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HERBICIDES ON WEED CONTROL AND YIELD POTENTIAL IN WHEAT-GREEN GRAM CROPPING SYSTEM UNDER TRANS-GANGETIC PLAINS OF PUNJAB"

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ABSTRACT

An field study was conducted during the two successive years of and Rabi, 2020-21, 2021-22 and Kharif, 2020-21, 2021-22 at research farm of Lovely Professional University, Jalandhar, Punjab (India) in a RBD (randomized block design) by eight weed controlling treatments with three replications. In wheat, seed yield, straw yield, and minimum total weed population and dry weight of weed in subsequent wheat were noted with Pyroxasulfone with at equality Pyroxasulfone as (PE) followed by HW twice (20 and 40 Days after sowing, 2, 4-D sodium salt with combination of 1 HW (60 DAS).The minimum weed population and dry weight of weeds, maximum weed control efficiency and green gram growth characters, No. of pods per plant, no. of seeds per pod, test weight, seed and straw yields were noted with Pendimethalin at 2 DAS (PE) with Imazethapyr at 30 DAS as (PE) which at par Imazethapyr as (PE) followed by (fb) Pendimethalin as (PoE), HW twice 20 and 40 days after sowing. It can be able to use for the extreme active weed controlling to rise the output in Green gram.

Keywords: *Herbicides, Cropping system, Green gram, Weed population and weed biomass*

Introduction

Wheat (*Triticum aestivum* L.) is the next most significant cereal crop afterward rice. All cereal crops, wheat is the best extensive main food for human ingesting. It is a photographic crop having occasionally lengthy time consequence. The wheat crop is largely grown in the Northern States and Uttar Pradesh is at the top with Total production of 25.22 million tons and it is followed by Punjab with 15.78MT. But the production of wheat crop is top in Punjab. Wheat is grown of November to December month in a number of states of India and harvesting is complete from April to May. The production of wheat is 99.70 M. Ton through grown in an area of 29.58 Million hectare in India. The production of wheat in India is about 3371 kg ha^{-1}[1]. In Punjab wheat grown in a range of 3480 thousand hectare by a produce of 16360 thousand tones. The productivity of wheat in Punjab is about 4700 kg ha^{-1}[2]. Weeds problem is major obstacles responsible for minimum productivity of irrigated wheat because, some monocot and dicot weeds infest wheat causing severe struggle for sunlight, important nutrients, moisture and space which clues reduction in wheat produce and equally its superiority (7, 6). Post-emergence of herbicide use of sulfosulfuron + metsulfuron-methyl remained identical real against monocot and dicot weeds, and noted expressively lower weed population and weed dry weight of these weeds and maximum seed yield at 60 DAS [27]. Farmers in India are adopting chemical weed control methods which are very effective, ideal and practical.

Mungbean (*Vigna radiata* L.) normally identified as "Green gram" is one of the greatest significant and

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widely grown pulse crop in India. It contains about 25 % protein, 62.6 % carbohydrate, 1.1 % fat, total dietary fiber 16.3 % and quite a lot of essential amino acid as well as lysine, which is commonly originate lacking in cereals and provided that protein rich régime to vegan population of the nation [21]. The occurrence of weeds not only disturb grain yield, but it correspondingly impacts the superiority of seed. Weed invasion and its strength at Initial phase is a very significant biotic constraint in irrigated mungbean and has been create to lessen 50- 80 per cent yield under green gram(18, 19, 8, 30, 20 and 33). Pendimethalin efficiently control the monocot and dicot weeds during early phase of crop rising at 3 to 4 leaf stage. Imazethapyr has also been noted to offer active weed switch in green gram after 30 days after sowing (28, 30). Imazethapyr, a wide-ranging herbicide, it is stay in soil for long time and less toxic effect on soil health [32]. For active managing of difficult weed flora, there is necessity to usage combination of different new herbicides [9] which would have a wide range of weed controller without crop damage and low residual impact on next crop and increases production of crop. [10].

2. Materials and Methods

2.1. Area of the field

The experiment was conducted with wheat in Rabi of 2020-2022 and green gram in kharif of 2020-2022. Two year of a cropping system has been completed at the research farm, Lovely Professional University, Jalandhar, (Punjab). The study was carried out in Sandy loam soil with low organic matter content.

2.2 Climatic Condition throughout cropping periods

Data of the maximum and minimum temperature of the experimental dated is shown in Figure 1 on a month wise (Source: Punjab Agriculture University Ludhiana, Punjab, India).

2.3. Experimental Treatments and Design

In wheat, the performance of four herbicides (Pyroxasulfone as preemergence and Sulfosulfuron + Metsulfuron, Clodinafop-propargyl and 2, 4-D sodium salt as postemergence) was evaluated by comparing with the 'hand weeding and 'weedy check' treatments as a check to observe the efficacy and economic of herbicide(s).

