



# Effects of Herbicides and Nano Urea Mixture on Weeds, Yield Attributes and Yield of Wheat (*Triticum aestivum*)

**Mo Asif<sup>a</sup>, Todar Mal Poonia<sup>a\*</sup>, Virender Singh Hooda<sup>a</sup>,  
Dharani Dhar Pradhan<sup>a</sup> and Bhavesh<sup>a</sup>**

<sup>a</sup> Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana 125004, India.

## **Authors' contributions**

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

## **Article Information**

DOI: 10.9734/IJECC/2023/v13i123785

## **Open Peer Review History:**

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/111271>

**Original Research Article**

**Received: 18/10/2023**

**Accepted: 23/12/2023**

**Published: 27/12/2023**

## **ABSTRACT**

Wheat (*Triticum aestivum*) is second most important staple crop in India after rice. Weeds have emerged as the major biotic stress in wheat. Post-emergence herbicidal combinations are used widely to control the complex weed flora in wheat crops. A field experiment was carried out to study the "Effects of herbicides and nano urea mixture on weeds, yield attributes and yield of wheat (*Triticum aestivum*)". The experiment was performed in randomized blocked design with three replications and fourteen treatments in Rabi season 2022-23 at Agronomy Research Farm, CCS Haryana Agricultural University, Hisar. Significantly minimum weed count (1.52 m<sup>-2</sup>) and dry weight (1.49 g m<sup>-2</sup>) and maximum weed control efficiency (88.6%) of *Phalaris minor* and broadleaved weeds (87%) was recorded with application of clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> followed by clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> at 90 DAS. In case of yield attributes i.e. number of effective tillers per meter row length (92.5), spike length (11.4 cm), number of grains spike<sup>-1</sup> (55.9) and 1000-grain weight (43.8) were higher with application of clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> followed by clodinafop + metribuzin 60 + 210 g

\*Corresponding author: E-mail: ansariasif11922@gmail.com;

ha<sup>-1</sup>. Grain yield (5876 kg ha<sup>-1</sup>) and B:C (1.94) was recorded higher with application of clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> followed by clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> which was significantly higher than weedy check but at par with the weed free treatment.

**Keywords:** Post-emergence; herbicides; weed; economics; nano urea; wheat.

## 1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the world's major cereal food crops and has a very important role in attaining food security. Wheat is a staple crop for many countries and is a significant source of dietary energy, protein and essential nutrients for a large portion of the global population [1],[2]. Weeds compete with wheat plants for resources such as sunlight, water, nutrients, and space, which can significantly impact crop growth and reduce yields if not properly managed [3,4]. The main biological constraint limiting the potential yield of any crop is weed [5]. Weeds are one of the crucial factors accountable for lower yield, declining productivity by 15-40% or even higher, and also for lowering grain quality [6,7,8]. In extreme case, losses due to weeds resulted in complete crop failure [9,6]. Wheat production increased significantly during and after the green revolution due to the use of larger fertiliser dosages, assured irrigation, dwarf and high yielding cultivars [10]. The high nutrient and water requirements along with less competitive nature of these high yielding dwarf varieties have provided the suitable environment for increased weed infestation. Due to the introduction of these high yielding dwarf wheat varieties, the spectrum of weed flora changed from the dominance of broadleaved weeds in the 1960s to grassy weeds in the early 1970s, specifically *Phalaris minor*, regarded as most notorious to crop production and account for about one third of total losses caused by all the pests. Thus, by the late 1970s, chemical weed management became a necessity. Wheat fields are susceptible to infestation by both grassy and broadleaved weeds. Crop rotation, soil type, meteorological conditions including temperature and humidity, soil moisture availability, cultural practises, and varieties utilised all play a significant role in the composition of these weeds [9,11,12,8]. Among grassy weeds, *Phalaris minor*, *Avena ludoviciana* and among broad leaved weeds *Rumex dentatus*, *Chenopodium album*, *Chenopodium murale*, *Fumaria parviflora* and *Medicago denticulata* are of major concern in irrigated wheat under rice-wheat system in India [13,7]. Littleseed canary grass (*Phalaris minor* Retz.), an invasive weed native to the

