Biological Forum – An International Journal **15(11): 39-47(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Influence of Herbicides on Weed Dynamics and Persistence in Fenugreek (*Trigonella foenum-graecum* L.) in Arid Region

Bhagyashree Phogat[1*], Narendra Kumar Pareek[2], Shish Pal Singh[1], Amar Singh Godara[1] and Abhijeet Purohit[1]

[1]Department of Agronomy, College of Agriculture,
Swami Keshwanand Rajasthan Agricultural University, Bikaner (Rajasthan), India,
[2]Department of Agronomy, College of Agriculture,
Fatehpur-Shekhawati (SKNAU, Jobner, Jaipur), (Rajasthan), India.

(Corresponding author: Bhagyashree Phogat)*
(Received: 11 September 2023; Revised: 02 October 2023; Accepted: 16 October 2023; Published: 15 November 2023)
(Published by Research Trend)

ABSTRACT: A field experiment was conducted at Instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner (Rajasthan) during *Rabi* 2021-22 and 2022-23. The research was conducted to find out effect on weed control parameters using treatments like chemical herbicides with alone/ combinations. The crop was infested by weeds right from sowing and many weed flushes were observed during the study. The experiment consisted of total fourteen treatments combinations (H_1 - Weedy check, H_2 - Weed free, H_3–Pendimethalin, H_4– Oxyfluorfen, H_5– Imazethapyr, H_6 - Diclosulam @20g/ha PE, H_7 - Diclosulam @25g/ha PE, H_8 - Flumioxazin @75 g/ha, H_9–Flumioxazin @100 g/ha, H_{10} - Pendimethalin + Imazethapyr, H_{11} - Pendimethalin + Oxyfluorfen, H_{12} - Imazethapyr + Imazamox (RM), H_{13} - Sodium Acifluorfen + Clodinafop-Propargyl 8% (RM), H_{14}–Fomesafen 11.1% + Fluazifop–p-butyl 11.1 % (RM)). These treatments were evaluated in Completely Randomized Block Design with three replications. In weedy check plots, fenugreek was mainly infested with mixed flora of broad-leaved weeds chiefly consisted of *Rumex dentatus, Chenopodium murale* L., *Melilotus indica* L. and *Chenopodium album.* The results indicate that at each stage of observation pre emergence application of pendimethalin + imazethapyr (RM) was found significantly superior in reducing total weed density, dry matter and their bio mass compared to weedy check and remains statistically at par with application of Pendimethalin + Oxyfluorfen, Imazethapyr + Imazamox and Imazethapyr.

Keywords: Completely Randomized Block Design, chemical herbicides, weed control parameters.

INTRODUCTION

Fenugreek is a tropical crop and is generally sown in *Rabi* season for seed production. Fenugreek is a slow growing crop during its initial stages of growth and it does not form a canopy that can suppress the weed growth and therefore, faces severe competition from the weeds. The dominant weed species which infest fenugreek fields are *Chenopodium album, Melilotus indica, Chenopodium murale, Coronopus didymus and Rumex dentatus* (Kumar *et al*., 2016). Some other major broad-leaved weeds are *Medicago denticulata, Anagallis arvensis, Convovlvulus arvensis* and among grassy weeds is *Phalaris minor*. Weeds offer maximum competition to fenugreek at its initial 25 days of growth and cause severe yield reductions in the crop ranging from 14.2 to 69.0% depending upon their density and duration of competition (Kumar *et al*., 2005). Manual weeding is generally not accomplished for weed control in fenugreek at critical period of crop-weed competition, due to non-availability of labour (Kumar *et al*., 2016). Manual weeding requires rigorous labour and therefore, limits its production area (Verma and Singh 2008; Dubey, 2014).

Chemical herbicides are a convenient and economical way to manage the weeds effectively (Bhutia *et al*., 2017). Besides growth and yield attributes, the nature of yield response to weed management practices and economic analysis determines the feasibility of adoption of any technology by the farmer. The use of selective herbicides in spices and condiments, can be an effective and economical way to control weeds (Gill *et al*., 2002). Therefore, crop-weed competition can be reduced by use of herbicides either alone or in conjunction with other weed control practices. Herbicidal weed management seems to be the most appropriate proposition for weed management. The advantage of chemical weeding over other techniques lies in its efficient weed control at most critical stage of crop growth. At present, no herbicide recommendation exists for Haryana conditions that can be adopted for seed crop of fenugreek.

Pendimethalin is a herbicide of dinitroaniline class, used in PRE and POE applications to control annual grasses and certain broadleaf weeds. It suppresses cell division and cell elongation. Imazethapyr belongs to imidazolinone group that can be used in crops like

groundnut, soybean and other legumes (Herbicide Handbook, USA, 2002). For controlling grasses and broadleaved weeds in pulse crops, imazethapyr can be applied either as pre-plant incorporation or as pre and post-emergence. Both roots as well as foliage can readily absorb imazethapyr which makes it suitable for PPI, PRE and POE applications (Cantwell *et al*., 1989; Pellerin and Webster 2004). Present investigation was carried out to evaluate the efficacy of PRE pendimethalin and PRE as well as POE imazethapyr and its ready-mix combinations against different weeds in fenugreek.

Gupta *et al*. (2017) observed that among the herbicidal weed control treatments, pre-emergence application of pendimethalin + imazethapyr (RM) at 1000 g ha^{-1} and post-emergence application of imazethapyr + imazamox (RM) at 80 g ha^{-1} provided highest weed control in case of black gram. Similarly, pendimethalin 30% EC + imazethapyr 2% SL premix @ 960 g a.i. ha^{-1} applied as pre-emergence in soybean crop provided highest weed control efficiency. Present investigation was carried out to evaluate the efficacy of PRE pendimethalin and PRE as well as POE imazethapyr and its ready-mix combinations against different weeds in fenugreek.

MATERIAL AND METHODS

The field experiment was conducted at Instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner (Rajasthan), situated at 28° 10' N latitude and 73° 35' E longitude at an altitude of 235 meters above mean sea level. Fenugreek variety RMT-305 was taken for this study. The experiment was carried out during *Rabi* 2021-22 and 2022-23. The experiment comprised of fourteen treatment combinations for weed management treatments including control.

