Eco. Env. & Cons. 30 (4) : 2024; pp. (1846-1849)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i04.063

Response of Wheat (*Triticum aestivum* L.) to Nano Urea under Different Combinations of Herbicides

Vaishnavi Rajput[1], Pradeep Rajput[2], Sanket Ingle[1], Pradeep Kr. Kanaujiya[2] and Jaidev Sharma[3]

ITM University, Gwalior 474001, M.P., India

(Received 30 May, 2024; Accepted 1 August, 2024)

ABSTRACT

A field experiment was conducted during the winter (*rabi*) season of 2023–24 at Crop research Centre 1 (CRC-1) of ITM University Gwalior, (M.P.), to investigate the response of wheat (*Triticum aestivum* L.) to nano-urea under different combinations of herbicide. The experiment consisted a split-plot design involving 4 herbicide-based weed management treatments, H1- Mesosulfuron-methyl 3% + Iodosulfuron-methyl sodium 0.6 WG @ 400 g ha^{-1}, H2- Clodinafop propargyl 15% + Metsulfuron-methyl 1% WP @ 400 g ha^{-1}, H3- weed-free check and H4- weedy check in main plots and 4 nutrient management treatments, N0- control (no nitrogen), N1- 100% recommended dose of nitrogen (RDN), N2- 75% RDN + 1 Spray of Nano urea at 40 days after sowing (DAS), and N3- 50% RDN + 2 Spray of Nano urea (at 40DAS and 60 DAS) in sub plots and replicated thrice. Results revealed that maximum grain and straw yield were significantly higher in weed-free check, being at par with H2-Clodinafop propargyl 15% + Metsulfuron methyl 1% WP @ 400 g ha^{-1} (3373.19 and 4232.63 kg ha^{-1}), followed by H1- Mesosulfuron-methyl 3% + Iodosulfuron-methyl sodium 0.6 WG @ 400 g ha^{-1} (3086.44 and 3941.72 kg ha^{-1}). Among nutrient management practices, grain and straw yield were significantly higher in N1-100% RDN (3610.96 and 4310.33 kg ha^{-1}), which was being at par with N2-75% RDN + 1 spray of nano-urea (3409.74 and 4221.20 kg ha^{-1}) over N3-50% RDN+ 2 sprays of nano-urea, respectively.

Key words: *Herbicides, Post-emergence, Weed, Nano-urea, Wheat, Yield attributes.*

Introduction

Wheat (*Triticum aestivum* L.) stands as the second most extensively grown crop globally, is cultivated in almost all parts of the country and occupies 34.30 million ha with a production of 110.60 million tonnes and an average productivity of 3552 kg ha^{-1} (Anonymous, 2022-23). Despite numerous factors influencing wheat productivity, one often underestimated factor contributing to reduced yield is the presence of weeds. Weeds can cause yield losses ranging from 10 to as hight as 82%, depending on factors such as weed density, weed species, timing of infestation, and the competitive abilities of the crop against these weeds within different agro-ecological contexts (Heyne, 1987). Weed management in wheat through herbicides is most economical and productive (Pal *et al*., 2016). Herbicide mixture was identified as a better option for managing weeds in wheat (Singh, 2013). Ready-mix application of Mesosulfuron-methyl + Iodosulfuron-methyl and Clodinafop propargyl + Metsulfuron methyl significantly reduced the weed density and resulted in higher productivity of wheat (Singh, 2013).

