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Growth and Yield Performance of Banana by Using NPK Fertilizer with Different Doses

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Abstract

The present study was conducted at Bangabandhu Academy for Poverty Alleviation and Rural Development (BAPARD) Agricultural Farm, Kotalipara, Gopalgonj to find out optimum dose of NPK fertilizers for evaluating banana cultivars in this region (AEZ-14). Four treatments were- T_0= Only cowdung (Control), T_1= Cowdung+ 400gm Urea+ 350gm TSP (Triple Super Phosphate) + 500gm MoP (Muriate of Potash) + 200gm Gypsam, T_2= Cowdung+ 500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam, T_3= Cowdung+ 600gm Urea+ 450gm TSP+ 700gm MoP+ 200gm Gypsam. The highest plant height at 60 DAP (Days after planting), 90 DAP, 120 DAP, 150 DAP, 180 DAP, 210 DAP and 240 DAP were 96.42cm, 121.28cm, 152.44cm, 185.50cm, 214.32cm, 234.50cm and 262.85cm respectively. The maximum functional leaves at 60 DAP, 90 DAP, 120 DAP, 150 DAP, 180 DAP, 210 DAP and 240 DAP were 3.78, 4.33, 6.45, 7.04, 7.62, 8.78 and 9.88 respectively that found in T_2 treatment except 60 DAP. In the case of bunch weight, the highest 7.50 kg was found in T_2 treatment. The maximum number of hands per bunch (5.60), number of fingers per bunch (50.0) and weight of per finger (102.50gm) were observed in T_2 treatment. The higher yield (18.75 t/ha) was given by the T_2 treatment than the other treatments. As a result, the optimum dose was using Cowdung+ 500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam for banana cultivation in this region. It will be helpful for farmers to reduce the wastage of fertilizer and economic banana cultivation. As a result, farmers will be motivated for banana cultivation.

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Introduction

Banana (*Musa spp.)* is one of the most popular, central fruit crops of the tropical and subtropical regions of the world grown on about 8.8 million hectares (Mohapatra *et al.*, 2010). It is the second largest produced fruit after citrus, contributing about 16% of the world's total fruit production (FAO, 2009). It is a very important fruit in world commerce (Samson, 1986) and is possibly the world's oldest cultivated plants (Kumar *et al.*, 2012). Banana is the quickest growing fruit in Bangladesh (Haque and Nasiruddin, 1990) and produces nearly 1.00 million tonnes of bananas annually (Hossain, 2014). It is also a nutritious fruit crop in the world and it is used both as a staple food and dietary supplements (Assani *et al.*, 2001). The per capita consumption of banana in Bangladesh is about 4.7 kg. This is very much lower than that consumed by Europe especially Belgium (26.7 kg), Sweden (16.7 kg) and Germany (14.5 kg) and UK at 10.5 kg (Siti Hawa, 1998).

Bananas are important in nutrition, therapeutics, traditional medicine, pharmaceuticals and food industries (Jideani, 2019). As a diet, banana is rich source of carbohydrate (27%) with 67 calories per 100 g fruit and is one of the most well-liked and widely traded fruits across the world (Emaga *et al.*, 2008; Kumar *et al.*, 2012). Bananas are also a rich source of minerals (K, P, Mg, Ca, Fe) and vitamins, including A, C and B_6. They are a good source of fat-free dietary fiber and used as a good supplement of rice. Banana is often the first solid food fed to infant. Ripe banana mixed with rice and milk is the traditional dish for Bangladeshi (Hossain, 2014). It enhanced digestive health, natural support for hearth health, weight management, enhanced skin and hair health benefits of cating ripe banana for women.

Banana is mainly cultivated for ripen fruits and cooked vegetables Bangladesh (Khanum *et al.*, 2000). Banana is cultivated almost everywhere in Bangladesh round the year. The foremost banana growing areas in Bangladesh are Narsingdi, Gazipur, Tangail, Rangpur, Bogra, Natore, Pabna, Noakhali, Faridpur and Khulna. Some wild varieties are grown in Sylhet, Moulvibazar, Netrokona, Rangamati, Khagrachhari and Bandarban in Bangladesh. In 2010-2011, the total production of banana in Bangladesh was 800840 metric tons and the cultivated area was about 130589 acres (BBS, 2012). The banana fruit is variable in size, shape, color and firmness, but is usually elongated and curved, with soft flesh covered with a rind which may be green, yellow, red, purple or brown color. The fruits grow in clusters hanging from the top of the plant.

