MSI Journal of
Multidisciplinary Research (MSIJMR)

EFFECTS OF VARIETIES AND PHOSPHORUS RATES ON THE GROWTH AND YIELD OF SOYBEAN (*Glycine max* (L) Merrill) IN GOMBE SUDAN SAVANNA

Haruna P.[1*], Ali B.A[2], Yusuf, R.[3], Yunusa, A.[4], Pudza J.Y[5]

[1*,2,3,4,5]Federal College of Horticulture Dadinkowa department of Agricultural Technology.

*** Correspondence:** Haruna P.

The authors declare that no funding was received for this work.

OPEN ACCESS

Received: 06-April-2026
Accepted: 01-May-2026
Published: 06-May-2026

This article is published in the **MSI Journal of Multidisciplinary Research (MSIJMR) ISSN 3049-0669 (Online)**

The journal is managed and published by MSI Publishers.

Volume: 3, Issue: 5 (May-2026)

ABSTRACT: Field experiment was conducted during the 2023 rainy season at Teaching and Research Farm of the Faculty of Agriculture, Federal University of Kashere (Latitude 90 54' 46''N, Longitude 110 0' 27''E at 431 m above the sea level) Akko Local Government Area, Gombe State and at the Teaching and Research Farm of Federal College of Horticulture Dadinkowa, Yamaltu-Deba Local Government Area, Gombe State, Latitude 100 18'E and Longitude 11030 N and altitude of 218m above sea level. The treatments consisted of two varieties of soybean (TGX-1951 and TGX1448-2E) and four phosphorus rates (0, 20, 40 and 60 kg/ha), these were laid out in a Randomized Complete Block Design (RCBD) with four replications. Results of the study showed that soybean variety TGX1448-2E and 60 kg/ha of phosphorus rate significantly gave higher pod yield over TGX-1951 and the other phosphorus rates. The control treatment of no phosphorus applied significantly gave lower pod yield in this study. TGX1448-2E and phosphorus rate of 60 kg/ha should be used by farmers who grow soybean based from their performances in terms of pod yield from the study areas.

Keywords: *Phosphorus, Rate, Soybean, Growth and Yield*

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is one of the most important legume crops for human nutrition and has been cultivated in arid and semi-arid regions. The importance of soybean is linked to its high protein content of 25%-29% (Bationo *et al.*, 2011). Soybean seed is a source of protein and oil for human nutrition and a source of soybean meal for livestock feed (Bationo *et al.*, 2011). Soybean protein meal and soybean oil account for 69% and 30%, respectively of the world's supply of protein meal and edible oil. Many international and domestic soybean processors prefer soybean with at least 340 g per kg protein and 190 g/kg oil, assuming 130 g/kg seed moisture. Soybean seed quality is determined by the quantity and quality of protein and oil content seed composition (Amba *et al.*, 2011).

In his study Devi *et al*. (2012) evaluated the effect of phosphorus on the growth and yield of soybean varieties sourced from republic of Niger and reported a significant response to applied phosphorus on pods/plant, grain and yield and 100-seed weight with highest response to the application of 60 kg phosphorus/ha.

Chiezey and Odunze (2009) studied the effect of three levels of phosphorus fertilizer 10, 20, 30 kg phosphorus/ha on soybean grain yield, results showed that the phosphorus fertilization significantly increased soybean grain yields the average yield responses to phosphorus varied from 87 kg/ha to 217 kg/ha. Kellman (2008) indicated that application of different levels of phosphorus 30, 60, 90 and 120 kg P205/ha caused a significant increase of growth and yield parameters of soybean (Gan *et al.,* 2003). The results of the study revealed that application of 120 kg/ha phosphorus gave higher pod yield of 1955.56 kg/ha compared to the control of 1274.07 kg/ha. Also, the results of the same study showed that plant height was significantly affected by phosphorus application (Guareschi *et al*., 2011).

The maximum plant height of 56.2 cm was recorded with application of 120 kg P_20_5/ha, while the minimum plant height of 49.37 cm was observed in the control. However, in the absence of a proper crop variety and fertilizer inputs, yields are low in alkaline soils. The applied phosphorus gets fixed immediately after application in calcareous soils and the availability to the crop is poor. Genotypic differences for better growth under alkaline conditions have been demonstrated because genetic effects modifying tolerance to alkaline are heritable (Fatima *et al.,* 2007).

It has been reported that imbalanced and inadequate nutrition results in poor yields of soybean (Lawson *et al.*, 2008). Due to fixation of applied phosphorus in Alkali soils, higher doses of the nutrient is required to satisfy the fixation needs and the requirements of the crop (Lawson *et al.*, 2008). Alkali soils are generally poor in fertility and require optimum doses of nutrients for higher productivity. In many agriculture production systems, phosphorus has been identified as the most efficient essential nutrient after nitrogen (Lawson *et al.*, 2008). Calcareous soils are wide in spread throughout the world, thus the availability of phosphorus in these soils is low due to the higher calcium carbonate content which fixes phosphorus (Erman *et al.*, 2009)

Soybean yield is low in Nigeria because farmers give little attention to the use of phosphorus at an optimum rate, which tends to reduce the yield of soybean. Herridge *et al.* (2009) reported that deficiency of SSP reduces nodule formation. Low yield of soybean in Nigeria are attributed to many factors such as declining soil fertility and use of low yielding soybean varieties (Ferguson *et al*., 2006). Phosphorus is a soybean plant growth booster nutrient and therefore, application of phosphorus fertilizer at optimum rates and the use of good varieties of soybean is essential (Bakere *et al*., 2012).

Considering the importance of soybean as one of the most important protein sources, there is therefore the need to increase its productivity through the use of a suitable variety and adequate phosphorus rate in order to increase its productivity. In the study areas, farmers do not use suitable varieties and adequate phosphorus in order to increase soybean yield. It is expected that the findings from this study will serve as a guide to farmers in knowing suitable varieties of soybean and optimum phosphorus that will enhance its growth and yield in the study areas. In the light of the above, the trial was designed with the following objectives; to determine the effect of variety and phosphorus rates on the growth and yield of soybean in the study areas.

MATERIALS AND METHODS

Experimental Sites

Field trials were conducted during the 2023 rainy season at the Teaching and Research Farm of the Department of Agronomy, Faculty of Agriculture, Federal University of Kashere (Latitude $9^0$54N, Longitude 11^0 27'E and altitude 349 m above the sea level) and at the Teaching and Research Farm of Federal College of Horticulture Dadinkowa, Latitude 10^0 18'E and Longitude $11^0$30 N and altitude of 218m above sea level.

Treatments and Experimental Design

The experiments consisted of two varieties of soybean **(**TGX-1951) and TGX1448-2E) and four rates of phosphorus (0, 20, 40 and 60 kg P205/ha). These were combined and laid out in a Randomized Complete Block Design (RCBD) with four replications.

