



Reviewed by

Dr. S.M. Patel,
Seed Spices Research Station,
Sardarkrushinagar Dantiwada
Agricultural University,
Sardarkrushinagar
Email: shileshp1967@gmail.com

*Correspondence

B. Malunekar
malunekar_bharat@rediffmail.com

Received: 19 August 2024

Revision: 05 September 2024

Accepted: 24 September 2024

Citation

Malunekar, B., Verma, A., Mali, G., Mohite, M. and Chitodkar, S. 2024. Influence of weed management and vermicompost on weed dynamics, yield and nutrient uptake by fenugreek. *Int J Seed Spice*, 14 (1):25-37

DOI

<https://doi.org/10.56093/IJSS.v14i1.3>

Affiliation

¹ Agriculture Research Station, Niphad, Mahatma Phule Krishi Vidyapeeth, Rahuri, India

² Department of Agronomy, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, India

³ Krishi Vigyan Kendra, Gudmalani, Agriculture University, Jodhpur, India

Influence of weed management and vermicompost on weed dynamics, yield and nutrient uptake by fenugreek

B. Malunekar^{1*}, A. Verma², G. Mali³, M. Mohite² and S. Chitodkar¹

Abstract

A field experiment was conducted at Instructional farm, RCA, MPUAT, Udaipur during *Rabi* 2016-17 and 2017-18 to study the weed dynamics, yield and nutrient uptake in fenugreek. An experiment consists of thirteen different weed management practices assigned to main plot and levels of vermicompost in sub plot. Results of the field experiment revealed that pre-emergence application of oxadiargyl 100 g ha⁻¹ fb hoeing at 40 DAS recorded the lowest weed density (24.25 /m²) and dry matter of total weeds (158.22 g/m²) over weedy check (245.42 /m² and 893.44 g/m²) and higher weed control efficiency (82.30 per cent). The same treatment registered higher yield attributes like number of pods (46.68), seeds per pod (17.33), seed weight per pod (9.05 g plant⁻¹) and test weight (12.59 g) seed yield (2820 kg ha⁻¹) over rest of the weed management treatments. Maximum yield loss 65.0 per cent was recorded in the weedy check (1055 kg ha⁻¹) compared with weed free check (2908 kg ha⁻¹). Weed management practices showed significant variation in nutrient uptake by weeds and fenugreek crop at harvest. Interaction effect of Weed management practices and vermicompost application to fenugreek crop showed significant effect on total dry matter accumulation by weeds. In addition, the fenugreek yields were significantly higher due to the combined effects of weed management practices and vermicompost application. A pooled study concluded that pre-emergence applications of oxadiargyl 100 g ha⁻¹ PE fb hoeing at 40 DAS along with a vermicompost application of 5 t ha⁻¹ were superior to pre-emergence applications for maximum seed yield and minimum weed uptake of nutrients and higher plant uptake for maximum seed yield in southern Rajasthan fenugreek.

Key words: Fenugreek, nutrient uptake, vermicompost, weed control efficiency, weed density, weed dynamics, weed index, weed management

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is most important seed

spice of semi-arid region of the country. Worldwide, India is one of the most important grower of fenugreek. India has always been recognized as a 'Land of Spices'. Fenugreek is mainly grown in Rajasthan, Gujarat, Uttar Pradesh and Tamil Nadu. Among these states, Rajasthan contributes 64.42 per cent of total production and it is called as 'Seed spice bowl of India'. India is largest grower of fenugreek occupying a 146234 hectare area with a production of 234595 Mt during 2022-23 (State Agri/Horti Departments/DASD). The plant belongs to the leguminaceae family and is cultivated for leafy vegetables, condiments and medicinal purposes (Singh *et al.*, 2021)

Several biotic and abiotic factors may contribute to the low productivity of this crop, but weed infestation appears to be the most critical. Weeds have been identified as a serious drawback since they create biotic stress in realizing the genetic yield potential. Weed management dictates most of the crop production practices and causes enormous losses (37 per cent) as compared to insect pests and diseases (Verma *et al.*, 2015). It is estimated that weeds cause an 86% loss in seed yield (Tripathi and Singh, 2008). Maximum crop-weed competition was found more critical during 25-30 days of sowing which causes serious yield reduction in fenugreek. Weed management through traditional methods like hand weeding is difficult because of its time, cost and labour consuming. Consequently, herbicides with a suitable dose remain the only option for controlling the diverse weed flora and reducing costs (Patel *et al.*, 2022). In present study imazethapyr + imazamox (RM), oxyfluorfen and oxydiargyl have been taken for testing at different doses for control of weed flora along with pendimethalin and imazethapyr. Sometimes, only herbicide is not able to control all weeds therefore, the combination of herbicide and hoeing to control weeds would not only reduce the cost of weed management, but it would benefit the crop by providing aeration and conservation of moisture.

Fenugreek is generally grown under semi-arid conditions on marginal and sub-marginal lands. Thus, for balanced nutrient management integrated application of inorganic and organic sources of nutrients is a pre-requisite. Vermicompost supplies major as well as minor nutrients besides improving the

soil health (Owla *et al.*, 2015). It also improves the soil structure by providing binding substance to soil aggregates leading to an increase in water retention in soil (Verma *et al.*, 2015). Besides, it improves the efficiencies of applied fertilizers. It acts as a chelating agent and affects the herbicide efficiency. Therefore, an effort was made to study the interaction between weed management and vermicompost application on weed dynamics, yield and nutrient uptake in fenugreek under southern Rajasthan conditions.