Banana production provides suitable options for subsistence and income generation in Bangladesh. It is a commercial fruit all over the world but in Bangladesh, it is grown in limited area commercially. Moreover, a large number of people were involved in the production and marketing of banana in Bangladesh. Also, the demand of banana is increasing day by day in Bangladesh. A small quantity of banana is exported to the Middle-East and European countries. Although bananas are important export commodities of some developing countries in Africa, Latin America and the Asia, unfortunately Bangladesh is not an exporting country. Banana cultivars are highly response to chemical fertilizers particularly at early stages of crop. Banana plants are heavy feeder and they uptake more nutrients from soil as compared to other crop due to their rapid and vigorous growth and higher yield (Rahale *et. al.,* 2020). Among the nutrients, nitrogen is one of the most essential elements for plant growth, flowering and productivity in banana cultivars (Mustaffa and kumar, 2012). Phosphorus is important to produce the healthy rhizome, strong root system; although the requirement of the phosphorus is low.

It also plays a vital role in overall development of the plant and flower set. Another important element for growth of banana is potassium (Lopez and Espinosa, 1998) and it also called the quality control mineral. Supply of potassic fertilizers in adequate quantity not only increases the growth and yield in banana but also the physiology of plant and offers resistance against biotic and abiotic stresses (Mustaffa and kumar, 2012).

Thus it is necessary to increase the production and the qualities of banana by improve production technology including judicious application of fertilizers. Unbalanced fertilizer use (both over-dose and under-dose) is the cause of yield gaps and food insecurity (Giller *et.al.,* 2021). The improper use of fertilizers can have a number of negative environmental effects including air pollution, water pollution, soil pollution, greenhouse gas emissions etc. Simonds (1966) and Koen (1976) reported that the optimum dose of organic and inorganic fertilizer is an important thing during banana cultivation. Different doses of Nitrogen vary the vegetative growth of banana plant (Hazarika et. al., 1991). Nitrogen, Phosphorus and Potassium are the most important essential plant nutrient for banana production. Deficient and imbalance of these nutrients results in poor growth and reduction in yield. Hence, the present study was carried out to find out optimum dose of NPK fertilizers for evaluating banana cultivars in this region (AEZ-14) (Agro-Ecological Zone-14) of Bangladesh.

Materials and methods

Field experiment was carried out at Bangabandhu Academy for Poverty Alleviation and Rural Development (BAPARD) Agricultural Farm, Kotalipara, Gopalgonj in the year 2021-2023 cropping season to find out the optimum dose of NPK and maximizing yield of banana in this region (AEZ-14). Experimental site situated between21°51´and 23°10´ north latitude and between 89°56´ and 90°10´ east longitude. The topography of the farm area is medium high land and the soil is sandy loam type. The average temperature of this site varies from 12.1 °C to 36.1 °C. Heavy rainfall occurs during rainy season.

Banana sucker (*Musa spp.)* was used for the experiment and it is a local variety of Banana called Sobri Kola. Sucker was collected from local area. The four cross ploughing has been done and raised beds were prepared. The banana sucker was planted in the pit during 15.11.2021. Before planting the pit was prepared in every bed. Total 64 pits were prepared and every bed contained 16 pits. The size of the pit was (60cm×60cm×60cm) and the pit to pit distance was 4m. Randomized Completely Block Design (RCBD) was used with 4 replications and 4 treatments. Treatments were-

T_0= Only cowdung (Control)

T_1= Cowdung+ 400gm Urea+ 350gm TSP (Triple Super Phosphate)+ 500gm MoP (Muriate of Potash)+ 200gm Gypsam

T_2= Cowdung+ 500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam

T_3= Cowdung+ 600gm Urea+ 450gm TSP+ 700gm MoP+ 200gm Gypsam

Fertilizer has been used as different doses. Equal amount of cowdung (10kg/pit) was used in each pit. Total amount of cowdung, TSP (Triple Super Phosphate), Gypsum and ½ of MoP (Murate of Potash) was used in during pit preparation. Urea and rest of MoP were used 2 months interval after plantation. Weeding has been done when necessary. Irrigation and drainage was done at proper time. Pest and diseases was controlled when necessary.

Data was recorded on the following parameters: Plant height at different DAP (Days after planting), Number of functional leaves at different DAP, Weight of bunch (Kg), Number of hands per bunch, Number of finger per bunch, weight of per fingure and Yield per ha (t). All data was taken carefully at proper time. Data was collected from research field and data was analyzed by using STAR (Statistical Tool for Agricultural Research) version 2.0.1.

