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Short communication

Effect of clodinafop propargyl alone and in combination with other herbicides on growth, yield attributes and yield of wheat

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Wheat (*Triticum aestivum* L.) plays an important role in ensuring global food security by feeding billions of people and providing half of their dietary protein and more than half of their calories (Meena *et al.,* 2017). It is mostly high in carbohydrates, but it also contains significant amounts of other nutrients like protein, fat, minerals and vitamins. In addition to its nutritious value and greater protein content than other cereals, it also has gluten protein that bakers need. It is very important for farmers and the Indian economy; hence there is a need to raise wheat's productivity level. It makes about 25 per cent of the nation's total grain production and is the second most important food crop after rice in terms of consumption. The crop is grown on an area of 223.4 million hectares with the production of 778.6 million metric tonnes in the world. In India, it is grown on an area of 31.62 million hectares with production of 109.2 million metric tonnes and productivity of 3.42 tonnes per hectare (Anonymous, 2021). While in Madhya Pradesh, it is grown on 10.02 million hectares area with the production of 16.52 million metric tonnes but productivity is far below (3.29 tonnes per hectare) than their yield potential (5.00 tonnes per hectare) and there is a need to enhance the productivity in the state. Weed management techniques play a key role in improving productivity of wheat. If weeds germinate with the emerging crop-seedlings and are not controlled in the early phases of crop growth, yields can be reduced by 10 to 40 per cent depending on the intensity and kind of weeds present in the area. Weeds compete with the crop for moisture, nutrients, space, light and other resources, which is one of the main reasons for wheat's low yield. As per a report, the yield of wheat was reduced by more than 60 per cent due to a mixed population of *Phalaris minor* and *Chenopodium album* (Singh and Singh, 2005).Therefore, control of mixed weed flora of wheat is most important for enhancing the crop yield.

The field experiment was carried out during the *rabi* season of 2021-22 at the Research Farm A, College of Agriculture, Ganj Basoda,District Vidisha (M.P.) (23^0 51' N, 77^0 55' E and at 416.66 m above mean sea level).The experimental site is characterized by sub-humid with hot dry summers and cool dry winters.The average annual rainfall in Vidisha district is 1135 mm, with most of it falling between mid-June and the end of September, with a little and occasional rains in the other months of the year. The soil in the Ganj Basoda district Vidisha region is classed as Vertisol. The depth ranges from medium to deep and the colour is black. The nine treatments viz.T_1- Clodinafop propargyl, T_2- Metsulfuron methyl, T_3- Carfentrazone ethyl, T_4- Metribuzin, T_5- Clodinafop propargyl+ metsulfuron methyl, T_6- Clodinafop propargyl + carfentrazone ethyl, T_7- Clodinafop propargyl + metribuzin, T_8-Hand weeding at 30 DAS and T_9- Weedy check were tested in randomized block design with three replications. Wheat variety HI-1544 (Purna) was treated with fungicide (Tebuconazole @ 2.5 g/kg seed) sown on 16th November, 2021at 20 cm apart using 100 kg seed/ha. The crop was harvested on 21st March, 2022. All the herbicides were applied by knapsack sprayer fitted with flat fan nozzle using spray volume of 500 litre/ha. All the herbicides were sprayed at 25 DAS of wheat crop as post emergence whereas, hand weeding was done at 30 DAS with the help of Khurpi. Other agronomic management practices were followed as per the standard recommendation. The observation on growth, yield and yield contributing parameters were recorded as per standard procedure. Grain yield and straw yield altogether were considered as biological yield. Harvest index denotes the ratio of grain yield to biological yield multiplied by 100. The statistical

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analysis of the data was done as per procedure of analysis of variance using F-test (Gomez and Gomez, 1984).

