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Influence of sowing time and phosphorus on phenology, thermal requirement and yield of fenugreek (*Trigonella foenum-graecum* L.) genotypes

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Abstract

Experiments were conducted at Hisar (Haryana, India) to study the effect of sowing time and phosphorus on phenology, thermal requirement and yield of two genotypes of fenugreek (*Trigonella foenum-graecum*). Genotype HM-65 performed better than T-8 with respect to yield and was more efficient in utilizing heat units. Delayed sowing resulted in significant reduction in time taken for initiation of flowering and maturity in both the genotypes. Thermal requirement decreased with delay in sowing in both the genotypes. Increasing levels of phosphorus up to 60 kg/ha significantly enhanced the yield but heat unit consumption slightly declined in both the genotypes.

Key words: fenugreek, phenology, phosphorus, sowing time, thermal requirement, *Trigonella foenum-graecum*, yield.

Temperature, being an index of sensible heat of atmosphere, is the most important parameter influencing the growth of the plant. It also influences morphology, development, production and occurrence of phenological phases. The concept of growing degree days is used in deciding planting dates and prediction of the occurrence of different phenophases (Nield & Seelay 1977). Climatic factors such as temperature, duration of bright sunshine and relative humidity differ with sowing time of the crop, which ultimately influences the growth and yield of the crop. Fenugreek (*Trigonella foenum-gracum*L.), a multi-purpose crop grown as a spice, fodder and also for vegetable purposes is largely cultivated in South West Haryana (India). The present investigation was carried out to study the effect of sowing time and phosphorus fertilization on yield, phenology and thermal requirement of two fenugreek genotypes.

Materials and methods

A field experiment was conducted at CCS Haryana Agricultural University, Hisar (India), during winter (*rabi*) season of 1995–96 and 1996–97 in a split plot design with three replications. The main plot treatments comprised of two genotypes of fenugreek (HM-65 and T-8) and three dates of sowing (November 16, December 1 and December 16) and the sub-plot treatments comprised of four levels of phosphorus (0, 30, 60 and 90 kg P_2O_5/ha). The soil of the experimental field was sandy loam in texture having available N-167.5 kg/ha, available P-7.4 kg/ha and available K-243.2 kg/ha with pH of 7.8. The crop was sown in lines 30 cm apart at a seed rate of 20 kg/ha for both the genotypes. A basal dose of 20 kg N/ha was given to all the treatments through urea. Full dose of phosphorus in the form of single superphosphate was drilled before sowing as per treatments. Intercultural operations were carried out as and when required. The crop was irrigated at 45 days after sowing and at 50% flowering stage. Cumulative heat unit consumption was computed as described by Iwata (1975).

$$\text{Cumulative heat units} = \sum_{i=1}^{n}\left(\frac{T\max+T\min}{2}\right) - Tb$$

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where, T max and T min are daily maximum and minimum temperatures of the day, respectively, and Tb is the base temperature (5°C). Air temperature data were obtained from the Agrometeorological Observatory situated about 200 m away from the experimental field. Daily heat units were computed from sowing to maturity of the crop.

Results and discussion

Effect of genotypes

The genotypes did not differ significantly with respect to number of days taken for initiation of flowering and maturity (Table 1). Genotype HM-65 yielded (seed) 20.4 and 17.0% higher than T-8 during 1995–96 and 1996–97, respectively. Saini *et al.* (1980) also obtained a higher seed yield in HM-65 than T-8. The genotype T-8 consumed more heat units for flowering and maturity as compared to HM-65. Significantly higher productivity (14.5 kg/ha per day) in HM-65 (pooled data) was due to its higher yield and comparatively shorter duration which were also reflected by lesser heat units consumed by HM-65 than T-8 (Tables 2 and 3). In spite of higher heat unit consumption, T-8 yielded less than HM-65 which indicated that T-8 was less efficient in heat unit consumption.