Mediterranean area, present on all continents with the exception of the polar regions. Weeds are generally controlled manually. However, manual weeding is time consuming and expensive, thus chemical weed management is the most straightforward and effective alternative method. Herbicides offer most ideal, practical, effective and economical means of reducing early weed competition and crop production losses [14,7]. Continuous use of herbicides, *P. minor* populations have developed multiple herbicide resistance (MHR) [15,16,8] making it the most prevalent weed species that restricts wheat productivity in N-W IGPs of India. Additionally, a few of the biotypes became resistant to a couple of novel herbicides, including pinoxaden and mesosulfuron + iodosulfuron. Even now, multiple herbicide resistances have been developed in *Phalaris minor* [15,17,2]. Earlier in India, the herbicide resistance problem was limited to only *Phalaris minor*, but with the intensive use of metsulfuron-methyl to control broad leaf weeds, it has now resulted in the aggravation of the resistance problem with the addition of one more case of *Rumex dentatus* [18,19]. Nano urea is potential component of 4R stewardship as it promotes precision sustainable agriculture. IFFCO nano urea liquid contains 40,000 ppm of nitrogen in 500 ml bottle which is equivalent to the impact of nitrogen provided by the one bag of conventional urea. So keeping this in view, the present experiment was carried out to study the herbicides bioefficacy in combination with nano urea against different weeds in wheat.

## 2. MATERIALS AND METHODS

The field experiment was conducted at Agronomy Research Farm, CCS Haryana Agricultural University, Hisar (Haryana) (29°8'56.62"N latitude and 75°41'4.24"E longitude) with an elevation of 215.2 m above mean sea level in winter season 2022-23 in the Haryana State of India to assess the "Effects of herbicides and nano urea mixture on weeds, yield attributes and yield of wheat (*Triticum aestivum*)". During the crop season 2022-23, the range of maximum and minimum temperature varied between 14.6-38.1°C and 4.4-19.3°C,

respectively. The total rainfall received during the crop growing period was 26.9 mm and the highest amount of rainfall received under 11<sup>th</sup> standard meteorological weeks (12<sup>th</sup> March-18<sup>th</sup> March) was 5.4 mm. The soil of the experimental site was sandy loam in texture, slightly alkaline in reaction (pH 8.2) and normal electrical conductivity (0.30 dS m<sup>-1</sup>). Organic carbon (0.36%) and nitrogen (137.98 kg ha<sup>-1</sup>) were determined to be low in the soil with medium phosphorus (15.11 kg ha<sup>-1</sup>) and potassium content (240.79 kg ha<sup>-1</sup>). The wheat variety HD 3086 was sown in a regularly tilled seed bed using 100 kg seed ha<sup>-1</sup> in rows 20 cm apart. The experiment was conducted in randomized complete block design with three replications. Different herbicides treatments were: T<sub>1</sub>: pinoxaden 50 g ha<sup>-1</sup>, T<sub>2</sub>: pinoxaden 50 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup>, T<sub>3</sub>: metribuzin 175 g ha<sup>-1</sup>, T<sub>4</sub>: metribuzin 175 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup>, T<sub>5</sub>: clodinafop 60 g ha<sup>-1</sup>, T<sub>6</sub>: clodinafop 60 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup>, T<sub>7</sub>: sulfosulfuron + metsulfuron (RM) 33 g ha<sup>-1</sup>, T<sub>8</sub>: sulfosulfuron + metsulfuron (RM) 33 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup>, T<sub>9</sub>: mesosulfuron + iodosulfuron (RM) 14.4 g ha<sup>-1</sup>, T<sub>10</sub>: mesosulfuron + iodosulfuron (RM) 14.4 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup>, T<sub>11</sub>: clodinafop + metribuzin (RM) (60 + 210 g ha<sup>-1</sup>), T<sub>12</sub>: clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup>, T<sub>13</sub>: weedy check and T<sub>14</sub>: weed free. The densities and dry weight of grassy and broadleaved weeds were measured using a quadrat (0.5 x 0.5 m), weed samples were collected from two randomly chosen locations in each plot. Each weed sample was divided into the following groups: grassy and broadleaved weeds. *Grassy weed* i.e. *Phalaris minor* and broadleaved weeds were counted in each sample and the density was expressed as a number m<sup>-2</sup>. *Phalaris minor* and broadleaved weeds from each quadrat were sun-dried before being placed in oven to obtain a constant weight at 65°C. The weight of the dried weed samples was measured g m<sup>-2</sup>. The weed control efficiency was determined by comparing the percentage of weed dry weight under different treatments to weedy conditions. The weed control efficiency (WCE) was calculated using the formula as given below:

$$\text{WCE (\%)} = \frac{\text{Weed dry weight in control plot (g m}^{-2}\text{)} - \text{Weed dry weight in treated plot (g m}^{-2}\text{)}}{\text{Weed dry weight in control plot (g m}^{-2}\text{)}} \times 100$$

Three rows each of one metre in length were randomly chosen from each plot for the purpose of calculating the number of effective tillers per

metre row length and the mean was taken. Based on prevailing market price of inputs on hectare basis, economics of each treatment was calculated. The data was analysed using the OP STAT software from CCS HAU, Hisar.