The weed control treatments had no adverse effect on plant population of wheat which was statistically the same in all herbicidal treatments, hand weeding or weedy check at 20 DAS and harvest stage (Table 1). There was no effect of control treatments on plant height and number of tillers at 30 DAS. However, the plant height and number of tillers were significantly influenced at 60, 90 DAS and at harvest stage (Table 1) as a result of weed control treatments applied. The hand weeded plot had highest plant height and number of tillers than the other treatments, because a weed free situation was obtained in the hand weeded plot. This might be due to the fact that there was no crop weed competition in these treatments and the plants were able to successfully utilized available soil moisture and plant nutrients, consequently the plant height and number of tillers increased up to maximum extent. The application of clodinafop propargyl + metsulfuron methyl (T_5) increased the plant height and number of tillers and found significantly superior to all the herbicidal treatments. This was followed by clodinafop propargyl+ metribuzin (T_7) and then clodinafop propargyl + carfentrazone ethyl (T_6) due to the excellent weed control provided by these treatments. The plants were able to avail the most of their available plant growth resources, resulting in increased plant height and number of tillers owing to the weed free environment. Similar results were also reported by Sandhu and Dhaliwal (2016) and Chaudhary *et al.* (2017).

Table 1: Plant population, plant height and number of tillers of wheat as influenced by weed control treatments at different time intervals

Treatments details	Plant population (m^{-2})		Plant height (cm)				Number of tillers (m^{-2})			
	20 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1-Clodinafop Propargyl @ 60 g a.i./ha	225.9	223.3	24.97	62.83	81.36	81.03	289.7	558.2	648.0	631.8
T_2-Metsulfuron Methyl @ 4 g a.i./ha	226.3	222.2	24.53	63.68	83.00	82.82	290.0	577.0	655.8	640.9
T_3-Carfentrazone Ethyl @ 20 g a.i./ha	224.6	220.0	25.62	62.10	83.01	82.78	286.7	572.8	651.4	636.2
T_4-Metribuzin @ 210 g a.i./ha	227.4	225.2	24.70	62.76	83.51	83.39	297.2	582.3	671.7	657.9
T_5-Clodinafop Propargyl + Metsulfuron Methyl @ 60+4 g a.i./ha	229.7	226.5	25.17	67.55	86.22	86.13	296.9	613.5	744.6	737.5
T_6-Clodinafop Propargyl + Carfentrazone Ethyl @ 60+20 g a.i./ha	225.4	223.3	25.33	64.44	84.25	84.11	288.6	588.4	697.1	685.8
T_7-Clodinafop Propargyl + Metribuzin @ 60+175 g a.i./ha	227.3	225.5	25.00	65.23	85.10	84.94	291.1	595.8	727.9	717.7
T_8-Hand weeding at 30 DAS (Once)	226.0	224.7	24.63	70.12	90.13	89.98	289.9	636.8	770.3	762.5
T_9-Weedy check	225.4	218.0	24.17	55.68	77.85	77.66	289.5	512.5	602.6	576.7
SEm±	1.03	1.73	0.54	0.23	0.22	0.21	2.63	1.97	2.76	2.81
CD at 5 %	NS	NS	NS	0.68	0.66	0.64	NS	5.92	8.28	8.41

All the yield attributing characters (Table 2) *viz.*, effective tillers, length of ear head, grains per ear head and test weight (1000 - grain weight) were significantly superior under the treatments receiving herbicide weed control or hand weeding than weedy check. The weedy check recorded the most inferior yield attributes as compared to other treatments. Whereas, hand weeded plot had higher increased yield attributing characters than weedy check plot because of the weed free condition created in the hand weeded plot at the critical stage of crop growth. Application of clodinafop propargyl + metsulfuron methyl (T_5) produced significantly higher effective tillers (613.59 m^{-2}), ear head length (10.93 cm) and test weight (45.50 g). But number of grains per ear head was recorded maximum with the application of clodinafop propargyl+metribuzin (T_7) which was statistically at par with clodinafop propargyl+metsulfuron methyl (T_5). This was because of the development of weed free situations in these plots which led to higher yield attributing characters. These findings are in accordance with those of Chaudhary *et al.* (2017) and Shaktawat *et al.* (2019).

