

Original Research Article

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## Influence of Different Dates of Sowing, Fertilizer Level and Weedicides on Growth and Yield of Fenugreek (*Trigonella foenum-graecum* L.) under Semi-Arid Conditions

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### ABSTRACT

An investigation was carried out at ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan during *Rabi* season 2016-17 to ascertain the suitable sowing date, fertilizers doses and weedicide for quality production of fenugreek variety AFG-3. Result illustrated that significantly higher plant height (70.10 cm), per plant primary branches (4.64), secondary branches (3.86), nodules (4.90), seed yield (1800 kg ha<sup>-1</sup>) and biological yield (5755.55 kg ha<sup>-1</sup>) were recorded in 30<sup>th</sup> October sown crop as compared to 15<sup>th</sup> October and 15<sup>th</sup> November sowing dates. Irrespective of sowing dates, the application of NPK level (F<sub>3</sub>) 50:50:25 kg ha<sup>-1</sup> recoded highest plant height (67.57 cm), per plant primary branches (4.33), secondary branches (3.28), nodules (3.72), seed yield (1675.92 kg ha<sup>-1</sup>) and biological yield (5333.32 kg ha<sup>-1</sup>). The pre-emergence application of oxadiargyl @ 75g a.i. ha<sup>-1</sup> provided more plant height (65.60cm), per plant primary branches (4.23), secondary branches (3.08), nodules (4.03), weed counts (47.88 and 65.14 weeds/m<sup>2</sup> area at 45 and 90 DAS, respectively), seed yield (1643.22 kg ha<sup>-1</sup>) and biological yield (5027.16 kg ha<sup>-1</sup>). The combined effect of the treatments D<sub>2</sub>x F<sub>3</sub>x W<sub>2</sub> given maximum plant height (72.33cm), number of primary and secondary branches (5.23 and 4.33), pods per plant (42.36), seed yield (2511.13 kg ha<sup>-1</sup>), gross return (Rs.158934 ha<sup>-1</sup>), net return (109632 ha<sup>-1</sup>) and BCR (3.22).

### Keywords

Sowing dates,  
Fertilizer doses,  
Weedicides,  
*Trigonella foenum-graecum* L., Semi-arid conditions

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### Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is an annual legume seed spice crop commonly known as methi, belongs to the family Fabaceae. The name fenugreek comes from the species name “foenum-graecum” means “Greek hay” (Flammang *et al.*, 2004). It is a self-pollinated crop with chromosome no. 2n=16. It believed to be a native of an area

extending from Iran to northern India (Marzougui *et al.*, 2007) and cultivated worldwide. In India, it is cultivated mainly in Rajasthan, Gujarat, Madhya Pradesh, Chhattisgarh, Maharashtra, Haryana, Punjab and Uttar Pradesh in an area of 2.27 lakh hectare, produced 2.47 lakh tonnes of seeds with an annual productivity of 1085 kg/hectare (Anonymous, 2016). Fenugreek is one of the major and important seed spice crop occupies

a prime position throughout the globe to add taste and flavour in various food items. Fenugreek seeds contain carbohydrates (48%), proteins (25.5%), mucilaginous matter (20%), fats (7.9%), saponin (4.8%) (Rao and Sharma, 1987) and volatile oil (0.02%) (Ravindran *et al.*, 2001). In England, seeds are extracted for steroidal substance "diosgenin" a sex hormone and oral contraceptive in family planning (Vasudevan *et al.*, 2008). Fenugreek seeds contain 4-hydroxyisoleucine- a novel amino acid, which are known in traditional medicine for their anti-diabetic properties (Sauvaire *et al.*, 1998). It significantly decreased the plasma triglyceride levels by 33% ( $P < 0.002$ ), total cholesterol (TC) by 22% ( $P < 0.02$ ), and free fatty acids by 14% (Narender *et al.*, 2006). Fenugreek leaves and seeds are extensively used to prepare extract and powder for medicinal purpose (Basch *et al.*, 2003). In addition to diabetic, seeds are also used for the treatment of various ailments i.e. chronic dysentery, diarrhoea, dyspepsia, chronic cough, enlargement of liver, spleen and rickets (Pruthi, 1979), stabilizing the insulin, blood sugar and haemoglobin levels (Mehta *et al.*, 2010). Fenugreek seeds also contain hormone precursors that can increase milk production in nursing mothers and it is widely used for insufficient lactation.