### 3. RESULTS AND DISCUSSION

#### 3.1 Weed Flora

The major grassy weed of the experimental field was *Phalaris minor* and among broadleaved weeds *Chenopodium album*, *Lathyrus aphaca*, *Medicago denticulate*, *Rumex dentatus*, *Convolvulus arvensis* and *Anagallis arvensis* were dominant.

#### 3.2 Density of *Phalaris Minor* (No. m<sup>-2</sup>)

The weed control treatments at 90 DAS (days after sowing) had significant effects on the weed densities. As weed growth was luxuriant and uninterrupted in the absence of any weed control practise throughout the crop growing season, the highest population of grassy weeds was observed in case of weedy check at 90 DAS, and it was significantly higher than other weed control treatments. Among all the herbicide treatments, clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> found most effective to reduce the density of weed, which was statistically at par with clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup>, mesosulfuron + iodosulfuron (RM) 14.4 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> and mesosulfuron + iodosulfuron (RM) 14.4 g ha<sup>-1</sup>. Clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> and mesosulfuron + iodosulfuron (RM) 14.4 g ha<sup>-1</sup> treated plots had lower weed density, which was due to the broad-spectrum activity of herbicides. Similar results were reported by Singh *et al.*, 2011 with ready-mix application of fenoxaprop and metribuzin (Accord Plus). Khan *et al.*, 2023c reported that the maximum density of *P. minor* (18.33 and 19.33 m<sup>-2</sup>) was recorded in plots treated with no dose of clodinafop-propargyl and fenoxaprop-P-ethyl nanoparticles (control) in both experimental years. However, with application of nanoparticles of clodinafop-propargyl and fenoxaprop-P-ethyl at recommended dose of normal herbicide resulted in minimum density (0.00 m<sup>-2</sup>) of weed under investigation *P. minor*.

#### 3.3 Density of Broadleaved Weeds (No. m<sup>-2</sup>)

The minimum weed density at 90 DAS was recorded under weed free treatment which was

followed by ready mix application of clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup>, which was at par with clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> but significantly superior over other treatments at 90 DAS. These results are in conformity with Singh *et al.* (2019) who reported that application of the tank mixed herbicides reduced broad leaf and narrow leaf weeds to a varying degree sometimes approaching to 100%.

### 3.4 Weed Dry Weight (gm<sup>-2</sup>)

All herbicide treatments caused significant reduction in weed biomass as compared to weedy check at 90 DAS. Among the herbicidal treatments, the lowest weed biomass was recorded by the application of clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup>, which was at par clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> but significantly superior over other treatments at 90 DAS. Weed biomass accumulation was reduced in treatments using post-emergence herbicides because of the minimum density of weeds. These results are in line with Qazizada *et al.* [20] Yadav *et al.* [21] and Shoeran *et al.* [22] Khan *et al.*, [2].

### 3.5 Weed Control Efficiency (%)

The weed control efficiency of herbicides was measured based on weed biomass, and it showed that the weed-free plot had the maximum efficiency of grassy weeds (100%) at 90 DAS. Among the herbicidal treatments, application of clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> recorded highest weed control efficiency of grassy weeds (88.6%), which was followed by the clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> (87.7%) as in Fig. 1. Weed control efficiency of broadleaved was higher (87%) under clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> *fb* clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> (85%) at 90 DAS. It might be due to better weed control as reflected in associated weed density and dry weight. Among herbicide treatments, minimum WCE of broadleaved weed was recorded under pinoxaden 50 g ha<sup>-1</sup> and clodinafop 60 g ha<sup>-1</sup> with and without nano urea, because these herbicides are grass killers. Lower weed control efficiency with these herbicides also reported by Singh *et al.* [23] Khan *et al.*, [8].