Cultural Practices

The soil fertility status of the experimental sites was determined before designing the experiment; two portions were selected randomly at a soil depth of 30cm to give a composite soil sample. The samples were analyzed to determine the physical and chemical properties of the experimental sites. The land was cleared manually using simple farm tools such as a cutlass, hand hoe and rake. The layout was designed and pegged after which beds were raised using a hand hoe. Three seeds of soybean were sown per hole at a spacing of 30 x 50cm and later thinned to two seedlings after emergence, weeding was done manually with the use of a hoe at 3 and 6 weeks after sowing (WAS).

Data Collection

Five stands were randomly sampled from each net plot and used for data collection on the variables.

Plant height (cm)

Plant height was measured from the base of the plant to the terminal bud of the main stem from the five sampled plants using a measuring tape graduated in cm and the average taken and recorded.

Number of leaves/plant

Total number of leaves/plant from the five sampled plants was obtained by physical counting, the average taken and recorded.

Number of branches/ plant

Number of branches/plant was obtained by physical counting of number branches from the five sampled plants, the average taken and recorded

Leaf area (cm^2)

Leaf area was determined from the five sampled plants in the middle rows using a leaf area meter (Model-MK-2) in each treatment; the average was taken and recorded (Shortal and Liebbardt, 2000).

Number of nodules/plant

Number of nodules/plant was obtained by physical counting of number of both effective and ineffective nodules from the five sampled plants, the average taken and recorded.

Days to 50 % flowering

Days to 50% flowering were determined when by noting the number of days when 50% of plants in each treatment have flowered.

Number of pods/plant

Number of pods/plant was obtained by physically counting the cobs from the five sampled plants in each treatment, the average taken and recorded.

Number of pods/ha

Number of pods/ha was obtained by physical counting from the five sampled plants in each treatment, the average determined and recorded.

100 Seed weight (g)

100 seeds were weighed from the five sampled plants in each treatment, the average taken and recorded.

Shelling %

Shelling % was obtained from the five sampled plants in each treatment, by dividing seed yield/plant with pod yield/plant; multiplied by 100%, the average taken and recorded.

Pod yield (g)/plant

Pod yield/plant was obtained by weighing the pods from the five sampled plants in each treatment, the average taken and recorded.

Pod yield (kg)/ha

Pod yield /ha was obtained by converting pod yield/plant to pod yield/ha.

Seed yield (g)/plant

Seed yield/plant was obtained by weighing the seeds from the five sampled plants in each treatment, the average taken and recorded.

Sees yield (kg)/ha

Seed yield/ha was obtained by converting seed yield per plant to seed yield/ha.

Data Analysis

Data collected were subjected to Analysis of Variance (ANOVA). Means were separated using the Least Significant Difference at 5% level of probability (Gomez and Gomez, 1984).

RESULTS

Physical and chemical characteristics of the soil used for the experiment in Kashere and Dadinkowa

Table 1 shows the physical and chemical characteristics of the soil in Kashere and Dadinkowa. The soil contained a higher proportion of sand (77.34 and 70.60), low clay (8.86 and 10.40), low silt (5.80 and 5.58), low organic carbon (3.60 and 3.30), medium PH (5.36 and 5.40), low total nitrogen (3.40 and 3.50), low available phosphorus (2.20 and 2.32), low available potassium (1.72 and 1.70), low available calcium (0.53 and 0.54), low available sodium (0.50, 0.51 and 0.51), low available magnesium (1.22 and 1.20) and low cation exchange capacity (5.25 and 5.40).

Plant height (cm)

Table 2 shows the effects of variety and phosphorus and phosphorus on plant height of soybean at Kashere and Dadinkowa. There was no significant difference (P≥0.05) among the treatment means due to variety on plant height. However, there was a significant difference (P≤0.05) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus rate significantly produced the highest treatment means of (47.61, 48.11 and 47.86) at Kashere, Dadinkowa and combined on plant height, followed by the 40 kg/ha which produced treatment means of (45.66, 46.05 and 45.86), followed by the 20 kg/ha of phosphorus rate which produced treatment means of (43.84, 44.90 and 44.37). The control treatment significantly gave the lowest treatment means of (42.71, 43.43 and 43.07). An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases in plant height of soybean at Kashere, Dadinkowa and combined. There was no significant interaction at (P≥0.05) of variety with phosphorus on plant height at Kashere, Dadinkowa and combined.

Number of leaves/plant

Table 2 shows the effects of variety and phosphorus on number of leaves/plant of soybean at Kashere, Dadinkowa and combined. There was a significant difference (P≤0.05) among the treatment means due to variety on number of leaves/plant. TGX-1951 significantly produced higher mean values of (14.43 and 14.54) in Kashere and combined, but lower mean value in Dadinkowa of (13.86) over TGX1448-2E, which produced mean values of (13.63 and 13.20) and a higher mean value in Dadinkowa over TGX-1951 of (14.64) on number of leaves/plant of soybean. Table 2 shows the effect of phosphorus on number of leaves/plant of soybean at Kashere, Dadikowa and the combined. There was a significant difference (P≤0.05) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus significantly produced higher treatment means of (16.08, 15.72 and 15.90), followed by the 40 kg/ha of phosphorus rate which produced treatment means of (14.81, 14.41 and 14.61), followed by 20 kg/ha of phosphorus rate of (13.48, 13.73 and 13.60). The control treatment of no phosphorus applied produced lower treatment means of (11.76, 13.12 and 12.44) on number of leaves/plant. An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases on number of leaves per plant of soybean at Kashere, Dadinkowa and the combined. There was no significant interaction at ($P>0.05$) of variety with phosphorus on the number of leaves/plant at Kashere, Dadinkowa and combined.

Number of branches/plant

Table 3 shows the effects of variety and phosphorus on number of branches/plant of soybean at Kashere, Dadikowa and combined. There was no significant difference ($P\geq0.05$) among the treatment means due to variety on number of branches/plant. However, there was a significant difference ($P\leq0.05$) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus significantly produced higher treatment means of (8.20, 7.99 and 8.09), followed by the 40 kg/ha of phosphorus rate which produced treatment means of (7.51, 7.29 and 7.40), followed by 20 kg/ha of phosphorus rate of (6.61, 6.58 and 6.59), while the control treatment of no phosphorus applied produced lower treatment means of (5.54, 5.92 and 5.73) on number of branches/plant. An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases on number of branches/plant of soybean at Kashere, Dadinkowa and the combined. There was no significant interaction at ($P>0.05$) of variety with phosphorus on the number of branches/plant at Kashere, Dadinkowa and combined.

