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Effect of phosphorus and iron on yield attributes, yield and economics of fenugreek (*Trigonella foenum-graecum* L.)

Vijay Kumar, KK Yadav and DP Singh

Abstract
A field experiment was conducted during *rabi* season 2019-20 at Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan) to evaluate the effect of phosphorous and iron on yield attributes, yield and economics of the fenugreek crop. Treatments comprises of four levels of phosphorus *viz.*, control, 20 kg, 40 kg and 60 kg P_2O_5 ha^{-1} and four levels of iron *viz.*, control, 5 kg, 7.5 kg and 10 kg $FeSO_4$ ha^{-1} and examined in factorial randomized block design (factorial RBD) with three replications taking fenugreek variety “PRM 45” as test crop. The results revealed that various levels of phosphorus showed significant effect on the plant height, test weight and yield (seed, haulm and biological) and harvest index of fenugreek crop. The maximum plant height (93.49 cm) at harvest was recorded with the application of 60 kg P_2O_5 ha^{-1}, which was statistically at par with the plant height under application of 40 kg P_2O_5 ha^{-1}. Application of increasing levels of P_2O_5 @ 60 kg P_2O_5 ha^{-1} has increased the test weight (12.07 g), seed pod^{-1} (17.64) seed yield (2061 kg ha^{-1}), haulm yield (6980 kg ha^{-1}) and biological yield (9040 kg ha^{-1}) of fenugreek crop, which were significantly at par with those recorded under application of 40 kg P_2O_5 ha^{-1}. The application of increasing levels of iron also has significant improvement in plant height (90.93 cm) and yield attributing characters test weight (11.89 g), number of seeds pod^{-1} (17.23), seed, haulm and biological yield were (1957), (6650) and (8607) kg ha^{-1} respectively, with the application of 10 kg $FeSO_4$ ha^{-1}, which were found at par with 7.5 kg of $FeSO_4$ ha^{-1}.

Keywords: Fenugreek, phosphorus, iron, yield, economics

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is an annual herb and widely distributed throughout the world. This crop belongs to family Leguminosae and sub-family Papilionaceae, the crop is commonly called as *methi* in Hindi. *Trigonella foenum-graecum* plants are semi-erect, tall, moderately branched and have typically yellow grains. Fenugreek is a native of South-Eastern Europe and West Asia. This crop is mainly cultivated during *rabi* season in North India. Rajasthan accounts for over 50.7 percent of India's output (Spice Board of India, 2018) [17]. The average yield of fenugreek under dryland conditions is 10-11 q ha^{-1}. Under good management conditions and using high yielding varieties an average yield of 15-20 q ha^{-1}can be obtained. However, yields have ranged from 15-28 q ha^{-1} (Meena *et al.*, 2013) [12]. Fenugreek is an important seed spice crop of Rajasthan state. Major fenugreek growing districts of Rajasthan are Bikaner, Jodhpur, Churu, Sikar, Jhunjhunu and Nagaur. The supply of phosphorus to legumes is more important than that of nitrogen because, later being fixed by symbiosis with rhizobium bacteria. The beneficial effects of phosphorus on nodulation, growth, yield and general behavior of legume crop have been well established because it plays an important role in root development. Phosphorus application to legumes plays a key role in the formation of energy rich phosphate bonds, phospholipids and for development of root system (Tisdale *et al.*, 1985) [19]. Iron is the most important micronutrient for all crops (Singh *et al.*, 2013) [15]. It plays an important role in synthesis and maintenance of chlorophyll in plant. Iron helps in the formation of chlorophyll and it is an important constituents of the enzyme nitrogenase, which is essential for nitrogen fixation (Yadav *et al.*, 2005) [20]. It has an essential role in nucleic acid metabolism. It activates number of enzymes, including aminolevolinic acid synthetase and coproporphyrinagen oxidase and being a structural component of hemes, hematin and leg hemoglobin (Kumar *et al*., 2009) [9]. Hence, prioritization for management of quality-related problems is important (Yadav and Singh, 2018) [21]. Considering vital importance of this crop and other facts mentioned above a field experiment was carried out to assess the effect of phosphorus and iron on growth, yield attributes, yield and economics of fenugreek under agroclimatic zone IV-a of Rajasthan.