The different weed control treatment resulted in significant differences in grain and straw yield of wheat (Table 2). Weedy check treatment produced the lowest grain yield (3175 kg ha^{-1}) and straw yield (5979 kg ha^{-1}) due to lowest value of yield attributing characters. Among herbicidal treatments, clodinafop propargyl + metsulfuron methyl (T_5) produced highest grain and straw yield (4854 and 7789 kg ha^{-1}) and proved to be significantly superior to other herbicidal treatments.

Table 2: Influence of weed control treatments on effective tillers, length of ear head, grains/ear head, test weight, grain yield, straw yield and harvest index in wheat

Treatments details	Effective tillers (m^{-2})	Length of ear head (cm)	Grains / ear head	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
T_1-Clodinafop Propargyl @ 60 g a.i./ha	505.41	8.98	39.44	37.01	3987	6209	39.10
T_2-Metsulfuron Methyl @ 4 g a.i./ha	517.24	9.81	41.09	36.56	4250	6575	39.26
T_3-Carfentrazone Ethyl @ 20 g a.i./ha	509.58	9.60	40.51	36.20	4159	6329	39.65
T_4-Metribuzin @ 210 g a.i./ha	532.19	10.37	42.36	36.35	4346	6658	39.49
T_5-Clodinafop Propargyl + Metsulfuron Methyl @ 60+4 g a.i./ha	613.59	10.93	45.50	38.23	4854	7789	38.39
T_6-Clodinafop Propargyl + Carfentrazone Ethyl @ 60+20 g a.i./ha	555.49	10.65	44.77	37.15	4482	7288	38.08
T_7-Clodinafop Propargyl + Metribuzin @ 60+175 g a.i./ha	594.71	10.84	46.74	37.49	4665	7512	38.31
T_8-Hand weeding at 30 DAS (Once)	652.10	11.20	48.52	37.84	5017	7926	38.76
T_9-Weedy check	395.60	7.86	31.58	36.47	3175	5979	34.68
SEm +	1.87	0.17	0.53	0.48	44.23	49.45	-
CD at 5 %	5.60	0.52	1.59	NS	132.60	148.25	-

However, the second-best treatment was clodinafop propargyl + metribuzin (T_7) producing 4665 kg ha^{-1} grain and 7512 kg ha^{-1} straw yield. The treatment was followed by clodinafop propargyl + carfentrazone ethyl (T_6). These three treatments reduced crop weed competition up to maximum extent and enhanced the availability of various inputs used during crop production. Therefore, higher growth parameters and yield attributing parameters were achieved, resulting in higher grain and straw yield. Under hand weeded plot (T_8), the weed free environment and least crop weed competition was persisted. Consequently, the highest grain yield (5017 kg ha^{-1}) and straw yield (7926 kg ha^{-1}) was secured. Similar findings were also reported by Chaudhary *et al.* (2017) and Shaktawat *et al.* (2019). The weedy check plot had lowest harvest index (34.68%). This could be attributed to the maximum partitioning of photosynthates towards the production of straw rather than the grain yield under weedy check. Among the herbicidal treatments, carfentrazone ethyl (T_3) recorded maximum (39.65%) harvest index because of higher amount of photosynthate assimilation. The other single applied herbicidal treatments also recorded harvest index in the same range. On the other hand, hand weeding also recorded harvest index in the same range (38.76%). All treated plots including hand weeding where weeds were controlled effectively, might have high coefficient of partitioning of photosynthates in the grains and accordingly the increased harvest index values were obtained under them. Similar findings were also reported by Shaktawat *et al.* (2019).

Among the herbicidal treatments, application of clodinafop propargyl + metsulfuron methyl @ 60 + 4 g *a.i.* ha^{-1} applied as post-emergence resulted in maximum growth parameters, yield attributing characters and yield of wheat.

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