Effect of Nutrient Management on Cowpea [*Vigna unguiculata* (L.) Walp]

ABSTRACT

A field experiment was carried out at Research Farm, College of Agriculture, Bharuch, NAU, (Gujarat) during *kharif* 2022 to study the effect of nutrient management on growth, yield and economics of cowpea. The experiment was laid out in RBD with factorial concept with three replication. The result revealed that significantly higher plant height, number of nodules/plant, number of branches/plant, dry matter accumulation, number of pods/plant, number of seeds/pod, length of pod, seed and stover yield and quality were recorded with the soil application of 20-40-00 N-P-S kg/ha. It also gave the higher net return and B:C ratio. Significantly higher plant height, number of nodules/plant, number of branches/plant, dry matter accumulation, number of pods/plant, number of seeds/pod, length of pod, seed and stover yield, quality, net return as well as B:C ratio with a foliar application of 1% enriched banana pseudostem sap (Novel) at branching and flowering stage.

Keywords:Cowpea, Nutrient management, Foliar application, Soil application, Yield

1. Introduction

Pulses play vital role in an Indian diet as vegetable protein being an essential supplement to cereal-based diet per capita. In India, pulses are grown nearly on 28.34 Mha with an annual production of 23.15 MT and average productivity of 817 kg/ha (Anon., 2021). In Gujarat the pulses are grown nearly on 0.88 Mha (3.10 % of total pulse area under countries) with an annual production of 1.06 MT leading to average productivity of 1204 kg/ha (Anon., 2021). Cowpea [*Vigna unguiculata* (L.) Walp.] is one of the most important pulse crops in the world. Cowpea is belonging to the family *Leguminosae* with subfamily *Papilionaceae*. It's called 'Black eye pea', 'Southern pea', 'China pea', '*kharif* pea', 'Marble pea', '*Chowli*' and 'Lobiya'. Cowpea is one of the important *kharif* pulse crops grown for vegetable, grain, forage and green manuring. This crop is of great importance because of availability of short duration, high yielding and quick growing varieties. It has considerable promise as an alternative pulse crop in dry land farming. Being rich in protein and containing many other nutrients, it is known as 'vegetable meat'.

Cowpea, being a legume, fixed atmospheric nitrogen and improves the soil fertility. The formation of root nodule and nitrogen fixation starts at about 15-20 days after sowing. Thus, a starter does of nitrogen may be required for boosting the initial growth stage. Nitrogen is the most important nutrient for the plant growth. The importance of phosphorus and sulphur application to cowpea increases nodulation, symbiotic nitrogen fixation, photosynthesis, early flower initiation as well as increasing the number of flowers. Urea is the nitrogenous fertilizer in amide form. Foliar spray of urea increases the yield due to different metabolic process enhanced in plant which led to increase the yield and yield contributing characters. The extract of marine macro algae viz., brown, red and green algae is known to have positive effect on growth and yield of crops. The brown algae are the most commonly used seaweeds in agriculture. Cattle urine is a good source of nitrogen, phosphate, potassium, calcium, magnesium, chlorite and sulphate. It contains 95% water, 2.5% urea, 2.5% others (mineral salts, hormones and enzyme). Novel organic liquid nutrient is a product of Navsari Agricultural University which was patented in the year of 2012. It is prepared from banana pseudostem sap. N:P:K (19:19:19) is water soluble fertilizer with an optimum combination of Nitrogen, Phosphorus and Potassium. It is readily soluble in water and is best for drip irrigation and foliar application of fertilizer. Looking into importance of different nutrients levels as soil application and foliar spray, a field experiment was conducted to see that effects on growth, yield and economics of cowpea under rainfed condition.

