



## EFFECT OF PHOSPHOROUS RATES ON GROWTH AND YIELD OF COWPEA [*Vigna unguiculata* (L.) Walph.] VARIETIES IN JOS NORTH, PLATEAU STATE, NIGERIA

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### ABSTRACT

The study was conducted in Jos North, Plateau State, Nigeria to determine the effect of phosphorous rates on the growth and yield of cowpea varieties during the 2017 and 2018 growing seasons. The study consisted of four phosphorous rates (0, 20, 40 and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and three cowpea varieties (IT93K-452-1, IT99K-499-35 and IT90K-277-2) factorially combined and laid out in a Randomized Complete Block Design (RCBD) replicated three times. Data collected were subjected to analysis of variance (ANOVA) using XLSTAT 2019 statistical package and Duncan Multiple Range Test (DMRT) was used to separate the means where significance was declared. The result showed that application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded the tallest plant height (40.60 and 41.11 cm), a greater number of leaves (59.11 and 60.22), higher number of seeds per pod (12.00 and 11.67), least number of days (36.78) to attain 50% flowering. The highest number of branches (15.89 and 15.78), larger leaf area (115.91 and 117.63 cm<sup>2</sup>), a greater number of pods per plant (56.78), higher total yield (1.88 tha<sup>-1</sup>) was obtained at application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. Similarly, varietal differences were highly significant (P≤0.01) on growth and yield of cowpea. IT93K-452-1 variety produced the tallest plant (38.37 and 38.97 cm), more leaves per plant (55.75 and 57.08), more branches per plant (15.25 and 15.28), larger leaves (112.78 and 113.35 cm<sup>2</sup>), more pods per plant (54.50 and 53.67), higher number seeds per pod (11.08 and 11.58), higher yield (1.82 and 1.88 tha<sup>-1</sup>) and the least number of days to reach 50% flowering. The interaction of phosphorous and variety was highly significant (P≤0.01) with IT93K – 452 – 1 showing greater response to the application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> on yield of cowpea. In conclusion, application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was the best rate for good growth and yield of cowpea. Higher growth and yield characters were consistently measured for IT93K-452-1 variety. It is recommended that farmers in the study area can apply 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to IT93K – 452 – 1 variety to enhance the productivity of cowpea.

**Keywords:** Cowpea, Variety, Phosphorous, Fertilizer, Growth, Yield, Interaction, Jos.

### INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walph.] is a grain legume plant belonging to the family Fabaceae (Mawo *et al.*, 2018). It is widely grown in Asia, the Mediterranean, Australia, Canada, the USA and Africa (Abdullah *et al.*, 2017). Tony *et al.*, 2014 states that Cowpea is grown in over 2/3 of the developing world as a component or relay crop with major cereal. It is estimate that the world total area under cowpea production was about 12.5 million hectares, and Africa alone accounted for over 8 million hectares, of which about 70% were in West Africa (Singh *et al.*, 2015). Nigeria is the world's largest producer of cowpea with an average production of 2.29 million tons followed by Niger with 1.10 million tons and Mali with 110,000



tons (FAO, 2012).

Cowpea is one of the most important leguminous crops in West Africa. It is the most important proteinous legume, grown widely in semiarid tropics of Africa and Asia (Mohammad *et al.*, 2013). It accounts for between 60-80% protein intakes of West African inhabitants. It is known that cowpea provides the cheapest source of protein for almost every person in both rural and urban communities of Africa (Mensah *et al.*, 2017). The young leaves, vegetative parts and green pods are edible, but the dry grain is boiled and eaten or milled into several dish preparations such as porridge and bean cake as well as processed into snacks, wean mix and more. It provides food, animal feed and cash income to farmers. Cowpea grains contain about 24% protein and constitute a major protein source for resource-poor rural and urban consumers. The crop residues from cowpea constitute an important source of livestock feed especially in the dry savanna of West African Semiarid Tropics. Apart from being a vegetable meal due to its high amount of protein in grain, cowpea forms excellent forage and it gives a heavy vegetative growth to cover the ground so well that it checks the soil erosion. The crop is able to fix about 70 – 240 kg ha<sup>-1</sup> of nitrogen in a year (Lachyan & Dalvi, 2013).

