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Research Paper

Yield, nutrient uptake and economics of pigeonpea (*Cajanus cajan* L.) genotypes under nutrient supply levels in dryland *Alfisols* of Karnataka

M.R. UMESH[1], M.A. SHANKAR[2] AND N. ANANDA[3]

University of Agricultural Sciences, GKVK, Bengaluru, Karnataka 560 065

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ABSTRACT

A field experiment was conducted at Bengaluru to study the impact of graded levels of nutrients on yield, yield attributes, nutrient uptake and economic returns of pigeonpea {*Cajanus cajan* (L.) Millsp.} genotypes during *kharif* 2006 and 2007. Experiment was laid out in factorial RCBD design in which fifteen NPK combinations along with or without zinc and sulphur were tested on 'TTB 7' and 'BRG 2' pigeonpea genotypes. Significant increase in grain (1.76t/ha) and stalk yields (5.86 t/ha) of pigeonpea was recorded after application of 50, 75 and 100 kg NPK/ha along with common dose of Zn (12.5 kg/ha) and S (10 kg/ha). The increase in grain yield was attributed to improvement in number of pods/plant, test weight and grain yield/plant. Combined nutrient uptake by grain and stalk was significantly higher in 50, 100 and 75 kg NPK along with Zn and S as compared to individual application. Interaction effect of pigeonpea genotypes and fertilizer levels was significant on seed yield and nutrient uptake. Higher yield has resulted in higher net income (25.52×10^3₹/ha) and B: C ratio (3.21) over other treatment combinations. The results showed that application of 50:100:75:10:12.5 kg N:P:K:S:Zn /ha is essential for obtaining high grain yield as well as net returns of pigeonpea variety 'BRG 2'.

Key words **:** *Alfisols*, Graded level of nutrient, Genotypes, Pigeonpea, Sulphur, Zinc

Pulses are important source of protein in the diets of a large section of vegetarian population in the developing countries in general and India in particular. Among the many cultivated legumes, pigeonpea is the most important rainfed pulse crop of Karnataka grown over an area of 3.58 lakhs hectare with a productivity of 991 kg/ha. More than 90% of pigeonpea cropped area is under rainfed characterized by severe drought and biotic stresses leading to lower productivity. Indeed, there is enormous yield gap of pigeonpea between achievable and its genetic potential owing to high yielding genotypes and hybrids. In recent year's release of new short duration dwarf genotypes of pigeonpea helps in achieving higher harvest index.

The development of modern agricultural technologies hence attracted the attention of higher levels of nutrients owing to adoption of high yielding genotypes, intensive cropping, changed cropping pattern *etc*., (Deshbhratar *et al.,* 2010). Among various reasons for low productivity one finds the role of nutrient supply in pulses of paramount importance. Imbalanced nutrients use especially NPK and limited micronutrients have created concern in India as it may affect overall pulse productivity. Response of pigeonpea to applied phosphorus (P) and potassium (K) was higher than nitrogen (N). In addition to major nutrients, smaller quantities of secondary and micronutrients such as sulphur (S) (Srinivasarao *et al.,* 2001) and zinc (Zn) (Dube *et al*., 2001) do enhance the yield as well as quality of pigeonpea. Further, combined application of major nutrients with sulphur (Deshbhratar *et al.,* 2010) or zinc (Shankaralingappa *et al.,* 2000; Puste and Jana, 1995) resulted in higher yield and quality of pigeonpea. The present study was undertaken to evaluate the effect of graded levels of nutrients along with S and Zn on pigeonpea genotypes in rainfed *Alfisols* of Karnataka.