2. Material and Methods

The field experiment was carried out at College Farm, Navsari Agricultural University, Bharuch (Gujarat) during *kharif* season of 2022. The soil was clayey in texture and slightly alkaline in

reaction. The soil was low in available N (234 kg/ha), low in available P_2O_5 (26 kg/ha), low in available sulphur (7.74 mg/kg) and high in available K_2O (287 kg/ha). The field experiment was laid out in FRBD with 18 treatment combinations consisting of two factors *viz.*, soil application [F_1: 20-40-00 (N-P-S kg/ha), F_2: 10-20-10 (N-P-S kg/ha) and F_3: 20-40-20 (N-P-S kg/ha)] and foliar spray [S_1: Control (Water), S_2: 1% Urea, S_3: 1% Cow urine, S_4: 1% Enriched banana pseudostem sap (Novel), S_5: 1% 19:19:19 (N:P:K) and S_6: 1% Sea weed extract] with three replications. Cowpea variety GC-5 was sown in line at 45 x 10 cm spacing. The crop was fertilized as per treatment. Nitrogen, phosphorus and sulphur were applied in the form of urea, DAP and element sulphur, respectively. Seeds were treated with *Rhizobium* and PSB strain of Navsari isolate (10 ml/kg seed) in treatment as common practices. While, foliar application was applied at branching and flowering stages as per treatment. For all the growth and development studies during the crop growth period, five plants were selected randomly from net plot and tagged in each plot for recording plant height, number of branches/plant, dry matter accumulation/plant, number of root nodules/plant, number of pod/plant, number of seeds/pod and pod length. 100 seeds were randomly taken from the bulk produce of each net plot and were counted and weighed. The weight was expressed as 100- seed weight in grams. The data on seed and stover yield were recorded from net plot and converted on hectare basis. The net realization and B:C ratio were calculated. The data recorded for various parameters during the course of investigation were statistically analysed by a producer appropriate to the design of experiment as described by Panse and Sukhatme (1985). The significance of difference was tested by “F” test at 5 per cent level.

3. Result and discussion

3.1 Growth parameters

3.1.1 Plant height (cm)

The results (Table 1) indicated that significantly highest plant height at harvest (54.92 cm) were recorded when application of 20-40-20 (N-P-S kg/ha) (F_3) but, it was statistically at par with treatment 20-40-00 (N-P-S kg/ha) (F_1).The increase in plant height is might due to availability of nutrients in balanced form especially nitrogen and phosphorus. Nitrogen is an important part of the compounds that regulate plant growth and development. Increase supplies of available phosphorus are play an important role in growth of new tissue and division of cells. Sulphur is essential for many growth functions in plant including nitrogen metabolism, enzyme activity and protein synthesis. Which turns to increase growth of plants. The result was in the conformity with the finding of Jat *et al.* (2013), Upadhyay and Singh (2016), Balai *et al.* (2017) and Nadeem *et al.* (2018).Significantly taller plants at harvest (57.26 cm) was recorded under foliar application of 1% enriched banana pseudostem sap (Novel) (S_4) but, found statistically at par with foliar application of 1% sea weed extract (S_6).This might be due to foliar application of nutrients at a critical crop growth stage (branching and flowering stage) helps to promoting the cell division and multiplication as well as cell elongation and development of leaves and other plant’s part. Banana pseudostem sap contains auxins and cytokinins, which are known to as plant growth hormones. These growth-promoting substances are effectively absorbed by the cowpea plants through foliar spraying, there is a possibility that it may promote plant height. Similar result has been reported by Singhal *et al.* (2015), Patel (2022) and Raut (2022).

3.1.2 Number of Root Nodules/Plant

Data furnished in Table 1 indicated that the soil application of different nutrients levels in cowpea was significantly higher number of nodules/plant (26.19) at 45 DAS was noted when crop fertilized with 20-40-20 (N-P-S kg/ha) (F_3) but, it was statistically at par with treatment 10-20-10 (N-P-S kg/ha) (F_2). Root nodules are specialized structures formed by certain plants in a symbiotic relationship with nitrogen-fixing bacteria, such as those of the genus *Rhizobium*. These nodules are responsible for biological nitrogen fixation, where atmospheric nitrogen is converted into a usable form by plants. While nitrogen is the primary nutrient involved in the formation and functioning of root nodules. Sulfur is involved in the synthesis of certain amino acids and proteins, which are essential for nodule development and nitrogen fixation. The results were closely related with the finding of Singh *et al.* (2017) and Dey *et al.* (2021). With respect to foliar nutrition, mean data presented in Table 1 that number of root nodules/plant at 45 DAS were not significantly affected due to different foliar nutrition, but maximum number of root nodules/plant (26.81) was observed with foliar application of 1% enriched banana pseudostem sap (Novel) (S_4).