Materials and methods

A field experiment was conducted at an Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur during *Rabi* 2016-17 and 2017-18. The soils of experimental field were clay loam in texture slightly alkaline in reaction with pH 8.1 medium in organic carbon (0.71 %), available nitrogen (285 kg ha⁻¹), available phosphorus (19.42 kg ha⁻¹) and high in available potassium (344.16 kg ha⁻¹). The field experiment was laid out in split plot design with three replications. Thirteen weed management treatments comprising T₁: Imazethapyr 70 g ha⁻¹ PE, T₂: Imazethapyr 70 g ha⁻¹ PE *fb* hoeing at 40 DAS, T₃: Imazethapyr 50 g ha⁻¹ PoE 2-4 leaf stage of weed, T₄: Imazethapyr + Imazamox (RM) 50 g ha⁻¹ PoE 2-4 leaf stage of weed, T₅: Imazethapyr + Imazamox (RM) 60 g ha⁻¹ PoE 2-4 leaf stage of weed, T₆: Pendimethalin 750 g ha⁻¹ PE, T₇: Oxyfluorfen 120 g ha⁻¹ PE, T₈: Oxyfluorfen 150 g ha⁻¹ PE, T₉: Oxyfluorfen 120 g ha⁻¹ PE *fb* hoeing at 40 DAS, T₁₀: Oxadiargyl 100 g ha⁻¹ PE, T₁₁: Oxadiargyl 100 g ha⁻¹ PE *fb* hoeing at 40 DAS, T₁₂: Weed free check and T₁₃: Weedy check in main plot treatments and levels of vermicompost *viz*: control and 5 t/ha in sub plot treatments. Fenugreek variety RMT-305 was sown at 30 cm distance with 25 kg ha⁻¹ seed rate and recommended dose of fertilizers (40 kg N and 40 kg P₂O₅ ha⁻¹) was applied as basal dose through urea and DAP. In weed free treatment two hand weeding (15 and 30 DAS) and two hoeing (20 and 40 DAS) was carried out. Afterwards, late-emerged weeds were removed by uprooting manually keeping plot weed free during crop growing period. Hoeing operation (as per treatment) was done manually at 40 DAS in fenugreek. Application of pre-emergence herbicide was done one day after sowing and post-emergence herbicide application was done at 20 DAS (2-4 leaf stage of weed) as per given

doses with knapsack sprayer fitted with flat fan nozzle using 500 litres of water per hectare.

Weed studies: In each plot as species wise weeds were counted from two randomly selected area of 0.25 m² using 0.5 m x 0.5 m quadrat at 60 DAS. The mean data were converted to per square metre and subjected to square root transformation $\sqrt{X+0.5}$ to normalize their distribution (Gomez and Gomez, 1984). The weeds were dried at 65°C temperature in oven till a constant weight was obtained which was expressed as weed dry matter. The dry matter was then computed in terms of g m⁻². Weed control efficiency (WCE) is a parameter to study the performance of the various weed control treatments on the basis of weed dry matter under investigation. Weed control efficiency was calculated at harvest using the following formula.

$$WCE = \frac{X-Y}{X} \times 100$$

Where, WCE = Weed control efficiency, X = Weed dry matter in weedy check and Y = Weed dry matter in treated plot.

Nutrient uptake by weeds: Uptake of N, P and K by weeds was estimated by using following formula:

$$\text{Nutrient uptake by weeds (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content in weeds (\%)} \times \text{Weed dry matter (kg ha}^{-1}\text{)}}{100}$$

Crop studies: The crop was harvested at physiological maturity when plants turned golden yellow. The harvested bundles were brought to the threshing floor and left for sun drying for a period of seven days. The dried bundles were weighed to record total biological yield. Observations like number of pod per plant, Number of seeds pod⁻¹, Seed weight plant⁻¹, 1000 - seeds weight were calculated. After threshing, winnowing and cleaning were done and seeds were weighed separately to record seed yield kg plot⁻¹ and yield expressed in terms of kg ha⁻¹.

Harvest index: The harvest index (HI) was calculated by dividing the economic yield (seed yield) by biological yield and expressed as percentage as given by Donald and Hamblin (1976)

$$\text{Harvest index} = \frac{\text{Economic yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

Nutrient content and uptake: Seed and haulm samples collected at harvest from each experimental unit were oven dried at 65°C till a constant weight and ground in laboratory mill. These samples were subjected to chemical analysis for determining N, P and K contents. The following standard methods for analysis were adopted.

Nitrogen : Nessler's reagent colorimetric method (Snell and Snell, 1949)

Phosphorus: Ammonium vanadomolybdate yellow colour method (Richards, 1968)

Potassium : Flame photometer method (Jackson, 1973)

Nutrient uptake: Uptake of N, P and K by seed and haulm were estimated by using following formula:

$$\text{Nutrient uptake by seed (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content in seed (\%)} \times \text{Seed yield (kg ha}^{-1}\text{)}}{100}$$

$$\text{Nutrient uptake by haulm (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content in haulm (\%)} \times \text{Haulm yield (kg ha}^{-1}\text{)}}{100}$$

All the data were subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Cochran and Cox (1967).

Results and Discussion

Weed flora: The experimental field was full of monocot and dicot weeds. Dicot weeds were more prominent (88.61%) compared to monocots (11.39%) during both the years (2016-17 and 2017-18). The weed flora under dicots included *Chenopodium album* (36.01%), *Chenopodium murale* (27.09%), *Fumaria parviflora* (11.63 %), *Malva parviflora* (1.98%), *Melilotus indica* (9.86%) and *Convolvulus arvensis* (2.04 %) whereas *Phalaris minor* (11.39%) was the only monocot weed.

