Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; 10(2): 870-872
Received: 01-01-2021
Accepted: 03-02-2021

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Effect of nutrient management on yield, economics and uptake of pigeonpea (*Cajanus cajan* (L.))

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Abstract
A field experiment entitled "Effect of nutrient management on growth and yield of pigeonpea" was conducted at Agronomy Farm, College of Agriculture, Nagpur. The experiment was designed in randomised block design with three replications and twelve treatments i.e. 100%RDF (25:50:00 kg ha^{-1}) (T_1), 125%RDF (31.5:62:5:00 kg ha^{-1})(T_2), 150%RDF (37.5:75:00 kg ha^{-1})(T_3), 100%RDF + 10 kg S ha^{-1} (T_4), 125%RDF + 10 kg S ha^{-1}(T_5), 150%RDF + 10 kg S ha^{-1}(T_6), 100%RDF + 20 kg S ha^{-1}(T_7), 125%RDF + 20 kg S ha^{-1}(T_8), 150%RDF + 20 kg S ha^{-1}(T_9), 100%RDF + 30 kg S ha^{-1}(T_{10}), 125%RDF + 30 kg S ha^{-1}(T_{11}), 150%RDF + 30 kg S ha^{-1}(T_{12}).
All growth parameters and yield contributing characters such as plant height, number of branches plant, number of pods plant^{-1}, number of seeds pod^{-1}, seed yield kg ha^{-1}, straw yield kg ha^{-1}, and harvest index were significantly influenced by fertilizer application. Maximum values of growth and yield contributing characters were recorded with application of 150% RDF + 30 kg S ha^{-1} and it was at par with 125% RDF + 30 kg S ha^{-1} with also 100% RDF + 30 kg S ha^{-1}. Statistically significant higher seed and straw kg ha^{-1} recorded with application with 100% RDF + 30 kg S kg ha^{-1}, however highest numerical values were recorded with 150% RDF + 30 kg S ha^{-1}. Nutrient uptake by crop was increased significantly with increase in levels of sulphur as well as recommended dose of fertilizer. Total uptake of nutrients was significantly more with application of 150% RDF + 30 kg S ha^{-1}. Application of 150% RDF + 30 kg S ha^{-1} was significantly beneficial for gross monetary returns (Rs 122535 ha^{-1}), net monetary returns (Rs 81485 ha^{-1}) and B:C ratio (2.8) However, application of 100% RDF + 30 kg S ha^{-1} was significantly found to be profitable with gross monetary returns (RS 116263 ha^{-1}), net monetary returns (RS 73363 ha^{-1}) and B:C ratio (2.7). Hence application of 100% RDF + 30 kg S ha^{-1} fertilizer dose is recommended to obtain higher yield with optimum cost over rest of the treatments under study.

Keywords: pigeonpea, fertilizer, yield, economics, uptake

Introduction
Pigeonpea is substantial crop among legumes. It has been identity element as pulse in diet plan of vidarbha. It is widely cultivated over Deccan plateau. Pulses are enriched with nutrient and high protein contentment as daily diet of Indians vegetarians for protein requirements. India yet achieves self-sufficiency in production of pulses. Per capita availability of pulses dwindling from 85g in 1956 to less than 60g at present time. This crop needs overall and better management including adequate nutrient supply. Thus, development if balanced fertilizer schedule and management technology is need of hour to feed the growing population. Among kharif grain legumes, it occupies first place. These crops have wide variations in the morphological characters, root system and nutrient requirements; thereby these crops possess differential capability to utilize plant nutrients from different soil layers, resulting in better use efficiency of the applied nutrient and residual fertility (Singh *et al.,* 2005) [6]. Phosphorus affects seed germination, cell division, flowering, fruiting, synthesis of fat, starch and in fact most biochemical activities. Sulphur had favourable effect on components due to proper partitioning of photosynthetic from source to sink. Sulphur improves the crop growth, nodulation and yield attributes, by regulating the metabolic and enzymatic processes including photosynthesis, respiration and legume (Rao *et al.*, 2003) [3]. Sulphur and Phosphorus have systematic and antagonistic effect with each other on their varying levels of application as well as level of availability in the soil (Gowda *et al*., 1982) [1].