Material and Methods

The field experimentation was implemented at the Agronomy Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, situated at a height of 582.17 meters above mean sea level with 24°35' N latitude and 73°42' E longitude in the south-eastern part of Rajasthan state. The region lies under the Rajasthan's agro-climatic zone IVa (Sub-Humid Southern Plains and Aravalli Hills) hard-rock area (Machiwal *et al.* 2017) [11]. This zone has common place subtropical climatic conditions described by wonderful winters and moderate summer related with high relative humidity during the long periods of July to September. The mean yearly rainfall of this locale is about 600 mm, the majority of which is contributed by south-west rainstorm from July to September. Total rainfall received during crop growing season was 5.60 mm.

The experimental soil has pH 8.0 which was slightly alkaline. However, experimental soil was medium in organic carbon (0.70%), available nitrogen (296.4 kg ha^{-1}) and available phosphorus (19.8 kg ha^{-1}) whereas, availability of potassium in soil was higher *i.e*., 349.8 kg ha^{-1}. The experiment was laid out in factorial randomized block design with four phosphorus levels (control, 20, 40, and 60 kg P_2O_5 ha^{-1}) and four ion levels (control, 5, 7.5, 10kg $FeSO_4$ ha^{-1}), allocated to main and sub plots respectively, and were replicated three times. The seed rate fenugreek was 25 kg ha^{-1}seed. The fenugreek variety "PRM-45" was sown during second week of November. The recommended dose of nitrogen, phosphorous and potash was 40-40-0 kg ha^{-1}, respectively, which was applied through urea, DAP. During the season one third quantity of total nitrogen and whole amount of phosphorous were applied as basal dose at sowing, while remaining quantity of nitrogen was applied in two split of equal quantity at first and second irrigation.

Plant height was recorded at harvest based on five arbitrarily chosen plants. From each plot the plant stature was estimated from the base of the plant to completely opened leaf tip with the assistance of meter scale and the normal plant height was worked out and expressed in centimeter. Pods collected randomly from five plants were threshed, cleaned and total numbers of seeds were counted and the average number of seeds pod^{-1} was recorded. For test weight, 1000 seeds were counted in randomly drawn sample drawn and the weight was recorded in gram.

The produce was kept for sun drying in field for some days and after drying the biological yield was recorded and expressed in kg ha^{-1}. After threshing the bundles from each plot, the grains were cleaned, dried and weighed. The grain yield was expressed in kg ha^{-1}. Harvest index was calculated by dividing the economic yield (grain yield) to the biological yield and expressed in percentage as suggested by Donald and Hamblin (1976) [3].

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1})} \times 100$$

Results and Discussion

Yield and Yield Attributes

Phosphorus

The phosphorus levels had significant effect on plant height. The data in Table 1 indicated that the maximum plant height (93.49 cm) was recorded with the application of 60 kg P_2O_5 ha^{-1} at harvest which was statistically at par with the treatment application of 40 kg P_2O_5 ha^{-1} (91.60 cm). However, the minimum plant height 78.21 cm was obtained under control treatment. The highest seeds pod^{-1} (17.64) was recorded with the treatment 60 kg P_2O_5 ha^{-1}, which was statistically at par with the application of 40 kg P_2O_5 ha^{-1} (17.13). The per cent increase in the number of seeds pod^{-1} with the application of 60 kg $P_2O_5ha^{-1}$was 15.29 per cent as compared to the control (Table 1). Application of increasing levels of P_2O_5 up to 60 kg P_2O_5 ha^{-1}has increased the seed weight of fenugreek crop. The maximum test weight of seeds 12.07 g was recorded with the treatment 60 kg P_2O_5 ha^{-1}, which was statistically at par with the treatment 40 kg P_2O_5 ha^{-1}. The minimum test weight (10.88 g) of fenugreek seeds were recorded with the control, which was 10.93 per cent less than that of maximum test weight obtained with the application of 60 kg P_2O_5 ha^{-1} (Table 1). It was revealed that harvest index become increasing with the increasing levels of P_2O_5 up to 60 kg ha^{-1}. The maximum per cent of harvest index (22.81%) was observed under the application of 60 kg P_2O_5 ha^{-1}, which was statistically at par with 20 and 40 kg P_2O_5 ha^{-1} except the control.