All growing plants require phosphorous for growth and development in significantly large quantity. Phosphorus is among the most needed elements for crop production in many tropical soils. Its deficiency is the most limiting plant nutrient for cowpea production in most tropical soils and forest- transition zone (Boahene, 2013). The deficiency can be so acute in some soils of the savanna areas that plant growth ceases as soon as the phosphorus stored in the seed is exhausted (Mokwunye and Bationo, 2002 in Singh *et al.*, 2011). Aziz *et al.* (2016) stated that among the essential plants nutrients, phosphorous is most important for seed production, helping to form a healthy and sound root system which is essential for nutrient uptake from the soil.

There are many reasons for low adoption of developed varieties in Africa including failure to consider farmers' needs and preferences in new varieties (Puovie *et al.*, 2017; Mohammad *et al.*, 2013). The success of modern days breeding is determined by adoption and use of improved crop varieties. Several improved cowpea varieties have been released in the last few decades in Nigeria (Mohammad *et al.*, 2013).

Cowpea production is an important agricultural venture because the crop is consumed worldwide. Despite the agronomic and economic importance of cowpea, most farmers do not produce cowpea in larger quantities because of edaphic and biological factors which limit its production. Tropical soils are inherently low in nutrient particularly nitrogen followed by phosphorus (Haruna and Aliyu, 2011). Attempts to improve cowpea production should be approached via a good understanding and manipulation of crops and their environment. In Nigeria most farmers do not apply fertilizer to cowpea since they perceived that cowpea does not require fertilizer or they sometimes use insufficient nutrient input, inappropriate fertilizers that resulted in less productivity and lower yields. The soils require good fertilization to supply the needed nutrients for optimum cowpea production. There is dearth of documented information on the rate of phosphorous fertilizer to be applied and other agronomic requirements of cowpea in the guinea savanna ecological zone. The use of fertilizer by farmers in the region were merely based on experiences. The general grain yield of Cowpea especially in the marginal areas is still low and no single variety can be suitable for all conditions, where varietal requirements in terms of plant type, seed type, maturity and use pattern are highly diverse from region to region making breeding programmes for cowpea more complex than for other crops. A better understanding of the phosphorous requirement and best cowpea variety in the agro-ecological zone ought to be investigated. Therefore, this study was carried out to



determine the effect of phosphorous rates on the growth and yield of cowpea varieties on the Jos Plateau which lies in the Guinea savanna ecological zone of Nigeria.

## MATERIALS AND METHODS

### Experiment Site

The experiment was conducted at the Federal College of Forestry Demonstration Farm located in Jos North, Plateau State, Nigeria during the 2017 and 2018 rainy seasons. It is located between latitude 9° 95' and longitude 8° 89' with an altitude of about 1200 m above the sea level. The area lies within the Northern Guinea Savanna region of Nigeria with mean annual rainfall of 1460mm and temperature between 19°C and 32°C (Olowolafe *et al.*, 2004).

### Soil Sampling and Analysis

Composite soil samples were randomly taken at various points from the experimental site at a depth of 0 -15 cm before sowing in each season using soil auger. The samples were analyzed to determine the physical and chemical properties such as texture, pH, organic carbon, organic matter, total nitrogen, available phosphorus, exchangeable bases such as Potassium, Magnesium, Calcium, Sodium and Cations Exchange Capacity using standard procedure as described by Black (1965). The analyses were carried out at the Soil Laboratory of Agricultural Services and Training Center Kassa, Vom, Plateau State.

### Treatments and Experimental Design

The treatments consisted of four phosphorous rates (0, 20, 40 and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and three cowpea varieties (IT93K – 452 – 1, IT99K – 499 – 35 and IT90K – 277 – 2) factorially combined (4 x 3) and laid out in a randomized complete block design (RCBD) replicated three times. Each plot size was 3 x 3 m and a border row of 0.5 m was left between plots while 1 m was left out as alley between replications. The total experimental area was 42.5 x 13 m (552.5 m<sup>2</sup>).

