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IMPACT OF NITROGEN AND PHOSPHORUS FERTILIZER ON GROWTH AND YIELD OF BAMBARA GROUNDNUT

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Abstract

Bambara groundnut (*Vigna subterranea*) is an indigenous African crop which belongs to the family fabacea and sub-family of faboidea. It seeds contain 63% carbohydrate, 19% protein and 6.5% oil and good source of fibre, calcium, iron and potassium. Hence, this study aimed to determine the effect of nitrogen (N) and phosphorus (P) on growth and yield bambara groundnut. A pot experiments was conducted in ladang 15 at the Faculty of Agriculture; Universiti Putra Malaysia. The experiment was performed Randomized Complete Block Design (RCBD). The size of the pot was 65.94 cm^2. The experiment was conducted in a factorial design with four levels of N (0, 10, 20, 30 kg/ha) and P (0, 20, 40 and 60 kg/ha). In this study, N and P fertilizer was played dominating role for vegetative growth of the plant. Plant height (20.65 cm), leaves number (262), leaf area (2140.54 cm^2), number of pod (47.25) and pod weight (22.8 g) increased with the application of level of N and P. Vegetative growth and yield of the plant was better at $N_{30}P_{60}$ kg/ha than the all other treatments. It can be concluded that by using $N_{30}P_{60}$ kg/ha growth and yield of bambara groundnut is maximum.

Key words: Bambara groundnut, nitrogen, phosphorus, growth, yield

Introduction

Bambara groundnut (*V. subterranea*) is basically cultivated in the west and central Africa but now its cultivation is spread all over the world. It can be grown in all kind of soil especially in marginal soil. Nitrogen is considered as an important element for the growth and improvement of crop. Patra *et al*., (1995) reported that root-shoot ratio as well as yield of pod is increased by the application of optimum fertilizer. On the other hand, P plays a vital role on the vegetative growth and seed production of the plant. Phosphorus is the most important element of ATP and also plays a major part in energy conversion in plants. In plant height, P showed significant difference with changing level of P fertilizer (Iman *et al*., 2014). Application of N and P fertilizer helps to get the better root development in bambara groundnut which ultimately results in the growth and yield of bambara groundnut. Many benificial activities are taking part in the plant root. Bambara groundnut has the potentiality to grow in the low fertility soil and can be grown-up well with the reasonable rainfall and sunshine. Weeding, mounded and earthing up is necessary for the plant when it statred to form pods. Generally bambara groundnut is cultured for human utilization. Bambara groundnut is measured as balanced diet because of the high percent of carbohydrate (65%), protein (18%) and fat (6.5%) contain in the seed (Mazahib *et al*., 2013). Bambara groundnut milk process similar as soybean and it's used as preventing milk (Yao *et al*., 2015). Limited research work is reported on the effects of N and P on bambara groundnut especially in Malaysia. Hence, the main objective of the study was to evaluate the effect of N and P on growth, yield of bambara groundnut.

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Materials and methods

Experimental site, design and treatments

A pot experiment was carried out in the Faculty of Agriculture at Ladang 15 at Universiti Putra Malaysia. For accomplished the experiment bambara groundnut seed

was used. During May to September, 2017 in the glass house condition the experiment was conducted. The experiment was conducted as factorial and the design was RCBD with four Replications. There were 64 experimental units (pots) and in each pot one seed was sowed. The size of the pot was uniform and size was 65.94 cm^2. Sandy clay loam soil was used to fill the pot and the amount was 10 kg/plot. Sixteen treatments of this experiment was the combination of different rate of N (0, 10, 20, 30 kg/ha) and P (0, 20, 40 and 60 kg/ha). All the pots were fertilized before planting the seed. Watering was done every day in the morning. Weeds were cleared manually every 5 days interval.

Yield components

Yield data collected included number of pods/plant, mean (100) seed weights, pod dry weight, seeds per pod and shelling outturn (%). To determine shelling percent of bambara groundnut were put in a bag and air dried thoroughly to a moisture level of 13 % before shelling. These were then weighed before shelling (W_P and W_S respectively). After shelling, the shelled seeds were weighed and recorded. The shelling percentage was determined as the weight of dry seed (Ws) divided by dry weight of pods (W_P).

Shelling outturn $(\%) = \frac{W_s}{W_p} \times 100$ for groundnut (Jonah *et al.,* 2012). Where, Ws = weight of dry seed, and W_P = weight of dry pods.

Statistical analysis

All data were subjected to statistical analysis of variance (ANOVA) using SAS version 9.4 (SAS, 2005) at the 5% significance level and least significant difference was employed for mean separation (Gomez and Gomez, 1984).