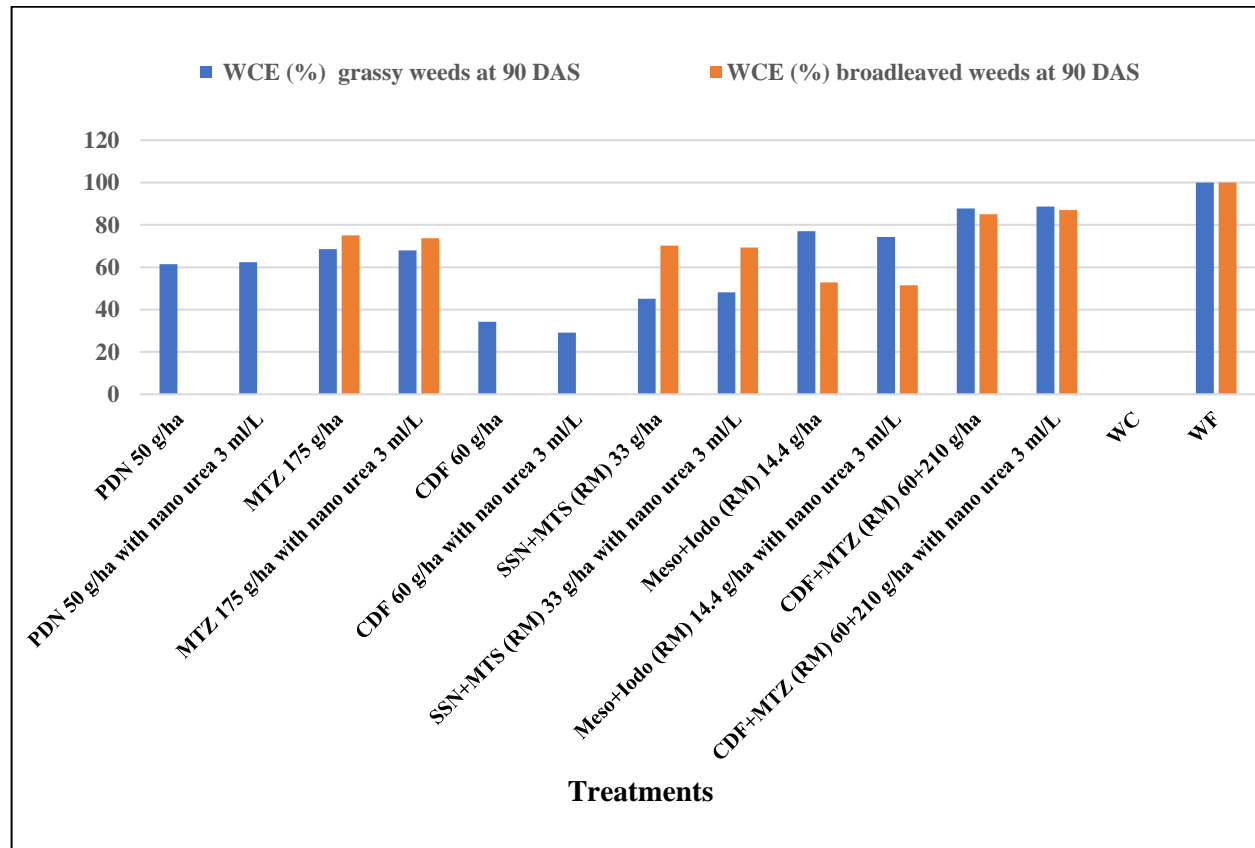
### 3.6 Yield

The effective tillers were significantly influenced by different weed control treatments (Table-2).

The data revealed that maximum effective tillers were found in weed free treatment (95.6) which was statistically at par with clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup>, with clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup>, metribuzin 175 g ha<sup>-1</sup> with and without nano urea but significantly superior over rest of the herbicide and weedy check. Among the herbicides, the highest effective tillers mrl<sup>-1</sup> were recorded in ready mix application of with clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> (92.5), followed by clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> (90.2). The lowest number of effective tillers was recorded in weedy check (71.1). Mahmood *et al.* [24] reported that the number of tillers caused by herbicides may be due to greater weed management, decrease of crop weed competition for nutrients, moisture, light and improved crop utilisation of resources.

Length of spike (cm) and Number of grains spike<sup>-1</sup> are another important component of grain yield (Table 2). Maximum length of spike was recorded under weed free (11.5 cm) followed by clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> (11.4 cm) and clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup> (10.8 cm). Among the herbicide treatments maximum and minimum number of grains spike<sup>-1</sup> recorded with application of clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> (55.9) and Clodinafop 60 g ha<sup>-1</sup> (45.8), respectively. All herbicidal treatment having higher number of grains spike<sup>-1</sup> than weedy check. Mahmood *et al.* [24] better weed control, the elimination of weed crop competition for nutrients, moisture, light and improved agricultural resource utilisation may be responsible for the increase in the number of grains spike<sup>-1</sup>.

Data in Table-2 indicated that the 1000-grain weight was not influenced significantly by different weed control treatments. All herbicidal treatment possesses numerically higher 1000 grain weight (g) than weedy check. Maximum 1000-grain weight recorded in weed free treatment (44 g), which followed by clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> (43.8 g) and clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup> (43.7). The lowest 1000 grain weight was recorded in weedy check (40.2). These findings are corroborated by Singh *et al.* (2015), which showed that weedy check plots had the lowest 1000-grain weight and those treated with a mixture of herbicides had the highest. Chhokar *et al.* [25] also reported that the herbicide-treated plots attained higher 1000-grain weights than the weedy plots.



