Plant Archives Vol. 25, Supplement 2, 2025 pp. 3132-3138 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.401

IMPACT OF NITROGEN AND HERBICIDAL COMBINATIONS ON GROWTH AND YIELD IN LATE SOWN WHEAT

Karishma Singh* and Joy Dawson
Department of Agronomy Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj – 211 007 (Uttar Pradesh), India
*Corresponding author e-mail: singhkarishma746@gmail.com
(Date of Receiving : 23-05-2025; Date of Acceptance : 31-07-2025)

ABSTRACT

A field experiment was conducted during the two consecutive *rabi* seasons of 2022-23 and 2023-24 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS. The experiment was tested in Split-Plot Design with 4 weed management practices in main-plots *viz* W_1-Weedy check, W_2 - Weed free, W_3 - Mesosulfuron + Iodosulfuron (Atlantis 3.6 WDG) at 14.4g/ha and W_4 - Clodinafop + Metribuzin (Shagun 21-11) at 270g/ha and 4 nitrogen management practices in sub-plots *viz* N_1 - 60 kg Nitrogen through urea as top dressing in two splits, N_2 - 4% urea as foliar spray, N_3 – 4ml of nano urea / L of water and N_4 - 2% urea as foliar spray + 2ml nano urea / L of water all at 30 and 50 DAS. The two-year study revealed that weed free in combination with 60 kg/ha nitrogen through urea as top dressing recorded higher growth and yield attributes and yield in wheat, also application of Metribuzin + Clodinafop at 270 g/ha in combination with 60 kg/ha nitrogen through urea as top dressing recorded next best results.
***Keyword*:** Foliar spray, Herbicide mixture, Nano urea, Nitrogen, Wheat

Introduction

In 2023–2024, India produced 112.74 million tons of wheat, setting a record despite of aberrant weather conditions at grain filling stage in different parts of the country (IIW&BR, Progress report, 2024). With the increase in population, food grain production needs to be increased simultaneously to meet the rising demand. A number of factors govern the productivity of crop such as timely sowing, crop establishment method, fertilizer and herbicide application, weather conditions and weed management etc. Among all these factors, weeds are one of the prominent reasons for reduction of wheat yield. Apart from all other factors, heavy infestation of weeds alone can result in reduction of almost 35-50% yield, which is a serious issue in sustaining productivity of wheat (Singh *et al.,* 1997 and Azad, 2003).

Wheat is infested with diverse type of weed flora like *Phalaris minor, Avena ludoviciana, Convolvulus arvensis, Chenopodium album, Melilotus indica, Melilotus alba, Lathyrus aphaca, Anagallis arvensis, Vicia sativa, Medicago denticulata, Fumaria parviflora* and *Cirsium arvensis etc.* (Singh *et al*., 1995). Although, manual weeding gives a better control of weeds throughout the season but is not suitable for larger areas and is economically inefficient also at the same time due to the involvement of large man power, time and capital. To tackle these issues, chemical method of weed control provides a great control towards growing weeds thereby increasing the productivity as well. Singh *et al*. (2015) reported that unchecked weed growth reduced grain yield of wheat by 43% when compared with metribuzin + clodinafop-propargyl 600 g/ha. Single or combinations of herbicides results in control the spread of both grassy and broadleaf weeds.

Nitrogen plays an important role in increasing the growth and productivity of crop. Nutrients gets lost from the soil through multiple processes such as leaching, denitrification and immobilization. Hence, timely application of nutrients in proper intervals by proper means (foliar or soil application) not only

completes the crop nutrient demand but also boosts the crop growth with increased production. Conventional urea is generally used by the farmers for meeting the nitrogen demand of the crop. Conventional urea is a traditional method and is used by the famers since ages. Nano urea, is a new technology discovered by the scientists which can multiply the crops growth in many folds only in less amount. Therefore, to test the efficacy of different weed management practices in combination with different nitrogen management methods, a field experiment was performed in the year 2022-23 and 2023-24.

