the interactive effects of nitrogen and phosphorus fertilizer sources, weedicide application timing, and foliar nitrogen spray on maize root growth and grain yield. Treatments included: T1 = Control; T2 = Weedicide before urea application + DAP + 0.5% N foliar spray (urea); T3 = Weedicide after urea application + DAP + 0.5% N foliar spray (urea); T4 = Weedicide before CAN application + NP + 0.5% N foliar spray (CAN); and T5 = Weedicide after CAN application + NP + 0.5% N foliar spray (CAN). Maize was sown at 25 kg ha⁻¹ in plots measuring 29 × 32 ft². Nitrogen, phosphorus, and potassium (NPK) were applied at 218, 115, and 125 kg ha⁻¹, respectively, using urea and calcium ammonium nitrate (CAN) as N sources, diammonium phosphate (DAP) and nitrophos (NP) as P sources, and sulfate of potash (SOP) as the K source. Zinc sulfate (33%) was applied at 15 kg ha⁻¹. DAP and SOP were incorporated at the time of sowing; urea was applied in three splits (germination, 32, and 45 days after sowing), while CAN and NP were applied in two splits. Foliar N (0.5%) was sprayed alongside weedicide application. Weedicide ‘Metolachlor’ was applied at 1 L acre⁻¹, either 4 days before or after the second N application, with an additional spray at 38 days after sowing for weed control. The crop received 10 irrigations, and standard agronomic and pest management practices were followed. Pre-sowing soil physicochemical properties were analyzed, and plant growth, yield, and chemical composition of roots, stalks, were determined using standard procedures.

Soil analysis

After the late maize harvest in November 2016, soil samples were collected from each plots. Samples were carried out in an icebox to the laboratory. Visible roots, gravel, and debris from the soil were removed by hand after sieving the soil less than 2 mm. Afterward, the soil was divided into three subsamples for the determination of physico-chemical analysis. Soil pH was determined by using carbon dioxide-free distilled water (1:2.5) and measured with a pH meter (Metro pH 320; Mettler-Toledo Instruments Ltd., Shanghai, China). Soil Olsen P was determined by Olsen *et al.* (1954) and total P Murphy and Riley (1962). SOC and TN were analyzed by CNHS EURO elemental analyzer (Milan, Italy).

Table 1. Physicochemical properties of soil

Properties	Readings	Units
Sand	49.03	%
Clay	23.57	%
Silt	27.40	%
Texture	Sandy clay loam	
Saturation percentage	38	%
Soil EC	1.92	dS m ⁻¹
Soil pH	8.5	-
Organic matter percentage	0.75	%



Vol. 3 No. 8 (August) (2025)

Total Nitrogen	0.03	%
Available Phosphorus	6.5	mg kg ⁻¹ soil
Available Potassium	132	mg kg ⁻¹ soil

Agronomic Parameters

The maize was harvested at zodiac stage (R₆). To assess maize growth and yield, plant height and cob length were recorded using scale, shoot fresh biomass after harvest and dry biomass and total grain weight were weighted using weighing balance. Crop roots were excavated from the soil, filter paper (Whatman No. 42) was placed under the root of the plant, carefully removed from the soil by washing with distilled water, assessed either amendment effect the root growth.

RESULTS

Maize is one of the important crops which are grown in Pakistan. However, weed infestation may limit maize growth and can cause yield loss in maize. The application of herbicides is an efficient way to suppress weeds but weedicides may have phytotoxic effects on the main crop also. So, weedicides should be applied judiciously. An experiment was carried out to evaluate the effect of timing of weedicide application with different fertilizer sources and foliar application of nitrogen on growth and yield of maize. Following are the results of the parameters which were studied.

Plant height (cm)

Plant height was significantly influenced by the applied treatments (Figure 1). The greatest height (115.2 cm) was achieved in T5, where weedicide application followed the second dose of CAN in combination with CAN plus nitrophos and a 0.5% foliar spray of nitrogen as CAN. This response did not differ significantly from T2 (110.4 cm), which received urea plus DAP, weedicide application prior to the second urea dose, and a 0.5% foliar spray of nitrogen as urea. Comparable plant heights were also recorded in T3 (107.2 cm) and T4 (107.1 cm); in T3, weedicide was applied after the second urea dose with urea plus DAP, whereas in T4 it was applied before the second CAN dose with CAN plus nitrophos. The lowest height (78.53 cm) was observed in T1.