Weed density, weed dry matter and weed control efficiency:

Effect of weed management on weed density: Different weed management practices tended to reduce the density of monocot weed in comparison to weedy check on pooled basis (Table 1). On pooled

basis, pre-emergence application of oxadiargyl 100 g ha⁻¹ fb hoeing at 40 DAS (1.75 m⁻²) recorded minimum density of *Phalaris minor* and it was significantly superior in reducing the weed density over rest of the treatments. The magnitude of reduction in density of *Phalaris minor* at harvest was 94.10 per cent in comparison to weedy check (29.67 m⁻²) by application of this treatment. Further, oxyfluorfen 120 g ha⁻¹ PE fb hoeing at 40 DAS and imazethapyr 70 g ha⁻¹ fb hoeing at 40 DAS were stand next in order of superiority after oxadiargyl 100 g ha⁻¹ PE fb hoeing at 40 DAS. The same treatment recorded lower density of dicot weeds (22.50 m⁻²) on pooled basis. The pooled data further explicit that this treatment was found statistically superior over other treatments of weed management under test. The next order of superiority was observed under imazethapyr 70 g ha⁻¹ fb hoeing at 40 DAS and found superior over weedy check (215.75 m⁻²). A significant reduction in density of total weeds was recorded by various weed control measures on pooled basis. Pre-emergence application of oxadiargyl 100 g ha⁻¹ fb hoeing at 40 DAS recorded minimum weed density of total weeds (24.25 m⁻²) on pooled basis. This treatment was significantly superior over other treatments under test. The magnitude of reduction in density of total weeds by different weed management treatments was 90.12 to 73.07 per cent in comparison to weedy check (245.42 m⁻²). The superiority of herbicide in integration with hoeing or weeding at 40 DAS over their alone application in reducing the weed density and weed dry matter has been also reported by Tiwari *et al.* (2006), Sharma *et al.* (2009), Punia and Tehlan (2017), Brar, (2018) and Deewan *et al.* (2018).

Weed dry matter: All weed management options tended to reduce the dry matter of monocot, dicot and total weeds compared to weedy check (Table 2). Application of oxadiargyl 100 g ha⁻¹ PE fb hoeing at 40 DAS recorded minimum weed dry matter (12.06 g m⁻²) and it was closely followed by oxyfluorfen 120 g ha⁻¹ PE fb hoeing at 40 DAS (13.51 g m⁻²), imazethapyr 70 g ha⁻¹ PE fb hoeing at 40 DAS (16.50 g m⁻²) and these three treatments were remained at par with each other and significantly superior over rest of the treatments on pooled basis. Minimum weed dry matter of dicot weeds was recorded under oxadiargyl 100 g ha⁻¹ PE fb hoeing

at 40 DAS (146.16 g m⁻²). This treatment was found statistically superior over rest of the treatments. The next order of superiority was observed with oxadiargyl 100 g ha⁻¹ PE (204.21 g m⁻²), imazethapyr 50 g ha⁻¹ PoE (208.54 g m⁻²) and imazethapyr 70 g ha⁻¹ PE fb hoeing at 40 DAS (210.92 g m⁻²) and these were remained at par with each other and significant over rest of the treatments.

All weed management options significantly reduced dry matter of total weeds at harvest. Lowest weed dry matter of total weeds was registered under oxadiargyl 100 g ha⁻¹ PE fb hoeing at 40 DAS (158.22 g m⁻²). This treatment was significantly superior over rest of the treatments. The next order of superiority was observed with imazethapyr 70 g ha⁻¹ PE fb hoeing at 40 DAS (158.22 g m⁻²), oxadiargyl 100 g ha⁻¹ PE (158.22 g m⁻²) and oxyfluorfen 120 g ha⁻¹ PE fb hoeing at 40 DAS (158.22 g m⁻²) on pooled basis and significantly superior over weedy check (893.44 g m⁻²).

Effect of Vermicompost on weed density and weed dry matter: Application of vermicompost didn't show any significant effect on weed density. However, it showed significant effect on weed dry matter at harvest. Application of 5 t of vermicompost recorded significantly higher dry matter of monocot, dicot and total weeds (60.41, 292.51 and 352.92 g m⁻², respectively) over control (53.75, 259.24 and 313.00 g m⁻², respectively).

Interaction effect: The interaction effect of weed management and vermicompost was found significant during period of investigation as well as on pooled basis (Table 2). At each level of weed management, the effect of vermicompost varied significantly in weed management treatments consistently and resulted into increased dry matter of total dicot weeds on pooled basis. The pooled data revealed that under the imazethapyr 70 g ha⁻¹ PE fb hoeing at 40 DAS and oxyfluorfen 120 & 150 g ha⁻¹ PE, application of vermicompost 5 t ha⁻¹ resulted in significant increased in the dry matter of dicot weed during both the years and on pooled basis. Whereas, significance of its application under other weed management treatments was inconsistent. The application of vermicompost gave significantly higher dry matter of dicot weeds at each level of weed management except oxadiargyl 100

g ha⁻¹ PE fb hoeing at 40 DAS on pooled basis. On the contrary, critical examination of data (Table 1) showed that at each level of vermicompost, all the weed management treatments resulting into significant decreased in dry matter of dicot weeds as compared with weedy check. Pre-emergence application of oxadiargyl 100 g ha⁻¹ fb hoeing at 40 DAS resulted into significantly lower dry matter than other treatments on pooled basis.