The experimental site was prepared manually using hoe, cutlass and rake to remove all the dirt and debris. The cowpea variety seeds were sown at a depth of 4 cm with 2 to 3 seeds per hole in each of the plots at a spacing of 75cm between rows and 20 cm within rows. The fertilizer was applied basally on treatment basis in the form of Single Super Phosphate (SSP) using broadcasting method before sowing. Weeding was carried out manually by hand pulling and hoeing at 4 and 6 weeks after sowing. Harvesting was carried out manually by handpicking when the pods have reached full maturity.

### Assessment of Growth Characters of Cowpea

To assess various growth characters, data were collected from 10 randomly selected plants within each plot and the following characters were taken and recorded.

1. Plant height: The plant height was measured using meter rule from the base to the tip of the last leaf of the plant in centimeter (cm).
2. Number of leaves per plant: This was determined by counting the number of leaves on each of the randomly selected and tagged plants (10 plants) from each plot.
3. Number of branches: This was carried out by counting the number of branches on each of the plants randomly selected and tagged.
4. Leaf area: This was determined by measuring the length and breadth of the leaf and multiplying them with K (correction factor for cowpea) to get the leaf area using a ruler in square centimeter (cm<sup>2</sup>).

$$\text{LeafArea} = \text{LeafLength} * \text{LeafBreadth} * K \quad \dots(1)$$

where; K = 0.75 for cowpea.



### **Assessment of Yield Characters of Cowpea**

1. Days to 50% flowering: This involved counting the number of days when half of the randomly selected and tagged cowpea plants had flowered.
2. Number of pods per plant: The number of pods per plant was also determined by counting the number of pods on each of the plants randomly selected (10 plants) from the plots and the mean calculated.
3. Number of seeds per pod: This was carried out by counting the number of seeds in each pod for the 10 plants randomly selected and tagged and the mean calculated.
4. Grain Yield: The grain yield was determined by drying the harvested pods followed by threshing and winnowing after which the grains were weighed using a weighing balance and the grain yield extrapolated in tons per hectare ( $\text{tha}^{-1}$ ).

$$GY = (TGW * 10000) / PS \quad \dots(2)$$

where; GY = Grain Yield (t), TGW = Total grain weight (t), PS = Plot size ( $\text{m}^2$ )

### **Data Analysis**

All data collected were subjected to analysis of variance (ANOVA) at 5% level of significance using XLSTAT 2019 statistical package to test the treatment effects and Duncan Multiple Range Test (DMRT) was used to separate the means where significance was declared.

## **RESULTS AND DISCUSSION**

The results for 2017 and 2018 seasons on physical and chemical properties of the soil sample for the experimental site is presented in Table 1. The result indicated that the soil was predominantly sandy loam in texture, slightly acidic according to the rating by London (1991) with pH value of 5.78 and 5.97 at both 2017 and 2018 seasons. This similar trend was observed and reported by Ayodele, & Oso (2014).

As presented in Table 1, the available phosphorus was moderately low ( $5.8$  and  $5.9 \text{ mg kg}^{-1}$ ) while the exchangeable cations were low especially  $\text{K}^+$  ( $7.98$  and  $7.8 \text{ C mol kg}^{-1}$ ),  $\text{Ca}^{2+}$  ( $5.60$  and  $5.87 \text{ C mol kg}^{-1}$ ),  $\text{Mg}^{2+}$  ( $10.7$  and  $13 \text{ C mol kg}^{-1}$ ) and  $\text{Na}^+$  was moderate ( $90$  and  $97.9 \text{ C mol kg}^{-1}$ ). This result implies that the soil is low in fertility. These results according to London (1991) ratings are generally low.