Leaf area (cm^2)

Table 3 shows the effects of variety and phosphorus on leaf area of soybean at Kashere, Dadikowa and combined. There was no significant difference ($P>0.05$) among the treatment means due to variety on leaf area. Also, there was no significant difference ($P>0.05$) among the treatment means due to phosphorus. There was also no significant interaction at ($P>0.05$) of variety with phosphorus on leaf area at Kashere, Dadinkowa and combined.

Number of nodules/plant

Table 4 shows the effects of variety and phosphorus on number of nodules/plant of soybean at Kashere, Dadikowa and combined. There was a significant difference ($P \leq 0.05$) among the treatment means due to variety on number of nodules/plant. TGX-1951 significantly produced a higher mean of (7.41) in Kashere over TGX1448-2E and lower means of (6.06 and 5.85) in Dadinkowa and combined over TGX1448-2E which produced higher means of (6.75 and 7.08) in Dadinkowa and combined. There was a significant difference ($P \leq 0.05$) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus significantly produced higher treatment means of (7.38, 7.09 and 7.23), followed by the 40 kg/ha of phosphorus rate which produced treatment means of (6.83, 6.57 and 6.70), followed by 20 kg/ha of phosphorus rate of (6.32, 6.29 and 6.30), while the control treatment of no phosphorus applied produced lower treatment means of (5.54, 5.67 and 5.61) on number of nodules/plant. An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases on number of nodules/plant of soybean at Kashere, Dadinkowa and the combined. There was no significant interaction at ($P > 0.05$) of variety with phosphorus on the number of nodules/plant at Kashere, Dadinkowa and combined.

Days to 50% flowering

Table 4 shows the effects of variety and phosphorus on days to 50% flowering of soybean at Kashere, Dadikowa and the Combined. There was no significant difference ($P > 0.05$) among the treatment means due to variety on days to 50% flowering. There was also no significant difference ($P > 0.05$) among the treatment means due to phosphorus. There was no significant interaction at ($P > 0.05$) of variety with phosphorus on days to 50% flowering at Kashere, Dadinkowa and combined.

Number of pods/plant

Table 5 shows the effect of variety on number of pods/plant of soybean at Kashere, Dadikowa and the Combined. There was no significant difference ($P \geq 0.05$) among the treatment means due to variety on number of pods/plant. There was a significant difference ($P \leq 0.05$) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus significantly produced higher treatment means of (32.48, 28.68 and 30.58), followed by the 40 kg/ha of phosphorus rate which produced treatment means of (30.28, 27.37 and 28.83), followed by 20 kg/ha of phosphorus rate of (28.98, 26.04 and 27.51). The control treatment of no phosphorus applied produced lower treatment means of (27.52, 24.63 and 26.08) on number of pods/plant. An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases on number of pods/plant of soybean at Kashere, Dadinkowa and the combined. There was no significant interaction at ($P \geq 0.05$) of variety with phosphorus on the number of pods/plant at Kashere, Dadinkowa and combined.

Number of pods/ha

Table 5 shows the effects of variety and phosphorus on number of pods/ha of soybean at Kashere, Dadikowa and combined. There was a significant difference ($P \leq 0.05$) among the treatment means due to variety on number of pods/ha at Kashere, Dadinkowa and combined. TGX-1951 significantly produced higher means of (3,213.33, 2,274.16 and 2,410.83) over TGX1448-2E which produced means of (2,422.49, 2,239.16 and 2,297.49). There was a significant difference ($P \leq 0.05$) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus significantly produced higher treatment means of (2,706.66, 2,389.99 and 2,548.33), followed by the 40 kg/ha of phosphorus rate which produced treatment means of (2,523.33, 2,280.83 and 2,402.49), followed by 20 kg/ha of phosphorus rate of (2,414.99, 2,169.99 and 2,292.49), while the control treatment of no phosphorus applied produced lower treatment means of (2,293.33, 2,052.49 and 2,173.33) on number of pods/ha. An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases on number of pods/ha of soybean at Kashere, Dadinkowa and combined. There was no significant interaction at ($P > 0.05$) of variety with phosphorus on the number of leaves per hectare at Kashere, Dadinkowa and combined.

100 seed weight (g)

Table 6 shows the effects of variety and phosphorus on 100 seed weight of soybean at Kashere, Dadikowa and combined. There was no significant difference (P≥0.05) among the treatment means due to variety on 100 seed weight at Kashere, Dadinkowa and combined. There was a significant difference (P≤0.05) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus significantly produced higher treatment means of (127.89, 116.98 and 122.43), followed by the 40 kg/ha of phosphorus rate which produced treatment means of (118.78, 110.15 and 114.46), followed by 20 kg/ha of phosphorus rate of (113.74, 104.32 and 109.03). The control treatment of no phosphorus applied produced lower treatment means of (106.55, 99.39 and 102.97) on 100 seed weight. An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases on 100 seed weight of soybean at Kashere, Dadinkowa and combined. There was no significant interaction at (P>0.05) of variety with phosphorus on 100 seed weight of soybean at Kashere, Dadinkowa and combined.

Shelling (%)

Table 6 shows the effects of variety and phosphorus on shelling % of soybean at Kashere, Dadikowa and combined. There was no significant difference (P>0.05) among the treatment means due to variety on shelling % at Kashere, Dadinkowa and combined. However, there was a significant difference (P≤0.05) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus significantly produced higher treatment means of (12.79, 12.08 and 12.44), followed by the 40 kg/ha of phosphorus rate which produced treatment means of (12.74, 12.05 and 12.28), followed by 20 kg/ha of phosphorus rate of (12.49, 11.85 and 12.27), while the control treatment of no phosphorus applied produced lower treatment means of (11.82, 11.81 and 11.84) on shelling %. An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases on shelling % of soybean at Kashere, Dadinkowa and combined. There was no significant interaction at (P≥0.05) of variety with phosphorus on shelling % of soybean at Kashere, Dadinkowa and combined.

Pod yield/plant (g)

Table 7 shows the effects of variety and phosphorus on pod yield/plant of soybean at Kashere, Dadikowa and combined. There was a significant difference (P≤0.05) among the treatment means due to variety on pod yield/plant at Kashere and Dadinkowa. TGX-1951 significantly produced a higher mean of (122.59) in Kashere over TGX1448-2E which produced a mean of (115.39) on pod yield/plant. However, in Dadinkowa and combined, TGX1448-2E significantly produced higher means of (117.03 and 119.81) over TGX-1951 which produced means of (106.10 and 110.75). There was also a significant difference ($P \leq 0.05$) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus significantly produced higher treatment means of (126.86, 120.73 and 123.57), followed by the 40 kg/ha of phosphorus rate which produced treatment means of (121.96, 116.69 and 119.32), followed by 20 kg/ha of phosphorus rate of (118.92, 108.17 and 113.54), while the control treatment of no phosphorus applied produced lower treatment means of (108.22, 101.13 and 104.68) on pod yield/plant. An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases on pod yield/plant of soybean at Kashere, Dadinkowa and combined. There was no significant interaction at ($P \geq 0.05$) of variety with phosphorus on pod yield/plant of soybean at Kashere, Dadinkowa and combined.