Result and discussion

Plant height at different DAP (Days after planting)

The plant height at different Days after planting (DAP) were recorded at 60 DAP, 90 DAP, 120 DAP, 150 DAP, 180 DAP, 210 DAP and 240 DAP (Table-1). The plant height at 60 DAP was varied from 75.36cm to 96.42cm (Table-1). Maximum plant height at 60 DAP (96.42cm) was recorded in T_3 which was statistically identical to T_1 and T_2. The minimum plant height at 60 DAP (75.36cm) was recorded in T_0. The plant height at 90 DAP was varied from 88.33cm to 121.28cm (Table-1).

Table 1. Plant height (cm) at different DAP.

Treatments	Plant height at different days after planting (DAP) (cm)						
	60 DAP	90 DAP	120 DAP	150 DAP	180 DAP	210 DAP	240 DAP
T_0 (Only cowdung)	75.36b	88.33c	104.45c	122.67c	142.78c	158.25b	174.36c
T_1 (Cowdung+ 400gm Urea+ 350gm TSP+ 500gm MoP+ 200gm Gypsam)	92.78a	115.50b	143.68b	172.60b	203.90b	225.86a	241.15b
T_2 (Cowdung+ 500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam)	93.50a	117.73b	145.65b	184.96a	214.32a	234.50a	262.85a
T_3 (Cowdung+ 600gm Urea+ 450gm TSP+ 700gm MoP+ 200gm Gypsam)	96.42a	121.28a	152.44a	185.50a	210.88a	232.92a	247.30b
F-test	*	*	*	*	*	*	*
CV (%)	4.82	3.49	5.14	7.08	6.65	3.18	6.91

In a column, figure with same letter do not differ significantly; *Significant at 5% level of significance; NS= Non Significant

Source: Data was collected from research field and data was analyzed by using STAR (Statistical Tool for Agricultural Research).

Maximum plant height at 90 DAP (121.28cm) was recorded in T_3 and the minimum plant height at 90 DAP (88.33cm) was recorded in T_0. The plant height in case of T_2 was 117.73cm which was statistically similar to T_1 that was 115.50cm. The plant height at 120 DAP was significantly varied from 104.45cm to 152.44cm (Table-1). Maximum plant height at 120 DAP (152.44cm) was recorded in T_3 and the minimum plant height at 120 DAP (104.45cm) was recorded in T_0. The plant height in case of T_2 was 145.65cm which was statistically similar to T_1 that was 143.68cm. The plant height at 150 DAP was varied from 122.67cm to 185.50cm (Table-1). Maximum plant height at 150 DAP (185.50cm) was recorded in T_3 which was statistically identical to T_2 and the minimum plant height at 150 DAP (75.36cm) was recorded in T_0.

The plant height at 180 DAP was varied from 142.78cm to 214.32cm (Table-1). Maximum plant height at 180 DAP (214.32cm) was recorded in T_2 which was statistically identical to T_3 and the minimum plant height at 180 DAP (142.78cm) was recorded in T_0. The plant height at 210 DAP was varied from 158.25cm to 234.50cm (Table-1). Maximum plant height at 210 DAP (234.50cm) was recorded in T_2 which was statistically identical to T_3 and T_1. The minimum plant height at 210 DAP (158.25cm) was recorded in case of T_0. The plant height at 240 DAP was significantly varied from 174.36cm to 262.85cm (Table-1). Maximum plant height at 240 DAP (262.85cm) was recorded in T_2 and the minimum plant height at 240 DAP (174.36cm) was recorded in T_0. The plant height in case of T_3 was 247.30cm which was statistically similar to T_1 that was 241.15cm. Difference in height might be due to competition for available sunlight, space, optimum fertilizers utilization and environmental factors. Similar findings with regards to plant height were also observed by *Badgujar et al.* (2004). Sing and Suryanaryana (1999) found the best plant height when use around 450gm of urea and Naresh-Babu (2004) found highest plant height when used 500gm urea. All the results have supported the present findings.

Number of functional leaves at different DAP

Number of functional leaves is an important factor for production and accumulation of food in a plant. The number of functional leaves was estimated at 60 DAP, 90 DAP, 120 DAP, 150 DAP, 180 DAP, 210 DAP and 240 DAP. The number of functional leaves at 60 DAP was estimated from 3.70 to 3.78 (Table-2). Maximum number of functional leaves at 60 DAP (3.78) was recorded in T_0 (Only cowdung) and the minimum number of functional leaves was recorded in T_3 which was statistically similar to T_1 and T_2.