Nitrogen is the element that is frequently found deficient in agricultural soils because plants require

([1]M.Sc. Student, [2]Assistant Professor and [3]Professor)

nitrogen in substantial quantities, and only a small fraction of the nitrogen is present in soils in the form (NH4+ and NO3-) that plants can readily absorb. The use of nitrogen fertilizers is essential for increasing the availability of nitrogen to crops in soil. Projections from FAO (2011) suggest that the worldwide consumption of nitrogenous fertilizers will approach approximately 180 million tonnes by the year 2030. (Herrera *et al*., 2016). However, recently developed nano-fertilizers like nano-urea enhance nutrient-use efficiency with a very low rate of application, reduced input cost, are environmentally safe, and most importantly, enhance productivity and quality (Kiran and Samal, 2021). Foliar application of nano-fertilizers significantly increased the yield of the crop (Tarafdar *et al*., 2012). So, keeping these facts in views the current investigation aims to scrutinize the influence of herbicide application and nutrient management practices on the growth, yield, and overall production of wheat.

Materials and Methods

A field experiment was conducted during *Rabi* season of 2023-24 at Crop Research Center, School of Agriculture, ITM University, Gwalior, (M.P.) which is situated at a height of about 412 m above mean sea level with latitude of 26.15º in North and longitude of 78.18º in the East in the gird zone. The average annual rainfall of gird zone was 750 mm. During the experiment the minimum and maximum temperature ranged between 5.3 °C and 38.6 °C, respectively. The soil of experimental sites was sandy loam in texture, having pH 7.9, electrical conductivity 0.41S/m, organic carbon 0.30, 175, 25 and 312 kg ha^{-1} available nitrogen, phosphorus and potassium respectively. The crop was fertilized with 120kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1}. The experiment was tested in a split-plot design with 4 herbicide-based weed management treatments, Mesosulfuron-methyl 3% + Iodosulfuron-methyl sodium 0.6 WG @ 400 g ha^{-1}, Clodinafop propargyl 15% + Metsulfuron-methyl 1% WP @ 400 g ha^{-1}, weed-free check and weedy check in main plots and 4 nutrient management treatments, control (no nitrogen), 100% recommended dose of nitrogen (RDN), 75% RDN + 1 Spray of Nano urea at 40 days after sowing (DAS), and 50% RDN + 2 Spray of Nano urea (at 40 DAS and 60 DAS) in sub plots and replicated thrice. Wheat variety '*Raj-4037*' was sown on 12th December 2023 with a seed rate of 100 kg ha^{-1}, maintaining a row-to-row spacing of 20 cm along with basal dose of recommended P and K, i.e. 60 and 40 kg ha^{-1}, applied uniformly across all treatments. Nitrogen was applied as per the treatments. In 100% RDN, nitrogen was applied at 60 kg ha^{-1} and 2 equal splits of 30 kg ha^{-1} top-dressed at 20 and 40 DAS. In 75% RDN + 1 spray of nano-urea, treatment nitrogen @ 45 kg ha^{-1} was applied basal, and rest 45 kg ha^{-1} top-dressed at 20 DAS as well as 1 spray of nano-urea was done at 40 DAS. In 50% RDN + 2 sprays of nano-urea, treatment nitrogen was applied basal as 30 kg ha^{-1}, and rest 30 kg ha^{-1} as top-dressed at 20 DAS as well as 2 sprays of nano-urea was done at 40 and 60 DAS. Nano-urea was applied by spraying @ 4 ml nano-urea $litre^{-1}$ of water. Urea, single superphosphate and muriate of potash were used as a source of soil-applied N, P and K fertilizer respectively. Herbicide were applied at 35 DAS with the help of machine operated knapsack sprayer fitted with flat fan nozzle using 500 liters water ha^{-1}. In weed-free check, total 6 hand-weedings were done at 15 days interval, starting from 20 DAS. At maturity, grain and straw yield of each plot recorded separately.

Weed density was recorded within a quadrat size of 0.50 m × 0.50 m placed randomly at three places in each net plot at 60 DAS and weed dry matter accumulation was calculated based on samples randomly collected within a quadrat. The samples were thoroughly dried at 65 to 70º C. The results were then converted to a per square meter basis and measured in grams and then converted on the basis of $1m^2$ area and measured in grams. The weed data were subjected to square root transformation to normalize the distribution.