Pod yield/ha (kg)

Table 7 shows the effects of variety and phosphorus on pod yield/ha of soybean at Kashere, Dadikowa and combined. There was a significant difference ($P \leq 0.05$) among the treatment means due to variety on pod yield/ha at Kashere, Dadinkowa and combined. TGX1448-2E significantly produced higher means of (9,615.83, 9,817.45 and 9,984.16) over TGX-1951 which produced means of (9,382.49, 8,841.66 and 9,229.99) on pod yield/ha. There was also a significant difference ($P \leq 0.05$) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus significantly produced higher treatment means of (10, 571.66, 10, 060.83 and 10. 297.49), followed by the 40 kg/ha of phosphorus rate which produced treatment means of (10, 163.33, 9, 724.16 and 9, 943.33), followed by 20 kg/ha of phosphorus rate of (9, 909.99, 9, 014.16 and 9, 461.66), while the control treatment of no phosphorus applied produced lower treatment means of (9, 018.33, 8, 427.49 and 8, 723.33) on pod yield/ha. An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases on pod yield/plant of soybean at

Kashere, Dadinkowa and combined. There was no significant interaction at ($P \geq 0.05$) of variety with phosphorus on pod yield/ha of soybean at Kashere, Dadinkowa and combined.

Seed yield/plant (g)

Table 8 shows the effects of variety and phosphorus on seed yield/plant of soybean at Kashere, Dadikowa and combined. There was a significant difference ($P \leq 0.05$) among the treatment means due to variety on pod yield/plant at Kashere and Dadinkowa. TGX-1951 significantly produced a higher mean of (91.94) in Kashere over TGX1448-2E which produced a mean of (86.54) on seed yield/plant. However, in Dadinkowa and combined, TGX1448-2E significantly produced higher means of (87.77 and 89.86) over TGX-1951 which produced means of (79.58 and 83.06). There was also a significant difference ($P \leq 0.05$) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus significantly produced higher treatment means of (95.15, 90.55 and 92.68), followed by the 40 kg/ha of phosphorus rate which produced treatment means of (91.47, 87.52 and 89.49), followed by 20 kg/ha of phosphorus rate of (89.19, 81.13 and 85.16), while the control treatment produced lower treatment means of (81.17, 75.85 and 78.51) on seed yield per plant. An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases on seed yield per plant of soybean at Kashere, Dadinkowa and combined. There was no significant interaction at ($P \geq 0.05$) of variety with phosphorus on seed yield/plant of soybean at Kashere, Dadinkowa and combined.

Seed yield /ha (kg)

Table 8 shows the effects of variety and phosphorus on seed yield/ha of soybean at Kashere, Dadikowa and combined. There was a significant difference ($P \leq 0.05$) among the treatment means due to variety on seed yield/ha at Kashere, Dadinkowa and combined. TGX1448-2E significantly produced higher means of (7211.87, 7363.09 and 7488.12) over TGX-1951 which produced means of (7036.87, 6631.25 and 6922.49) on seed yield/ha. There was also a significant difference ($P \leq 0.05$) among the treatment means due to phosphorus. The 60 kg/ha of phosphorus significantly produced higher treatment means of (7928.75, 7545.63 and 7723.12), followed by the 40 kg/ha of phosphorus rate which produced treatment means of (7622.50, 7293.12 and 7457.50), followed by 20 kg/ha of phosphorus rate of (7432.49, 6760.62 and 7096.25), while the control treatment of no phosphorus applied produced lower treatment means of (6763.75, 6320.62 and 6542.50) on seed yield/ha. An increase in phosphorus rate from the control treatment of 0 kg/ha to 60 kg/ha significantly led to increases on seed yield/ha of soybean at Kashere, Dadinkowa and combined. There was no significant interaction at ($P \geq 0.05$) of variety with phosphorus on seed yield/ha of soybean at Kashere, Dadinkowa and combined.

DISCUSSION

Effects of soil on the growth and yield of soybean at Kashere and Dadinkowa

The physical property of the soil at the trial sites was identified as sandy-loam with higher proportion of sand, low clay and low silt. The chemical analysis revealed that the soil contained low amount of organic carbon, total nitrogen, available phosphorus, magnesium, calcium, sodium and moderate cation exchange capacity. Phosphorus is an essential nutrient for crop growth and is an active ingredient of the protoplasm. It stimulates early growth and root formation, hastens maturity, promotes seed development, gives the stability to stem and contributes to the general hardiness of plants (Fatima *et al.*, 2007; Basu and Badoria, 2008; Amba *et al.,* 2011).

Majority of the tropical soils contain little available phosphorus for optimum growth and yield, consequently widespread responses to phosphorus have been obtained with most crops in the forest and savannah zones (Chiezey and Odunze, 2009; Bationo *et al.,* 2011; Bakere and Hailemariam, 2012; Bakere *et al*., 2012). From this study, it was observed that plots that received higher rates of phosphorus, promoted plant growth and yield; this signifies that when phosphorus fixation is very low, it enables plants to grow better and yield higher than soils that have higher fixation. This observation was reported by Chiezey and Odunze (2009); Bationo *et al. (*2011); Bakere and Hailemariam (2012); Bakere *et al*. (2012) that under low phosphorus fixation soil, crops grow and yield higher, whereas where fixation is higher in certain soils, growth and yield of crops is greatly affected and consequently reduced.

