E-ISSN: 2618-0618
P-ISSN: 2618-060X
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www.agronomyjournals.com
2024; 7(3): 318-320
Received: 11-12-2023
Accepted: 27-01-2024

Bishal Kumar Mishra
Ph.D., Research Scholar, Department of Agronomy, Shri Durga Ji Post Graduate College, Azamgarh, Uttar Pradesh, India

Phool Chandra Singh
Associate Professor, Department of Agronomy, Shri Durga Ji Post Graduate College, Azamgarh, Uttar Pradesh, India

Corresponding Author:
Bishal Kumar Mishra
Ph.D., Research Scholar, Department of Agronomy, Shri Durga Ji Post Graduate College, Azamgarh, Uttar Pradesh, India

Chemical control of complex weed flora for achieving higher productivity in wheat (*Triticum aestivum* L.)

Bishal Kumar Mishra and Phool Chandra Singh

DOI: https://doi.org/10.33545/2618060X.2024.v7.i3e.416

Abstract
A field experiments was conducted during winter seasons of 2020 and 2021 at Shree Durga Ji Post Graduate College, Chandeshwar, Azamgarh, U.P. to study the effect of herbicides on wheat and associated weeds. Five weed species were common infesting wheat fields were *Phalaris minor, Chenopodium album, Anagallis arvensis, Parthenium hysterophorus and Cyperus rotundus.* Among the herbicidal treatments, post-emergence application of carfentrazone ethyl at 0.025 kg a i/ha performed significantly with respect to reduction in density of weeds ultimately enhanced the production of biological yield of wheat.

Keywords: Wheat, herbicide, weeds and Biological yield

1. Introduction
The most significant staple crop, wheat makes for 30–35% of the nation's overall grain supply (Singh *et al*. 2013) [10]. One of the main biotic barriers to increased productivity is weed infestation. Because it is less expensive, requires less time, and is more effective, herbicidal weed control is recommended. Herbicide selection for crop infestations should take into account the type of weeds present, as well as the best time, dose, and administration technique (Kumar *et al*. 2012) [12]. Wheat is grown in a variety of agroclimatic settings, which leads to its infestation by various weed flora. However, grass weeds-particularly *Phalaris minor*, *Chenopodium album*, and *Angallis arvensis*-present the biggest threat.
Growers typically use post-emergence herbicides, which are typically administered 7–10 days following the initial irrigation. Pendimethalin applied prior to emergence in wheat allows for targeted weed management. Three main herbicides are used to suppress broadleaved weeds in wheat: carfentrazone, 2,4-D, and metsulfuron. A mixture of herbicides is required to combat complex weed flora and to give season-long weed control. To address the heterogeneous populations of weeds associated with wheat, a combination method using either tank-mixed or ready-mixed herbicides is used. In light of the aforementioned information, the current study was conducted to evaluate how well pesticides worked to suppress weeds in wheat.

2. Materials and Methods
In 2020 and 2021, a field experiment was carried out at the Agricultural Research Farm of Shri Durga Ji Post Graduate College in Azamgarh (U.P.). The texture of the soil in the experimental field was sandy loam. Nine treatments were used in the experiment: metribuzin 0.3 kg a.i. ha^{-1}, sulfosulfuron 0.03 kg a.i. ha^{-1}, metsulfuron-methyl 0.005 kg a.i. ha^{-1}, clodinafop-propargyl 0.04 kg a.i. ha^{-1} kg, 2,4-D 0.6 kg a.i. ha^{-1} kg, carfentrazone-ethyl 0.025 kg. a.i. ha^{-1}, weed free and weedy check weed control treatments were tested in a randomised block design with four replications. On November 26, 2021, wheat of variety HD-2967 was seeded at a rate of 100 kg/ha with a row-to-row spacing of 22.5 cm. Through the use of urea, single super phosphate, and muriate of potash, the crop was fertilised with 120 kg N, 60 kg P2O5, and 30 kg K2O/ha, respectively. At the time of sowing, the necessary amount of half N, entire P2O5, and K2O was drilled.

At the tillering and flag-leaf stages, the remaining half N was aired in two equal parts. Using a backpack power sprayer and 600 litres of water per hectare, herbicides were administered according to treatment. Using a backpack sprayer, the herbicides were administered 33 days after the seeds were sown. Weeds were pulled out as soon as they showed up in weed-free treatment.

