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IMPACT OF CHEMICAL AND ORGANIC FERTILIZER ON THE YIELD AND NUTRITIONAL COMPOSITION OF BAMBARA GROUNDNUT (*VIGNA SUBTERRANEA* L. VERDE.)

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Abstract

A pot experiment was conducted to find out the effects of chemical and organic fertilizer on the yield and nutritional composition of bambara groundnut (*Vigna subterranea*)**.** The size of the pot was 65.94 cm^2. Different rates of compost, biofertilizer, gypsum was used along with the combination of different doses of nitrogen and phosphorus fertilizer. N and P fertilizers were found to play dominating role to increase yield and nutritional composition of the plant. Number of pod (41.75), 100-seed weight (34.25 g), protein (22.15%), Ca (803.25 mg/ka) increased with the application of N and P 30 and 60 kg/ha, respectively which was better than all other treatments. The application of N_{30} + P_{60} kg/ha increased yield and nutritional composition of bambara groundnut.

Introduction

Bambara groundnut (*Vigna subterranea*) is basically cultivated in the west and central Africa but now its cultivation has spread all over the world. It can be grown in all kinds of soil especially in marginal soil. Although urea is the most suitable source of N, the plants do not use more than 50% (Hayat *et al*. 2012) and through volatilization, denitrification and leaching the remaining N is lost. Phosphorus furnishes superior root and soil contact which outcome the higher absorption of mineral nutrients. Application of nitrogen and phosphorus fertilizer increases the growth and yield of bambara groundnut (Hasan *et al*. 2018). Biofertilizer (B-Green biofertilizer) are cost-effective and also the renewable on the basis of plant to acquire essential nutrients. Biofertilizer supply nutrient like nitrogen and phosphorus and their actions in the soil or rhizosphere and formulate them into an obtainable form for plants. A legume lives in association with rhizobium bacteria and helps to improve the soil status (Okon 2016). In the composted organic wastes a little amount of C : N ratios exits which are very useful for improving crop yields (Hayat *et al*. 2012). Soil bacteria are one of the important biotic components that influence decomposition and nutrient mineralization in the terrestrial ecosystem (Laldinthar and Dkhar 2015). Bambara groundnut is considered as balanced diet because of the high per cent of carbohydrate (65%), protein (18%) and fat (6.5%) in the seed (Mazahib *et al*. 2013). The milk of bambara groundnut used as preventing milk. So far very little reports on the effects of chemical and organic fertilizer on bambara groundnut are available especially in Malaysia. Hence, the present study was carried out to evaluate the impact of chemical and organic fertilizer on yield and nutritional composition of bambara groundnut.

Materials and Methods

A pot experiments was conducted from February to June in 2017 at the Faculty of Agriculture in Ladang 15, Universiti Putra Malaysia. The size of the pot was 65.94 cm^2. There were 40

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experimental units (pot) and in each pot one seed was sowed. Sandy clay loam soil was used to fill the pot and the amount was 10 kg/plot. N, P and K were mixed with the soil in the form of urea, triple super phosphate (TSP) and MOP. Ten different levels of chemical and organic fertilizers (T_1: N_{30} + P_{60} kg/ha, T_2: N_{20} + P_{60} kg/ha, T_3: N_{25} + P_{50} + K_{75} kg/ha, T_4: compost 2.5 t/ha, T_5: compost 5.00 t/ha, T_6: compost 7.5 t/ha, T_7: compost 10 t/ha, T_8: B-green biofertilizer 15 kg/ha, T_9: gypsum 400 kg/ha and T_{10}: B-green biofertilizer 15 kg/ha + gypsum 400 kg/ha) were applied. The experiment was performed in RCBD with four replications.

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

The amount of protein was measured by Kjeldahl method (Kjeldahl 1883). An extraction of lipid was utilized by using Soxtec System (Soxtec System 2050 Foss Tecator) (Lin *et al.* 2006). To determine the moisture per cent in the seed, oven was used (Willits 1951). Fiber determination was carried out by utilizing Fibertec System (Fenton and Fenton 1979). The mineral composition of the seed was determined by dry ashing method (Cotteine 1980).

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

Results and Discussion

The effect of different rates of chemical and organic fertilizer had significant impact on yield parameters of bambara groundnut (Table 1). But the effects of different chemical and organic fertilizer level on SP and harvest index (HI) of bambara groundnut did not vary significantly. As soon as the vegetative stage finish, pod are started to form until harvest. Application of N and P increased the pod number at T_1 and it was statistically dissimilar to all other applied fertilizer (Table 1). This indicates that number of pod increase with increasing N and P level. T_1 (N_{30} + P_{60} kg/ha) treatment had the highest (62.14%) increased on number of pod per plant when compost was applied at 2.5 t/ha (Table 1). There exists an increasing trend with increasing fertilizer and compost level. The growth and yield differences among the chemical and organic treatments have been related to N, P and K availability to crops and release pattern by organic residues (Leconte *et al.* 2011). This result is similar to the finding of Khan *et al.* (2018).