The integration of pre-emergence application of herbicide with hoeing at 40 DAS reduced total weed count and dry matter most efficiently during the entire crop season compared to weedy check and herbicide applied alone either as pre or post-emergence. Therefore, pre-emergence application of herbicide followed by weeding or hoeing at 40 DAS was a most appropriate time for weeding or hoeing in fenugreek (Ghahari *et al.*, 2013). This might be due to the fact that broad spectrum contact herbicide used mainly as a pre-emergence controlled early as well as late flushes of weeds up to the most critical stage of crop-weed competition, due to the persistence and prolonged activity in the soil and later hoeing at 40 DAS controlled late flushes of weeds resulting in excellent performance compared to herbicides specially applied alone either as pre or post-emergence. Higher efficacy of herbicides at the early growth stage and hoeing at later stage (at 40 DAS) was the most effective measure to combat with weeds emerged during the vegetative stage of crop (30 to 60 DAS), thereby, reducing the weed density and dry matter in these treatments also reported by Singh *et al.* (2014), Fageria *et al.* (2014), Meena *et al.* (2013), Kumar *et al.* (2016)

Weed control efficiency: An examination of data (Table 1) revealed that different weed management treatments had affected weed control efficiency of monocot, dicot and total weeds. It clearly shows that different weed management treatments recorded weed control efficiency of total weeds from 52.83 to 82.30 per cent in total weeds. The highest weed control efficiency was recorded under the application of oxadiargyl 100 g ha⁻¹ PE fb hoeing at 40 DAS resulting in monocot (91.27%), dicot (80.66%) and total weeds (82.30%). Also, imazethapyr 70 g ha⁻¹ PE fb hoeing at 40 DAS (74.56%) and oxyfluorfen 120 g ha⁻¹ PE fb hoeing at 40

DAS (73.48%) stood next in order of superiority. Among alone herbicide higher weed control efficiency was recorded by pre-emergence application oxadiargyl 100 g ha⁻¹ (73.48%) followed by imazethapyr 50 g ha⁻¹ PoE (66.00%). The integration of herbicide with weeding or hoeing resulted into higher weed control efficiency was also reported by Tiwari *et al.* (2007), Chopra and Chopra, (2007), Sharma (2009), Kumar *et al.* (2013), Meena *et al.* (2013), Fageria *et al.* (2014), Fageria *et al.* (2014), Singh *et al.* (2014), Kumar *et al.* (2016), Punia and Tehlan (2017) and Brar (2018).

Yield attributes

Weed management: Application of different weed management practices tended to increase the yield attributes. Different weed management practices had significant effect on number of pods plant⁻¹, seeds per pod, seed weight per plant (g) and test weight (g) over weedy check on pooled basis (Table 3). The maximum number of pods (49.82 plant⁻¹), seed weight per plant (17.87), seed weight per plant (9.26 g) and test weight (12.64 g) was registered under the weed free check. Among weed management treatments pre-emergence application of oxadiargyl 100 g ha⁻¹ fb hoeing at 40 DAS maximum number of pods (46.68 plant⁻¹), seed weight per plant (17.33), seed weight per plant (9.05 g) and test weight (12.59 g) and it was significantly superior over rest of the treatments.

Effect of vermicompost: It is obvious from the data of both the years of investigation that application of vermicompost resulted in significantly higher number of pods (43.03 plant⁻¹), seed weight per plant (17.42), seed weight per plant (7.58 g) and test weight (12.50 g) over control.

Seed yield and harvest index

Weed management: Maximum seed yield was registered with weed free check (2908 kg ha⁻¹) and results of it were found at par with a pre-emergence application of oxadiargyl 100 g ha⁻¹ fb hoeing at 40 DAS (2820 kg ha⁻¹). However, the seed yield produced by both the treatments was statistically higher over rest of the treatments and weedy check (1055 kg ha⁻¹). The same treatment recorded higher haulm and biological yield as well as harvest index (6703 kg ha⁻¹, 9523 kg ha⁻¹ and 29.66 per cent), respectively over weedy check (Table 4).

Table 1. Effect of weed management and vermicompost on category wise weed density, weed dry matter and weed control efficiency in fenugreek at harvest (Pooled mean of two years)

Treatments	Weed density (m ⁻²)			Weed dry matter (g m ⁻²)			Weed control efficiency (%)		
	Monocot	Dicot	Total	Monocot	Dicot	Total	Monocot	Dicot	Total
Imazethapyr 70 g ha ⁻¹ PE	4.68 (21.58)	7.13 (50.33)	8.50 (71.92)	84.73	353.33	438.07	38.65	53.25	51.00
Imazethapyr 70 g ha ⁻¹ PE fb hoeing at 40 DAS	1.85 (3.00)	5.50 (29.58)	5.76 (32.75)	16.50	210.92	227.42	88.05	72.09	74.56
Imazethapyr 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	4.58 (20.67)	5.69 (31.81)	7.27 (52.53)	95.32	208.54	303.85	30.99	72.40	66.00
Imazethapyr + Imazamox (RM) 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	4.48 (19.83)	6.81 (46.00)	8.13 (65.83)	82.11	286.31	368.42	40.55	62.14	58.81
Imazethapyr + Imazamox (RM) 60 g ha ⁻¹ PoE 2-4 leaf stage of weed	4.09 (16.50)	6.45 (41.16)	7.61 (57.66)	71.31	249.72	321.04	48.37	66.95	64.08
Pendimethalin 750 g ha ⁻¹ PE	5.05 (25.00)	6.44 (41.08)	8.15 (66.08)	121.41	222.97	344.38	12.10	70.50	61.47
Oxyfluorfen 120 g ha ⁻¹ PE	3.18 (9.75)	7.51 (56.01)	8.13 (65.76)	50.52	371.18	421.69	63.43	50.89	52.83
Oxyfluorfen 150 g ha ⁻¹ PE	2.55 (6.25)	7.01 (48.76)	7.43 (55.01)	23.19	315.76	338.95	83.21	58.22	62.08
Oxyfluorfen 120 g ha ⁻¹ PE fb hoeing at 40 DAS	1.64 (2.18)	5.91 (34.50)	6.10 (36.68)	13.51	261.98	275.49	90.22	65.33	69.18
Oxadiazyl 100 g ha ⁻¹ PE	2.71 (6.94)	5.87 (34.03)	6.55 (42.46)	33.27	204.21	237.48	75.91	73.04	73.48
Oxadiazyl 100 g ha ⁻¹ PE fb hoeing at 40 DAS	1.49 (1.75)	4.79 (22.50)	4.79 (24.25)	12.06	146.16	158.22	91.27	80.66	82.30
Weed free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.00	0.00	0.00	100.00	100.00	100.00
Weedy check	5.49 (29.67)	14.70 (215.75)	15.68 (245.42)	138.12	755.32	893.44	0.00	0.00	0.00
SEm ±	0.02	0.04	0.04	1.02	4.14	5.08			
CD (P=0.05)	0.05	0.11	0.11	3.14	12.77	15.66			
Levels of vermicompost									
Control	3.27 (12.55)	6.52 (50.41)	7.32 (62.96)	53.75	259.24	313.00			
Vermicompost 5 t ha ⁻¹	3.27 (12.54)	6.50 (50.09)	7.30 (62.63)	60.41	292.51	352.92			
SEm ±	0.01	0.02	0.02	0.41	1.54	1.84			
CD (P=0.05)	NS	NS	NS	1.16	4.36	5.20			

