www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 1922-1926

www.thepharmajournal.com
Received: 26-10-2022
Accepted: 29-11-2022

YD Charjan
Agriculture Research Station, Achalpur, Maharashtra, India

K Kharabe
Agriculture Research Station, Achalpur, Maharashtra, India

RS Wankhade
Agriculture Research Station, Achalpur, Maharashtra, India

Corresponding Author:
YD Charjan
Agriculture Research Station, Achalpur, Maharashtra, India

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

YD Charjan, K Kharabe and RS Wankhade

Abstract
A field experiment was conducted at, 21° 10 North latitude and 79° 19 East longitudes with a subtropical climate. The soil was black in colour, fairly deep, well drained clayey in texture, low in nitrogen, low in available phosphorus, high in available potash and low available in sulphur and alkaline in reaction. 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}). Pigeonpea variety PKV-Tara was used as test crop.
The seeds pod, seed yield kg ha^{-1}, straw yield kg ha^{-1}, and harvest index were significantly influenced by fertilizer application. Maximum value of growth and yield contributing character 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}. Highest values of seed yield kg ha^{-1}, straw yield kg ha^{-1}, harvest index was 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 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).

Keywords: Nutrient management, yield, uptake, nutrient, pigeonpea, *Cajanus cajan* L.

Introduction
Globally, pulses are grown in an area of about 85.40 million ha with 87.40 million tons production. The average productivity of country is about 814 kg ha^{-1} against average global productivity of 1023 kg ha^{-1}. To make nation self-sufficient in pulses, productivity levels of pulses need to be increase from 598 kg ha^{-1} to 1200 kg ha^{-1} by 2020 (Ali and Kumar., 2005) [1]. The productivity of pulses increased to 13% at 814 kg ha^{-1} during 2017-18 from the level of 743 kg ha^{-1} during 2014-15. Madhya Pradesh contributes highest in area with 7.48 million ha and production with 8.11 million tons, whereas Maharashtra ranks third with area 4.35 million ha and production 3.30 million tons. (Anonymous, 2018) [2]

Pigeonpea is short lived perennial shrub that is traditionally cultivated as annual crop in developing countries. Among kharif grain legumes, it occupies first place. These crops have wide variations in the morphological characters, root system and nutrient requirements; thereby this crop 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) [9].

Fertilizers, a key component of management influence the growth, development and yield. As full plant expression in pigeon pea can be achieved with proper and definite fertilizer schedule. Growth and yield determination of pigeon pea are favorably influenced by a recommended dose of nitrogen, phosphorus and sulphur with respective contentment source. Sulphur is now known as fourth major nutrient in addition to nitrogen, phosphorus and potassium. Sulphur is involved in the chlorophyll formation and encourages vegetative growth. Sulphur involved various oxidizing metabolism in soil and plant nutrition also required for enzymatic action. It is also involved in synthesis of methionine, cysteine, cysteine vitamins like thiamine and biotin. Sulphur is mostly required by oilseed crops and secondly by legumes. Nitrogen is an essential element for structure of chloroplast and in the process of photosynthesis in leaves, has a direct role for production of material grain filling.

Its productivity is very low due to poor soil fertility especially phosphorus and sulphur. Phosphorus affects seed germination, cell division, flowering, fruiting, synthesis of fat, starch and in fact most biochemical activities. 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) [4]

Material and Methods

The present experiment was conducted during *kharif* season of 2019-2020 at College of Agriculture, Nagpur, (Maharashtra), Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The topography of experimental plot was leveled and the soil was medium black in color, fairly deep, well drained and clayey in texture. Soil samples from 0 to 30 cm strata drawn randomly from several spots before laying out experiment and a composite sample was prepared and analyzed for estimation of various physico-chemical properties. The soil of experimental plot was clayey in texture, poor in available nitrogen, medium in available phosphorus, high in available potash and poor available sulphur content in soil and alkaline in reaction. Nagpur is located at latitude at 20° 10' north and longitude 79° 19' east at the elevation of 321 m above mean sea level (MSL) and lies under sub-tropical zone with assured but variable rainfall in *Kharif* season, normally cool *rabi* and associated with hot and dry summer. The total rainfall during crop growth period from July, 2019 to February, 2020 was 1149.7 mm and there are 48 rainy days. Maximum temperature was ranging from 35.4 ^{0}C and Minimum temperature was 11.6 ^{0}C. The experiment was laid out in Randomised Block Design replicated thrice. There were twelve treatments combination.

