



Enhancing Nutrient Uptake and Economic Return of Fenugreek through Different Herbicides Application

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Abstract: A field experiment was conducted to study the effect of different herbicide on nutrient uptake in fenugreek at experimental field of the Agricultural Research Station Mandor, Jodhpur during winter (rabi) season of 2021-22. The study included ten treatment combinations of herbicides of which four namely Pendimethalin, Pendimethalin + Imazethapyr, Diclosulam, Flumioxazin were applied pre-emergence while four others viz. Imazethapyr, Sodium acifluorfen + Clodinafop propargyl, Fomesafen + Fluazifop p-butyl, Fluazifop p-butyl were applied 20 days after sowing. Additionally, a manually maintained weed-free plots and a weedy check plot were also maintained for comparison. Among the various treatments tested, the combination of Pendimethalin + Imazethapyr was particularly effective, resulting in significantly higher seed and straw yields of 1652 kg ha⁻¹ and 4041 kg ha⁻¹, respectively. This treatment also enhanced nitrogen content and uptake in both seeds (3.169% and 52.35 kg ha⁻¹) and straw (0.998% and 40.33 kg ha⁻¹), while yielding net returns of Rs. 79,162 ha⁻¹ and a benefit-to-cost (B:C) ratio of 4.32 for fenugreek cultivation.

Key words: Economics. fenugreek, herbicides, nitrogen uptake, weed management.

Fenugreek (*Trigonella foenum-graecum* L.), commonly referred to as 'Methi' in Hindi, is an annual seed spice crop belonging to the *Fabaceae* family. The name fenugreek is derived from the species name "*foenum-graecum*," meaning "Greek hay" (Flammang *et al.*, 2004). This plant is native to eastern Europe and Ethiopia and is widely cultivated in countries such as India, Argentina, Southern France, Algeria, Morocco, and Lebanon (Pargi, 2009). Fenugreek is valued in traditional medicine for treating diabetes, indigestion, elevated lipids, and edema (fluid retention) of the legs. It also serves as a dietary protein source for both humans and animals. The seeds, known for their strong aroma and bitter taste, are utilized as a yellow dye in cosmetics and for medicinal purposes. Fenugreek acts as a soil renovator and is widely used as green manure. Both the seeds and leaves are commonly used for culinary and medicinal purposes, with shoots and leaves being rich in protein, minerals, and vitamins A and C. Recent

studies highlight fenugreek seeds' substantial content of the steroidal substance diosgenin, which is used as a precursor in the synthesis of sex hormones for oral contraceptives (Sharma, 2009). Additionally, fenugreek seeds are used as condiments for flavoring food, known for their aromatic, carminative, tonic, and galactagogue properties, and as an emollient for intestinal inflammation. Numerous studies have explored fenugreek's therapeutic potential in conditions such as diabetes, cancer, hypertension, cataracts, gastric disorders, and obesity (Rathore *et al.*, 2013).

Weed infestation poses a significant challenge in fenugreek cultivation, especially during the early growth stages due to the crop's slow initial growth (Chovatia *et al.*, 2010). Weeds compete with the crop for essential resources, impacting plant growth and yield (Oerke, 2006; Ryan *et al.*, 2009; Smith *et al.*, 2010). High weed infestation can drastically reduce seed yield which may reach as high as 37% Verma *et al.* (2015). Hand weeding, though effective, is labour-intensive and costly (Bagri *et al.*, 2014), exacerbated by labour shortages during peak periods. Chemical weed control, often used in large-scale production, offers a faster and more cost-effective solution. Hence, the present experiment was conducted to study the effect of different herbicides and their combinations on weed control, yield, nitrogen uptake and economic return of fenugreek.

Materials and Methods

The experiment was conducted at the Research Farm of the Agricultural Research Station in Mandor, Jodhpur, located between 26°15' N and 26°45' N latitude and 73°00' E and 73°29' E longitude. This region is classified within agro-climatic zone Ia, recognized as the Arid Western Plains Zone of Rajasthan. The soil at the experimental site was characterized as loamy sand, slightly alkaline in nature with a pH of 8.2. Nutrient analysis revealed low organic carbon content (0.13%) and available nitrogen levels (174 kg ha⁻¹), while phosphorus (22.2 kg ha⁻¹) and potassium (325 kg ha⁻¹) were found to be at medium levels. The experiment was conducted in randomized block design with ten treatments combinations of herbicides viz. Pendimethalin 1 kg ha⁻¹, PE (T₁), Pendimethalin + Imazethapyr (Ready mix) 800 g ha⁻¹, PE (T₂), Diclosulam 20 g ha⁻¹, PE (T₃),