Sr. No.	Treatment	Symbols
1.	Weedy check	H_1
2.	Weed free	H_2
3.	Pendimethalin (30% EC) @750g/ha PE	H_3
4.	Oxyfluorfen (23.5% EC) @ 150g/ha PPI	H_4
5.	Imazethapyr (10% SL) @50g/ha POE 20 DAS (at 2-4 leaf stage)	H_5
6.	Diclosulam (84% WDG) @20g/ha PE	H_6
7.	Diclosulam (84% WDG) @25g/ha PE	H_7
8.	Flumioxazin (51 % WDG) @75 g/ha PE	H_8
9.	Flumioxazin (51 % WDG) @100 g/ha PE	H_9
10.	Pendimethalin 30% EC + Imazethapyr 2% EC (Rm) @ 800 ml/ha PE	H_{10}
11.	Pendimethalin 24 %EC + Oxyfluorfen 4.1 % EC (Rm) @500g/ha PPI	H_{11}
12.	Imazethapyr + Imazamox (35% WG) @50 g/ha 20 DAS POE (at 2-4 leaf stage)	H_{12}
13.	Sodium Acifluorfen 16.5 %+Clodinafop Propargyl 8% (Rm) @240 g/ha POE (at 2-4 leaf stage)	H_{13}
14.	Fomesafen 11.1 % + Fluazifop–p-butyl 11.1 % (Rm) @220 g/ha POE (at 2-4 leaf stage)	H_{14}

As per treatment, herbicides were sprayed with knapsack sprayer fitted with flat fen nozzle using 500 litres of water per hectare after calibration. Hand weeding operation 20 and 40 DAS performed with hand hoe.

In order to evaluate effect of treatments weed parameters and following observations were recorded during the course of investigation. The details of the techniques employed for recording observations are as follows.

Weed density m^{-2} 30, 60 and 90 DAS. In each plot broad-leaved weeds were counted from two randomly selected area of 0.25 m^2 using 0.5 m · 0.5 m quadrate at 30, 60 and 90 DAS and their average was multiplied by four to obtain the density for one square meter area. The mean data were subjected to square root transformation $(x + 0.5)^{1/2}$ to normalize their distribution (Gomez and Gomez 1984).

Weed dry matter 30, 60, 90 DAS (kg ha^{-1}). The weeds under 0.25 m^2 area were removed 30, 60, 90 DAS and classified as broad leaved weeds. These were dried at 65°C temperature till a constant weight was observed and converted into kg ha^{-1}.

Weed control efficiency (%). Weed control efficiency was calculated at harvest using the following formula (Mani *et al.*, 1968).

$$WCE = \frac{\text{Dry matter of weeds in control plot} - \text{Dry matter of weeds in treated plot}}{\text{Dry matter of weeds in control plot}} \times 100$$

Weed persistence index (WPI). Weed persistence index was calculated by the following formula (Mishra and Mishra 1997).

$$\text{Weed persistence index (WPI)} = \frac{\text{Dry weight of weeds in treated plot} - \text{Weed count in the control plot}}{\text{Dry weight of weeds in control plot}}$$

The experiment consisting of 14 treatment combinations was laid out in factorial randomized block design with three replications. The treatments were randomly allotted to different plots using random number table of Fisher and Yates (1963).

RESULT AND DISCUSSION

A. Weeds density and dry weight

The results reveal that all the herbicide control measures showed marked variation in reduction of

weed count of broad-leaved as well as their dry matter accumulation at various growth stages compared to weedy check during both the years of research and on pooled basis. The experimental field was full of weeds during both the years of research comprised of broad leaved weeds. On pooled basis, among the total weed population, broad leaved weeds were more prominent. The weed flora under broad leaved weeds were *Rumex dentatus, Chenopodium murale* L., *Melilotus indica* L. *and Chenopodium album*. The dominance of weed species in fenugreek also reported by Singh *et al*. (2014); Kumar *et al*. (2016).

At all stages of observations, dry weight and density of broad leaved weeds were found the lowest with pre emergence application of pendimethalin + imazethapyr. Pre emergence application of pendimethalin + imazethapyr (Rm) reduced 61.71, 63.19, 60.89 and 51.35 per cent dry weight of broad leaved weeds (Table 4) at 30, 60, 90 DAS and at harvest, respectively over weedy check on pooled basis. Alike weed density, pre-emergence application of pendimethalin + imazethapyr also reduced 34.5 (Table 1 (a)), 51.20 (Table 2 (a)) and 47.82 (Table 3 (a)) per cent of broad leaved weeds at 30, 60 and 90 DAS, respectively over weedy check. These results suggest that the pre-emergence application of pendimethalin + imazethapyr (Rm) was effective in reducing the growth of broad-leaved weeds throughout the crop growth period. It's important to note that these percentages represent the level of weed suppression achieved by the herbicide treatment compared to not using any herbicides (weedy check).

Weed density Table 1 (a) to 3 (c) and weed dry weight Table 4 indicated that pre emergence application of pendimethalin + imazethapyr performed best in controlling all the weeds such as *Rumex dentatus, Chenopodium murale* L., *Melilotus indica* L. and *Chenopodium album* at 30, 60 and 90 DAS, respectively over weedy check. This treatment reduced 49.37, 49.84, 50.16 and 44.27 per cent of broad leaved weeds at 30 and 60 DAS (Table 1 (b)), (Table 2 (b)) and 32.48, 45.87, 48.30 and 50.79 per cent of broad leaved weeds at 90 DAS (Table 3 (b)), respectively over weedy check. It was found significantly superior to rest of the treatments during either of years of the experimentation. The superiority of this treatment in controlling weeds over the rest of treatments was because of the fact that this treatment checked early growth of weeds right from their germination (as it was soil applied) and late emerging weeds were effectively controlled by pre emergence application of pendimethalin + imazethapyr, residual effect of herbicide and smothering effect of fenugreek (due to better growth at earlier stage because of weed free condition) on weeds.

Hence, crop could remain weed free for comparatively longer duration in general and during critical period of crop – weed competition. The superiority of this combination of herbicides may also be due to double mode of action. The excellence of this herbicide in reducing total weed density and dry matter has also been reported by Singh *et al*. (2019); Singh *et al*. (2021).

Pendimethalin is versatile pre-emergence herbicides, rapidly absorbed by germinating weeds and inhibit both cell division and cell elongation in the roots and shoot meristems of the susceptible plants. Moreover, it is superior pre-emergence herbicide due to the fact that pendimethalin is less susceptible to degradation in soil system (Eshel *et al*., 1979) and it appears that efficacy of this herbicide in suppressing the weed growth could be continuous for a longer time during crop growth period. This could be reasoned for reduced total weed dry matter under the effect of pendimethalin. Tabatabi *et al*. (1963) also reported lower weed density and dry weight of weeds under application of pendimethalin alone.

Table 1 (a): Effect of herbicidal weed control on category wise weed density at 30 DAS.

