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Integrated weed management in fenugreek (*Trigonella foenum-graecum* L.)

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Abstract
A field experiment entitled "Integrated weed management in fenugreek (*Trigonella foenum-graecum* L.)" was conducted on medium black calcareous soil at Junagadh (Gujarat) during *rabi* season of 2019-20 The experiment was laid out in randomized block design with three replications. The experiment comprising 12 treatments which some of them is mentioned here *viz.,* Pendimethalin 0.90 kg/ha (PE) *fb* HW at 30 DAS, Oxyfluorfen 0.180 kg/ha (PE) *fb* HW at 30 DAS, Tank mix Pendimethalin 0.450 kg/ha + Oxyfluorfen 0.090 kg/ha as pre-emer. *fb* HW at 30 DAS, HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS, HW at $T_1$5 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer. At 30 DAS, HW at 15 and 30 DAS, Weed free and Weedy check. The fenugreek (cv. Gujarat Fenugreek 2) was sown on 29th November 2019 at a spacing of 30 cm x 10 cm using seed rate of 20 kg/ha with standard package of practices. The results of the experiment indicated that HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer. at 30 DAS, HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS and HW at 15 and 30 DAS improved growth, yield parameters, suppressed weed growth, higher weed control efficiency and ultimately recorded higher seed yield of fenugreek along with higher net returns.

Keywords: *Trigonella foenum-graecum*, fenugreek, hand weeding, herbicide, pre emergence and post-emergence herbicide

1. Introduction
Fenugreek (*Trigonella foenum-graecum* L.) is an annual plant in the family Fabaceae, with leaves consisting of three small obovate to oblong leaflets. It is cultivated World Wide as a semi-arid crop. It's seeds and leaves are common ingredients in dishes from South and Central Asia. Regular consumption of fenugreek increases the risk for serious medical side effects. Fenugreek is believed to have been brought into cultivation in the Near East. Fenugreek is small seeded self-pollinated, diploid annual legume plant with chromosome number 2n=16. India has been from ancient times, regarded as the home of cultivated spices crops and has been exporting maximum quantity of spices and condiments to the Western countries. The important fenugreek growing countries are India, Egypt, France, Morocco, Argentina and Lebanon.

Fenugreek is used for kidney ailments, a vitamin deficiency disease called beriberi, mouth ulcers, boils, bronchitis, and infection of the tissues beneath the surface of the skin (cellulitis), tuberculosis, chronic coughs, chapped lips, baldness, cancer, Parkinson's disease, and exercise performance. Seeds are bitter in taste due to presence of two alkaloids "Trigonellin" and "Choline". Being a legume, its roots are endowed with a mini-factory to synthesize nitrogenous food for the plant. (Agarwal *et al.*,2001) [1].

In India, fenugreek is grown in about 1,29,000 hectare with an annual production of about 2,02,600 tonnes of seeds (Anon., 2019) [2]. Gujarat and Rajasthan together contributed more than 80% of total seed spices produced in the country. While other states where spices commonly grown are Haryana, Madhya Pradesh, Maharashtra, Bihar, Kerala, Uttar Pradesh, West Bengal, Orissa, Karnataka and Tamil Nadu In Gujarat, fenugreek occupied an area of 7326 hectare producing 14,173 tonnes of seeds. The major fenugreek growing districts in Gujarat are Dahod, Banaskatha, Patan, Surendranagar, Kachchh, and Mehsana. (Anon. 2019) [2].

In our country weed is one of the important factors responsible for low yield of fenugreek. The weed problem in fenugreek is very serious due to its slow growing habits particularly in initial stages; it is highly infested with weeds which drastically reduced the seed yield.