Effect of sowing time

Delayed sowing (December 16) resulted in significant reduction in number of days required by the crop for flowering and maturity over early sowing. Seed yield under different sowing dates differed significantly. Maximum seed yield was obtained from the crop sown on December 1 followed by November 16 and December 16 sown crops. Similarly, the highest productivity was recorded from the crop which was sown on December 1. This increase in seed yield might be due to favourable weather conditions at reproductive phase. Higher productivity in December 1 sown crop is also an indicator of this date as an

Table 1. Effect of sowing time and phosphorus levels on flower initiation, maturity, seed yield and productivity of fenugreek genotypes

Treatment	Flower initiation (days)		Maturity (days)		Seed yield (kg/ha)			Productivity (kg/ha/day)	
	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	Pooled	1995–96	1996–97
Genotype									
HM-65	68.0	71.0	137.0	140.0	2102	1907	2004	15.4	13.6
T-8	71.0	74.0	141.0	144.0	1746	1630	1688	12.3	11.2
SEm±	1.0	1.0	1.4	1.6	23	28	26	0.3	0.4
CD (5%)	NS	NS	NS	NS	71	90	83	0.9	1.1
Sowing time									
November 16	73.0	76.0	148.0	153.0	1974	1815	1894	13.3	11.9
December 1	69.0	73.0	140.0	143.0	2126	2034	2080	15.2	14.2
December 16	67.0	70.0	129.0	131.0	1672	1456	1564	12.9	11.1
SEm±	1.1	1.3	1.8	1.9	28	33	30	0.4	0.4
CD (5%)	3.6	4.0	5.8	6.0	87	110	93	1.1	1.3
Phosphorus level									
P_0	72.0	75.0	141.0	145.0	1665	1439	1552	11.8	9.9
P_{30}	70.0	74.0	139.0	143.0	1917	1791	1854	13.8	12.5
P_{60}	69.0	72.0	137.0	141.0	2056	1906	1981	15.0	13.5
P_{90}	68.0	71.0	137.0	140.0	2060	1937	1999	14.7	13.8
SEm±	1.3	1.3	2.0	2.2	25	37	32	0.4	0.5
CD (5%)	NS	NS	NS	NS	71	108	99	1.2	1.6

NS = Not Significant

Table 2. Heat units (day°C) consumed by fenugreek genotypes for initiation of flowering under different sowing dates and phosphorus levels

Genotype	Phosphorus level (kg/ha)	Sowing date (1995–96)				Sowing date (1996–97)			
		Nov. 16	Dec. 1	Dec. 16	Mean	Nov. 16	Dec. 1	Dec. 16	Mean
HM-65	P_0	703.5	611.1	572.1	628.9	572.4	505.3	511.3	529.7
	P_{30}	692.2	583.5	553.9	609.9	572.4	498.5	488.4	519.8
	P_{60}	670.8	559.2	553.9	594.6	560.5	489.4	478.3	509.4
	P_{90}	670.8	559.2	545.9	592.0	549.8	480.1	488.4	506.1
	Mean	684.3	578.2	556.4	606.3	563.8	493.3	491.6	516.2
T-8	P_0	713.6	620.7	596.1	643.5	611.4	539.2	527.3	559.3
	P_{30}	697.6	597.0	584.1	626.2	611.4	519.1	499.4	543.3
	P_{60}	692.2	597.0	584.1	624.4	630.0	498.5	499.4	542.6
	P_{90}	692.2	573.2	584.1	616.5	578.2	498.5	499.4	525.4
	Mean	698.9	597.0	587.1	627.8	601.0	513.8	506.4	542.6

CD (5%)	1995–96	1996–97
Genotypes	NS	20.0
Date of sowing	22.8	18.2
Phosphorus levels	NS	NS
Interactions	NS	NS

optimum time for sowing. Taneja *et al.* (1985) also obtained higher seed yield of fenugreek sown on November 25 compared to other dates of sowing. Dealy in sowing resulted in decreased heat unit consumption during both the years (Tables 2 and 3). The almost similar heat unit consumption under three dates of sowing with large variation in number of days taken to maturity indicates that

