EFFECT OF NITROGEN AND PHOSPHORUS ON THE GROWTH AND DEVELOPMENT OF BARI PANIKACHU-1 (*Colocasia esculenta*)

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CERTIFICATE

This is to certify that the thesis entitled **"EFFECT OF NITROGEN AND PHOSPHORUS ON THE GROWTH AND DEVELOPMENT OF BARI PANIKACHU-1 (*Colocasia esculenta*)"** submitted to the Department of Soil Science, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTERS OF SCIENCE (M.S.)** in **SOIL SCIENCE**, embodies the result of a piece of bonafide research work carried out by **MUNTASIRA BINTA MAHABUB**, Registration No. **19-10223** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

December, 2021
Dhaka, Bangladesh

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Dedicated to

My

Beloved Parents

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EFFECT OF NITROGEN AND PHOSPHORUS ON THE GROWTH AND DEVELOPMENT OF BARI PANIKACHU-1 (*Colocasia esculenta*)

ABSTRACT

The present study was conducted at the research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 during the period from February 2021 to July 2021 to observe the effect of nitrogen and phosphorus for the growth and development of BARI panikachu-1 (*Colocasia esculenta*). Single factor experiment consisted of 8 treatments *viz*. T_1 ($N_0P_0K_0$ kg ha^{-1}), T_2 (Recommended Fertilizer Doses; RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}), T_3 ($N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}), T_4 ($N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}), T_5 ($N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}), T_6 ($N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) and T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}). Cowdung @ 5 t ha^{-1} was added with each treatment except control. This experiment was laid out in randomized complete block design (RCBD) with three replications. Results indicated that the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) showed the maximum plant height (87.50 cm), petiole length (28.97 cm), leaf breadth (23.54 cm), plant base diameter (26.13 cm), length of stolon (89.23 cm), fresh weight of rhizome plant^{-1} (693.30 g), fresh weight of stolon palnt^{-1} (1238.00 g), rhizome yield (17.83 t ha^{-1}) and stolon yield (29.41 t ha^{-1}) followed by the treatment T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) while control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) showed the minimum results on the above mentioned parameters. In terms of pH and nutrient status in post harvest soil, available S content varied significantly but pH, organic carbon (OC) and available P content was non-significant among the treatments. The maximum S content (29.37 ppm) was found from the treatment T_5 ($N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) while the minimum was recorded from control treatment. The maximum pH, OC and available P content were recorded from T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}). Therefore, BARI panikachu-1 cultivation, the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) can be considered as the best and next to T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) under the present study.

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ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
DMRT	=	Duncan’s Multiple Range Test
et al.,	=	And others
e.g.	=	exempli gratia (L), for example
etc.	=	Etcetera
FAO	=	Food and Agricultural Organization
g	=	Gram (s)
i.e.	=	id est (L), that is
kg	=	Kilogram (s)
LSD	=	Least Significant Difference
m^2	=	Meter squares
mL	=	Mili Litre
M.S.	=	Master of Science
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
var.	=	Variety
^oC	=	Degree Celceous
%	=	Percentage
NaOH	=	Sodium hydroxide
GM	=	Geometric mean
mg	=	Miligram
P	=	Phosphorus
K	=	Potassium
Ca	=	Calcium
L	=	Litre
µg	=	Microgram
USA	=	United States of America
WHO	=	World Health Organization

CHAPTER I

INTRODUCTION

Roots and Tuber crops are the 2nd most principal food crops in the world after cereals, generally found in tropical and subtropical zone in the world, nearly 2.2 billion people depend upon roots and tuber crops in the world (FAO, 2018). Annual global production of roots and tuber crops are 836 million tones and Asia is a major producer followed by Africa, Europe and America (FAOSTAT, 2010). Tuber crops have an immense potential as functional foods and nutritional ingredients to be explored in disease risk reduction and wellness (Chandrasekara *et al*., 2016). *Colocasia esculenta* is commonly known as taro, aroid, arvi, sakeen, kochai etc. one of the important tuber vegetable of the world and known as “Great leaved Caladium” or “Elephant ear” in English, “Dasheen” in USA, and “cocoyam” in West Africa (Markam *et al*., 2016). It occupied 9th positions among the food crops in the world (Kumar *et al*., 2016). Taro (*Colocasia esculenta* var. esculenta) is intensively produced in the Pacific Islands and forms a significant proportion of their diet; West Africa cultivates the largest area and is the leading producer of the crop in the world (FAOSTAT, 2010).

In Bangladesh it is locally known as kachu, panikachu, mukhikachu etc. and popularly cultivated tuber crops. *Colocasia* is originated in South East Asia including India (Chang, 1958) and Malaysia (Keleny, 1962). Taro belonging to the tribe Colocasiae, sub tribe Colocasiniae, of the family Araceae and considered as a polymorphic species. It has been found in diploid (2n=28) and triploid (3n=42) form. Diploids show high fertility while triploids are highly sterile (Jos and Vijaya Bai 1977). Plants are perennial but cultivated as annuals, lactiferous and very variable herb with 30-150 cm in height. Leaves are large or rather large, obliquely erect, long petioled, with varing colour and size. Petiole is sheathering at the base, uniformly light or dark green, green with dark streaks or violet, 40-150 cm long. It consists mainly of the leaves with long petiole which arises in a whorl from the apex of the underground rhizome. Rhizomes are cylindrical with short internodes and few side tubers.

Among the different factors contributing to low yield, soil-plant nutrition is worthy of mention as soil fertility management and proper nutrition of these crops can result in large yield gains (Noor *et al.*, 2015). The *Colocasia* responds well to manure and fertilizer application, adequate supply of nutrition is a precondition of higher production. The nutrients requirement of *Colocasia* crops is high because of high biological yields therefore, sufficient plant nutrients have to be supplied to sustain rapid growth for higher production of corms/rhizome and stolon. The information regarding nutritional requirement of *Colocasia* (taro) is very scanty. There is a need to standardize the optimum dose of nutrients for improving the productivity of taro.

Nitrogen has numerous functions in the plant. Many plant enzymes are proteinaceous and hence nitrogen play a key role in many metabolic reactions of plant and adequate N promotes vigorous vegetative growth and impart deep green color. In cereals crops it increase the plumpness of a grains (Buke *et al*., 2016). Nitrogen is also the part of chlorophyll molecule so a deficiency of nitrogen will result in a chlorotic condition of the plant which decreases the quality of its fruits. Plant root absorb N in the form of a NO_3^- or NH_4^+ ions. Urea (NH_2CONH_2) can also be absorbed by plant leaves when applied in solution form as a foliar application (Mandal and Sen, 2005; Ogbonna and Nweze, 2012). In this form N is directly and rapidly absorbed through the leaf epidermis. In *Colocasia* as well, the application of N significantly improve its yield and yield components (Buke *et al*., 2016).

Phosphorus plays an important role in structural components of the cell. It is a constituent of sugar-phosphotase-ADP/ATP, also has an important role in energy transformation and metabolic process of plant (Ogbonna and Nweze, 2012). The phosphorus requirement of taro is less as compared to nitrogen and potassium. Phosphorous stimulates early root formation and growth, gives a rapid and vigorous growth to plants. Phosphorous is needed in the genetic coding material which controls cell division (Omid *et al*., 2016).

Some work on nutrient management in different tuber crops have been carried out in India. Suja et al. (2006) reported that the application of NPK @ 50:25:75 kg ha^{-1} produce higher yield. Joshi *et al*. (2017) reported that the application of NPK fertilizer @ 60:40:60 and vermicompost @ 20t ha^{-1} had significantly increased the tuber yield and growth parameters of tikhur (East Indian arrowroot). However, the proper information on nutrient management in *Colocasia* crop is lacking. Hence, this study was undertaken with the following objective:

1. To observe the effect of N and P on the growth and development of BARI panikachu-1
2. To evaluate the interaction effect of N and P for the growth and yield of BARI panikachu-1
3. To find out the suitable doses of N and P for maximum growth and yield of BARI panikachu-1

CHAPTER II

REVIEW OF LITERATURE

Nitrogen (N) and phosphorus (P) are the most important macronutrients for maximizing the yield of taro (*Colocasia esculenta*). The proper fertilizer management basically influences its growth and yield performance. Experimental evidences showed that there is a profound influence of N and P fertilizers on this crop. The fertilizer requirements, however, varies with the soil and cultural conditions. Research works have been done in various parts of the world including Bangladesh is not adequate and conclusive. Some of the important and informative works conducted home and abroad in this aspect, have been furnished in this chapter.