Application of various levels of phosphorus has significantly influenced the seed yield of fenugreek crop. The maximum seed yield (2061 kg ha^{-1}) was produced by the application of 60 kg P_2O_5 ha^{-1}, which was statistically at par with that produced by 40 kg P_2O_5 ha^{-1} (2002 kg ha^{-1}). Data presented in the Table 1 clearly depicts that the maximum haulm yield (6980 kg ha^{-1}) was produced by 60 kg P_2O_5 ha^{-1}, which was statistically at par with the haulm yield (6773 kg ha^{-1}) produced under 40 kg P_2O_5 ha^{-1}. The minimum haulm yield (5687 kg ha^{-1}) was recorded under control treatment, which was 19.09 per cent lower than that of 40 kg P_2O_5 ha^{-1} and 22.73 per cent than the application of 60 kg P_2O_5 ha^{-1}. The maximum biological yield (9040 kg ha^{-1}) was recorded with the application of treatment 60 kg P_2O_5 ha^{-1}, which was statistically at par with the application of 40 kg P_2O_5 ha^{-1} (8775 kg ha^{-1}). However, the minimum biological yield (7080 kg ha^{-1}) was recorded with the control treatment. The yield characters and yield of fenugreek crop was increased due to the application of increased levels of phosphorus fertilization, which increased the soil availability of phosphorus evenly and it is an important nutrient both as a part of many main plant structure compounds and as a catalysis in the conversion of various key biochemical reactions in plants. Phosphorus is noted particularly for its function in absorbing and transforming the sun's energy into useful plant compounds. A critical part of ATP, the "energy currency" of plants, is phosphorus (Halvin *et al*., 2005) [5]. Adequate P levels encourage vigorous root and shoot growth, promote early maturity, increase water use efficiency and grain yield as the Rajasthan is a water scarce state (Kookana *et al.* 2016) [7]. Thus, phosphorus deficiency stunts vegetative growth and grain yield. Because of these above mentioned roles of phosphorus, the growth and yield attributing characters and yields might have been increased. These results are closely in line with the findings of Kumawat and Yadav (2009) [10], (Chandar *et al.* 2012) [2], Kumar *et al.* (2015) [8], Sharma *et al.* (2014) [13], Shukla *et al*. (2017) [14], Sujan *et al.* (2017) [18] and Somdutt *et al*. (2019) [16].

Iron

It is evident from the results presented in Table 1 that application of increasing levels of $FeSO_4$ from control to 10 kg ha^{-1} has significantly improved the various growth and yield attributing characters of the fenugreek and finally improved the grain and haulm yield. The maximum plant height of fenugreek at harvest were observed with the application of 10 kg $FeSO_4$ha^{-1} (90.93 cm), which was statistically at par with the treatment application of 7.5 kg $FeSO_4$ ha^{-1}. The supplementation of iron sulphate has significantly influenced the thousand seed weight, seeds pod^{-1} yield (seed, haulm and biological) of fenugreek crop. The highest test weight was obtained with the application of 10 kg $FeSO_4$ ha^{-1} (11.89g) over the control treatment, which was minimum (11.28 g) under control. Significantly higher number of seeds pod^{-1} (17.64) was found under the application of 10 kg $FeSO_4$ ha^{-1}, which was remained statistically at par with the 7.5 kg $FeSO_4$ ha^{-1} except 5 kg $FeSO_4$ ha^{-1} and control. The maximum seed, haulm and biological yield were 1957, 6650 and 8607 kg ha^{-1} recorded with the application of 10 kg $FeSO_4$ ha^{-1}, which was not differing significantly with 7.5 kg of $FeSO_4$ ha^{-1}. Similar results were also reported by Yadav *et al.* (2012) [22] and Yadav *et al.* (2021) [23].

Table 1: Effect of various levels of phosphorus and iron on growth and yield attributing characters of fenugreek crop

Treatments	Plant height (cm)	Test weight (g)	Seeds pod^{-1}	Yield (kg ha^{-1})			HI %
				Seed	Haulm	Biological	
Phosphorus (kg ha^{-1})							
P_1(Control)	78.21	10.88	15.30	1392	5687	7080	19.55
P_2 (20)	85.72	11.47	16.70	1731	6054	7785	22.21
P_3 (40)	91.60	11.73	17.13	2002	6773	8775	22.80
P_4 (60)	93.49	12.07	17.64	2061	6980	9040	22.81
S.Em±	1.58	0.14	0.24	44	98	109	0.51
CD (*p*= 0.05)	4.58	0.39	0.70	128	283	313	1.46
Iron (kg ha^{-1})							
F_1 (Control)	81.92	11.28	16.14	1568	6106	7674	20.29
F_2(5.0)	85.70	11.19	16.44	1709	6225	7935	21.37
F_3 (7.5)	90.48	11.79	16.96	1952	6513	8465	22.99
F_4 (10)	90.93	11.89	17.23	1957	6650	8607	22.70
S.Em±	1.58	0.14	0.24	44	98	109	0.51
CD (*p*= 0.05)	4.58	0.39	0.70	128	283	313	1.46