Vol. 3 No. 8 (August) (2025)

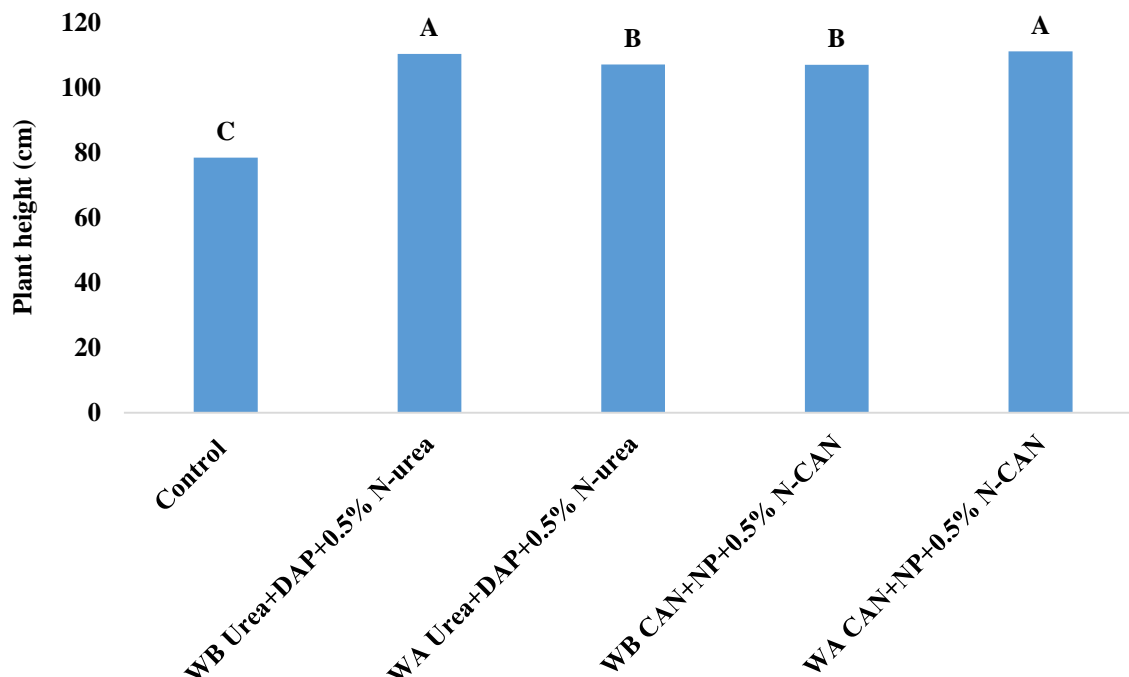


Figure 1. Interactive effect of nitrogen and phosphorus fertilizer sources and weedicide with foliar spray of urea/CAN on plant height (cm) of maize

Cob length (cm)

As shown in Figure 2, cob length of maize was significantly influenced by the applied treatments compared to the control. The greatest cob length (18.22 cm) was recorded in T5, where weedicide was applied after the second dose of CAN in combination with CAN plus nitrophos and a 0.5% nitrogen foliar spray as CAN. A slightly lower but statistically comparable value (17.88 cm) was observed in T4, which received the same fertilizer combination and foliar spray, but with weedicide applied before the second dose of CAN. A similar trend with respect to the timing of weedicide application was noted in T3 (17.22 cm) and T2 (16.55 cm), both of which were fertilized with urea plus DAP and supplemented with a 0.5% nitrogen foliar spray as urea. The shortest cob length (10.99 cm) was recorded in T1.



