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EFFICACY OF DIFFERENT PRE AND POST EMERGENCE HERBICIDES IN CLUSTERBEAN

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SUMMARY

Efficacy of different herbicides in clusterbean was studied at Research Farm, Department of Agronomy, CCS Haryana Agricultural University, Hisar during *kharif* 2018 and 2019. *Digera arvensis*, *Trianthema portulacastrum, Echinochloa colona* and *Cyperus rotundus* dominated the weed flora of the experimental field. Application of pendimethalin + imazethapyr (RM) at 1000 g/ha resulted in lower weed density, less dry matter accumulation by weeds and provided higher weed control efficiency of 97.6 and 85.8% during 2018 and 2019, respectively followed by pendimethalin + imazethapyr (TM) at 750 + 50 g/ha and pyroxasulfone + pendimethalin 106 + 1000 g/ha (TM). Highest seed yield (1047 kg/ha) was recorded with weed free treatment. Among different herbicides, pendimethalin + imazethapyr (RM) at 1000 g/ha resulted in more pods/plant, taller plants and higher seed yield (907 kg/ha) followed by pendimethalin + imazethapyr (TM) at 750 + 50 g/ha (887 kg/ha) as pre-emergence application. Weedy conditions resulted in more than 60% reduction in seed yield as compared to weed free.

Key words : Clusterbean, Herbicides, pre-emergence, weed control efficiency and seed yield

Clusterbean (*Cyamopsis tetragonoloba* L.) commonly known as Guar is a deep rooted drought tolerant legume grown in the arid and semiarid regions during *Kharif* season cultivated under rainfed or restricted irrigation condition. It is a multipurpose crop used as a green fodder, vegetable as well as green manure, seed purpose and is also an important industrial crop mainly grown for extraction of gum which can be used in almost all types of industries *viz*., fertilizers, petroleum, pharmaceuticals, food additives, oil drilling etc. (Sharma *et al*., 2019) The by product after gum extraction can be used as protein supplement for animals. India being the largest producer of the clusterbean contributes about 80% of the total production of clusterbean in the World. Haryana is the 2nd largest producer of clusterbean after Rajasthan (Sangwan *et al*., 2018). Clusterbean is a poor competitor of weeds and also a crop of rainy season. In *kharif* season, the weed population increases tremendously with the frequent rains which competes for the nutrients, moisture and space causing considerable yield reduction ranging from 29-48 per cent depending on the infestation of weed species and their densities. Critical period of crop weed competition in clusterbean has been identified as 20-40 days after sowing (DAS) and presence of weeds beyond this result in even more than 80% yield reduction depending on the intensities of weeds infestation and its duration (Patil *et al.,* 2021). Guar crop is infested with both grasses and broad leaved weeds. Weeds are ubiquitous and their presence in different crops particularly in rainy season crops act as major limiting factor in achieving potential harvest. Hand weeding is a common and traditional method of weed control but unavailability of labor during peak weeding periods, increasing wages imposing limitations on economic feasibility of hand weeding and incessant rains during the rainy season are the major constraints. Hence, use of herbicides/ chemicals have assumed a greater significance, particularly in intensive agriculture due to their ability of providing quick, effective, selective and economical weed control in terms of time and labour. Sequential application of herbicides aims at controlling broad spectrum control and consistent control of weeds throughout the growing season of crop. Many pre-plant incorporated (PPI) and pre-emergence (PRE) herbicides like fluchloralin, trifluralin and pendimethalin recommended for use in clusterbean provide the weed control during the early stages of crop growth but are not effective for an adequate length of time. Sometimes, inadequate moisture in the surface soil due to prevailing winds during sowing time also reduces the efficacy of the pre-emergence herbicides like pendimethalin (Punia *et al*., 2011). Later flushes of weeds not only impede the crop growth but also hamper the realization of the potential yield of the crop. So the use of the herbicides with longer residual activity which provide the season long weed control or sequential application of pre-emergence and post emergence herbicide is required to control the weeds in legume crops. Keeping it in view, the field experiment was conducted to study the bio-efficacy of different pre and post-emergence herbicides on weed control efficiency and yield of clusterbean.