In manufacturing industry, fenugreek extracts are used in soaps and different cosmetics. Steroid diosgenin used in pharmaceutical industry (Mehrafarin *et al.*, 2010). It can be grown under wide range of climatic conditions. It requires cool climate and dry weather at the time of maturity. It can be grown in all types of soils, which is well drained. Unlike other legumes, it is fairly tolerant to salinity. However, it is better to avoid salty and acidic soils. Being a legume, its roots are endowed with root nodules containing "Rhizobium" which fix atmospheric nitrogen for plant, thus its cultivation enriches the soil with nitrogen.

There is a need to standardize various agronomic techniques to improve seed yield and quality in fenugreek. Balanced nutrient, proper sowing time and managing weed population, obviously these three factors will not only enhance the productivity of seed but also decide the ultimate commercial success of fenugreek crop for pod vegetable. Similarly, the plants grown in last week of October to first week of November with proper nutrient management gives maximum vegetative growth of fenugreek in terms of plant height, number of branches per plant, number of leaves, number of pods, number of seeds per pod, weight of seeds per pod, seed yield per plant and seed yield per hectare (Nandre *et al.*, 2011).

The growth and seed yield are largely influenced by the nutrient status of the soil apart from genetic potential of the variety. Altering the soil nutrients and fertility status by providing balanced and adequate dose of major nutrients like nitrogen, phosphorus and potassium as per the crop requirement, is one of the easiest way to boost up the productivity of fenugreek. It is important to standardize the optimum sowing times, major nutrients levels and effective weed management tactics for realizing better seed production and productivity of fenugreek crop. In the light of above cited facts and lack of above information on these aspects particularly for semi-arid conditions, the present study was undertaken to find out effect of sowing dates, NPK levels and weedicides on growth, yield and quality of fenugreek.

## **Materials and Methods**

The field experiment entitled studies on effect of sowing dates, NPK levels and weedicides on the growth and yield of fenugreek (*Trigonella foenum-graecum* L.) was conducted during the Rabi season of 2016-17 at ICAR-National Research Centre on Seed

Spices, Ajmer. Experimental site was located at 74° 36' 01" E longitude and 26° 22' 31" N latitude with an altitude of 460.17 m above mean sea level. The region falls under 3<sup>rd</sup> agro climatic zone of Rajasthan. The soil of research farm is sandy loam having pH 8 to 8.3 and 0.15 to 0.23% organic carbon, available N 178.5 kg ha<sup>-1</sup> (low), P<sub>2</sub>O<sub>5</sub> 12 kg ha<sup>-1</sup> (medium), K<sub>2</sub>O 85 kg ha<sup>-1</sup> (low). The treatments consisted of three dates of sowing (D<sub>1</sub>-15<sup>th</sup> October, D<sub>2</sub>-30<sup>th</sup> October and D<sub>3</sub>-15<sup>th</sup> November), three doses of fertilizers NPK levels (F<sub>1</sub>-30:30:15 kg/ha, F<sub>2</sub>-40:40:20 kg/ha and F<sub>3</sub>-50:50:25 kg/ha) and two weedicides (W<sub>1</sub>-pendimethalin @ 1 kg/ha and W<sub>2</sub>-oxadiargyl @ 75 g a.i./ha). The experiment was laid out in Randomized Block Design with factorial concept. Eighteen treatment combinations were applied in three replications. The fenugreek variety AFG-3 was sown in standard crop geometry as accordance to package of practices adopted by ICAR-NRCSS. Full dose of phosphorus, potash and half dose of nitrogen were given as basal dose at the time of soil preparation for sowing. The remaining nitrogen was applied in two equivalent split doses as top dressing in standing crop in at 30 and 60 days after sowing (DAS). The NPK were applied in the form of fertilizer urea, di-ammonium phosphate (DAP) and murate of potash (MOP). The pre-calculated quantities of weedicides i.e. pendimethalin @ 1.0 kg/ha and oxadiargyl @ 75 g a.i. /ha were applied with the help of knapsack sprayer just after sowing as pre-emergence weedicide.