In the application of T_1 (N_{30} + P_{60} kg/ha) number of pods per plant, 100-seed weight and number of seeds per pod were significantly higher than all other treatments effect. The highest number of pods per plant (41.75) was observed at the treatment of T_1 and lowest (25.75) was in T_4 (compost 2.5 t/ha). On the other hand, T_1 treatment had the highest increased at (42.19, 43.98 and 20.68%) on pod fresh weight, pod dry weight, 100-seed weight, respectively when N and P was applied at N_{30} + P_{60} kg/ha (Table 1) in compared to T_4 (compost 2.5 t/ha). These results indicated that the plants which were fertilized with highest amount of N and P was registered the better result in yield parameter. Ntundu *et al.* (2006) also reported that there was significant difference among the bambara groundnut plant for yield related characteristics.

Treatment T_1 (49.67 g) also produced the highest pod weight and T_4 (compost 2.5 t/ha) (34.95 g) lowest. This result was quite dissimilar with the result of Ellah and Singh (2008) because of lower application of P (0, 15, 30 kg/ha).The difference observed between the treatments might be due to the fact that in the organic residues, nutrient availability depends on nutrient concentration and release with synchrony with crop needs. In the present study, the highest plant growth and

yield reported at N_{30} + P_{60} kg/ha could be attributed to the nutrients being readily available from the source.

Table 1. Effect of chemical and organic fertilizer on NPPP, PFwt, PDwt, SW-100, SPP, SP and HI.

Treatment	NPPP	PFwt (g)	PDwt	SW-100	SPP	SP	HI
T_1	41.75a	49.68a	19.15a	34.25a	1.25bc	74.53a	48.53ab
T_2	34.75bcd	41.35bc	16.35ab	32.38abc	1.00c	69.60abc	45.03b
T_3	29.50de	46.40ab	18.58a	33.20ab	1.50abc	72.50ab	49.18ab
T_4	25.75	34.95d	13.30b	28.38e	1.00c	65.93bc	49.75ab
T_5	28.50de	35.93cd	16.23ab	30.25cde	1.00c	73.83ab	52.78a
T_6	26.25e	35.28d	14.58b	29.20de	2.00a	63.03c	50.85ab
T_7	33.75bcd	39.68cd	16.05ab	31.63bcd	1.50abc	73.63ab	50.53ab
T_8	31.50cde	37.85cd	14.15b	29.45de	1.25bc	68.45abc	50.65ab
T_9	37.50abc	41.07bc	14.07b	29.93cde	1.50abc	68.45abc	45.25ab
T_{10}	38.00ab	47.98a	18.35a	32.28abc	1.75ab	69.50abc	50.98ab

T_1: N_{30} + P_{60} kg/ha, T_2: N_{20}+P_{60} kg/ha, T_3: N_{25} + P_{50} + K_{75} kg/ha, T_4: compost 2.5 t/ha, T_5: compost 5.00 t/ha, T_6: compost 7.5 t/ha, T_7: compost 10 t/ha, T_8: B-green biofertilizer 15 kg/ha, T_9: gypsum 400 kg/ha and T_{10}: B-green biofertilizer 15 kg/ha + gypsum 400 kg/ha. Means with the same letter have no significant difference.

Table 2. Effect of different rates of compost on proximate composition (%) from the seed of bambara groundnut.

Treatments	Moisture	Ash	Protein	Fibre
T_1	3.05a	3.53a	22.15a	6.45a
T_2	3.03a	3.35a	20.55b	5.48bc
T_3	3.13a	3.68a	20.43bc	5.70ab
T_4	3.13a	3.18a	19.48cde	5.00bc
T_5	3.08a	3.43a	19.50cde	4.58c
T_6	3.28a	3.38a	18.68b	4.85bc
T_7	3.03a	3.45a	19.33de	4.60c
T_8	3.23a	3.38a	19.45cde	4.98bc
T_9	3.35a	3.53a	19.95bcd	5.05bc
T_{10}	3.18a	3.38a	19.68bcde	5.20bc

T_1: N_{30} + P_{60} kg/ha, T_2: N_{20}+P_{60} kg/ha, T_3: N_{25} + P_{50} + K_{75} kg/ha, T_4: compost 2.5 t/ha, T_5: compost 5.00 t/ha, T_6: compost 7.5 t/ha, T_7: compost 10 t/ha, T_8: B-green biofertilizer 15 kg/ha, T_9: gypsum 400 kg/ha and T_{10}: B-green biofertilizer 15 kg/ha + gypsum 400 kg/ha. Means with the same letter have no significant difference.