Materials and Methods
A field experiment was conducted during *kharif* season of 2019-20 at the Agronomy research farm, Nagpur, Maharashtra. The soil was clayey in texture, alkaline in reaction and medium in organic carbon, low available nitrogen, low in available phosphorus (19.7 kg/ha), high in

available potassium and low in available sulfurcontent. The rainfall distribution is normal. The rainfall distribution is normal and mean annual precipitation was 1149.7 mm. The maximum and minimum temperature ranged from 25.7 ^{0}C to 35.4 ^{0}C and 11.6 ^{0}C to 25.5 ^{0}C respectively. The crop was rainfed during whole period. The experiment was laid out in a randomized block design with twelve treatments replicated three times. The treatment consisted of three levels viz, 100% recommended dose of fertilizer (RDF), 125% RDF and 150% RDF and three levels of sulphur viz., 0, 10 and 30 kg ha^{-1}. The recommended dose of fertilizer was 25 kg N, 50 kg P_20_5 ha^{-1}. Full dose of fertilizer was applied at sowing time and applied as basal through urea, ammonium phosphate, and bensulf respectively. PKV-Tara variety of pigeonpea was used for experiment purpose. Two hoeing and hand weeding done to keep free from weed infestation. Yield attributes, yield and nutrient uptake of elements were recorded.

Results and Discussion

Yield and yield attributes and economics

Yield parameters like number of pods per plant, seeds per pod and seed yield per plant were significantly affected by application of levels of RDF and sulphur. Application of 150% RDF (37.5:75:00) NPK kg ha^{-1} and sulphur 30kg ha^{-1} recorded maximum values of yield attributes and however it was at par with 125% RDF + 30 kg S ha^{-1} with also 100% RDF + 30 kg S ha^{-1}. Which might be attributed to continued positive influence of treatments on yield attributes. The root growth and development of root was due to availability of nitrogen and phosphorus to crop initially and early nitrogen fixation lead to higher photosynthetic activity and better nodulation resulting to height. Similar findings were also revealed by Sharma *et al*., (2012) [4].

Significant increase in seed yield plant^{-1} due to improved nitrogenage activity and nitrogen fixation which increased dry matter production that is translocated to seed and with application of sulphur various processes such as cell division, flowering and fruiting, water relations that ultimately yielded increase in seed yield plant^{-1} (Punse *et al.*,2018) [2].

Seed yield and straw yield has been significantly influenced and higher with application of 150% RDF (37.5:75:00) NPK kg ha^{-1} and sulphur 30 kg ha^{-1} also found to be at par with 125% RDF + 30 kg S ha^{-1} and 100% RDF + 30 kg S ha^{-1}. The improvement in seed yield with application of phosphorus fertilizers could be ascribed to its pivotal role in roots development, photosynthesis, energy transfer reaction, biological nitrogen fixation processes, again application of sulphur might be shown direct role of sulphur in root inoculation and enzymatic role in zinc and molybdenum in various metabolic processes in pigeon pea showing significance in increasing seed yield, same was observed by Tripathi *et al.* (2008) [7].

Higher values of GMR, NMR and B:C ratio were recorded with application of 150% RDF (37.5:75:00) NPK kg ha^{-1} and sulphur 30kg ha^{-1}. But application of 100% RDF (37.5:75:00) NPK kg ha^{-1} and sulphur 30kg ha^{-1}was found to profitable for obtaining optimum yield.

Table 1: Yield attributes, yield and economics as influenced by various treatments.