### Data collection and statistical analysis

Observations on plant height (cm) were recorded from five randomly selected and tagged plants/plot at 30, 60, 90 DAS and at harvest measuring base of plant to tip of the main shoot. The numbers of primary and secondary branches per plant were recorded at 60, 90 DAS and at harvest. Fresh weight of

plant (g) and numbers of nodules per plant were recorded at 60 and 90 DAS, whereas, number of weeds per m<sup>2</sup> area and their fresh (g) and dry weight (g) at 45 and 60 DAS along with days taken to 50 per cent flowering were recorded. The yield attributes viz., number of pods per plant, number of seeds per pod, pod length (cm), pod weight (g), test weight (g), seed yield, biological yield and straw yield in kg/ha and harvest index (%) were recorded. All the data related to the growth parameters and yield and yield attributes were obtained and statistically analyzed using OPSTAT software developed by CCSHAU, Hisar (India).

## Results and Discussion

### Growth parameters

The data on various growth parameters viz., plant height (cm), number of primary branches per plant, secondary branches per plant, number of nodules per plant at different growth stages and days taken to 50% flowering was recorded and presented in table 1. It was illustrated that, the sowing dates, fertilizer doses and weedicide applications were significantly influenced all growth attributes. The higher plant height at 45, 60, 90 DAS and at harvest were obtained in crop sown on 30<sup>th</sup> October with the application of NPK @ 50:50:25 kg/ha and oxadiargyl @ 75g a.i. /ha (pre-emergence). The maximum plant height 70.10, 67.57 and 65.60 cm was recorded in the treatment of D<sub>2</sub> (30<sup>th</sup> October), F<sub>3</sub> (NPK level 50:50:25kg/ha) and W<sub>2</sub> (oxadiargyl @ 75g a.i. /ha), respectively. However, non-significant response of both the weedicides on plant height was recorded at harvest but found better at early plant growth stages. Bhutia and Sharangi (2018) and Sultana *et al.*, (2016) had recorded the similar kind of observations in fenugreek in respect to sowing dates; get support to the present findings. Dutta *et al.*, (2008) had also found an

increase in plant height in black cumin with the advancement of sowing times up to 15<sup>th</sup> November. Numbers of primary and secondary branches per plant were also found highest in same sowing date (30<sup>th</sup> October), fertilizer dose (NPK@ 50:50:25 kg/ha) and weedicide (oxadiargyl @ 75g a.i. /ha as pre-emergence) at harvesting stage. The above three treatments were found significantly superior over rest of the treatments. Similar trends in numbers of primary and secondary branches per plant in fenugreek were also recorded at 45, 60 and 90 DAS in all the treatments (Table1).

Number of nodules per plant at 60 and 90 DAS was differed significantly due to sowing dates irrespective of NPK levels and weedicides. The more nodules were recorded at 60 DAS as compared to 90 DAS in all treatments. At 60 DAS, 4.90 nodules/plant were found in crop sown 30<sup>th</sup> October (D<sub>2</sub>) as compared to 15<sup>th</sup> October (D<sub>1</sub>) (4.17) and 15<sup>th</sup> November (D<sub>3</sub>) (2.67). Similarly highest nodule (4.27 and 4.03 per plant) was found under fertilizer dose (NPK level 50:50:25 kg/ha) and weedicide (oxadiargyl @ 75g a.i. /ha.), respectively. Fresh weight of plant at 60 DAS and 90 DAS was influenced by sowing dates, NPK levels and weedicides. The higher fresh weight of plant (29.36g) at 90 DAS was recorded in fenugreek crop sown on 30<sup>th</sup> October followed by 15<sup>th</sup> October (26.98 g) and 15<sup>th</sup> November (12.53 g). The maximum fresh weight of plant 24.46 g and 24.13g was found in fertilizers dose (NPK level 50:50:25 kg/ha) and weedicide (oxadiargyl @ 75g a.i. /ha.) at 90 DAS. The fenugreek crop sown on 30<sup>th</sup> October had taken minimum days (51 days) to 50% flowering with the application of fertilizers dose (NPK levels: 50:50:25 kg/ha) and weedicide (oxadiargyl @ 75g a.i. /ha) considered as most suitable date of sowing, fertilizers doses and weedicides for fenugreek under semi-arid conditions. The similar increase in growth parameters under higher fertilizer levels were also noticed by Kumar *et*