Effect of varieties on the growth and yield of soybean in Kashere and Dadinkowa

In this study, the effect of variety was studied; results showed that TGX-1951 significantly produced higher number leaves per plant over TGX 1448-2E, this is because the genetic make of these two varieties is not the same, hence their performances varied. This observation is similar to the findings of Akande *et al.* (2007); Ali *et al.* (2013) who reported that selection of suitable cultivars for agro-climatic zones is of prime concern for soybean growers. Also, they reported that identification of suitable plant traits showing maximum contribution to final seed yield is important for plant architects. That varieties such as Rawal, Williams-82, SA-72-60, and PSC-60 was tested through field study using randomized complete block design and found that variety PSC-60 showed best performance as it gave significantly higher seed yield (697.3 kg/ha), biomass (2008 kg/ha) plant population (31 plants/ha), plant height (27.43 cm), number of leaves per plant (25), number of pods/plant (16.3), number of seeds per pod (2.867) and number of seeds per plant (32.87). On the other hand soybean variety Williams-82 was found to be inferior as it gave lowest value of these parameters. On the part of pod yield/plant and per hectare and seed yield per plant and per hectare, TGX -1951 out yielded over TGX 1448-2E. The same trend was observed in the yield parameters as the case in growth parameters where TGX-1951 performed better than TGX1448-2E in producing higher pod yield and seed yield per plant and per hectare. This observation may mean that since TGX-1951 produced higher growth parameters such as number of leaves per plant and number of nodules/plant, it has transformed into the production of yield parameters such as pod and seed yields. These observations are similar to Arshad *et al.* (2006); Ali *et al.* (2013) who also reported significant increases on plant height at harvest, number of pods/plant, weight of 100 seeds and seed yield which were used to assess the performance of improved varieties of soybean. They found that the recommended improved varieties of soybean had a wide range of maturity and diverse morphology (Adeniyan, and Ayoola, 2006). Jin *et al.* (2010) also observed that yield increase is correlated with increasing pod number, while seed size and seeds per pod does not change greatly over time. Similar results were reported by Khan *et al.* (2000), who studied heritability and correlation among yield determining components of 86 genotypes in Pakistan and observed that seed yield had a significant positive relationship with all yield components except plant height. Similarly, Ali *et al.* (2013) conducted a trial to compare seed yield and yield contributing traits and observed that statistically higher seed yield (697.3 kg/ha), plant population (31 plants/ha), number of pods/plant (16.3), number of seeds per pod (2.867) and number of seeds / plant (32.87) were recorded in soybean variety PSC-6. They also observed that this variety did not differ significantly from soybean variety SA-72-60 with respect to number of pods/plant and from both SA-72-60 and Rawal with respect to number of seeds per plant. On the other hand, they observed that soybean variety Williams-82 was found to be inferior as it gave lowest seed yield (354.2 kg/ha), plant population (21.33 plants/m^2), number of pods/plant (9.57), number of seeds/ pod (2.23) and number of seeds/plant (20.77). Board *et al.* (2003); Liu *et al*. (2005); Arshad *et al.* (2006); Malik *et al*. (2007); Ali *et al.* (2013) also found that plant height, number of leaves/plant, number of pods and seeds to be the most important plant traits that contributed to improve economic yield in soybean crop and suggested that these traits should be given more importance while selecting superior soybean genotypes. Similarly, Abana *et al.* (2020) evaluated twelve soybean varieties at the School of Agriculture and Agricultural Technology Research Farm to determine their performance in a humid tropical environment of Nigeria. Results obtained showed that there were significant differences at 5 % probability level among the varieties for most of the characters evaluated. Number of days to 50% flowering was lower in the early maturing varieties than the late maturing varieties, while late flowering ones were TGX 1440-1E and TGX 1987-57F. Plant height varied between 24.3 and 39.3 cm. Dry matter accumulation among the varieties was significant. Differences were observed in dry matter accumulation with TGX 1987-14F having the highest value. Soil nitrogen at the experimental site before planting was low (0.032 %), but was marginally increased to 0.063 % after planting, although nodulation was generally poor among the varieties. Seed yield ranged from 200 kg to 430 kg. The best yielding varieties for the humid tropical environment were TGX 1987-14F and TGX 1987-10F. These two varieties had greater seed yield, number of seeds per pod, higher dry matter accumulation and 100 seeds weight than the other varieties.

Effect of phosphorus rates on the growth and yield of soybean in Kashere and Dadinkowa

In this study the effect of phosphorus was evaluated, results showed that when a higher rate of phosphorus fertilizer was applied, it delayed days to flowering. This was because, higher rates of phosphorus influenced nitrogen fixation and resulted in vigorous growth at the expense of earliness to flowering. This means that the higher the rate of phosphorus, the more the number of days to 50% flowering. This observation agrees with the work of Chemining *et al.* (2004); Ferguson *et al.* (2006); Erman *et al.* (2009); Devi *et al.* (2012) who studied the response of soybean to various rates of phosphorus fertilizer and recorded a delay in days to flowering. Comparing the two varieties of soybean on plant height, number of leaves/plant, number of branches/plant, leaf area, number of nodules/plant, days to 50% flowering, number of pods/plant, number of seeds per plant, 100 seed weight, pod yield/plant and pod yield/ha were higher in TGX1448-2E than TGX-1951.

This observation may be as a result of the fact that TGX1448-2E is a newly released variety from IITA, Ibadan and possess the desirable qualities over TGX-1951 which was lately released and so was able to exhibit its performances over TGX-1951. This observation is in line with the report of Gan *et al.* (2003); Kamara *et al.* (2007); Herridge *et al*. (2008); Kamara *et al*. (2011) who reported that newly released varieties exhibit superior performances than the late released varieties because the rate of pollution of the newly released varieties is low compared to the old varieties, hence enable them to perform much better in terms of growth and yield.

The nutrient content of phosphorus varies depending upon the source, moisture content, storage and handling methods. Phosphorus is an important resource for crop production and soil sustainability (Kellman*,* 2008; Lawson *et al.*, 2008; Ikeogu and Nwofia, 2013). Among the practices recommended for improving soil quality and soil fertility in tropical and sub-tropical regions, is the application of phosphorus (Mabapa *et al*., 2010).

Among the five rates of phosphorus (0, 20, 40 and 60 kg/ha tried, 60 kg/ha seemed to have enhanced vegetative and reproductive performance over the other rates because plants that received 60 kg/ha of phosphorus fertilizer rate grew taller, accumulated more dry matter per plant, produced a greater number of nodules/plant, greater leaf area and higher number of pods/plant. Phosphorus as shown by researchers is one of three major elements essential for crop growth and development (Ogoke *et al*., 2004; Malik *et al*., 2006; Makoi *et al.,* 2009; Maccauley, 2011).

Number of pods/plant, number of seeds per pod, 100 seed weight, pod yield/plant and pod yield/ha were significantly increased with increase in phosphorus fertilizer rates from the control of 0 kg/ha to 60 kg/ha. These results are in line with the works of (Ontieno *et al*., 2007; Rahman *et al*., 2012) who reported that when phosphorus fertilizer rates vary accordingly, crop performances will vary as well. This means that the more the rate of phosphorus fertilizer applied, the higher the rate of growth and yield of the crop more especially where fixation of phosphorus is minimal.

CONCLUSION

From the results, TGX1448-2E treated with 60 kg/ha of phosphorus significantly produced higher growth and yield traits than TGX-1951 and other phosphorus. The control treatment also significantly produced lower means values on growth and yield characters studied throughout the period of the study. TGX1448-2E and 60 kg/ha of phosphorus should be adopted by farmers who grow soybean in the study areas based from their good performances in terms of growth and yield from this study.