Materials and Methods

Experimental site

A field experiment was conducted during the two consecutive *rabi* seasons of 2022-23 and 2023-24 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences. The experimental site is located at 25°24'22" N latitude and 81°50'56" E longitude at an altitude of 98 m above mean sea level and lies in the agro-climatic zone IV i.e. middle gangetic plain. The state experiences wide variation in temperature during different seasons. At the time of experiment the weekly maximum average temperature recorded was 27.3°C and 28.1°C whereas the weekly minimum average temperature recorded was 11.4°C and 11.8°C in two years. During the crop growth period, 6.24 and 23.8 mm of rainfall were received, which was spread out over 6 and 5 days of rain in the respective experimental years. The wheat variety HD-2967 used is developed by ICAR which is a high yielding double dwarf variety highly suitable in diverse agro-climatic conditions across the country. The sowing was done on 28th of November in both the years with a recommended seed rate of 125 kg/ha. As per the soil sample collected (0-30cm) from the experimental site, the analysis indicated the soil being sandy loam in texture (Piper, 1966) along with a pH of 6.70 and 6.60 (Jackson, 1979), EC of 0.32 and 0.22 (Jackson, 1979), Organic carbon of 0.45 and 0.52% (Jackson, 1979) in first and second year of study. The available nutrients in the soil sample were also analysed and the results revealed a lower availability of nitrogen 230.54 and 231.66 kg/ha (Subbiah & Asija 1956), a medium availability of phosphorus 12.81 and 12.11 kg/ha (Olsen *et al*. 1954) and available potassium 194.62 and 193.07 kg/ha (Jackson 1979).

Experimental design and treatment details

The experiment was tested in Split- Plot Design with 4 weed management practices in main-plots *viz* W_1-Weedy check, W_2 - Weed free, W_3 - Mesosulfuron + Iodosulfuron (Atlantis 3.6 WDG) at 14.4g/ha and W_4 - Clodinafop + Metribuzin (Shagun 21-11) at 270g/ha and 4 nitrogen management practices in sub-plots *viz* N_1 - 60 kg/ha Nitrogen through urea as top dressing in two splits, N_2 - 4% urea as foliar spray, N_3 – 4ml of nano urea / L of water and N_4 - 2% urea as foliar spray + 2ml nano urea / L of water all at 30 and 50 DAS. The 16 treatment combinations as per the factors taken were namely, Weedy check + 60 kg/ha N through urea as top dressing in splits at 30 and 50 DAS (W_1N_1), Weedy check + 4% urea as foliar spray at 30 and 50 DAS (W_1N_2), Weedy check + 4ml of nano urea / L of water at 30 and 50 DAS (W_1N_3), Weedy check + 2% urea + 2ml nano urea / L water at 30 & 50 DAS (W_1N_4), Weed free + 60 kg N through urea as top dressing in splits at 30 and 50 DAS (W_2N_1), Weed free + 4% urea as foliar spray at 30 and 50 DAS (W_2N_2), Weed free + 4ml of nano urea / L of water at 30 and 50 DAS (W_2N_3), Weed free + 2% urea at 30 DAS + 2ml nano urea / L water at 50 DAS (W_2N_4), Mesosulfuron + Iodosulfuron + 60 kg N through urea as top dressing in splits at 30 and 50 DAS (W_3N_1), Mesosulfuron + Iodosulfuron + 4% urea as foliar spray at 30 and 50 DAS (W_3N_2), Mesosulfuron + Iodosulfuron + 4ml of nano urea / L of water at 30 and 50 DAS (W_3N_3), Mesosulfuron + Iodosulfuron + 2% urea + 2ml nano urea / L water at 30 & 50 DAS (W_3N_4), Clodinafop + Metribuzin + 60 kg/ha N through urea as top dressing in splits at 30 and 50 DAS (W_4N_1), Clodinafop + Metribuzin + 4% urea as foliar spray at 30 and 50 DAS (W_4N_2), Clodinafop + Metribuzin + 4ml of nano urea / L of water at 30 and 50 DAS (W_4N_3) and Clodinafop + Metribuzin + 2% urea + 2ml nano urea / L water at 30 & 50 DAS (W_4N_4). The recommended rate of 120 kg/ha Nitrogen, 60 kg/ha Phosphorous and 60 kg/ha Potassium were uniformly applied. Half of N (60 kg/ha) was given as basal dose whereas full dose of P & K was given at the time of sowing. The remaining dose of N was given in two equal splits at 30 & 50 DAS. The herbicides were applied with the help of Knapsack Spray at 35 DAS. The irrigation was given at the important growth stages. However, it was skipped during the rainy days.

Statistical analysis

The data collected on growth and yield parameters were subjected to statistical analysis using Fisher's analysis of variance (ANOVA) for split plot design as per the procedure described by Gomez and Gomez, (1984). The sub plots factors in split plot design allowed for higher precision with lesser error among the treatments to test the effect of different methods involved for nitrogen management in the experimental field.