Vol. 3 No. 8 (August) (2025)

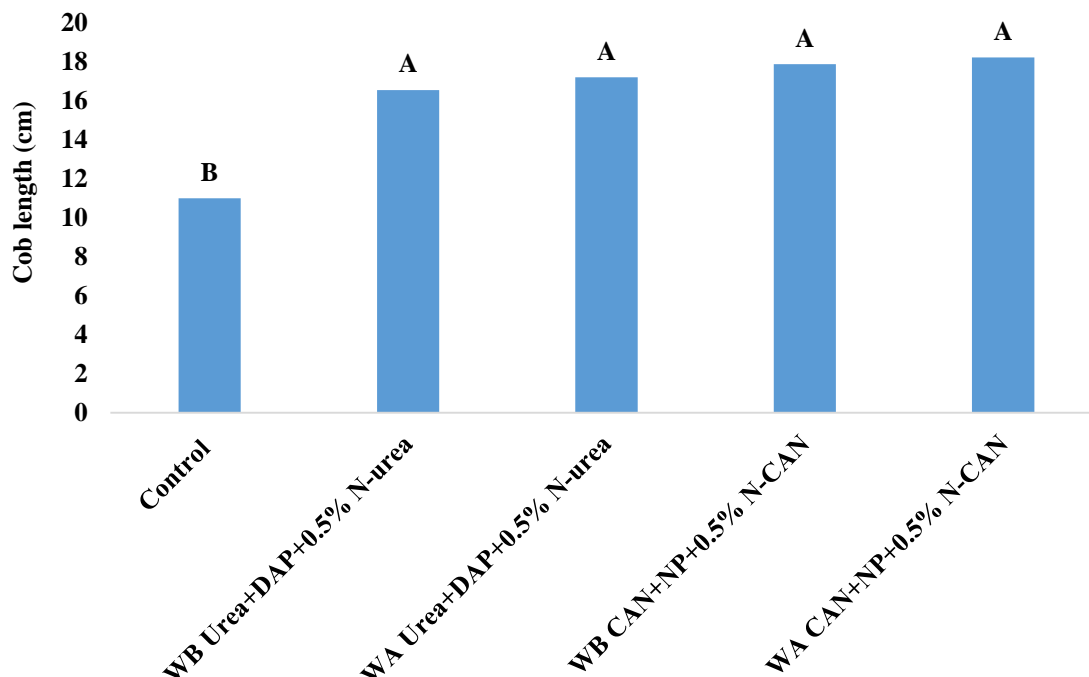


Figure 2. Interactive effect of nitrogen and phosphorus fertilizer sources and weedicide with foliar spray of urea/CAN on cob length (cm) of maize

Number of grains per cob

Figure 3 illustrates that the number of grains per cob of maize was markedly enhanced by all fertilizer and weedicide treatments compared with the control. Among the treatments, T5 produced the highest number of grains per cob (633), where CAN plus nitrophos were applied together with weedicide application after the second dose of CAN and a 0.5% nitrogen foliar spray as CAN. This value was statistically comparable to T4 (604), which received the same fertilizer combination and foliar spray, but with weedicide applied prior to the second CAN dose. A consistent trend related to weedicide timing was also evident with the urea plus DAP combination: T3 (587) outperformed T2 (537), reflecting the advantage of weedicide application after the second urea dose. In contrast, the control (T1) produced the lowest number of grains per cob, highlighting the positive influence of integrated fertilizer management and weed control practices.



Vol. 3 No. 8 (August) (2025)