*al.*, (2004) in french bean and Mehta *et al.*, (2010) in fenugreek. Similarly, the minimum number of weed counts/m<sup>2</sup> area *viz.*, 47.88 and 65.14 were recorded in the plots treated with oxadiargyl @ 75g a.i. per hectare at 45 and 90 DAS, respectively (Table 2). Likewise fresh weight and dry weight of weed was obtained lower in same weedicide with the sowing date 30<sup>th</sup> October and NPK level (30:30:15 kg/ha).

The data of combined effect of all treatments i.e. sowing dates, NPK levels and weedicides on growth attributes of fenugreek are presented in table 4, showed that the treatment combination of D<sub>2</sub>xF<sub>3</sub>xW<sub>1</sub> given maximum average plant height 72.33 cm, 5.23 primary, 4.33 secondary branches per plant, whereas highest number of nodules per plant (5.33) was recorded D<sub>1</sub>xF<sub>3</sub>xW<sub>2</sub> treatment combination under semi-arid conditions.

### **Yield attributes and yield**

The results obtained from the effect of different sowing dates, fertilizers doses (NPK level) and weedicides on yield attribute and yield of fenugreek are presented in table 3. It was revealed that the yield attribute i.e. number of pods/plant, pod length, pod weight and number of seed per pod were significantly influences with various sowing dates, NPK levels and weedicide use. The crop sown on 30<sup>th</sup> October resulted maximum number of pods per plant (37.23), pod length (9.95 cm), pod weight (9.19 g), number of seeds per pod (15.98) and test weight (14.95 g) over early and late sown crops (Table 3). This might be due to better start and growth of fenugreek with favourable environmental and congenial micro-climate inside the soil, better embryo development and seed germination. These findings are in close conformity with the report made by Bhutia and Sharangi (2016) in fenugreek. Similarly, the maximum seed yield (1800 kg/ha), straw yield (3955.55 kg/ha) and biological yield (5755.55 kg/ha) was obtained from 30<sup>th</sup> October sown crop.

**Table.1** Effect of sowing dates, NPK levels and weedicides on various growth parameters at different plant growth stages of fenugreek under semi-arid conditions

Treatments	Plant height (cm)				No. of primary branches/plant			No. of secondary branches/plant			No. of nodules /plant		Fresh wt. of plant (g)		Days to 50% flowering
	45 DAS	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	60 DAS	90 DAS	
Sowing dates															
<b>15<sup>th</sup> October (D<sub>1</sub>)</b>	7.35	29.24	57.02	65.42	3.92	4.18	4.27	2.42	3.00	3.15	4.17	2.58	9.92	26.98	52.77
<b>30<sup>th</sup> October (D<sub>2</sub>)</b>	7.48	32.61	61.48	70.10	4.28	4.53	4.64	3.22	3.70	3.86	4.90	3.16	9.88	29.36	51.00
<b>15<sup>th</sup> November (D<sub>3</sub>)</b>	5.37	29.05	54.69	60.12	2.57	3.10	3.38	1.01	1.88	2.05	2.67	2.38	4.46	12.53	60.83
<b>SEm±</b>	0.14	0.72	0.68	0.84	0.07	0.07	0.08	0.08	0.09	0.06	0.10	0.09	0.50	0.87	0.58
<b>CD (p=0.05)</b>	0.41	2.08	1.96	2.43	0.20	0.22	0.24	0.23	0.26	0.19	0.31	0.25	1.43	2.51	1.67
NPK levels															
<b>30:30:15 kg/ha (F<sub>1</sub>)</b>	6.54	29.70	56.33	63.72	3.25	3.63	3.87	1.92	2.61	2.78	3.75	2.45	7.68	21.80	56.05
<b>40:40:20 kg/ha (F<sub>2</sub>)</b>	6.61	30.46	55.82	64.33	3.63	3.95	4.08	2.16	2.82	3.00	3.72	2.65	7.48	22.61	54.77
<b>50:50:25 kg/ha (F<sub>3</sub>)</b>	7.06	30.74	61.05	67.57	3.80	4.22	4.33	2.57	3.15	3.28	4.27	3.02	9.10	24.46	53.77
<b>SEm±</b>	0.14	0.72	0.68	0.84	0.07	0.07	0.08	0.08	0.09	0.06	0.10	0.09	0.50	0.87	0.58
<b>CD (p=0.05)</b>	0.41	NS	1.96	2.43	0.20	0.21	0.24	0.23	0.26	0.19	0.31	0.25	1.50	2.62	1.67
Weedicides															
<b>Pendimethalin @ 1.0 kg/ha</b>	6.68	28.95	56.60	64.82	3.57	3.86	3.97	2.07	2.82	2.96	3.80	2.58	7.18	21.79	55.77
<b>Oxadiargyl @ 75g a.i./ha</b>	6.78	31.65	58.87	65.60	3.62	4.01	4.23	2.36	2.90	3.08	4.03	2.84	9.00	24.13	53.96
<b>SEm±</b>	0.11	0.59	0.55	0.69	0.05	0.06	0.07	0.06	0.07	0.05	0.08	0.07	0.40	0.71	0.47
<b>CD (p=0.05)</b>	NS	1.70	1.60	NS	0.17	0.12	0.20	0.56	0.22	0.17	NS	0.21	1.17	2.05	1.37