Results and Discussion

Growth and weed parameters

Plant Height

During the first year of study (2022-23), maximum plant height was observed in weed free plot which was followed by Metribuzin + Clodinafop at 270 g/ha, the plots treated with Mesosulfuron + Iodosulforon at 14.4 g/ha was found to be next in the sequence. In the second year (2023-24), higher plant was recorded in weed free plots and it was closely followed by Metribuzin + Clodinafop at 270 g/ha. The plot treated with Mesosulfuron + Iodosulforon at 14.4 g/ha was next in sequence. The weed-free environment allowed the plants to attain maximum growth by acquiring the available nutrients and resources, resulting in enhanced plant height. Among the nitrogen management practices, in the first year of study, significantly higher plant height was recorded in the plots treated with 60 kg/ha nitrogen through urea as top dressing. During the second year, plots applied with 60 kg/ha nitrogen through urea as top dressing recorded higher plant height followed by 4% urea spray. The results were in line with Amani and Behzad, (2020).

Plant dry weight

In the first year of study, higher plant dry weight was observed in weed free plots which was followed by plots treated with Metribuzin + Clodinafop at 270 g/ha. Similar was the pattern observed in the second season also. Reduction in weed population might have influenced the plant biomass. Under nitrogen management practices, during both the years of study, application of 75 kg/ha nitrogen through urea as top dressing and 4% urea spray recorded at par values. Jan *et al*. (2010) stated that supplying N in three splits (at planting, tillering, and stem elongation) resulted in better efficiency of N biomass production in wheat compared to a single application at planting or two split applications at planting and tillering.

Total weed density

The data was subjected to square root transformation before the statistical analysis to normalise the data distribution. In the first year of study, lowest weed density was recorded in the weed free plots and application of both the herbicide combinations were found to be statistically at par when compared with weed free plot. Similar was the trend in the second year of study also. The application of herbicides significantly reduced the growth and population of weeds which reduce the crop-weed competition for the available resources. The results were in line with Patel *et al.* 2024, who reported that application of metribuzin 42% + clodinafop propargyl 140 + 40 g/ha recorded significantly lower density of weeds. Among the nitrogen application methods, in the first year, lowest weed density was with 4ml nano urea/l water while 2% urea + 2 ml nano-urea/ l water and 4% urea were statistically at par. The results were similar with Asif *et al.* 2023, who showed the effective results of herbicides when combined with nano urea.

Simple correlation coefficient was worked out (Figure 1.). There was a negative correlation between total weed density and grain yield. The regression equation developed for grain yield with total weed density in the year 2022-23, revealed that at 11.5% variation in yield due to weed density, the grain yield was expected to fall by 0.027kg/ha. While in the year 2023-24, 61.8% variation in yield due to weed count (1 weed/m^2) is estimated to be 0.043 kg/ha.

Total weed dry weight

The data was subjected to square root transformation before the statistical analysis to normalise the data distribution. At 60 DAS, in the first year lowest weed dry weight was in the plots kept weed free. However, both the herbicidal combinations showed at par values with weed free. The herbicides are applied at 35 DAS, and when the crop reaches to 60 DAS, the weeds are almost killed and hence the dry weight also reduces. In the weedy check plots, the weeds were allowed to grow, due to which the population of weeds and their multiplication increased with time. Similar results were reported by Pal *et al.* 2015, who showed the reduction in weed biomass upon the application of Mesosulfuron +Iodosulfuron.

Simple correlation coefficient was worked out (Figure 2.). There was a negative correlation between grain yield and weed dry weight. The equation revealed that, 14.8% variation in yield could be due to decrease in yield/g increase in weed biomass is estimated to be 0.065 kg/ha. Similarly, during the second year, 59.7% decrease in yield due to weed biomass is estimated to be 0.160 kg/ha.

Weed Index

It is defined as the magnitude yield reduction due to presence of weeds in comparison with weed free check and is expressed in percentage (Gill and Kumar, 1969). Next to weed free plots, lowest reduction in yield was in plot treated with Metribuzin + Clodinafop at 270g/ha during first year and in the second year of study, this was found to be statistically at par with weed free. However, nitrogen management methods did not have any impact on weed index. In a study conducted by Chand and Puniya (2017) the results demonstrated that lower weed index was observed in

the crop upon application of Clodinafop + metribuzin (60+210 g/ha).