2.1 Effect of N and P on growth and yield attributing traits in *Colocasia*

Singh *et al*. (2021) carried out an Influence of differential levels of inorganic and organic sources of nutrients on growth and yield of Bun/taro investigation to study the influence of differential levels of inorganic and organic sources of nutrients on growth and yield of Bun. The experiment was laid out in a factorial randomized complete block design with sixteen treatment combinations consisted of four levels of fertilizers ($N_0P_0K_0$, $N_{50}P_{40}K_{50}$, $N_{75}P_{60}K_{75}$ and $N_{100}P_{80}K_{100}$) and four levels of Farm Yard Manure (0, 10, 20 and 30 t ha^{-1}). The result revealed that the plant height, leaf area index, length of corm, width of corm, weight of corm plant^{-1}, dry matter (%) of tuber and tuber yield increased significantly at each level of fertilizer. The plant height and leaf area index at 3 month after planting, length of corm, weight of corm plant^{-1}, dry matter (%) and tuber yield increased significantly at each level of FYM. However, the plant height and leaf area index at 5 month after planting and width of corm responded significantly up to FYM @ 20 t ha^{-1}. The weight of corm was not influenced significantly with the FYM levels under $N_0P_0K_0$, and $N_{100}P_{80}K_{100}$ (except FYM @ 10 t ha^{-1}) and it responded to each successive level of FYM under remaining two fertilizer doses. The successive doses of FYM were significantly responded by tuber yield under all the fertilizer doses except FYM @10 t ha^{-1} under $N_0P_0K_0$. It shows that the dose of FYM @10 t ha^{-1} might not be sufficient to improve the tuber yield significantly where no fertilizer was applied. The fertilizer dose @ $N_{100}P_{80}K_{100}$ kg ha^{-1} in conjunction with FYM @ 30 t ha^{-1} was found better in terms of higher tuber yield (35.1 t ha^{-1}) of Bunda (*Colocasia esculenta*).

Omid *et al*. (2018) conducted an experiment entitled "effect of nitrogen, phosphorus and potassium on growth and yield of Arvi (*Colocasia esculenta* L.)" Total ten treatment *viz*. T_1 - NPK 60:30:80 kg ha^{-1}, T_2 - NPK 60 :60:120 kg ha^{-1}, T_3 -NPK 60 :90:160 kg ha^{-1}, T_4 - NPK 90:30:80 kg ha^{-1}, T_5 -NPK 90:60:120 kg ha^{-1}, T_6 -NPK 90:90:160 kg ha^{-1}, T_7 -NPK 120:30:80 kg ha^{-1}, T_8 -NPK 120:60:120 kg ha^{-1}, T_9 -NPK 120:90:160 kg ha^{-1} and T_{10} - Control were tried to assess the impact of nitrogen, phosphorous and potassium on growth and yield of colocasia during investigation. Out of these, the treatment with NPK 120:30:80 was found significantly superior in terms of plant height (cm.), plant spread (cm), number of leaves $plant^{-1}$, number of tillers $plant^{-1}$, girth of pseudostem from ground level (cm) , length of leaf (cm), width of leaf (cm), petiole length (cm) and petiole breadth (cm). Similarly, yield and yield attributing parameters i.e., number of corms $plant^{-1}$, corm length (cm), corm girth (cm), weight of corm (g), corm yield $plant^{-1}$ (g), and corm yield (q ha^{-1}) were found significantly superior with the application of NPK 120:30:80 as compared to control and other treatments. Finally, a dose of NPK @ 120:30:80 kg ha^{-1} gave the highest yield of corm i.e., 289.83 q ha^{-1}, whereas lowest yield of corm i.e., 92.25 q ha^{-1} was observed under control during the cropping period.

Joshi *et al*. (2017) studied the effect of four levels of fertilizers ($N_0P_0K_0$, $N_{30}P_{20}K_{30}$, $N_{60}P_{40}K_{60}$ and $N_{90}P_{60}K_{90}$ kg ha^{-1}) in Tikhur (*Curcuma angustifolia* Roxb)r. Individual application of fertilizer $N_{60}P_{40}K_{60}$ and vermicompost 20 t ha^{-1} had significantly increased the number of leaves per plant, plant height and leaf area index of Tikhur as compared to control whereas primary rhizome yield, secondary rhizome yield, total rhizome yield, gross and net return increased significantly as compared to fertilizer $N_{30}P_{20}K_{30}$ and vermicompost 10 t ha^{-1}. The increase in fertilizer dose up to $N_{60}P_{40}K_{60}$ had significantly increased and increase in vermicompost dose up to 20 t ha^{-1} significantly decreased the gross and net benefitcost ratio of Tikhur. The interaction of $N_{60}P_{40}K_{60}$ with 20 t ha^{-1} vermicompost was found superior in case of total rhizome yield, gross and net return whereas, gross and net benefit : cost ratio was found superior under interaction of $N_{60}P_{40}K_{60}$ with 0 t ha^{-1} vermicompost.

Suminarti *et al*. (2016) found that plant density of *Colocasia* only significantly influenced the number of tubers per plant and starch content. The optimum application of NK fertilizers was applied as 127.04 kg N ha^{-1} and 164.64 kg K_2O ha^{-1} with the tuber yield of 16.72 t ha^{-1}. The highest starch content (28.36%) achieved at the application of 127.84 kg N ha^{-1} and 162.08 kg K_2O ha^{-1}.

Buke and Gidago (2016) observed that the influences of different rates of NP on yield components and yield of Taro or Boloso-1 (*Colocasia esculenta* L. Schott.). The treatments consisted of four levels of N (0, 23, 46 and 69 kg ha^{-1}) and four levels of P (0, 10, 20 and 30 kg ha^{-1}). Where increase in N level had significant effect on number of suckers, plant height, plant diameter, tuber length and tuber diameter, both the years but leaf number and tuber weight for first year and only tuber weight for second year showed non-significant difference in both N and P different levels. NP interaction significantly affected the average number of suckers, plant height, plant diameter, tuber length and tuber diameter. But the interaction had no effect on leaf number and tuber weight. Whereas NP significantly affected sucker number, plant height, leaf number, plant diameter, tuber length and tuber diameter but the interaction had no effect on tuber weight.

Noor *et al*. (2015) conducted experiment to find out optimum doses of N, P, K and S for yield maximization of aquatic taro (*Colocasia esculenta*). There were four levels of nitrogen (0, 75, 100 and 125 kg ha^{-1}), four levels of phosphorus (0, 30, 45 and 60 kg ha^{-1}), four levels of potassium (0, 80, 100 and 120 kg ha^{-1}) and four levels of sulphur (0, 10, 20 and 30 kg ha^{-1}). The yield attributes and yield of aquatic taro were significantly increased by the application of NPKS fertilizers. The highest stolon yields (25.60 and 28.16 t ha^{-1} for 2008-09 and 2010-11, respectively) were found in $N_{100}P_{45}K_{100}S_{20}$ kg ha^{-1} combination. From the regression analysis, it could be concluded that around 110-50-105-24 kg ha^{-1} N-P-K-S was the optimum dose for the production of aquatic taro.

Isaac *et al*. (2015) reported that average weight of corm (21.40 g), average weight of cormel (9.50 g), length of corm (9.45 cm), girth of corm (8.92 cm), yield of corm 440.31g $plant^{-1}$, yield of corm 8.52 t ha^{-1} was recorded significantly highest in treatment 50% NK and full P basal soil application (urea, rajphos and muriat of potash) and 50% NK foliar spray (urea 2% and sulphate of potash 2%) followed by treatment 50% NPK basal soil application (urea, rajphos and muriate of potash) and 50% NPK foliar spray (19:19:19-0.5% and 13:0:45-0.5%).