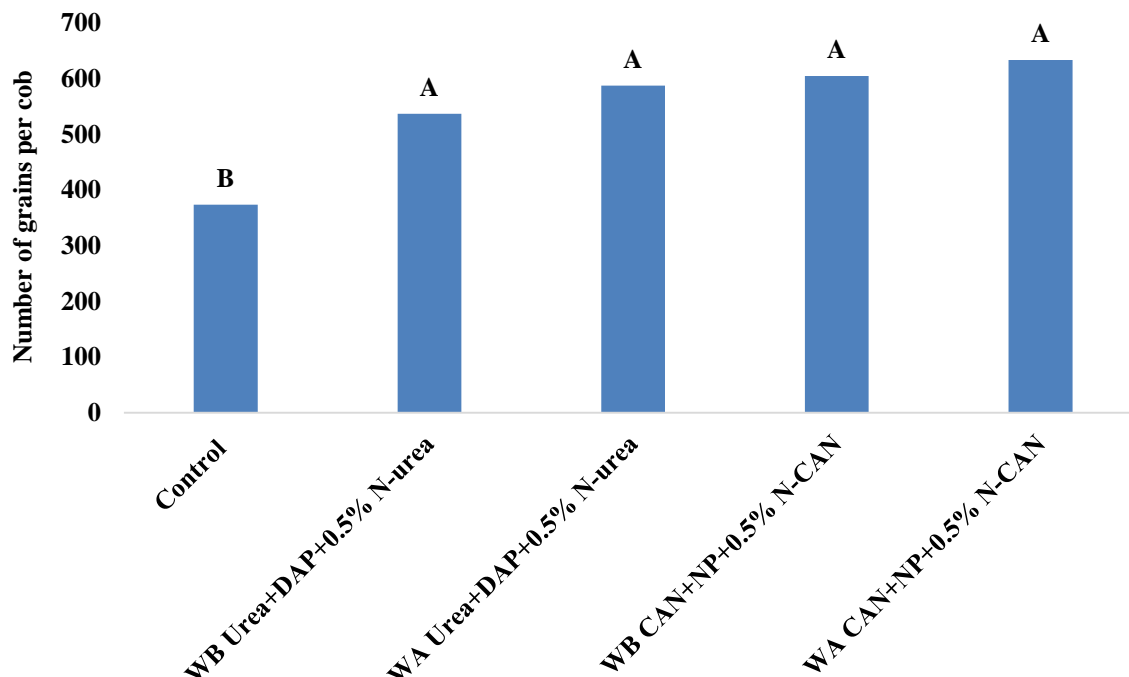


Figure 3. Interactive effect of nitrogen and phosphorus fertilizer sources and weedicide with foliar spray of urea/CAN on number of grains per cob of maize

Number of grains per row

The number of grains per row was the highest in T₅ (36) in which weedicide application was carried out after the second dose of CAN along with 0.5 % nitrogen foliar spray as CAN and fertilizer combination CAN plus nitrophos was used. The results of this treatment were not significantly different from the T₃ (34) in which fertilizer combination applied was urea plus DAP and weedicide was applied after the second dose of urea besides the application of 0.5 % nitrogen foliar spray as urea. The application of weedicide before the second dose of urea in case of urea and DAP fertilizer combination in T₂ (32) showed non-significant difference with T₄ (35) in which weedicide was applied before the second dose of CAN and CAN plus nitrophos fertilizer combination was used. The number of grains per row was the lowest in T₁ (23). All the treatments resulted in more number of grains per row of maize compared to control as shown by Figure 4.



Vol. 3 No. 8 (August) (2025)