Mali and Suwalka (1987) [8] reported that weeds were found hurdle to in be a serious in fenugreek production, mechanical removal of weed is laborious, time consuming and costly. Weed reduced yield by competing with fenugreek plant for resources, such as moisture, nutrients, space and sunlight not only throughout the growing season but also create problems during harvesting and inverting procedures and reduce harvesting efficiency. Other important biological factors in weed management decisions include weed and crop density, seed bank processes, demographic variation, weed-crop competition**.**

Herbicides used alone or in combination with other weed management techniques reduce crop weed competition and the risk of weeds growing unchecked in period of adverse weather or soil condition. Therefore, the suitable combination of different methods of weed control should be practiced for minimizing losses caused by the weeds in fenugreek and also for protection of the environment. Pre-emergence application of herbicides may lead to cost-effective control of the weeds right from the start which otherwise may not be possible by manual weeding.

2. Materials and Methods

A field experiment was conducted in C-6 plot of Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh during *rabi*2019-20. Geographically, Junagadh is situated at 21.500 N latitude and 70.500 E longitude with an altitude of 60 m above the mean sea level under South Saurashtra Agro-climatic region of Gujarat state and enjoys a typically subtropical climate characterized by fairly cold and dry winter, hot and dry summer and warm and moderately humid monsoon. The rainy season commences in the first fortnight of June and ends by mid of September with an average rainfall of 1094 mm (average of last 10 years). The experimental soil was clayey in texture and slightly alkaline in reaction with pH 8.0 and EC 0.56 dS/m. The soil was low in available nitrogen (248 kg/ha), medium in available phosphorus (37 kg/ha) and high in available potash (272 kg/ha). During the crop season, the minimum and maximum temperature ranged between 9.7° C to 20.3 °C and 26.7 °C to 34.3 °C, respectively. While the average relative humidity was in the ranges of 44% to 66.5%. Wind speed ranges from 2.2 km/hr to 4.9 km/hr. Rainfall was not received during crop growing season. The range of average sun shine, and evaporation was 3.2 to 9.1 hr, and 3.1 to 5.8 mm, respectively.

The experiment comprising 12 treatments *viz.*, of T_1(Pendimethalin 0.90 kg/ha (PE) *fb* HW at 30 DAS), T_2(Oxyfluorfen 0.180 kg/ha (PE) *fb* HW at 30 DAS), T_3(Oxadiargyl 0.075 kg/ha (PE) *fb* HW at 30 DAS), T_4(Tankmix Pendimethalin 0.450 kg/ha + Oxyfluorfen 0.090 kg/ha as pre-emer. *fb* HW at 30 DAS), T_5(Tank mix Pendimethalin 0.450 kg/ha +Oxadiargyl 0.035 kg/ha as pre-emer. *fb* HW at 30 DAS), T_6(HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS), T_7 (HW at 10 DAS *fb* Metribuzin 0.150 kg/ha (PoE) a$T_3$0 DAS), T_8 (HW at 10 DAS *fb* Propaquizafop 0.075 kg/ha (PoE) at 30 DAS), T_9 (HW at 15DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer. at 30DAS),T_{10}(HWa$T_1$5 and 30 DAS),T_{11}(Weed free) and T $_{12}$(Weedy check).

The fenugreek (cv. Gujarat Fenugreek 2) was sown on 29th November 2019 at a spacing of 30 cm x 10 cm using seed rate of 20 kg/ha. The gross plot size was 5.0 m × 2.4 mind net plot size was 4.0m × 1.8 m.

In aspect of weed studies the observation on various parameters species wise weed count, dry weight of weed, weed index, weed control efficiency (%) and herbicidal efficiency index was recorded during experiment of research.

The crop was raised as per the recommended package of practices. The crop was harvested at physiological maturity on March 03, 2020. The growth and yield attributes were recorded from the five tagged plants in each plot. Seed and Straw yield were recorded from the net plot area and converted into kilogram per hectare base.

The expenses to be incurred for all the cultivation operations from preparatory tillage to harvesting including the cost of inputs *viz.* seeds, fertilizers, herbicides, etc. applied to each treatments will be calculated on the basis of prevailing local charges. The gross realization in terms of rupees per hectare will be worked out taking into consideration the fenugreek seed and straw yields from each treatment and local market prices. Net returns of each treatment will be calculated by deducting the total cost of cultivation from the gross returns. The benefit cost ratio (B:C) was calculated by dividing gross return with cost of cultivation.

