



Competence of Herbicide Chemicals on Weed Control and Growth Parameters on Wheat (*Triticum aestivum*)

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Authors' contributions

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

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ABSTRACT

Wheat is a worldwide significant crop. Roughly one-sixth of the total fertile land in the world is cultivated with wheat crops. It supplies about 25% of the food calories for the world's growing population. Wheat crops are infested with several weeds namely *Phalaris minor*, *Chenopodium ablum*, *Anagallis arvensis*, *convolvulus arvensis*, etc. *Phalaris minor* Linn (Canary grass) and *Avena fatua* (Wild oat) is the primary concern in a large area of the North-western plain zone. Weed management is indispensable for increasing crop production under such circumstances, Judicious use of herbicides is the only suitable way for effective and economical weed control. Numerous post-emergence herbicides are available globally to control weeds in wheat crops that cause plant death by affecting protein or RNA biosynthesis. Post-emergence application of sulfosulfuron against *Phalaris minor* provided a 25% wheat yield compared to the weedy check. The data from the study revealed that the significant maximum number of grains/ ear head (62.17) was recorded with the

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application of Carfentrazone ethyl 5% + clodinafop propargyl 15% DF 620g/ha, which was closely followed by under the treatment of Carfentrazone ethyl 5% + clodinafop propargyl 15% DF 300g/ha (42.13) and Carfentrazone ethyl 5% + clodinafop propargyl 15% DF 800g/ha (61.98). The significantly minimum number of grains/earhead (57.59) was recorded in weedy check plot.

Keywords: *Wheat; Phalaris minor; herbicides; carfentrazone; clodinafop propargyl.*

1. INTRODUCTION

Wheat (*Triticum aestivum*) is a crop of global significance. It is a staple food of millions of people. Approximately one-sixth of the total arable land in the world is cultivated with wheat. It supplies about 20 percent of the food calories for the world's growing population. In general, wheat contains carbohydrates (70%), protein (12%), lipids (2%), vitamins and minerals (2%), and crude fiber (2%).

The major wheat-producing states of India are U.P., Punjab, and Haryana with the production of 30.29, 17.2, and 12.60 million tons. The first rank of U.P. in percentage share of wheat production (32.26%) the second in Punjab (18.33%) and third is Haryana (13.50%) but productivity is maximum in the Punjab [1].

Several constraints viz., delayed sowing, continuous canal water irrigation, and availability of fertilizers not timely according to need and infestation of weed affects wheat productivity adversely.

Wheat crops are infested with a number of weed namely *Phalaris minor*, *Chenopodium album*, *Cyperus rotundus*, *Melilotus alba*, *Anagallis arvensis*, *convolvulus arvensis*, etc. *Phalaris minor* Linn (Canary grass) and *Avena fatua* (Wild oat) are a primary concerns in a large area of the North-western plain zone. *Chenopodium album* is a prominent weed in wheat among broad leaved weeds. Among the many factors adversely influencing wheat productivity, weed infestation is one of them. Weeds compete with crop plants for nutrients, light, space, moisture, and many other growths [2].

The wheat crop was infested with both grassy weeds and not grassy weeds in their experimental field the grassy weeds *Phalaris minor* and *Avena ludoviciana* were of primary concern [3].

Weeds may encourage the development of disease, provide shelter, and acts as an alternate host for pests [4]. Weed infestation is one of the main causes of low wheat yield not only in India but all over the world, as it reduces wheat yield by 37.50% [5,6].

Thus, weed management is indispensable for increasing crop production under such circumstances, Judicious use of herbicides is the only suitable way for effective and economical weed control. Numerous post-emergence herbicides are available globally to control weeds in wheat crops, that cause plant death by affecting protein or RNA biosynthesis. Post-emergence application of sulfosulfuron against *Phalaris minor* provided a 25% wheat yield compared to weedy check [7]. Keeping this in mind, the present study on bio-efficacy of Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF as a post-emergence herbicide against predominant weeds of wheat as conducted to assess the efficiency of this herbicide.

2. MATERIALS AND METHODS

The experiment was laid out in a "Randomized Block Design" with three replications. There were 11 treatments used in this research. Three replicates were used. Total number of plots was 33. The field border was 1.0 m and the irrigation channel was 1.25. The spacing between the field border was 20 cm. The gross plot size was 5.0 x 4.0. The crop variety of wheat k-307 was sown. Fertilizer NPK was used.