Treatments	Weed density (No. m^{-2})		
	Broad-leaved weeds		
	2021-22	2022-23	Pooled
H_1	5.59 (30.79)	5.56 (30.4)	5.58 (30.6)
H_2	0.70(0.00)	0.70(0.00)	0.70(0.00)
H_3	4.25 (17.6)	4.44 (19.2)	4.35 (18.4)
H_4	4.49 (19.69)	4.63 (20.95)	4.56 (20.31)
H_5	4.14 (16.65)	4.14 (16.61)	4.14 (16.63)
H_6	4.57 (20.38)	4.66 (21.18)	4.61 (20.79)
H_7	4.63 (20.98)	4.79 (22.42)	4.71 (21.69)
H_8	4.87 (23.19)	5.17 (26.28)	5.02 (24.73)
H_9	5.39 (28.52)	5.58 (30.67)	5.49 (29.6)
H_{10}	3.65 (12.85)	3.64 (12.77)	3.65 (12.81)
H_{11}	3.82 (14.1)	3.98 (15.37)	3.9 (14.74)
H_{12}	4.16 (16.82)	4.23 (17.41)	4.2 (17.12)
H_{13}	5.14 (25.89)	5.33 (27.86)	5.23 (26.87)
H_{14}	5.48 (29.49)	5.55 (30.27)	5.51 (29.87)
SEm±	0.27	0.26	0.19
CD (P=0.05)	0.78	0.75	0.53

Values transformed to √x+0.5 and actual values are in parentheses

H_1 - Weedy check; H_2 - Weed free; H_3 - Pendimethalin; H_4 - Oxyfluorfen; H_5 - Imazethapyr; H_6 - Diclosulam @20g/ha PE; H_7 - Diclosulam @25g/ha PE; H_8 - Flumioxazin @75 g/ha; H_9 - Flumioxazin @100 g/ha; H_{10} - Pendimethalin + Imazethapyr; H_{11} - Pendimethalin + Oxyfluorfen; H_{12} - Imazethapyr + Imazamox (Rm); H_{13} - Sodium Acifluorfen + Clodinafop Propargyl 8% (Rm); H_{14} - Fomesafen 11.1% + Fluazifop–p-butyl 11.1 % (Rm)

Table 1 (b): Effect of herbicidal weed control on individual weed density at 30 DAS.

Treatments	Weed density (No. m^{-2})											
	Rumex dentatus			*Chenopodium murale* L.			*Melilotus indica* L.			*Chenopodium album*		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
H_1	3.03 (8.69)	2.93 (8.06)	2.98 (8.38)	3.03 (8.68)	3.01 (8.59)	3.02 (8.63)	2.79 (7.3)	2.82 (7.46)	2.81 (7.38)	2.57 (6.12)	2.61 (6.29)	2.59 (6.21)
H_2	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)
H_3	2.27 (4.67)	2.09 (3.88)	2.19 (4.28)	2.23 (4.46)	2.60 (6.26)	2.42 (5.36)	2.16 (4.16)	2.37 (5.14)	2.27 (4.65)	2.19 (4.31)	2.10 (3.92)	2.15 (4.11)
H_4	2.56 (6.04)	2.03 (3.61)	2.31 (4.82)	2.28 (4.69)	2.67 (6.62)	2.48 (5.66)	2.29 (4.73)	2.44 (5.46)	2.36 (5.09)	2.17 (4.23)	2.40 (5.26)	2.29 (4.74)
H_5	2.40 (5.24)	2.03 (3.64)	2.22 (4.44)	2.19 (4.31)	2.31 (4.84)	2.25 (4.57)	1.92 (3.17)	2.23 (4.49)	2.08 (3.83)	2.10 (3.93)	2.03 (3.64)	2.07 (3.79)
H_6	2.51 (5.8)	2.17 (4.19)	2.35 (5)	2.36 (5.09)	2.70 (6.81)	2.54 (5.95)	2.39 (5.2)	2.47 (5.62)	243 (5.41)	2.19 (4.29)	2.25 (4.56)	2.22 (4.43)
H_7	2.62 (6.38)	2.28 (4.71)	2.46 (5.55)	2.36 (5.07)	2.63 (6.4)	2.50 (5.73)	2.42 (5.36)	2.48 (5.63)	2.45 (5.49)	2.16 (4.17)	2.49 (5.68)	2.33 (4.92)
H_8	2.73 (6.93)	2.48 (5.66)	2.61 (6.29)	2.66 (6.58)	2.81 (7.38)	2.73 (6.98)	2.39 (5.21)	2.73 (6.93)	2.56 (6.07)	2.23 (4.47)	2.61 (6.31)	2.43 (5.39)
H_9	2.90 (7.91)	3.00 (8.5)	2.95 (8.21)	3.00 (8.49)	2.96 (8.24)	2.98 (8.37)	2.64 (6.47)	2.82 (7.47)	2.73 (6.97)	2.48 (5.65)	2.64 (6.46)	2.56 (6.05)
H_{10}	2.04 (3.65)	1.93 (3.24)	1.98 (3.44)	1.96 (3.34)	2.03 (3.61)	1.99 (3.48)	1.71 (2.42)	1.97 (3.4)	1.85 (2.91)	1.98 (3.44)	1.74 (2.52)	1.87 (2.98)
H_{11}	2.25 (4.55)	2.02 (3.57)	2.14 (4.06)	2.00 (3.51)	2.23 (4.48)	2.12 (4.00)	1.78 (2.66)	2.21 (4.4)	2.01 (3.53)	1.97 (3.38)	1.85 (2.92)	1.91 (3.15)
H_{12}	2.32 (4.87)	2.03 (3.63)	2.18 (4.25)	2.22 (4.41)	2.41 (5.33)	2.32 (4.87)	2.02 (3.58)	2.29 (4.74)	2.16 (4.16)	2.11 (3.96)	2.05 (3.71)	2.08 (3.84)
H_{13}	2.86 (7.7)	2.75 (7.07)	2.81 (7.38)	2.78 (7.25)	2.89 (7.84)	2.84 (7.55)	2.53 (5.91)	2.79 (7.27)	2.66 (6.59)	2.35 (5.03)	2.49 (5.68)	2.42 (5.35)
H_{14}	2.86 (7.66)	2.91 (7.97)	2.88 (7.81)	2.94 (8.12)	2.93 (8.08)	2.93 (8.1)	2.75 (7.08)	2.83 (7.49)	2.79 (7.28)	2.67 (6.63)	2.69 (6.73)	2.68 (6.68)
SEm±	0.33	0.27	0.22	0.25	0.24	0.17	0.25	0.26	0.18	0.24	0.26	0.17
CD (P=0.05)	0.97	0.79	0.62	0.72	0.71	0.48	0.73	0.74	0.51	0.69	0.76	0.50

Values transformed to √x+0.5 and actual values are in parentheses

H_1 - Weedy check; H_2 - Weed free; H_3 - Pendimethalin; H_4 - Oxyfluorfen; H_5 - Imazethapyr; H_6 - Diclosulam @20g/ha PE; H_7 - Diclosulam @25g/ha PE; H_8 - Flumioxazin @75 g/ha; H_9 - Flumioxazin @100 g/ha; H_{10} - Pendimethalin + Imazethapyr; H_{11} - Pendimethalin + Oxyfluorfen; H_{12} - Imazethapyr + Imazamox (Rm); H_{13} - Sodium Acifluorfen + Clodinafop Propargyl 8% (Rm); H_{14} - Fomesafen 11.1% + Fluazifop–p-butyl 11.1 % (Rm)

Table 2 (a): Effect of herbicidal weed control on category wise weed density at 60 DAS.