Treatments	No. of pods plant^{-1}	No. of seeds pod^{-1}	Seed Yield plant^{-1} (g)	Test weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	GMR (Rs ha^{-1})	NMR (Rs ha^{-1})	B:C ratio
T_1 - 100% RDF (25:50:00 kg ha^{-1})	104.8	3.22	33.47	9.75	1123	3781	77310	35460	1.8
T_2 - 125% RDF (31.25:62.5:00 kg ha^{-1})	110.2	3.31	35.98	9.8	1209	3979	82743	40243	1.9
T_3 - 150% RDF (37.5:75:00 kg ha^{-1})	119.6	3.42	40.7	9.87	1385	4433	94157	51157	2.2
T_4 - 100% RDF + 10 kg S ha^{-1}	106.3	3.27	34.85	9.77	1197	3983	82140	39790	1.9
T_5 - 125% RDF + 10 kg S ha^{-1}	116.4	3.38	38.4	9.83	1309	4263	89402	46402	2.1
T_6 - 150% RDF + 10 kg S ha^{-1}	127.5	3.53	44.96	9.96	1529	4736	103174	59674	2.4
T_7 - 100% RDF + 20 kg S ha^{-1}	112.3	3.34	36.86	9.81	1248	4086	85338	42738	2.0
T_8 - 125% RDF + 20 kg S ha^{-1}	123.4	3.48	43.65	9.91	1456	4637	98913	55663	2.3
T_9 - 150% RDF + 20 kg S ha^{-1}	131.4	3.59	47.58	9.98	1641	5028	110449	66699	2.5
T_{10} - 100% RDF + 30 kg S ha^{-1}	135.6	3.64	49.62	10.01	1733	5227	116263	73363	2.7
T_{11} - 125% RDF + 30 kg S ha^{-1}	138.2	3.68	52.34	10.03	1830	5489	122597	79047	2.8
T_{12} - 150% RDF + 30 kg S ha^{-1}	141.1	3.72	53.52	10.05	1880	5552	125535	81485	2.8
S.E (m) ±	2.77	0.04	1.32	0.09	62.1	136.2	3561	3561	-
C.D at 5%	7.91	0.11	3.91	NS	177.2	367.7	10148	10148	-
G. M.	122.25	3.46	42.73	9.89	1461	4551	990002	58077	2.3

Nutrient uptake by pigeonpea

Application of 150% RDF (37.5:75:00) NPK kg ha^{-1} and sulphur 30 kg ha^{-1} recorded highest uptake of nitrogen, phosphorus, potassium, sulphur. Thus, plant might have developed extensive rooting patterns even under deeper layers and were able to absorb higher quantity of nutrients (Sharma and Abrol 2007) [5].

Table 2: Uptake of nitrogen, phosphorus, potassium, sulphur as influenced by various treatments

Treatments	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium uptake (kg ha^{-1})	Sulphur uptake (kg ha^{-1})
T_1 - 100% RDF (25:50:00 kg ha^{-1})	85.96	17.28	66.06	9.81
T_2 - 125% RDF (31.25:62.5:00 kg ha^{-1})	95.65	19.02	71.43	11.07
T_3 - 150% RDF (37.5:75:00 kg ha^{-1})	113.62	22.33	82.15	13.56
T_4 - 100% RDF + 10 kg S ha^{-1}	93.70	18.71	70.48	10.72
T_5 - 125% RDF + 10 kg S ha^{-1}	106.08	21.04	78.12	12.47
T_6 - 150% RDF + 10 kg S ha^{-1}	125.61	24.80	90.42	15.47
T_7 - 100% RDF + 20 kg S ha^{-1}	100.41	19.84	74.14	11.60
T_8 - 125% RDF + 20 kg S ha^{-1}	120.43	23.72	86.99	14.50
T_9 - 150% RDF + 20 kg S ha^{-1}	135.06	26.78	97.07	16.99
T_{10} - 100% RDF + 30 kg S ha^{-1}	143.63	28.50	102.40	18.04
T_{11} - 125% RDF + 30 kg S ha^{-1}	149.39	30.28	108.43	19.23
T_{12} - 150% RDF + 30 kg S ha^{-1}	156.24	31.16	110.80	19.99
S.E (m) ±	4.68	0.98	3.04	0.72
C.D at 5%	13.31	2.77	8.53	2.02
G. M.	119.06	23.61	86.54	14.45

Conclusion

Application of 100% RDF + 30 kg S ha^{-1} found to be profitable and produced optimum growth and yield attributes as well as optimum seed and straw yield kg ha^{-1}. Application of 150% RDF + 30 kg S ha^{-1} shown maximum uptake of nutrients. Gross monetary returns (Rs ha^{-1}), net monetary returns (Rs ha$^{-1)}$ and B: C ratio was recorded profitable also beneficial with the application of 100% RDF + sulphur 30 kg ha^{-1}.

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