3.1.3 Number of Branches/Plant

Data mentioned in Table 1 indicated that the significantly higher number of branches/plant at harvest (5.90) was registered when application of 20-40-20 (N-P-S kg/ha) (F_3) but, it was statistically at par with treatment 20-40-00 (N-P-S kg/ha) (F_1). The maximum number of branches attributed due to application of nitrogen, phosphorus and sulphur which helps in efficient utilization of nutrients, which resulted in attaining better crop canopy and simulation of root growth and increased metabolic activities. These results were in line with Jat *et al.* (2013), Upadhyay and Singh (2016), Balai *et al.* (2017) and Nadeem *et al.* (2018). Significantly higher number of branches/plant at harvest (6.19) was recorded when foliar application of 1% enriched banana pseudostem sap (Novel) (S_4), however it was found statistically at par with foliar application of 1% sea weed extract (S_6). Foliar spray of enriched banana pseudostem sap (Novel) at branching and flowering stage increased branches/plant due to content cytokinins and gibberellic acids. While sea weed extract contains cytokinins and auxin which promotes the cell division and proliferation, stem elongation. These results was in conformity with those of Parmar *et al.* (2022), Patel (2022) and Raut (2022).

3.1.4 Dry matter accumulation/plant

Among three different soil application, significantly higher dry matter accumulation/plant (27.14 g) at harvest was noted when crop fertilized with 20-40-20 (N-P-S kg/ha) (F_3) but, it was found statistically at par with treatment 20-40-00 (N-P-S kg/ha) (F_1). The increase in dry matter accumulation/plant might be due to application of nitrogen, phosphorus and sulphur fertilizer in adequate amount leads to improve the root growth and development and thereby higher uptake of nutrients provided better condition for cell division and cell enlargement resulting in increases in the photosynthetic efficiency and thus increased the production of photosynthates reflected in better growth and ultimately in higher dry matter accumulation. These finding were corroborate the results reported by Jat *et al.* (2013), Upadhyay and Singh (2016), Balai *et al.* (2017) and Nadeem *et al.* (2018). It is inferred from the data furnished in Table 1 indicated that the significantly higher dry matter accumulation/plant at harvest (28.01 g) was recorded under foliar application of 1% enriched banana pseudostem sap (Novel) (S_4), however it was statistically at par with foliar application of 1% sea weed extract (S_6). Banana pseudostem sap or sea weed extract contains nutrients as well as growth-promoting substances that can be absorbed by the leaves and effectively utilized by the plants, it may contribute to increased biomass production and dry matter accumulation. Similar finding was reported by Parmar *et al.* (2022).

3.2 Yield attributes

3.2.1 Numbers of Pods/Plant

Among three different soil application, significantly highest number of pod/plant (20.19) was recorded when crop fertilized with 20-40-20 (N-P-S kg/ha) (F_3) but, it was statistically at par with treatment 20-40-00 (N-P-S kg/ha) (F_1). The increase in number of pods/plantmight be due to optimum supply of nitrogen, phosphorus and sulphur to the crop. Nitrogen and phosphorus levels resulted in higher number of branches having a greater number of pods which was due to maximization of photosynthesis and respiration, storage of energy, cell division and elongation which ultimately leads to enhancement in seed production. They have also been reported by Jat *et al.* (2013), Singh and Singh (2017), Pargi*et al.* (2018) and Sonloi*et al.* (2022). It is inferred from the data furnished in Table 1 that the number of pods/plant (20.09) was recorded with foliar application of 1% enriched banana pseudostem sap (Novel) (S_4), which was statistically at par with foliar application of 1% sea weed extract (S_6).Foliar spray of nutrients at different crop growth stages resulted in better growth of plants associated with increased availability of nutrients might have resulted in greater translocation of photosynthates from source to sink site that favourably resulted into increased number of pods/plant. Banana pseudostem sap contains gibberellic acid and cytokinins, while sea weed extract contains auxin and cytokinins which promotes the plant growth, which leads to increases photosynthetic activities and increasing number of pods/plant. These results was in conformity with those of Singhal *et al.* (2015), Fernando and Karunarathna (2020), Patel (2022) and Raut (2022).