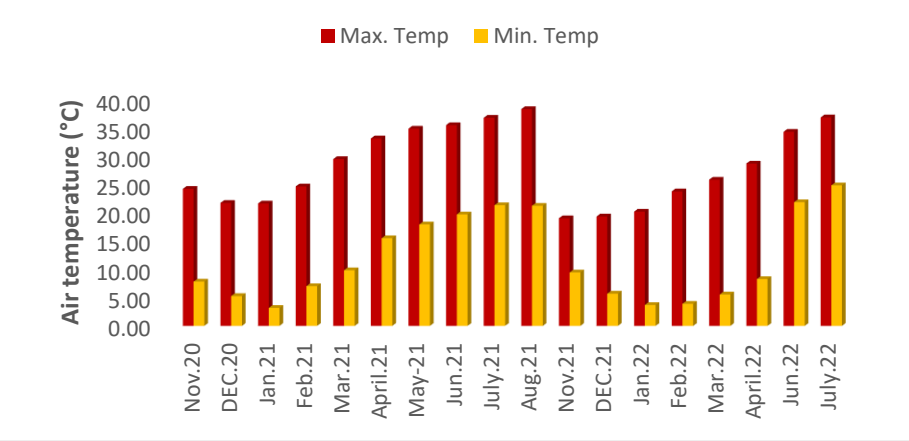

Figure 1: Monthly wise average of maximum and minimum temperature at the experimental site from November 2020 to August 2022.

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The study considered eight treatment such as T_1= Pyroxasulfone 85 % WP @ 120 g ha^{-1} (PE), T_2= Pyroxasulfone 85 % WP @ 110 g ha^{-1} (PE), T_3= Sulfosulfuron 75 % + Metsulfuron 5% WG @ 40 g ha^{-1} (PoE), T_4= Two hand weeding (30 and 60 DAS), T_5= Sulfosulfuron 75 % + Metsulfuron 5% WG @ 35 g ha^{-1} 35 (PoE), T_6= Clodinafop-propargyl 15 % WP @ 400 g ha^{-1} (PoE) + One hand weeding at 60 DAS, T_7= 2, 4-D sodium salt 80 % WP @ 750 g ha^{-1} (PoE) + One hand weeding at 60 DAS, T_8= Weedy check (Control). The wheat trial was led in a randomized block design (RBD) with three repetitions. The net pot extent of wheat trial was 8 meter length and 7 meter width.

For kharif green gram, the evaluation of five herbicides (Imazethapyr as (PE & PoE), Pendimethalin as (PE) and following herbicides are use at (PoE) Quizalofop-p-ethyl, Imazethapyr + Imazamax and Sodium Acifulourfen and Clodinafop-propargyl) was study with comparing weedy check. The study considered eight treatment such as T_1= Imazethapyr 10 % SL @ 60 g ha^{-1} (PE), T_2= Pendimethalin 30 % EC @ 1 kg ha^{-1} (PE), T_3= Pendimethalin 30 % EC @ 1 kg ha^{-1}

(PE) as + Imazethapyr @ 50 g ha^{-1} (PoE), T_4= Hand weeding twice (20 and 40 DAS), T_5= Quizalofop-p-ethyl 5 % EC @ 75 g ha^{-1} (PoE), T_6= Imazethapyr 35 % + Imazamax 35 % WG @ 75 g ha^{-1} (PoE), T_7= Sodium Acifulourfen 16.5 % and Clodinafop- propargyl 8 % EC @ 180 g ha^{-1} (PoE), T_8= Unweeded check (Control). The green gram trial was led in a randomized block design (RBD) with three replications. The net pot extent of wheat trial was 8 meter length and 7 meter width.

3. Results and discussion

3.1. Effect of herbicides on Weeds in kharif wheat

In wheat, there were seven weed species in the winter of 2020-21 and 2021-22; for there were two grasses *Phalaris minor* Retz. *Cynodon dactylon* (L.), sedges such as *Cyperus rotundus* (L.) and four broadleaf weeds *Cannabis sativa* (L.), *Chenopodium album* (L.), *Medicago denticulate* Willd. and *Parthenium hysterophorus* (L.). Similar weed species were also reported by the (6, 29 and 20).

The species wise and total weed population (density) of both monocot, sedges and dicot weeds were meaningfully regulator of Pyroxasulfone (120 g ha^{-1}) as PE at par Pyroxasulfone (110 g ha^{-1}) as PE (Table 1). However hand weeding alike meaningfully lesser weed population as compare to control. The herbicides with the combination of one hand weeding after 60 DAS shows better performance. The weedy check plot was observed highest plant population as compare to other herbicidal treatment. The outcomes are in near conformism with [16], [14].

Weed treatment had a significant effect on the reduction of weed biomass during both years of the learning (Table 2). Weed species and total minimum dry biomass of weeds remained recorded using Pyroxasulfone (120 g ha^{-1}) as PE and Pyroxasulfone vapor (110 g ha^{-1}) as PE fb 2, 4-D sodium salt (750 g ha^{-1}). 1) PoE + One hand weeding at 60 DAS this result revealed that [13]. The weedy check plot was observed highest weed dry biomass over remaining herbicidal treatment. But, all herbicides existing an important lessening in total weed dry biomass as likened to the control.

Weed control efficiency (WCE) and weed index (WI) are dynamic factors to evaluate the performance of several weed management treatments. The weed control efficacy data showed that all treatments generally provided greater than 64% weed control efficacy over the weed control. Maximum (90%) weed control efficiency and minimum weed index observed with pre-emergent use of Pyroxasulfone (120 g ha^{-1}) as PE which was at similarity through Pyroxasulfone (110 g ha^{-1}) as PE *fb* 2, 4-D sodium salt

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(750 g ha^{-1}) PoE + One hand weeding at 60 DAS (Table 3). Among herbicides, the minimum weed control efficiency was noted through Sulfosulfuron + Metsulfuron (40 g ha^{-1}) as PoE. Consecutive use of Pyroxasulfone (110 g ha^{-1}) as pre-emergent control Phalaris minor (91.78%) at 60 days after sowing (figure 5 and 6). Similar result were also found in [3]. Minimum weed control efficiency and higher weed index detected in control.