Results and Discussion

Effect of N and P on plant height, leaves number, branch number and leaf area of bambara groundnut

The plant height, leaves number, branch number and leaf area were not significantly increased by the combination of N and P fertilizer in the form urea and TSP respectively but were significantly increased with different levels of applied N and P fertilizer (table 1). The lowest plant height (18.36 cm) was registered in the application of N_{10} kg/ha. The mean highest plant height (20.69 cm) was recorded used of P_{60} kg/ha and significantly different from other P level. At maturity stage, P_{60} kg/ha was identified the highest number of leaves better than the control (P_0 kg/ha). The number of branch

Table 1: Effect of N and P on plant height, leaves number, branch number and leaf area of bambara groundnut

Treatments	Plant height	Leaves number	Branch number	Leaf area
N_0 kg/ha	19.0ab	231.5a	77.4a	1921.7b
N_{10} kg/ha	18.4b	230.4a	76.8a	2142.6ab
N_{20} kg/ha	19.3a	232.2a	77.3a	2042.3ab
N_{30} kg/ha	19.7a	236.5a	78.6a	2272.8a
P_0 kg/ha	18.2c	226.7b	75.6b	1988.8b
P_{20} kg/ha	18.4bc	228.8b	76.3b	2047.7b
P_{40} kg/ha	19.0b	229.4b	76.6b	1881.4b
P_{60} kg/ha	20.7a	245.7a	81.7a	2461.6a

Different letters correspond to significant differences between rates of the same protein content ($P \leq 0.05$)

was significantly increased by the application of P_{60} kg/ha. The highest leaf area (2461.6 cm^2) was produced with the application of P_{60} kg/ha compared to control (P_0 kg/ha). This finding pointed out that application of P_{60} kg/ha at harvesting stage revealed an increment of 13.56% for plant height, 8.38% for leaves number, 8.11% for branch number and 30.84% for leaf area compare to P_0 kg/ha (control). Vegetative growth of the plant generated an increased trend as level of P increased.

In this experiment, vegetative growth increased with the increasing level of N and P at all the stage of growth. Similar result was reported by Nweke *et al.,* (2013) that plant growth increases with increasing N and P level over control. According to Hossain *et al*., (2007), N (0, 20, 40, 60 kg/ha and P (0, 30, 60, 90 kg/ha) dose were applied and found the better growth and yield parameter at N_{60} + P_{60} kg/ha. This result showed that plant growth increased at N_{60} + P_{60} kg/ha and the result also supported this study. Slightly higher dose of P (0, 25, 50, 75 kg/ha) was applied by (Ikenganyia *et al.,* 2017) and that's why in P_{75} kg/ha gave highest increase in plant growth compare to control. The result supported the present study because plant height increased with the increasing P fertilizer.

Effect of N and P on days of flowering, days of maturity, plant fresh weight and plant dry weight of bambara groundnut

Days of flowering significantly increased in bambara groundnut plant with increasing N and P fertilization rates (table 2). On the other hand there was no significant difference got in the combination of N and P fertilizer. At the treatment of N_{30} kg/ha days of maturity of the plant attained 3.28% decrease compare with N_0 kg/ha (control). Moreover, the level of N and P at 30 and 60 kg/ha respectively influenced the plant to get early flowering and obtain maturity.

Table 2: Effect of N and P on days of flowering, days of maturity, plant fresh weight and plant dry weight of bambara groundnut

Treatments	DF	DM	PFwt	PDwt
N_0 kg/ha	42.6a	97.1a	69.5a	33.0a
N_{10} kg/ha	41.9ab	96.7ab	70.3a	33.1a
N_{20} kg/ha	41.4ab	95.6b	70.2a	32.5a
N_{30} kg/ha	40.7b	93.4c	69.2a	31.9a
P_0 kg/ha	42.5a	98.0a	66.8b	30.2b
P_{20} kg/ha	42.1a	96.4b	70.1ab	32.9ab
P_{40} kg/ha	41.8a	96.1b	70.0ab	32.4ab
P_{60} kg/ha	40.1b	92.9c	72.2a	34.9a

Different letters correspond to significant differences between rates of the same protein content ($P \leq 0.05$)

A number of environmental factors such as temperature, altitude, soil condition and also various fertilizers can affect flowering and maturity of bambara groundnut. In this study, bambara groundnut started flowering within 40 to 43 days after planting. Flowering in bambara groundnut is dependent on the germination date, seasonal temperature profile as well as photo thermal response of the plant. Similar factors may be responsible for the variation in days to flowering in the current study. It was observed that the plants which started flowering early, the earlier it will get the physiological maturity (Shegro *et al*., 2010). Similar observation was also found in this experiment.

