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Effect of Phosphorus and Growth Regulators on Growth and Yield of Fenugreek (*Trigonella Foenum Graecum* L.)

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ABSTRACT

A field experiment was conducted during *rabi* season 2010-11 to study the effect of phosphorus and growth regulators on growth and yield of fenugreek in alfisols. Three levels of phosphorus (20, 40 and 60 kg/ha), three growth regulators (NAA @ 20 ppm, GA_3 @ 50 ppm and Ethrel @ 75 ppm), and the combination of P doses and growth regulators were evaluated. Levels of phosphorus, and plant growth regulators had significant effect on all growth and yield characters recorded. Among the treatments evaluated, maximum plant height (56.6 cm), fresh weight (2693.7 g/m^2) and dry weight of the plant (727.3 g/m^2) were recorded with the application of 60 kg/ha P_2O_5 along with spraying of 50 ppm GA_3 at 25 DAS. Yield attributes like pod per plant (28.5), number of seeds per pod (15.6), test weight(14.6 g), seed yield (1670 kg/ha), straw yield (4823kg/ha) and biological yield (6312kg/ha) were maximum with the basal application of phosphorus 60 kg/ha followed by spraying of 20 ppm NAA. Application of 60 kg/ha phosphorus along with application of NAA 20 ppm at 25 DAS was found to be highly beneficial in alfisols.

Key words : Fenugreek, Growth regulator, Phosphorus.

Fenugreek belongs to the family Leguminosae. It is an erect annual herb, growing to a height of about 45-60 cm. it is commonly called as methi. It is also called as goat horn or cow shorn. It is grown for its green leaves and seeds. The leaf is used as green vegetable. Seeds are rich in protein, minerals and vitamins. It is also claimed that seeds could be used against diabetes. The active principle is the alkaloid 'trigonelline'. Fenugreek seed contains the steroid substances 'diosgenin' which is used as an oral contraceptive. India is one of the major producers and exporter of fenugreek. Rajasthan, Gujarat, U.P and M.P are important states in India growing fenugreek on large scale. It is well known as traditional medicine for diabetes, indigestion, elevation of lipids and edema of the legs, its seeds have a strong aroma and somewhat bitter in taste. Seeds of fenugreek are used as yellow dye in cosmetics and medicinal purpose. It is used as a spice, vegetable and medicinal plant.

Phosphorus plays a key role in the enhancing productivity of fenugreek by providing proper nutritional environment as well as plant. stated that phosphorus uptake is seed and straw of fenugreek increased with increasing levels of Phosphorus up to 40 kg/ha. Increasing Phosphorus rate up to 50 kg /ha increased pods per plant, seed and straw yield of fenugreek. Exogenous application of growth regulators and micronutrients offers unique opportunities of scaling of plants to desirable size and alter physiological process in plants to increase seed yield and quality (Alagakannan and Vijayakumar, 1999). Hence the present experiment was conducted to effect of phosphorus and growth regulators on growth and yield of fenugreek.

MATERIAL AND METHODS

A field experiment was conducted during *rabi* season 2010 at Hyderabad in alfisols. The soil was medium in organic carbon (0.57%), low available nitrogen (192.0 kg/ha), medium available phosphorus (12.5 kg/ha) and medium in available potassium (245.0 kg/ha) and the soil was neutral in pH. The experiment was laid out in Completely Randomized Block Design with three replications with 18 treatments. Three levels of phosphorus (20, 40 and 60 kg/ha), three growth regulators (NAA @ 20 ppm, GA_3 @ 50 ppm and Ethrel @ 75 ppm) and the combination of P doses and growth regulators were evaluated. 50 kg N and 20 kg K_2O were applied as basal dose in all the treatments to meet the N and K requirement of the crop. The fenugreek cv. Lam Selection-1 was used as a test

Table 1.Effect of phosphorus and plant growth regulators on plant height, number of branches fresh and dry weight of plant per at harvest.