Shaabanand-Kisetu (2014) observed that the effect of different rates of NPK fertilizer on performance of Irish potato (*Solanum tuberosum* L.). This experiment employed use of 150 and 300 kg ha^{-1} of NPK (23:10:5) fertilizer and a local cultivar Alika of Irish potato as a response crop. Results indicated that the significantly highest average marketable number of tubers per plant (3.5) and tuber yield (18.74 t ha^{-1}) was recorded at an application of 300 kg NPK ha^{-1}. The lowest average number of tubers per plant (2.2) was recorded in the absolute control while the lowest tuber yield (14.99 t ha^{-1}) was recorded at 150 kg NPK ha^{-1}.

Uwah *et al*. (2013) reported that application of N at the highest rate increased plant height, produced higher number of leaves and branches $plant^{-1}$, stem girth, number and weight of tubers $plant^{-1}$ and total fresh tuber yield of Cassava compared with other treatments. The fresh tuber yield at 120 kg N ha^{-1} was higher however, it was comparable with that of 80 kg N ha^{-1}. Cassava growth, fresh tuber yield and all yield attributes peaked at 80 kg K ha^{-1}. The 120 kg N ha^{-1} and 80 kg K ha^{-1} increased fresh tuber weight by 48 and 45 % and total fresh tuber yield by 36 and 27 % respectively, compared with the control plots.

Ukaoma and Ogbonnaya (2013) observed that the effect of nitrogen, phosphorus and potassium (NPK) fertilizer treatment on tuber yield of cassava (*Manihot esculenta* Crantz). Cassava genotype of NR8082 was planted with the rate of fertilizer application were 0, 200, 300, 400 kg ha^{-1}. The results showed that inorganic fertilizer significantly influenced the tuber yield of cassava. Most appreciable yield was obtained with 300 kg N ha^{-1} in single application and 300 kg N/400 kg P/200 kg K ha^{-1} in combination producing 39.5 t ha^{-1}. The results also showed that inorganic fertilizer enhanced tuber yield whereas plots not treated with fertilizer produced lower tuber yield.

Verma *et al*. (2012) observed that the highest petiole length, number of cormels, length, diameter and weight of corms as well as cormel were recorded in taro from the application of vermicompost (1 t ha^{-1}) + full dose of FYM (10 t ha^{-1}) + 75% recommended dose of NPK which was statistically at par with vermicompost (1 t ha^{-1}) + full dose of FYM (10 t ha^{-1}) + 50% recommended dose of NPK. The highest yield (18. 47 t ha^{-1}) was also recorded in vermicompost (1 t ha^{-1}) + full dose of FYM (10 t ha^{-1}) + 75% recommended dose of NPK closely followed by vermicompost (1 t ha^{-1}) +

full dose of FYM (10 t ha^{-1}) + 50% recommended dose of NPK (18.10 t ha^{-1}). However, organic treatment FYM (10 t ha^{-1}) + neem cake (1 t ha^{-1}) showed highest dry matter (27.29%) and starch (17.06%) content.

Ogbonna and Nweze (2012) evaluate the growth and yield response of cocoyam cultivar to the application of NPK @ 15:15:15 kg ha^{-1} identifying high yielding cocoyam cultivars and optimum rates of the fertilizer for optimum production at the two locations in south eastern Nigeria. The result showed that the application of NPK kg ha^{-1} 15:15:15 fertilizer increased growth in cocoyam. However, the highest tuber yield 37.85 t ha^{-1} at Nsukka and 20.84 t ha^{-1} at Umudike were realized in response to the application of 200 and 250 kg ha^{-1}, respectively. Further increases above these rates in the locations declined in tuber yield. The cocoyam cultivar also produced the highest tuber yield ha^{-1} among the five cultivarsin both Nsukka (30.10 t ha^{-1}) and Umudike (19.068 t ha^{-1})

Santosa *et al*. (2011) applied four doses of nitrogen (0, 50, 100 and 150 kg ha^{-1} N) and three doses of potassium (0, 50 and 100 kg ha^{-1} K_2O). in *Amorphophallus muelleri*, the results showed that application of N and K fertilizers significantly increased vegetative growth, i.e. number of leaves, number of leaflets and second leaf size, but did not affect harvesting time. Fresh weight and dry matter content of daughter corm were significantly affected by N and K applications. Combination of 50 kg ha^{-1} N and 100 kg ha^{-1} K_2O resulted in higher corm weight than other treatments. It is evident that the application of nitrogen and potassium is important in *Amorphophallus muelleri*.

Adhikari (2009) studied the effect of NPK on vegetative growth and yield of potato cultivars at different nutrient levels (0:0:0, 50:50:50, 100:50:50, 100:75:50, 100:75:100, 100:100:100 and 150:100:100 kg ha^{-1} N, P_2O_5 and K_2O). Variety Kufri Sindhuri was taller than variety Desiree at all the stages of plant growth. Increasing levels of NPK increased the plant height by 15-42%. Kufri Sindhuri responded nitrogen up to 150 kg ha^{-1} while variety Desiree yielded higher at 100:100:100 kg NPK ha^{-1}.

Attoe *et al*. (2009) tested the effect of five rates each of N, P and K on UGI variety (yellow ginger) in two separate locations of Akamkpa (rainforest zone) and Obubra (derived savanna zone) in Cross River State of Nigeria. The result showed that the tallest plants with more leaves and shoots were produced with higher rates of N at Obubra while the largest leaf area was produced at Akamkpa. The trend in growth and yield parameters showed that ginger performed better in Obubra than in Akamkpa and rhizome yield were also better in 2007 with lower amount of rainfall in the two locations. The study therefore confirmed that the optimum NPK treatment combination of 200:80:150 kg ha^{-1} gave the best rhizome yield during the trials.

Jurri (2008) observed that the application of 200 kg vermicompost along with 75% recommended dose of NPK ha^{-1} significantly produced higher weight of corm, weight of side cormels, number of main cormels $plant^{-1}$, number of side cormels, number of tillers $plant^{-1}$, weight of total tuber yield $plant^{-1}$, marketable tuber yield ha^{-1}, maximum gross return, maximum net return and maximum benefit cost ratio. While, the treatment FYM + neem cake produced higher plant height. However, the treatment vermicompost @ 200 kg ha^{-1} + 50% RD of NPK was the most effective to produce higher content of ascorbic acid and dry matter content in cormels. Whereas, the maximum dry matter content of corm was recorded in recommended dose of NPK @ 80:50:100 kg ha^{-1}.

Law-Ogbomo and Remison (2007) studied the influence of NPK fertilizer @ 15:15:15 application on *Dioscorea rotundata* cv “Obiaoturugo” to determine the optimum level of NPK fertilizer application on yam with five treatments (0, 100, 200, 300 and 400 kg of NPK fertilizer ha^{-1}). The fertilizer trials showed that vine length, number of leaves and leaf area index significantly increased as fertilizer application increased thereby resulting in higher tuber yield. The averaged tuber yield for 2004 (15.60 t ha^{-1}) was higher than the average yield of 2005 (14.70 t ha^{-1}). The optimum tuber yield was obtained in both years with the application of 300 kg ha^{-1} of NPK.

Chattopadhyay *et al*. (2006) studied the effect of different levels of NPK fertilizers on growth and productivity of elephantfoot yam and the results indicated that the maximum plant height (89.5 cm), pseudostem girth (19.2 cm) were recorded with highest NPK level (175:125:175 kg ha^{-1}) but maximum canopy spread (123.1 cm) was observed with NPK level 150:100:150 kg ha^{-1}.

Mandal and Sen (2005) conducted the experiment on different N:P:K fertilizer levels (50:25:50, 75:50:75 and 100:75:100 kg ha^{-1}) with different spacing (60×30 cm, 60×40 cm and 60×50 cm) on eddoe taro revealed that the highest cormels yield (14.99 t ha^{-1}) was obtained with the highest fertilizer level i.e., 100:75:100 kg (N P and K ha^{-1}) with closer spacing of 60 × 30 cm.