Simple correlation coefficient was worked out (Figure 3.). There was a negative correlation between grain yield and weed index. In the first year of study, the equation revealed that, with 21.2% variation in grain yield due to weed index, the grain yield is expected to reduce by 0.016 kg/ha. In the second year, the equation revealed that with 79.2% variation in grain yield due to weed index, the weed index was expected to fall by 0.053kg/ha.

Crop Resistance Index

It gives the relationship between a proportionate increase in crop biomass and a proportionate decrease in weed biomass in the treated plots (Misra and Misra, 1997). In the first year of study, it was found that after weed free, the application of Metribuzin + Clodinafop at 270 g/ha performed better. This was followed by the application Mesosulfuron +Iodosulfuron at 14.4 g/ha. The second year also showed the similar results. Kumar *et al.* (2013) also reported similar results that Clodinafop 60 g/ha+ metribuzin 122.5 g/ha resulted in higher values of crop resistance index.

Yield and yield attributes

Spike/m^2

In the first year of study, significantly maximum number of spikes/m^2 was in weed free plot. Next in the sequence was the plots treated with Clodinafop + Metribuzin at 270g/ha and Mesosulfuron + Iodosulfuron at 14.4 g/ha. In the second year of study, application of Clodinafop + Metribuzin at 270g/ha recorded at par values with weed free. Chand and Puniya (2017) published similar results, showing that weed free produced the maximum number of earheads/m^2 with tunes of 406 and 397, which was statistically equivalent to Clodinafop + metribuzin. Under nitrogen management practices, in the first year, application of 60 kg/ha nitrogen as top dressing observed higher number of spikes/m^2. It was followed by 4% urea spray. Both the treatments were statistically comparable. Similar findings were reported in the second year also. According to data from Mhango *et al*. (2024), the number of tillers grew as the number of split applications increased. This is because more nitrogen moved to the growth regions, which led to the production of more tillers.

Grains/spike

Different weed management practices, nitrogen application failed to produce significant variations in grains/spike during both the years. However, higher no. of grains/spike was recorded in weed free plots during both years of study which was closely followed by the plots treated with Metribuzin + Clodinafop at 270 g/ha among the weed management practices. In the nitrogen application methods, higher grains/spike was recorded by the plots treated by 60 kg/ha nitrogen through urea as top dressing.

Test weight

In the first year of study, test weight was not influenced by different weed management practices while during the second year, maximum values were obtained by the weed free plots. The results were in line with Chand and Puniya (2017), where weed control treatments significantly increased the test weight. Application of both the herbicide combinations were statistically at par with weed free. Under nitrogen management methods, highest value was recorded with 60 kg/ha nitrogen as top dressing, while application of 4% urea spray was next in the sequence. This could be because of increased nitrogen intake, that is linked to food production which causes more cell division and enlargement. The results were in conformity with by Mathukia *et al.* (2014) that 40 kg N/ha as basal + 40kg N/ha at 25DAS + 40kg N/ha at 45 DAS significantly enhanced plant height, number of effective tillers and 1000-grain weight.

Grain yield

In the first year of study, maximum grain yield was recorded in weed free plot. This was followed by the plot treated with Clodinafop + Metribuzin at 270g/ha, which had a 14.6% higher yield than the weedy check, and the application of Mesosulfuron + Iodosulfuron at 14.4g/ha, which had a 9.8% higher grain yield than the weedy check. In the second year of study, similar was the trend; The highest grain production was reported in the weed-free plot, which was 7.44% greater than the weedy check. This was closely followed by the herbicide treated plots. Clodinafop + Metribuzin at 270g/ha increased grain yield by 7.08%, whereas Mesosulfuron + Iodosulfuron at 14.4g/ha increased grain yield by 5.27% when compared to weedy check. Crop plants exhibited enhanced nutrient uptake in a weed-free environment, resulting in increased grain output as compared to weedy check. Jaidev *et al.* (2012) also recorded the similar findings in which the yield attributing parameters were significantly more productive with the application of Metribuzin and Clodinafop. Under nitrogen management methods, in the first season, next to top dressing of 60 kg/ha nitrogen through urea, was plot receiving 4% urea spray, it was followed by 4ml nano urea spray/l water and then their combinations. It was recorded that the top dressing of 60 kg/ha nitrogen

through urea was found to be statistically significant as compared to rest of the nitrogen applications. In the second year similar was the trend and 4% urea spray was found to be statistically at par with the application of 60 kg/ha nitrogen through urea. Higher grain yield represents the fact that the nutrient requirement of crop at important growth stages was fulfilled by two split application of urea as top dressing.