MATERIALS AND METHODS

A field experiment was conducted at Bengaluru (77^0 35' E, 120 58' N, 930 m) Karnataka, having sub-tropical and warm (18–28.4°C) climate throughout the growing season. The average annual rainfall of the station is 927 mm distributed in 62 rainy days (>2.5mm). The total recorded rainfall in 2006 and 2007 was 704.2 mm and 889 mm, respectively, which was 24 and 5 % lower than normal rainfall distributed in 41 and 59 rainy days. The rainfall had profound impact on grain yield of pigeonpea in 2006. The

[1]**Corresponding author Email:** mruagron@rediffmail.com; mrumeshagri@gmail.com

[1]Assistant Professor of Agronomy, UAS, Raichur; [2]Dean (Agri.), COA, Hassan; [3]Senior Surveillance, DWSRC, Hebbal, UAS, Bangalore

soil fertility improvement after first year of experimentation may be due to legume effect and higher doses of fertilizers.

The experiment was conducted in fixed plots in both years of study. The experimental soil was sandy clay loam in texture, slightly acidic in reaction (pH 6.7), médium in available N (220 kg/ha), P (30 kg/ha) and K (285 kg/ha). The land was kept fallow in the previous season before first year trial. The genotypes selected for the trial were released by University of Agricultural Sciences, Bangalore suitable for rainfed areas of the region and resistant to fusarium wilt and sterility mosaic diseases. Both the genotypes of pigeonpea were planted at 90 cm row spacing with 30 cm intra-row spacing (37,037 plants/ha) on 15 August, 2006 and 30 July, 2007. Individual plot size was 4.8 × 3.0 m (14.4m^2) planted in E-W direction. Two grains/hill were hand dibbled in furrows and after 15 days plants were thinned out to maintain required plant population. Grains were inoculated with biofertilizers (*Rhizobium* spp.) and PSB (*Bacillus polymyxa*). Regular plant protection measures were followed to control pest and diseases. Crop received no irrigation throughout the cropping period. The other crop management practices were performed as per the standard recommendation of the region. Harvesting of 'BRG 2' and 'TTB 7' was done at 165 and 180 days after planting, respectively.

The experiment was laid out in factorial randomized complete block design with three replications. The main factor consists of two pigeonpea genotypes 'TTB 7' and 'BRG 2' and second factor with fifteen nutrient levels *viz*., $P_{75}K_{50}$SZn(-N), $N_{25}P_{75}K_{50}$SZn, $N_{37.5}P_{75}K_{50}$SZn, $N_{50}P_{75}K_{50}$SZn, $N_{37\cdot5}K_{50}$SZn(-P), $N_{37.5}P_{50}K_{50}$SZn, $N_{37.5}P_{100}K_{50}$SZn, $N_{37.5}P_{75}$SZn(-K), $N_{37.5}P_{75}K_{25}$SZn, $N_{37.5}P_{75}K_{75}$SZn, $N_{50}P_{100}K_{75}$SZn, $N_{37.5}P_{37.5}K_{37.5}$S(-Zn), $N_{37.5}P_{37.5}K_{37.5}$Zn(-S), $N_{25}P_{50}K_{25}$SZn and $N_{25}P_{50}K_{25}$. The nutrients were applied in the form of urea, single super phosphate, muriate of potash, elemental sulphur and zinc sulphate fertilizers for NPKS and Zn respectively. Recommended dose of fertilizers for pigeonpea was applied as per the recommendation. For all treatments, 10 kg of elemental sulphur and 12.5 kg zinc sulphate were applied at the time of planting except in $N_{37.5}P_{37.5}K_{37.5}$S(-Zn) and $N_{37.5}P_{37.5}K_{37.5}$Zn (-S) treatments. Except nitrogen entire quantity of all the nutrients were applied at the time of planting.

Agronomic data collected include pods/plant, number of grains/pod, 100 grain weight and grain yield/plant at final harvest of the crop. Five plants were harvested randomly to record yield components and biomass production per plant. The plants from net plot area (8.64 m^2) were used for estimation of grain and stalk yield of pigeonpea and data was converted into per hectare basis. Plant samples were air dried before drying in forced-air oven set at 70^{o}C for 72 hours. Oven dried samples were ground in a Willeymill to pass through 2 mm sieve. Duplícate sub samples and grain were analysed for N, P, K, S and Zn concentrations using standard procedures. Nutrient uptake per hectare was calculated by multiplying respective nutrient concentration into grain and stover and yield/ha. Economic returns of the trial was worked out based on the prevailing market prices of input and outputs. The experimental data were analysed statistically by following Fischer's method of analysis of variance and procedure given by Gomez and Gomez (1984). F–test was significant at P=0.05 the results have been compared among treatments based on critical difference at same level of significance.