MATERIALS AND METHODS

The field experiment was conducted during *Kharif* 2018 and 2019 at the Research Farm, Department of Agronomy, CCSHAU, Hisar, which is characterized by the semi-arid climate with hot and dry summers and extremely cold winters. The major part of the annual rainfall is received during monsoon season *i.e*. June to mid-September.The weekly mean maximum air temperature ranged between 30.8 to 37.2°C and weakly mean minimum temperature ranged between 14.4 to 28.0°C during the crop season of *kharif* 2018, whereas during the crop season of *kharif* 2019, it ranged from 31.8 37.2°C and 14.9 to 27.3°C, respectively. The mean weekly relative humidity ranged from 73 to 98 % in the morning and 30 to 87% in the evening during 2018, while in 2019 it ranged between 73 to 93 % in the evening and 31 to 73% in the evening, respectively. The crop received 259 and 247.2 mm of rainfall in the growing season of 2018 and 2019, respectively (Fig. 1). Texture of soil at Hisar was sandy loam with pH 8.10 and organic carbon 0.45%. Soils were deficient in available N (147 kg/ha), medium in P (10 kg/ha) and sufficient in K (220 kg/ha) at Hisar, respectively. The thirteen treatments with different herbicides combination were laid out in in a randomized block design (RBD) with three replications. Treatments comprised of pyroxasulfone 127.5 g/ha (pre-emergence, PRE), pyroxasulfone + pendimethalin (TM) 106 + 1000 g/ ha (PRE), pyroxasulfone + imazethapyr (TM) 106 + 50 g/ha (PRE), pendimethalin + imazethapyr (RM) 1000 g/ha (PRE), imazethapyr 100 g/ha (PRE), pendimethalin 1000 g/ha (PRE), pendimethalin + imazethapyr (TM) 750 + 50 g/ha (PRE), imazethapyr + imazamox (RM) 70 g/ha (post-emergence, POE), pyrithiobac-Na 62.5 g/ha (post-emergence, POE), pyrithiobac-Na + imazethapyr (TM) 50 + 50 g/ha

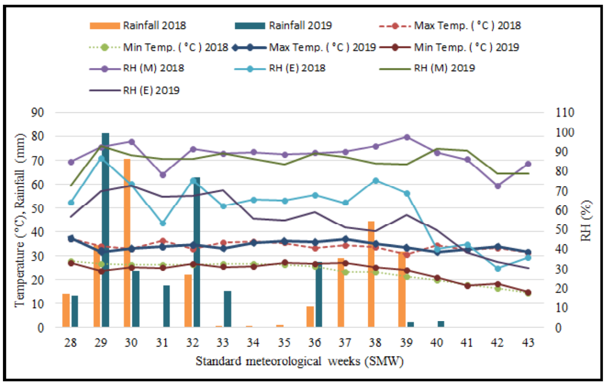

Fig. 1. Mean weekly meteorological data of Hisar during 2018 and 2019.

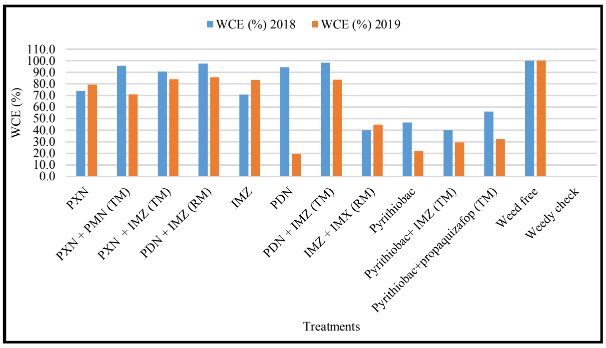

Fig. 2. Effect of different herbicides on WCE (%) in clusterbean at 55 DAS.

(POE), pyrithiobac-Na + propaquizafop (TM) 62.5 + 62.5 g/ha (POE), weedy check and weed free. HG-563 variety of clusterbean was sown with the recommended seed rate (20kg/ha) and spacing (30 × 15 cm) and fertilizer rate (20: 40: 20, N: P_2O_5: K_2O kg/ ha) using seed-cum fertilizer drill. Application of PRE and POE (post emergence) herbicides in different treatments were done by using flat fan nozzle mounted on a backpack sprayer. The weeds were uprooted randomly at one placeby quadrate of one square metre with the help of khurpi in each plot. The weeds were oven dried for ten days and theirweight was recorded in gram. Weed control efficiency of various treatments were worked out with the help of following formula.

$$\text{Weed control efficiency (\%)} = \frac{\text{DMC} - \text{DMT}}{\text{DMC}} \times 100$$

Where,

DMC = Dry matter of weeds in control/un-weeded plot.