Harvest index

In the first year, highest values of harvest index was recorded in weedy check. The treatments were found to be statistically at par with weedy check. In the second season, weed free plot recorded highest values and it was followed by Metribuzin + Clodinafop at 270 g/ha then Mesosulfuron + Iodosulfuron at 14.4 g/ha. Jitendra *et al.* (2022) in his study concluded that higher harvest index was obtained with the application of Mesosulfuron + Iodosulfuron. Among the nitrogen application methods, during the first year, foliar spray of 4ml nano urea/L water showed maximum values harvest index and it was followed by 2% urea spray in combination with 2ml nano urea/L water. However, the treatments were statistically non-significant with each other. In the second season, top dressing of 60 kg nitrogen/ha showed significantly higher harvest index followed by weed free plots. Foliar spray of 4% urea/L water was at par with top dressing of 60 kg/ha nitrogen through urea. The results were with those of Amani and Behzad (2020) and Amanullah *et al.* (2015).

Conclusion

The treatment, weed free in combination with 60 kg/ha nitrogen through urea as top dressing recorded higher growth, yield attributes and yield in wheat closely *fb* application of Metribuzin + Clodinafop at 270 g/ha in combination with 60 kg/ha nitrogen through urea as top dressing recorded next best results.

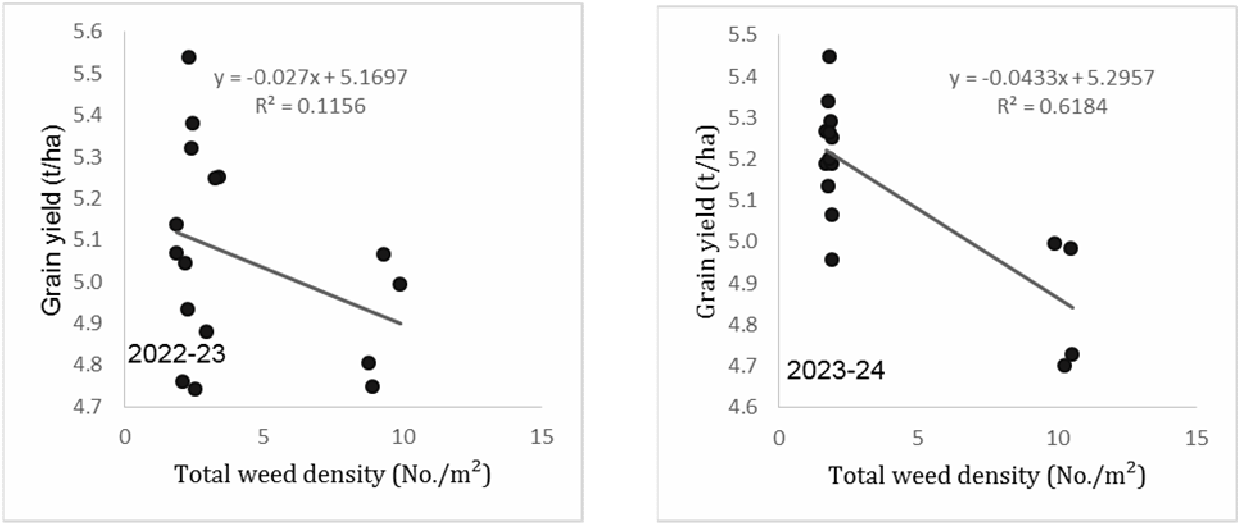

Fig. 1 : Regression analysis of weed density & grain yield during 2022 - 23 and 2023 - 24