**Table 1:** Physical and Chemical Properties of Soil at the Experimental Site

| Soil composition                                  | 2017       | 2018       |
|---|------------|------------|
| <b>Physical composition</b>                       |            |            |
| Sand (g kg <sup>-1</sup> )                        | 837        | 833        |
| Silt (g kg <sup>-1</sup> )                        | 101        | 102        |
| Clay (g kg <sup>-1</sup> )                        | 62         | 65         |
| Textural class (USD)                              | Sandy Loam | Sandy Loam |
| <b>Chemical composition</b>                       |            |            |
| Soil pH   | 5.78       | 5.97       |
| Organic carbon (%)                                | 1.61       | 0.79       |
| Available P (mg kg <sup>-1</sup> )                | 5.8        | 5.9        |
| Total Nitrogen (%)                                | 0.47       | 0.25       |
| <b>Exchangeable Cations (Cmolkg<sup>-1</sup>)</b> |            |            |
| Calcium   | 5.60       | 5.87       |
| Magnesium   | 10.7       | 13.0       |
| Sodium  | 90         | 97.9       |
| Potassium   | 7.98       | 7.8        |
| Cation Exchange Capacity (Cmolkg <sup>-1</sup> )  | 3.59       | 3.50       |

Source: Field Work 2017 and 2018 as Analyzed in Agricultural Services and Training Center KASSA/VOM.

### Assessment of Growth Characters of Cowpea

The effect of Phosphorous rates on the growth characters of cowpea in Jos North, Plateau State, Nigeria in 2017 and 2018 seasons is presented in Table 2. The result showed that the application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> produced taller plants of 40.60 and 41.11 cm height followed by application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> with 39.74 and 40.49 cm, the application of 20 and 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> produced the least plant height (34.95 and 35.67 cm and 31.81 and 32.44 cm) respectively. The number of leaves (59.11 and 60.22) of cowpea was highest with application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, then 58.33 and 59.78 leaves with the application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, the application of 20 and 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> gave the least number of leaves of 52.00 and 51.78 and 48.22, respectively, in 2017 and 2018 seasons. Statistically similar number of branches were measured with the application of 40 (15.44) and 60 (15.89 and 15.78) kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> but different from the application of 20 (13.56 and 14.11) and 0 (13.44) kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded the highest leaf area (120.16 and 120.74 cm<sup>2</sup>) for cowpea, followed by 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (115.91 and 117.63 cm<sup>2</sup>) with the control (0kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) having the smallest leaf area. This implies that the growth characters of cowpea increase with increasing rates of phosphorous fertilizer. This is consistent with the findings of Nkaa *et al* (2014). Similarly, Salve and Gungal (2011) and Kabir *et al.* (2013) found that applying 50-60 kg P ha<sup>-1</sup> to plants enhanced plant height considerably. The involvement of phosphorus in the development of a more extensive root system, which improved proper absorption of water and nutrients from the soil, could explain the rise in plant growth caused by phosphate application as explained by Imam *et al.* (2014). However, the findings contrast those of Shiyam (2010), who found that varying phosphorus levels had no significant effect on plant height. The significant growth response of cowpea to Phosphorus fertilizer application can be attributed to the fact that Phosphorus stimulates root and plant growth, initiates nodule formation, and influences the overall efficiency of the rhizobium-legume symbiosis, thereby optimizing the Biological Nitrogen Fixation (BNF) system of legumes (Ndor *et al.*, 2012).





Table 2 shows the varietal difference for both seasons (2017 and 2018) among the three cowpea varieties. IT93K-452-1 variety consistently produced the highest plant height (38.37 and 38.97 cm), number of leaves (55.78 and 57.08), number of branches (15.25 and 15.28) and leaf area (112.78 and 113.35 cm<sup>2</sup>) as against the other varieties. Individual variety genetic differences could explain the differences in plant height (Magani and Kuchinda, 2009). The findings are also in line with those of Karikari *et al.* (2015), who believe that plant growth is influenced by diversity. There was also a significant effect in the relationship between the varieties and the phosphorus treatments (Nkaa *et al.*, 2014). Singh *et al.* (2003) found that differences in cowpea variety development and yield were mostly related to changes in the varieties' underlying genetic composition. Similarly, Haruna and Usman (2013) found significant differences in growth and yield characteristics of certain improved cowpea varieties at the same location, which they attributed to the genetic makeup of the varieties studied.