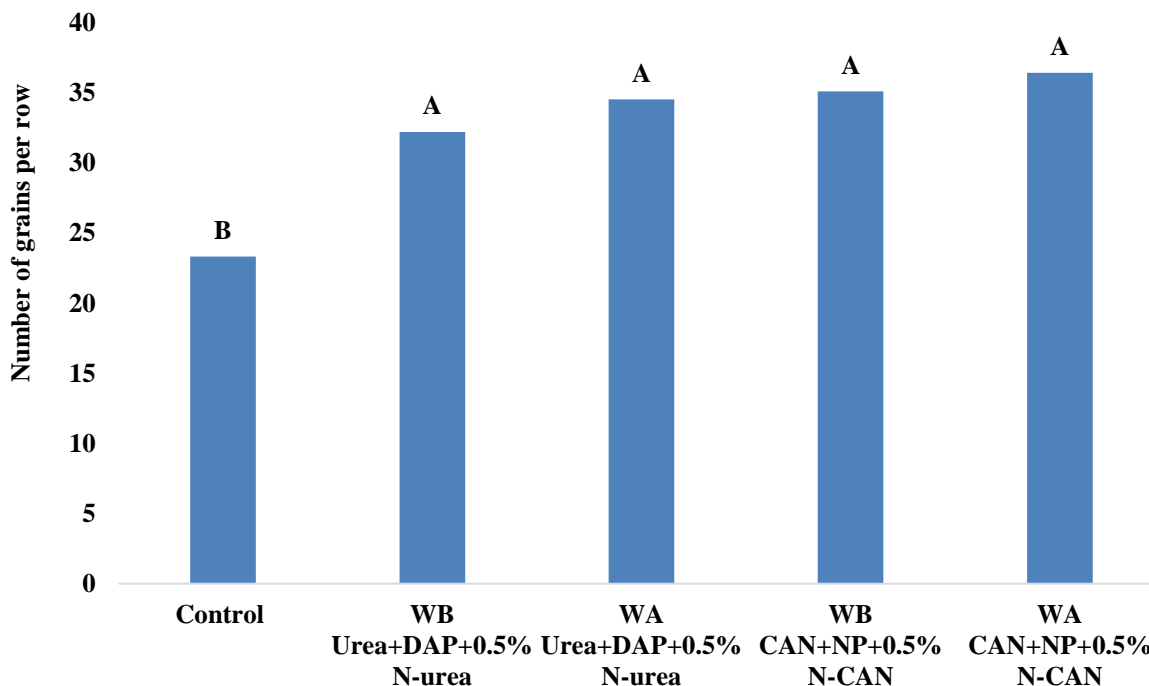


Figure 4. Interactive effect of nitrogen and phosphorus fertilizer sources and weedicide with foliar spray of urea/CAN on number of grains per row of maize

Root length (cm)

The root length of maize was greater in all treatments in comparison to control as indicated by Figure 5. Among the treatments receiving urea plus DAP, root length was slightly higher in T3 (29 cm), where weedicide was applied after the second urea dose, compared to T2 (28 cm), where weedicide was applied before the second dose; both treatments also received a 0.5% nitrogen foliar spray as urea. The maximum root length (32 cm) was recorded in T5, which received CAN plus nitrophos along with weedicide application after the second CAN dose and a 0.5% nitrogen foliar spray as CAN. A similar response was observed in T4 (30 cm), where the same fertilizer combination was used but weedicide was applied before the second CAN dose. The lowest root length (27 cm) was observed in the control.



Vol. 3 No. 8 (August) (2025)

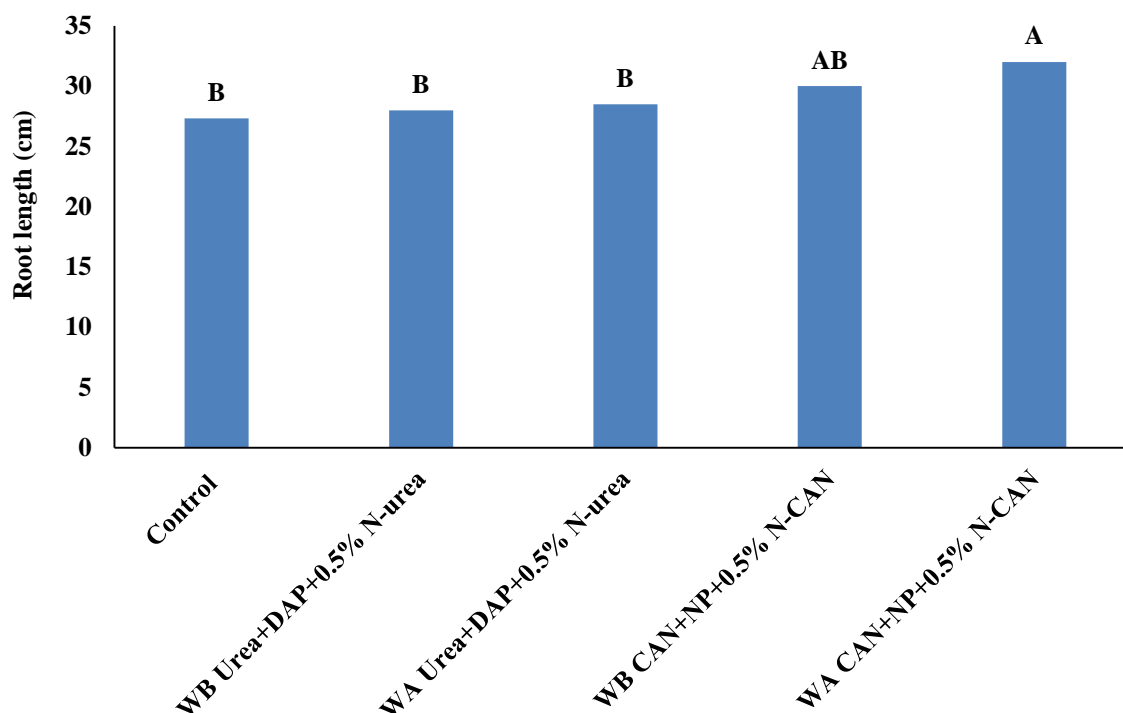


Figure 5. Interactive effect of nitrogen and phosphorus fertilizer sources and weedicide with foliar spray of urea/CAN on root length (cm) of maize