REFERENCES

1. Abana, P. C., Ogoke, I. J., & Offor, M. O. (2020). Evaluation of selected soybean varieties on the growth and yield in a humid tropical environment. *Journal of Agriculture*, *2*(1), 1–12.

2. Adeniyan, O. N., & Ayoola, O. T. (2006). Growth and yield performance of some improved soybean varieties as influenced by intercropping with maize and cassava in two contrasting locations in Southwest Nigeria. *African Journal of Biotechnology*, *5*(20), 1886–1889.

3. Akande, S. R., Oladele, O. F., & Ayanwole, J. A. (2007). Field evaluation of soyabean varieties at Ilorin in the Southern Guinea Savanna ecology of Nigeria. *African Journal of Agricultural Research*, *2*(8), 356–359.

4. Ali, A., Iqbal, Z., Safdar, M. E., Ashraf, M., Aziz, M., Asif, M., Mubeen, M., Noorka, I. R., & Rehman, A. (2013). Comparison of yield performance of soybean varieties under semi-arid conditions. *The Journal of Animal and Plant Sciences*, *23*(3), 828–832.

5. Amba, A. A., Agbo, E. B., Voncir, N., & Oyawoye, M. O. (2011). Effect of phosphorus fertilizer on some soil chemical properties and nitrogen fixation of legumes at Bauchi. *Continental Journal of Agricultural Science*, *5*(1), 39–44.

6. Arshad, M., Ali, N., & Ghafoor, A. (2006). Character correlation and path coefficient in soybean *Glycine max* (L.) Merrill. *Pakistan Journal of Botany*, *38*(1), 121–130.

7. Basu, M., & Bhadoria, P. B. S. (2008). Performance of groundnut (*Arachis hypogea* L.) under nitrogen fixing and phosphorus solubilizing microbial inoculants with different levels of cobalt in alluvial soils of Eastern India. *Agronomy Research*, *6*(1), 15–25.

8. Bationo, A., Waswa, B., Okeyo, J., Maina, F., Kihara, J., & Mokwunye, U. (2011). *Fighting poverty in Sub-Saharan Africa: The multiple roles of legumes in integrated soil fertility management*. Springer.

9. Bekere, W., Endalkachew, W., & Tesfu, K. (2012). Growth and nodulation response of soybean (*Glycine max* L.) to *Bradyrhizobium* inoculation and phosphorus levels under controlled condition in South Western Ethiopia. *African Journal of Agricultural Research*, *7*(30), 4266–4270.

10. Board, J. E., Kang, M. S., & Bodrero, M. L. (2003). Yield components as indirect selection criteria for late-planted soybean cultivars. *Agronomy Journal*, *95*(2), 420–429.

11. Chemining'wa, G. N., Muthamia, J. W., & Obudho, E. O. (2004). Effect of rhizobia inoculation and urea application on nodulation and dry matter accumulation of green manure legumes at Katumani and Kabete sites of Kenya. *Legume Research Network Project Newsletter*, *11*, 12–18.

12. Chiezey, U. F., & Odunze, A. C. (2009). Soybean response to application of poultry manure and phosphorus fertilizer in the sub-humid savanna of Nigeria. *Journal of Ecology and the Natural Environment*, *1*(2), 25–31.

13. Devi, K. N., Singh, L. N. K., Devi, T. S., Devi, H. N., Singh, T. B., Singh, K. K., & Singh, W. M. (2012). Response of soybean (*Glycine max* (L.) Merrill) to sources and levels of phosphorus. *Journal of Agricultural Science*, *4*(6), 44–53.

14. Erman, M., Yildirim, B., Togay, N., & Cig, F. (2009). Effect of phosphorus application and *Rhizobium* inoculation on the yield, nodulation and nutrient uptake in field pea (*Pisum sativum* species *arvense* L.). *Journal of Animal and Veterinary Advances*, *8*(2), 301–304.

15. Fatima, A., Zia, M., & Chaudhary, M. F. (2007). Effect of *Rhizobium* strains and phosphorus on growth of soybean (*Glycine max*) and survival of *Rhizobium* and phosphorus solubilizing bacteria. *Pakistan Journal of Botany*, *39*(2), 459–464.

16. Ferguson, R. B., Shapiro, C. A., Dobermann, A. R., & Wortmann, C. S. (2006). *Fertilizer recommendation for soybean* (NebGuide G859). University of Nebraska-Lincoln Extension.

17. Gan, Y., Stulen, I., van Keulen, H., & Kuiper, P. J. C. (2003). Effect of N fertilizer top-dressing at various stages on growth, N2 fixation and yield of three soybean (*Glycine max* L. Merrill) genotypes. *Field Crops Research*, *80*(2), 147–155.

18. Gomez, K. A., & Gomez, A. A. (1984). *Statistical procedures for agricultural research* (2nd ed.). International Rice Research Institute; Wiley.

19. Guareschi, R. F., Gazolla, P. R., Perin, A., & Santini, J. M. K. (2011). Anticipated fertilization on soybean with triple superphosphate and potassium chloride coated with polymers. *Ciência e Agrotecnologia*, *35*(4), 643–648.

20. Herridge, D. F., Peoples, M. B., & Boddey, R. M. (2009). Global inputs of biological nitrogen fixation in agricultural systems. *Plant and Soil*, *311*(1-2), 1–18.

21. Ikeogu, U. N., & Nwofia, G. E. (2013). Yield parameters and stability of soybean (*Glycine max* (L.) Merril) as influenced by phosphorus fertilizer rates in two Ultisols. *Journal of Plant Breeding and Crop Science*, *5*(4), 54–63.

22. Jin, J., Liu, X., Wang, G., Mi, L., Shen, Z., Chen, X., & Herbert, S. J. (2010). Agronomic and physiological contributions to the yield improvement of soybean cultivars released from 1950 to 2006 in Northeast China. *Field Crops Research*, *115*(1), 116–123.

23. Kamara, A. Y., Abaidoo, R., Kwari, J., & Omoigui, L. (2007). Influence of phosphorus application on growth and yield of soybean genotypes in the tropical savannas of northeast Nigeria. *Archives of Agronomy and Soil Science*, *53*(5), 539–552.

24. Kamara, A. Y., Ekeleme, F., Omoigui, L. O., & Ajeigbe, H. A. (2011). Phosphorus and nitrogen fertilization of soybean in the Nigerian savanna. *Experimental Agriculture*, *47*(3), 479–492.

25. Kellman, A. W. (2008). *Rhizobium inoculation cultivar and management effects on the growth, development and yield of common bean (Phaseolus vulgaris L.)* [Doctoral dissertation, Lincoln University]. Lincoln University Research Archive.