3. Results and Discussion

The results revealed that different treatments manifested significant influence on growth and yield of fenugreek (Table 1). Among the different weed management treatments, the weed free (T_{11}) registered significantly the highest plant height (70.67 cm) at harvest, which remained statistically at par with the treatment T_9(HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer. At 30 DAS) and T_6(HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha(PoE)at 30 DAS).

At harvest, maximum number of branches per plant (5.00) was recorded under weed free (T_{11}), but it was found statistically at par with treatments T_9 (HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer. At 30 DAS) and T_6(HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS).

A perusal of data presented in Table 1. Revealed that different weed management treatments did not significantly influence days to 50% flowering. This could be resulted in to less weed-crop competition throughout the growth stage of crop and created favourable environment for plant growth. Thus, enhance availability of nutrients, moisture, light and space which might have accelerated the photosynthetic rate, thereby increasing the supply of carbohydrates, resulted in increase in growth characters. These findings are in close agreement with those of Singh *et al.* (2003) [12], Kour *et al.* (2014) [6], Prachand *et al.* (2014) [11], Mishra *et al*. (2001) [9] and Kamboj *et al.* (2005) [5].

A glance of data in (Table 1) indicated that different weed management practices coerced their significant influence on number of pods per plant. Significantly higher number of pods per plant (27.33) was recorded with treatment T $_{11}$(Weed free) but, it was statistically at par with treatment T_9(HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha+ Metribuzin 0.075 kg/ha post-emer. at 30 DAS), T_6(HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS) and T_{10}(HW at 15 and 30 DAS).

The number of seeds per pod as influenced by different weed control treatments recorded at harvest is narrated in (Table 1). Significantly higher number of seeds per pod (17.33) was

recorded with treatment T_{11}(Weed free) but, it was statistically at par with treatment T_9 (HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075kg/ha as post-emer.at 30 DAS) and T_6(HW aT_{10} DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS).

A perusal of data in (Table 1) revealed that different weed management treatments exhibited their significant influence on seed yield. Significantly higher seed yield (1702kg/ha) was recorded with treatment T_{11}(Weed free) but, it was statistically at par with treatment T_9 (HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075kg/ha as post-emer. at 30 DAS), T_6 (HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) a$T_3$0 DAS) and T_{10} (Hand weeding at 15 and 30 DAS) with seed yield of 1567, 1493 and 1483kg/ha. Treatment T $_{12}$(Weedy Check) was found significantly minimum seed yield(870kg/ha). So the extent of increase in grain yield with the treatments T $_{11}$(Weed free), T_9 (HW a$T_1$5 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer. a$T_3$0 DAS), T_6(HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS) and T_{10}(Hand weeding at 15 and 30 DAS) was 95.63, 80.11, 71.60 and 70.45%, respectively over weedy check (T_{12}).

Scrutiny of data in (Table 1) showed that different weed management treatments caused their significant influence on straw yield. Treatment T_{11}(weed free) recorded significantly higher straw yield (2723 kg/ha), but it was statistically at par with treatment T_9(HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer. at 30 DAS) and T_6 (HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS)with corresponding straw yield of 2528 and 2497 kg/ha. However, significantly minimum straw yield (1480 kg/ha) was obtained with Treatment T $_{12}$ (Weedy check). So the magnitude of increase in straw yield with the treatments T $_{11}$(weed free), T_9 (HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer. at 30DAS) and T_6(HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS) was 83.90, 70.81, 68.71 percent, respectively over weedy check(T $_{12}$).

It might be due to early season control of weeds by application of pre emergence herbicides and at later stage by post emergence herbicide as evidenced by less number of weed and dry weight of weeds, which might have maintained high soil fertility status and moisture content by means of less removal of plant nutrients and water through weeds. This might have increased nutrients and water uptake by the crop leading to increased rate of photosynthesis. Supply of photosynthates to various metabolic sinks might have favoured yield and yield attributes. The lowest value of yield and yield attributes *viz*., number of pods per plant, seed yield and straw yield under treatment T $_{12}$ (Weedy check). These findings are in close conformity with those reported by Mali and Suwalka (1987) [8], Gaikwad and Pawar (2003) [3], Guriqbal (2005) [4] and Nalini *et al*. (2015) [10].