	Treatment	Plant height (cm)	No. of branches	Fresh weight (g)/m^2	Dry weight (g)/m^2
T_1	20 kg P_2O_5	46.0	4.7	2601.4	660.7
T_2	40 kg P_2O_5	48.2	5.1	2631.7	671.1
T_3	60 kg P_2O_5	50.3	5.4	2658.6	680.6
T_4	20 kg P_2O_5 + control (water spray)	45.6	4.6	2551.4	630.2
T_5	40 kg P_2O_5 + control (water spray)	48.0	5.0	2583.0	640.6
T_6	60 kg P_2O_5 + control (water spray)	50.1	5.4	2610.3	650.0
T_7	NAA at 20 ppm	46.3	5.5	2603.7	669.1
T_8	20 kg P_2O_5 + NAA at 20 ppm	47.2	5.7	2623.2	676.8
T_9	40 kg P_2O_5 + NAA at 20 ppm	49.2	6.1	2652.0	686.9
T_{10}	60 kg P_2O_5 + NAA at 20 ppm	51.4	6.4	2679.5	696.7
T_{11}	GA_3 at 50 ppm	52.0	5.0	2620.2	699.6
T_{12}	20 kg P_2O_5 + GA_3 at 50 ppm	52.1	5.1	2638.6	707.2
T_{13}	40 kg P_2O_5 + GA_3 at 50 ppm	54.6	5.4	2661.2	715.9
T_{14}	60 kg P_2O_5 + GA_3 at 50 ppm	56.6	5.7	2693.7	727.3
T_{15}	Ethrel at 75 ppm	40.0	6.3	2544.8	636.2
T_{16}	20 kg P_2O_5 + Ethrel at 75 ppm	40.7	6.3	2563.1	643.3
T_{17}	40 kg P_2O_5 + Ethrel at 75 ppm	43.2	6.5	2601.4	655.3
T_{18}	60 kg P_2O_5 + Ethrel at 75 ppm	45.7	6.8	2631.3	665.7
	SE (m)±	0.7	0.1	8.9	2.7
	CD at 5%	2.0	0.3	26.5	8.0

variety. Seeds were dibbled at a distance of 30x10 cm @20 kg /ha. Thinning was done at 25 DAS by retaining one healthy seedling per hill. Spraying of growth regulators was taken up at 25 DAS, immediately after thinning. The plots were kept weed free by hand weeding. Need based plant protection was given by Dimethoate 2 ml/l at flowering and pod formation stage to prevent to aphid infestation. The soil was drenched with Mancozeb @ 0.2 per cent and Carbendazim @ 0.1 per cent thrice at an interval of 25, 45 and 60 DAS to prevent root rot infestation. Observations were recorded on 5 randomly selected plants in each treatment. Plant height, number of branches, number pods per plant, number of seed, days to 50 per cent flowering, 1000 seed weight (test weight), seed yield and straw yield and harvest index was recorded on the sampled plants. The crop was harvested at maturity by manually in each treatment separately and tied into bundles were weighed determine total biomass per treatment and converted into kg/ha. The bundles were manually threshed and seed yield was recorded.

RESULTS AND DISCUSSION

Effect of phosphorus:

Among the phosphorus doses evaluated, P_2O_5 @ 60 kg/ha recorded maximum plant height(50.3cm), number of branches per plant(5.4cm), fresh weight(2658.6g/m^2) and dry weight of plant(680.6g/m^2) which was on par with application of P_2O_5 @ 40 kg/ha but was significantly superior to the application of P_2O_5 @ 20 kg/ha (Table No 1) . This may be attributed to better nutritional balance in the root zone as well as in the plant system. Increased levels of Phosphorus had increased fresh weight and dry weight of the plant significantly. The growth attributes are in close conformity with the of Pareek and Gupta (1981), Mandal and Maiti (1992) in fenugreek who reported the plant height, number of branches per plant, fresh and dry weight of the plant increased significantly with phosphorus application.

Table 2. Effect of phosphorus and plant growth regulators on days to 50% flowering, number of pods / plant and number of seeds / pod.