DMT= Dry matter of weeds in treated plot

Data were analyzed using OPSTAT software to evaluate the differences between treatments and comparisons were made at 5 per cent level of significance.

RESULTS AND DISCUSSION

Weed density

Clusterbean due to initial slow growth faces acute crop weed competition with weeds. Results showed that the weed flora of the experimental field was consisted of *Trianthema portulacastrum* (in 2018) and Digera arvensis (in 2019) among broad leaf weeds, *Echinochloa colona* as a major grassy weed and *Cyperus rotundus* as sedges. Punia *et al*. (2011) and Poonia *et al.* (2021) also reported that *D. arvensis* and *T. portulacastrum*were the major broad leaf weeds with higher relative density. Application of different herbicides resulted in significantly lower weed density of *T. portulacastrum*, *D. arvensis* and *E. colona* as compared to weedy check. During 2018, the density of *Trianthema portulacastrum* was significantly lower with application of pyroxasulfone + pendimethalin (TM, PRE) at 106 +50 g/h which was at par with pendimethalin + imazethapyr (RM, PRE) 1000 g/ha, pendimethalin + imazethapyr (TM, PRE) at 750 +50 g/ha. Similarly, the density of *E. colona* was significantly lower under different herbicide treatments as compared to weedy check, except application of pyrithiobac-Na at 62.5 g/ha (PoE) during both the year of experimentation. During the 2019, all the herbicide treatments, except pendimethalin 1000 g/ha (PRE) reduced the density of *D. arvensis* significantly as compared to weedy check. The density of *C. rotundus* varied with different herbicide treatments during both the years (Table 1 and 2). Singh *et al* (2019) also reported the inconsistent weed control by the pendimethalin application.

Weed dry matter, weed control efficiency (WCE) and weed index (WI)

At 55 DAS, application of different herbicides resulted in significantly lower weed dry matter accumulation as compared to weedy check. Pre-emergence application of pendimethalin + imazethapyr (RM) 1000 g/ha resulted in significantly lower dry matter accumulation by weeds being at par with pendimethalin + imazethapyr (TM, PRE) 750 + 50 g/ha, pyroxasulfone + pendimethalin 106 + 1000 g/ha, pendimethalin 1000 g/ha than other herbicide treatments during 2018. Similarly, during 2019, the pre-emergence application of pendimethalin + imazethapyr (RM) 1000 g/ha and pendimethalin + imazethapyr (TM) 750 + 50 g/ha resulted in lower weed dry matter accumulation while the alone application of pendimethalin resulted higher dry matter accumulation due to less control of *D. arvensis*, a major broad leaved weed. Application of pre-emergence herbicides resulted in the lower dry matter accumulation by weeds than post-emergence herbicides, except pendimethalin 1000 g/ha during 2019. The weed free treatment resulted in highest weed control efficiency as the regular weeding made sure that the weeds were absent from the field followed by

TABLE 1
Effect of different herbicide treatments on weed density in clusterbean at 55 DAS during kharif 2018.