The seeds of Pigeonpea variety PKV-TARA were obtained from Section of Agronomy, College of Agriculture Nagpur. Before sowing the seed was treated with *rhizobium* and PSB culture @ 25 g kg^{-1} of seed. Pigeonpea was sown on 16th July, 2019. The sowing was done by dibbling with 2 seeds per hill at a distance of row to row 90 cm and plant to plant 30 cm (90 cm x 30 cm) at about 5.0 cm depth. The emergence of seedling was started 4 days after sowing and completed by 8-10 days. The complete recommended dose of fertilizer 25 kg N ha^{-1}, 50 kg P_2O_5 ha^{-1} applied to the experimental after sowing as basal application through urea and DAP in granular form, and sulphur through bensulf. Data collected during the course of investigation were statistically analyzed by adopting standard procedure by Panse and Sukhatme (1985) [7]. The critical difference (CD) was worked out at 5% level significance. For the treatment comparison, where ever the "F'' test revealed significant, the treatment effects are presented by preparing the table of mean of important character with the appropriate standard error of mean and critical difference (CD) value.

Results and Discussion

Significantly more no. of pods plant^{-1} was observed under the treatment receiving 150% RDF + 30 kg sulphur ha^{-1} produced maximum no. of pods plant^{-1} (141.1) and it was statistically at par with 125% RDF + 30 sulphur kg ha^{-1} (138.24) and 100% RDF + 30 kg sulphur ha^{-1} (136.66). Increasing levels of sulphur from 0 to 30 kg ha^{-1} with increased levels of RDF increased the no. of pods of plant ranging from 104.89 to 141.1 showing highest value i.e. 141.1 in treatment receiving 150% RDF + 30 kg sulphur ha^{-1}.The lowest mean no. of branches of plant was recorded in 100% RDF is 104.89. All these higher levels produced significantly more pods per plant than other remaining treatments.

The favorable effect of phosphorus application on above character was mainly due to its primary role in photosynthesis by way of rapid energy transfer and thereby increased the availability of photosynthesis. These results increased in total biomass production and their translocation in plant parts. Supply of sulphur in adequate and appropriate amount also helps in flower primordial initiation. The increase no. of pods of pigeon pea might be due to the availability of available forms of SO_4 during all the growth stages with applied elemental sulphur as reported by Goud *et al*., (2010) [3].

The no. of seeds pod^{-1} differed significantly among the treatments. The treatment receiving 150% RDF + 30 kg sulphur ha^{-1} produced maximum no. of seeds pod^{-1} (3.72) and it was statistically at par with 125% RDF + 30 sulphur kg ha^{-1} (3.69) and 100% RDF + 30 kg sulphur ha^{-1} (3.64). Increasing levels of sulphur from 0 to 30 kg ha^{-1} with increased levels of RDF increased the no. of seeds pod^{-1} ranging from 3.22 to 3.72 showing highest value i.e. 3.72 in treatment receiving 150% RDF + 30 kg sulphur ha^{-1}. The lowest no. of seeds pod^{-1} was recorded in 100% RDF is (3.22). All these higher levels produced significantly more no. of seeds pod^{-1} than other remaining treatments. Every increase in phosphorus as well as sulphur levels brought about significant increase in no. of seeds might be due to better assimilation of photosynthates similar results found by Kumar *et al.* (2012) [5].

Table 1: Number pods plant^{-1}, no. of seed pod^{-1}, seed yield plant^{-1} (g) and test weight (g) as influenced by various treatments.