Values are $\sqrt{X+5.0}$ transformed and actual values are in parentheses

Table 2. Interaction effect of weed management and vermicompost on dry matter of monocot, dicot and total weeds at harvest of fenugreek

Weed Management	Dry matter (g m ⁻²)					
	Monocot		Dicot		Total	
	Control	Vermicompost 5 t ha ⁻¹	Control	Vermicompost 5 t ha ⁻¹	Control	Vermicompost 5 t ha ⁻¹
Imazethapyr 70 g ha ⁻¹ PE	82.10	87.36	332.75	373.91	414.86	461.27
Imazethapyr 70 g ha ⁻¹ PE fb hoeing at 40 DAS	14.08	18.92	200.94	220.90	215.02	239.82
Imazethapyr 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	91.02	99.62	196.62	220.46	287.63	320.08
Imazethapyr + Imazamox (RM) 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	75.06	89.15	275.27	297.35	350.34	386.50
Imazethapyr + Imazamox (RM) 60 g ha ⁻¹ PoE 2-4 leaf stage of weed	66.07	76.55	237.18	262.27	303.25	338.82
Pendimethalin 750 g ha ⁻¹ PE	117.49	125.33	210.79	235.15	328.29	360.48
Oxyfluorfen 120 g ha ⁻¹ PE	44.64	56.40	340.85	401.50	385.49	457.90
Oxyfluorfen 150 g ha ⁻¹ PE	20.25	26.13	292.65	338.86	312.90	364.99
Oxyfluorfen 120 g ha ⁻¹ PE fb hoeing at 40 DAS	12.54	14.48	250.32	273.65	262.85	288.13
Oxadiargyl 100 g ha ⁻¹ PE	31.52	35.03	193.95	214.46	225.47	249.49
Oxadiargyl 100 g ha ⁻¹ PE fb hoeing at 40 DAS	10.46	13.66	138.72	153.59	148.52	167.92
Weedy free check	0.00	0.00	0.00	0.00	0.00	0.00
Weedy check	133.55	142.70	700.10	810.54	833.65	953.24
	SEM ±	CD (P=0.05)	SEM ±	CD (P=0.05)	SEM ±	CD (P=0.05)
Weed management at the same level of vermicompost	0.82	2.32	3.06	8.64	3.66	10.33
Vermicompost at the same or different levels of weed management	1.81	5.10	7.23	20.43	8.83	24.94

Table 3. Effect of weed management and vermicompost on yield attributes of fenugreek (pooled)

Treatment	Pods plant ⁻¹	Seeds pod ⁻¹	Seed weight (g plant ⁻¹)	Test weight (g)
Weed management				
Imazethapyr 70 g ha ⁻¹ PE	35.71	16.90	6.13	12.06
Imazethapyr 70 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	43.22	17.21	8.45	12.35
Imazethapyr 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	42.48	17.15	7.16	12.25
Imazethapyr + Imazamox (RM) 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	41.17	17.10	6.89	12.12
Imazethapyr + Imazamox (RM) 60 g ha ⁻¹ PoE 2-4 leaf stage of weed	42.59	17.15	7.19	12.28
Pendimethalin 750 g ha ⁻¹ PE	37.22	17.08	6.24	12.08
Oxyfluorfen 120 g ha ⁻¹ PE	35.57	16.90	5.84	12.06
Oxyfluorfen 150 g ha ⁻¹ PE	36.62	17.05	6.19	12.08
Oxyfluorfen 120 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	42.07	17.13	6.97	12.23
Oxadiargyl 100 g ha ⁻¹ PE	42.90	17.17	7.46	12.30
Oxadiargyl 100 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	46.68	17.33	9.05	12.59
Weed free check	49.82	17.87	9.26	12.64
Weedy check	25.71	16.55	4.52	11.38
SEm ±	0.58	0.25	0.10	0.17
CD (P=0.05)	1.79	NS	0.32	NS
Levels of vermicompost				
Control	37.24	16.82	6.48	11.87
Vermicompost 5 t ha ⁻¹	43.03	17.42	7.58	12.50
SEm ±	0.42	0.13	0.06	0.09
CD (P=0.05)	1.20	0.37	0.16	0.24

Table 4. Effect of weed management and vermicompost on yield and harvest index of fenugreek (Pooled mean)