Treatments	Dose (g/ha)	Time of application	*Trianthema portulacastrum* (No./m^2)*	*Echinochloa colona* (No./m^2)*	*Cyperus rotundus* (No./m^2)*	Weed dry matter (g/m^2)*
Pyroxasulfone	127.5	PRE	3.0 (8.7)	1.9 (2.7)	2.4 (4.7)	7.8 (60.6)
Pyroxasulfone + pendimethalin (TM)	106 + 1000	PRE	1.0 (0.0)	1.0 (0.0)	2.2 (4.0)	3.3 (10.3)
Pyroxasulfone + imazethapyr (TM)	106 + 50	PRE	3.3 (10.0)	1.9 (2.7)	1.7 (2.7)	4.8 (21.7)
Pendimethalin + imazethapyr (RM)	1000	PRE	1.2 (0.7)	1.5 (1.3)	2.6 (5.3)	2.5 (6.0)
Imazethapyr	100	PRE	4.7 (21.3)	2.8 (6.7)	2.2 (4.0)	8.3 (67.7)
Pendimethalin	1000	PRE	2.5 (5.3)	2.1 (3.3)	2.7 (6.3)	3.8 (13.2)
Pendimethalin + imazethapyr (TM)	750 + 50	PRE	1.9 (4.0)	1.7 (2.0)	2.3 (4.7)	3.0 (8.0)
Imazethapyr + imazamox (RM)	70	POE	10.1 (101.0)	3.9 (14.7)	2.2 (4.7)	11.7 (137.2)
Pyrithiobac-Na	62.5	POE	11.4 (129.0)	5.8 (33.3)	2.2 (4.7)	11.2 (124.7)
Pyrithiobac-Na + imazethapyr (TM)	50 + 50	POE	9.6 (91.3)	4.7 (22.0)	2.4 (4.7)	11.8 (139.3)
Pyrithiobac Na + propaquizafop (TM)	62.5 + 62.5	POE	11.9 (142.0)	3.3 (10.0)	2.7 (6.3)	10.2 (103.7)
Weed free	-	-	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
Weedy check	-	-	14.3 (204.0)	5.7 (31.3)	2.7 (6.3)	15.4 (235.7)
SEM (±)			0.5	0.3	0.5	0.42
CD (p=0.05)			1.4	0.8	NS	1.22

the application of pendimethalin + imazethapyr (RM) 1000 g/ha during 2018 and 2019 with WCE of 97.6 and 85.8%, respectively. Application of pendimethalin + imazethapyr (TM) 750 + 50 g/ha and pyroxasulfone + imazethapyr also resulted in more than 90 % WCE in 2018 and 80% in 2019 (Fig. 2). WCE was lower with the application of post-emergence herbicides as compared to pre-emergence herbicides. These results are in accordance with Meena *et al.* (2020) who reported that application of pendimethalin + imazethapyr (RM) reduced the weed density of different weeds significantly as compared to weedy check.

During 2019, the highest weed index (WI) was found in the weedy check treatment (63.0%) due to more reduction in yield as a result of more weed infestation; less availability of resources and more competition faced by crop. Lowest WI was observed in pendimethalin + imazethapyr (RM)1000 as pre-emergence (13.4%) followed by pendimethalin + imazethapyr (TM) 750 + 50 g/ha (19.1%) (Table 3). Pre-emergence herbicides application, except pendimethalin, resulted in lower WI as compared to post-emergence herbicides application. Lower weed index due to herbicides application was also reported by Brar (2018).

Effect on crop

The yield parameters *viz*., plant height at harvest, number of pods/plant, pod length and seed yield were significantly influenced by weed control treatments as compared to weedy check. This may be due to lower weed density and weed biomass accumulation resulting in less crop weed competition under different herbicide treatments as compared to weedy check. Keeping the field weed free resulted in taller plants, more number of pods/plants and seed yield as compared to other treatments. During 2019, application of pendimethalin + imazethapyr (1000 g/ha, RM) as pre-emergence resulted in taller plants (77.7 cm), more pods/plant (73.6) and higher seed yield (907 kg/ha) which was significantly higher than other herbicide applications but at par with pendimethalin + imazethapyr (TM) 750 + 50 g/ha (PRE), imazethapyr (100 g/ha, PRE) and pyroxasulfone + imazethapyr (TM) (106 + 1000 g/ha, PRE). Application of different herbicides resulted in significantly higher seed yieldas compared to weedy check (Table 3). During 2018, irrigation followed by rainfall leads to flooding conditions and no seed yield was obtained due to crop failure. During *kharif* 2019, keeping crop weed free throughout the growing season resulted in significantly higher seed yield (1047 kg/ha) as compared to herbicide application either as pre or post-emergence. Presence of weeds resulted in 63 per cent reduction in grain yield as compared to weed free treatment. These results corroborate with the finding of Sangwan *et al.* (2018) and Meena *et al* (2020) where application of pendimethalin + imazethapyr (RM) application resulted in higher seed yield of clusterbean as compared to other herbicide treatments due to lower weed dry

TABLE 2

Effect of different herbicide treatments on weed density in clusterbean at 55 DAS during kharif 2019.