RESULTS AND DISCUSSION

Yield attributes

Short duration dwarf pigeonpea 'BRG 2' produced higher pods/plant (20%) and grain yield/plant (28%) over 'TTB 7' and no difference in grains/pod. Test weight was significantly higher in 'BRG 2'. These variations in yield attributes of pigeonpea genotypes may be attributed to inherent yield potential as influenced by genetic composition and graded nutrients application. Puste and Jana (1995) and Shankaralingappa *et al.* (1999) reported variation in yield and yield attributes under different nutrient application rates.

The number of pods/plant and grain yield/plant of pigeonpea genotypes increased significantly under higher nutrient application rates. Application of $N_{50}P_{100}K_{75}S_{10}$ and $Zn_{12.5}$ has resulted in more number of pods/plant and grain yield/plant as compared to other levels. With the increased N application rate upto 50 kg/ha significant increase in number of pods/plant and grain yield/plant was recorded (Table 1). Application of P increased from 0 to 50, 75 and 100 kg/ha the corresponding increase in grain yield/plant was 11, 31 and 39 % respectively over control. With respect to K application graded levels from 0 to 25, 50 and 75 kg/ha has resulted in improved grain yield per plant to the tune of 26, 32 and 49% respectively over control. Significantly higher grain yield/plant was recorded when S and Zn applied along with NPK and increase was of the order of 17 and 8% higher over control respectively. Individual grain weight was also increased due to graded NPK, S and Zn application. The maximum number of grains/plant, grain yield/plant and test weight of rainfed pigeonpea under graded levels of P and S with common N dose was also reported by Deshbhratar *et al.* (2010).

Grain and stalk yield

Significant difference in yield was observed between pigeonpea genotypes under graded levels of nutrient application (Table 1). 'BRG 2' produced significantly higher grain yield (10%) over 'TTB 7'. The consistant difference in grain yield was observed in both 2006 and 2007. But 'TTB 7' produced significantly higher stalk yield (12.4%) over 'BRG 2'. Poor grain yield and high stalk yield may resulted in lower harvest index (0.2). Relatively longer crop growth period and inherent capacity of 'TTB 7'coupled with graded nutrient supply was responsible for lower harvest index. The genotypic variation for yield and harvest index under different nutrient supply levels was also reported by Shankaralingappa *et al.* (2000) and Natarajan *et al.* (1998).

Application of graded levels of NPK fertilizers along with S and Zn had significantly influence on grain and stalk yield of pigeonpea (Table1). Results pooled over two years has indicated that increased quantity of N application from 25 to 50 kg/ha, P from 50 to 100 kg/ha and K from 25 to 75 kg/ha grain yield was increased to an extent of 34, 22 and 20%, respectively. Application of 10 kg S/ha was significantly improved the pigeonpea grain yield (12%) as compared to no S. Further, combined application of S and Zn resulted in 22% higher grain yield over control. Interaction effect of pigeonpea genotypes and nutrient levels had significant influenceongrain and stalk yield. 'BRG 2' under graded levels of fertilizers recorded significantly higher grain and stalk yieldsas compared to 'TTB 7' and lower fertilizer rates. However, the higher response to applied fertilizers can be realized during sufficient rainfall year. Relatively lower pigeonpea yield was recorded in 2006 due to low rainfall in terms of quantity and distribution. Extent of grain yield reduction in 2006 over 2007 due to low soil moisture was 13% with nutrient levels and 12% of pigeonpea varieties.