The number of functional leaves at 90 DAP was varied significantly from 3.98 to 4.33 (Table-2). Maximum number of functional leaves at 90 DAP (3.78) was observed in T_2 which was statistically

similar to T_3. Number of functional leaves at 90 DAP in T_1 was 4.25 which was statistically similar to T_3. The minimum number of functional leaves was recorded in T_0 (Only cowdung) that was 3.98. The number of functional leaves at 120 DAP was estimated from 6.45 to 4.10 (Table-2). Maximum number of functional leaves at 120 DAP (6.45) was observed in T_2 which was statistically similar to T_3. Number of functional leaves at 120 DAP in T_1 was 5.80 which was statistically similar to T_3. The minimum number of functional leaves was recorded in T_0 that was 4.10.

Table 2. Number of functional leaves at different DAP.

Treatments	Number of functional leaves at different days after planting (DAP)						
	60 DAP	90 DAP	120 DAP	150 DAP	180 DAP	210 DAP	240 DAP
T_0 (Only cowdung)	3.78	3.98c	4.10c	4.45c	4.82c	4.92c	5.23c
T_1 (Cowdung+ 400gm Urea+ 350gm TSP+ 500gm MoP+ 200gm Gypsam)	3.75	4.25b	5.80b	6.14b	6.38b	6.85b	7.05b
T_2 (Cowdung+ 500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam)	3.72	4.33a	6.45a	7.04a	7.62a	8.78a	9.88a
T_3 (Cowdung+ 600gm Urea+ 450gm TSP+ 700gm MoP+ 200gm Gypsam)	3.70	4.28ab	6.10ab	6.32b	6.85ab	7.48b	8.02b
F-test	NS	*	*	*	*	*	*
CV (%)	5.52	7.31	4.82	5.01	2.31	5.01	7.08

In a column, figure with same letter do not differ significantly; *Significant at 5% level of significance; NS= Non Significant
Source: Data was collected from research field and data was analyzed by using STAR (Statistical Tool for Agricultural Research).

The number of functional leaves at 150 DAP was varied significantly from 4.45 to 7.04 (Table-2). Maximum number of functional leaves at 150 DAP (7.04) was recorded in T_2. In case of T_3 we observed it was 6.32 which was statistically similar to T_1 and the minimum number of functional leaves at 150 DAP was recorded in T_0 that was 4.45. The number of functional leaves at 180 DAP was estimated from 4.82 to 7.62 (Table-2). Maximum number of functional leaves at 180 DAP (7.62) was observed in T_2 which was statistically similar to T_3. Number of functional leaves at 120 DAP (6.38) in T_1 which was statistically similar to T_3 that was 6.85. The minimum number of functional leaves at 180 DAP (4.82) was recorded in T_0.

The number of functional leaves at 210 DAP was varied significantly from 4.92 to 8.78 (Table-2). Maximum number of functional leaves at 210 DAP (8.78) was recorded in T_2. In case of T_3 we observed it was 7.48 which was statistically similar to T_1 and the minimum number of functional leaves at 210 DAP was recorded in T_0 that was 4.92. The number of functional leaves at 240 DAP was observed from 5.23 to 9.88 (Table-2). The highest number of functional leaves at 240 DAP (9.88) was recorded in T_2. In case of T_3 it was 8.02 and in case of T_1 it was 7.05 which were statistically similar to each other. The minimum number of functional leaves at 240 DAP was 5.23 which was recorded in T_0. Maximum number of functional leaves at different days after planting was found at T_2 except 60 DAP might be due to the availability of proper amount of nutrients with water and sunlight. The present findings are in the conformity with findings of Suresh *et.al.* (2008) in Nendran and Rahate *et. al* (2020) in Konkan safed Velchi.

Weight of bunch (Kg)

The weight of bunch was observed from 3.25 kg to 7.50 kg (Table-3). Maximum weight of bunch was recorded with T_2 (7.50 kg). The minimum weight of bunch was observed in T_0 (3.25 kg) when we used only cowdung. In case of T_1 about 5.50 kg bunch was found which was statistically similar with T_3 (5.80 kg). As a result, the maximum performance was found by using this combination of organic and inorganic fertilizer in every pit (10 kg Cowdung+

500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam). By using more than this dose or less than this dose the weight of bunch was reduced. Increased availability and uptake of nutrients led to the better expression of growth and yield attributes which ultimately resulted in higher yield. Similar findings were reported by Ebeed *et. al.* (2004) in Grand Naine and Rahate *et. al.* (2020) in Grand Naine.

Number of hands per bunch

Number of hands per bunch was observed from 3.20 to 5.60 (Table-3). Maximum number of hands per bunch was recorded with T_2 (5.60). The minimum number of hands per bunch was observed in T_0 (3.20) when we use only cowdung. In case of T_1 about 4.75 hands per bunch was found which was statistically similar with T_3 (4.80).