2.1 Crop Variety under Study

K0307: It is widely adaptable and has a high yield potential variety used investigation. It is a one-gene dwarf variety developed from CSAUA&T, Kanpur (U.P.) during 2007, which is mostly situated to normal sown and late sown condition, under good fertilizer, irrigation management matures in about 125-130 days after sowing. It is resistant to the rust disease of wheat. The yield potentiality of this variety is about 55-60 q/ha.

Table 1. Experimental treatment combinations with symbol

S. No.	Name of the treatment	Dose (gm/ml ha ⁻¹)	Method of application	Symbol
1.	Carfentrazone ethyl + clodinafop propargyl 15% DF	300	Foliar spray	T ₁
2.	Carfentrazone ethyl + clodinafop propargyl 15% DF	400	Foliar spray	T ₂
3.	Carfentrazone ethyl + clodinafop propargyl 15% DF	500	Foliar spray	T ₃
4.	Carfentrazone ethyl + clodinafop propargyl 15% DF	800	Foliar spray	T ₄
5.	Clodinafop propargyl 15% WP	400	Foliar spray	T ₅
6.	Carfentrazone-ethyl 40% DF	50	Foliar spray	T ₆
7.	Carfentrazone ethyl 20% + Sulfosulfuron 25% WG	100	Foliar spray	T ₇
8.	Clodinafop propargyl 15% + Metsulfuron Methyl 1% WP	400	Foliar spray	T ₈
9.	Weed free	-	-	T ₉
10.	Hand weeding @ 15 and 30 DAS	-	-	T ₁₀
11.	Weedy check	-	-	T ₁₁

Table 2. Amount of herbicide and water requirement

Name of the treatment	Dose (gm/ml ha ⁻¹)	Dose/plot (g)	Amount of water liter/plot
T ₁ - Carfentrazone ethyl + clodinafop propargyl 15% DF	300	0.60	1.0
T ₂ - Carfentrazone ethyl + clodinafop propargyl 15% DF	400	0.80	1.0
T ₃ - Carfentrazone ethyl + clodinafop propargyl 15% DF	500	1.0	1.0
T ₄ - Carfentrazone ethyl + clodinafop propargyl 15% DF	800	1.60	1.0
T ₅ - Clodinafop propargyl 15% WP	400	0.80	1.0
T ₆ - Carfentrazone-ethyl 40% DF	50	0.20	1.0
T ₇ - Carfentrazone ethyl 20% + Sulfosulfuron 25% WG	100	0.80	1.0
T ₈ - Clodinafop propargyl 15% + Metsulfuron Methyl 1% WP	400	0.10	1.0

3. RESULTS

3.1 Weed Control Efficiency after Application of Herbicides

At 30 days after herbicides application weed control efficiency was recorded (Tables 3-5), the data indicated that among all the different treatments higher weed control efficiency against different weeds was recorded in weed free plot followed by Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @800/ha (86.03%, 79.14%, 86.44%, 92.63%, 87.53%, 87.02 and 100%) followed by Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @500/ha (84.50%, 75.94%, 85.04%, 88.94%, 75.07%, 79.95%, and 83.26%) and Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @400/ha (80.57%, 73.99%, 81.87%, 85.25%, 71.00%, 76.54 %, and 76.15%), respectively which was on par with each other. *Phalaris minor*, *Avena ludoviciana*, and *Melilous* spp. as the major dominant weed species in wheat crop [8].

3.2 Weed Control Efficiency at 45 & 60 Days after Application of Herbicides

At 45 days after the application of herbicides the data indicated that among all the different treatments higher weed control efficiency was

recorded in weed free plots (100%) followed by Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @800/ha followed by Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @500/ha and Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @400/ha, which was on par with each other. Application of Carfentrazone-ethyl 40% DF proved effective in reduction of weed biomass and increase in wheat yield. In this result support by the findings of Khan et al. [9].