Proximate composition (Protein, fibre) contents in the seed of bambara groundnut were positively influenced by the application of different rates of chemical and organic fertilizer (Table 2). Moisture and ash contents of the seed were not showed any significant difference. The mean highest protein content (22.15%) was recorded by the used of T_1 and significantly different from

other fertilizer and compost level. T_1 gave 13.56% more advanced in protein content compare to T_6. The lowest protein content (18.68%) was registered in the application of T_6. There was a decrease in protein content in the seed of bambara groundnut with decreasing N and P level.

Results also revealed that protein and fibre content increased with increase rate of N and P level. This increment could be due to the vital of N and P in enlargement of vegetative growth of plant parts. However, protein and fibre contents were higher than the value reported for raw groundnut seeds (Adeyeye 2011). This is because protein and fibre may be restricted the plants to grow in soils having low sulfur. These results are in agreement with findings of Soto *et al.* (2004). N and P contribute greatly to the synthesis of fibre and protein and the higher N and P available to the crop; the higher protein can be synthesized. High level of protein in bambara groundnut would make it useful in supplementing the nutrients derived from tubers and cereals in places where other legumes are not easily available.

Table 3. Effect of different rates of compost on mineral composition (mg/kg) from the seed of bambara groundnut.

Treatments	Ca	K	Mg	Mn	Zn	Cu	Fe
	Macronutrients			Micronutrients			
T_1	803.25a	529.0a	717.0a	25.1a	66.95a	4.6a	58.8ab
T_2	719.75b	482.5bc	639.0b	24.3ab	56.7bc	3bcd	59.7a
T_3	714.75b	484.5b	651.0b	22.2a-d	55.1bc	3.8bc	57.4a-c
T_4	602.5a-c	400.0e	606.8bc	19.4d	45.0d	1.9e	52.9a-c
T_5	624.8de	401.5e	602.0bc	20.9bcd	50.5cd	2.2de	50.3c
T_6	637.3de	419de	589.3bc	20.4cd	51.6bcd	2.2de	51.9bc
T_7	644.3cde	415.3de	564.0c	22.6a-d	53.0bc	2.6cde	58.9ab
T_8	680.3bcd	442.3cd	621.3bc	24.4ab	54.0bc	2.8bcde	58.2ab
T_9	685.8bcd	440.0de	604.8bc	23.4ab	58.1b	3.1bcd	59.7a
T_{10}	706.5bc	448.8bcd	628.5bc	23abcd	57.0bc	3.5b	57.6abc

T_1: N_{30} + P_{60} kg/ha, T_2: N_{20}+P_{60} kg/ha, T_3: N_{25} + P_{50} + K_{75} kg/ha, T_4: compost 2.5 t/ha, T_5: compost 5.00 t/ha, T_6: compost 7.5 t/ha, T_7: compost 10 t/ha, T_8: B-green biofertilizer 15 kg/ha, T_9: gypsum 400 kg/ha and T_{10}: B-green biofertilizer 15 kg/ha + gypsum 400 kg/ha. Means with the same letter have no significant difference.

The results showed that application of chemical and organic fertilizer at different rates varied significantly on macronutrient Ca, K, Mg and Cu and Zn varied significantly (Table 3). There was no significant difference on Mn and Fe content in seed of bambara groundnut. The highest Ca was gained in the treatment of T_1 and T_2 as compared to T_4. The applied level of fertilizer and compost affected the Ca content in the seed of bambara groundnut. Application of T_1 exposed an increment of 33.3% than T_4. But slightly higher Ca content was reported by (Adam *et al*. 2015) that 958.0 to 990.0 mg/kg.

The Mg content in the seed ranges from 606.8 to 717.0 mg/ka. Mg content 18.16% increase compared to T_4. Similar result was reported by (Benvindo 2018). The Zn content in the seed measured in the treatment of T_1 was significantly higher than the effect of all other treatment. The Zn content was increased 48.8% at T_1 compared to T_4. The treatment T_2 and T_3 were statically

similar but significantly better than the T_4. This result is similar to the findings of Ijarotimi and Esho (2009).

Bambara groundnut is an edible legume which serves as one of the main sources of income for small holder farmers. The yield related character and nutritional composition of the plant increased 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 obtaining maximum yield and nutritional composition of bambara groundnut.

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