Treatments	Weed density (No. m^{-2})		
	Broad-leaved weeds		
	2021-22	2022-23	Pooled
H_1	6.4 (40.44)	6.05 (36.11)	6.23 (38.28)
H_2	0.70(0.00)	0.70(0.00)	0.70(0.00)
H_3	4.36 (18.52)	4.25 (17.55)	4.3 (18.03)
H_4	4.34 (18.33)	4.4 (18.83)	4.37 (18.56)
H_5	3.49 (11.69)	3.45 (11.41)	3.47 (11.55)
H_6	4.84 (22.95)	4.8 (22.58)	4.82 (22.76)
H_7	4.88 (23.29)	5.15 (26.07)	5.02 (24.69)
H_8	5.22 (26.79)	5.34 (28)	5.28 (27.4)
H_9	5.53 (30.13)	5.84 (33.56)	5.69 (31.85)
H_{10}	3.07 (8.91)	3.01 (8.59)	3.04 (8.75)
H_{11}	3.26 (10.16)	3.13 (9.28)	3.2 (9.74)
H_{12}	3.46 (11.48)	3.71 (13.26)	3.59 (12.36)
H_{13}	5.54 (30.18)	5.76 (32.72)	5.65 (31.45)
H_{14}	6.06 (36.18)	6.1 (36.66)	6.08 (36.44)
SEm±	0.31	0.29	0.21
CD (P=0.05)	0.90	0.83	0.60

Values transformed to √x+0.5 and actual values are in parentheses

H_1 - Weedy check; H_2 - Weed free; H_3 - Pendimethalin; H_4 - Oxyfluorfen; H_5 - Imazethapyr; H_6 - Diclosulam @20g/ha PE; H_7 - Diclosulam @25g/ha PE; H_8 - Flumioxazin @75 g/ha; H_9 - Flumioxazin @100 g/ha; H_{10} - Pendimethalin + Imazethapyr; H_{11} - Pendimethalin + Oxyfluorfen; H_{12} - Imazethapyr + Imazamox (Rm); H_{13} - Sodium Acifluorfen + Clodinafop Propargyl 8% (Rm); H_{14} - Fomesafen 11.1% + Fluazifop–p-butyl 11.1 % (Rm)

Table 2 (b): Effect of herbicidal weed control on individual weed density at 60 DAS.

Treatments	Weed density (No. m^{-2})											
	Rumex dentatus			*Chenopodium murale* L.			*Melilotus indica* L.			*Chenopodium album*		
	2021-22	2022-23	Pooled	2021-22	2021-22	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
H_1	3.16 (9.48)	3.2 (9.75)	3.18 (9.62)	3.25 (10.04)	3.01 (8.59)	3.13 (9.31)	3.25 (10.04)	2.85 (7.6)	3.05 (8.82)	3.37 (10.88)	3.27 (10.17)	3.32 (10.53)
H_2	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
H_3	1.73 (2.5)	2.44 (5.46)	2.12 (3.98)	2.48 (5.64)	2.41 (5.3)	2.44 (5.47)	2.48 (5.64)	1.67 (2.28)	2.11 (3.96)	2.29 (4.74)	2.24 (4.51)	2.26 (4.62)
H_4	1.76 (2.59)	2.47 (5.62)	2.14 (4.1)	2.44 (5.43)	2.49 (5.72)	2.46 (5.57)	2.44 (5.43)	1.79 (2.72)	2.14 (4.07)	2.32 (4.88)	2.3 (4.77)	2.31 (4.82)
H_5	1.72 (2.46)	2.1 (3.89)	1.92 (3.17)	1.69 (2.37)	1.69 (2.35)	1.69 (2.36)	1.69 (2.37)	1.53 (1.85)	1.62 (2.11)	2.23 (4.49)	1.95 (3.32)	2.1 (3.91)
H_6	1.88 (3.05)	2.47 (5.59)	2.2 (4.32)	2.63 (6.42)	2.72 (6.89)	2.68 (6.66)	2.63 (6.42)	2.23 (4.47)	2.44 (5.44)	2.75 (7.06)	2.48 (5.63)	2.62 (6.34)
H_7	2.02 (3.58)	2.85 (7.63)	2.47 (5.61)	2.54 (5.96)	2.77 (7.18)	2.66 (6.57)	2.54 (5.96)	2.53 (5.91)	2.54 (5.94)	2.88 (7.79)	2.42 (5.35)	2.66 (6.57)
H_8	2.17 (4.19)	2.95 (8.21)	2.59 (6.2)	2.75 (7.08)	2.79 (7.29)	2.77 (7.18)	2.75 (7.08)	2.41 (5.33)	2.59 (6.21)	2.99 (8.44)	2.77 (7.17)	2.88 (7.81)
H_9	2.45 (5.51)	3.03 (8.69)	2.76 (7.1)	2.9 (7.92)	2.84 (7.59)	2.87 (7.76)	2.9 (7.92)	2.74 (7)	2.82 (7.46)	3.05 (8.78)	3.28 (10.28)	3.17 (9.53)
H_{10}	1.51 (1.79)	1.69 (2.36)	1.61 (2.08)	1.61 (2.08)	1.52 (1.82)	1.57 (1.95)	1.61 (2.08)	1.43 (1.54)	1.52 (1.81)	1.86 (2.96)	1.84 (2.87)	1.85 (2.91)
H_{11}	1.59 (2.04)	1.83 (2.85)	1.72 (2.45)	1.63 (2.17)	1.63 (2.16)	1.63 (2.17)	1.63 (2.17)	1.4 (1.46)	1.52 (1.82)	2.07 (3.78)	1.82 (2.81)	1.95 (3.3)
H_{12}	1.69 (2.35)	2.29 (4.73)	2.01 (3.54)	1.75 (2.57)	1.83 (2.85)	1.79 (2.71)	1.75 (2.57)	1.57 (1.96)	1.66 (2.26)	2.12 (3.99)	2.05 (3.72)	2.09 (3.85)
H_{13}	2.3 (4.77)	2.96 (8.26)	2.65 (6.52)	2.95 (8.18)	2.87 (7.73)	2.91 (7.95)	2.95 (8.18)	2.86 (7.68)	2.9 (7.93)	3.09 (9.05)	3.09 (9.05)	3.09 (9.05)
H_{14}	3.01 (8.57)	3.09 (9.06)	3.05 (8.82)	3.14 (9.33)	3.11 (9.18)	3.12 (9.26)	3.14 (9.33)	2.8 (7.32)	2.97 (8.33)	3.07 (8.95)	3.41 (11.1)	3.24 (10.03)
SEm±	0.22	0.26	0.16	0.32	0.33	0.23	0.32	0.23	0.19	0.38	0.33	0.24
CD (P=0.05)	0.65	0.74	0.47	0.93	0.95	0.66	0.93	0.68	0.55	1.10	0.95	0.70

Values transformed to √x+0.5 and actual values are in parentheses

H_1 - Weedy check; H_2 - Weed free; H_3 - Pendimethalin; H_4 - Oxyfluorfen; H_5 - Imazethapyr; H_6 - Diclosulam @20g/ha PE; H_7 - Diclosulam @25g/ha PE; H_8 - Flumioxazin @75 g/ha; H_9 - Flumioxazin @100 g/ha; H_{10} - Pendimethalin + Imazethapyr; H_{11} - Pendimethalin + Oxyfluorfen; H_{12} - Imazethapyr + Imazamox (Rm); H_{13} - Sodium Acifluorfen + Clodinafop Propargyl 8% (Rm); H_{14} - Fomesafen 11.1% + Fluazifop–p-butyl 11.1 % (Rm).