DISCUSSION

Weeds infestation is an important issue in maize production since weeds compete with crop and cause yield losses. Weeds also cause hindrance in crop harvesting and increase the cost of production (Zaib *et al.*, 2023). Chemical method is efficient for weed control (Shaba *et al.*, 2015). However, weedicide and fertilizer application should be wisely managed to achieve optimum crop yield. When the competition between the main crop and weeds is reduced by weed and fertilizer management, the efficiency of applied fertilizers is improved so higher grain yield is achieved (Zaib *et al.*, 2023). A field study was conducted to find the appropriate time of herbicide application along with nitrogen foliar spray and the effect of different sources of nitrogen and phosphorus fertilizers on the growth and yield of maize.

The maximum plant height was noted in the treatment in which CAN plus nitrophos fertilizer combination was used and weedicide application was carried out after the second dose of CAN along with 0.5% nitrogen foliar spray as CAN. This may be due to the effective control of weeds and reduction in the competition of weeds with main crop which resulted in greater capacity of maize plants to utilize water, light and nutrients and more metabolite production for the synthesis of new tissues (Ahmed *et al.*, 2008). Zubair *et al.* (2023) reported increase in plant height with effective weed control. However, these results are contradicted with Arif *et al.* (2011) who reported non-significant effect of herbicidal treatments on plant height of maize.

The highest cob weight, cob length, cob diameter and number of grains per cob was observed in the treatment with CAN plus nitrophos fertilizer combination in which weedicide was applied after the second dose of CAN along with 0.5% nitrogen foliar spray as CAN. The increase in cob growth attributes may be due to the combined effect of nutrient management and weed control. Zaib *et al.* (2023) found that management of crop nutrients results in higher crop production. Cob length is an important component to



Vol. 3 No. 8 (August) (2025)

determine maize yield. If cob length is more, the number of grains per cob is higher and consequently yield would be greater (Tahir *et al.*, 2009). Khatam *et al.* (2013) revealed increase in cob length and number of grains per cob with the use of herbicides. Nadeem *et al.* (2008) also found that cob length increases with herbicide application for weed control. zaib *et al.* (2023) reported higher cob weight through weed control by the utilization of herbicides. Results show that number of grains per cob was more in CAN plus nitrophos combination compared to urea plus DAP. This may be due to consistent release of nitrogen from CAN and improvement in nitrogen availability to the crop. Nitrogen plays a critical part in crop productivity, and its application positively affects the grain yield of maize (Hammad *et al.*, 2011).

The maximum biological yield was obtained when CAN plus nitrophos fertilizer combination was used and weedicide application time was after the second dose of CAN along with 0.5% nitrogen foliar spray as CAN. The increase in biological yield of maize may be due to the better nutrient management and lesser weed competition with the main crop (Zaib *et al.*, 2023). The biological yield of maize is increased when weed density is reduced and the growth and development of maize plants is improved so plant synthesizes more biomass (Nadeem *et al.*, 2008). Weed control and the application of balanced amount of fertilizers is suggested to achieve greater yield of maize (Ali *et al.*, 2016). Kebede and Anbasa (2017) reported increase in above ground biomass of maize through the application of herbicides. Iftikhar-ud-Din *et al.* (2011) revealed that the application of phosphorus and herbicide results in significantly higher biomass yield of maize. zaib *et al.* (2023) found that the application of nitrogen and weed control by herbicides in maize resulted in higher biological yield.