Mandal and Sen (2005) conducted the experiment on different fertilizer levels (50:25:50, 75:50:75 and 100:75:100 kg N, P_2O_5 and K_2O/ha) with different spacing (60x30 cm, 60x40 cm and 60x50 cm) on eddoe taro revealed that the highest cormels yield (14.99 t/ha) was obtained with the highest fertilizer level i.e., 100, 75, 100 kg (N, P_2O_5 and K_2O/ha) with closer spacing of 60×30 cm.

Kumar *et al*. (2004) studied the effects of nitrogen fertilizer levels (40, 80, 120 and 160 kg/ha) and application methods (2 and 3 splits) on the growth and yield of colocasia (*C. esculenta)* during 1995 at Kanpur, Uttar Pradesh. The result revealed that Corm yield was increased with nitrogen level up to 120 kg/ha and it was found higher when nitrogen was applied in 3 splits (1/3 at planting + 1/3 at 30 days after planting + 1/3 at 60 days after planting) as compared with 2 splits (1/2 at planting + 1/2 at 30 days after planting).

Sau *et al.* (2002) reported that Petiol length of taro cultivator BCC-1 and CE-**6** showed an increasing trend up to 120 DAP with highest values of each N and K at 150 kg per ha. Dry weights of leaves and cormels were highest with each parameters N and K 150 kg /ha but it was almost at par with N @100 kg and K @150 kg/ha. whereas, LAI at was found to be higher with N @ 100 kg and K @ 150 kg but at par with N and K @ 150 kg/ha. Crop growth rate (CGR) increased gradually up to 90-120 DAP and recorded highest value at 150 kg each of N and K but at par with 100 kg N and 150 kg K/ha. Yield attributes like number of cormels and average weight of cormel were higher in cultivar BCC-1 followed by Telia for each of N and K 150 kg/ha which was closely followed by 100 kg and 150 kg/ha N and respectively. Similarly the highest cormel yield (12.25 t/ha) was found to be associated with BCC-1 followed by Telia (10.19 t/ha).

Rajeshkumar and Vijoykumar (2001) work out the effect of nitrogen, potassium and spacing in arvi *(Colocasia esculenta* L. Schott). cv. kadama local. The study revealed that the application of 120 kg N/ha gave highest plant height (70.40 cm), number of leaves (6.50), weight of cormels (235.66 g) per plant and mean cormel yield (10.44 t/ha) while potassium did not influence the plant height, number of leaves and leaf length. Application of potassium significantly increased the mean cormel yield (9.28 t/ha) up to 80 kg K_2O/ha. The higher net profit of Rs. 24,040.00, Rs.19,980.00, and Rs.20,785.00 were obtained by application of 120 kg/ha nitrogen, 80 kg/ha potassium respectively at plant spacing of 60x30 cm, for two year of experimentation.

Awad *et al.* (2001) reported that the increase in the N, P and K fertilization levels had a stimulative effect on increased yield of corms. However, application of 120 kg N fed^{-1} and highest levels of phosphorus and potassium fertilizers gave the highest weight of corms and potassium content in corms. Percentage of dry matter in corms decreased with increasing nitrogen-levels and with decreasing phosphorus and/or potassium levels. However, the highest yield and its components *i.e.* corm quality and nutrient content were obtained when the plants received 120 kg N plus 30 kg P_2O_5 and 96 kg K_2O fed^{-1} and produced the maximum yield of taro corms.

Sen *et al.* (1999) conducted on experiment on influence of organic and inorganic source of N fertilizers towards stolon production of swamp Taro *(Colocasia esculenta)* cv. BCST-1 and was observed that number of stolons affected significantly by different treatments. The number of stolons was low in April at the time of first initiation, but increased gradually up to July and reached its maximum in all the treatments. Stolon count was maximum in May (>25000/ha) with higher levels of N fertilizer combinations (T_b T_3 and T_5) & reached its maximum (>75000/ha) in July. The stolon yield per hectare was highest (160.39q) in Ti i.e., 400 kg mustard cake + 325 kg N/ha which was followed by T_5 (153.71q) and T_3 (146.1q).

Mukhopadhyay and Sen (1999) reported that application of N along with *Azotobacter* in soil were increased the corm yield whereas, application of only *Azotobacter* to seed, was recorded slightly higher corm yield (4.34- 6.49%) than its soil application. They further reported that 100% recommended dose of N and inoculated with *Azotobacter* before planting recorded the maximum tuber yield of 64.9 tonnes per hectare.

Halavatau *et al.* (1998) conducted an experiment to study the effect of inorganic fertilizers on taro *(Colocasia esculenta)* and reported that placement of P fertilizers and number and timing of N applications were found to increased fertilizer efficiencies Critical leaf concentrations of N and P were determined. Leaf concentrations sampled during early vegetative growth were found to be good indicators of the effect of N or P deficiency on yield. Economic analysis of fertilizer applications demonstrated a high level of profitability.

Escalada and Ratilla (1998) reported that application of green manure (7.23 or 10.84 t/ha) promoted vigorous growth and yield. Significantly higher total corm yields than the control (untreated) was obtained as compared to those treated only with 60-39.6-74.7 kg/ha (N, P, K).

Mehla *et al.* (1997) conducted a field experiment on three spacing (30×30 cm, 45×30 cm and 60×30 cm) and four fertilizer levels consisting of various combinations of N and P during the rainy seasons of 1993-94 and 1994-95. They reported that the yield attributes and corm yields increased significantly with increase in fertilizer level up to 100 kg N + 50 kg P_2O_5/ha. Interactions between spacing and fertilizer level were found significant and the highest corm yield was obtained at 30×30 cm spacing with 150 kg N + 75 kg P_2O_5/ha.

Haroon *et al.* (1997) observed that the yield decreased of Colocasia as the NPK rate decreased from the usual farmer's rate of 185:190:80 kg N P_2O_5 K_2O/ha.

Verma *et al.* (1996) conducted the experiment on Colocasia which consisting of different combinations of 0, 40, 80 and 120 kg/ha of N and K. They reported that the increasing levels of N had positive effects on plant height, number of suckers/plant and number of leaves/plant. Increasing level of N up to 80 kg/ha significantly increased tuber yields and increasing levels of K had similar effects. There was also a significant interaction between the 2 nutrients, 80 kg N and 120 kg K_2O /ha recorded the highest yields.

Poihega *et al.* (1996) reported that increase in corm yield of Colocasia was recorded with application of P and the effects were enhanced by green manure.

Mohankumar *et al.* (1990) recommended three split application (basal, 30 and 60 DAP) of NPK @ 80:25:100 kg/ha for higher corm yield of *Colocasia esculenta*.

Mohankumar and Sadanandan (1989) reported that the increasing nitrogen levels from 40 to 80 kg and K_2O levels from 50 to 100 kg/ha were increased the plant height, LAI, CGR and dry matter production in *Colocasia esculenta.* However, higher dose of N @ 120 kg and K_2O @ 150 kg/ha showed no further increases in values of these trails.

Das and Sethumadhavan (1980) reported that the total tuber yield of cocoyam were increased 56, 34 and 21 % with the application of 120 kg N, 75 kg P_2O_5 and 150 kg K_2O/ha respectively, as compared with the fertilizer dose of 40: 25: 90 kg NPK /ha.

Mandal *et al.* (1972) reported that *Colocasia antiquorum* cv. V-90, V- 250 and V-260 recorded highest average tuber yields of 21.2, 20.0 and 22.1 t/ha, respectively, by the application of 100 kg N + 50 kg P_2O_5 + 100 kg K_2O/ha, as compared with respective yields of 14.5, 13.7 and 15.1 t/ha received from control.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka during the period of February 2021 to July 2021 to study the effect of N and P for the growth and development of BARI panikachu-1 (*Colocasia esculenta*). Details of different materials used and methodologies followed to conduct the studies are presented in this chapter.

3.1 Site description

The experiment was conducted at the Sher-e-Bangla Agricultural University research field, Dhaka, under the Agro-ecological zone of Modhupur Tract, AEZ-28. The land area is situated at 23°41' N latitude and 90°22' E longitude at an altitude of 8.6 meter above sea level. The experimental site is shown in the AEZ Map of Bangladesh in Appendix I.