Table 3 (a): Effect of herbicidal weed control on category wise weed density at 90 DAS.

Treatments	Weed density (No. m^{-2})		
	Broad-leaved weeds		
	2021-22	2022-23	Pooled
H_1	6.39 (40.38)	6.5 (41.69)	6.44 (41.03)
H_2	0.70(0.00)	0.70(0.00)	0.70(0.00)
H_3	4.13 (16.56)	4.49 (19.63)	4.31 (18.1)
H_4	4.57 (20.34)	4.63 (20.94)	4.6 (20.64)
H_5	3.67 (12.96)	4.05 (15.93)	3.87 (14.45)
H_6	4.63 (20.9)	4.69 (21.54)	4.66 (21.22)
H_7	4.84 (22.97)	5.02 (24.68)	4.93 (23.82)
H_8	5.17 (26.18)	5.34 (28.03)	5.25 (27.11)
H_9	5.82 (33.34)	6.07 (36.38)	5.95 (34.86)
H_{10}	3.42 (11.2)	3.31 (10.44)	3.36 (10.81)
H_{11}	3.44 (11.36)	3.81 (14.01)	3.63 (12.69)
H_{12}	3.97 (15.3)	4.37 (18.58)	4.18 (16.94)
H_{13}	5.61 (30.98)	5.79 (32.98)	5.7 (31.99)
H_{14}	6.05 (36.05)	6 (35.53)	6.02 (35.8)
SEm±	0.33	0.29	0.22
CD (P=0.05)	0.96	0.85	0.63

Values transformed to √x+0.5 and actual values are in parentheses

H_1 - Weedy check; H_2 - Weed free; H_3 - Pendimethalin; H_4 - Oxyfluorfen; H_5 - Imazethapyr; H_6 - Diclosulam @20g/ha PE; H_7 - Diclosulam @25g/ha PE; H_8 - Flumioxazin @75 g/ha; H_9 - Flumioxazin @100 g/ha; H_{10} - Pendimethalin + Imazethapyr; H_{11} - Pendimethalin + Oxyfluorfen; H_{12} - Imazethapyr + Imazamox (Rm); H_{13} - Sodium Acifluorfen + Clodinafop Propargyl 8% (Rm); H_{14} - Fomesafen 11.1% + Fluazifop–p-butyl 11.1 % (Rm)

Table 3 (b): Effect of herbicidal weed control on individual weed density at 90 DAS.

Treatments	Weed density (No. m^{-2})											
	Rumex dentatus			*Chenopodium murale* L.			*Melilotus indica* L.			*Chenopodium album*		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
H_1	2.69 (6.71)	2.79 (7.29)	2.74 (7)	3.18 (9.64)	3.35 (10.75)	3.27 (10.19)	3.18 (9.62)	3.32 (10.49)	3.25 (10.05)	3.86 (14.41)	3.7 (13.16)	3.78 (13.79)
H_2	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
H_3	1.96 (3.35)	2.43 (5.42)	2.21 (4.39)	1.99 (3.46)	2.21 (4.38)	2.1 (3.92)	1.98 (3.42)	2.07 (3.78)	2.02 (3.6)	2.61 (6.33)	2.56 (6.05)	2.59 (6.19)
H_4	2.07 (3.77)	2.46 (5.56)	2.27 (4.66)	2.21 (4.39)	2.13 (4.05)	2.17 (4.22)	2.15 (4.11)	2.05 (3.7)	2.1 (3.91)	2.93 (8.07)	2.85 (7.63)	2.89 (7.85)
H_5	1.94 (3.25)	2.36 (5.06)	2.16 (4.16)	1.77 (2.65)	2.22 (4.42)	2.01 (3.53)	1.87 (3)	1.85 (2.93)	1.86 (2.97)	2.14 (4.06)	2 (3.52)	2.07 (3.79)
H_6	2.14 (4.09)	2.57 (6.12)	2.37 (5.1)	2.25 (4.57)	2.23 (4.49)	2.24 (4.53)	2.21 (4.39)	2.17 (4.23)	2.19 (4.31)	2.89 (7.85)	2.68 (6.7)	2.79 (7.28)
H_7	2.28 (4.71)	2.64 (6.47)	2.47 (5.59)	2.39 (5.23)	2.26 (4.62)	2.33 (4.92)	2.46 (5.54)	2.32 (4.9)	2.39 (5.22)	2.83 (7.49)	3.03 (8.69)	2.93 (8.09)
H_8	2.28 (4.72)	2.6 (6.28)	2.45 (5.5)	2.79 (7.31)	2.44 (5.47)	2.62 (6.39)	2.32 (4.9)	2.37 (5.12)	2.35 (5.01)	3.12 (9.25)	3.41 (11.16)	3.27 (10.21)
H_9	2.65 (6.53)	2.68 (6.66)	2.66 (6.59)	3 (8.52)	3 (8.48)	3 (8.5)	2.63 (6.43)	3.23 (9.92)	2.95 (8.18)	3.52 (11.86)	3.44 (11.32)	3.48 (11.59)
H_{10}	1.92 (3.19)	1.77 (2.65)	1.85 (2.92)	1.71 (2.43)	1.82 (2.83)	1.77 (2.63)	1.68 (2.33)	1.67 (2.3)	1.68 (2.31)	1.94 (3.25)	1.78 (2.66)	1.86 (2.95)
H_{11}	1.91 (3.16)	2.36 (5.06)	2.15 (4.11)	1.79 (2.71)	1.96 (3.35)	1.88 (3.03)	1.67 (2.3)	1.75 (2.58)	1.71 (2.44)	1.92 (3.19)	1.88 (3.02)	1.9 (3.11)
H_{12}	1.94 (3.25)	2.43 (5.42)	2.2 (4.33)	2 (3.52)	2.22 (4.41)	2.11 (3.96)	1.87 (3)	1.99 (3.45)	1.93 (3.23)	2.46 (5.53)	2.41 (5.3)	2.43 (5.42)
H_{13}	2.44 (5.45)	2.66 (6.57)	2.55 (6.01)	3 (8.5)	2.79 (7.27)	2.9 (7.89)	2.51 (5.79)	3.07 (8.95)	2.81 (7.37)	3.43 (11.24)	3.27 (10.19)	3.35 (10.72)
H_{14}	2.69 (6.76)	2.67 (6.64)	2.68 (6.7)	3.13 (9.28)	2.97 (8.3)	3.05 (8.79)	2.93 (8.06)	3.15 (9.45)	3.04 (8.76)	3.53 (11.95)	3.41 (11.14)	3.47 (11.55)
SEm±	0.23	0.22	0.16	0.33	0.27	0.21	0.32	0.32	0.22	0.45	0.36	0.28
CD (P=0.05)	0.67	0.65	0.46	0.95	0.79	0.59	0.92	0.94	0.64	1.30	1.03	0.81