The measured data was analysed statistically using analysis of variance (ANOVA) and least significant difference (LSD) at 5% level of significance were calculated for each treatment and treatment means were compared.

Results and Discussion

Weed flora

The weed flora of the experimental field constituted mainly of narrow leaf weeds, broad leaf weeds and sedges. *Phalaris minor* and *Cynodon dactylon* belongs to narrow leaf category; *Chenopodium* album, *Anagallis arvensis*, *Convolvulus arvensis*, *Melilotus alba*, *Melilotus indica* and *Fumaria* parviflora belongs to broad leaf categories (BLW's); and *Cyperus rotundus*

belong to sedges group. Similar weed flora was recorded by Jaiswal *et al*. (2020).

Effect of herbicide application and nutrient management practices on weed

Among main plot treatments, after the H3-weed free check (0 no. of weeds m^{-2} and 17.11 g m^{-2}), ready-mix combination of H2-Clodinafop propargyl + Metsulfuron methyl (CP + MSM) registered the significantly lowest weed density and weed dry weight (34.56 no. of weeds m^{-2} and 5.34 g m^{-2}), followed by ready-mix H1-Mesosulfuron-methyl + Iodosulfuron- methyl (38.12 no. of weeds m^{-2} and 12.53 g m^{-2}). However, the highest weed density and weed dry weight were recorded with H4-weedy check (162.37 no. of weeds m^{-2} and 52.86 g m^{-2}). The weed-free environment created by these treatments has minimized the crop-weed competition which led to better growth of the crop. The results are in agreement with those reported by Chopra *et al*. (2008) and Malik *et al*. (2008). Among nutrient management practices, the highest total weed density and weed dry weight at 60 DAS was observed with the N0- nitrogen control plot (67.94 no. of weeds m^{-2} and 21.53 g m^{-2}). N1- 100% RDN was found significantly lowest weed density and weed dry weight (49.69 no. of weeds m^{-2} and 14.59 g m^{-2}), statistically at par with N2- 75% RDN + 1 spray of nano-urea (54.10 no. of weeds m^{-2} and 15.89 g m^{-2}) followed by N3- 50% RDN + 2 sprays on nano-urea (63.30 no. of weeds m^{-2} and 18.71 g m^{-2}). However, the successive increment in nitrogen level significantly suppressed the total weed density and weed dry weight which is mainly owing to vigorous growth of wheat seedlings.

Table 1. Effect of herbicide application and nutrient management practices on total weed density, weed dry weight and Weed control efficiency at 60 DAS on wheat

Treatments	Total weed density (no.m^{-2})	Weed dry matter accumulation (g m-2)	Weed control efficiency (%)
Main plot factor: Herbicide application			
H1	6.19	3.59	
	(38.12)	(12.53)	76.97
H2	5.90	2.40	
	(34.56)	(5.34)	90.02
H3	0.71	0.71	
	0	0	100.00
H4	12.73	7.28	
	(162.37)	(52.86)	0.00
SEm±	0.04	0.02	-
CD at 5%	0.15	0.08	-
Sub plot factor: Nutrient management practice			
N0	6.86	3.86	
	(67.94)	(21.53)	65.88
N1	5.85	3.17	
	(49.69)	(14.59)	67.65
N2	6.15	3.33	
	(54.10)	(15.89)	66.81
N3	6.66	3.62	
	(63.30)	(18.71)	66.65
SEm±	0.14	0.07	-
CD	0.41	0.23	-
Interaction H × N	NS	NS	-

*Value in parenthesis is original. **Value transformed by √5e + 0.5

Herbicide application and nutrient management practices showed an influence on weed control efficiency (WCE %). Always, the maximum WCE was recorded with H3-weed-free treatment (100%). However, among the herbicide treatments, application of H2- Clodinafop propargyl 15% + Metsulfuron methyl 3% was recorded higher WCE (%) is (90.02%) at harvest stage of crop. Minimum WCE (76.97%) was recorded with the application of H1- Mesosulfuron methyl + Iodosulfuron methyl. These results are in close conformity with findings of Yadav *et al*. (2009). In nutrient management practices the maximum WCE was found non-significant but maximum WCE was recorded with N1- 100% RDN (67.65%) followed by N2-75% RDN + 1 spray of nano-urea (66.81%) followed by N3- 50% RDN + 2 sprays of nano-urea (66.65%).