Interaction of genotypes and nutrient levels was significant for both grain and stalk yields (Table 2). Application of $N_{50}P_{100}K_{75}$SZn has significant influence on seed yield in 'BRG 2' (1.95 t/ha) and stalk yield (6.34 t/ha) in TTB-7. Significantly lower seed and stalk yield were recorded by application of $N_{25}P_{50}K_{25}$ without S and Zn. The increased levels of NPK fertilizers improved the partitioning of more biomass towards economic parts due to readily available form of nutrients from fertilizers. The results are in agreement with the findings of Singh *et al.* (1994) and Shankarlingappa *et al.* (2000).

Table 1. Yield attributes of pigeonpea genotypes as influenced by graded levels of nutrient application

Treatment	Pods/ plant	Grains/ pod	1,000-grains weight (g)	Grain yield/ plant (g)	Grain yield (t/ha)	Stalk yield (t/ha)	HI	Cost of cultivation (× 10^3 ₹/ha)	Net returns (× 10^3₹/ha)	B : C ratio
Genotypes (V)										
'TTB 7'	88.5	4.3	107	33.7	1.25	5.27	0.20	6.90	14.44	2.09
'BRG 2'	106.5	4.5	118	43.3	1.39	4.69	0.23	6.90	16.58	2.40
SEm±	0.5	0.07	02	0.6	0.03	0.26	0.01			
CD (P=0.05)	1.4	NS	06	1.8	0.09	0.73	0.02			
Nutrient levels (F)										
$P_{75}K_{50}$SZn (-N)	80.2	4.3	108	25.8	0.93	4.11	0.20	6.81	11.03	1.62
$N_{25}P_{75}K_{50}$SZn	91.2	4.4	113	32.3	1.10	4.40	0.22	6.91	14.22	2.06
$N_{37.5}P_{75}K_{50}$SZn	99.9	4.5	116	41.5	1.40	5.21	0.22	7.00	19.66	2.81
$N_{50}P_{75}K_{50}$SZn	106.2	4.7	122	45.3	1.49	5.27	0.23	7.13	21.22	2.98
$N_{37.5}K_{50}$SZn(-P)	85.1	4.3	106	31.7	0.97	4.65	0.19	5.43	13.34	2.46
$N_{37.5}P_{50}K_{50}$SZn	96.1	4.4	112	35.3	1.18	4.97	0.21	6.47	16.21	2.51
$N_{37.5}P_{100}K_{50}$SZn	105.9	4.6	114	44.1	1.45	5.46	0.22	7.51	20.17	2.69
$N_{37.5}P_{75}$SZn(-K)	88.3	4.4	117	31.4	1.05	4.04	0.22	6.40	13.69	2.14
$N_{37.5}P_{75}K_{25}$SZn	97.0	4.7	113	39.6	1.31	5.00	0.22	6.70	18.24	2.72
$N_{37.5}P_{75}K_{75}$SZn	107.2	4.6	118	46.8	1.57	5.71	0.23	7.30	22.61	3.1
$N_{50}P_{100}K_{75}$SZn	112.7	4.7	124	51.6	1.76	5.86	0.24	7.95	25.52	3.21
$N_{37.5}P_{75}K_{50}$S	100.5	4.5	108	38.3	1.39	5.37	0.20	6.52	20.19	3.1
$N_{37.5}P_{75}K_{50}$Zn	95.8	4.4	110	35.4	1.24	4.59	0.22	6.83	16.93	2.48
$N_{25}P_{50}K_{25}$SZn	86.8	4.4	104	31.3	1.16	4.69	0.19	6.08	16.03	2.64
$N_{25}P_{50}K_{25}$	83.7	4.2	101	27.1	0.94	3.69	0.20	5.45	13.47	2.47
SEm±	1.4	0.2	0.8	1.8	0.01	0.09	0.01			
CD (P=0.05)	3.9	NS	2.2	5.1	0.03	0.26	0.03			
Interaction (VxF)										
SEm±	2.0	0.5	3	2.2						
CD (P=0.05)	5.6	NS	9	6.5						