Table 3. Heat units (day°C) consumed by fenugreek genotypes up to maturity under different sowing dates and phosphorus levels

Genotype	Phosphorus level (kg/ha)	Sowing date (1995–96)				Sowing date (1996–97)			
		Nov. 16	Dec. 1	Dec. 16	Mean	Nov. 16	Dec. 1	Dec. 16	Mean
HM-65	P_0	1669.7	1672.0	1636.3	1659.3	1580.9	1518.1	1555.9	1551.6
	P_{30}	1619.0	1595.5	1572.2	1595.6	1522.0	1495.9	1504.2	1507.4
	P_{60}	1598.0	1532.5	1530.1	1553.5	1478.1	1419.0	1431.7	1442.9
	P_{90}	1598.0	1552.0	1505.1	1551.7	1478.1	1401.6	1431.7	1437.1
	Mean	1621.2	1588.0	1560.9	1590.0	1514.8	1458.6	1480.9	1484.7
T-8	P_0	1818.3	1734.9	1659.1	1737.4	1680.0	1639.4	1555.9	1625.1
	P_{30}	1770.8	1714.1	1593.0	1692.6	1636.3	1588.7	1504.2	1576.4
	P_{60}	1730.3	1647.0	1572.2	1649.8	1615.9	1540.9	1455.2	1537.3
	P_{90}	1730.3	1647.0	1593.0	1656.7	1597.3	1540.9	1455.2	1531.1
	Mean	1762.4	1685.7	1604.3	1684.1	1632.4	1577.5	1492.6	1567.5

CD (5%)	1995–96	1996–97
Genotypes	35.6	33.3
Date of sowing	44.3	45.7
Phosphorus levels	32.4	30.3
Interactions	NS	NS

higher temperatures prevailed during the reproductive phase of late sown crop leading to forced maturity.

Effect of phosphorus

Phosphorus application had no significant effect on flower initiation and maturity. Increasing rate of phosphorus up to 60 kg/ha significatly increased seed yield and productivity over lower doses. On the basis of pooled data, an increase in seed yield up to 19.4, 27.6 and 28.8% was recorded over control with the application of 30, 60 and 90 kg P_2O_5/ha, respectively. This increase in yield was mainly attributed to the key role of phosphorus in root development, energy transformation and metabolic processes of plant through which more translocation of photosynthates towards sink development might have occurred. Significant increase in seed yield of fenugreek due to phosphate fertilization was also reported by Pareek & Gupta (1981), Verma *et al.* (1991) and Detroja *et al.* (1995). The optimum doses of phosphorous for HM-65 were 65.4, 69.4 and 63.1 kg P_2O_5/ha under November 16, December 1 and December 16 dates of sowing, respectively. Under the same sowing times, the optimum doses for T-8 were 64.2, 65.7 and 57.6 kg P_2O_5/ha, respectively. With increase in levels of phosphorus application, the heat units required by the crop for maturity decreased. This was because of enhanced growth and development rate and reduced duration of crop growth which ultimately increased crop productivity. Maximum heat units were consumed by genotype T-8 sown on November 16 without phosphorus. This might be due to slow growth rate which prolonged the maturity period. The heat unit consumption of fenugreek genotypes was correlated with yield at optimum stage of planting (December 1) and correlation coefficients (r) are presented in Table 4. The 'r' values ranged between 0.96 and 0.99, which are highly significant at $P<0.01$.

Table 4. Correlation coefficients (r) between heat unit consumption and yield of fenugreek genotypes sown on December 1 (optimum date of planting)

Genotype	Phenological stage	
	Flowering	Maturity
HM-65	0.98**	0.99**
T-68	0.96**	0.98**

** Significant at $P < 0.01$

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