\*NPK: N- nitrogen, P-phosphorus and K-potash.

**Table.2** Effect of sowing dates, NPK levels and weedicides on number of weeds/m<sup>2</sup> area and fresh and dry weight of weeds/m<sup>2</sup> area in fenugreek under semi-arid conditions

Treatments	No. of weed/m <sup>2</sup> area		Fresh weight of weed (g)		Dry weight of weed (g)	
	45 DAS	90 DAS	45 DAS	90 DAS	45 DAS	90 DAS
Sowing dates						
<b>15<sup>th</sup> October (D<sub>1</sub>)</b>	54.38	65.22	61.32	302.38	9.77	36.47
<b>30<sup>th</sup> October (D<sub>2</sub>)</b>	53.61	62.94	60.91	236.58	9.55	31.57
<b>15<sup>th</sup> November (D<sub>3</sub>)</b>	50.94	81.22	60.88	345.02	12.05	39.69
SEm±	2.46	3.64	2.83	7.94	0.53	0.98
CD (P=0.05)	NS	10.48	NS	22.84	1.54	2.82
NPK levels						
<b>30:30:15 kg/ha (F<sub>1</sub>)</b>	45.38	73.44	65.53	306.72	11.58	38.88
<b>40:40:20 kg/ha (F<sub>2</sub>)</b>	58.77	61.55	50.36	232.72	8.02	31.76
<b>50:50:25 kg/ha (F<sub>3</sub>)</b>	54.77	74.38	67.22	344.55	11.77	37.08
SEm±	2.46	3.64	2.83	7.94	0.53	0.98
CD (P=0.05)	7.09	10.48	8.15	22.84	1.54	2.82
Weedicides						
<b>Pendimethalin @ 1.0 kg/ha (W<sub>1</sub>)</b>	58.07	74.44	66.19	309.27	10.99	36.75
<b>Oxadiargyl @ 75g a.i./ha (W<sub>2</sub>)</b>	47.88	65.14	55.88	280.05	9.92	35.06
SEm±	2.01	2.97	2.31	6.48	0.43	0.80
CD (P=0.05)	5.79	8.55	6.66	18.64	NS	NS

\*NPK: N- nitrogen, P-phosphorus and K-potash.