**Fig. 1. Effect of weed control treatments on WCE (%) of grassy and broadleaved weeds**

*PDN- pinoxaden, MTZ- metrivuzin, CDF- clodinafop, SSN- sulfosulfuron, MTS- metsulfuron, Meso-mesosulfuron, Iodo- iodosulfuron, WF-weed free and WC- weedy check*

**Table 1. Effect of different herbicides on weed count (No. m<sup>-2</sup>) and dry wight of grassy and broadleaved weeds in wheat at 90 DAS**

Treatments	<i>P. minor</i>	<i>M. denticulata</i>	<i>R. dentatus</i>	<i>L. aphaca</i>	<i>C. album</i>	Dry weight (g m <sup>-2</sup> )	
						Grassy	BLW
Pinoxaden 50 g ha <sup>-1</sup>	2.23 (4.0)	4.39 (18.3)	3.87 (14.0)	4.86 (22.5)	2.88 (7.3)	2.29 (4.3)	6.00 (35.0)
Pinoxaden 50 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	2.06 (3.3)	4.43 (18.6)	3.82 (13.6)	4.83 (22.3)	3.20 (9.3)	2.27 (4.2)	6.00 (35.0)
Metribuzin 175 g ha <sup>-1</sup>	2.36 (4.6)	2.73 (2.0)	2.15 (3.6)	3.54 (11.6)	1.00 (0.0)	2.11 (3.5)	3.04 (8.4)
Metribuzin 175 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	2.23 (4.0)	1.81 (2.3)	1.89 (2.6)	3.30 (10.0)	1.00 (0.0)	2.16 (3.7)	3.17 (9.1)
Clodinafop 60 g ha <sup>-1</sup>	2.82 (7.0)	4.46 (19.0)	4.03 (15.3)	4.60 (20.3)	3.08 (8.6)	2.87 (7.3)	6.00 (35.0)
Clodinafop 60 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	2.60 (6.0)	4.43 (18.6)	3.87 (14.0)	4.82 (22.3)	2.98 (7.9)	2.80 (6.9)	6.00 (35.0)
Sulfosulfuron+metsulfuron (RM) 33 g ha <sup>-1</sup>	2.54 (5.6)	2.94 (7.6)	1.71 (2.0)	3.57 (12.3)	2.23 (4.0)	2.65 (6.1)	3.38 (10.5)
Sulfosulfuron+metsulfuron (RM) 33 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	2.43 (5.0)	2.88 (7.3)	2.62 (6.0)	3.34 (12.0)	2.15 (3.6)	2.58 (5.7)	3.41 (10.8)
Mesosulfuron + iodosulfuron (RM) 14.4 g ha <sup>-1</sup>	1.89 (2.6)	2.88 (7.3)	2.81 (7.0)	3.60 (12.3)	1.71 (2.0)	1.88 (2.6)	4.14 (16.3)
Mesosulfuron + iodosulfuron (RM) 14.4 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	2.00 (3.0)	3.00 (8.0)	2.62 (6.0)	3.60 (12.3)	1.98 (2.9)	2.02 (3.1)	4.35 (18.0)
Clodinafop + metribuzin (RM) 60 + 210 g ha <sup>-1</sup>	1.61 (1.6)	1.73 (2.0)	1.50 (1.3)	3.16 (9.0)	1.71 (2.0)	1.52 (1.4)	2.44 (5.1)
Clodinafop + metribuzin (RM) 60 + 210 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	1.52 (1.3)	1.62 (1.6)	1.24 (0.7)	3.10 (8.6)	1.61 (1.6)	1.49 (1.3)	2.34 (4.5)
Weedy check	3.46 (11.0)	4.61 (20.3)	4.12 (16.0)	4.85 (22.6)	3.20 (9.3)	3.47 (11.1)	6.00 (35.0)
Weedy free	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
SEm ±	0.17	0.10	0.27	0.21	0.15	0.11	0.18
C.D. (p=0.05)	0.49	0.30	0.56	0.64	0.44	0.32	0.54

Original data given in parenthesis was subjected to square root ( $\sqrt{x+1}$ ) transformation before analysis