Values transformed to √x+0.5 and actual values are in parentheses

H_1 - Weedy check; H_2 - Weed free; H_3 - Pendimethalin; H_4 - Oxyfluorfen; H_5 - Imazethapyr; H_6 - Diclosulam @20g/ha PE; H_7 - Diclosulam @25g/ha PE; H_8 - Flumioxazin @75 g/ha; H_9 - Flumioxazin @100 g/ha; H_{10} - Pendimethalin + Imazethapyr; H_{11} - Pendimethalin + Oxyfluorfen; H_{12} - Imazethapyr + Imazamox (Rm); H_{13} - Sodium Acifluorfen + Clodinafop Propargyl 8% (Rm); H_{14} - Fomesafen 11.1% + Fluazifop–p-butyl 11.1 % (Rm)

Table 4: Effect of herbicidal weed control on weed dry matter (kg ha^{-1}).

Treatments	30 DAS			60 DAS			90 DAS			At harvest		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
H_1	18.96 (358.99)	17.63 (310.21)	18.31 (334.6)	26.37 (695.14)	26.06 (678.55)	26.22 (686.85)	32.68 (1067.53)	30.43 (925.46)	31.58 (996.5)	34.12 (1163.8)	32.17 (1034.61)	33.16 (1099.21)
H_2	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
H_3	10.59 (111.61)	10.47 (109.21)	10.53 (110.41)	12.8 (163.37)	14.01 (195.68)	13.42 (179.52)	16.36 (267.28)	17.46 (304.37)	16.92 (285.83)	19.24 (369.76)	20.2 (407.45)	19.73 (388.6)
H_4	10.65 (112.82)	10.81 (116.35)	10.73 (114.58)	13.8 (189.88)	14.04 (196.75)	13.92 (193.31)	17.29 (298.57)	17.5 (305.6)	17.4 (302.09)	20.06 (401.96)	20.41 (415.94)	20.23 (408.95)
H_5	9.53 (90.34)	9.6 (91.65)	9.57 (90.99)	11.65 (135.3)	11.41 (129.6)	11.53 (132.45)	15.41 (236.84)	15.51 (240.09)	15.46 (238.47)	18.58 (344.84)	18.65 (347.2)	18.62 (346.02)
H_6	10.71 (114.28)	10.67 (113.39)	10.69 (113.84)	14.08 (197.82)	14.12 (198.96)	14.1 (198.39)	17.49 (305.23)	17.32 (299.32)	17.4 (302.28)	20.28 (410.94)	20.13 (404.71)	20.21 (407.82)
H_7	10.77 (115.5)	10.83 (116.82)	10.8 (116.16)	14.94 (222.81)	14.82 (219.1)	14.88 (220.95)	18.1 (326.94)	17.99 (323.01)	18.04 (324.98)	20.76 (430.65)	20.59 (423.57)	20.68 (427.11)
H_8	13.53 (182.53)	13.06 (170.11)	13.3 (176.32)	17.12 (292.43)	16.63 (275.96)	16.87 (284.19)	19.91 (395.78)	18.12 (327.95)	19.04 (361.87)	22.39 (500.75)	21.72 (471.27)	22.06 (486.01)
H_9	12.64 (159.23)	12.07 (145.18)	12.36 (152.21)	16.16 (260.51)	15.82 (249.77)	15.99 (255.14)	19.11 (364.8)	19 (360.65)	19.06 (362.73)	21.68 (469.45)	21.66 (468.5)	21.67 (468.98)
H_{10}	7.11 (50.01)	6.91 (47.21)	7.01 (48.61)	9.31 (86.18)	9.97 (98.94)	9.65 (92.56)	11.71 (136.59)	12.96 (167.36)	12.35 (151.98)	15.6 (242.94)	16.64 (276.46)	16.13 (259.7)
H_{11}	8.98 (80.23)	9.53 (90.36)	9.26 (85.3)	10.26 (104.71)	9.78 (95.11)	10.02 (99.91)	14.66 (214.48)	14.14 (199.33)	14.4 (206.91)	17.9 (319.85)	17.37 (301.22)	17.64 (310.54)
H_{12}	10.22 (103.9)	10.32 (105.99)	10.27 (104.95)	11.81 (139.07)	11.23 (125.71)	11.53 (132.39)	15.53 (240.56)	15.07 (226.68)	15.3 (233.62)	18.63 (346.46)	18.3 (334.24)	18.46 (340.35)
H_{13}	12.53 (156.52)	11.7 (136.32)	12.12 (146.42)	16.21 (262.19)	15.47 (238.97)	15.85 (250.58)	19.29 (371.53)	18.5 (341.74)	18.9 (356.64)	21.8 (474.91)	21.22 (449.6)	21.51 (462.25)
H_{14}	11.34 (128.19)	12.97 (167.61)	12.18 (147.9)	15.18 (230)	16.62 (275.67)	15.92 (252.83)	18.36 (336.73)	19.63 (384.82)	19.01 (360.78)	21.11 (444.97)	22.27 (495.37)	21.69 (470.17)
SEm±	4.35	5.55	3.48	6.90	6.17	4.54	11.33	7.92	6.81	8.94	6.56	5.19
CD (P=0.05)	12.66	16.14	10.01	20.05	17.94	13.05	32.93	23.02	19.58	26.00	19.08	14.91

Values transformed to √x+0.5 and actual values are in parentheses

H_1 - Weedy check; H_2 - Weed free; H_3 - Pendimethalin; H_4 - Oxyfluorfen; H_5 - Imazethapyr; H_6 - Diclosulam @20g/ha PE; H_7 - Diclosulam @25g/ha PE; H_8 - Flumioxazin @75 g/ha; H_9 - Flumioxazin @100 g/ha; H_{10} - Pendimethalin + Imazethapyr; H_{11} - Pendimethalin + Oxyfluorfen; H_{12} - Imazethapyr + Imazamox (Rm); H_{13} - Sodium Acifluorfen + Clodinafop Propargyl 8% (Rm); H_{14} - Fomesafen 11.1% + Fluazifop–p-butyl 11.1 % (Rm)

Imazethapyr an important herbicide is identified in reducing broad-leaved weeds belongs to imidazolinone

group with a toxicity class of III and used as selective herbicide. It is mostly applied as pre-emergence to control broad-leaved weeds emerged after 15-20 days of sowing in pulse crop (Herbicide handbook 1989). Reduced weed density and weed biomass with the application of imazethapyr alone has also been reported by Singh *et al*. (2014).