3. Results and Discussion

3.1 Effects of weed control measures on *Chenopodium album*

The findings show that weed suppression, as assessed at 90-day stages of crop growth, had a substantial impact on the number of *Chenopodium album* per unit area. The weedy check had the highest number of *Chenopodium album* per unit area, while the weed-free plot had the lowest number during the 90-day stage of crop growth. Up to 90 days of crop growth, the population of *Chenopodium album* per unit area increased; after that, it dropped under conditions of weed control. In both crop seasons, not a single weed was detected in the weed-free plot at any point during the crop growing process. Among the different herbicides administered, carfentrazone-ethyl at 0.025 kg a.i. ha^{-1} showed the lowest population of *Chenopodium album* per unit area at the 90-day stage of crop growth, whereas clodinafop-propargyl at 0.04 kg a.i. ha^{-1} showed the highest density of *Chenopodium album*. When carfentrazone-ethyl (0.025 kg a.i. ha^{-1}) and metsulfuron methyl (0.005 kg a.i. ha^{-1}) were applied post-emergence, the populations of *Chenopodium album* meter-2 produced by both treatments were significantly lower than those of the other chemical weed control practices at 90 DAS. During the crop seasons, the density of *Chenopodium album* meter-2 was significantly lower in both treatments when 2,4-D at 0.6 kg a.i. ha^{-1} and pendimethalin at 1.0 kg a.i. ha^{-1} were applied. However, none of these treatments were able to reduce the density of *Chenopodium album* to the point where a weed-free situation was reached during both crop sessions. The reduced weed density seen with that treatment may be the result of weed free's innate capacity to inhibit weed germination, cell division, and growth. Comparable results were noted by Malik *et al*. (2013) [4] and Pandey and Kumar (2005) [6] and Tomar and Tomar (2014) [11].

3.2 Effects of weed control measures on *Anagallis arvensis*

Anagallis arvensis density increased for ninety days, after which it declined under weed control. At the 90-day stage of crop growth, the maximum and minimum densities of *Anagallis arvensis* were observed in the weedy check and weed-free conditions, respectively. During the crop seasons, it was discovered that the amount of *Anagallis arvensis* metre-2 was significantly impacted by weed management measures. During the crop session, no weeds were found in the weed-free plot at any point in the crop growing process. When compared to weedy check during the crop season, at 90 DAS, all chemical weed control strategies produced significantly fewer weeds per meter-2. However, the difference between clodinafop-propargyl 0.04 kg a.i. ha^{-1} and weedy check was not as noticeable. At the 90-day stages of crop growth, clodinafop-propargyl 0.04 kg a.i. ha^{-1} had a significantly higher weed population of *Anagallis arvensis* than the other chemical methods of weed control practices during the crop seasons. Chemical weed control practices had a lower weed population of *Anagallis arvensis* than that of clodinafop-propargyl 0.04 kg a.i. ha^{-1}. With the exception of metsulfuron-methyl (0.005 kg a.i. ha^{-1}) in 2019–20, post-emergence spraying of carfentrazone–ethyl 0.025 kg a.i. ha^{-1} similarly resulted in a decreased population of *Anagallis arvensis* meter–-2 at 90 days of crop growth. Among the different herbicides administered, carfentrazone-ethyl at 0.025 kg a.i. ha^{-1} showed the lowest population of *Anagallis arvensis* per unit area at the 90-day stage of crop growth, whereas clodinafop-propargyl at 0.04 kg a.i. ha^{-1} showed the highest density of *Anagallis arvensis.* In comparison to other chemical weed control methods, the post-emergence application of carfentrazone-ethyl at 0.025 kg a.i. ha^{-1} did not differ significantly from that of metsulfuron methyl at 0.005 kg a.i. ha^{-1}. Both treatments resulted in a significantly lower plant population of *Anagallis arvensis* meter-2, However, during the crop period, none of them were able to lower the overall weed density to the point where there were no weeds at all. This resulted from the herbicides' ability to eradicate weeds. Punia *et al*. (2008) [7], Kumar *et al*. (2012) [2], and Singh *et al*. (2012) [9] also reported findings that were similar.