Table 2. Interaction of genotypes and nutrient supply levels on grain and stalk yield of pigeonpea (Pooled data over two years)

Treatment	Grain yield (t/ha)		Stalk yield (t/ha)	
	'TTB 7'	'BRG 2'	'TTB 7'	'BRG 2'
$P_{75}K_{50}$SZn (-N)	0.89	0.99	3.91	3.88
$N_{25}P_{75}K_{50}$SZn	1.09	1.18	4.22	4.13
$N_{37.5}P_{75}K_{50}$SZn	1.39	1.52	5.28	5.07
$N_{50}P_{75}K_{50}$SZn	1.49	1.68	5.40	5.22
$N_{37.5}K_{50}$SZn(-P)	0.94	1.07	4.70	3.90
$N_{37.5}P_{50}K_{50}$SZn	1.20	1.30	5.08	4.78
$N_{37.5}P_{100}K_{50}$SZn	1.45	1.64	5.73	5.31
$N_{37.5}P_{75}$SZn(-K)	1.03	1.09	3.74	3.94
$N_{37.5}P_{75}K_{25}$SZn	1.30	1.44	4.90	4.72
$N_{37.5}P_{75}K_{75}$SZn	1.56	1.77	5.69	5.66
$N_{50}P_{100}K_{75}$SZn	1.69	1.95	6.34	5.67
$N_{37.5}P_{75}K_{50}$S	1.31	1.28	5.95	4.85
$N_{37.5}P_{75}K_{50}$Zn	1.21	1.32	5.02	4.26
$N_{25}P_{50}K_{25}$SZn	0.95	1.05	4.56	4.24
$N_{25}P_{50}K_{25}$	0.84	0.95	3.85	3.53
SEm$\pm$	0.04		0.36	
CD (P=0.05)	0.12		1.03	

Nutrient uptake

Uptake of N, P, K, S and Zn by pigeonpea genotypes in grain, stalk and total is presented in table 3 and 4. The significant difference was recorded in nutrient uptake between pigeonpea genotypes (Table 3). The differences in nutrient uptake was related to yield performance of the genotype, as there was no difference in nutrient concentration. 'TTB 7' produced higher biomass which resulted in higher uptake. Improved genotypes can be expected to be more responsive to nutrient application due to their higher yield potential and nutrient requirement at critical growth stages as reported by Srinivasarao *et al*. (2003) and Sharma *et al.* (2010).

Application of graded levels of nutrients significantly increased the grain, stalk and total uptake of N, P, K, S and Zn by pigeonpea. Uptake of nutrients were more in the second year than in the first year was mainly due to well distributed rainfall. Increased N uptake 55 and 53 % by grain stalk respectively in 75 kg N/ha application over recommended 25 kg N/ha. Uptake of N followed the pattern of dry matter accumulation. Across nutrient levels, remarkably higher N content in grain (2.9- 3.7%) and stalk (0.8-1.2%) was observed in both the years due to different nutrient levels. The increased N uptake by pigeonpea could be attributed to higher yield coupled with slight improvement in nutrient concentration of grain and non-grain parts. There was no significant difference in nutrient content between genotypes. Increasing N level increased the vegetative growth and root biomass and increased the availability of nutrients in soil resulting in higher uptake of nutrients (Shankarlingappa *et al.,* 2000).

Significant improvement in P uptake upto 31% by application of 100 kg P/ha over recommended 50 kg/ha. The

Table 3. Effect of nutrients application levels on NPK uptake in grain, stalk and total by pigeonpea genotypes (Pooled data over two years)