**Table 2:** Effect of Phosphorous Rates on the Growth Characters of Cowpea Varieties in Jos North, Plateau State, Nigeria

| Treatment  | Plant height (cm)  |                    | Number of leaves   |                    | Number of branches |                    | Leaf area (cm <sup>2</sup> ) |                     |
|--|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|------------------------------|---------------------|
|  | 2017               | 2018               | 2017               | 2018               | 2017               | 2018               | 2017                         | 2018                |
| Phosphorus (Kgha <sup>-1</sup> P <sub>2</sub> O <sub>5</sub> ) |                    |                    |                    |                    |                    |                    |                              |                     |
| 0  | 31.81 <sup>d</sup> | 32.44 <sup>d</sup> | 48.22 <sup>c</sup> | 48.22 <sup>c</sup> | 13.44 <sup>b</sup> | 13.44 <sup>c</sup> | 90.03 <sup>d</sup>           | 90.91 <sup>d</sup>  |
| 20   | 34.95 <sup>c</sup> | 35.67 <sup>c</sup> | 52.00 <sup>b</sup> | 51.78 <sup>b</sup> | 13.56 <sup>b</sup> | 14.11 <sup>b</sup> | 95.21 <sup>c</sup>           | 95.43 <sup>c</sup>  |
| 40   | 39.74 <sup>b</sup> | 40.49 <sup>b</sup> | 58.33 <sup>a</sup> | 59.78 <sup>a</sup> | 15.44 <sup>a</sup> | 15.44 <sup>a</sup> | 120.16 <sup>a</sup>          | 120.74 <sup>a</sup> |
| 60   | 40.60 <sup>a</sup> | 41.11 <sup>a</sup> | 59.11 <sup>a</sup> | 60.22 <sup>a</sup> | 15.89 <sup>a</sup> | 15.78 <sup>a</sup> | 115.91 <sup>b</sup>          | 117.63 <sup>b</sup> |
| SE±  | 0.15               | 0.20               | 0.35               | 0.30               | 0.26               | 0.21               | 0.57                         | 0.42                |
| LS   | **                 | **                 | **                 | **                 | **                 | **                 | **                           | **                  |
| Variety  |                    |                    |                    |                    |                    |                    |                              |                     |
| IT90K-277-2  | 35.84 <sup>b</sup> | 36.61 <sup>b</sup> | 53.08 <sup>c</sup> | 52.83 <sup>c</sup> | 13.92 <sup>c</sup> | 14.00 <sup>b</sup> | 100.60 <sup>c</sup>          | 101.67 <sup>c</sup> |
| IT93K-452-1  | 38.37 <sup>a</sup> | 38.97 <sup>a</sup> | 55.75 <sup>a</sup> | 57.08 <sup>a</sup> | 15.25 <sup>a</sup> | 15.58 <sup>a</sup> | 112.78 <sup>a</sup>          | 113.35 <sup>a</sup> |
| IT99K-499-35   | 36.12 <sup>b</sup> | 36.71 <sup>b</sup> | 54.42 <sup>b</sup> | 55.08 <sup>b</sup> | 14.58 <sup>b</sup> | 14.50 <sup>b</sup> | 102.60 <sup>b</sup>          | 103.52 <sup>b</sup> |
| SE±  | 0.13               | 0.18               | 0.30               | 0.26               | 0.22               | 0.18               | 0.49                         | 0.37                |
| LS   | **                 | **                 | **                 | **                 | **                 | **                 | **                           | **                  |
| Interaction  |                    |                    |                    |                    |                    |                    |                              |                     |
| V x P  | **                 | **                 | **                 | **                 | NS                 | **                 | **                           | **                  |