3.2 Influence of herbicides on growth character in Rabi wheat

A comparatively higher number of plant per hectare, plant population observed highest under pre-emergence application of Pyroxasulfone (120 g ha^{-1}) as PE which was on the same near of Pyroxasulfone (110 g ha^{-1}) as PE *fb* hand weeding (30 and 60 DAS). Shows better result as compare to weed check (Table 4). The herbicides with the combination of one hand weeding after 60 DAS shows better performance.

A significant lessening in plant height was observed in the no-weed control, which may have been due to competition between the crop and the weed for soil moisture, plant nutrients, sunlight and space during the active growth period (Table 4). These results were consistent with those reported by [23] and [24].

These results were in agreement with the consequences stated by [23] and [24]. Higher plant height were recorded for the application of Pyroxasulfone (120 g ha^{-1}) as PE which was on the same level of Pyroxasulfone (110 g ha^{-1}) as PE as liken to weedy check.

The data presented 60 days after sowing in (Table 5) exposed that weed controller treatments meaningfully pretentious the active tillers in wheat. Pre-emergent use of Pyroxasulfone (120 g ha^{-1}) as PE which was on the same level of Pyroxasulfone (110 g ha^{-1}) as PE fb post-emergence application of 2, 4-D sodium salt (750 g ha^{-1}) PoE + One hand weeding at 60 DAS produced a higher number of viable tillers than the other herbicide treatments and remained at the same level as the no-weed control, this result showing close agreement with [15]. This can be attributed to viable weed control, leading to less weed problems.

3.3 Impact of herbicides on yield and yield characteristics and economics of rabi wheat

The higher stature of yield characteristics, *viz*. No. of spike m^{-2}, Spike length (cm), No. of grains $spike^{-1}$ and Test weight (g) for the use of Pyroxasulfone (120 g ha^{-1}) as PE which was at par with Pyroxasulfone (110 g ha^{-1}) as PE *fb* post-emergent use of 2, 4-D sodium salt (750 g ha^{-1}) PoE + One hand weeding at 60 DAS, HW twice (20 and 40 DAS), Clodinafop-propargyl 400 g ha^{-1} + 1 HW (60 DAS) as liken to control (Table 10). Similar result were also found in [4], [13].

Herbicide application had an important consequence on the yield of wheat grain and straw (Table 5). This may be due to the good seed yield obtained in these treatments due to better weed management. The highest wheat grain yield was noted through Pyroxasulfon (120 g ha^{-1}) as PE, which was comparable to Pyroxasulfon (110 g ha^{-1}) because PE almost alike results were found in [5] and [11]. the herbicides Sulfosulfuron + Metsulfuron (35 g ha^{-1}) applied post-emergence yielded a grain yield of 2.6 ton ha^{-1}, which is the lowest wheat grain yield associated to control (Table 10).

Maximum values of gross return (₹ 78,555 ha^{-1}), net monetary returns (₹ 53038 ha^{-1}) and Benefit cost ratio (1.77) remained noted through Pyroxasulfone (120 g ha^{-1}) as PE which was on the same level of Pyroxasulfone (110 g ha^{-1}) as PE. The minimum net monetary returns and Benefit cost ratio were though detected by weedy check practice throughout together the years (Table 10). The variation in Benefit cost ratio is due to the price of chemical weed controller and return of the crop. The alike result was observed by [20].

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3.4. Influence of herbicides on Weeds in kharif green gram

Both monocot and dicot weeds were observed but dominance of both weeds was more in entire field. Among mentioned five weed species in the winter of 2020-21 and 2021-22; for there were two grasses *Commelina benghalensis* L., *Digitaria sanguinalis* L., sedges *Cyperus rotundus* L., and two broadleaf weeds such as *Cassia tora* L., *Celosia argentea* L. Similar weed flora were also observed in (31 and 26).

Weed free treatment results shows less species wise, total weed population and dry weight of weeds. Herbicidal treatments significantly influenced the weed population and dry weight of weeds. The density and biomass of both monocot and docot weeds were suggestively lowest by all weed controller treatments likened to control, though, weed free (two hand weedings) noted minimum count of dicot, monocot and total weeds than the remaining of the treatments. The lowest weed population and dry weight of weeds were seen for the use of pendimethalin (1 kg ha^{-1}) as (PE) with followed by Imazethapyr (50 g ha^{-1}) as (PoE) at 40 days after sowing (Table 6 and 7). Higher weed population were count under weedy check as liken to herbicidal treatment. Similar outcome were detected in [34].

Weed control efficiency (WCE) show the true magnitude of weed dry weight reduction by different weed treatments. Weed control efficiency (WCE) varied with different weed control methods at 40 days after sowing (Table 8). In the WCE, the total dry weight of the weeds, which consist of different weed species with different proportions, was taken into account. At 40 DAS, the maximum weed control efficiency (86.94%) and weeding index (0.00) of grasses, sedges and broadleaf weeds were recorded with the combined application of Pendimethalin (1 kg g ha^{-1}) + Imazethapyr (50 g ha^{-1}) fb HW twice (20 and 40 DAS), Figure 3 and 4. Lowest weed control efficiency and higher weed index recorded in weed control in both years. This result was in close agreement with [31].