3.2.2 Numbers of seeds/pod and pod length

It is apparent from data in Table 1 showed that number of seeds/plant and length at harvesting under different nutrients levels as soil application was found significant. Significantly higher numbers of pods/plant (11.65) and pod length (13.11 cm) were recorded when crop fertilized with 20-40-20 (N-P-S kg/ha) (F_3) but, found statistically at par with treatment 20-40-00 (N-P-S kg/ha) (F_1).It may be due to the fact that application of nitrogen, phosphorus and sulphur increase seeds/pod and pod length of cowpea. Nitrogen is a vital role in photosynthesis, promotes vegetative growth and can contribute to

increase pod formation and seeds/pod. These results was in conformity with those of Jat *et al.* (2013), Singh and Singh (2017), Pargi*et al.* (2018) and Sonloi*et al.* (2022).The data outlined in Table 1 clearly indicated that treatmentfoliar application of 1% enriched banana pseudostem sap (Novel) (S_4) recorded significantly higher seeds/pod (12.00) andpod length was not significantly affected due to different foliar nutrition.This might be due to enhanced photosynthetic activity and higher uptake of nutrients and there by increased plant dry matter production in the pod setting phase which might have improved the pod development. The results were strongly supported by Fernando and Karunarathna (2020), Patel (2022) and Raut (2022).

3.2.3 100 Seed Weight (g)

A perusal of data narrated in Table 1 showed that 100 seed weight was found non significant due to different nutrients levels as soil application, but maximum 100 seed weight (8.62 g) were recorded when crop fertilized with 20-40-20 (N-P-S kg/ha). The 100 seed weight was influenced non significantly by foliar nutrition, but maximum 100 seed weight (8.80 g) was recorded with foliar application of 1% enriched banana pseudostem sap (Novel) (S_4).

3.2.4 Seed and stover yield (kg/ha)

The results showed in Table 2indicated that different nutrients levels as soil applicationexert significant effect on seed and stover yield. Among three different nutrients levels as soil application, significantly higher seed and stover yield (1099 and 1895 kg/ha, respectively) which was statistically at par with treatments of 20-40-00 (N-P-S kg/ha) (F_1) (1034 and 1801 kg/ha, respectively). However, significantly the lowest seed and stover yield (1000 and 1725 kg/ha, respectively) was noted with crop fertilized with 10-20-10 (N-P-S kg/ha) (F_2). The highest seed and stover yield could be due to the cumulative effect of improvement in yield attributes *viz*., number of pods/plant, number of seeds/pod, pod length and 100 seed weight. The improvement in seed yield was mainly on account of increase in the growth parameters and yield attributes of cowpea which resulted in higher production of photosynthates were utilized by the plant for development of sink under adequate supply of nutrients due to increasing in rate of nitrogen, phosphorus and sulphur fertilizer. Similar response trend was also observed by Singh *et al.* (2007), Jat *et al.* (2013), Singh and Singh (2017) and Pargi*et al.* (2018). As regards to foliar spray application, significantly higher seed and stover yield (1151 and 2005 kg/ha, repectively) of cowpea was observed under the foliar application of 1% enriched banana pseudostem sap (Novel) (S_4), however it was statistically at par with foliar application of 1% sea weed extract (S_6) (1038 and 1843 kg/ha, respectively). Moreover, significantly the lowest seed and stover yield (947 and 1709 kg/ha, respectively) was noted with Control (S_1). The overall improvement in all the growth and yield attributing components may be due to adequate supply of nutrients with easy availability to plant at most critical growth period resulted into better growth and yield attributing characters. The better growth of crop ultimately diverted more energy under sink source relationship which helped in providing more yield. These results was in conformity with those of Singhal *et al.* (2015), Fernando and Karunarathna (2020), Patel (2022) and Raut (2022).