Treatment	No. of pods plant^{-1}	No. of seeds pod^{-1}	Seed Yield plant^{-1} (g)	Test weight (g)
T_1 - 100% RDF (25:50:00 kg ha^{-1})	104.89	3.22	33.47	9.75
T_2 - 125% RDF (31.25:62.5:00 kg ha^{-1})	110.20	3.31	35.98	9.80
T_3 - 150% RDF (37.5:70:00 kg ha^{-1})	119.65	3.42	40.70	9.87
T_4 - 100% RDF + 10 kg S ha^{-1}	106.30	3.27	34.85	9.77
T_5 - 125% RDF + 10 kg S ha^{-1}	116.40	3.38	38.40	9.83
T_6 - 150% RDF + 10 kg S ha^{-1}	127.50	3.53	44.96	9.96
T_7 - 100% RDF + 20 kg S ha^{-1}	112.30	3.34	36.86	9.81
T_8 - 125% RDF + 20 kg S ha^{-1}	123.40	3.48	43.65	9.91
T_9 - 150% RDF + 20 kg S ha^{-1}	131.40	3.59	47.58	9.98
T_{10} - 100% RDF + 30 kg S ha^{-1}	135.66	3.64	49.62	10.01
T_{11} - 125% RDF + 30 kg S ha^{-1}	138.24	3.68	52.34	10.03
T_{12} - 150% RDF + 30 kg S ha^{-1}	141.10	3.72	53.52	10.05
S.E (m) ±	2.77	0.04	1.32	0.09
C.D at 5%	7.91	0.11	3.91	NS
G. M.	122.25	3.46	42.73	9.89

The seed yield plant^{-1} differed significantly among the treatments. The treatment receiving 150% RDF + 30 kg sulphur ha^{-1} produced maximum seed yield plant^{-1} (53.52) and it was statistically at par with 125% RDF + 30 sulphur kg ha^{-1} (52.34) and 100% RDF + 30 kg sulphur ha^{-1} (49.62). Increasing levels of sulphur from 0 to 30 kg ha^{-1} with increasing levels of RDF increased the seed yield plant^{-1} ranging from 33.47 to 56.92 showing highest value i.e. 56.92 in treatment receiving 150% RDF + 30 kg sulphur ha^{-1}.The lowest seed yield plant^{-1} was recorded in 100% RDF is (33.47). All these higher levels produced significantly more seed yield plant^{-1} than other remaining treatments. Application of phosphorus produced significant role in increased photosynthesis efficiency and thus increased the availability of photosynthesis resulted in biomass production which ultimately increased seed yield plant^{-1} was confirmed by Ali *et al*., (2005) [1] in mung bean. Significant increase in seed yield plant^{-1} due to improved nitrogenase activity and nitrogen fixation which increased dry matter production that is translocated to seed production 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) [8]

The test weight differed significantly among the treatments. The treatment receiving 150% RDF + 30 kg sulphur ha^{-1} produced maximum test weight (10.05 g). The lowest test weight was recorded in 100% RDF is (9.75 g). All these higher levels produced significantly more test weight than other remaining treatments. The seed yield differed significantly among the treatments. The treatment receiving 150% RDF + 30 kg sulphur ha^{-1} produced maximum seed yield (1880 kg ha^{-1}) and it was statistically at par with 125% RDF + 30 sulphur kg ha^{-1} (1830 kg ha^{-1}) and 100% RDF + 30 kg sulphur ha^{-1} (1733 kg ha^{-1}). Increasing levels of sulphur from 0 to 30 kg ha^{-1} with increased levels of RDF increased the seed yield ranging from 1123 kg ha^{-1} to 1880 kg ha^{-1} showing highest value i.e. 1880 kg ha^{-1} in treatment receiving 150% RDF + 30 kg sulphur ha^{-1}.The lowest seed yield was recorded in 100% RDF is (1123 kg ha^{-1}). All these higher levels produced significantly more seed yield than other remaining treatments.

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) [12].

Table 2: Mean seed yield (kg ha^{-1}), straw yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index (%) as influenced by various treatments.