Treatment	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)		
	Grain	Stalk	Total	Grain	Stalk	Total	Grain	Stalk	Total
Genotypes									
'TTB 7'	46.5	55.1	101.6	3.0	3.2	6.0	15.0	10.7	25.7
'BRG 2'	49.8	53.3	103.1	3.5	3.1	6.4	16.8	10.6	27.3
SEm±	0.73	0.79	1.43	0.1	0.1	0.1	0.4	0.2	0.5
CD (P=0.05)	2.07	NS	NS	0.3	0.2	0.2	1.0	NS	1.5
Fertility levels									
$P_{75}K_{50}$SZn (-N)	29.8	33.4	63.2	2.0	2.1	4.1	9.9	9.7	19.6
$N_{25}P_{75}K_{50}$SZn	38.7	42.6	81.3	2.5	2.4	4.9	12.9	8.7	21.6
$N_{37.5}P_{75}K_{50}$SZn	52.2	59.6	111.8	3.4	3.3	6.7	16.8	11.4	28.1
$N_{50}P_{75}K_{50}$SZn	60.4	65.3	125.7	4.3	3.6	7.9	20.5	12.5	33.0
$N_{37.5}K_{50}$SZn(-P)	30.9	39.6	70.4	2.0	2.0	3.6	11.2	8.7	19.9
$N_{37.5}P_{50}K_{50}$SZn	45.8	54.2	100	2.9	2.9	5.8	14.1	10.7	24.8
$N_{37.5}P_{100}K_{50}$SZn	57.9	62.3	120.2	3.8	3.8	7.6	17.8	12.2	30.0
$N_{37.5}P_{75}$SZn(-K)	32.1	35.8	67.8	2.3	2.2	4.5	9.3	7.8	17.1
$N_{37.5}P_{75}K_{25}$SZn	49.6	53.0	102.5	3.2	3.0	6.2	15.3	10.2	25.5
$N_{37.5}P_{75}K_{75}$SZn	61.8	64.7	126.5	3.7	3.9	7.6	20.2	11.8	32.0
$N_{50}P_{100}K_{75}$SZn	70.3	73.9	144.1	4.9	4.3	9.2	24.5	13.3	37.7
$N_{37.5}P_{75}K_{50}$S	44.2	60.5	104.7	3.5	3.2	6.7	15.4	11.8	27.2
$N_{37.5}P_{75}K_{50}$Zn	42.0	52.0	94.0	3.3	2.9	6.2	14.6	10.0	24.6
$N_{25}P_{50}K_{25}$SZn	33.2	48.5	81.6	2.3	2.6	4.9	11.0	8.8	19.8
$N_{25}P_{50}K_{25}$	28.5	36.2	64.7	2.0	1.8	3.8	9.5	7.3	16.8
SEm±	2.14	2.3	4.16	0.18	0.17	0.22	1.04	0.46	1.56
CD (P=0.05)	6.04	6.51	11.76	0.52	0.47	0.61	2.93	1.29	4.4

P content of grain (0.3%) and stalk (0.75%) might be responsible for increased uptake. This could be attributed to the fact that added phosphorus increased nutrient content by providing balanced nutritional environment inside the plant and higher photosynthetic efficiency which favoured growth and crop yield. Increased levels of P can enhances uptake of NPK by seed and stalk was reported by Singh and Sekhon (2007), Chaudhari *et al*. (2010) and Subhash Babu *et al*. (2013).

Increase in K uptake by grain due to 75 kg K/ha was 47% and in stalk it was 30% over recommended 25 kg/ha. Further, addition of 10 kg S/ha and 12.5 kg $ZnSO_4$/ha can enhances the uptake of S and Zn to the extent of 17 and 15% respectively. The NPK uptake was linearly related with grain yield (r^2=0.69, 0.74 and 0.69 respectively). The favourable response with the combined application of NPK fertilizers and S and Zn was reported by Ahlawat *et al*. (2005). Significant impact on nutrient uptake due to application of P and S were also reported by Shankaralingappa *et al.* (2000), Deshbhratar *et al.* (2010) and P and Zn by Puste and Jana (1995).