Note: Means in a column of any set of treatment(s) followed by different letter (s) are significantly different, WAS = Weeks After Sowing, SE = Standard Error, LS = Level of Significance, NS = Not Significant, \*\*Significant at  $p \leq 0.01$



As presented in Table 2, the highest grain yield of 75 and 1.82tha<sup>-1</sup> was produced by IT93K-452-1 variety in both seasons. Varieties IT90K-277-2 and IT99K-499-35 produced least grain yield in both seasons. Days to first flowering and days to 50% flowering of the varieties was influenced by phosphorus levels of cowpea varieties (Mawo *et al.*, 2018). Ndor *et al.* (2012) found a considerable variance in growth and yield characters of some improved cowpea varieties, which they attributed to the genetic makeup of the varieties studied and the available phosphorus in the soil. Similar report was made by Krasilnikoff *et al.* (2003) and Singh *et al.* (2003) that varieties differ in their genetic makeup and this could have reflected their yield. Olaleye *et al.* (2011) discovered a discrepancy in the differential phosphorus responses of 35 cowpea lines, which he linked to low soil fertility. This analysis backs up the findings of Haruna and Usman (2013) and Singh *et al.* (2011), who found that spreading and semi-spreading cowpea varieties have different growth and development potential, which can alter crop production.

### Assessment of Yield Characters of Cowpea

The effect of Phosphorous rates on the yield characters of cowpea varieties in Jos North, Plateau State, Nigeria for the 2017 and 2018 seasons as presented in Table 3 indicates that there were significant differences among the treatments at  $p \leq 0.01$ . The result showed that the least number of days for cowpea plant to attain 50% flowering (36.78 days) was observed at application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> with the untreated plots (0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) taking more days (43.00 and 43.44) to reach 50% flowering. The application of 40 and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was found to produce statistically similar number of pods plant<sup>-1</sup> (55.00 and 55.33), number of seeds pod<sup>-1</sup> (11.67 and 11.56 and 12.00 and 12.33) and total yield (1.80 and 1.82 t/ha and 1.88 and 1.84 t/ha) in 2017 and 2018 seasons respectively. The use of P fertilizer boosted the components of yield in terms of number of pods per plant, number of seeds per pod, and total yield significantly (P0.01). Other researchers have observed a considerable increase in yield qualities of cowpea in response to P treatment, and the findings in this study are consistent with their findings (Singh *et al.*, 2011; Ndor *et al.*, 2012; Haruna and Usman, 2013). The findings were comparable to those of Boahene (2013), who found that phosphorus application improved the number of pods plant<sup>-1</sup>, hundred seed weight, shelled seed yield, and dry matter yield up to a rate of 20 kg P ha<sup>-1</sup>, but dropped after that rate of P.

Highly significant ( $P \leq 0.01$ ) varietal difference was observed in both seasons (Table 3). The highest number of days (40.58 and 40.83) to reach 50% flowering was obtained at IT90K-277-2 variety followed by IT99K-499-35 (39.50 and 39.42) and IT93K-452-1 with less (38.67 and 38.75) number of days to attain 50% flowering. Similarly, varietal differences were highly significant ( $P \leq 0.01$ ) with respect to number of pods per plant in both seasons. IT93K-452-1 variety consistently gave higher (53.67 and 54.50) pods per plant in 2018 as against IT99K-499-35 (48.92 and 51.00) and IT90K-277-2 (47.67 and 48.83) varieties, respectively. Varietal differences were observed to be highly significant ( $P \leq 0.01$ ) on number of seeds per pod in both seasons. In 2018 and the mean IT93K-452-1 variety gave the highest (11.58 and 11.67) number of seeds per pod followed by IT99K-499-35 (10.75 and 10.92) and IT90K-277-2 produced the least) number of seeds per pod (10.42 and 10.50 in both seasons. The result (Table 3) indicates that there was significant difference variety of on yield of cowpea in 2017 and 2018 growing seasons.