**Table.3** Effect of different sowing dates, NPK levels and weedicides on yield attributes and seed yield of fenugreek under semi-arid conditions

Treatments	Number of pod/plant	Pod length (cm)	Pod weight (g)	No. of seed/pod	Test weight (g)	Seed yield (kg/ha)	Straw yield (kg/ ha)	Biological yield (kg/ ha)	Harvest Index (%)
<b>Sowing dates</b>									
<b>15<sup>th</sup> October (D<sub>1</sub>)</b>	33.73	9.75	8.51	15.43	14.52	1661.11	3325.92	4987.03	33.98
<b>30<sup>th</sup> October (D<sub>2</sub>)</b>	37.23	9.95	9.19	15.98	14.95	1800.00	3955.55	5755.55	31.52
<b>15<sup>th</sup> November (D<sub>3</sub>)</b>	25.50	9.69	6.10	15.91	12.51	1124.07	2501.85	3625.92	32.23
SEm±	0.79	0.25	0.36	0.33	0.24	53.36	191.61	188.43	0.92
CD (P=0.05)	2.28	NS	1.03	1.01	0.70	153.40	550.85	541.70	NS
<b>NPK levels</b>									
<b>30:30:15 kg/ha (F<sub>1</sub>)</b>	30.46	9.67	7.68	15.70	13.88	1440.75	2911.11	4351.85	33.71
<b>40:40:20 kg/ha (F<sub>2</sub>)</b>	31.43	9.78	8.00	15.50	13.99	1468.51	3214.81	4683.34	32.45
<b>50:50:25 kg/ha (F<sub>3</sub>)</b>	34.56	9.92	8.12	16.12	14.11	1675.92	3657.40	5333.32	31.57
SEm±	0.79	0.25	0.36	0.33	0.24	53.36	191.61	188.43	0.920
CD (P=0.05)	2.28	NS	1.08	1.01	NS	153.40	550.85	541.70	NS
<b>Weedicides</b>									
<b>Pendimethalin @ 1.0 kg/ha (W<sub>1</sub>)</b>	31.84	10.05	8.30	16.13	13.70	1413.57	3138.27	4551.85	32.22
<b>Oxadiargyl @ 75g a.i./ha (W<sub>2</sub>)</b>	32.46	9.54	10.08	15.43	14.28	1643.22	3383.95	5027.16	32.94
SEm±	0.64	0.20	0.29	0.27	0.20	43.57	331.88	153.85	0.75
CD (P=0.05)	1.94	0.62	0.78	0.82	0.57	125.25	NS	442.30	NS

\*NPK: N- nitrogen, P-phosphorus and K-potash

**Table.4** Interaction effect of different sowing dates, NPK levels and weedicides on growth parameters, yield attribute and seed yield of fenugreek

Treatments	Plant height (cm)	No. of primary branches/plant	No. of secondary branches/plant	No. of nodules /plant	No. of pods/plant	Pod length (cm)	No. of seeds/pod	Seed yield (kg /ha)
D <sub>1</sub> F <sub>1</sub> W <sub>1</sub>	66.13	3.86	3.06	3.83	30.60	9.93	15.13	1444.46
D <sub>1</sub> F <sub>1</sub> W <sub>2</sub>	62.40	4.23	3.10	4.00	31.00	9.06	16.10	1400.00
D <sub>1</sub> F <sub>2</sub> W <sub>1</sub>	65.03	4.03	2.73	3.53	31.40	8.80	14.43	1533.30
D <sub>1</sub> F <sub>2</sub> W <sub>2</sub>	63.26	4.06	3.20	3.76	37.46	9.70	15.66	1866.66
D <sub>1</sub> F <sub>3</sub> W <sub>1</sub>	65.53	4.30	3.63	4.60	36.93	10.96	16.10	1822.23
D <sub>1</sub> F <sub>3</sub> W <sub>2</sub>	70.16	5.13	3.20	5.33	35.00	10.03	15.20	1900.00
D <sub>2</sub> F <sub>1</sub> W <sub>1</sub>	67.06	4.16	3.06	4.46	38.13	10.26	17.00	1677.76
D <sub>2</sub> F <sub>1</sub> W <sub>2</sub>	68.26	4.23	3.23	5.06	39.70	9.70	15.56	2011.13
D <sub>2</sub> F <sub>2</sub> W <sub>1</sub>	70.50	5.23	4.06	4.86	33.46	10.63	16.66	1477.76
D <sub>2</sub> F <sub>2</sub> W <sub>2</sub>	70.43	4.26	4.20	4.86	31.06	9.46	14.80	1700.03
D <sub>2</sub> F <sub>3</sub> W <sub>1</sub>	72.00	4.73	4.26	4.96	38.66	10.20	16.80	1422.20
D <sub>2</sub> F <sub>3</sub> W <sub>2</sub>	72.33	5.23	4.33	5.20	42.36	9.43	15.06	2511.13
D <sub>3</sub> F <sub>1</sub> W <sub>1</sub>	56.83	3.36	2.10	2.46	21.40	9.83	15.86	1166.66
D <sub>3</sub> F <sub>1</sub> W <sub>2</sub>	61.66	3.40	2.16	2.66	21.93	9.26	14.56	944.46
D <sub>3</sub> F <sub>2</sub> W <sub>1</sub>	58.53	3.10	1.96	2.70	29.10	10.70	15.40	1033.33
D <sub>3</sub> F <sub>2</sub> W <sub>2</sub>	58.26	3.80	1.83	2.63	26.13	9.43	16.06	1200.00
D <sub>3</sub> F <sub>3</sub> W <sub>1</sub>	61.80	2.93	1.80	2.76	26.90	9.16	17.76	1144.43
D <sub>3</sub> F <sub>3</sub> W <sub>2</sub>	63.63	3.70	2.46	2.80	27.53	9.76	15.83	1255.56
SEm±	<b>2.07</b>	<b>0.21</b>	<b>0.17</b>	<b>0.26</b>	<b>1.94</b>	<b>0.62</b>	<b>0.82</b>	<b>130.70</b>
CD (P=0.05)	<b>NS</b>	<b>0.63</b>	<b>0.48</b>	<b>0.78</b>	<b>NS</b>	<b>1.87</b>	<b>NS</b>	<b>375.76</b>