**Table 2. Effect of different weed control treatments on yield attributes and yield of wheat**

Treatments	Number of effective tillers (mrl <sup>-1</sup> )	Length of spike (cm)	Grains spike <sup>-1</sup>	Test weight (g)	Grain yield (kg ha <sup>-1</sup> )	B-C ratio
Pinoxaden 50 g ha <sup>-1</sup>	81.1	8.9	52.4	41.5	5191	1.68
Pinoxaden 50 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	79.5	8.6	53.0	40.1	5072	1.64
Metribuzin 175 g ha <sup>-1</sup>	86.0	9.0	53.3	42.7	5596	1.83
Metribuzin 175 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	87.0	9.2	53.4	42.6	5632	1.82
Clodinafop 60 g ha <sup>-1</sup>	76.2	8.5	45.8	40.6	4905	1.63
Clodinafop 60 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	78.5	8.6	45.8	40.7	4844	1.57
Sulfosulfuron+metsulfuron (RM) 33 g ha <sup>-1</sup>	81.0	8.8	52.0	42.2	5342	1.74
Sulfosulfuron+metsulfuron (RM) 33 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	80.7	9.0	53.7	42.7	5275	1.71
Mesosulfuron + iodosulfuron (RM) 14.4 g ha <sup>-1</sup>	81.3	8.8	52.2	42.3	5363	1.74
Mesosulfuron + iodosulfuron (RM) 14.4 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	82.3	9.0	52.4	42.1	5430	1.75
Clodinafop + metribuzin (RM) 60 + 210 g ha <sup>-1</sup>	90.2	10.8	53.5	43.7	5806	1.89
Clodinafop + metribuzin (RM) 60 + 210 g ha <sup>-1</sup> with nano urea 3 ml L <sup>-1</sup>	92.5	11.4	55.9	43.8	5876	1.94
Weedy check	71.1	8.3	44.8	40.2	4448	1.52
Weedy free	95.6	11.5	57.4	44.0	6033	1.60
SEm ±	4.0	0.5	2.3	2.2	190	
C.D. (p=0.05)	11.6	1.4	6.8	NS	557	

### 3.7 Grain Yield (kg ha<sup>-1</sup>)

Perusal data in Table-2 exhibited that all herbicide treatments significantly influence the grain yield and maximum grain yield was recorded in weed free treatment (6033 kg ha<sup>-1</sup>), which was statistically at par with clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> (5876 kg ha<sup>-1</sup>), clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup> (5806 kg ha<sup>-1</sup>), metribuzin 175 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> (5632 kg ha<sup>-1</sup>) and metribuzin 175 g ha<sup>-1</sup> (5596 kg ha<sup>-1</sup>) but significantly higher than other treatments. Minimum grain yield was recorded in weedy check plots (4448 kg ha<sup>-1</sup>), which was significantly lower than all the herbicide treatments except clodinafop. The presence of weeds throughout the growing season resulted in a significant reduction in grain yield. Specifically, the grain yield was reduced by 26.27% in weedy check compared to weed-free conditions. This indicates that weeds had a substantial negative impact on the overall productivity of the crop during the growing season. The findings reported by Sheoran *et al.* (2013) and Singh *et al.* [23] are consistent with the observation that the presence of weeds throughout the growing season can lead to a significant reduction in grain yield. Kumari *et al.* [26] found that the ready-mix application of sulfosulfuron + metsulfuron 32 g ha<sup>-1</sup> resulted in the highest grain yield among the different herbicide treatments they tested. The specific grain yield achieved with this treatment was reported to be 6.42 tons per hectare (t ha<sup>-1</sup>). Almost similar findings were reported by Chand and Puniya [27] that the pre-mix application of clodinafop + metribuzin (60+210 g ha<sup>-1</sup>) followed by sulfosulfuron + metsulfuron (32 g/ha) and pinoxaden+ metribuzin (40+210 g ha<sup>-1</sup>), gave higher yields and better weed control than other treatments. Khan *et al.*, 2023c reported that the maximum grain yield of wheat crop was recorded with application of nanoparticles of clodinafop-propargyl and fenoxaprop-P-ethyl nanoparticles as compared to control in both experimental years [28-30].

### 4. B-C RATIO

To examine the economic feasibility and viability of different treatments under investigation economics of wheat production in terms B-C ratio. The B-C ratio is a financial indicator that compares the total benefits generated from an investment or activity to the total costs incurred. Among the different herbicidal treatments higher B-C ratio was recorded by clodinafop +

metribuzin (RM) 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> (1.94) *fb* clodinafop + metribuzin (RM) 60 + 210 g ha<sup>-1</sup> (1.89) and metribuzin 175 g ha<sup>-1</sup> (1.83). Lowest B:C was reported from weedy check (1.52). The low B-C ratio from the weedy check treatment indicate that the presence of weeds had a substantial negative impact on wheat yield and overall profitability. These findings are consistent with the findings of Qazizada *et al.* [20] that the application of pendimethalin 1000 g ha<sup>-1</sup> (just after sowing) *fb* pinoxaden + metribuzin as a tank mix 50 + 105 g ha<sup>-1</sup>. The economic benefits can be attributed to improved crop productivity, enhanced quality and potentially reduced costs associated with weed management. Herbicide treatment led to a higher B-C ratio, as reported by Kumar *et al.* [26].