**Table 3:** Effect of Phosphorous Rates on the Yield Characters of Cowpea Varieties in Jos North, Plateau State, Nigeria

| Treatment   | Days to 50% Flowering |                    | Number of Pods Plant <sup>-1</sup> |                    | Number of Seeds Pod <sup>-1</sup> |                    | Total Yield (t ha <sup>-1</sup> ) |                   |
|---|-----------------------|--------------------|------------------------------------|--------------------|-----------------------------------|--------------------|-----------------------------------|-------------------|
|   | 2017                  | 2018               | 2017                               | 2018               | 2017                              | 2018               | 2017                              | 2018              |
| Phosphorus<br>(Kgha <sup>-1</sup> P <sub>2</sub> O <sub>5</sub> ) |                       |                    |                                    |                    |                                   |                    |                                   |                   |
| 0   | 43.00 <sup>a</sup>    | 43.44 <sup>a</sup> | 42.22 <sup>c</sup>                 | 43.00 <sup>d</sup> | 8.67 <sup>c</sup>                 | 8.89 <sup>c</sup>  | 1.33 <sup>b</sup>                 | 1.55 <sup>b</sup> |
| 20  | 40.22 <sup>b</sup>    | 40.33 <sup>b</sup> | 47.78 <sup>b</sup>                 | 50.44 <sup>c</sup> | 9.89 <sup>b</sup>                 | 10.44 <sup>b</sup> | 1.38 <sup>b</sup>                 | 1.47 <sup>b</sup> |
| 40  | 38.33 <sup>c</sup>    | 38.11 <sup>c</sup> | 55.00 <sup>a</sup>                 | 56.78 <sup>a</sup> | 11.67                             | 12.00 <sup>a</sup> | 1.80 <sup>a</sup>                 | 1.88 <sup>a</sup> |
| 60  | 36.78 <sup>d</sup>    | 36.78 <sup>d</sup> | 55.33 <sup>a</sup>                 | 55.56 <sup>b</sup> | 11.56                             | 12.33 <sup>a</sup> | 1.82 <sup>a</sup>                 | 1.84 <sup>a</sup> |
| SE±   | 0.22                  | 0.27               | 0.54                               | 0.41               | 0.27                              | 0.22               | 0.04                              | 0.04              |
| LS  | **                    | **                 | **                                 | **                 | **                                | **                 | **                                | **                |
| Variety   |                       |                    |                                    |                    |                                   |                    |                                   |                   |
| IT90K-277-2   | 40.58 <sup>a</sup>    | 40.83 <sup>a</sup> | 47.67 <sup>c</sup>                 | 48.83 <sup>c</sup> | 10.00 <sub>c</sub>                | 10.42 <sup>b</sup> | 1.49 <sup>b</sup>                 | 1.64 <sup>b</sup> |
| IT93K-452-1   | 38.67 <sup>c</sup>    | 38.75 <sup>b</sup> | 53.67 <sup>a</sup>                 | 54.50 <sup>a</sup> | 11.08 <sub>a</sub>                | 11.58 <sup>a</sup> | 1.75 <sup>a</sup>                 | 1.82 <sup>a</sup> |
| IT99K-499-35  | 39.50 <sup>b</sup>    | 39.42 <sup>b</sup> | 48.92 <sup>b</sup>                 | 51.00 <sup>b</sup> | 10.25 <sub>b</sub>                | 10.75 <sup>b</sup> | 1.51 <sup>b</sup>                 | 1.59 <sup>b</sup> |
| SE±   | 0.19                  | 0.23               | 0.46                               | 0.35               | 0.23                              | 0.19               | 0.03                              | 0.04              |
| LS  | **                    | **                 | **                                 | **                 | **                                | **                 | **                                | **                |
| Interaction   |                       |                    |                                    |                    |                                   |                    |                                   |                   |
| V x P   | **                    | **                 | NS                                 | **                 | NS                                | *                  | **                                | **                |

Means in a column of any set of treatment(s) followed by different letter (s) are significantly different, WAS = Weeks After Sowing, SE = Standard Error, LS = Level of Significance, \*\*Significant at  $p \leq 0.01$