3.3 Quality parameters

3.3.1 Protein Content in Seed (%)

Protein content in seed (%) was not significantly influenced due to different nutrients levels as soil application. However, crop fertilized with 20-40-20 (N-P-S kg/ha) (F_3) registered numerically maximum protein content (23.21 %). It is inferred from the data furnished in Table 2 that the protein content in seed (%) was not significantly influenced due tofoliar application. numerically maximum protein content (23.24%) was registered under foliar spray application of 1% enriched banana pseudostem sap (Novel) (S_4).

3.4 Economics

Data presented in Table 2, it could be seen that the maximum net realizations and benefit: cost ratio of ₹49625/ha and 2.28, respectively with crop fertilize with 20-40-20 (N-P-S kg/ha). These were closely followed by crop fertilize with 20-40-00 (N-P-S kg/ha) (47657 ₹/ha) with B: C ratio of 2.33. The data from Table 2 reflected that maximum net return (57233 ₹/ha) was secured with foliar spray application of 1% enriched banana pseudostem sap (Novel) (S_4) along with B:C ratio of 2.61 followed by foliar spray application of 1% urea (S_2) with net return (47814 ₹/ha) and B:C ratio of 2.39.

3.5 Soil fertility status

The mean data given in Table 3 showed that different nutrient level as soil application did not exert their significant effect on pH, electrical conductivity and available K_2O. Among three different soil application, significantly higher organic carbon, available N, P2O5 and S in soil (0.310%, 247 kg/ha, 30.50 kg/ha and 8.14 mg/kg) was assessed when crop fertilized with 20-40-20 (N-P-S kg/ha). Data furnished in Table 3 inferred that pH, electrical conductivity, organic carbon, available N, P2O5, K2O and S in soil were assessed not significantly influenced by different foliar spray application treatments.

4. Conclusion

Based on the results of one year experiment, it can be concluded that cowpea crop was fertilized with 20-40-00 N-P-S kg/ha for getting higher and profitable yield. Besides, foliar spray application of 1% enriched banana pseudostem sap (Novel) at branching and flowering stage was also found remunerative.

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Table 1: Effect of different nutrients management treatmentson growth and yield attributes of cowpea

Treatment	Plant height (cm)	Numberof root nodules/plant	Numberof branches/plant	Dry matter accumulation/plant	Number of pods/plant	Number of seeds/pod	Length of pod (cm)	100 seed weight (g)
Soil application (F)								
F_1: 20-40-00 (N-P-S kg/ha)	52.01	23.14	5.77	25.67	19.54	11.09	12.54	8.30
F_2: 10-20-10 (N-P-S kg/ha)	49.48	24.64	5.35	23.95	18.30	10.86	12.04	8.08
F_3: 20-40-20 (N-P-S kg/ha)	54.92	26.19	5.90	27.14	20.19	11.65	13.11	8.62
S.Em.±	1.44	0.66	0.15	0.79	0.51	0.20	0.28	0.15
CD at 5%	4.13	1.91	0.44	2.27	1.46	0.56	0.82	NS
Foliar spray application (S)								
S_1: Control (Water)	48.07	2.63	5.25	23.90	17.80	10.36	11.92	7.96
S_2: 1% Urea	50.84	2.88	5.44	24.59	18.80	11.11	12.35	8.11
S_3: 1% Cow urine	50.75	2.55	5.48	24.47	18.51	11.01	12.28	8.19
S_4: 1% Enriched banana pseudostem sap (Novel)	57.26	2.72	6.19	28.01	21.09	12.00	12.93	8.80
S_5: 1% 19:19:19 (N:P:K)	51.36	2.41	5.55	24.71	18.98	11.16	13.13	8.69
S_6: 1% Sea weed extract	54.52	2.36	6.13	27.85	20.89	11.56	12.76	8.25
S.Em.±	2.03	0.11	0.22	1.12	0.72	0.28	0.40	0.21
CD at 5%	5.85	0.31	0.62	3.21	2.07	0.79	NS	NS
Interaction(F x S)								
S.Em.±	3.52	1.62	0.37	1.93	1.25	0.49	0.69	0.30
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
CV%	11.71	11.43	11.45	13.11	11.16	7.39	9.58	7.67