Flumioxazin 100 g ha⁻¹, PE (T₄), Imazethapyr 50 g ha⁻¹(20 DAS) (T₅), Sodium acifluofan + Clodinafop propargyl (Ready mix) 210 g ha⁻¹(20 DAS) (T₆), Fomesafen + Fluazifop p-butyl 220 g ha⁻¹ 20 DAS (Ready mix) (T₇), Fluazifop p-butyl, 250 g ha⁻¹(20 DAS) (T₈), weed free (T₉) and weedy check (T₁₀) and three replications. Yield and nitrogen content (Jackson, 1973) was determined at the harvest of crop.

Total uptake of nitrogen by the crop in each treatment was computed from N content in grain and stover using the following relationship:

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

$$N \text{ uptake in stover (kg ha}^{-1}\text{)} = \frac{\% N \text{ in stover} \times \text{Stover yield kg ha}^{-1}}{100}$$

The economic analysis was carried out by considering the actual expenditure incurred on various agricultural operations, cost of inputs and labor charges, and prevailing market price of crop produce. Gross income was calculated by totalling the income from selling price of economic produce. Net income was calculated as the difference between gross income and total cost of cultivation.

Treatment wise benefit-cost (B-C) ratio was also calculated to ascertain economic viability of the treatments by using the following formula:

$$B \text{ C ratio} = \frac{\text{net return (₹ ha}^{-1}\text{)}}{\text{cost of cultivation (₹ ha}^{-1}\text{)}} \times 100$$

Result and Discussion

Seed and straw yield: Seed yield of fenugreek was significantly higher in all the herbicidal treatments as compared to weedy check (Table 1). Among herbicides, Pendimethalin + Imazethapyr recorded maximum seed yield which was statistically at par with that recorded following application of pendimethalin, Imazethapyr and Fluazifop p-butyl and was also significantly higher over that recorded following application of Flumioxazin, Diclosulam, Sodium acifluofan + Clodinafop propargyl, Fomesafen + Fluazifop p-butyl and weedy check. The extent of yield increase following application of Pendimethalin + Imazethapyr Pendimethalin, Imazethapyr and Fluazifop p-butyl 74.63, 70.30, 67.02 and 58.77% respectively over weedy check. Among all the treatments, weed free treatment and weedy check treatment recorded the maximum and minimum seed yield of fenugreek, respectively. This observed increases in yield and related

Table 1. Effect of different herbicide treatments on yield, N content, uptake and economics of fenugreek

Treatment	Seed yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	N content (%)		N uptake (kg ha ⁻¹)		Total cost of cultivation (Rs. ha ⁻¹)	Gross returns (Rs. ha ⁻¹)	Net returns (Rs. ha ⁻¹)	B:C ratio
			Seed	Straw	Seed	Straw				
Pendimethalin 1 kg ha ⁻¹ , PE	1611	3963	3.15	0.99	50.67	39.27	23,304	1,00,494	77,190	4.31
Pendimethalin + Imazethapyr (Ready mix) 800 g ha ⁻¹ , PE	1652	4041	3.17	1.00	52.35	40.33	23,821	1,02,983	79,162	4.32
Diclosulam 20 g ha ⁻¹ , PE	1463	3581	2.89	0.92	42.30	32.95	24,214	91,208	66,994	3.76
Flumioxazin 100 g ha ⁻¹ , PE	1464	3595	2.86	0.91	41.80	32.75	26,160	91,305	65,145	3.49
Imazethapyr 50 g ha ⁻¹ , (20 DAS)	1580	3920	3.11	0.97	49.15	37.98	29,653	98,660	74,790	3.32
Sodium acifluorfen + Clodinafop propargyl (Ready mix) 210 g ha ⁻¹ , (20 DAS)	1080	2915	2.81	0.90	30.35	26.26	33,346	68,130	44,354	2.05
Fomesafen + Fluazifop p-butyl (Ready mix) 220 g ha ⁻¹ , (20 DAS)	1010	2889	2.74	0.91	27.62	26.15	23,035	64,217	41,182	2.78
Fluazifop p-butyl, 250 g ha ⁻¹ (20 DAS)	1502	3891	3.11	0.94	46.71	36.54	23,802	94,283	70,481	3.96
Weed free	1749	4257	3.39	1.08	59.26	45.81	30,855	1,06,491	75,636	3.44
Weedy check	946	2672	2.75	0.82	26.00	21.88	22,269	60,046	37,777	2.69
SEm±	53	143	0.07	0.02	2.34	1.90	-	-	-	-
CD (P=0.05)	156	424	0.12	0.07	6.95	5.65	-	-	-	-