Economics

The maximum gross return (Rs. 103373 ha^{-1}) was gained with the application of 60 kg P_2O_5 ha^{-1}, which was statistically at par with the treatment application of 40 kg P_2O_5 ha^{-1} (Rs. 100389 ha^{-1}). Similarly, the maximum net return (Rs. 77993 ha^{-1}) was gained with the application of 60 kg P_2O_5 ha^{-1}, which was statistically at par with the treatment application of 40 kg P_2O_5 ha^{-1} (Rs. 76096 ha^{-1}). The highest benefit cost ratio (3.12) was obtained with the application of 40 kg P_2O_5 ha^{-1}, which was statistically superior over rest of the treatments, followed by the treatment application of 60 kg P_2O_5 ha^{-1} (3.07) and 20 kg P_2O_5 ha^{-1} (2.76). However, the lowest BC ratio (2.28) was obtained with control treatment. The present investigation revealed that the maximum return was obtained with 60 kg P_2O_5 ha^{-1}, and highest benefit-cost ratio was obtained with 40 kg P_2O_5 ha^{-1} (3.12) phosphorus levels (Table 2). The highest gross return (Rs. 98237 ha^{-1}) was gained with the application of 10 kg $FeSO_4$ ha^{-1}, which was statistically at par with the treatment application of 7.5 kg $FeSO_4$ ha^{-1}(Rs. 97611 ha^{-1}). Similarly, highest net return (Rs. 74142 ha^{-1}) was gained with the application of 10 kg $FeSO_4$ ha^{-1}, which was statistically at par with the treatment application of 7.5 kg $FeSO_4$ ha^{-1} (Rs. 73714 ha^{-1}). The highest BC ratio (3.07) was gained with the application of 7.5 kg $FeSO_4$ ha^{-1}, which was statistically at par with the treatment application of 10 kg $FeSO_4$ ha^{-1}(3.06). However, the lowest BC ratio (2.46) was obtained with control treatment. The present investigation revealed that the highest benefit cost ratio was gained with the application of 7.5 kg $FeSO_4$ ha^{-1} (Table 2). This might be due to the higher seed and haulm yield produced by the treatment (Aswal and Yadav 2007) [1]. The results are in line with the findings of Jamal *et al*. (2018) [6] and Gidaganti *et al*. (2019) [4].

From this study it may be concluded that, application of 40 kg P_2O_5 ha^{-1} + 7.5 kg $FeSO_4$ ha^{-1} proved the most proficient in improving the yield of fenugreek crop and also found economically viable treatment combination.

Table 2: Effect of various levels of phosphorus and iron on economics of fenugreek crop

Treatments	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	BC ratio
Phosphorus (kg ha^{-1})			
P_1(Control)	72756	50636	2.285
P_2 (20)	87416	64210	2.765
P_3 (40)	100389	76096	3.129
P_4 (60)	103373	77993	3.070
S.Em±	1805	1805	0.077
CD (*p*= 0.05)	5215	5215	0.222
Iron (kg ha^{-1})			
F_1 (Control)	81031	57726	2.461
F_2(5.0)	87054	63354	2.652
F_3 (7.5)	97611	73714	3.072
F_4 (10)	98237	74142	3.065
S.Em±	1805	1805	0.077
CD (*p*= 0.05)	5215	5215	0.222

References

1. Aswal, Subhash, Yadav KK. Effect of sulphur and zinc on growth, yield, quality and net returns of mustard (*Brassica juncea* (L.) Czern and Coss). Current Agriculture. 2007;31(1-2):127-129.
2. Chandar S, Rawat TS, Lakhawat SS, Yadav KK. Effect of organic manures and biofertilizers on the yield parameters of Gladiolus cv. White prosperity. Ecology, Environment and Conservation. 2012;18(1):91-94.
3. Donald CM, Hamblin J. The biological yield and harvest index of cereals as agronomist and plant breeding criteria. Advance Agronomy. 1976;28:361-404.
4. Gidaganti A, Thomas T, Rao S, David AA. Effect of different levels of micronutrients on crop growth and