3.5 Effect of herbicides on kharif green gram

The collected data (Table 9) revealed that all weed treatments significantly higher plant population after 40 days after sowing better observed when applying Pendimethalin (1 kg ha^{-1}) + Imazethapyr (50 g ha^{-1}) fb Imazethapyr (60 g ha^{-1}) as PE compared to control.

A significant reduction in plant height was observed in the no-weed control, which may have been due to competition between the crop and the weed for soil moisture, plant nutrients, sunlight and space during the active growth period. Greengram growth characters were significantly affected by weed treatments. Hand weeding twice at 15 and 30 DAS than other herbicide treatments. However, the combination of pre-emergence and post-emergence application of Pendimethalin (1 kg ha^{-1}) + Imazetapyr (50 g ha^{-1}) produced significantly taller plants (32.62 cm). Plant height of greengram under different herbicide combinations was comparable. This result revealed that [22].

The consecutive use of pre-emergence and post-emergence herbicide Pendimethalin (1 kg ha^{-1}) with combination of Imazethapyr (50 g ha^{-1}) resulted higher number of branches per plant. Different weed control method significantly affected no. of branches per plant as liken to weedy check. The similar result were observed in [20].

3.6 Impact of herbicides on yield and yield attributes and economics of kharif green gram

With respect to yield characteristics, a significantly higher number of pods per plant, grains per pod and test weight were recorded when Pendimethalin (1 kg ha^{-1}) + Imazetapyr (50 g ha^{-1}) was applied (Table 10). Pre-emergence application of Imazetapyr (60 g ha^{-1}), Pendimethalin (1 kg ha^{-1}) and HW

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twice (20 and 40 DAS) produced comparable results in terms of number of pods per plant and seeds per pod. Better weed control in these treatments would favor increased resource-relatedness, leading to more yield-attributing traits [12], [17]. The lowest number of pods per plant was noted during the control.

Seed yield and straw yield of greengram improved meaningfully absence of crop weed competition due to the use of Pendimethalin (1 kg ha^{-1}) *fb* Imazethapyr (50 g ha^{-1}) noted meaningfully higher mean grain yield and straw yield over other treatments (Table 5). The lower seed and straw yield observed in weedy chaeck as compare to rest of the treatment. Similar consequence were also detected in [22].

Table.1: Influence of herbicides on weed species and total weed density (no. m^{-2}) at 60 days after sowing of Wheat by weed management treatments (Cumulative data for two years 2020-21 to 2021-22)

Treatments	Grasses		Sedges	Broadleaf				Total weed density
	P. minor	C. dactylon	C. rotundus	C. sativa	C. album	M. denticulate	P. hysterophorus	
Pyroxasulfone (120 g ha^{-1})	1.18 (1.41)	1.29 (1.67)	1.23 (1.53)	0.98 (1.00)	1.05 (1.11)	0.98 (0.97)	0.99 (0.99)	2.94 (8.67)
Pyroxasulfone (110 g ha^{-1})	1.22 (1.51)	1.33 (1.79)	1.29 (1.67)	1.08 (1.17)	1.10 (1.21)	1.01 (1.03)	1.01 (1.03)	3.14 (9.89)
Sulfosulfuron + Metsulfuron (40 g ha^{-1})	1.86 (3.49)	1.79 (3.22)	1.99 (3.96)	1.40 (1.96)	1.37 (1.88)	1.44 (2.08)	1.39 (1.93)	4.30 (18.52)
HW twice (20 and 40 DAS)	1.08 (1.18)	1.07 (1.15)	1.05 (1.10)	1.05 (1.11)	1.02 (1.05)	1.01 (1.09)	1.02 (1.05)	2.80 (7.82)
Sulfosulfuron + Metsulfuron (35 g ha^{-1})	1.88 (3.57)	1.63 (2.68)	1.98 (3.94)	1.45 (2.11)	1.44 (2.08)	1.48 (2.20)	1.40 (1.97)	4.30 (18.53)
Clodinafop-propargyl 400 g ha^{-1} + 1 HW (60 DAS)	1.75 (3.09)	1.67 (2.79)	1.84 (3.39)	1.36 (1.86)	1.36 (1.86)	1.37 (1.88)	1.34 (1.82)	4.10 (16.84)
2, 4-D sodium salt 750 g ha^{-1} + 1 HW (60 DAS)	1.55 (2.42)	1.58 (2.51)	1.76 (3.08)	1.25 (1.58)	1.35 (1.82)	1.34 (1.81)	1.03 (1.06)	3.77 (14.27)
Unweeded check (Control)	2.62 (6.91)	2.15 (4.63)	2.22 (4.90)	1.70 (2.89)	1.57 (2.47)	1.50 (2.26)	1.63 (2.67)	5.16 (26.71)
SE (m±)	**0.08**	**0.13**	**0.11**	**0.12**	**0.11**	**0.11**	**0.14**	**0.08**
CD (p = 0.05)	**0.25**	**0.39**	**0.33**	**0.36**	**0.31**	**0.34**	**0.41**	**0.24**

All Numbers are exposed to converted values to square root (√x+0.5).