Treatment	Seed yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)	Biological yield (kg ha ⁻¹)	Harvest Index (%)
Weed management				
Imazethapyr 70 g ha ⁻¹ PE	1897	5712	7609	24.81
Imazethapyr 70 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	2260	6122	8382	26.88
Imazethapyr 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	2132	6132	8264	25.72
Imazethapyr + Imazamox (RM) 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	2102	6161	8263	25.29
Imazethapyr + Imazamox (RM) 60 g ha ⁻¹ PoE 2-4 leaf stage of weed	2162	5174	7336	29.37
Pendimethalin 750 g ha ⁻¹ PE	2004	6031	8035	24.87
Oxyfluorfen 120 g ha ⁻¹ PE	1837	5342	7179	25.60
Oxyfluorfen 150 g ha ⁻¹ PE	1976	4916	6892	28.62
Oxyfluorfen 120 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	2114	5377	7491	28.17
Oxadiargyl 100 g ha ⁻¹ PE	2216	5337	7553	29.27
Oxadiargyl 100 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	2820	6703	9523	29.66
Weed free check	2908	6863	9771	29.97
Weedy check	1055	4220	5275	20.09
SEm ±	31	68	95	0.16
CD (P=0.05)	95	209	293	0.49
Levels of vermicompost				
Control	1880	5539	7418	25.13
Vermicompost 5 t ha ⁻¹	2348	5860	8208	28.46
SEm ±	18	44	51	0.18
CD (P=0.05)	50	125	143	0.51

Table 5. Interaction effect of weed management and vermicompost on yield and harvest index of fenugreek (pooled mean)

Treatment	Seed yield (kg ha ⁻¹)		Haulm yield (kg ha ⁻¹)		Biological yield (kg ha ⁻¹)		Harvest index	
Weed management	Vermicompost		Vermicompost		Vermicompost		Vermicompost	
	Cont	5 t ha ⁻¹	Control	5 t ha ⁻¹	Control	5 t ha ⁻¹	Control	5 t ha ⁻¹
Imazethapyr 70 g ha ⁻¹ PE	1600	2194	5623	5801	7223	7995	22.15	27.47
Imazethapyr 70 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	1999	2520	5833	6411	7832	8931	25.53	28.23
Imazethapyr 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	1877	2386	5882	6382	7760	8768	24.23	27.20
Imazethapyr + Imazamox (RM) 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	1827	2378	5900	6422	7726	8800	23.62	26.97
Imazethapyr + Imazamox (RM) 60 g ha ⁻¹ PoE 2-4 leaf stage of weed	1899	2424	5116	5232	7015	7656	27.08	31.66
Pendimethalin 750 g ha ⁻¹ PE	1788	2220	5999	6063	7787	8283	22.95	26.80
Oxyfluorfen 120 g ha ⁻¹ PE	1625	2050	5112	5571	6737	7621	24.14	27.07
Oxyfluorfen 150 g ha ⁻¹ PE	1777	2175	4866	4967	6771	7014	26.23	31.01
Oxyfluorfen 120 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	1906	2321	5125	5629	7031	7951	27.12	29.22
Oxadiargyl 100 g ha ⁻¹ PE	1971	2461	5183	5491	7153	7952	27.60	30.94
Oxadiargyl 100 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	2556	3085	6548	6789	9104	9874	28.10	31.22
Weed free check	2636	3179	6652	6894	9287	10073	28.38	31.56
Weedy check	976	1134	4037	4404	5013	5537	19.53	20.66
	SEm	CD (P=0.05)	SEm ±	CD (P=0.05)	SEm ±	CD (P=0.05)	SEm ±	CD (P=0.05)
Weed management at the same level of vermicompost	35	100	89	250	101	286	0.36	1.02
Vermicompost at the same or different levels of weed management	60	170	139	393	181	512	0.44	1.24

Levels of vermicompost: Application of vermicompost significantly enhanced the seed yield, haulm and biological yield as well as harvest index (2348 kg ha^{-1} , 5860 kg ha^{-1} , 8208 kg ha^{-1} and 28.46%), respectively over check (Table 5).

Interaction effect: The interaction effect of weed management and vermicompost on seed yield was found significant on pooled basis (Table 5). It was noted that for each level of weed management, addition of vermicompost 5 t ha^{-1} significantly increased the yield over control with highest increment (37.13%) under pre-emergence application of imazethapyr 70 g ha^{-1} . A further insight of data revealed that in comparison to the weedy check application of all weed management treatment resulted in significantly higher seed yield irrespective of vermicompost application. However, the yield obtained under weed free check was at par with oxadiargyl 100 g ha^{-1} PE fb hoeing at 40 DAS which was in turn significantly superior over rest of the treatments at each level of vermicompost. This can be attributed to the reduced weed density and dry matter which resulted in higher weed control efficiency and lesser nutrient mining altogether with a lesser degree of competition for other growth resources (moisture, space and light). Weed management practices reduced the weed infestation and create conditions more favourable for crop growth. Tiwari *et al.* (2006), Mehta *et al.* (2010), Singh *et al.* (2014), (Bagri *et al.*, 2014) and (Kumar *et al.*, 2016) also reported similar results.

Nutrient uptake by weeds

Uptake of N, P and K by weeds at harvest showed that all the weed management treatments recorded reduced nutrient uptake compared to weedy check on pooled basis (Table 6). Application of oxadiargyl 100 g ha^{-1} PE fb hoeing at 40 DAS recorded lowest N, P and K uptake by weeds *i.e.*, 21.72 , 3.31 and 25.24 kg ha^{-1} on a pooled basis, respectively and it was significantly superior over rest of the treatments. The next best treatment in this regard was imazethapyr 70 g ha^{-1} fb hoeing at 40 DAS 31.52 , 4.78 and 35.94 kg ha^{-1} . Due to application of vermicompost significantly increased the N, P and K uptake over control on a pooled basis. Vermicompost application resulted in 49.12 , 7.48 and 57.10 kg ha^{-1} increased in uptake by weeds on a pooled basis. There exists a direct relationship between weed

dry matter accumulation and nutrient uptake by weeds. Therefore, it is obvious that nutrient uptake by weeds almost follows the footstep of dry matter accumulation of weeds. It is found that various treatments of weed management significantly reduced the nutrient mining at various stages of crop growth over weedy check (Table 6). All weed management practices tended to reduce nitrogen, phosphorus and potassium uptake by total weeds at harvest. Application of oxadiargyl 100 g ha^{-1} PE fb hoeing at 40 DAS, imazethapyr 70 g ha^{-1} PE fb hoeing at 40 DAS, oxyfluorfen 120 g ha^{-1} PE fb hoeing at 40 DAS and oxadiargyl 100 g ha^{-1} PE recorded lower nutrient uptake at harvest. This might be due to the integration of herbicide followed by hoeing at 40 DAS proved to be most efficient weed control measure in order to reduce the density as well as dry matter of weeds. Reduced nutrient uptake by weeds due to different weed management treatments in fenugreek were also reported by Khokhar and Nepalia, (2010), Bagri *et al.* (2014), Owla *et al.* (2015) and Deewan *et al.* (2018).