The grain yield of maize was the highest in the treatment in which CAN plus nitrophos fertilizer combination was used and weedicide application was done after the second dose of CAN along with 0.5% nitrogen foliar spray as CAN. The control of weeds by the application of various herbicides could result in the diversion of nutrients to the main crop and enhancement of the grain yield of maize (Arif *et al.*, 2011). Khan *et al.* (2014) found that grain yield of maize is significantly improved through the application of herbicides. Mehmeti *et al.* (2019) revealed increase in the grain yield of maize with the use of herbicides. The increase in the grain yield of maize may be due to the foliar application of nitrogen. Amanullah *et al.* (2013) revealed that the foliar application of nitrogen results in significantly higher grain yield of maize. Khan *et al.* (2016) concluded that maize yield and yield components are improved with the application of herbicides due to weed control. The highest concentration of nitrogen, phosphorus and potassium in plant samples was obtained in the treatment where CAN plus nitrophos fertilizer combination was used and weedicide application was carried out after the second dose of CAN along with 0.5% nitrogen foliar spray as CAN. The greater concentration of N, P and K in plant samples may be due to lesser competition between weeds and maize by the efficient control of weeds which could result in better uptake of nutrients by maize plants. Zaib *et al.* (2023) stated that weeds are adverse to crop plants with regard to the uptake of nutrients and moisture and utilize higher amount of nutrients in comparison to crop plants. Greater concentration of nitrogen in plant samples may be due to the foliar application of nitrogen. Amanullah *et al.* (2013) showed that the foliar application of nitrogen enhanced growth and yield of maize.



Conclusion

The findings of this study demonstrate that the integration of fertilizer source, herbicide timing, and foliar nitrogen spray plays a crucial role in optimizing maize growth and yield under weed-infested conditions. Among the tested treatments, the combination of CAN + NP fertilizers with weedicide applied after the second dose of CAN along with a 0.5% foliar N spray as CAN proved to be the most effective. This treatment significantly improved plant height, cob development, root biomass, biological yield, and grain yield compared to the urea + DAP fertilizer source under the same management practice. The results highlight that using CAN + NP not only enhances nutrient availability but also minimizes the stress associated with herbicide application, ultimately leading to superior crop performance. Therefore, adopting CAN + NP in combination with properly timed herbicide application and foliar nitrogen supplementation can be recommended as a viable strategy to improve maize productivity and ensure sustainable crop management.

References

- Ahmed, S. A., H. M. Shams, I. M. El-Metwally, M. N. Shehata and Mona A. El-Wakeel. 2008. Efficiency of some weed control treatments on growth, yield and its attributes of maize (*Zea mays* L.) plants and associated weeds. *J. Agric. Sci. Mansoura Univ.* 33: 4777-4789.
- Amanjyoti, Singh, J., Sowdhanya, D., Rasane, P., Singh, J., Ercisli, S., ... & Ullah, R. (2024). Maize. In *Cereals and nutraceuticals* (pp. 47-80). Singapore: Springer Nature Singapore.
- Amanullah, A.Z. Khan, A. Jan, Z. Shah, B. Ahmad, S.K. Khalil, A. Ali, Hidayatullah, F. Ahmad and A. Nawaz. 2013. Foliar application of nitrogen at different growth stages influences the phenology, growth and yield of maize (*Zea mays* L.). *Soil Environ.* 32: 135-140.
- Arif, M., T. Mukhtar, S. U. Rahman, K. Hussain, A. Razaq and A. Iqbal. 2011. Efficacy of different herbicides against weeds in maize (*Zea mays* L.). *Pak. J. Weed Sci. Res.* 17: 125-133.
- Behera, P., Das, N., & Karan, N. (2024). SUSTAINABLE WEED MANAGEMENT STRATEGIES FOR CROP PRODUCTION. *COMPREHENSIVE INSIGHTS INTO ENVIRONMENTAL SCIENCE*, 159.
- Brankov, M., M. Simic, J. Mesarovic, B. Kresovic and V. Dragicevic. 2020. Integrated effects of herbicides and foliar fertilizer on corn inbred line. *Chil. J. Agric. Res.* 80: 50-60.
- Bukhsh, M.A.A.H.A., R. Ahmad, J. Iqbal, M.M. Maqbool, A. Ali, M. Ishaque and S. Hussain. 2012. Nutritional and physiological significance of potassium application in maize hybrid crop production. *Pak. J. Nutr.* 11: 187-202.
- Hammad, H. M., A. Ahmad, T. Khaliq, W. Farhad and M. Mubeen. 2011. Optimizing rate of nitrogen application for higher yield and quality in maize under semiarid environment. *Crop Environ.* 2: 38-41
- Iftikhar-ud-Din, G. Ullah, M.S. Baloch, A.A. Baloch, I. Ullah and E. A. Khan. 2011. Effect of phosphorus and herbicide on yield and yield components of maize. *Pak. J. Weed Sci. Res.* 17: 1-7.
- Imoloame, E.O. and J.O. Omolaiye. 2017. Weed infestation, growth and yield of maize (*Zea mays* L.) as influenced by periods of weed interference. *Adv. Crop Sci. Tech.* 5: 267.
- Kebede, M. and F. Anbasa. 2017. Efficacy of pre-emergence herbicides for the control of