### **Interaction Effect of Phosphorous and Variety on the Yield (tons ha<sup>-1</sup>) of Cowpea**

The interaction between phosphorous and variety on grain yield of cowpea in both seasons is presented in Table 4. In 2017, variety IT93K-452-1 variety in combination with 40 and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, produced the highest grain yield (2.18 and 2.05 t/ha) which were found to be statistically similar. In 2018, variety IT93K-452-1 in combination with 40kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> produced the highest grain yield (2.35 tons ha<sup>-1</sup>). The result revealed that variety IT90K-277-2 did not respond to the application of phosphorus application. It's possible that this is related to phosphorus' function in enhancing photosynthetic efficiency, which leads to appropriate seed production and grain filling. The maximum yield components of cowpea were reported when 40 and 60 kg P ha<sup>-1</sup> were applied to IT93K – 452 – 1. This means that when 40 and 60 kg P ha<sup>-1</sup> were applied to the IT93K-452-1 variety, increased yield was observed. According to Mawo *et al.* (2018), there was no significant interaction effect between phosphorous and cowpea on cowpea growth and yield characteristics.



**Table 4:** Interaction Effect of Phosphorous and Variety on the Yield (tons ha<sup>-1</sup>) of Cowpea in Jos North, Plateau State, Nigeria

| Phosphorus<br>(Kgha <sup>-1</sup> P <sub>2</sub> O <sub>5</sub> ) | 2017 Variety       |                    |                    | 2018 Variety        |                   |                     |
|---|--------------------|--------------------|--------------------|---------------------|-------------------|---------------------|
|   | IT90K-277-2        | IT93K-452-1        | IT99K-499-35       | IT90K-277-2         | IT93K-452-1       | IT99K-499-35        |
| 0   | 1.29 <sup>e</sup>  | 1.35 <sup>e</sup>  | 1.34 <sup>e</sup>  | 1.70 <sup>cd</sup>  | 1.46 <sup>e</sup> | 1.49 <sup>de</sup>  |
| 20  | 1.39 <sup>de</sup> | 1.41 <sup>de</sup> | 1.35 <sup>e</sup>  | 1.50 <sup>de</sup>  | 1.45 <sup>e</sup> | 1.45 <sup>e</sup>   |
| 40  | 1.66 <sup>bc</sup> | 2.18 <sup>a</sup>  | 1.57 <sup>cd</sup> | 1.68 <sup>cde</sup> | 2.35 <sup>a</sup> | 1.60 <sup>cde</sup> |
| 60  | 1.64 <sup>bc</sup> | 2.05 <sup>a</sup>  | 1.78 <sup>b</sup>  | 1.66 <sup>cde</sup> | 2.03 <sup>b</sup> | 1.82 <sup>c</sup>   |
| SE±   |                    | 0.06               |                    |                     | 0.07              |                     |
| LS  |                    | **                 |                    |                     | **                |                     |

Note: Means followed by different letter (s) are significantly different, SE = Standard Error, LS = Level of Significance, \*\*Significant at  $p \leq 0.01$



## CONCLUSION AND RECOMMENDATIONS

It can be concluded from the results obtained that phosphorous rates and variety had significant effect on the growth and yield of cowpea. The application of 60 kg P ha<sup>-1</sup> gave the highest plant height, number of leaves, number of branches and least number of days to reach 50% flowering. While the application of 40 kg P ha<sup>-1</sup> gave the highest leaf area, number of podsplant<sup>-1</sup>, number of seedspod<sup>-1</sup> and total yield. IT93K-452-1 variety produced the highest response for growth and yield as against the other two varieties. The application of 40 kg P ha<sup>-1</sup> to IT93K – 452 – 1 was found to produce the highest growth and yield components of cowpea. This implies that phosphorous rates significantly affected the growth and yield of cowpea varieties. It is therefore, recommended that 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> be applied to IT93K-452-1 variety for higher yield of cowpea in the study area.

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