Among the herbicidal treatment, the maximum net returns were recorded with Pendimethalin 1 kg ha^{-1} *fb* Imazethapyr 50 g ha^{-1} (Table 5) *fb* Imazethapyr (60 g ha^{-1}) and the minimum Quizalofop-p-ethyl 75 g ha^{-1}. The highest benefit:cost ratio was achieved with Pendimethalin 1 kg ha^{-1} + Imazethapyr 50 g ha^{-1} and the lowest Quizalofop-p-ethyl (75 g ha^{-1}) as compare to control. The maximum net return for the pre-emergent use of Pendimethalin (1 kg ha^{-1}) *fb* Imazethapyr (50 g ha^{-1}) it is similar to [26].

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Table.2. Influence of herbicides on weed species and total weed biomass (no. m^{-2}) at 60 days after sowing of Wheat by weed controller treatments (cumulative data of two years 2020-21 to 2021-22)

Treatments	Grasses		Sedges	Broadleaf				Total weed density
	P. minor	C. dactylon	C. rotundus	C. sativa	C. album	M. denticulate	P hysterophorus	
Pyroxasulfone (120 g ha^{-1})	0.42 (0.17)	0.35 (0.13)	0.37 (0.138)	0.20 (0.042)	0.32 (0.101)	0.22 (0.049)	0.22 (0.048)	0.82 (0.68)
Pyroxasulfone (110 g ha^{-1})	0.41 (0.10)	0.36 (0.13)	0.38 (0.144)	0.22 (0.047)	0.33 (0.125)	0.23 (0.054)	0.24 (0.056)	0.84 (0.71)
Sulfosulfuron + Metsulfuron (40 g ha^{-1})	0.66 (0.44)	0.57 (0.33)	0.53 (0.283)	0.31 (0.097)	0.47 (0.219)	0.26 (0.070)	0.91 (0.820)	1.50 (2.26)
HW twice (20 and 40 DAS)	0.38 (0.14)	0.41 (0.17)	0.30 (0.092)	0.19 (0.038)	0.30 (0.090)	0.20 (0.040)	0.20 (0.039)	1.79 (0.62)
Sulfosulfuron + Metsulfuron (35 g ha^{-1})	0.67 (0.44)	0.54 (0.29)	0.55 (0.305)	0.33 (0.111)	0.50 (0.253)	0.27 (0.074)	0.69 (0.481)	1.25 (1.57)
Clodinafop-propargyl 400 g ha^{-1} + 1 HW (60 DAS)	0.60 (0.36)	0.51 (0.26)	0.48 (0.234)	0.28 (0.080)	0.38 (0.146)	0.30 (0.091)	0.66 (0.434)	1.27 (1.61)
2, 4-D sodium salt 750 g ha^{-1} + 1 HW (60 DAS)	0.50 (0.25)	0.48 (0.23)	0.49 (0.244)	0.25 (0.062)	0.37 (0.135)	0.30 (0.088)	0.28 (0.077)	1.23 (1.52)
Unweeded check (Control)	1.42 (2.01)	1.20 (1.43)	1.03 (1.065)	0.55 (0.301)	0.95 (0.910)	0.58 (0.340)	0.60 (0.360)	2.45 (5.98)
SE (m±)	**0.04**	**0.06**	**0.04**	**0.02**	**0.06**	**0.03**	**0.04**	**0.10**
CD (p = 0.05)	**0.12**	**0.17**	**0.11**	**0.06**	**0.18**	**0.09**	**0.122**	**0.30**

All Numbers are exposed to converted values to square root (√x+0.5).

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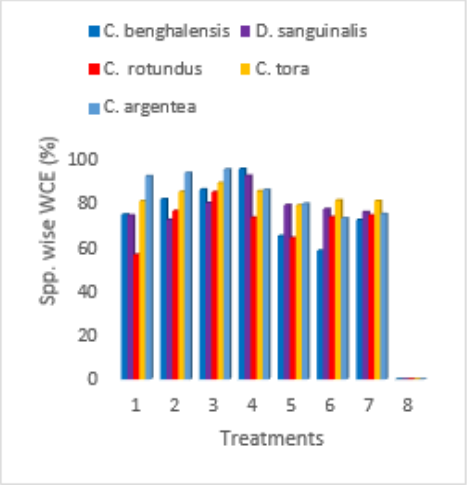

Fig.3 Impact of different weed management treatment On weed count in green gram

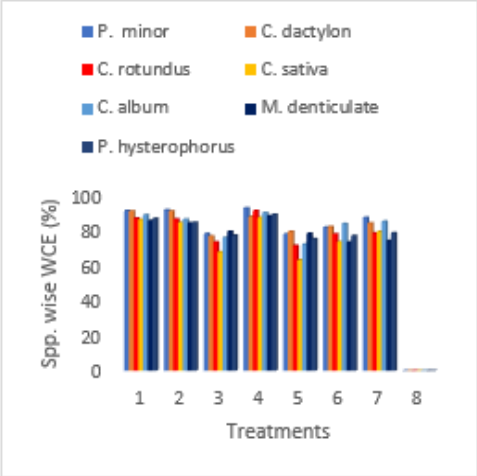

Fig.5 Impact of altered herbicides on Spp. weed control efficiency in wheat field