26. Khan, A., Hatam, M., & Khan, A. (2000). Heritability and interrelationship among yield determining components of soybean varieties. *Pakistan Journal of Agricultural Research*, *16*(1), 5–8.

27. Lawson, I. Y. D., Mensah, E. A., & Yeboah, E. N. (2008). Improving the establishment and yield of soybean through planting depth and land preparation methods in Northern Ghana. *West African Journal of Applied Ecology*, *14*(1), 14–23.

28. Liu, X., Jin, J., Herbert, S. J., Zhang, Q., & Wang, G. (2005). Yield components, dry matter, LAI and LAD of soybeans in Northeast China. *Field Crops Research*, *93*(1), 85–93.

29. Mabapa, P. M., Ogola, J. B. O., Odhiambo, J. J. O., Whitbread, A., & Hargreaves, J. (2010). Effect of phosphorus fertilizer rates on growth and yield of three soybean (*Glycine max*) cultivars in Limpopo Province. *African Journal of Agricultural Research*, *5*(19), 2653–2660.

30. Maccauley, A. (2011). *Nitrogen fixation by annual legume green manures in a semi-arid cropping system* [Master’s thesis, Montana State University]. MSU ScholarWorks.

31. Makoi, J. H. J. R., Chimphango, S. B. M., & Dakora, F. D. (2009). Effect of legume plant density and mixed culture on symbiotic N2 fixation in five cowpea (*Vigna unguiculata* L. Walp.) genotypes in South Africa. *Symbiosis*, *48*, 57–67.

32. Malik, M. F., Ashraf, M., Qureshi, A. S., & Ghafoor, A. (2007). Assessment of genetic variability, correlation and path analyses for yield and its components in soybean. *Pakistan Journal of Botany*, *39*(2), 405–413.

33. Ogoke, I. J., Togun, A. O., Carsky, R. J., & Dashiell, K. (2004). Effect of phosphorus fertilizer on soybean pod yield in Guinea Savanna. *Nigerian Agricultural Journal*, *35*, 40–50.

34. Otieno, P. E., Muthomi, J. W., Chemining’wa, G. N., & Nderitu, J. H. (2007). Effect of rhizobia inoculation, farmyard manure and nitrogen fertilizer on growth, nodulation and yield of selected food grain legumes. *African Crop Science Conference Proceedings*, *8*, 305–312.

35. Rahman, M., Imran, M., & Ashrafuzzaman, M. (2012). Effect of inoculant on yield and yield contributing characters of summer mungbean cultivars. *Journal of Environmental Science and Natural Resources*, *5*(1), 211–215.

36. Shortal, J. G., & Liebbardt, W. C. (2000). Techniques for evaluation of crop growth. *Journal of Environment*, *4*(2), 186–191.

Table 1: Physical and Chemical Characteristics of the Soil Used for the Experiment in Kashere, Dadinkowa and Combined in 2023 Rainy Season

	Kashere	Dadinkowa
Physical Characteristics	Sandy loam	Sandy loam
Sand (%)	77.34	70.60
Clay (%)	8.86	10.40
Silt (%)	5.80	5.58
Chemical Characteristics		
Organic Carbon (%)	3.60	3.30
PH	5.36	5.40
Total N (%)	3.40	3.50
P (mg/kg)	2.20	2.32
K (mg/kg)	1.72	1.70
Ca (mg/kg)	0.53	0.54
Na (mg/kg)	0.50	0.51
Mg (mg/kg)	1.22	1.20
CEC (mg/kg)	5.25	5.40

Source: *Analyzed at ATBU, Bauchi, 2023.*

Table 2: Effects of Variety and Phosphorus Rates on Plant Height (cm) and Number of Leaves/Plant of Soybean (*G. max*) at Kashere, Dadinkowa and Combined in Gombe state, Nigeria

Treatments	Plant Height (cm)			Number of Leaves/Plant		
Variety (V)	Kashere	Dadinkowa	Combined	Kashere	Dadinkowa	Combined
TGX-1951	44.84	45.20	45.02	14.43	13.86	14.54
TGX1448-2E	45.07	46.65	45.56	13.63	14.64	13.74
LS	0.869	0.449	0.528	0.005	0.044	0.003
LSD	NS	NS	NS	0.511	0.773	0.497
Phosphorus Rates (kg)/Ha						
0	42.71	43.43	43.07	11.76	13.12	12.44
20	43.84	44.90	44.37	13.48	13.73	13.60
40	45.66	46.05	45.86	14.81	14.41	14.61

60	47.61	48.11	47.86	16.08	15.72	15.90
LS	0.102	0.053	0.003	0.001	0.001	0.001
LSD	4.121	3.308	2.434	0.722	1.093	0.703
Interaction						
LS	0.930	0.984	0.990	0.132	0.984	0.067
V x P	NS	NS	NS	NS	NS	NS

LSD = Least Significant Difference at 5% Level of Probability, NS = Not Significant at 5% level of Probability.

Table 3: Effects of Variety and Phosphorus Rates on Number of Branches/Plant and Leaf Area (cm^2) of Soybean (*G. max*) at Kashere, Dadinkowa and Combined in Gombe State, Nigeria

Treatments	Number of Branches/Plant			Leaf Area (cm^2)		
Variety (V)	Kashere	Dadinkowa	Combined	Kashere	Dadinkowa	Combined
TGX-1951	7.11	6.85	6.83	50.60	49.29	50.01
TGX1448-2E	6.82	7.05	7.08	49.29	49.41	49.29
LS	0.408	0.471	0.271	0.091	0.907	0.227
LSD	NS	NS	NS	NS	NS	NS
Phosphorus Rates (kg)/Ha						
0	5.54	5.92	5.73	47.65	47.32	47.48
20	6.61	6.58	6.59	48.78	48.75	48.77
40	7.51	7.29	7.40	51.00	50.04	50.52
60	8.20	7.99	8.09	52.37	51.29	51.83
LSD	1.029	0.860	0.643	2.195	2.833	1.667
LS	0.004	0.001	0.001	0.002	0.001	0.001
Interaction						
LS	0.533	0.593	0.338	0.233	0.593	0.316
V x P	NS	NS	NS	NS	NS	NS

Table 4: Effects of Variety and Phosphorus Rates on Number of Nodules/Plant and Days to 50% Flowering of Soybean (*G. max*) at Kashere, Dadinkowa and Combined in Gombe State, Nigeria

LS = Level of Significance at 5%, LSD = Least Significant Difference at 5% Level of Probability, NS = Not Significant at 5% level of Probability.