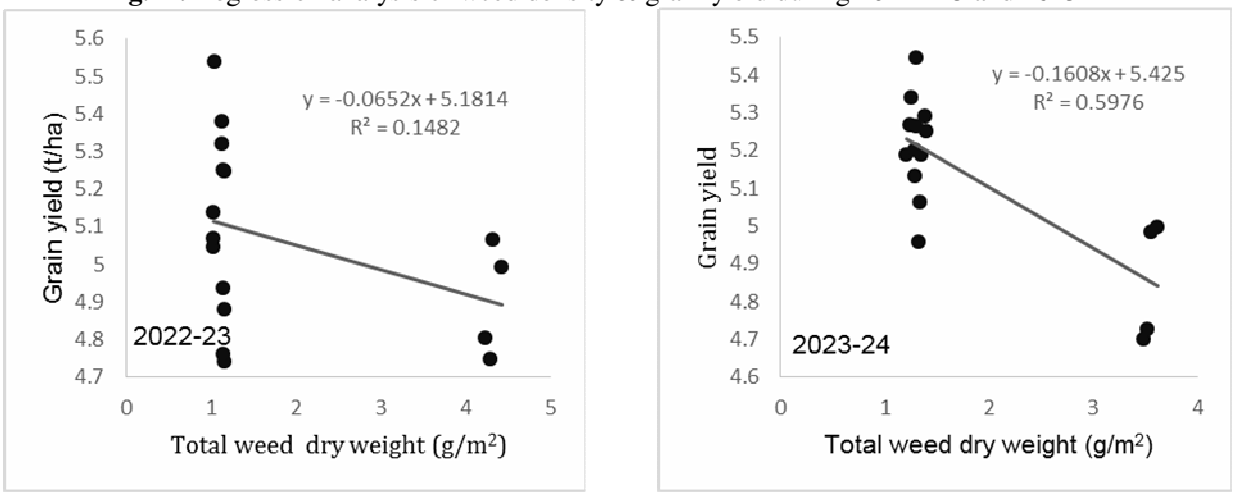

Fig. 2 : Regression analysis of weed dry weight at 60 DAS and grain yield during 2022 - 23 and 2023–24

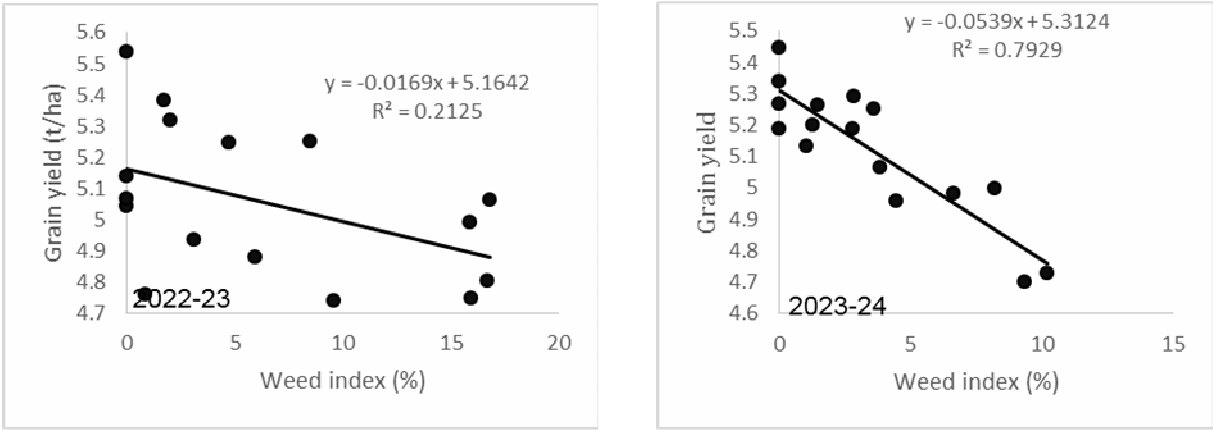

Fig. 3 : Regression analysis of weed index at 60 DAS and grain yield during 2022 - 23 and 2023 – 24

Table 1 : Effect of nitrogen and weed management practices on growth in late-sown wheat.