Vol. 3 No. 8 (August) (2025)

- major weeds in maize (*Zea mays* L.) at Bako, Western Oromia, Ethiopia. *Am. J. Agric. For.* 5: 173-180.
- Khan, L. A., G. Hassan, N. Malik, R. Khan, H. Khan and S.A. Khan. 2016. Effect of herbicides on yield and yield components of hybrid maize (*Zea mays*). *Planta Daninha.* 34: 729-736.
- Khan, N., N.W. Khan, S.A. Khan, M.A. Khan and K.B. Marwat. 2012. Combined effect of nitrogen fertilizers and herbicides upon maize production in Peshawar. *J. Anim. Plant Sci.* 22: 12-17.
- Khatam, A., M.Z. Khan, K. Nawab, I.A. Mian and W. Ahmad. 2013. Effect of various herbicides and manual control on yield, yield components and weeds of maize. *Pak. J. Weed Sci. Res.* 19: 209-216.
- Kumar, P., Kaur, J., Suby, S. B., Sekhar, J. C., & Lakshmi, S. P. (2018). Pests of maize. In *Pests and their management* (pp. 51-79). Singapore: Springer Singapore.
- Mehmeti, A., R. Fetahaj, A. Demaj, F. Nishori and V. Rracaj. 2019. Evaluation of pre- and post-emergence herbicides for weed control in maize (*Zea mays* L.). *J. Cent. Eur. Agric.* 20: 208-221.
- Nadeem, M.A., R. Ahmad, M. Khalid, M. Naveed, A. Tanveer and J.N. Ahmad. 2008. Growth and yield response of autumn planted maize (*Zea mays* L.) and its weeds to reduced doses of herbicide application in combination with urea. *Pak. J. Bot.* 40: 667-676.
- Patel, V. J., P. N. Upadhyay, J. B. Patel and B. D. Patel. 2006. Evaluation of herbicide mixtures for weed control in maize (*Zea mays* L.) under middle Gujarat conditions. *J. Agric. Sci.* 2: 81-86.
- Tahir, M., M.R. Javed, A. Tanveer, M.A. Nadeem, A. Wasaya, S.A.H. Bukhari and J. Rehman. 2009. Effect of different herbicides on weeds, growth and yield of spring planted maize (*Zea mays* L.). *Pak. J. Life Soc. Sci.* 7: 168-174.
- Tanveer, A., M.A. Nadeem, M.S. Quddus and F. Elahi. 2011. Effect of formasulfuron + isoxadifen-ethyl in combination with urea on maize weed control and yield. *Herbologia.* 12: 65-72.
- Tesfay, A., M. Amin and N. Mulugeta. 2014. Management of weeds in maize (*Zea mays* L.) through various pre and post emergency herbicides. *Adv. Crop Sci. Technol.* 2: 151.
- Varshney, S., S. Hayat, M.N. Alyemeni and A. Ahmad. 2012. Effects of herbicide application in wheat fields: is phytohormones application a remedy? *Plant Signal. Behav.* 7: 570-575.
- Zaib, M., Zubair, M., Aryan, M., Abdullah, M., Manzoor, S., Masood, F., & Saeed, S. (2023). A review on challenges and opportunities of fertilizer use efficiency and their role in sustainable agriculture with future prospects and recommendations. *Curr Res Agric Farm*, 4(4), 1-14.
- Zubair, M., Raza, I., Batool, Y., Arif, Z., Muneeb, M., Ashfaq, M. U., ... & Ali, A. (2023). A Review of Remediation Strategies against Arsenic (As) Removal from Groundwater by Using Different Filtration Techniques. *Current Research in Agriculture and Farming*, 4(3), 1-14.