	Treatment	Days to 50% flowering	No. of pods/plant	No. of seeds/ pod
T_1	20 kg P_2O_5	44.3	25.5	14.4
T_2	40 kg P_2O_5	45.0	26.2	14.6
T_3	60 kg P_2O_5	45.7	27.0	15.1
T_4	20 kg P_2O_5 + control (water spray)	46.3	24.6	14.3
T_5	40 kg P_2O_5 + control (water spray)	46.7	25.5	14.6
T_6	60 kg P_2O_5 + control (water spray)	47.3	26.2	15.0
T_7	NAA at 20 ppm	44.2	24.6	15.0
T_8	20 kg P_2O_5 + NAA at 20 ppm	44.7	26.9	15.1
T_9	40 kg P_2O_5 + NAA at 20 ppm	45.1	27.7	15.3
T_{10}	60 kg P_2O_5 + NAA at 20 ppm	45.6	28.5	15.6
T_{11}	GA_3 at 50 ppm	42.7	23.3	14.6
T_{12}	20 kg P_2O_5 + GA_3 at 50 ppm	43.7	26.0	14.6
T_{13}	40 kg P_2O_5 + GA_3 at 50 ppm	45.0	26.8	15.1
T_{14}	60 kg P_2O_5 + GA_3 at 50 ppm	44.4	27.6	15.4
T_{15}	Ethrel at 75 ppm	47.0	23.3	14.0
T_{16}	20 kg P_2O_5 + Ethrel at 75 ppm	47.7	25.1	14.0
T_{17}	40 kg P_2O_5 + Ethrel at 75 ppm	48.0	26.1	14.3
T_{18}	60 kg P_2O_5 + Ethrel at 75 ppm	48.7	26.8	14.8
	SE (m)±	0.1	0.2	0.1
	CD at 5%	0.3	0.7	0.2

Similarly among the phosphorus doses, application of 60 kg/ha phosphorus recorded maximum number of pods per plant (27), test weight (13.9 g), seed yield (1602 kg/ha) straw yield (4306 kg/ha) and biological yield (5798 kg/ha) and significantly superior to other phosphorous doses (40 kg/ha and 20 kg/ha) (Table 2 and 3). The significant improvement in yield attributes due to application of higher dose of phosphorus could be described as overall improvement in vigour and growth of the crop. It may be due to the beneficial effect of added phosphorus on plant growth and seed development. However, significantly higher harvest index (31.2%) was recorded with the application of 20 kg/ha phosphorus. Improved water use efficiency by phosphorus application might have increased seeds per pod and straw yield. Phosphorus application was widely reported to have increased the uptake of NPK by the plant resulting in higher uptake of nitrogen and phosphorus during seed formation thus showing significant improvement in seed and straw yield, number of seeds per plant and test weight. These results are in conformity with the findings of Khiriaya et al ., (2003), Jat *et al.*(1998), Kumar *et al.* (1999), and Ram and Varma (2000).

Effect of growth regulators

Among the different plant growth regulators evaluated, 50 ppm GA_3 resulted in maximum plant height (52 cm), fresh and dry weigh of the plant (2620.2kg/ha and 699.6 kg/ha, respectively). GA_3 has important role on stem elongation and internodal length. Therefore plants treated with the GA_3 grew taller by the process of cell elongation and cell division. The two processes follow each other closely and contribute growth of plants (Krishamoothy, 1981).

Maximum and fresh (2620.2 g/m^2) and dry weights (699.6 g/m^2) of plant were recorded with foliar spray of 50 ppm GA_3 which was on par with the spraying of NAA 20 ppm and significantly superior to the application of Ethrel 75 ppm. Maximum number of branches per plant was

Table 3. Effect of phosphorus and plant growth regulators on test weight, seed yield, and straw yield, biological yield and harvest index.