At 60 days after application of herbicides the data indicated that among all the different treatments higher weed control efficiency was recorded in weed free plot (100%) followed by Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @800/ha (89.10%, 83.59%, 89.64%, 92.15%, 89.42%, 84.83% and 91.41%) followed by Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @500/ha (88.35%, 80.52%, 87.80%, 90.08%, 83.11%, 79.54% and 89.81%) and Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @400/ha (84.98%, 80.34%, 85.97%, 87.79%), respectively for *Phalaris minor*, *Avena ludoviciana*, *Chenopodium album*, *Melilotus alba*, which was on par with each other, whereas Carfentrazone ethyl 20% + Sulfosulfuron 25% WP, Clodinafop propargyl

15% WP for monocot weeds and Carentrazone ethyl 40% DF for dicot weeds were next in effect are on par with Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @300g/ha.

3.3 Growth and Yield Parameters

The plant height was recorded at harvest Table 6, and the significant maximum plant

height (82.13cm) was recorded in weed-free plots, which was comparable to twice hand weeding at 15 and 30 days after sowing of wheat (82.03cm). Among herbicides significantly maximum height (82.13cm) was recorded with the application of Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @400g/ha. The significantly minimum plant height (71.59cm) was recorded in weedy check plot.

Table 3. Phalaris minor control efficacy (%) after spraying of herbicides

Treatment	30 DAA	45 DAA	60 DAA
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 300 g/ha	68.00	74.83	76.78
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 400 g/ha	80.57	83.39	84.98
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 500 g/ha	84.50	87.23	88.35
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 800 g/ha	86.03	88.22	89.10
Clodinafop propargyl 15% WP @ 400 g/ha	76.38	79.22	78.04
Carfentrazone-ethyl 40% DF @ 50 g/ha	43.65	55.03	58.47
Carfentrazone ethyl 20% + Sulfosulfuron 25% WG @ 100 g/ha	66.33	72.23	71.13
Clodinafop propargyl 15% + Metsulfuron Methyl 1% WP @ 400 g/ha	74.52	77.53	76.34
Weed free	100.00	100.00	100.00
Hand weeding @ 15 and 30 DAS	80.90	66.26	61.45
Weedy check	-	-	-
SE m+	4.895	5.442	0.723
CD 5%	14.541	16.166	2.147

Table 4. Avena ludociciana control efficacy (%) after spraying of herbicides

Treatment	30 DAA	45 DAA	60 DAA
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 300 g/ha	60.22	68.09	69.95
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 400 g/ha	73.99	77.43	80.34
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 500 g/ha	75.94	78.60	80.52
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 800 g/ha	79.14	81.48	83.59
Clodinafop propargyl 15% WP @ 400 g/ha	63.84	66.69	63.40
Carfentrazone-ethyl 40% DF @ 50 g/ha	39.22	45.91	42.44
Carfentrazone ethyl 20% + Sulfosulfuron 25% WG @ 100 g/ha	55.77	62.10	60.63
Clodinafop propargyl 15% + Metsulfuron Methyl 1% WP @ 400 g/ha	61.75	68.17	66.94
Weed free	100.00	100.00	100.00
Hand weeding @ 15 and 30 DAS	73.60	50.27	45.75
Weedy check	-	-	-
SE m+	5.641	5.695	0.750
CD 5%	16.758	16.920	2.227

Table 5. Chenopodium album control efficacy (%) after spraying of herbicides

Treatment	30 DAA	45 DAA	60 DAA
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 300 g/ha	69.19	74.05	75.48
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 400 g/ha	81.87	85.12	85.97
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 500 g/ha	85.04	85.86	87.80
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 800 g/ha	86.44	88.28	89.64
Clodinafop propargyl 15% WP @ 400 g/ha	35.04	45.30	46.56
Carfentrazone-ethyl 40% DF @ 50 g/ha	72.89	78.05	78.89
Carfentrazone ethyl 20% + Sulfosulfuron 25% WG @ 100 g/ha	58.63	62.88	65.84
Clodinafop propargyl 15% + Metsulfuron Methyl 1% WP @ 400 g/ha	31.51	39.35	41.05
Weed free	100.00	100.00	100.00
Hand weeding @ 15 and 30 DAS	82.57	40.28	38.32
Weedy check	-	-	-
SE m+	5.102	4.929	0.863
CD 5%	15.156	14.642	2.565