Nutrient uptake by seed and haulm

Uptake of N, P and K by seed and haulm at harvest showed that all the weed management treatments affected nutrient uptake by fenugreek (Table 6). Highest nutrient uptake of N, P and K was recorded by weed free check (94.02 , 9.80 and 16.62 kg ha^{-1}) which was at par with application of oxadiargyl 100 g ha^{-1} PE fb hoeing at 40 DAS (89.47 , 9.46 and 16.03 kg ha^{-1}) on a pooled basis, respectively. Weedy check recorded minimum uptake of nutrient (28.60 , 3.23 and 5.36 kg ha^{-1}). Application of vermicompost significantly increased the N, P and K uptake over control on a pooled basis. Vermicompost application resulted in 72.62 , 7.75 and 13.22 kg ha^{-1} increased in nutrient uptake by seed on a pooled basis. The same trend was observed in nutrient uptake by haulm due to application of various weed management treatments and Vermicompost application. Weed management practices tended to enhance the uptake of nitrogen, phosphorus and potassium by seed and haulm over weedy check (Table 6). The highest nitrogen, phosphorus and potassium uptake by the crop was recorded with weed free plot followed by oxadiargyl 100 g ha^{-1} PE fb hoeing at 40 DAS which might be ascribed to higher yield under these treatments as uptake of nutrient is mainly the

function of crop yield and nutrient concentration. Thus, the higher nutrient uptake by crop might be due to lesser crop-weed competition coincident with increased nutrient availability, better crop growth and higher crop biomass production integrates with more nutrient content. Such results corroborate with the findings of Bagri *et al.* (2014) and Singh *et al.* (2014).

Conclusion:

Based on a two-year study, it can be concluded that pre-emergence application of oxadiargyl 100 g ha⁻¹,

followed by hoeing at 40 DAS, was superior for efficient weed management in terms of minimizing weed density, weed dry matter, higher weed control efficiency, decreased weed nutrient uptake, and increased fenugreek seed yield. Moreover, integration of weed management practices along with vermicompost application enhanced seed yield and nutrient uptake by seed and haulms.

Conflict of interest: The authors declare no conflict of interest.

Table 5. Effect of weed management and vermicompost on nutrient uptake by weeds, seed and haulm at harvest (pooled mean)

Treatment	Nutrient uptake by weeds (kg ha ⁻¹)			Nutrient uptake by seed (kg ha ⁻¹)			Nutrient uptake by haulm (kg ha ⁻¹)		
	N	P	K	N	P	K	N	P	K
Weed Management									
Imazethapyr 70 g ha ⁻¹ PE	60.70	9.27	69.32	57.13	5.92	10.45	55.81	7.52	64.13
Imazethapyr 70 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	31.52	4.78	35.94	69.89	7.42	12.70	59.71	8.26	68.75
Imazethapyr 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	41.90	6.41	48.30	64.98	6.83	11.97	60.29	8.25	68.75
Imazethapyr + Imazamox (RM) 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	50.87	7.75	58.65	63.88	6.90	11.63	60.21	8.19	69.10
Imazethapyr + Imazamox (RM) 60 g ha ⁻¹ PoE 2-4 leaf stage of weed	43.92	6.71	51.68	65.98	7.05	12.04	50.07	7.02	58.12
Pendimethalin 750 g ha ⁻¹ PE	47.69	7.21	55.11	60.40	6.47	11.14	57.90	8.11	68.31
Oxyfluorfen 120 g ha ⁻¹ PE	57.49	8.90	67.58	55.07	5.90	9.98	52.35	7.11	59.94
Oxyfluorfen 150 g ha ⁻¹ PE	46.22	7.07	54.46	59.68	6.47	10.98	47.22	6.66	55.15
Oxyfluorfen 120 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	38.20	5.71	44.51	64.25	6.99	11.71	50.66	7.17	60.77
Oxadiargyl 100 g ha ⁻¹ PE	32.51	4.95	38.35	67.86	7.31	12.53	50.63	7.14	60.13
Oxadiargyl 100 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	21.72	3.31	25.24	89.47	9.46	16.03	64.91	8.98	75.17
Weed free check	0.00	0.00	0.00	94.02	9.80	16.62	68.82	9.17	77.99
Weedy check	123.89	18.61	143.54	28.60	3.23	5.36	41.33	5.58	47.52
SEm ±	0.70	0.11	0.86	1.02	0.11	0.18	0.73	0.09	0.74
CD (P=0.05)	2.16	0.34	2.64	3.15	0.34	0.55	2.23	0.28	2.29
Levels of vermicompost									
Control	42.67	6.47	49.47	56.80	6.05	10.34	53.02	7.35	61.98
Vermicompost 5 t ha ⁻¹	49.12	7.48	57.10	72.62	7.75	13.22	57.74	7.91	66.30
SEm ±	0.39	0.06	0.48	0.73	0.06	0.13	0.53	0.07	0.56
CD (P=0.05)	1.10	0.16	1.35	2.07	0.17	0.37	1.50	0.19	1.57