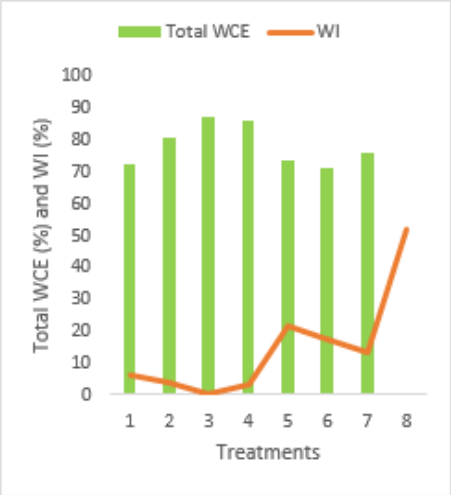

Fig.4 Impact of different weed management treatment On weed control efficiency and weed index in Green gram

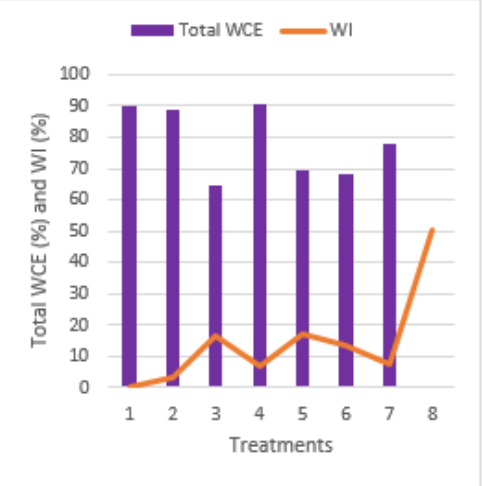

Fig.6 Impact of altered herbicides on total weed control efficiency in wheat

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Table.3: Influence of herbicides on weed species, total weed control efficiency (no. m^{-2}) at 60 days after sowing and WI (%) of Wheat by weed controller treatments (cumulative data of two years 2020-21 to 2021-22)

Treatments	Grasses		Sedges	Broadleaf				Total WCE (%)	Weed Index (%)
	P. minor	C. dactylon	C. rotundus	C. sativa	C. album	M. denticulate	P. hysterophorus		
Pyroxasulfone (120 g ha^{-1})	91.37	91.07	87.06	86.23	88.94	85.60	86.82	90.00	0.00
Pyroxasulfone (110 g ha^{-1})	91.78	91.06	86.50	84.41	86.30	84.29	84.61	88.87	3.41
Sulfosulfuron + Metsulfuron (40 g ha^{-1})	78.20	76.81	73.35	67.76	75.97	79.45	77.22	64.76	16.21
HW twice (20 and 40 DAS)	92.85	87.90	91.35	87.40	90.16	88.41	89.17	90.41	6.54
Sulfosulfuron + Metsulfuron (35 g ha^{-1})	77.92	79.39	71.29	63.21	72.20	78.41	75.28	69.14	17.10
Clodinafop-propargyl 400 g ha^{-1} + 1 HW (60 DAS)	81.90	82.08	78.02	73.57	83.94	73.39	76.97	68.28	13.53
2, 4-D sodium salt 750 g ha^{-1} + 1 HW (60 DAS)	87.37	84.19	78.53	79.41	85.20	74.13	78.62	77.58	7.20
Unweeded check (Control)	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	50.43
SE (m±)	-	-	-	-	-	-	-	-	**0.49**
CD (p = 0.05)	-	-	-	-	-	-	-	-	**1.47**

Table.4: Influence of herbicides on growth characters of kharif green gram at 60 days after sowing by weed controller treatments (Cumulative data of two years 2020-21 to 2021-22)

Treatments	**Plant population (no. m^{-2})**	**Plant height (cm)**	**No. of tillers m^{-2}**
Pyroxasulfone (120 g ha^{-1})	179.72	47.99	97.87
Pyroxasulfone (110 g ha^{-1})	178.72	47.47	97.56
Sulfosulfuron + Metsulfuron (40 g ha^{-1})	172.94	46.00	92.43
HW twice (20 and 40 DAS)	177.70	46.39	94.82
Sulfosulfuron + Metsulfuron (35 g ha^{-1})	171.83	45.55	91.79
Clodinafop-propargyl 400 g ha^{-1} + 1 HW (60 DAS)	176.82	46.16	93.95
2, 4-D sodium salt 750 g ha^{-1} + 1 HW (60 DAS)	177.82	46.71	95.94
Unweeded check (Control)	165.01	38.75	77.05
SE (m±)	**0.85**	**0.69**	**0.69**
CD (p = 0.05)	**2.57**	**2.09**	**2.10**

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Table.5: Impact of herbicides on yield and yield characteristics and the economy of wheat (Cumulative data 2020-21 and 2021-22)