The data on sedge weeds at harvest (Table 2) subsequently to the treatment T $_{11}$(Weed free), significantly lowest number of sedge weeds at harvest (25.00 weeds per m^2) were recorded under the treatment T_6(HW at 10 DAS *fb* Quizalofop ethyl 0.040 kgha^{-1} (PoE) at 30 DAS), which remained statistically at par with the treatment T_9 (HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg ha^{-1} + Metribuzin 0.075 kg ha^{-1} as post-emer. at 30 DAS) and T_{10}(Hand weeding at 15 and 30 DAS). Maximum numbers of sedge weeds (65.00 weeds per m^2) were recorded under T $_{12}$(Weedy check).

The data on monocot weeds at harvest (Table 2) revealed that in addition to treatment $_{11}$(Weed free), significantly the lowest number of monocot weeds (5.33 weeds per m^2) was recorded under the treatment T_6(HW at 10 DAS *fb* Quizalofop ethyl 0.040 kgha^{-1} (PoE) at 30 DAS), which remained statistically at par with the treatment T_9 (HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg ha^{-1} + Metribuzin 0.075 kg ha^{-1} as post-emer. at 30 DAS).Maximum numbers of monocot weeds were (41.00 weeds per m^2) recorded under treatment T_{12} (Weedy check).

The data on dicot weeds at harvest (Table 2) subsequently to the treatment T $_{11}$(Weed free), significantly the lowest number of dicot weeds (8.66 weeds per m^2) was recorded under the treatment T_6 (HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg ha^{-1} (PoE) at 30 DAS) which remained statistically at par with treatment T_9(HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg ha^{-1} + Metribuzin 0.075 kg ha^{-1} as post-emer. at 30 DAS). Conversely, significantly the highest density of dicot weeds (55.00 weeds perm^2) was recorded under weedy check (T_{12}).

Table 1: Growth and yield of fenugreek under different weed management treatments.

Treatments		Plant height (cm)	Number of branches	Days to 50% flowering	Number of pods per plant	Number of seeds per pod	Seed yield (kg/ha)	Straw yield (kg/ha)
T_1	Pendimethalin 0.90 kg/ha(PE) *fb* HW at 30 DAS	58.33	4.00	38.33	17.33	14.33	1370	2310
T_2	Oxyfluorfen 0.180 kg/ha (PE) *fb* HW at 30 DAS	54.67	3.43	39.33	18.33	13.67	1334	2401
T_3	Oxadiargyl 0.075 kg/ha (PE) *fb* HW at 30 DAS	55.00	3.00	41.00	16.33	13.00	1290	2200
T_4	Tankmix Pendimethalin 0.450kg/ha + Oxyfluorfen 0.090 kg/ha as pre-emer. *fb* HW at 30 DAS	53.66	3.53	40.33	19.67	14.00	1393	2368
T_5	Tankmix Pendimethalin 0.450 kg/ha + Oxadiargyl 0.035kg/ha as pre-emer. *fb* HWat 30 DAS	55.67	2.67	39.00	19.00	13.88	1373	2334
T_6	HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS	66.67	4.33	35.63	23.33	15.85	1493	2497
T_7	HW at 10 DAS *fb* Metribuzin 0.150kg/ha (PoE) at 30 DAS	57.63	3.67	40.33	20.67	13.77	1385	2350
T_8	HW at 10 DAS *fb* Propaquizafop 0.075 kg/ha (PoE) at 30 DAS	54.33	3.33	37.33	21.00	13.33	1330	2261
T_9	HW at 15 DAS *fb* tankmix Quizalofop ethyl 0.020kg/ha + Metribuzin 0.075kg/ha as post-emer.a$T_3$0DAS	67.87	4.67	35.60	24.67	16.33	1567	2528
T_{10}	Hand weeding at 15 and 30 DAS	61.67	4.27	38.89	22.87	14.67	1483	2387
T_{11}	Weed free	70.67	5.00	33.53	27.33	17.33	1702	2723
T_{12}	Weed Check (control)	53.00	2.33	42.33	13.67	12.33	870	1480
S.Em. +		1.77	0.31	0.91	1.46	0.50	75	95
CD at 5%		4.19	0.92	NS	4.33	1.89	230	271
C.V%		7.43	15.42	5.14	12.42	7.07	8.94	6.98