Treatments	Plant height (cm) 60DAS		Plant dry weight (g) 60DAS		Total weed density* (No./m^2) 60DAS		Total weed dry weight* (g/m^2)60DAS		Weed Index (%)		Crop Resistance Index (%)	
	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24
Weed management												
Weedy check	36.9	36.9	4.90	5.8	9.24 (90.22)	10.30 (106.69)	4.32 (18.15)	3.55 (12.09)	16.33	8.60	0.0	0.00
Weed free	39.4	39.9	5.20	6.3	2.09 (3.98)	1.76 (2.60)	1.03 (0.57)	1.25 (1.07)	0.00	0.00	33.94	12.40
Mesosulfuron +Iodosulfuron at 14.4g/ha	38.2	38.1	5.03	6.0	3.05 (9.22)	1.92 (3.19)	1.16 (0.84)	1.35 (1.33)	7.18	3.70	22.21	9.36
Metribuzin + Clodinafop at 270g/ha	38.6	39.7	5.10	6.1	2.33 (5.04)	1.82 (2.83)	1.14 (0.80)	1.32 (1.24)	1.90	1.60	23.72	10.35
SEm+	0.08	0.35	0.02	0.04	0.77	0.23	0.01	0.02	0.37	0.71	0.48	0.35
CD (P=0.05)	0.29	1.21	0.09	0.13	2.65	0.80	0.03	0.07	1.30	2.46	1.67	1.20
Nitrogen application												
60 kg/ha Nitrogen through urea	40.2	40.6	5.29	6.21	4.54 (31.72)	3.88 (26.88)	1.94 (5.32)	1.93 (4.17)	6.52	3.66	21.78	7.53
4% urea	39.3	39.6	5.17	6.11	4.32 (28.26)	4.01 (29.75)	15.91 (5.10)	1.87 (3.95)	5.88	2.73	19.72	7.91
4ml nano urea/l water	35.6	36.7	4.84	5.88	3.84 (23.43)	3.91 (28.50)	1.89 (4.91)	1.83 (3.76)	6.78	3.71	18.43	8.41
2% urea + 2ml nano urea/l water	38.0	37.8	4.92	6.00	4.02 (25.05)	4.00 (30.18)	1.90 (5.03)	1.85 (3.85)	6.24	3.84	19.94	8.25
SEm+	0.18	0.37	0.05	0.04	0.17	0.17	0.01	0.02	0.56	0.33	0.31	0.37
CD (P=0.05)	0.52	1.08	0.15	0.11	0.48	NS	0.02	0.05	NS	NS	0.91	NS

*Data subjected to square root transformation to √x+0.5. Figures in parenthesis are original values.

Table 2 : Effect of nitrogen and weed management practices on yield in late-sown wheat.

Treatments	Spike/m^2 (No.)		Grains/ spike (No.)		Test weight (g)		Grain yield (t/ha)		Harvest Index (%)	
	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24
Weed management										
Weedy check	250.0	239.5	43.46	43.29	37.02	37.37	4.48	4.85	42.70	37.95
Weed free	291.6	272.9	45.75	45.46	39.32	40.20	5.35	5.31	41.79	39.17
Mesosulfuron +Iodosulfuron at 14.4g/ha	279.1	245.8	44.67	44.00	38.42	38.56	4.97	5.12	41.03	38.65
Metribuzin + Clodinafop at 270g/ha	281.2	260.4	45.21	45.21	37.64	39.18	5.25	5.22	41.24	38.81

SEm+	5.35	4.46	0.57	0.49	0.57	0.51	0.02	0.04	0.27	0.15
CD (P=0.05)	18.50	15.43	NS	NS	NS	1.76	0.07	0.13	0.93	0.53
Nitrogen application										
60 kg/ha Nitrogen through urea	295.8	270.8	46.21	45.25	39.88	39.67	5.23	5.25	41.55	38.92
4% urea	285.4	260.4	45.17	44.63	38.72	38.87	5.05	5.19	41.54	38.82
4ml nano urea/l water	250.0	241.6	43.21	44.00	36.45	38.21	4.83	4.99	42.03	38.43
2% urea + 2ml nano urea/l water	270.8	245.8	44.50	44.08	37.34	38.56	4.92	5.06	41.63	38.42
SEm+	5.03	4.96	0.87	0.45	0.63	0.48	0.03	0.03	0.17	0.14
CD (P=0.05)	14.69	14.48	NS	NS	1.83	NS	0.10	0.07	NS	0.42

Acknowledgement

The authors are grateful to Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj for providing the necessary requirements during the experiment. Also, the authors are thankful to Bayer Crop Science, UPL Limited and IFFCO, Phoolpur for providing fresh samples of Atlantis 3.6 WDG, Shagun 21-11 and Nano-Urea respectively during both the years of study.

References

Amani, A. and Behzad, A.M. (2020). Effect of Split Application of Nitrogen on Growth and Yield of Wheat (*Triticum aestivum* L.). *Journal of Experimental Agriculture International* **42**(6), 44-48.

Amanullah, A.I., Hidayatullah, K.I., Kumar, M. and Shah, A. (2015). Foliar nitrogen management for improving growth and yield of dryland wheat. *Cercetari Agronomice in Moldova,* **48**(3), 163.

Asif, Mo, Poonia, Mal, Todar, Hooda, Singh Virendra, Pradhan, Dhar, Dharani and Bhavesh (2023). Effects of Herbicides and Nano Urea Mixture on Weeds, Yield Attributes and Yield of Wheat (*Triticum aestivum*). *International Journal Environment Climate Change* **13**(12), 1211-1220.