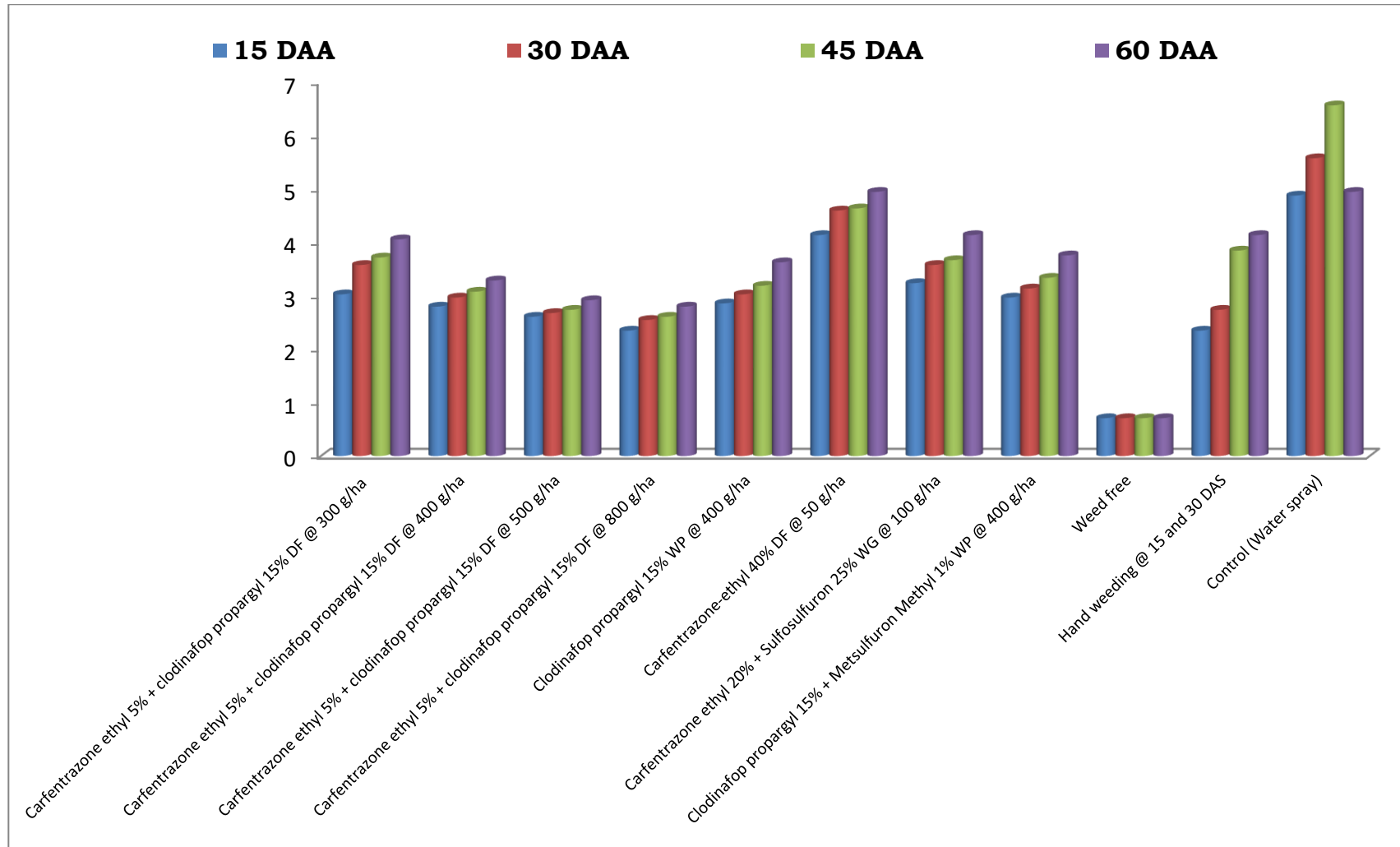


Fig. 1. *Phalaris minor* density/m² after spraying of herbicides

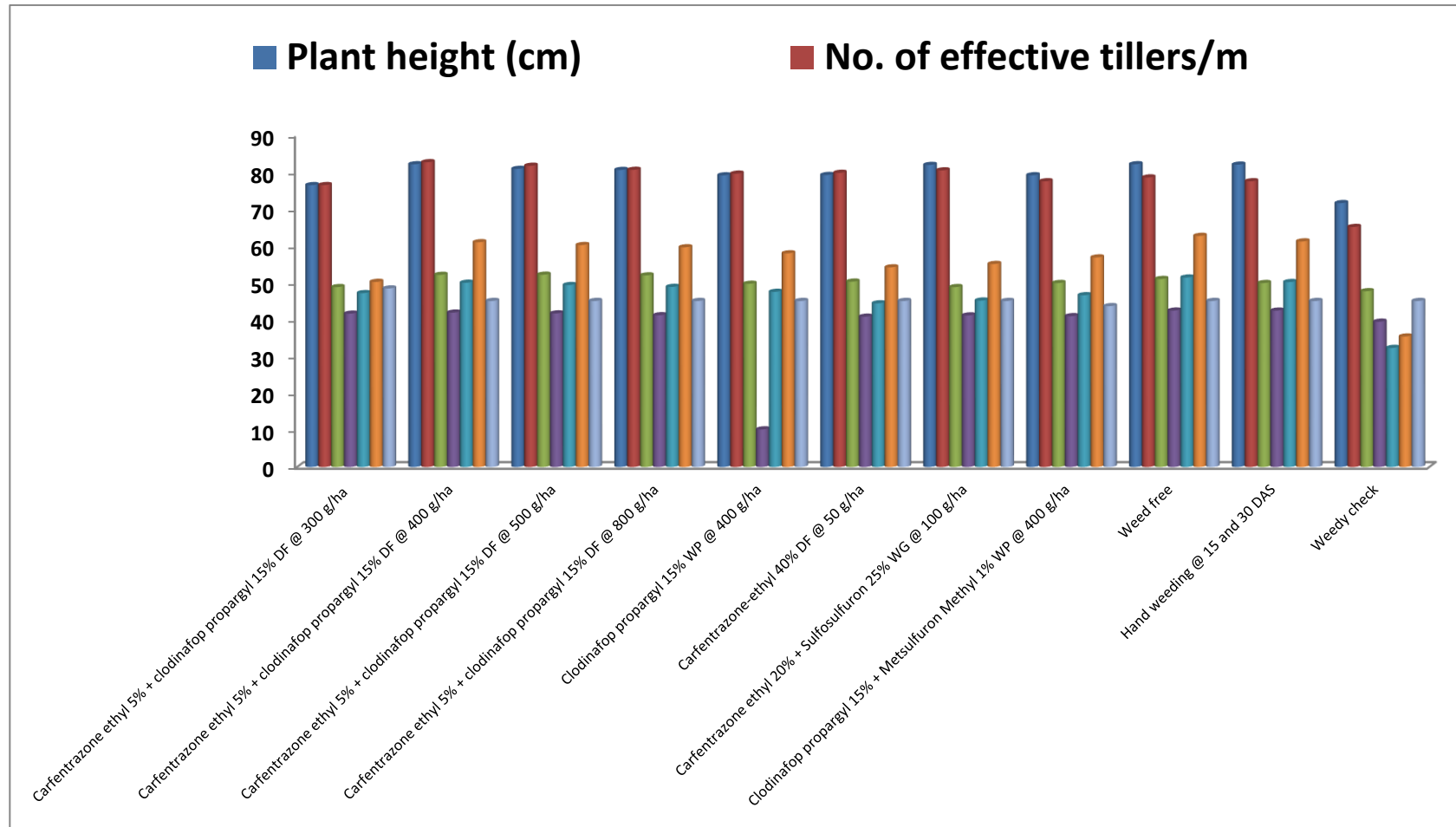


Fig. 2. Effect of herbicides on yield parameter, grain yield of wheat

Table 6. Effect of herbicides on yield parameter, grain yield of wheat

Treatment	Plant height (cm)	Grain yield (q/ha)	Straw yield (q/ha)
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 300 g/ha	76.47	47.17	50.22
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 400 g/ha	82.13	49.99	60.98
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 500 g/ha	80.88	49.36	60.21
Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @ 800 g/ha	80.59	48.86	59.60
Clodinafop propargyl 15% WP @ 400 g/ha	79.13	47.52	57.97
Carfentrazone-ethyl 40% DF @ 50 g/ha	79.22	44.40	54.16
Carfentrazone ethyl 20% + Sulfosulfuron 25% WG @ 100 g/ha	81.94	45.15	55.08
Clodinafop propargyl 15% + Metsulfuron Methyl 1% WP @ 400 g/ha	79.15	46.60	56.85
SE m+	1.081	0.540	0.85
CD 5%	3.211	1.603	2.41

The data revealed that the significantly maximum number of grains/ ear head (52.17) was recorded with the application of Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @500g/ha, which was closely followed by under the treatment of Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @400g/ha (52.13) and Carfentrazone ethyl 5% + clodinafop propargyl 15% DF @800g/ha (51.98). The significant minimum number of grains/earhead (47.69) was recorded in weedy check plot.