Table 2: Sedge, monocot, dicot weed count at harvest, dry weight of weeds (kg/ha), weed index, weed control efficiency, herbicidal efficiency index and economics of fenugreek under different weed management treatments

Treatments		Sedge weed countperm^2	Monocot weed count per m2	Dicot weed Counter m^2	Dry weight of Weeds (kg/ha)	WI (%)	WCE (%)	HEI (%)	Net returns (₹/ha)	B: C ratio
T_1	Pendimethalin 0.90 kg/ha(PE) *fb* HW at 30DAS	5.49 (29.67)	3.38 (11.00)	3.24 (10.00)	156.67	19.50	75.26	2.32	54293	2.80
T_2	Oxyfluorfen 0.180 kg/ha(PE) *fb* HW at 30 DAS	5.52 (30.00)	3.23 (10.00)	3.11 (9.33)	136.67	21.63	78.35	2.47	52510	2.75
T_3	Oxadiargyl 0.075kg/ha (PE) *fb* HW at 30 DAS	5.64 (31.33)	3.63 (12.67)	3.48 (11.67)	170.00	24.23	73.14	1.79	49326	2.63
T_4	Tank mix Pendimethalin 0.450kg/ha +Oxyfluorfen 0.090kg/ha as pre-emer. *fb* HW aT30 DAS	5.43 (29.00)	3.03 (8.67)	3.43 (11.33)	158.33	18.16	75.03	2.40	55021	2.78
T_5	Tankmix Pendimethalin 0.450 kg/ha+ Oxadiargyl 0.035 kg/ha as pre-emer. *fb* HW aT30 DAS	5.27 (27.33)	3.49 (11.66)	3.62 (12.66)	163.33	19.34	74.24	2.24	54754	2.83
T_6	HWat 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30DAS	5.05 (25.00)	2.41 (5.33)	3.03 (8.66)	103.33	12.27	82.72	4.39	62241	3.09
T_7	HWaT10 DAS *fb* Metribuzin 0.150kg/ha (PoE) at 30DAS	5.92 (34.67)	3.41 (11.33)	3.67 (13.00)	160.00	18.64	74.72	2.34	56439	2.95
T_8	HWaT10 DAS *fb* Propaquizafop 0.075kg/ha (PoE) at 30DAS	5.90 (34.33)	3.67 (13.00)	3.71 (13.33)	183.33	21.84	71.09	1.82	52134	2.74
T_9	HWaT15 DAS *fb* tankmix Quizalofop ethyl 0.020 kg/ha +Metribuzin 0.075 kg/ha as post-emer.at 30DAS	5.34 (28.00)	2.85 (7.67)	3.08 (9.00)	96.33	7.98	84.67	5.26	66841	3.25
T_{10}	Hand weeding a T15 and 30 DAS	5.43 (29.00)	3.89 (14.66)	3.75 (13.66)	120.00	12.86	81.04	-	58389	2.77
T_{11}	Weed free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	00	0.00	100.00	-	59057	2.29
T_{12}	Weedy check (control)	8.09 (65.00)	6.42 (41.00)	7.44 (55.00)	633.33	48.90	0.00	-	29241	2.20
S.Em. +		0.10	0.18	0.17	13.20					
CD at 5%		0.30	0.54	0.51	38.73					
C.V%		6.99	9.62	8.68	13.19					

The data on dry weight of weeds in (Table 2) show that there were conspicuous differences in dry weight of weeds at harvest among different weed management treatments. Next to the treatment T 11(Weed free), treatment T_9 (HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer. at 30 DAS) recorded significantly the lowest dry weight of weeds (96.33 kg/ha) at harvest. However, it was statistically at par with treatment T_6 (HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS and T_{10} (Hand weeding at 15 and 30 DAS) with weed dry weight of 103.33, 120.00 kg/ha respectively. Conversely, significantly the highest dry weight of weeds (633.33 kg/ha) was observed under weedy check (T_{12}).