Table 2:Effect of different nutrients management treatmentson yield, quality and economics of cowpea

Treatment	Grain yield (kg/ha)	Stover yield (kg/ha)	Protein content (%)	Cost of cultivation (₹/ha)	Net returns (₹/ha)	B: C ratio
Soil application (F)						
F_1: 20-40-00 (N-P-S kg/ha)	1034	1801	22.33	35730	47657	2.33
F_2: 10-20-10 (N-P-S kg/ha)	1000	1725	22.79	36170	44340	2.23
F_3: 20-40-20 (N-P-S kg/ha)	1099	1895	23.21	38841	49625	2.28
S.Em.±	27.43	46.92	0.28	-	-	-
CD at 5%	79	135	NS	-	-	-
Foliar spray application (S)						
S_1: Control (Water)	947	1709	22.13	34303	42653	2.24
S_2: 1% Urea	1024	1738	22.76	34363	47814	2.39
S_3: 1% Cow urine	1020	1740	22.59	34403	47556	2.38
S_4: 1% Enriched banana pseudostem sap (Novel)	1151	2005	23.24	35603	57233	2.61
S_5: 1% 19:19:19 (N:P:K)	1039	1808	22.93	36003	47797	2.33
S_6: 1% Sea weed extract	1083	1843	23.01	40303	46691	2.16
S.Em.±	38.80	66.36	0.39	-	-	-
CD at 5%	111	191	NS	-	-	-
Interaction(F x S)						
S.Em.±	67.19	114.93	0.67	-	-	-
CD at 5%	NS	NS	NS	-	-	-
CV%	11.15	11.02	5.14	-	-	-

Table 3:Effect of different nutrients management treatments on soil fertility status

Treatment	pH	EC (dS/m)	OC (%)	Available nutrient (kg/ha)			S (mg/kg)
				N	P_2O_5	K_2O	
Soil application (F)							
F_1: 20-40-00 (N-P-S kg/ha)	7.78	0.301	0.301	245	29.2	295	7.42
F_2: 10-20-10 (N-P-S kg/ha)	7.82	0.305	0.294	230	28.0	291	7.83
F_3: 20-40-20 (N-P-S kg/ha)	7.68	0.296	0.310	247	30.5	303	8.14
S.Em.±	0.08	0.003	0.003	4.71	0.54	5.04	0.16
CD at 5%	NS	NS	0.010	13	1.56	NS	0.46
Foliar spray application (S)							
S_1: Control (Water)	7.82	0.308	0.291	229	27.8	284	7.56
S_2: 1% Urea	7.77	0.293	0.299	245	28.8	301	7.76
S_3: 1% Cow urine	7.74	0.310	0.296	234	28.2	289	7.70
S_4: 1% Enriched banana pseudostem sap (Novel)	7.68	0.294	0.311	250	31.1	306	7.98
S_5: 1% 19:19:19 (N:P:K)	7.80	0.301	0.302	247	29.3	294	7.87
S_6: 1% Sea weed extract	7.75	0.297	0.308	239	30.1	304	7.94
S.Em.±	0.11	0.005	0.005	6.66	0.77	7.12	0.23
CD at 5%	NS	NS	NS	NS	NS	NS	NS
Interaction(F x S)							
S.Em.±	0.19	0.008	0.009	11.54	1.33	12.34	0.39
CD at 5%	NS	NS	NS	NS	NS	NS	NS
CV%	4.25	4.56	4.89	8.30	7.87	7.21	8.75