Treatment	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
T_1 - 100% RDF (25:50:00 kg ha^{-1})	1123	3781	4945	22.71
T_2 - 125% RDF (31.25:62.5:00 kg ha^{-1})	1209	3979	5172	23.36
T_3 - 150% RDF (37.5:70:00 kg ha^{-1})	1385	4433	5797	23.88
T_4 - 100% RDF + 10 kg S ha^{-1}	1197	3983	5210	22.36
T_5 - 125% RDF + 10 kg S ha^{-1}	1309	4263	5562	23.54
T_6 - 150% RDF + 10 kg S ha^{-1}	1529	4736	6227	24.54
T_7 - 100% RDF + 20 kg S ha^{-1}	1248	4086	5309	23.51
T_8 - 125% RDF + 20 kg S ha^{-1}	1456	4637	6043	24.09
T_9 - 150% RDF + 20 kg S ha^{-1}	1641	5028	6639	24.17
T_{10} - 100% RDF + 30 kg S ha^{-1}	1733	5227	6921	25.04
T_{11} - 125% RDF + 30 kg S ha^{-1}	1830	5489	7269	25.17
T_{12} - 150% RDF + 30 kg S ha^{-1}	1880	5552	7402	25.40
S.E (m) ±	62.18	136.2	183.5	_
C.D at 5%	177.24	367.74	524.41.27	_
G. M.	1461	4551	6041	23.98

The beneficial effect of phosphorus on production of grains was observed investigation higher seed yield was obtained by application of 80 kg P_2O_5 ha^{-1} similar findings was reported by Kumar *et al*., (2012) [5].

The straw yield differed significantly among the treatments. The treatment receiving 150% RDF + 30 kg sulphur ha^{-1} produced maximum straw yield (5552 kg ha^{-1}) and it was statistically at par with 125% RDF + 30 sulphur kg ha^{-1} (5489 kg ha^{-1}) and 100% RDF + 30 kg sulphur ha^{-1} (5227 kg ha^{-1}). Increasing levels of sulphur from 0 to 30 kg ha^{-1} with increasing levels of RDF increased the straw yield ranging from 3781 kg ha^{-1} to 5552 kg ha^{-1} showing highest value i.e. 5552 kg ha^{-1} in treatment receiving 150% RDF + 30 kg sulphur ha^{-1}. Lowest straw yield was recorded in 100% RDF is (3781 kg ha^{-1}). All these higher levels produced significantly more straw yield than other remaining treatments. Improvement in straw yield might have resulted from favourable influence of sulphur on plant height, branching and leaf area index and efficient and greater partitioning of metabolites and adequate translocation of nutrients to developing reproductive structures (Singh and Ali, 1994) [13].

The biological yield differed significantly among the treatments. The treatment receiving 150% RDF + 30 kg sulphur ha^{-1} produced maximum biological yield (7402 kg ha^{-1}) and it was statistically at par with 125% RDF + 30 sulphur kg ha^{-1} (7269 kg ha^{-1}) and 100% RDF + 30 kg sulphur ha^{-1} (6921 kg ha^{-1}). Increasing levels of sulphur from 0 to 30 kg ha^{-1} with increased levels of RDF increased the biological yield ranging from 4945 kg ha^{-1} to 7402 kg ha^{-1} showing highest value i.e. 7402 kg ha^{-1} in treatment receiving 150% RDF + 30 kg sulphur ha^{-1}. Lowest biological yield was recorded in 100% RDF is (4945 kg ha^{-1}). All these higher levels produced significantly more biological yield than other remaining treatments.

The harvest index differed significantly among the treatments. The treatment receiving 150% RDF + 30 kg sulphur ha^{-1} recorded maximum harvest index 25.40% over 125% RDF + 30 sulphur kg ha^{-1} is 25.0% and 100% RDF + 30 kg sulphur ha^{-1} is 24.9%. Increasing levels of sulphur from 0 to 30 kg ha^{-}

[1] with increased levels of RDF increased the harvest index ranging from 22.71% to 25.40% showing highest value i.e. 25.40% in treatment receiving 150% RDF + 30 kg sulphur ha^{-1} Lowest harvest index was recorded in 100% RDF is (22.71%). All these higher levels produced significantly more harvest index than other remaining treatments. The use chemical fertilizers improve harvest index due to greater availability of nitrogen, phosphorus and sulphur in early growth stages for fast developments of roots and translocation as well as assimilation of foods that might made harvest index of T_{12} found to be significantly superior over other treatment, similar results reported by Kumar *et al.* (2014) [6].