yield parameters of green gram (*Vigna radiate* L.) Cv. IPM 02-03. International Journal of Chemical Studies. 2019;7(3):866-869.
5. Halvin JL, Beaton JD, Tisdal SL, Nelson WL. Fertility and Fertilizers. An introduction to nutrient management. Prentice Hall, New Jersey, USA, 2005.
6. Jamal A, Khan MI, Tariq M, Fawad M. Response of mung bean crop to different levels of applied iron and zinc. Journal of Horticulture and Plant Research. 2018;3:13-22.
7. Kookana RS, Maheshwari B, Dillon P, Dave SH, Soni P, Bohra H, *et al*. Groundwater scarcity impact on inclusiveness and women empowerment: Insights from school absenteeism of female students in two watersheds in India, International Journal of Inclusive Education. 2016;20(11):1155-1171. DOI: 10.1080/13603116.2016.1155664
8. Kumar M, Kumar R, Singh PK, Singh M, Yadav KK, Mittal HK. Catchment delineation and morphometric analysis using geographical information system. Water Science and Technology. 2015;72(7):1168-1175.
9. Kumar V, Dwivedi VN, Tiwari DD. Effect of phosphorus and iron on yield and mineral nutrition in chickpea. Annals of Plant Soil Research. 2009;11:16-18.
10. Kumawa RM, Yadav KK. Effect of FYM and phosphorus on the performance of fenugreek (*Trigonella foenum-graecum* L.) irrigated with saline water. Environment and Ecology. 2009;27(2):611-616.
11. Machiwal D, Singh PK, Yadav KK. Estimating aquifer properties and distributed groundwater recharge in a hard-rock catchment of Udaipur, India. Applied Water Science. 2017;7(6):3157-3172.
12. Meena ML, Lata HM, Kumar K. Role of phytosiderophores in iron uptake by plants. Agricultural Science Digest. 2013;33(1):73-76.
13. Sharma S, Sharma Y, Balai CM. Yield attributes and yield of fenugreek (*Trigonellafoenum-graecum* L.) under different levels of phosphorus, molybdenum and inoculation of PSB. Agriculture Update. 2014;9(3):301-305.
14. Shukla RD, Singh A, Verma S, Singh AK, Dubey D, Kumar S. Effect of crop geometry and phosphorus levels on growth and productivity of chickpea (*Cicer arietinum* L.). Journal of Pharmacognosy and Phytochemistry. 2017;6(5):659-661.
15. Singh DP, Yadav KK, Qureshi FM. Available micronutrient status, their relationship with soil physico-chemical properties and content in wheat crop of semi-arid eastern plain zone of Rajasthan. Green Farming. 2013;4:137-142.
16. Somdutt, Dashora LN, Mundra SL, Choudhary J, Choudhary P. Effect of inorganic and organic sources of fertilization on productivity of fenugreek (*Trigonella foenum-graecum* L.) under agroclimatic conditions of Southern Rajasthan. Journal of Pharmacognosy and Phytochemistry. 2019;8(4):1886-1888.
17. Spice Board of India, 2018. Major spice/state wise area and production of spices. Retrieved on February 9, 2021 from www.indianspices.com/statistics.
18. Sujan MHK, Mitoo SMR, Islam F. Effect of phosphorous and sulphur fertilization on vegetative growth of fenugreek (*Trigonella foenum-graecum* L.). International Journal of Development and Sustainability. 2017;6(12):2208-2226.
19. Tisdale SL, Nelson WS, Beaton. Soil Fertility and Fertilizers. Mcmillan Publishers Company, New York, 1985.
20. Yadav BR, Chhipa BR, Yadav KK. Physico-chemical properties of soil as influenced by FYM and iron application under graded levels of alkalinity. Current Agriculture. 2005;29(1-2):91-95.
21. Yadav KK, Singh PK. Prioritization for Management of Groundwater Quality-Related Problems of Rajsamand District of Rajasthan. In: V. P. Singh *et al*. (eds.), Groundwater, Water Science and Technology Library. 2018;76:211-227. https://doi.org/10.1007/978-981-10-5789-2_16
22. Yadav KK, Chandra S, Sharma M, Singh PK, Lakhawat SS. Effect of cyclic use of sewage water on growth, yield and heavy metal accumulation in cabbage. Ecology, Environment and Conservation. 2012;18(1):95-100.
23. Yadav KK, Meena MK, Mali NL. Impact of graded levels of fertility and biofertilizers on yield attributes and yield of mungbean [*Vigna radiata* (L.) Wilczek]. International Research Journal of Humanities and Interdisciplinary Studies. 2021;2(6):280-289.