3.2 Climate

The experimental area is under the sub-tropical climate that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April-September) and less rainfall associated with moderately low temperature during the Rabi season (October-March). The weather data during the study period of the experimental site is shown in Appendix II.

3.3 Soil

The farm soil belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. The experimental area was flat having available irrigation and drainage system. The land was above flood level and sufficient sunshine was available during the experimental period. Before set up the experiment, soil samples from 0-15 cm depths were collected from experimental field. The analyses were done at Soil Science Laboratory, SAU, Dhaka. The physicochemical properties of the initial soil are presented in Appendix III.

3.4 Treatments

Single factor experiment was considered for the present study which is as follows:

1. $T_1 = N_0P_0K_0$ kg ha^{-1}
2. T_2 = RFD ($N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1})
3. $T_3 = N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}
4. $T_4 = N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}
5. $T_5 = N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}
6. $T_6 = N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}
7. $T_7 = N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}

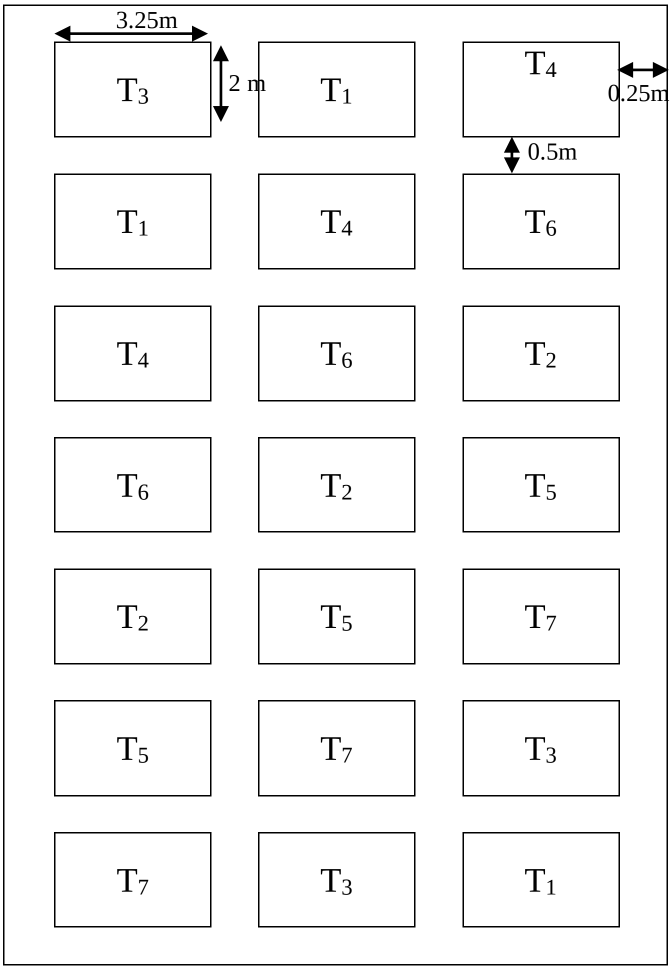
NB: In each treatment cowdung @ 5 t ha^{-1} was added except control treatment.

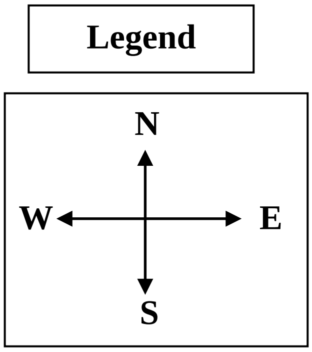
3.5 Plant materials and collection of seeds

BARI panikachu-1 was used as plant materials for the present study collected from BARI (Bangladesh Agricultural Research Institute), Joydebpur, Gazipur, Bangladesh.

3.6 Preparation of experimental land

The plot selected for the experiment was opened in the first week of February 2021 with a power tiller, and was exposed to the sun for a week. The experimental field was prepared to a fine tilth. The ploughing was done with tractor drawn cultivator followed by one cross harrowing to pulverize the soil. Finally, the field was leveled with planker and layout of the experimental plots was done (Figure 1).





Treatments

1. $T_1 = N_0P_0K_0$ kg ha^{-1}
2. T_2 = RFD ($N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1})
3. $T_3 = N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}
4. $T_4 = N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}
5. $T_5 = N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}
6. $T_6 = N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}
7. $T_7 = N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}

NB: In each treatment cowdung @ 5 t ha^{-1} was added except control treatment

Figure 1. Layout of the experiment field

3.7 Fertilizer application

The following doses of fertilizer were applied for cultivation of crop.

Nutrient element	Fertilizer	Recommended doses ha^{-1}
N, P, K, S	Cowdung	5 t
N	Urea	As per treatment
P	TSP	As per treatment
K	MoP	165 kg
S	Gypsum	65 kg

Cowdung was applied at the rate of 5 ton ha^{-1} during 15 days before transplanting. The fertilizers N, P, K and S in the form of urea, TSP, MoP and gypsum, respectively were applied. The entire amount of TSP, MoP and gypsum were applied at the final preparation of land. Urea was applied in three equal installments at seedling establishment to harvest.

3.8 Experimental design and layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications (block). The experiment plot was first divided into three equal blocks. Each block was divided into 7 sub plots where N and P treatments were assigned. Thus the total number of unit plots was 7×3=21. The size of the unit plot was 3.25 m × 2.0 m. The distance maintained between the row was 0.5 m and between column was 0.5 m. The treatments were randomly assigned to the plots within each block. Layout of the experiment field is presented in Figure 1.

3.9 Transplanting

Cormels were used as planting material. Before planting, the seed material was treated with Bavistin @ 1.0 g/litre of water. The treated seed materials were then transplanted in ridges at a distance of 80 cm × 65 cm spacing and 6 to 8 cm in depth.

3.10 Intercultural operations

After establishment of seedlings, various intercultural operations were accomplished for better growth and development of the seedlings.

3.10.1 Gap filling

Gap filling was done at 15 days after planting. The gaps (unsprouted/failed seeds) were replaced by using treated and sprouted cormels.

3.10.2 Irrigation and drainage

Flood irrigation was given to maintain a constant level of standing water upto 3 cm at the early stages to enhance vegetative growth. The field was finally dried out at 15 days before harvesting.

3.10.3 Weeding

Weeds under experimental plots were removed timely by hand weeding.

3.10.4 Plant protection

The crop was affected severely by red mite during the cropping period. Vertimek 0.18EC @ 1.25 ml per litre of water were sprayed at 7, 14 and 21 days after planting to protect the crop from red mite.

3.11 Harvesting, threshing and cleaning

The crop was harvested when the leaves were partially dried and showed maturity symptoms. Harvesting was done separately for each treatment with the help of spade on July 12, 2021.

3.12 General observation of the experimental field

The field was observed time to time to detect visual difference among the treatments and any kind of infestation by weeds, insects and diseases so that considerable losses by pest was minimized.

3.13 Recording of data

The following data were recorded during the study period:

3.13.1 Growth parameters

1. Plant height (cm)
2. Petiole length (cm)
3. Leaf breadth (cm)
4. Plant base diameter (cm)

3.13.2 Yield contributing parameters

1. Length of stolon (cm)
2. Fresh weight of rhizome plant^{-1} (kg)
3. Fresh weight of stolon palnt^{-1} (g)

3.13.3 Yield parameters

1. Rhizome yield (t ha^{-1})
2. Stolon yield (t ha^{-1})

3.13.4 Nutrient content of post harvest soil

1. pH
2. Percent organic carbon content (%OC)
3. Percent phosphorus (%P)
4. Potassium (K) (meq/100 g soil)
5. Percent sulphur (%S)

3.14 Procedures of recording data

A brief outline of the data recording procedure is given below:

3.14.1 Plant height

Height of the plant was measured from the ground level to tip of the plant in centimeters and mean of five plants was taken.

3.14.2 Petiole length (cm)

Petiole length (cm) was measured with the help of a tape for all the leaves of the randomly selected five plants in each plot at final harvest stage and average values were computed.