At harvest available nitrogen in soil was significantly influenced due to application of 150% RDF + 30 kg sulphur ha^{-1} significantly and recorded higher available nitrogen (231.65 kg ha^{-1}) over 125% RDF + 30 kg sulphur ha^{-1} and 100% RDF + 30 kg sulphur ha^{-1}.

Table 3: Final soil fertility status as influenced by various treatments

Treatment	Available Nitrogen kg ha^{-1}	Available Phosphorus kg ha^{-1}	Available Potassium kg ha^{-1}	Available Sulphur mg kg^{-1}
T_1 - 100% RDF (25:50:00 kg ha^{-1})	203.38	14.20	390.12	13.24
T_2 - 125% RDF (31.25:62.5:00 kg ha^{-1})	207.55	15.35	395.04	14.19
T_3 - 150% RDF (37.5:70:00 kg ha^{-1})	217.30	17.86	405.60	16.07
T_4 - 100% RDF + 10 kg S ha^{-1}	205.90	14.77	391.18	13.85
T_5 - 125% RDF + 10 kg S ha^{-1}	212.30	16.35	399.21	16.81
T_6 - 150% RDF + 10 kg S ha^{-1}	222.42	18.92	412.56	17.32
T_7 - 100% RDF + 20 kg S ha^{-1}	209.31	15.87	397.70	14.93
T_8 - 125% RDF + 20 kg S ha^{-1}	219.14	18.28	408.10	18.28
T_9 - 150% RDF + 20 kg S ha^{-1}	226.42	20.18	417.02	19.13
T_{10} - 100% RDF + 30 kg S ha^{-1}	215.63	17.31	403.32	15.78
T_{11} - 125% RDF + 30 kg S ha^{-1}	225.30	19.34	414.32	18.21
T_{12} - 150% RDF + 30 kg S ha^{-1}	231.65	21.57	422.30	19.76
S.E (m) ±	1.85	0.41	1.83	0.35
C.D at 5%	5.27	1.17	4.96	1.01
G. M.	216.46	17.53	404.98	16.46
Initial	201.4	13.35	393.31	12.44

At harvest available phosphorus in soil was significantly influenced due to application of 150% RDF + 30 kg sulphur ha^{-1} significantly and recorded higher available phosphorus (21.57 kg ha^{-1}) over 125% RDF + 30 kg sulphur ha^{-1} and 100% RDF + 30 kg sulphur ha^{-1}. At harvest available potassium in soil was significantly influenced due to application of 150% RDF + 30 kg sulphur ha^{-1} significantly and recorded higher available potassium (422.30 kg ha^{-1}) over 125% RDF + 30 kg sulphur ha^{-1} and 100% RDF + 30 kg sulphur ha^{-1}. At harvest available sulphur in soil was significantly influenced due to application of 150% RDF + 30 kg sulphur ha^{-1} significantly and recorded higher available sulphur (21.61 kg ha^{-1}) over 125% RDF + 30 kg sulphur ha^{-1} and 100% RDF + 30 kg sulphur ha^{-1}.

Table 4: Gross monetary returns (GMR) (Rs ha^{-1}) and net monetary returns (NMR) (Rs ha^{-1}) and Benefit: Cost (B:C) ratio of pigeon pea as influenced by various treatments.