Treatments	Dose (g/ha)	Time of application	*Digera arvensis* (No./m^2)*	*Echinochloa colona* (No./m^2)*	*Cyperus rotundus* (No./m^2)*	Weed dry matter (g/m^2)*
Pyroxasulfone	127.5	PRE	3.2 (9.3)	1.5 (1.3)	4.9 (22.7)	7.8 (59.5)
Pyroxasulfone + pendimethalin (TM)	106 + 1000	PRE	2.5 (5.3)	1.5 (2.0)	4.5 (19.3)	9.2 (84.4)
Pyroxasulfone + imazethapyr (TM)	106 + 50	PRE	1.4 (1.3)	2.5 (5.3)	4.0 (15.3)	6.8 (45.7)
Pendimethalin + imazethapyr (RM)	1000	PRE	1.5 (1.3)	2.5 (5.3)	4.4 (18.7)	6.4 (41.1)
Imazethapyr	100	PRE	1.7 (2.6)	2.8 (7.3)	3.8 (13.3)	7.0 (48.1)
Pendimethalin	1000	PRE	6.4 (40.0)	2.6 (6.0)	4.8 (22.7)	15.2 (230.4)
Pendimethalin + imazethapyr (TM)	750 + 50	PRE	2.2 (4.0)	1.7 (2.0)	4.5 (19.3)	6.7 (45.6)
Imazethapyr + imazamox (RM)	70	POE	2.0 (3.3)	4.7 (21.3)	4.0 (15.3)	12.3 (155.5)
Pyrithiobac Na	62.5	POE	1.2 (0.6)	5.5 (29.3)	5.0 (24.0)	14.9 (222.4)
Pyrithiobac Na + imazethapyr (TM)	50 + 50	POE	1.7 (2.0)	4.4 (18.7)	4.4 (18.7)	14.3 (208.4)
Pyrithiobac Na + propaquizafop (TM)	62.5 + 62.5	POE	1.7 (2.0)	3.5 (11.7)	4.5 (19.3)	13.9 (194.2)
Weed free	-	-	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
Weedy check	-	-	8.7 (76.0)	5.8 (33.0)	4.8 (22.0)	17.0 (289.4)
SEM (±)			0.4	0.3	0.2	11.4 (129.5)
CD (p=0.05)			1.1	0.8	0.6	0.6

*Original data were subjected to square root transformation and presented in parentheses.

TABLE 3
Effect of different herbicide treatments on yield attributes and yield of clusterbean during 2019

Treatments	Dose (g/ha)	Time of application	Plant height at harvest (cm)	No. of pods/plant	Pod length (cm)	Seed yield (kg/ha)	WI (%)
Pyroxasulfone	127.5	PRE	68.6	63.0	6.2	669	36.1
Pyroxasulfone + pendimethalin (TM)	106 + 1000	PRE	71.3	67.7	6.3	696	33.5
Pyroxasulfone + imazethapyr (TM)	106 + 50	PRE	75.4	69.6	6.8	802	23.4
Pendimethalin + imazethapyr (RM)	1000	PRE	77.7	73.6	6.5	907	13.4
Imazethapyr	100	PRE	77.6	68.6	6.3	822	21.5
Pendimethalin	1000	PRE	60.3	50.0	5.7	530	49.4
Pendimethalin + imazethapyr (TM)	750 + 50	PRE	75.4	73.3	6.8	847	19.1
Imazethapyr + imazamox (RM)	70	POE	66.7	62.0	6.0	645	38.4
Pyrithiobac Na	62.5	POE	60.6	57.0	5.7	550	47.5
Pyrithiobac Na + imazethapyr (TM)	50 + 50	POE	60.1	55.7	5.8	542	48.2
Pyrithiobac Na + propaquizafop (TM)	62.5 + 62.5	POE	62.3	57.0	5.5	557	46.8
Weed free	-	-	82.5	81.0	7.0	1047	0.0
Weedy check	-	-	56.1	36.0	5.2	387	63.0
SEM (±)			1.9	2.5	0.3	27.7	
CD (p=0.05)			5.5	7.1	0.7	80.5	

matter accumulation and higher weed control efficiency providing the crop less competitive micro climate for better growth and higher seed yield.

CONCLUSION

So, on the basis of present study, it can be concluded that pre-emergence application of pendimethalin + imazethapyr (RM) at 1000 g/ha, pendimethalin + imazethapyr (TM) at 750 + 50 g/ha, pyroxasulfone + pendimethalin 106 + 1000 and imazethapyr 100 g/ha were found effective to control the complex weed flora and for obtaining higher seed yield of clusterbean.

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