References

- Bagri, P.R., Naruka, I.S., Shaktawat, R.P.S., Rathore, S.S. and Singh, D. 2014. Weed management in fenugreek (*Trigonella foenum-graecum* L.). *Int J Seed Spices*, 4(2):36-41.
- Brar, S.K. 2018. Effect of weed management practices on the performance of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub]. *Agri Sci Digest*, 38(2):135-138.
- Chopra, N. and Chopra, N.K. 2007. Production of weed free mother bulb of onion (*Allium cepa*) through integration of herbicide and weeding. *Ind J Agron.*, 52(1):80-82.
- Cocharan, W.G. and Cox, G.M. 1967. Experimental designs (II Ed.). John Wiley and Sons, Singapore.
- Deewan, P., Mundra, S.L., Trivedi, J., Meena, R.H. and Verma, R. 2018. Nutrient uptake in maize under different weed and nutrient management options. *Ind J Weed Sci.*, 50(3): 278-281.
- Donald, C.M. and Humblin. 1976. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. *Advances in Agron.*, 28:361-405.
- Fagaria, V.D., Gupta, K.C. and Saxena, R. 2014. Integrated weed management in fenugreek (*Trigonella foenum-graecum* L.) in semi arid regions of Rajasthan. *Int J Agri Sci.*, 10(1): 302-304.
- Ghahari, M., Bardaran., R. and Forutani, R. 2013. Effect of planting density and weeding time on weeds and fenugreek dry matter. *Middle-East J Sci Res.*, 18(8):1171-1176.
- Gomez, A.K. and Gomez, A.A. 1984. Statistical procedures for agricultural research (2nd ed.), John Willey and Sons. Singapore.
- Jackson, M.L. 1973. Soil chemical analysis. Ed. 2. Prentice Hall Inc. Pvt. Ltd., New Delhi. pp. 134-82.
- Khokhar, A.K. and Nepalia, V. 2010. Effect of herbicides and nutrient management on weed flora, nutrient uptake and yield of wheat (*Triticum aestivum*) under irrigated conditions. *Ind J Weed Sci.*, 42(1 & 2):14-18.
- Kumar, R., Malik, Y.P. and Punia, S.S. 2016. Weed control in fenugreek with pendimethalin and imazethapyr. *Ind J Weed Sci.*, 48(2):225-227.
- Kumar, S., Rana, S.S., Chander, N. and Sharma, N. 2013. Integrated weed management in garlic. *Ind J Weed Sci.*, 45(2):126-130.
- Major spices state wise area production 2022-23. State Agri/Horti Department/DASD, Kozhikkode, Govt. of India. Pp 1-4 (www.Indianspices.com).
- Mani, V.S., Malla, M.L., Gautam, K.C. and Das, B. 1973. Weed killing chemicals in potato cultivation. *PANS*, 23(8):17-18.
- Mehta, R.S., Meena, S.S. and Lal, G. 2010. Effect of irrigation levels and weed control methods on dry matter accumulation, growth dynamics and yield of fenugreek (*Trigonella-foenium-graecum* L.). *Ind J Horti.*, 67(2):219-224.
- Meena, S.S., Mehta, R.S., Lal, G. and Anwer, M.M. 2013. Economic feasibility of weed management practices in fenugreek. *Ind J Horti.*, 70(1):150-153.
- Owla, M.L., Nepalia, V., Chouhan, G.S. and Singh, D. 2015. Effect of fertility levels, nutrient sources and weed control on weed dynamics and yield of quality protein maize (*Zea mays*) and relative nitrogen and phosphorus uptake. *Ind J Agron.*, 60(2):267-272.
- Patel, S.M., Patel, K.I., Fadadu, M. and Patel, P.J. 2022. Weed management in isabgul (*Plantago ovata* Forsk). *Int J Seed Spices*, 12(1):75-81.
- Punia S.S. and Tehlan, S. 2017. Bioefficacy of different herbicides in fenugreek. *Ind J Weed Sci.*, 49(3):298-299.
- Richards, L.A. 1968. Diagnosis and improvement of saline and alkaline soils. USDA Hand book No. 60, Oxford and IBH Pub. Co. New Delhi.
- Sharma, O.L. 2009. Integrated weed management in fenugreek. *Ind J Weed Sci.*, 41(3&4):133-135.
- Singh, N., Mundra, S.L. and Kaushik, M.K. 2014. Production potential of fenugreek as influenced by weed management practices. *Ind J Weed Sci.*, 46(2):197-199.
- Singh, O.V. Singh, K., Meena, V. S. Shekhawat, N. and Gupta, V. 2021. Identification of an extra early maturing accession IC 0624520 of fenugreek (*Trigonella foenum-graecum* L.). *Int J Seed Spice.*, 11(2):50-52.
- Snell, P.D. and Snell, G.T. 1949. Colorimetric method of analysis, 3rd Ed. Vol. II-D, Van Mastrand CO. Inc. New York.

- Tiwari, R.C. Bairwa, P.K. Sharma and Khandelwal, S.K. 2006. Effect of phosphorus and weed control on fenugreek (*Trigonella foenum - graecum* L.). *Leg Res.*, 29(4):304-307.
- Tiwari, D.K., Kewat, M.L., Khan, J.A. and Khamparia, N.K. 2007. Evaluation of efficacy of post-emergence herbicides in soybean (*Glycine max*(L.). *Ind J Agron.*, 52(1):74-76.
- Verma, S.K., Singh, S.B., Meena, R.N., Prasad, S.K., Meena, R.S. and Gaurav. 2015. A review of weed management in India: the need of new directions for sustainable agriculture. *The Bioscan*, 10:253-263.
- Tripathi, S.S. and Singh, V.P. 2008. Efficiency of herbicides on weed infestation and seed yield of fenugreek. *Ind J Weed Sci.*, 40(1&2):113-114.