Treatment	COC (Rs ha^{-1})	GMR (Rs ha^{-1})	NMR (Rs ha^{-1})	B: C ratio
T_1 - 100% RDF (25:50:00 kg ha^{-1})	41850	77310	35460	1.8
T_2 - 125% RDF (31.25:62.5:00 kg ha^{-1})	42500	82743	40243	1.9
T_3 - 150% RDF (37.5:70:00 kg ha^{-1})	43000	94157	51157	2.2
T_4 - 100% RDF + 10 kg S ha^{-1}	42350	82140	39790	1.9
T_5 - 125% RDF + 10 kg S ha^{-1}	43000	89402	46402	2.1
T_6 - 150% RDF + 10 kg S ha^{-1}	43500	103174	59674	2.4
T_7 - 100% RDF + 20 kg S ha^{-1}	42600	85338	42738	2.0
T_8 - 125% RDF + 20 kg S ha^{-1}	43250	98913	55663	2.3
T_9 - 150% RDF + 20 kg S ha^{-1}	43750	110449	66699	2.5
T_{10} - 100% RDF + 30 kg S ha^{-1}	42900	116263	73363	2.7
T_{11} - 125% RDF + 30 kg S ha^{-1}	43550	122597	79047	2.8
T_{12} - 150% RDF + 30 kg S ha^{-1}	44050	125535	81485	2.8
S.E (m) ±	-	3561	3561	_
C.D at 5%	-	10148	10148	_
G. M.	43025	990002	58077	2.3

The maximum gross monetary return (125535 Rs ha^{-1}), net monetary return (81485 Rs ha^{-1}) and B:C ratio (2.8) were recorded by treatment receiving 150% RDF + 30 kg sulphur Rs ha^{-1}. Application of 150% RDF + 30 kg sulphur Rs ha^{-1} recorded highest gross and net monetary returns and it is statically at par with 125% RDF + 30 sulphur kg Rs ha^{-1} and 100% RDF + 30 sulphur kg Rs ha^{-1}. Highest B:C ratio was recorded with 150% RDF + 30 kg sulphur Rs ha^{-1}. Similar results were found by Singh *et al.* (2016) and Kumar *et al.* (2014) [6].

References

1. Ali M, Kumar S. Yet to see a breakthrough In: Survey of Indian Agriculture. The Hindu, Chennai, India; c2005. p.

54-56.
2. Anonymous. Annual report, Directorate of pulse development; c2017-18.
3. Goud VV, Kale HB. Productivity and profitability of pigeon pea under different sources of nutrients in rainfed condition of central India. J Food Legumes. 2010;23:212-217.
4. Gowda CLL, Kaul AK. Pulses in Bangladesh, BARI and FAO publication; c1982. p. 338-407.
5. Kumar S, Tomar J, Giri R, Kumar A, Singh S. Effect of phosphorus and sulphur on growth and yield of pigeon pea (C*ajanus cajan)*, Adv. Res. J Crop Improv. 2012;3(1):50-52.
6. Kumar S, Kumar S, Singh O, Singh BP. Effect of phosphorus and sulphur fertilization on productivity and nutrient uptake of pigeonpea (*Cajanus cajan*). Ann. Agric. Res. New Series. 2014;35(1):54-57.
7. Panse VG, Sukhatme PV. Statistical method for Agriculture workers. 4th Edn. ICAR, New Delhi; c1985. p. 145-156.
8. Punse M, Pagar PC, Rangari P, Siddagangaamma KR. Effect of phosphorus and sulphur on growth, yield and economics of green gram. J Soils and Crops. 2018;28(2):402-406.
9. Singh YP, Sharma SC, Moon JS. Effect of sulphur on yield and its uptake in groundnut (Arachis hypogea) and its residual effect on succeeding wheat (*Triticum aestivum*). Ind. J Agron. 2005;50:116-118.
10. Singh PK, Subodh Kumar, Arvind Kumar, Sachin Kumar. Effect of phosphorus and sulphur fertilization on growth, yield, nutrient uptake, their recovery and use efficiency by pigeon pea (*Cajanus cajan* (L.) Millisp) genotypes. Asian J Biol. Life Sci. 2014;32(1-2):55-61.
11. Singh SK, Kumari N, Singh CS, Karmakar S, Puran AN. Performance of hybrid pigeon pea (*Cajanus cajan* L.) as influenced by nutrient and lime levels under rainfed condition of Jharkhand. The Bioscan. 2016;11(1):227-330.
12. Tripathi CM, Vishwaskarma SP. Effect on yield and economics of pigeon pea under rainfed condition. Progre. Res. 2008;3(2):160-162.
13. Ali A, Kalloo CL, Singh UB. Preventing lost circulation in severely depleted unconsolidated sandstone reservoirs. SPE Drilling & Completion. 1994 Mar 1;9(01):32-38.