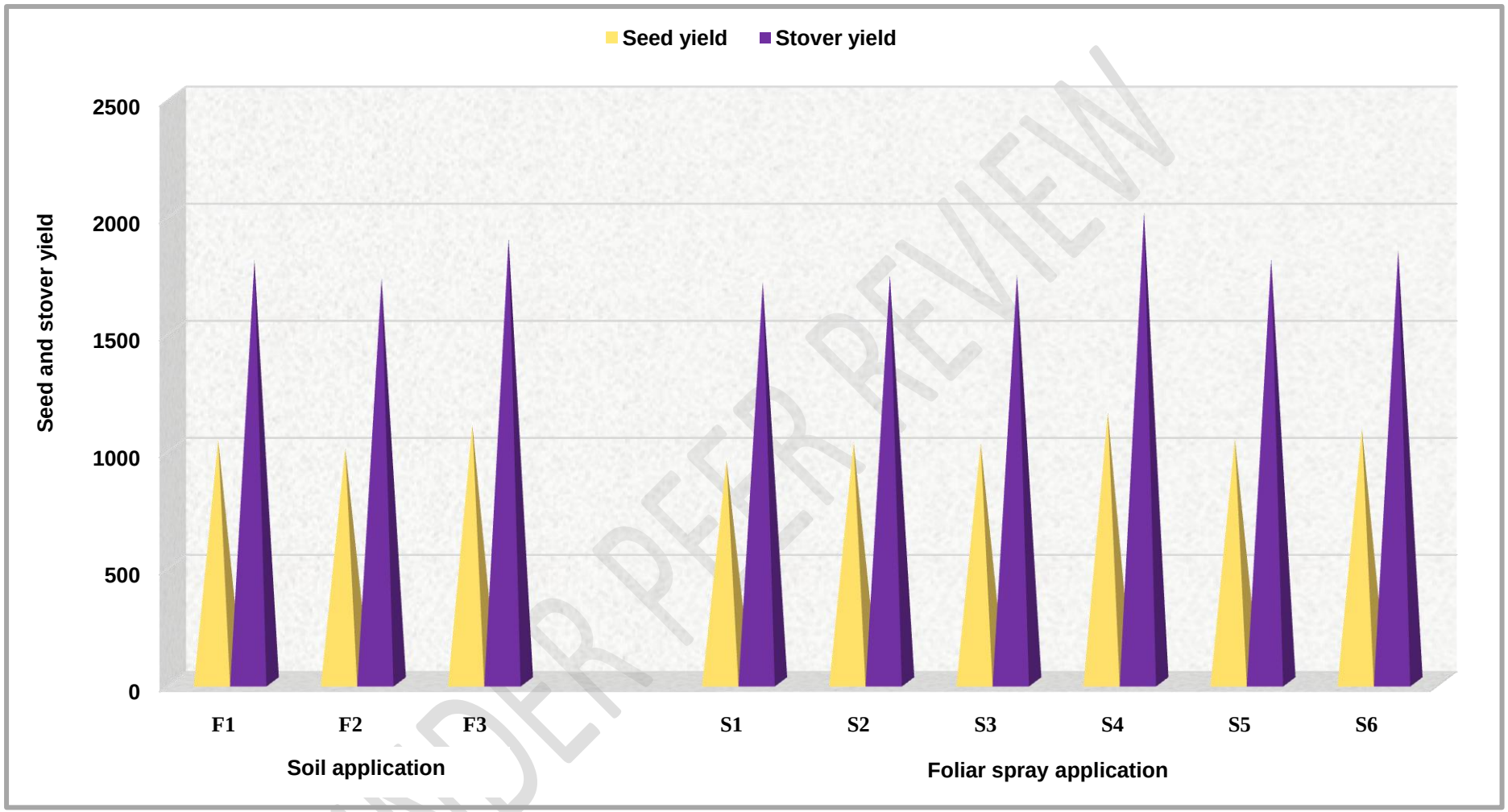

Figure1: Seed and stover yield of cowpea as influenced bydifferent nutrient management treatments