attributes can be ascribed to the effectiveness of these herbicidal treatments in maintaining nearly weed-free conditions up to 30-35 days after sowing (DAS). This reduced competition for nutrients and other growth factors by weeds, leading to a significant decrease in weed dry matter and, consequently, less competition overall. These results are consistent with previous studies conducted by Gill *et al.* (2003), Nandekar *et al.* (2004), Kumar *et al.* (2005), Kamboj *et al.* (2005) and Meena and Mehta (2009).

The data shown in Table 1 indicate that the straw yield of fenugreek also increased with the application of various herbicide combinations when compared to the weedy check. The pattern of this increase in straw yield closely similar to that of the seed yield, showing that the herbicide treatments were effective in boosting overall crop productivity. These results are strongly supported with the finding of Patel *et al.* (2019), Kumar *et al.* (2016), Fagaria *et al.* (2014), Mehta *et al.* (2010) in fenugreek crop.

Nitrogen content in seed and straw: There was significant variation in nitrogen content in seed and straw of fenugreek over weedy check. Pendimethalin + Imazethapyr recorded the

maximum nitrogen content in seed and straw, being at par with Pendimethalin, Imazethapyr and Fluazifop p-butyl. The extent of increase was 15.32, 14.45, 13.21 and 13.17% in seeds and 21.86, 21.00, 18.32 and 14.65% in straw over weedy check treatments, respectively. N content in the other remaining herbicide treatments was also significantly higher over weedy check. Findings of several researchers (Prajapati and Patel, 2001; Bhunia *et al.*, 2006; Mehriya *et al.*, 2007) corroborate the results of present experiment and confirmed increasing tendency of quality of fenugreek due to weed control measures. Higher concentration of nutrients in crop can be ascribed mainly to the greater availability of nutrients under reduced crop-weed competition under different weed control treatments as per their efficiency that would otherwise have been utilized by fast growing weeds under weed infested conditions.

Nitrogen uptake: Nitrogen uptake by seed and straw of fenugreek was found significantly higher among all the herbicides treatments over weedy check (Table 1). Amongst herbicides, application Pendimethalin + Imazethapyr recorded maximum nitrogen uptake by seed and straw of fenugreek which was statistically

at par with application of Pendimethalin, Imazethapyr and Fluazifop p-butyl. Uptake following these herbicides was higher to that recorded compared to that reported following application of Flumioxazin, Diclosulam, Sodium acifluofan + Clodinafop propargyl, Fomesafen + Fluazifop p-butyl and weedy check. Higher availability of nutrients for the crop under comparatively weed free situation could be the reason behind. Thus, increase in crop dry matter and grain and straw yields with a concomitant increase in nutrient concentration seemed to be the most important reason of higher uptake of nutrients by crop under these treatments. Such findings have also been reported by Mehriya *et al.* (2007) and Bhunia *et al.* (2006) in fenugreek.

Economics: Net returns from fenugreek were higher in all the herbicides treatments over weedy check and were maximum following Pendimethalin + Imazethapyr application closely followed by the net returns following application of Pendimethalin and Fluazifop p-butyl. Application of these herbicides has nearly doubled the net returns *viz a viz* weedy check. These returns were also higher than those recorded after application of Imazethapyr, Flumioxazin, Diclosulam, Sodium acifluofan + Clodinafop propargyl, Fomesafen + Fluazifop p-butyl and weedy check. The B:C ratio from fenugreek cultivation was higher in all the herbicides treatments over weedy check and the trend followed the pattern described above for net returns. Similar findings have also been reported by Dubey *et al.* (2018); Patel *et al.* (2019); Kumar *et al.* (2016) in fenugreek.

Conclusion

It can be concluded from the above results that pre-emergence application of Pendimethalin + Imazethapyr most effectively controlled the weeds in fenugreek and resulted in its maximum seed and straw yield, net returns and B: C ratio.

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