3.14.3 Leaf breadth (cm)

Leaf breadth (cm) was measured with the help of a tape for all the leaves of the randomly selected five plants in each plot at final harvest stage and average values were computed.

3.14.4 Plant base diameter (cm)

Average diameter of plant base was measured at the time of harvest from five selected plants per plot at the top shoulder and expressed in centimeter.

3.14.5 Length of stolon (cm)

Average stolon length was measured from randomly selected 20 stolon with the help of a meter scale and the average value was recoded in centimeter.

3.14.6 Fresh weight of rhizome plant^{-1} (kg)

After removing the adhering soil and other waste materials (rotten leaves, root etc.) the cleaned rhizome of five randomly selected plants were weighed in physical balance and average was taken. It was expressed in kg.

3.14.7 Fresh weight of stolon palnt^{-1} (g)

Stolon was collected from randomly selected 5 plants of each plot as and when necessary. Collected stolon was weighed at each of collection and all collected totals were recorded in gram.

3.14.8 Rhizome yield (t ha^{-1})

Calculated rhizome yield per plot was converted to t ha^{-1}.

3.14.9 Stolon yield of (t ha^{-1})

Calculated stolon yield per plot was converted to t ha^{-1}.

3.14.10 Nutrient content of post harvest soil

3.14.10.1 pH of post harvest soil

Soil pH was measured with the help of a glass electrode pH meter, the soil water ratio being maintained at 1: 2.5 as described by (Akul *et al.* 1982).

3.14.10.2 Soil organic carbon content

Organic carbon in the soil sample was determined by the wet oxidation method. The underlying principle was used to oxidize the organic carbon with an excess of 1N $K_2Cr_2O_7$ in presence of conc. H_2SO_4 and conc. H_3PO_3 and titrate the excess $K_2Cr_2O_7$ solution with IN $FeSO_4$.

3.14.10.3 Available phosphorus

Available P was extracted from the soil with 0.5 M $NaHCO_3$ solutions, pH 8.5 (Olsen *et al.,* 1954). Phosphorus in the extract was then determined by developing blue color with reduction of phosphomolybdate complex and the color intensity was measured calorimetrically at 660 nm wavelength and readings were calibrated with the standard P curve (Akul *et al.*, 1982).

3.14.10.4 Available sulphur

Available sulphur was extracted from the soil with Ca $(H_2PO_4)_2.H_2O$ (Fox *et al.,* 1964). Sulphur in the extract was determined by the turhidimetric method as described by hunt (1980) using a Spectrophotometer (LKB Novaspce. 4049).

3.15 Statistical analysis

The data obtained for different characters were statistically analyzed to observe the significant difference among the treatment by using the MSTAT-C computer package program. The mean values of all the characters were calculated and analysis of variance was performed. The significance of the difference among the treatments means was estimated by the Least Significant Difference Test (LSD) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The present investigation was conducted with a view to observe the effect of N and P for the growth and development of BARI panikachu-1 (*Colocasia esculenta*). The results of the present study is presented and discussed in this chapter through some different Tables and Graphs and also possible interpretations have been given under the following headings.

4.1 Growth parameters

4.1.1 Plant height

Data presented in Figure 2 and Appendix 4 on plant height of panikachu showed significant variation on plant height among the treatments of nitrogen (N) and phosphorus (P) fertilizers at different levels. The treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) gave the highest plant height (87.50 cm); this treatment differed significantly with other treatments which was followed by the treatment T_5 ($N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}), T_6 ($N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) and T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) (81.37, 81.73 and 82.37 cm respectively). The lowest plant height (51.43 cm) was observed in control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) and it was significantly lower than other treatments. Similar result was also observed by Omid *et al*. (2018); they found significant variation on plant height of *Colocasia esculenta* due to different doses of N and P which was supported by the findings of Buke and Gidago (2016) and Jurri (2008).

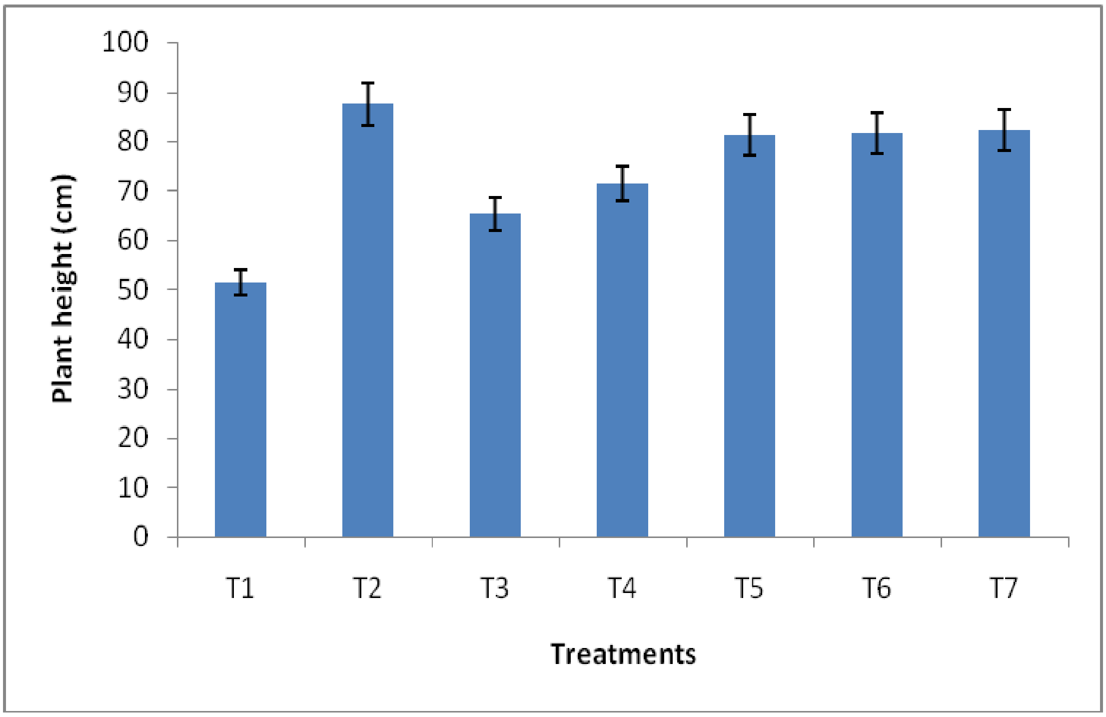


Figure 2. Plant height of BARI panikachu-1 as influenced by different levels of nitrogen and phosphorus ($LSD_{0.05}$ = 3.588)

T_1 = control; $N_0P_0K_0$ kg ha^{-1}, T_2 = RFD ($N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}), T_3 = $N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_4 = $N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_5 = $N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_6 = $N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_7 = $N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}

4.1.2 Petiole length (cm)

The recorded data on petiole length of panikachu presented in Figure 3 and Appendix 4 varied significantly due to different levels of N and P. The highest petiole length (28.97 cm) was identified from the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) which also showed statistically identical result with T_5 ($N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}), T_6 ($N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) and T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}). The lowest petiole length (16.20 cm) was observed from the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) which differed significantly to other treatments. The result obtained from the present study was similar with the findings of Omid *et al.* (2018) and Rajeshkumar and Vijoykumar (2001); they found petiole length of *Colocasia esculenta* varied significantly due to variation on N and P doses.