Weed control efficiency and weed persistence index. All the herbicide control measures resulted in differed efficiency to control weeds during both the crop seasons and pooled analysis (Table 5). Pooled data shows the weed control efficiency ranged between 100 to 55.79 per cent in weed free to application of Flumioxazin @ 75 g/ha (H_8). Pre-emergence application of pendimethalin + imazethapyrin at 800 ml ha^{-1} (H_{10}) and pre plant incorporation of pendimethalin + oxyfluofen at 500 g ha^{-1} (H_{11}) resulted in higher values of 76.37 and 71.75 per cent, respectively in comparison to weedy check. Density of weeds in the treated plots is directly related with the weed control efficiency.

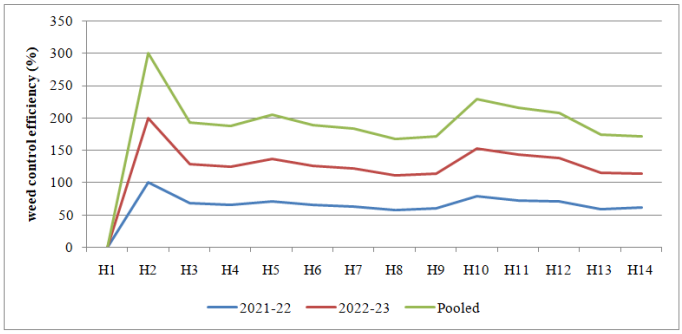

Fig. 1. Effect of herbicidal weed control on weed control efficiency (%) at harvest.

Table 5: Effect of herbicidal weed control on weed control efficiency (%) at harvest.

Treatments	Broad-leaved weeds		
	2021-22	2022-23	Pooled
H_1	0.0	0.0	0.0
H_2	100	100	100
H_3	68.23	60.62	64.65
H_4	65.46	59.80	62.80
H_5	70.37	66.44	68.52
H_6	64.69	60.88	62.90
H_7	63.00	59.06	61.14
H_8	56.97	54.45	55.79
H_9	59.66	54.72	57.33
H_{10}	79.13	73.28	76.37
H_{11}	72.52	70.89	71.75
H_{12}	70.23	67.69	69.04
H_{13}	59.19	56.54	57.95
H_{14}	61.77	52.12	57.23
SEm±	-	-	-
CD (P=0.05)	-	-	-

H_1 - Weedy check; H_2 - Weed free; H_3 - Pendimethalin; H_4 - Oxyfluorfen; H_5 - Imazethapyr; H_6 - Diclosulam @20g/ha PE; H_7 - Diclosulam @25g/ha PE; H_8 - Flumioxazin @75 g/ha; H_9 - Flumioxazin @100 g/ha; H_{10} - Pendimethalin + Imazethapyr; H_{11} - Pendimethalin + Oxyfluorfen; H_{12} - Imazethapyr + Imazamox (Rm); H_{13} - Sodium Acifluorfen + Clodinafop Propargyl 8% (Rm); H_{14} - Fomesafen 11.1% + Fluazifop–p-butyl 11.1 % (Rm)

Table 6: Effect of herbicidal weed control on weed persistence index at 90 DAS.

Treatments	Broad-leaved weeds		
	2021-22	2022-23	Pooled
H_1	1.00	1.00	1.00
H_2	0.00	0.00	0.00
H_3	0.46	0.53	0.50
H_4	0.59	0.68	0.64
H_5	0.21	0.25	0.23
H_6	0.58	0.67	0.63
H_7	0.55	0.63	0.59
H_8	0.59	0.67	0.63
H_9	0.62	0.71	0.67
H_{10}	0.21	0.24	0.23
H_{11}	0.22	0.25	0.24
H_{12}	0.38	0.44	0.41
H_{13}	0.62	0.71	0.67
H_{14}	0.58	0.66	0.62
SEm±	0.01	0.01	0.01
CD (P=0.05)	0.02	0.03	0.02

H_1 - Weedy check; H_2 - Weed free; H_3 - Pendimethalin; H_4 - Oxyfluorfen; H_5 - Imazethapyr; H_6 - Diclosulam @20g/ha PE; H_7 - Diclosulam @25g/ha PE; H_8 - Flumioxazin @75 g/ha; H_9 - Flumioxazin @100 g/ha; H_{10} - Pendimethalin + Imazethapyr; H_{11} - Pendimethalin + Oxyfluorfen; H_{12} - Imazethapyr + Imazamox (Rm); H_{13} - Sodium Acifluorfen + Clodinafop Propargyl 8% (Rm); H_{14} - Fomesafen 11.1% + Fluazifop–p-butyl 11.1 % (Rm)

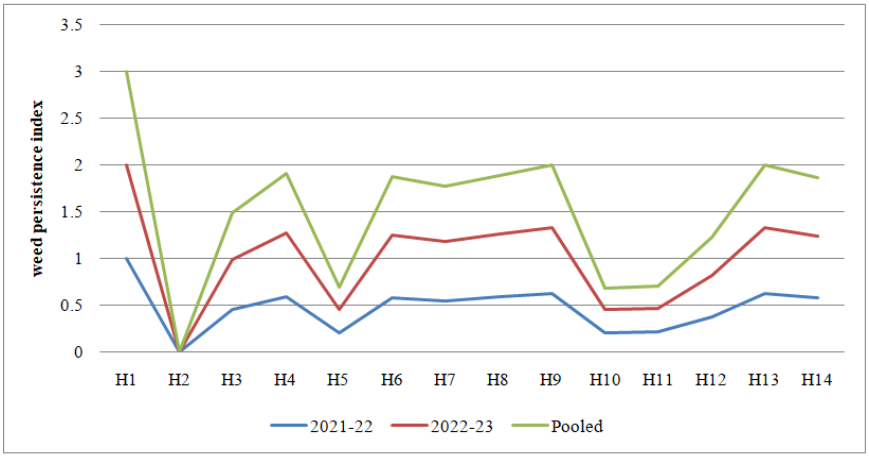

Fig. 2. Effect of herbicidal weed control on weed persistence index at 90 DAS.

As discussed in preceding paragraphs, germination and consequent growth of weeds are inhibited under the influence of herbicide application. It leads to the higher mortality of weeds in the herbicidal control measures. These seem to be the most spectacular reasons of accumulating lesser density of weeds and as a consequence of higher weed control efficiencies (Mishra *et al.*, 2001; Sharma and Shrivastava 2002; Guriqbal, 2005).

Similarly weed persistence index at 90 DAS also showed variable response with different herbicides and ranged from 1.0 to 0.23 in pooled data. Application of pendimethalin + imazethapyr (Rm), imazethapyr alone and pendimethalin + oxyfluofen (Rm) recorded significantly lowest values of weed persistence index of 0.23, 0.23 and 0.24, respectively (Table 6) (Sangeetha *et al.*, 2011; Chandrakar *et al.*, 2014; Kumawat *et al*., 2018).