Azad, B.S. (2003). Efficacy of herbicides for controlling weeds in wheat with special reference to *Phalaris minor*. *Annals of Plant Protection Sciences,* **11**(1), 119–22.

Chand, L. and Puniya, R. (2017). Bio-efficacy of alone and mixture of herbicides against complex weed flora in wheat (*Triticum aestivum*) under sub-tropical conditions. *Indian Journal of Agricultural Sciences,* **87**(9), 1149–54.

Gill, G.S., Kumar, V. (1969). Weed Index – A new method for reporting weed control trials. *Indian Journal of Agronomy,* **14**(2), 96 – 98.

Gomez, K.A. and Gomez, A.A. (1984). *Statistical Procedures for Agricultural Research* (2nd Ed.) *John Willey and Sons Inc.* New York, USA.

ICAR-IIWBR (2024). Progress Report of AICRP on Wheat and Barley 2023-24, Social Sciences. Eds, Satyavir Singh, Anuj Kumar, Anil Kumar Khippal, Raj Kumar, Randhir Singh, Gyanendra Singh and Ratan Tiwari. ICAR-Indian Institute of Wheat and Barley Research, Karnal, Haryana, India. P. 29.

Jackson, M.L. (1979). *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

Jaidev, Singh., Kumar, S., Kumar, R. and Singh, A. K. (2012). Weed management studies in wheat. *In, Proceedings of International Agronomy Congress*. Pp,126-127.

Jan, M.T., Khan, J.M., Khan, A., Arif, M., Shah, M., Nullah, N. (2010). Wheat nitrogen indices response to nitrogen source and application time. *Pakistan Journal of Botany*. **42**(6), 4267-4279.

Jitender, A., Sandeep, K.P. and Singh, B. (2022). Effect of post emergence herbicidal combinations tank mixed with zinc or/and iron sulphate on growth and straw yield of wheat crop (*Triticum aestivum* L.). *Indian Journal of Ecology,* **49**(5), 1952-1956.

Kumar, S., Rana, S.S., Ramesh and Chander, N. (2013). Herbicide combinations for broad-spectrum weed control in wheat. *Indian Journal of Weed Science* **45**(1), 29–33.

Malik, R.S., Yadav, A., Malik, R.K. (2007). Efficacy of tank-mix application of sulfonylurea herbicides against broadleaf weeds in wheat and their residual effects on succeeding crop of sorghum under zero tillage. *Indian Journal of Weed Science*, **39**, 185-189.

Mathukia, R.K., Kapadiya, J.K. and Panara, D.M. (2014). Scheduling of nitrogen and potash application in irrigated wheat (*Triticum aestivum* L.). *Journal of Wheat Research,* **2**,171- 172.

Mhango, A., Singh, I., Rana, M.K. and Arya, R. (2024). Effect of split application of nitrogen at different growth stages on early sown wheat (*Triticum aestivum* L.). *International Journal of Research in Agronomy,* **7**(6), 239-242.

Mishra, M. and Mishra, A. (1997). Estimation of Integrated Pest Management Index in Jute, A New Approach. *Indian J. Weed Sci.,* **29**(1), 39 – 42.

Olsen, S.R., Cole, C.V., Watanbe, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soil with sodium bicarbonate. USDA, Circular 939.

Patel, K.. Harsh, Patel, V.J. and Chaudhari, D.D. (2024). Evaluating the effect of herbicide combinations and sequential applications for broad-spectrum weed control in wheat *Agriculture Association of Textile Chemical and Critical Reviews Journal,* **12**(14),270-274.

Piper, C.S. (1966). *Soil and Plant analysis*. Inter Science Publishers, New York. Pp,47-49.

Singh, R.K., Singh, D.K. and Singh, R.P. (1997). Weed crop competition in wheat as affected by different weed species. *Indian Journal of Weed Science* **29**(3&4), 198–9.

Singh, R., Singh, A.P., Chaturvedi, S., Pal, R.R., Jodh, P. (2015). Control of complex weed flora in wheat by metribuzin + clodinafop application. *Indian Journal of Weed Science,* **47**(1), 21-24.

Singh, S., Malik, R.K., Balyan, R.S. and Singh, S. (1995). Distribution of weed flora of wheat in Haryana. *Indian Journal of Weed Science*, **27**, 114–121.

Subbiah, B.V. and Asija, G.L. (1956). A rapid procedure for determination of available nitrogen in soils. *Current Science,* **25**, 259-260.