	Treatment	Test weight (g)	Seed yield(kg/ha)	Straw yield(kg/ha)	Biological yield(kg/ha)	Harvest index (%)
T_1	20 kg P_2O_5	13.4	1503	3512	4824	31.2
T_2	40 kg P_2O_5	13.8	1552	3919	5326	29.1
T_3	60 kg P_2O_5	13.9	1602	4306	5798	27.6
T_4	20 kg P_2O_5 + control (water spray)	12.4	1495	3461	4606	32.5
T_5	40 kg P_2O_5 + control (water spray)	12.8	1546	3889	5113	30.2
T_6	60 kg P_2O_5 + control (water spray)	13.1	1591	4212	5568	28.6
T_7	NAA at 20 ppm	13.9	1525	3893	5137	29.7
T_8	20 kg P_2O_5 + NAA at 20 ppm	14.1	1567	4016	5326	29.4
T_9	40 kg P_2O_5 + NAA at 20 ppm	14.5	1619	4414	5812	27.2
T_{10}	60 kg P_2O_5 + NAA at 20 ppm	14.6	1670	4823	6312	26.5
T_{11}	GA_3 at 50 ppm	13.5	1496	3365	4641	32.2
T_{12}	20 kg P_2O_5 + GA_3 at 50 ppm	13.6	1505	3518	4826	31.2
T_{13}	40 kg P_2O_5 + GA_3 at 50 ppm	14.1	1559	3910	5296	29.4
T_{14}	60 kg P_2O_5 + GA_3 at 50 ppm	14.2	1609	4312	5812	27.7
T_{15}	Ethrel at 75 ppm	12.9	1421	3225	4292	33.1
T_{16}	20 kg P_2O_5 + Ethrel at 75 ppm	13.1	1432	3414	4486	31.9
T_{17}	40 kg P_2O_5 + Ethrel at 75 ppm	13.5	1482	3824	4964	29.9
T_{18}	60 kg P_2O_5 + Ethrel at 75 ppm	13.5	1541	4226	5454	28.3
	SE (m)±	0.1	16.0	1.3	1.6	0.5
	CD at 5%	0.4	42.0	3.80	4.6	1.6

observed in foliar application of 75 ppm ethrel (6.28) which was significantly superior to other growth regulator applications. (Table no 1).

Application of 50 ppm GA_3 took minimum days (42.7) to 50 per cent flowering. Application of gibberellins is known to induce flowering in large number of plants which otherwise would be indefinitely vegetative. Application of 20 ppm NAA significantly increased the number of pods per pant, number of seeds per pods (table no.2), seed yield, test weight, straw yield and biological yield of fenugreek (Table no.3). Growth stimulators are reported to improvement photosynthesis rate by increasing CO_2 fixation and reducing photorespiration. This hormonal interference at the molecular level is ultimately expressed in the form of alteration in growth behavior of various morphological components of the pant which in turn is expressed as yield. (Alagukannan and Vijay Kumar, 1999).

Combined effect of Phosphorus and growth regulators

Among the combination of phosphorus doses and growth regulators, maximum plant height (56.6 cm) was recorded with the application of 60 kg/ha P_2O_5 along with spraying of GA @ 50 ppm which was significantly superior to all other treatments. Maximum number of branches (6.8) was recorded with the application of 60 kg/ha P_2O_5 along with application of Ethrel @ 75 ppm which was significantly superior to all other treatments. Application of 60 kg/ha P_2O_5 along with application of NAA @ 20 ppm recorded maximum number of pods (28.5) which was significantly superior to all other treatments i.e. phosphorus doses, growth regulators and their combinations. Similarly highest seed yield was recorded in application of 60 kg/ha P_2O_5 along with application of NAA @ 20 ppm (1670 kg/ha) which was significantly superior to all other treatments. This may be due to improved plant

height, more number of branches, increased fresh and dry weight of plants, higher number of pods per plant, and better filling of grains as indicated by higher test weight. Among the various treatments evaluated, basal application of NPK @ 50-60-20 kg/ha and subsequent spraying of NAA 20 ppm at 25 DAS was found to be superior to all other treatments in terms of seed yield and adoption of the same may be beneficial to fenugreek growers.

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