### 5. CONCLUSION

Amongst herbicides treatments highest grain yield was recorded with the ready mixed application of clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> (5876 kg ha<sup>-1</sup>) followed by clodinafop + metribuzin 60 + 210 g ha<sup>-1</sup> (5806 kg ha<sup>-1</sup>), metribuzin 175 g ha<sup>-1</sup> with nano urea 3 ml L<sup>-1</sup> (5632 kg ha<sup>-1</sup>) and metribuzin 175 g ha<sup>-1</sup> (5596 kg ha<sup>-1</sup>). The improved grain yield can be attributed to several factors, including reduced weed density, lower dry matter of weeds, lower weed index, and improved yield attributes. Specifically, the grain yield was reduced by 26.27% in weedy check compared to weed-free conditions.

### ACKNOWLEDGEMENT

The author would like to thank Tadar Mal, Virendra Singh Hooda their assistance in conducting this research. The authors are thankful to Head of the Department and to CCS Haryana Agricultural University, Hisar, India for providing the necessary research facilities.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

### REFERENCES

1. Rueda AVPJ, Gerhards RR, Fournaise NE. The influence of post-emergence weed harrowing on selectivity, crop recovery and crop yield in different growth stages of winter wheat. *Weed Research*. 2011;51:478-488.



2. Khan BA, Nadeem MA, Najeeb Alawadi H, Javaid MM, Mahmood A, Qamar R, Iqbal M, Mumtaz A, Maqbool R, Oraby H, Elnaggar N. Synthesis, characterization, and evaluation of nanoparticles of clodinafop propargyl and fenoxaprop-P-ethyl on weed control, growth, and yield of wheat (*Triticum aestivum* L.). *Green Processing and Synthesis*. 2023c;12(1):20230105.
3. Nadeem MA, Khan BA, Chadar AR, Maqbool R, Raza A, Javaid MM, Irfan M. Weed control and sustainable rice production through rice intensification system and conventional practices of weed competition periods and age of transplanted seedlings. *Semina: Ciências Agrárias*. 2022;43(5):2271-2292.
4. Maqbool R, Khan BA, Nadeem MA, Azam R, Raza A, Nijabat A, Amin MM. Allelopathic effect of aqueous extract of *Polygonum bistorta* and *Terminalia chebula* on germination and seedling growth of *Daucus carota* and *Medicago polymorpha*. *Semina: Ciências Agrárias*. 2022;43(5): 2253-2270.
5. Rao AN, Wani SP. Trend in managing weeds of rice in Asian-Pacific region. In: *Souvenir. 25th Asian-Pacific Weed Science Society Conference, Weed Science, Jabalpur, Madhya Pradesh, India*. 2015;1-3.
6. Singh S, Kirkwood RC. and Marshall, G. Biology and control of *Phalaris minor* Retz. (littleseed canary grass) in wheat. *Crop Protection*. 1999;18:1-16.
7. Khan BAA, Nijabat MI, Khan I, Khan S, Hashim MA, Nadeem M. Ikram Implications of Mulching on Weed Management in Crops and Vegetables. In: Akhtar K, Arif M., Riaz M, Wang H. (eds) *Mulching in Agroecosystems*. Springer, Singapore. 2022a;199-213.
8. Khan BA, Nadeem MA, Javaid MM, Maqbool R, Ikram M, Oraby H. Chemical synthesis, characterization, and dose optimization of chitosan-based nanoparticles of clodinafop propargyl and fenoxaprop-p-ethyl for management of *Phalaris minor* (little seed canary grass): First report. *Green Processing and Synthesis*. 2022b;11(1):1118-1127.
9. Chhokar RS, Sharma RK, Chander S. Managing the weed problems in wheat. *Journal of Wheat Research*. 2007;1(1&2):103-107.
10. Choudhary PP, Singh R, Ghosh D, Sharma AR. Herbicide use in Indian agriculture. ICAR- Directorate of Weed Research, Jabalpur, Madhya Pradesh, India. 2016;110.
11. Chhokar RS, Sharma RS, Sharma I. Weed management strategies in wheat—A review. *Journal of Wheat Research*. 2012;4(2):1-21.
12. Singh S, Malik RK, Balyan RS, Singh S. Distribution of weed flora of wheat in Haryana. *Indian Journal of Weed Science*. 1995;27(3-4):114–121.
13. Singh T, Singh G. Weed flora in wheat (*Triticum aestivum*): A review. *International Journal of Chemical Studies*. 2020;8(6):2096-2098.
14. Khan BA, Nadeem MA, Nawaz H, Amin MM, Abbasi GH, Nadeem M, Ayub MA. Pesticides: impacts on agriculture productivity, environment, and management strategies. In *Emerging Contaminants and Plants: Interactions, Adaptations and Remediation Technologies Cham: Springer International Publishing*. 2023a;109-134.
15. Dhawan RS, Singh N, Singh S. Littleseed canary grass resistance to sulfonyl-urea herbicides and its possible management with pendimethalin. *Indian Journal of Weed Science*. 2012;44(4): 218–224.
16. Singh S, Chhokar RS, Garg R. Poonia T. Herbicide resistance in weeds: Problems and management. *Indian Journal of Agronomy*. 2021;66(5):167-183.
17. Rasool R, Bhullar MS, Gill GS. Growth stage of *Phalaris minor* Retz. and wheat determines weed control and crop tolerance of four post-emergence herbicides. *Spanish Journal of Agricultural Research*. 2017;15(1):1-8.
18. Chaudhary A, Chhokar RS, Dhanda S, Kaushik P, Kaur S, Poonia TM, Punia SS. Herbicide resistance to Metsulfuron-Methyl in *Rumex dentatus* L. in north-west India and its management perspectives for sustainable wheat production. *Sustainability*. 2021;13(12):6947.
19. Javaid MM, A. Mahmood DS. Alshaya MD. AlKahtani H. Waheed A. Wasaya SA. Khan M. Naqvi, M. Haider MA. Shahid MA. Nadeem S. Azmat BA. Khan RM, Balal K, A. Attia and S. Fiaz. Influence of environmental factors on seed germination and seedling characteristics of perennial