Treatments	No. of spike m^{-2}	Spike length (cm)	No. of grains/spike	Test weight (g)	Seed yield t ha^{-1}	Straw yield (t ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
Pyroxasulfone (120 g ha^{-1})	340.69	11.48	32.59	38.69	3251	3794	78555	53038	1.77
Pyroxasulfone (110 g ha^{-1})	337.78	11.43	32.14	37.69	3140	3772	75980	31869	1.73
Sulfosulfuron + Metsulfuron (40 g ha^{-1})	331.02	11.20	31.62	36.30	2724	3268	65909	24425	1.59
HW twice (20 and 40 DAS)	335.67	11.37	31.87	36.38	3038	3611	73481	36444	1.69
Sulfosulfuron + Metsulfuron (35 g ha^{-1})	330.93	11.16	31.55	36.04	2695	3234	65207	23862	1.58
Clodinafop-propargyl 400 g ha^{-1} + 1 HW (60 DAS)	335.26	11.24	31.74	36.18	2811	3250	67892	23957	1.59
2, 4-D sodium salt 750 g ha^{-1} + 1 HW (60 DAS)	336.23	11.55	32.45	38.87	3017	3154	72533	26002	1.67
Unweeded check (Control)	320.81	10.77	30.18	34.78	1611	2441	39494	317	1.01
SE (m±)	**0.70**	**0.56**	**0.43**	**0.37**	**49.47**	**53.63**	-	-	-
CD (p = 0.05)	**2.12**	**1.69**	**1.32**	**1.12**	**150.04**	**162.79**	-	-	-

Table.6: Influence of herbicides on different species and total weed density (no. m^{-2}) at 40 days after sowing of kharif green gram by weed controlled treatments (Cumulative data for two years 2020-21 to 2021-22)

Treatments	Grasses		Sedges	Broadleaf		Total weed density
	C. benghalensis	D. sanguinalis	C. rotundus	C. tora	C. argentea	
Imazethapyr (60 g ha^{-1})	1.53 (2.35)	1.80 (3.23)	2.41 (5.83)	1.17 (1.37)	1.23 (1.52)	4.01 (16.07)
Pendimethalin (1 kg ha^{-1})	1.36 (1.84)	1.59 (2.53)	1.85 (3.42)	1.14 (1.31)	1.05 (1.11)	3.56 (12.64)
Pendimethalin (1 kg ha^{-1}) fb Imazethapyr (50 g ha^{-1})	1.21 (1.59)	1.31 (1.72)	1.08 (1.17)	1.07 (1.15)	1.12 (1.25)	2.64 (6.96)
HW twice (20 and 40 DAS)	1.03 1.06	1.07 (1.14)	1.88 (3.53)	1.10 (1.20)	1.42 (2.03)	2.98 (8.90)
Quizalofop-p-ethyl (75 g ha^{-1})	1.57 (2.45)	1.79 (3.21)	3.68 (13.54)	1.39 (1.93)	1.49 (2.23)	4.73 (22.34)
Imazethapyr + Imazamax (75 g ha^{-1})	1.64 2.69	1.69 (2.54)	3.40 (11.55)	1.65 (2.74)	1.77 (3.14)	4.64 (21.58)
Sodium Acifulourfen and Clodinafop- propargyl (180 g ha^{-1})	1.51 (2.28)	1.68 (2.82)	3.32 (11.03)	1.20 (1.45)	1.39 (1.94)	4.41 (19.48)
Unweeded check (Control)	3.19 (10.16)	3.32 (11.03)	4.70 (22.05)	2.84 (8.08)	3.48 (12.12)	7.97 (63.45)
SE (m±)	**0.12**	**0.12**	**0.14**	**0.15**	**0.16**	**0.11**
CD (p = 0.05)	**0.37**	**0.32**	**0.41**	**0.45**	**0.47**	**0.32**

All Numbers are exposed to converted values to square root (√x+0.5).

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Table.7: Effect of herbicides on weed species and total dry biomass (g m^{-2}) 40 days after sowing of kharif green gram by anti-weed treatment (cumulative data for two years 2020-21 to 2021-22)

Treatments	Grasses		Sedges	Broadleaf		Total weed density
	C. benghalensis	D. sanguinalis	C. rotundus	C. tora	C. argentea	
Imazethapyr (60 g ha^{-1})	0.35 (0.12)	0.026 (0.068)	0.40 (0.157)	0.30 (0.087)	0.17 (0.03)	0.77 (0.60)
Pendimethalin (1 kg ha^{-1})	0.29 (0.08)	0.027 (0.073)	0.29 (0.087)	0.29 (0.069)	0.15 (0.025)	0.58 (0.34)
Pendimethalin (1 kg ha^{-1}) fb Imazethapyr (50 g ha^{-1})	0.25 (0.06)	0.23 (0.054)	0.24 (0.057)	0.23 (0.052)	0.14 (0.02)	0.48 (0.23)
HW twice (20 and 40 DAS)	0.16 (0.02)	0.15 (0.023)	0.31 (0.098)	0.26 (0.067)	0.23 (0.054)	0.50 (0.25)
Quizalofop-p-ethyl (75 g ha^{-1})	0.39 (0.15)	0.24 (0.056)	0.35 (0.125)	0.31 (0.095)	0.29 (0.089)	0.72 (0.52)
Imazethapyr + Imazamax (75 g ha^{-1})	0.43 (0.18)	0.25 (0.060)	0.32 (0.097)	0.29 (0.085)	0.30 (0.093)	0.72 (0.51)
Sodium Acifulourfen and Clodinafop- propargyl (180 g ha^{-1})	0.35 (0.12)	0.25 (0.064)	0.30 (0.094)	0.32 (0.077)	0.27 (0.078)	0.66 (0.43)
Unweeded check (Control)	0.66 (0.43)	0.51 (0.260)	0.59 (0.355)	0.69 (0.43)	0.57 (0.33)	1.34 (1.80)
SE (m±)	**0.02**	**0.02**	**0.03**	**0.03**	**0.02**	**0.07**
CD (p = 0.05)	**0.06**	**0.05**	**0.08**	**0.09**	**0.05**	**0.21**