Table 1: Density of *Chenopodium album* and *Anagallis arvensis* metre^{-2} at 90 days' stages of crop growth as influenced by different weed management practices

Treatment		*Chenopodium album*	*Anagallis arvensis*
		90 DAS	90 DAS
		2020-21	2020-21
T_1	Metribuzin	3.61(12.00)	4.87(22.75)
T_2	Pendimethalin	3.54(11.50)	4.39(18.25)
T_3	Sulfosulfuron	4.82(22.25)	5.41(28.25)
T_4	Metsulfuron methyl	2.78(6.75)	3.64(12.25)
T_5	Clodinafop-propargyl	7.83(60.25)	7.47(54.75)
T_6	2,4-D	3.39(10.50)	4.21(16.75)
T_7	Carfentrazone –ethyl	2.65(6.00)	3.39(10.50)
T_8	Weed free	1.00(0.00)	1.00(0.00)
T_9	Weedy	8.47(70.75)	8.80(76.50)
S.Em(±)		0.11	0.13
C.D. (P=0.05)		0.33	0.40

Original values in parentheses and data subjected to square root ($\sqrt{x+1}$) transformation

3.3 Effects of weed control measures on Biological yield

Adoption of various weed management strategies has a considerable impact on the wheat crop's biological yield. During the crop session, the maximum and minimum biological yield in the weed-free and weedy check conditions, respectively, were recorded. During both crop sessions, the maximum and minimum biological yield under treatment with carfentrazone-ethyl (0.025 kg a.i. ha^{-1}) and clodinafop-propargyle (0.04 kg a.i/ha) was reported among the numerous herbicides administered. Weed control techniques considerably enhanced the biological yield ha^{-1} compared to an unweeded treatment in 2020–21, the increase in biological production was from 33.47 to 50.69 percent. With the exception of carfentrazone-ethyl (0.025 kg a.i. ha^{-1}) and metsulfuron methyl (0.005 kg a.i. ha^{-1}), further weed-free treatment produced a significantly higher biological yield than chemical methods of weed control. The increase in biological yield was between 7.52% and 51.16% in 2020–21 compared to chemical methods of weed control in both crop seasons, with the exception of 2,4-D (0.6 kg a. e. ha^{-1}). A considerably larger biological yield was also obtained by applying carfentrazone-ethyl 0.025 kg a.i. ha^{-1} post-emergence compared to metribuzin 0.3 kg a.i. ha^{-1}, sulfosulfuron 0.03 kg a.i. ha^{-1}, and clodinafop-propargyl 0.04 kg a.i. ha^{-1}.. The application of 0.005 kg a.i. ha^{-1} of metsulfuron methyl resulted in a significantly greater biological yield compared to 0.03 kg a.i. ha^{-1} of sulfosulfuron and 0.04 kg a.i. ha^{-1} of clodinafop-propargyl. During the crop seasons, there was no discernible

difference in the biological yield caused by metribuzin (0.3 kg a.i. ha^{-1}), pendimethalin (1.0 kg a.i. ha^{-1}), sulfosulfuron (0.3 kg a.i. ha^{-1}), and clodinafop-propargyl (0.04 kg a.i. ha^{-1}). This may be because these treatments, like enhancement, effectively reduce weeds. The biological and financial yield of the crop is eventually impacted by any factor influencing these parameters. The amount of leaves, tillers, and dry matter accumulation in the plant prior to anthesis and sink component are examples of source and sink components. More biological yield was the result of growth and development. Comparable results were noted by Tomar & Tomar (2014) [11] and Malik *et al*. (2013) [4].

Table 2: Effect of weed management practices on biological yield (q ha^{-1})

Treatment		Biological Yield (q ha^{-1})
		2020-21
T_1	Metribuzin	101.60
T_2	Pendimethalin	103.40
T_3	Sulfosulfuron	98.60
T_4	Metsulfuron methyl	108.00
T_5	Clodinafop-propargyl	94.60
T_6	2,4-D	106.10
T_7	Carfentrazone –ethyl	110.40
T_8	Weed free	113.00
T_9	Weedy	75.00
S.Em(±)		2.63
C.D. (P=0.05)		7.67

NS * - Non Significant

Conclusion

Out of all the sprayed herbicides, carfentrazone-ethyl at 0.025 kg an i/ha shown to be the most effective at controlling weeds, both grassy and non-grassy. Carfentrazone-ethyl 0.025's ability to suppress weed growth led to a significantly better biological yield of wheat compared to the unweeded control. In this regard, we would recommend that researchers and farmers be more actively involved in incorporating ecological and technical principles into weed control decision-making.

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