As a result, the maximum performance was found by using this combination of organic and inorganic fertilizer in every pit (10 kg Cowdung+ 500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam). By using more than this dose or less than this dose the number of hands per bunch was reduced. Maximum number of hands per bunch might be due to proper nutrient management led to yield attributes which ultimately resulted in higher yield. Similar results recorded by Patel *et. al.* 2011) in banana cultivars in Grand Naine and Balasubrahmanyam *et.al.* (2003) in banana cultivars in Grand Naine.

Table 3. Weight of bunch (Kg), Number of hands per bunch, Number of finger per bunch, Weight of per finger (gm), Yield per ha (t).

Treatments (Fertilizer doses)	Weight of bunch (Kg)	Number of hands per bunch	Number of finger per bunch	Weight of per finger (gm)	Yield per ha (t)
T_0 (Only cowdung)	3.25c	3.20c	20c	73.75c	8.20c
T_1 (Cowdung+ 400gm Urea+ 350gm TSP+ 500gm MoP+ 200gm Gypsam)	5.5b	4.75b	42b	78.20c	13.50b
T_2 (Cowdung+ 500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam)	7.50a	5.60a	50a	102.50a	18.75a
T_3 (Cowdung+ 600gm Urea+ 450gm TSP+ 700gm MoP+ 200gm Gypsam)	5.80b	4.80b	43b	88.60b	14.50b
F-test	*	*	*	*	*
CV (%)	8.98	6.24	8.04	8.68	9.24

In a column, figure with same letter do not differ significantly; *Significant at 5% level of significance; NS= Non Significant
Source: Data was collected from research field and data was analyzed by using STAR (Statistical Tool for Agricultural Research).

Number of finger per bunch

Number of finger per bunch was observed from 20 to 50 (Table-3). Maximum number of finger per bunch was recorded with T_2 (50). The minimum number of finger per bunch was observed in T_0 (20) when we use only cowdung. In case of T_1 about 42 fingers per bunch was found which was statistically similar with T_3 (43). As a result, the maximum performance was found by using this combination of organic and inorganic fertilizer in every pit (10 kg Cowdung+ 500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam). By using more than this dose or less than this dose the number of finger per bunch was reduced. It has might be due to optimum use of fertilizers similar results were reported by Balasubrahmanyam *et.al.* (2003) in banana cultivars in Grand Naine.

Weight of per finger (gm)

Significantly highest finger weight (102.5gm) was recorded in T_2 treatment and the lowest finger weight (73.75gm) was observed in T_0 (Table-3). Significantly highest finger weight (102.5gm) due to NPK fertilizer levels were recorded in T_2 and lowest finger weight (73.75gm) due to NPK fertilizer zero level, only use cowdung 10 kg/pit. As a result, the maximum performance was found by using this combination of organic and inorganic fertilizer in every pit (10 kg

Cowdung+ 500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam) and lowest finger weight due to use no NPK fertilizers. Similar findings were recorded by Pathak *et. al.* (1992) at Harichal and Rahate *et. al.* (2020) at Grand Naine in India.

Yield per ha (mt)

Yield is an important factor during cultivation of any crop and it is closely related with economic return. In case of this study, the yield was observed from 8.20 t/ha to 18.75 t/ha (Table-3). Maximum yield was recorded with T_2 (18.75 t/ha) and the minimum yield was observed in T_0 (8.20 t/ha) when we use only cowdung. In case of T_1 about 13.50 t/ha yield was found which was statistically similar with T_3 (14.50 t/ha). As a result, the maximum performance was found by using this combination of organic and inorganic fertilizer in every pit (10 kg Cowdung+ 500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam). By using more than this dose or less than this dose the yield was reduced. Increased availability and uptake of optimum nutrients led to the excellent expression of growth and yield attributes which ultimately resulted in higher yield. Similar results were reported by Balasubrahmanyam *et.al.* (2003).

Conclusion

The result of the study showed that T_2 (Cowdung+ 500gm Urea+ 400gm TSP+ 600gm MoP+ 200gm Gypsam) gave the higher yield other than two treatments T_1 (Cowdung+ 400gm Urea+ 350gm TSP+ 500gm MoP+ 200gm Gypsam) and T_3 (Cowdung+ 600gm Urea+ 450gm TSP+ 700gm MoP+ 200gm Gypsam). So the optimum doses of the NPK fertilizer for banana cultivation is 500gm Urea, 400gm TSP and 600gm MoP for the Agro Ecological Zone 14. On the other hand farmer will be benefited from banana production in this area.

Abbreviation

DAP= Days after planting
TSP= Triple Super Phosphate
MoP= Muriate of Potash
AEZ=Agro-Ecological Zone

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