4. CONCLUSION

Tested herbicides failed to attain the plant height up to the level of significant. However, manual weeding registered numerically higher plant height over unseeded treatment. Plant height was registered significantly maximum 82.13cm in treatment T₂ Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 400g/ha, respectively. However, treatments weedy check plot was recorded significantly lowest plant height at harvest. Number of grains/ha recorded significant result with different herbicidal as well as weed free treatments. The yield attribute was improved under Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF herbicide application. Maximum and minimum values of these attributes were recorded under weed free and weedy check plots, respectively. Although manual weeding treatment recorded highest yield attributes than all other herbicidal treatments as well as weedy check. Yield attributes viz., 1000 grain weight among herbicidal treatment, 1000 grain weight shows significant result. The maximum 1000 grain weight was recorded under the treatment Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 400g/ha and minimum 1000 grain weight was recorded under weedy check plot. Grain yield (51.40 q/ha) was found significantly maximum in weed free plot [10]. Among herbicidal application of treatments

Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 400g/ha recorded the maximum value under application. The corresponding values was 49.99 q/ha. Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 800 g/ha showed cent per cent mortality of *Chenopodium album*, *melilotus alba*, *medicago indiculate*, *Anagallis arvensis* and *Rumex dentatus* broad leaf weeds as well as grassy weeds *Phalaris minor* and *Avena ludoviciana*. Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 800g/ha followed by Clodinafop propargyl 15% WP @ 400 g/ha were found superior concerning cent per cent mortality of *Chenopodium album*, *Melilotus alba*, *Medicago denticulate*, *Anagallis arvensis* and *Rumex dentatus* as well as found effective against the control of *Phalaris minor* and *Avena ludoviciana* over other herbicides. Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 800 g/ha was found more effective against control of grassy and broad-leaved weeds in wheat crop except Carfentrazone ethyl 40% DF and all the herbicides proved their superiority in controlling all types of weed species successfully. Rahaman and Mukherjee [11] also reported that the major weed flora of wheat crop like *Polygonum orien*.

Weed free and manual weeding recorded significantly lowest weed dry matter over all herbicide's application treatments. The herbicides application shows greater effect on weed control efficiency. The weed control efficiency against broad leaved weeds was recorded in weed free (100%) followed by Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 800g/ha followed by Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 500g/ha and Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 400g/ha, respectively at 30 days after application of herbicides. The weed control efficiency was recorded in weed free (100%) followed by

Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 800g/ha followed by Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 500g/ha and Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 400g/ha which was at par with each other at 45 days after application of herbicides. Weed control efficiency recorded at 60 days after application of herbicides. among all the different treatments higher weed control efficiency against weeds was recorded in weed free plot (100%) followed by Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 800g/ha (89.10%, 83.59%, 89.64%, 92.15%, 89.42%, 84.83% and 91.41%) followed by Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 500g/ha (88.35%, 80.52%, 87.80%, 90.88%, 83.11%, 79.54% and 89.81%) and Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 400g/ha (84.98%, 80.34%, 85.97%, 87.79%, 81.29%, 76.98% and 88.61%), respectively for *Phalaris minor*, *Avena ludoviciana*, *Chenopodium album*, *Melilotus alba*, *Medicago denticulate*, *Anagallis arvensis* and *Rumex dentatus*. Which was on par with each other whereas Carfentrazone ethyl 20% + Sulfosulfuron 25% WG, Clodinafop propargyl 15% WP for monocot weeds and Carfentrazone ethyl 40% DF for dicot weeds were next in effect and are at par with Carfentrazone ethyl 5% + Clodinafop propargyl 15% DF @ 300g/ha. The field experiment was conducted during Rabi season of 2017-18 from the above studies it is clear that Carfentrazone ethyl 5% + clodinafop propargyl 15% DF at all doses gave effectively control against all the weeds available in the field along with significant increase in yield. Carfentrazone ethyl 5% + clodinafop propargyl 15% DF showed better benefit to cost ratio in comparison to its other doses and available market samples for weed control in wheat crop. This is mainly due to effective control of weeds. These results are inconformity with the findings of Bharat et al [12].

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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