Effect of herbicide application and nutrient management practices on crop

The grain and straw yield were found significantly affected due to nutrient and weed management practices. However, among the herbicide treatments, application of H2- Clodinafop propargyl 15% + Metsulfuron methyl 3% recorded significantly more grain (3373.19 kg ha^{-1}) and straw yield (4232.63 kg ha^{-1}) as compared to other herbicide treatments. However, it was recorded at par with H3- weed-free (3503.21 and 4312.05 kg ha^{-1} grain and straw yield) treatment and followed by H1- Mesosulfuron methyl + Iodosulfuron methyl (3086.44 and 3941.72 kg ha^{-1} grain and straw yield). The lowest grain and straw yield (40.58 g) were recorded with H4- weedy check (2019.51 & 2640.08 kg ha^{-1} grain and straw yield).

The grain and straw yield of wheat was found to be significantly higher in the N1-100% RDN (3610.96 & 4310.33 kg ha^{-1} grain and straw yield) and statistically equivalent to N2- 75% RDN+ 1 spray of nano-urea (3409.74 & 4221.20 kg ha^{-1} grain & straw yield) followed by N3- 50% RDN + 2 sprays of nano-urea (2911.84 & 3778.89 kg ha^{-1} grain & straw yield). The lowest grain and straw yield were recorded with N0- nitrogen control plot (2049.81 & 2816.06 kg ha^{-1} grain and straw yield). Superior performance of 100% RDN was mainly owing to higher availability of nitrogen compared to nano-urea-based nitrogen management. Nano-urea contained only 4% N (weight/volume basis) and providing hardly 50 to 100 g nitrogen ha^{-1} which might not be able to substitute to 50% RDN (60 kg ha^{-1}) of wheat in spite of having higher efficiency of nano-fertilizers. (Sarkar *et al*., 2023). The data pertinent to the harvest index reveals that the effect of different herbicide application and nutrient management practices was found to be non-significant. Among, herbicide treatments application of H2- Clodinafop propargyl 15% + Metsulfuron methyl 3%, was recorded maximum harvest index (44.18) and in case of nutrient management practices, N1- 100% RDN (45.60) recorded maximum value for harvest index.

The interaction effect of herbicide application and nutrient management practices did not show any significant difference in weed density, weed dry matter accumulation, WCE, grain and straw yield.

Table 2. Effect of herbicide application and nutrient management practices on Grain and Straw yield of wheat

Treatments	Grain Yield (kg ha^{-1})	Straw Yield (kg ha^{-1})	Harvest Index (%)
Main plot factor: Herbicide			
H1	3086.44	3941.72	43.62
H2	3373.19	4232.63	44.18
H3	3503.21	4312.05	44.52
H4	2019.51	2640.08	43.49
SEm±	38.92	57.44	-
CD at 5%	134.69	198.77	-
Sub plot factor: Nitrogen level			
N0	2049.81	2816.06	42.28
N1	3610.96	4310.33	45.60
N2	3409.74	4221.20	44.51
N3	2911.84	3778.89	43.42
SEm±	77.16	124.06	-
CD at 5%	225.23	362.11	-
Interaction H × N	NS	NS	-

Conclusion

On the basis of the results obtained in this study, it was concluded that for getting higher wheat grain and straw yield, the crop should be kept free from weed competition with the application of Clodinafop propargyl 15% + Metsulfuron methyl 1% 400 g ha^{-1} along with 100% RDN.

Conflict of Interest- None

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