CONCLUSIONS

Based on the research finding, it seems quite logical to conclude efficient weed control in fenugreek can be achieved either by pre-emergence application of pendimethalin + imazethapyr (RM) under paucity of farm labourers.

FUTURE SCOPE

It is assumed that by the year 2050 the demand for the seed spices will increase nearly by three fold. The average yield of this crop in the zone is far away from its yield potential owing to many reasons but lack of the appropriate irrigation schedule and effective weed management are felt important one. Practices to increase the yield of seed spices are to be experimented.

Acknowledgement. I avail this work opportunity with great pleasure to express my unfathomable gratitude and whole hearted thanks to my research supervisor and respected guide Dr. N.K. Pareek, Associate Professor & Head, Department of Agronomy, College of Agriculture, Fatehpur (SKNAU, Jobner), Dr. Shish Pal Singh and Dr. Amar Singh Godara for taking up this work, thought provoking ideas, valuable advice, constant encouragement, excellent criticism and taking much effort to complete my research work as a great success.
Conflict of Interest. None.

REFERENCES

Bhutia, H. P., N. Chattopadhyay, J. K. Hore, R. Yonzone, and R. Lepcha (2017). Weed and Water Management in Fenugreek (*Trigonella foenum graecum* L.)- A review. *Journal of Crop and Weed*, *13*(3), 204-208.

Cantwell, J. R., Liebl, R. A. and Slife, F. W. (1989). Biodegradation Characteristics of Imazaquin and Imazethapyr. *Weed Science*, *37*, 815-819.

Chandrakar, D. K., Chandrakar, K., Nagre, S. K., Singh, A. P. and Nanda, H. C. (2014). Effect of Different Weed Management Practices on Weed Dynamics and Performance of Rajmash. In: Biennial Conference of Indian Society of Weed Science on *"Emerging Challenges in Weed Management"* February 15-17, DWSR, Jabalpur. pp. 243.

Dubey, S. K. and Arora, A. (2014). Persistence of Pendimethalin and Chlorimuron – P - Ethyl in Soil and iIts Impact on Soil Microorganisms. *Pesticide Research Journal*, *26*(2), 189-192.

Gill, B. S., Randhawa, G. S. and Saini, S. S. (2002). Integrated Weed Management in Fenugreek (*Trigonella foenum-graecum* L.). *Indian Journal of Agronomy*, *47*(2), 284-288.

Gomez, A. A. and Gomez, A. A. (1984). *Statistical Procedures for Agricultural Researcher* (2nd *ed*.). John Wiley and Sons. Singapore.

Guriqbal, S. (2005). Effect of Chemical and Mechanical Weed Management on Growth and Grain Yield of Soybean (*Glycine max* (L) Merril.). *Indian Journal of Weed Science*, *37*(1&2), 131-132.

Gupta, V., Sasode, D. S., Kansana, B. S., Arora, A., Dixit, J. P. and Joshi, E. (2017). Weed Management with Pre- and Post-emergence Herbicides in Black gram. *Indian Journal of Weed Science*, *49*(3), 256-259.

Herbicide Hand Book (2002). Imazethapyr. WSSA Herbicide Handbook – 8th Edition, 2002. pp. 256-258.

Kumar, A., Tripathi, S. S., Singh, G. and Singh, V. P. (2005). Efficacy of Herbicides on Weeds and Seed Yield of Fenugreek. *Indian Journal of Weed Science*, *37*(3&4), 279-280.

Kumar, R., Malik, Y. P. and Punia, S. S. (2016). Weed Control in Fenugreek with Pendimethalin and Imazethapyr. *Indian Journal of Weed Science*, *48*(2), 225-227.

Kumawat, A., Singh, S. P., Yadav, R. S. and Jakhar, R. R. (2018). Productivity Augmentation of Greengram Through Weed Management. *Legume Research*, *41* (3), 410-415.

Mani, V. S., Gautam, K. C. and Chakraberty, T. K. (1968). Losses in Crop Yield in India due to Weed Growth. *PANS 42*, 142-158.

Mishra, M., and Mishra, A. (1997). Estimation of IPM index in Jute: a new approach.

Mishra, O. R., Goutam, V. S., Rajput, A. M. and Patidar, G. L. (2001). Integrated Weed Management and its Economics in Soybean (*Glycine max* (L) Merril.). *Crop Research*, *21*, 115-119.

Pellerin, K. J. and Webster, E. P. (2004). Imazethapyr at Different Rates and Timings in Drill and Water Seeded Imidazolinone-Tolerant Rice. *Weed Technology*, *18*, 223-227.

Sharma, R. K. and Shrivastava, U. K. (2002). Weed Control in Soybean (*Glycine max* (L) Merril.). *Indian Journal of Agronomy*, *47*, 269-272.

Sharma, Rajvir, S. S. Pahuja, R. S. Balyan, and R. K. Malik (2002). Effect of Sulfonylurea Herbicides Applied Alone and Tank Mix with Metribuzin on Weeds in Wheat and their Residual Effect on Succeeding Crop of Sorghum. *Indian Journal of Weed Science, 34***(**3&4), 178-183.

Singh, A., Chand, M., Punia, S. S., Singh, N. A. R. E. N. D. E. R. & Rana, S. S. (2019). Efficacy of different herbicides on weed dynamics and productivity of kharif maize (*Zea mays*) and their residual effect on succeeding wheat crop (*Triticum aestivum*). *Indian Journal of Agricultural Sciences*, *90*, 55-59.

Singh, D., Mir, N. H., Singh, N. and Kumar, J. (2014). Promising Early Post-Emergence Herbicides for Effective Weed Management in Soybean. *Indian Journal of Weed Science*, *46*, 135–137.

Singh, R., Choudhary, S., Mehta, R. S., Aishwath, O. P., & Lal, G. (2022). Yield Losses Due to Weeds, Critical Period for Weed-crop Competition in Fenugreek (*Trigonella foenum-graecum* L.). *Legume Research: An International Journal*, *45*(10).

Tabatabi, M. A. and Bremmer, J. M. (1969). Use of p – nitro phenyl phosphate for assay of soil phosphate activity. *Soil Biology and Biochemistry*, *1*(4), 301-307.

Verma, S. K. and Singh, S. B. (2008). Enhancing of Wheat Production through Appropriate Agronomic Management. *Indian Farming*, *58*, 15-18.

Yates, Frank, and Kenneth Mather (1963). "Ronald Aylmer Fisher, 1890-1962. 91-129.

How to cite this article: Bhagyashree Phogat, Narendra Kumar Pareek, Shish Pal Singh, Amar Singh Godara and Abhijeet Purohit (2023). Influence of Herbicides on Weed Dynamics and Persistence in Fenugreek (*Trigonellafoenum-graecum* L.) in Arid Region. *Biological Forum – An International Journal*, *15*(11): 39-47.