Economics

'BRG 2' recorded higher net returns (16.58 × 10^3₹/ha) and benefit: cost ratio (2.4), which may be ascribed to differences in grain yield levels between genotypes. Increased level 50-100-75 NPK kg/ha application has the higher cost of cultivation (7.95 × 10^3₹/ha) as compared to lower levels. This might be due to additional cost towards higher nutrient dose. Higher net returns and benefit-cost ratio was recorded with the application of higher levels of nutrients owing to more gain in yield as compared to increase in cost of production. Increase in quantity of N application from 25 to 50 kg/ha, P from 50 to 100 kg/ha and K from 25 to 75 kg/ha has resulted in 49, 24 and 24% higher net returns respectively. Among nutrient combination levels maximum net returns (25.52 × 10^3₹/ha and 22.61 × 10^3₹/ha) and B: C ratios (3.21 and 3.1) were recorded with $N_{50}P_{100}K_{75}$ and $N_{37.5}P_{75}K_{75}$ application during both the years, Further, integration of S and Zn with NPK enhanced net returns and benefit: cost ratio as compared to application without NPK. This could be attributed to higher economic yield of the pigeonpea coupled better market price. Improvement in grain yield and economic returns under graded levels of NPK was reported by Shankarlingappa *et al.* (2000) and Ahlawat *et al.* (2005).

The present study thus indicates that high yielding dwarf genotype of pigeonpea 'BRG 2' has higher grain yield potential and harvest index, which enhanced nutrient uptake and economic returns over existing long duration genotype 'TTB 7'. Further, application of 50-100-75 kg NPK/ha was found to be effective in achieving higher yield and economic returns over present recommended dose of fertilizers for *Alfisols*. Combined application of

Table 3. Effect of nutrients application levels on S and Zn uptake in grain, stalk and total by pigeonpea genotypes over two years

Treatment	S uptake (kg/ha)			Zn uptake (kg/ha)		
	Grain	Stalk	Total	Grain	Stalk	Total
Genotypes						
'TTB 7'	0.9	2.1	3.0	1.08	1.70	2.78
'BRG 2'	1.0	2.2	3.2	1.44	1.79	3.22
SEm±	0.01	0.1	0.01	0.01	0.02	0.04
CD (P=0.05)	0.04	0.1	0.09	0.04	NS	0.12
Fertility levels						
$P_{75}K_{50}$SZn (-N)	0.60	1.34	1.94	0.67	1.16	1.83
$N_{25}P_{75}K_{50}$SZn	0.79	1.66	2.45	0.87	1.56	2.43
$N_{37.5}P_{75}K_{50}$SZn	1.18	2.30	3.48	1.25	2.15	3.40
$N_{50}P_{75}K_{50}$SZn	1.39	2.74	4.13	1.53	2.16	3.69
$N_{37.5}K_{50}$SZn(-P)	0.74	1.73	2.46	0.77	1.30	2.07
$N_{37.5}P_{50}K_{50}$SZn	0.84	2.11	2.94	1.22	1.67	2.88
$N_{37.5}P_{100}K_{50}$SZn	1.20	2.76	3.96	1.39	1.86	3.25
$N_{37.5}P_{75}$SZn(-K)	0.80	1.63	2.43	1.21	1.41	2.61
$N_{37.5}P_{75}K_{25}$SZn	0.99	1.71	2.70	1.33	1.74	3.07
$N_{37.5}P_{75}K_{75}$SZn	1.10	2.40	3.50	1.45	2.16	3.61
$N_{50}P_{100}K_{75}$SZn	1.47	2.91	4.38	1.60	2.35	3.95
$N_{37.5}P_{75}K_{50}$S	0.93	2.31	3.24	0.71	1.12	1.83
$N_{37.5}P_{75}K_{50}$Zn	0.60	1.64	2.24	0.78	1.43	2.21
$N_{25}P_{50}K_{25}$SZn	0.70	1.92	2.62	0.75	1.36	2.11
$N_{25}P_{50}K_{25}$	0.54	1.43	1.97	0.58	1.09	1.66
SEm±	0.04	0.09	0.09	0.04	0.06	0.12
CD (P=0.05)	0.1	0.24	0.25	0.1	0.17	0.34

NPK fertilizers along with S and Zn enhanced pigeonpea yield, nutrient uptake and economic returns.

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