Plant fresh weight positively influenced by different level of P application of bambara groundnut plant (table 2). Combination of N and P fertilizer and different level of N fertilizer of the plant had found no significant difference. Significant increased of plant fresh weight was registered at P_{60} kg/ha (72.20 g). However control (P_0 kg/ha) treatment had relatively lowest plant fresh weight accumulation than other treatment. Plant fresh weight increased 8.11% at P_{60} kg/ha followed by 4.91% at P_{20} kg/ha compare to control (P_0 kg/ha). Plant fresh weight increased with the application of different level of P. Short vegetative growth of the plant was due to depletion of nutrients in control plots over time hence plants showed stunted growth owing to inadequate supply of nutrients. The higher plant growth might be attributed to the gradual release of essential nutrient from N and P as required by bambara groundnut.

Effect of N and P on pod number (PN), 100-seed weight (100-Swt), pod dry weight (Pod-Dwt), seed per pod (SPP) and shelling percentage (SP) of bambara groundnut

Combination of N and P fertilizer exerted no significant influenced on PN, 100-Swt, Pod-Dwt, SPP and SP but varied significantly at different level of P

Table 3: Effect of N and P on pod number (PN), 100-seed weight (100-Swt), pod dry weight (Pod-Dwt), seed per pod (SPP) and shelling percentage (SP) of bambara groundnut.

Treatments	PN	100-Swt	Pod-Dwt	SPP	SP
N_0 kg/ha	31.1c	32.4ab	19.5a	1.0a	63.3a
N_{10} kg/ha	33.3bc	31.6b	19.9a	1.1a	67.8a
N_{20} kg/ha	35.7ab	35.1a	21.4a	1.1a	65.9a
N_{30} kg/ha	36.8a	34.1ab	21.5a	1.3a	62.5a
P_0 kg/ha	30.1c	31.4b	19.0b	1.1a	58.4b
P_{20} kg/ha	32.3bc	33.0b	19.9b	1.3a	65.6a
P_{40} kg/ha	33.5b	31.5b	20.6ab	1.1a	66.7a
P_{60} kg/ha	42.0a	37.3a	22.8a	1.1a	68.8a

Different letters correspond to significant differences between rates of the same protein content ($P \leq 0.05$)

application. Initially in all treatments podding started to form early but the number of pod increased until harvest. In the application of N_{30} kg/ha and P_{60} kg/ha were significantly higher than all other N and P level. At P_{60} kg/ha, the pod number increased from 30.06 g to 42.00 g with increasing P application, reaching the maximum value at P_{60} kg/ha treatment. The greatest increase in the pod number in bambara groundnut was 39.72% at P_{60} kg/ha followed by 11.44% at P_{40} kg/ha and 7.49% at P_{20} kg/ha compared to control (P_0 kg/ha). An increasing trend with increasing level of P fertilizer was observed. The highest 100-seed weight was 18.81% at P60 kg/ha compares to P_0 kg/ha (control). Similar result was reported by Toungos *et al*., (2012) and he applied four dose of P_2O_5 (0, 30, 60, 90 kg/ha) and got the highest increased 23.77% in the application of 60 kg/ha over control.

The pod weight per plant ranged from 19.04 to 22.76 g. P_{60} kg/ha gave 19% increase over control. This result was slightly dissimilar from the result of Ellah *et al*., (2008) because the lowest apply of P (0, 15, 30 kg/ha). P_{30} kg/ha gave 5.71% increase over the control which was lower than the current study. Lower pod weight per plant ranging from 4 to 57.52 g was reported by (Mohammed, 2014). Ntundu *et al.,* (2006) reported that there was no significant difference among the bambara groundnut plant for the number per pod, hundred seed weight and yield per plot over two seasons in Tanzania. At the harvesting time, the great effect was revealed in the application of P_{60} kg/ha and this was significantly higher than the effect of all other applied P fertilizer. Tanimu and Yayock (1990) reported in Nigeria a field experiment with different combinations of N and P (0, 10, 20, 30, 40, 50, and 60 kg/ha) have significantly higher yield and increase 32% over control.

Vegetative growth of the plant is performed well

with the application of N and P fertilizer. The yield and yield related character of bambara groundnut increase with N_{30} kg/ha and P_{60} kg/ha fertilizer application. The application of N_{30} and P_{60} kg/ha could be recommended for getting maximum growth and yield of bambara groundnut.

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