- ryegrass (*Lolium perenne* L.). Scientific Reports. 2022;12(1):1-11.
20. Qazizada GS, Todar Mal SK, Kumar P. Effect of pre and post-emergence herbicides on weed infestation, crop growth and economics of wheat. The Pharma Innovation Journal. 2022;11(3): 152-157.
  21. Yadav DB, Yadav A, Punia SS, Chauhan BS. Management of herbicide-resistant Phalaris minor in wheat by sequential or tank-mix applications of pre-and post-emergence herbicides in north-western Indo-Gangetic Plains. Crop Protection. 2016;89:239-247.
  22. Shoeran S, Punia SS, Yadav A, Singh S. Bioefficacy of pinoxaden in combination with other herbicides against complex weed flora in wheat. Indian Journal of Weed Science. 2013;45(2): 90-92.
  23. Singh B, Kumar M, Dhaka AK. Comparative efficacy of tank mixture of post emergence herbicides for the control of mixed weed flora in wheat. Journal of Pharmacognosy and Phytochemistry. 2019;8(2):384-389.
  24. Mahmood A, Iqbal J, Chattha MB, Azhar GS. Evaluation of various herbicides for controlling grassy weeds in wheat. Mycopath. 2013;1(1):39-44.
  25. Chokkar RS, Sharma RK, Singh RK, Gill SC, Meena RP. Ready mix combination of pinoxaden and clodinafop for efficient control of grass weeds in wheat. Journal of Wheat Research. 2015; 7(1):55-58.
  26. Kumari A, Kumar S, Singh B, Dhaka A. Evaluation of herbicides alone and in combination for weed control in wheat. Indian Journal of Weed Science. 2013;45(3):210-213.
  27. Chand L, Puniya R. 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. 2017 ;87(9):1149-54.
  28. Singh S, Singh K, Punia SS, Yadav A, Dhawan RS. Effect of stage of Phalaris minor on the efficacy of accord plus (fenoxaprop + metsulfuron+ ready mix). Indian Journal of Weed Science. 2011;43(1&2):23- 31.
  29. Singh R, Singh AP, Chaturvedi S, Pal RR, Jodh P. Control of complex weed flora in wheat by metribuzin + clodinafop application. Indian Journal of Weed Science. 2015;47(1):21-24.
  30. Khan BA, Nadeem MA, Iqbal M, Yaqoob N, Javaid MM, Maqbool R, Oraby H. Chitosan nanoparticles loaded with mesosulfuron methyl and mesosulfuron methyl+ florasulam+ MCPA isooctyl to manage weeds of wheat (*Triticum aestivum* L.). Green Processing and Synthesis. 2023b;12(1):20228152.

© 2023 Asif et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

*The peer review history for this paper can be accessed here:*

<https://www.sdiarticle5.com/review-history/111271>