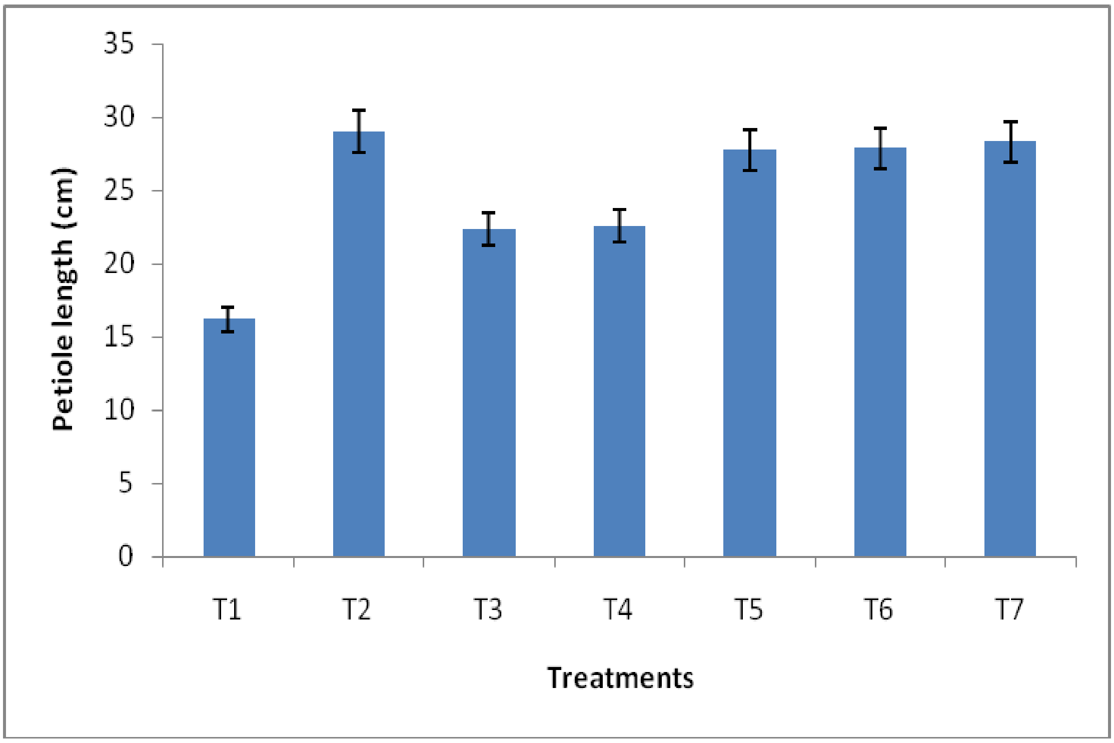


Figure 3. Petiole length of BARI panikachu-1 as influenced by different levels of nitrogen and phosphorus ($LSD_{0.05}$ = 1.935)

T_1 = control; $N_0P_0K_0$ kg ha^{-1}, T_2 = RFD ($N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}), T_3 = $N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_4 = $N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_5 = $N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_6 = $N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_7 = $N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}

4.1.3 Leaf breadth

Different treatments on N and P fertilizers on leaf breadth of panikachu had significant influence (Figure 4 and Appendix IV). Results exhibited that the maximum leaf breadth (23.54 cm) was performed by the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}). The treatment T_6 ($N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) and T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) also performed higher leaf breadth (22.70 and 22.36 cm, respectively) that was statistically identical with T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}). The minimum leaf breadth (13.97 cm) was performed by the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) which was statistically different to other treatments. The treatment T_3 ($N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) also gave lower result on leaf breadth (17.37 cm) compared to other treatments but significantly different with control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}). This result was also supported by the findings of Rajeshkumar and Vijoykumar (2001) and Omid *et al*. (2018); they observed significant variation on leaf breadth with the variation of N and P doses to *Colocasia esculenta*.

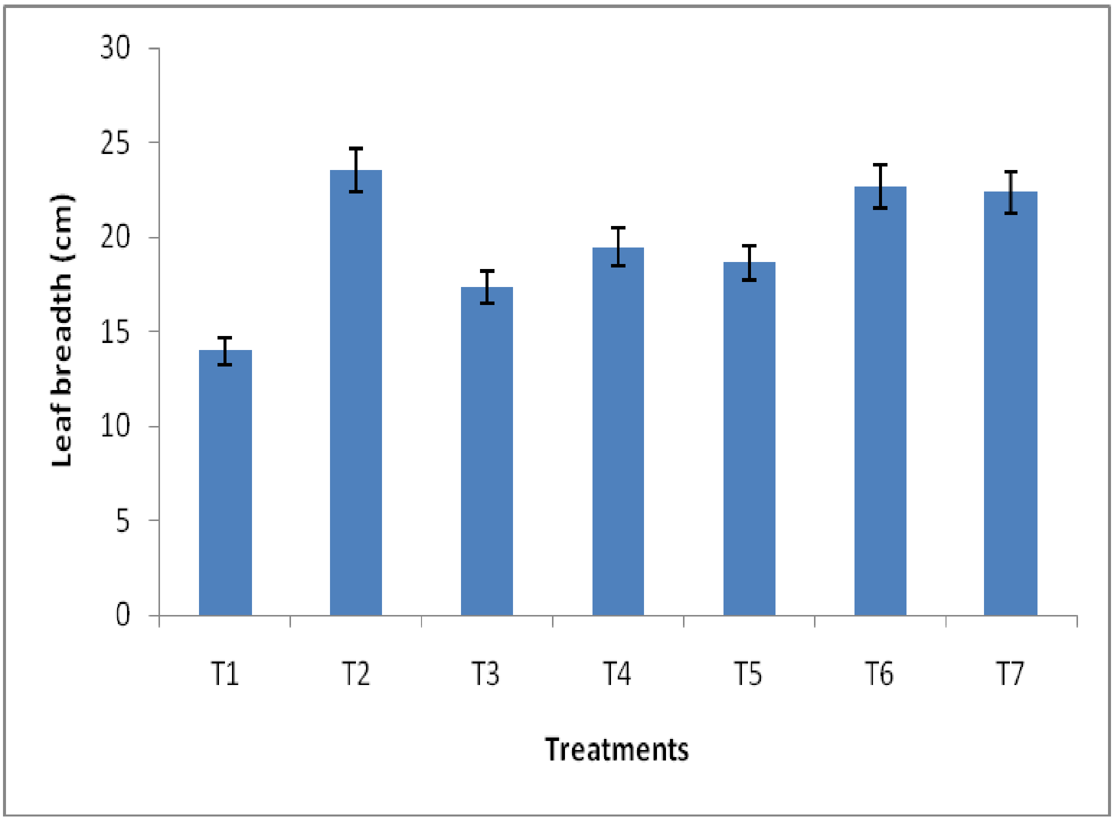


Figure 4. Leaf breadth of BARI panikachu-1 as influenced by different levels of nitrogen and phosphorus ($LSD_{0.05}$ = 1.816)

T_1 = control; $N_0P_0K_0$ kg ha^{-1}, T_2 = RFD ($N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}), T_3 = $N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_4 = $N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_5 = $N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_6 = $N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_7 = $N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}

4.1.4 Plant base diameter

Table 1 and Appendix 4 showed significant variation on plant base diameter among the treatments influenced by different levels of N and P fertilizers. Results indicated that the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}), T_6 ($N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) and T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) showed statistically identical results among them but the maximum plant base diameter (26.13 cm) was recorded from T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}).

Table 1. Plant base diameter (cm) of BARI panikachu-1 as influenced by different levels of nitrogen and phosphorus

Treatments	Plant base diameter (cm)
T_1	18.03 d
T_2	26.13 a
T_3	20.03 c
T_4	24.12 b
T_5	20.37 c
T_6	25.77 a
T_7	25.47 a
$LSD_{0.05}$	1.114
CV(%)	5.74

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T_1 = control; $N_0P_0K_0$ kg ha^{-1}, T_2 = RFD ($N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}), T_3 = $N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_4 = $N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_5 = $N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_6 = $N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_7 = $N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}

The minimum result on plant base diameter (18.03 cm) was recorded from control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) that was significantly different to other treatments. Treatment T_3 ($N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) and T_5 ($N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) showed non-significant variation between them but gave lower performance on plant base diameter. Similar result was also observed by Buke and Gidago (2016) who reported that increase in N level had significant effect on plant base diameter and N and P interaction significantly affected the average plant diameter of *Colocasia esculenta*.

4.2 Yield contributing parameters

4.2.1 Length of stolon (cm)

The results exhibited in Figure 5 and Appendix 5 on stolon length of panikachu varied significantly due to different levels of N and P fertilizers. Results revealed that the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) had the maximum stolon length (89.23 cm); this result varied significantly with other treatments. The second and third highest stolon length (86.80 and 86.20 cm, respectively) were recorded from T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) and T_6 ($N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}), respectively that were significantly different from T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}). The minimum stolon length (65.37 cm) was recorded from the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) and this result was differed significantly with other treatments. Treatment T_3 ($N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) also performed lower stolon length (75.33) but significantly higher from control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}). Similar result was also observed by Sen *et al.* (1999) and found different organic and inorganic sources of N showed significant variation on stolon length of *Colocasia esculenta*.