All Numbers are exposed to converted values to square root (√x+0.5)

Table.8: Effect of herbicides on species, total weed control efficiency 40 days after sowing and WI (%) of kharif green gram by anti-weed management treatment (cumulative data for two years 2020-21 to 2021-22)

Treatments	Grasses		Sedges	Broadleaf		Total weed density (%)	Weed Index (%)
	C. benghalensis	D. sanguinalis	C. rotundus	C. tora	C. argentea		
Imazethapyr (60 g ha^{-1})	73.81	73.33	55.79	79.76	90.91	72.63	6.49
Pendimethalin (1 kg ha^{-1})	80.68	71.42	75.36	83.93	92.45	80.90	3.86
Pendimethalin (1 kg ha^{-1}) fb Imazethapyr (50 g ha^{-1})	85.01	78.97	83.81	87.91	93.95	86.94	0.00
HW twice (20 and 40 DAS)	94.18	91.12	72.40	84.28	84.74	86.03	3.45
Quizalofop-p-ethyl (75 g ha^{-1})	64.14	78.00	63.26	77.90	78.65	73.78	21.53
Imazethapyr + Imazamax (75 g ha^{-1})	57.60	76.17	72.63	80.11	72.13	71.25	17.73
Sodium Acifulourfen and Clodinafop- propargyl (180 g ha^{-1})	71.36	74.83	73.39	79.86	74.02	75.79	13.18
Unweeded check (Control)	0.00	0.00	0.00	0.00	0.00	0.00	52.11
SE (m±)	-	-	-	-	-	-	**0.54**
CD (p = 0.05)	-	-	-	-	-	-	**1.63**

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Table.9: Effect of herbicides on growth characters of kharif green gram at 40 days after sowing by weed management treatments (Cumulative data for two years 2020-21 to 2021-22)

Treatments	Plant population (No. m^{-2})	Plant height (cm)	No. of branches $plant^{-1}$
Imazethapyr (60 g ha^{-1})	29	31.64	2.95
Pendimethalin (1 kg ha^{-1})	28	32.36	3.05
Pendimethalin (1 kg ha^{-1}) *fb* Imazethapyr (50 g ha^{-1})	29	32.62	3.12
HW twice (20 and 40 DAS)	28	31.85	2.84
Quizalofop-p-ethyl (75 g ha^{-1})	27	30.68	2.66
Imazethapyr + Imazamax (75 g ha^{-1})	28	31.14	2.73
Sodium Acifulourfen and Clodinafop- propargyl (180 g ha^{-1})	29	31.62	2.82
Unweeded check (Control)	28	29.86	2.54
SE (m±)	**0.72**	**0.77**	**0.23**
CD (p = 0.05)	**2.19**	**2.33**	**0.69**

Table.10: Impact of herbicides on yield and yield attributes and economics of kharif green gram

Treatments	No. of pods/plant	No. of grains/pod	Test weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
Imazethapyr (60 g ha^{-1})	20.15	10.47	31.88	678	2277	46342	18879	1.69
Pendimethalin (1 kg ha^{-1})	21.00	11.36	32.65	697	2372	47661	19533	1.70
Pendimethalin (1 kg ha^{-1}) *fb* Imazethapyr (50 g ha^{-1})	21.26	11.99	32.86	725	2448	49559	21393	1.76
HW twice (20 and 40 DAS)	15.76	9.75	30.99	700	2366	47854	19935	1.72
Quizalofop-p-ethyl (75 g ha^{-1})	15.98	8.26	28.79	569	2051	39020	11435	1.42
Imazethapyr + Imazamax (75 g ha^{-1})	16.35	8.77	29.48	596	2075	40822	13227	1.48
Sodium Acifulourfen and Clodinafop- propargyl (180 g ha^{-1})	18.96	9.57	30.46	629	2118	43021	15123	1.55
Unweeded check (Control)	14.35	7.76	26.60	347	1222	23798	-2437	0.91
SE (m±)	0.54	0.50	0.83	49.47	53.63	-	-	-
CD (p = 0.05)	1.63	1.52	2.52	150.04	162.79	-	-	-

Conclusion

It can be concluded that all types of weed such as grasses, sedges and broadleaf in kharif green gram were controlled by consecutive use of Pendimethalin (1 kg ha^{-1}) as Pre-emergent followed by Imazethapyr (50 g ha^{-1}) as post-emergence as they provide higher seed yield and Benefit cost ratio with bettare weed control efficiency without detrimental effect on subsequent wheat crop. In wheat, the use of Pyroxasulfon (120 g ha^{-1}) as pre-emergent was comparable to Pyroxasulfon (110 g ha^{-1}) as PE fb post-emergent use of 2,4-D sodium salt (750 g ha^{-1}) Afterward emergence, they were the most effective all types of weeds were controlled and higher seed yields and monetary benefits were

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obtained. The use of premix herbicides can be beneficial for operational and environmentally friendly weed control in wheat.

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Conflict of Interest

All authors declare no conflicts of interest in this paper

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