#D<sub>1</sub>-1<sup>st</sup> sowing date (15<sup>th</sup> October), D<sub>2</sub>-2<sup>nd</sup> sowing date (30<sup>th</sup> October), D<sub>3</sub>-3<sup>rd</sup> sowing date (15<sup>th</sup> November); F<sub>1</sub>-(NPK:30:30:15 kg/ha), F<sub>2</sub>-(NPK:40:40:20 kg/ha) and F<sub>3</sub>-(NPK:50:50:25 kg/ha) and W<sub>1</sub>- pendimethalin @ 1.0 kg/ha and W<sub>2</sub>-oxadiargyl @ 75g a.i./ha.

**Table.5** Interaction effect of different sowing dates, NPK levels and weedicides on yield and economics of fenugreek under semi-arid conditions

Treatment combinations	Seed yield	Straw yield	Gross returns	Cost of cultivation	Net returns	B:C ratio
D <sub>1</sub> F <sub>1</sub> W <sub>1</sub>	1444.46	2833.33	92334.69	46582.90	45751.79	1.98
D <sub>1</sub> F <sub>1</sub> W <sub>2</sub>	1400.00	3266.66	90533.33	47395.40	43137.93	1.91
D <sub>1</sub> F <sub>2</sub> W <sub>1</sub>	1533.30	3322.23	98642.47	47743.60	50898.87	2.07
D <sub>1</sub> F <sub>2</sub> W <sub>2</sub>	1866.66	2933.33	117866.69	48556.10	69310.59	2.43
D <sub>1</sub> F <sub>3</sub> W <sub>1</sub>	1822.23	3411.10	116156.18	48489.70	67666.48	2.40
D <sub>1</sub> F <sub>3</sub> W <sub>2</sub>	1900.00	4188.90	122377.80	49302.00	73075.80	2.48
D <sub>2</sub> F <sub>1</sub> W <sub>1</sub>	1677.76	3344.43	107354.89	46582.90	60772.99	2.30
D <sub>2</sub> F <sub>1</sub> W <sub>2</sub>	2011.13	3933.33	128534.65	47395.40	81139.25	2.71
D <sub>2</sub> F <sub>2</sub> W <sub>1</sub>	1477.76	3511.13	95688.29	47743.60	47944.69	2.00
D <sub>2</sub> F <sub>2</sub> W <sub>2</sub>	1700.03	4300.00	110601.98	48556.10	62045.88	2.28
D <sub>2</sub> F <sub>3</sub> W <sub>1</sub>	1422.20	4511.10	94354.20	48489.70	45864.5	1.95
D <sub>2</sub> F <sub>3</sub> W <sub>2</sub>	2511.13	4133.33	158934.71	49302.00	109632.71	3.22
D <sub>3</sub> F <sub>1</sub> W <sub>1</sub>	1166.66	1866.70	73733.42	46582.90	27150.52	1.58
D <sub>3</sub> F <sub>1</sub> W <sub>2</sub>	944.46	2222.23	61112.49	47395.40	13717.09	1.29
D <sub>3</sub> F <sub>2</sub> W <sub>1</sub>	1033.33	2611.10	67222.2	47743.60	19478.58	1.41
D <sub>3</sub> F <sub>2</sub> W <sub>2</sub>	1200.00	2611.10	77222.20	48556.10	28666.10	1.59
D <sub>3</sub> F <sub>3</sub> W <sub>1</sub>	1144.43	2833.33	74332.65	48489.70	25842.95	1.53
D <sub>3</sub> F <sub>3</sub> W <sub>2</sub>	1255.56	2866.66	81067.35	49302.00	31765.35	1.64