Variety (V)	Kashere	Dadinkowa	Combined	Kashere	Dadinkowa	Combined
TGX-1951	7.41	6.06	5.85	53.51	51.11	52.31
TGX1448-2E	5.63	6.75	7.08	50.40	49.64	50.02
LS	0.001	0.018	0.001	0.235	0.294	0.128
LSD	0.606	0.550	0.397	NS	NS	NS
Phosphorus Rates (kg)/Ha						
0	5.54	5.67	5.61	47.12	47.74	47.43
20	6.32	6.29	6.30	52.18	49.76	51.00
40	6.83	6.57	6.70	52.69	50.97	51.83
60	7.38	7.09	7.23	55.83	53.03	54.43
LS	0.003	0.012	0.001	0.151	0.083	0.018
LSD	0.857	0.778	0.561	7.602	4.069	4.213
Interaction						
LS	0.832	0.968	0.896	0.979	0.993	0.976
V x P	NS	NS	NS	NS	NS	NS

LS = Level of Significance at 5%, LSD = Least Significant Difference at 5% Level of Probability, NS = Not Significant at 5% level of Probability.

Table 5: Effects of Variety and Phosphorus Rates on Number of Pods/Plant and Number of pods/ha of Soybean (*G. max*) at Kashere, Dadinkowa and Combined in Gombe State of Nigeria

Treatments	Number of Pods/Plant			Number of Pods/Ha		
Variety (V)	Kashere	Dadinkowa	Combined	Kashere	Dadinkowa	Combined
TGX-1951	30.56	27.29	28.93	3, 213.33	2,274.16	2,410.83
TGX1448-2E	29.07	26.87	27.57	2, 422.49	2,239.16	2,297.49
LS	0.150	0.006	0.016	0.500	0.512	0.506
LSD	NS	NS	NS	450.700	428.300	268.100
Phosphorus Rates (kg)/Ha						

0	27.52	24.63	26.08	2,293.33	2,052.49	2,173.33
20	28.98	26.04	27.51	2,414.99	2,169.99	2,292.49
40	30.28	27.37	28.83	2,523.33	2,280.83	2,402.49
60	32.48	28.68	30.58	2,706.66	2,389.99	2,548.33
LS	0.020	0.001	0.001	0.210	0.420	0.315
LSD	2.981	1.137	1.528	218.200	186.700	162.300
Interaction						
LS	0.938	0.559	0.976	0.432	0.433	0.433
V x P	NS	NS	NS	NS	NS	NS

LS = Level of Significance at 5%, LSD = Least Significant Difference at 5% Level of Probability, NS = Not Significant at 5% level of Probability.

Table 6: Effects of Variety and Phosphorus Rates on Shelling % and 100 Seed Weight (gm) of Soybean (*G. max*) at Kashere, Dadinkowa and Combined in Gombe State of Nigeria

Treatments	100 Seed Weight (g)			Shelling %		
Variety (V)	Kashere	Dadinkowa	Combined	Kashere	Dadinkowa	Combined
TGX-1951	118.32	109.99	112.58	12.55	12.11	12.34
TGX1448-2E	115.17	105.43	111.87	12.37	11.78	12.17
LS	0.483	0.170	0.219	0.468	0.284	0.375
LSD	NS	NS	NS	NS	NS	NS
Phosphorus Rates (kg) Ha						
0	106.55	99.39	102.97	11.82	11.81	11.84
20	113.74	104.32	109.03	12.49	11.85	12.27
40	118.78	110.15	114.46	12.74	12.05	12.28
60	127.89	116.98	122.43	12.79	12.08	12.44
LS	0.026	0.009	0.001	0.055	0.060	0.063
LSD	13.274	9.567	8.793	0.752	0.882	0.713
Interaction						
LS	0.998	0.720	0.930	0.845	0.661	0.750
V x P	NS	NS	NS	NS	NS	NS

LS = Level of Significance at 5%, LSD = Least Significant Difference at 5% Level of Probability, NS = Not Significant at 5% level of Probability.

Table 7: Effects of Variety and Phosphorus Rates on Pod Yield/Plant (g) and Pod Yield/Ha (kg) of Soybean (*G. max*) at Kashere, Dadinkowa and Combined in Gombe State of Nigeria

Treatments	Pod Yield/Plant (g)			Pod Yield/Ha (kg)		
Variety (V)	Kashere	Dadinkowa	Combined	Kashere	Dadinkowa	Combined
TGX-1951 TGX1448-2E	122.59 115.39	106.10 117.03	110.75 119.81	9,382.49 9,615.83	8,841.66 9,817.45	9,229.99 9,984.16
LS	0.049	0.003	0.026	0.890	0.892	0.891
LSD	7.174	4.937	4.202	717.400	493.700	420.200
Phosphorus Rates (kg)/Ha						
0	108.22	101.13	104.68	9,018.33	8,427.49	8,723.33
20	118.92	108.17	113.54	9,909.99	9,014.16	9,461.66
40	121.96	116.69	119.32	10,163.33	9,724.16	9,943.33
60	126.86	120.73	123.57	10,571.66	10,060.83	10,297.49
LS	0.010	0.002	0.011	0.034	0.035	0.035
LSD	10.146	6.982	5.942	101.46	698.200	594.200
Interaction						
LS	0.978	0.062		0.990	0.992	0.991
V x P	NS	NS	NS	NS	NS	NS

LS = Level of Significance at 5%, LSD = Least Significant Difference at 5% Level of Probability, NS = Not Significant at 5% level of Probability.

Table 8: Effects of Variety and Phosphorus on Seed Yield/Plant (g) and Seed yield/ha (kg) of Soybean (*G. max*) at Kashere, Dadinkowa and Combined in Gombe State of Nigeria

Treatments	Seed Yield/Plant (g)	Seed Yield/Ha(kg)

Variety (V)	Kashere	Dadinkowa	Combined	Kashere	Dadinkowa	Combined
TGX-1951 TGX1448-2E	91.94 86.54	79.58 87.77	83.06 89.86	7, 036.87 7, 211.87	6, 631.25 7, 363.09	6, 922.49 7,488.12
LS	0.039	0.002	0.020	0.668	0.669	0.668
LSD	5.381	3.703	3.152	538.050	370.275	315.15
Phosphorus Rates (kg)/Ha						
0	81.17	75.85	78.51	6, 763.75	6, 320.62	6, 542.50
20	89.19	81.13	85.16	7, 432.49	6760.62	7096.25
40	91.47	87.52	89.49	7, 622.50	7293.12	7457.50
60	95.15	90.55	92.68	7, 928.75	7545.63	7723.12
LS	0.001	0.002	0.008	0.026	0.026	0.026
LSD	7.845	5.237	4.457	76.095	53.65	45.65
Interaction						
LS	0.551	0.470	0.510	0.743	0.744	0.744
V x P	NS	NS	NS	NS	NS	NS

LS = Level of Significance at 5%, LSD = Least Significant Difference at 5% Level of Probability, NS = Not Significant at 5% level of Probability.