The data pertaining to weed index is presented in (Table 2). Among different treatments excluding weed free (T_{11}), the lowest WI of 7.98% was recorded under the treatment T_9(HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer.at 30 DAS), closely followed by T_6 (HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS) and T_{10} (Hand weeding at 15 and 30 DAS) with WI of 12.27% and 12.86% respectively. So this might be attributed to the effective control of weeds under these treatments, which reflected in less number of weeds and ultimately lower weed biomass. On the other hand the highest WI (48.90%) was recorded under the weedy check(T 12). The weedy check (T_{12}) recorded significantly the highest dry weight of weeds owing to uncontrolled condition favoured luxurious weed growth leading to increased dry matter.

The computed data on weed control efficiency was presented in (Table 2). The 100%WCE was observed under weed free (T_{11}). Among the weed management treatments, thehighest WCE (84.67%) was registered under the treatment T_9(HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer. at 30 DAS) closely followed by T_6 (HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS), T_{10} (Hand weeding at 15 and 30 DAS), T_2(Oxyfluorfen 0.180 kg/ha (PE) *fb* HW at 30 DAS) and T_1(Pendimethalin 0.90kg/ha (PE) *fb* HW at 30 DAS) with WCE of 82.72,81.04,78.35,75.26% respectively. This might be due to lower dry weight of weed and weed index under these treatments. On the other hand the lowest WCE (71.09%) was recorded under the treatment T_8(HW aT$_{10}$ DAS *fb* Propaquizafop 0.075 kg/ha (PoE)at 30 DAS).

Among the herbicidal treatments, the highest HEI (5.26%) was observed under the treatment T_9(HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075kg/ha as post-emer. at 30 DAS), followed by T_6(HW at 10 DAS *fb* Quizalofop ethyl 0.040kg/ha (PoE) aT30 DAS) with HEI of 4.39%. This might be due to higher seed yield and lower dry weight of weed under these treatments. However, the lowest HEI (1.79%) was observed under the treatment T_3 (Oxadiargyl 0.075 kg/ha (PE) *fb* HW at 30 DAS). Similar findings were reported by Nalini *et al*. (2015) [10], Mishra *et al*. (2001) [9] and Verma *et al.* (2015) [13].

The data on economics (Table 2), indicated that maximum net return of 66841/ha was realized with T_9(HW aT15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emer. at 30 DAS) followed by the treatment T_6(HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS) by recording net return of 62241/ha. This might be due to effective and efficient control of weeds by hand weeding and herbicides *viz*., Quizalofop ethyl and

metribuzin. The lowest net return of Rs 29241/ha was achieved under weedy check (T_{12}).

An appraisal of data in (Table 2) showed that maximum B: C ratio 3.25 was obtained with the T_9(HW at 15 DAS *fb* tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075kg/ha as post-emer. at 30 DAS), followed by the treatment T_6 (HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha (PoE) at 30 DAS) by securing BCR of 3.09. The lowest BCR of 2.20 was accrued under weedy check (T_{12}). The highest B: C ratio under these treatments might havebeen due to less cost of herbicides and higher production of grain as well as fodder. Similar results are also reported by Lhungdim *et al.* (2013) [7] and Vijayalaxmi *et al.* (2012) [14].

4. Conclusion

On the basis of the results of the one year field study, it can be concluded that effective and economically viable weed management in fenugreek can be achieved by HW a$T_1$5 DAS *fb* application of tank mix Quizalofop ethyl 0.020 kg/ha + Metribuzin 0.075 kg/ha as post-emergence at 30 DAS OR HW at 10 DAS *fb* Quizalofop ethyl 0.040 kg/ha as post-emergence at 30 DASO Radopting HW at 15and 30 DAS according to availability of labours OR maintaining the crop weed free throughout crop growth period under South Saurashtra Agro-climatic Zone of Gujarat.

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