#D<sub>1</sub>-1<sup>st</sup> sowing date (15<sup>th</sup> October), D<sub>2</sub>-2<sup>nd</sup> sowing date (30<sup>th</sup> October), D<sub>3</sub>-3<sup>rd</sup> sowing date (15<sup>th</sup> November); F<sub>1</sub>-(NPK:30:30:15 kg/ha), F<sub>2</sub>-(NPK:40:40:20 kg/ha) and F<sub>3</sub>-(NPK:50:50:25 kg/ha) and W<sub>1</sub>- Pendimethalin @ 1.0 kg/ha and W<sub>2</sub>-oxadiargyl @ 75g a.i./ha.

The significant variations due to fertilizer levels were recorded for yield and yield dynamics, i.e. maximum number of pods m, (34.56), pod length (9.92 cm), pod weight/plant (8.12 g), number of seeds/pod (16.12) and seed yield (1675.92 kg/ha) under the application of NPK level (F<sub>3</sub>) 50:50:25 kg/ha followed by NPK level (F<sub>2</sub>) 40:40:20 NPK kg/ha and 30:30:15 NPK kg/ha (F<sub>1</sub>). Irrespective of sowing date and NPK levels, pre-emergence application of oxadiargyl @ 75 g a.i. per ha given best yield attributes and yield of fenugreek. The results are in accordance with the findings of Meena *et al.*, (2013) and Maliwal and Gupta (1989).

The interaction effect of sowing dates, NPK levels and weedicides on yield attributes and yield of fenugreek illustrated that the treatment combination of D<sub>2</sub>x F<sub>3</sub>x W<sub>1</sub> given maximum average number of pods/ plant (42.36) and seed yield (2511.13 kg/ha). However, its response on pod length and number of seeds per pod was non-significant. Nandre *et al.*, (2011) had also observed the comparable results in fenugreek are accordance with findings.

**Economic analysis:** Varying sowing dates, fertilizer doses and weedicides widely influenced gross return, net return as well as benefit cost ratio (BCR). The higher gross return (Rs. 158934 ha<sup>-1</sup>), net return (Rs. 109632 ha<sup>-1</sup>) and BCR (3.22) were obtained in treatments combination of D<sub>2</sub>x F<sub>3</sub>x W<sub>2</sub> (in 30<sup>th</sup> October sowing date with NPK level 50:50:25 kg/ha and pre-emergence use of oxadiargyl @ 75g a.i. /ha) followed by D<sub>2</sub>x F<sub>1</sub>x W<sub>2</sub> (Table 5). The higher return in 30<sup>th</sup> October sown crop with NPK level 50:50:25 kg/ha and oxadiargyl @ 75 g a.i./ha is due to higher plant growth, number of pods/ plant and seed yield. The similar observations were also recorded by Nandre *et al.*, (2011) and Bhutia and Sharangi (2016) are close conformity of present findings. In conclusion, it was evident from the study that, the fenugreek variety AFG-3 sown on 30<sup>th</sup> October and applied fertilizers doses NPK 50:50:25 kg/ha with pre-emergence application of oxadiargyl @ 75 g a.i./ha is better for realizing higher growth attributes, seed yield,

net return and BCR among all the treatment combinations.

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