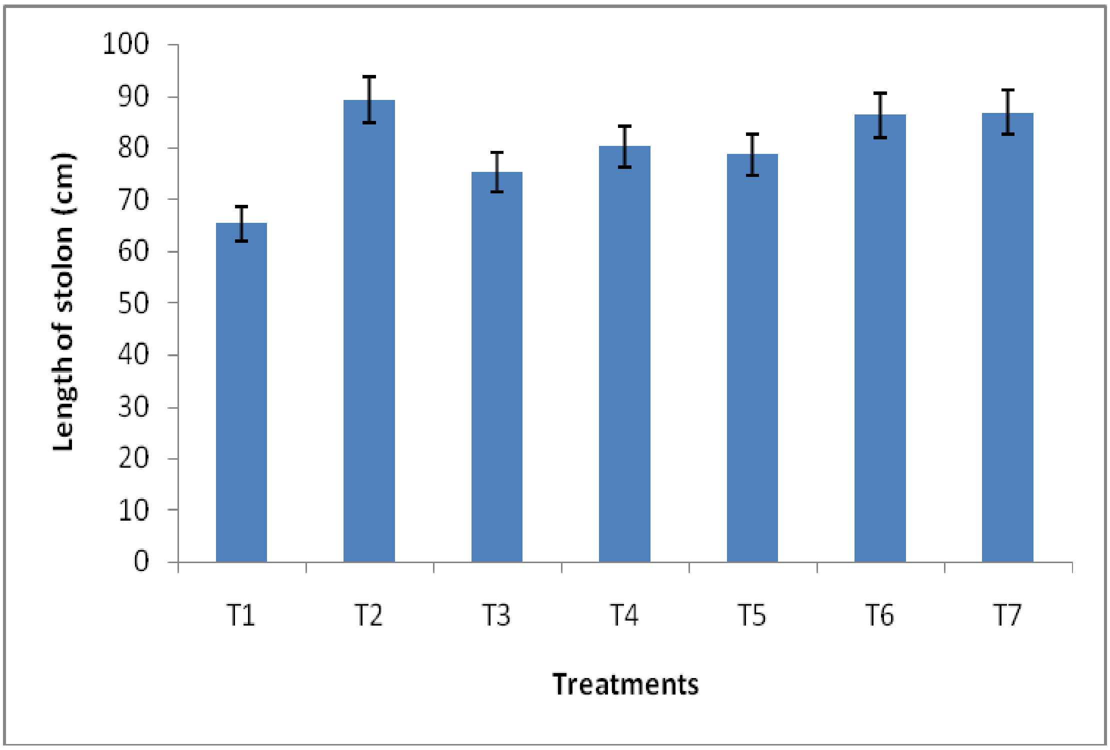


Figure 5. Stolon length of BARI panikachu-1 as influenced by different levels of nitrogen and phosphorus ($LSD_{0.05}$ = 2.349)

T_1 = control; $N_0P_0K_0$ kg ha^{-1}, T_2 = RFD ($N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}), T_3 = $N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_4 = $N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_5 = $N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_6 = $N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_7 = $N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}

4.2.2 Fresh weight of rhizome plant^{-1} (kg)

Fresh rhizome weight plant^{-1} of panikachu varied significantly due to different N and P fertilizers levels (Table 2 and Appendix V). Results showed that the highest fresh weight of rhizome plant^{-1} (693.30 g) was recorded from the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) that was significantly different with other treatments. The second highest fresh weight of rhizome plant^{-1} (650.00 g) was recorded from T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) but significantly lower than T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}). The lowest fresh weight of rhizome plant^{-1} (220.00 g) was found from the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) which was significantly lower than other treatments. Similar result was observed by Isaac *et al*. (2015), Omid *et al*. (2018) and Singh *et al*. (2021).

Table 2. Yield attributes of BARI panikachu-1 as influenced by different levels of nitrogen and phosphorus

Treatments	Yield attributing parameters	
	Fresh weight of rhizome plant^{-1} (g)	Fresh weight of stolon palnt^{-1} (g)
T_1	220.00 g	652.80 g
T_2	693.30 a	1238.00 a
T_3	343.30 f	868.00 f
T_4	483.30 d	1069.00 d
T_5	456.70 e	1013.00 e
T_6	593.30 c	1107.00 c
T_7	650.00 b	1180.00 b
$LSD_{0.05}$	18.14	30.68
CV(%)	7.07	10.40

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T_1 = control; $N_0P_0K_0$ kg ha^{-1}, T_2 = RFD ($N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}), T_3 = $N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_4 = $N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_5 = $N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_6 = $N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_7 = $N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}

4.2.3 Fresh weight of stolon plant^{-1}

Among the different treatments of N and P fertilizers, fresh weight of stolon plant^{-1} of panikachu presented in Table 2 and Appendix V differed significantly. The treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) gave the highest fresh weight of stolon plant^{-1} (1238.00 g) and the treatment T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) gave the second highest fresh weight of stolon plant^{-1} (1180.00 g) but significant variation was found between them. The lowest fresh weight of stolon plant^{-1} (652.80 g) was given by the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) that was significantly different with other treatments. Treatment T_3 ($N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) also showed lower fresh weight of stolon plant^{-1} (868.00 g) but it was significantly higher than T_1 ($N_0P_0K_0$ kg ha^{-1}). Alike result was also observed by the findings of Sen *et al.* (1999) and Noor *et al*. (2015).

4.3 Yield parameters

4.3.1 Rhizome yield (t ha^{-1})

The rhizome yield of panikachu shown in Table 3 and Appendix VI differed significantly due to different doses of N and P fertilizers. The results showed that the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) gave the highest rhizome yield ha^{-1} (17.83 t ha^{-1}) and it was significantly varied with other treatments. The second highest rhizome yield ha^{-1} (16.84 t ha^{-1}) was recorded from T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) whereas significantly different with T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}). The lowest rhizome yield ha^{-1} (7.70 t ha^{-1}) was given by the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) that differed significantly with other treatments. Treatment T_3 ($N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) also gave lower rhizome yield ha^{-1} (10.30 t ha^{-1}) but significantly higher from T_1 ($N_0P_0K_0$ kg ha^{-1}) treatment. Similar result was also observed by the findings of Isaac *et al*. (2015), Omid *et al*. (2018) and Singh *et al*. (2021); they reported higher yield of rhizome with N and P application to *Colocasia esculenta* and significant influence was observed with different doses of N and P.

Table 3. Yield parameters of BARI panikachu-1 as influenced by different levels of nitrogen and phosphorus

Treatments	Yield parameters	
	Rhizome yield (t ha^{-1})	Stolon yield (t ha^{-1})
T_1	7.70 f	16.93 f
T_2	17.83 a	29.41 a
T_3	10.30 e	21.52 e
T_4	13.30 d	25.80 c
T_5	12.74 d	24.61 d
T_6	15.62 c	26.61 c
T_7	16.84 b	28.18 b
$LSD_{0.05}$	0.661	0.928
CV(%)	6.85	8.40

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T_1 = control; $N_0P_0K_0$ kg ha^{-1}, T_2 = RFD ($N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}), T_3 = $N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_4 = $N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_5 = $N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_6 = $N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_7 = $N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}

4.3.2 Stolon yield (t ha^{-1})

Different doses of N and P fertilizers showed significant variation on per hectare stolon yield (Appendix VI and Table 3). The results presented in Table 3 showed that the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) gave the highest stolon yield (29.41 t ha^{-1}). The treatment T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) gave second highest stolon yield (28.18 t ha^{-1}) followed by T_6 ($N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) (12.62 t ha^{-1}) that was significantly varied to T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}). The control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) gave the minimum stolon yield ha^{-1} (16.93 t ha^{-1}) that was significantly different to other treatments. Treatment T_3 ($N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) also performed lower stolon yield (21.52 t ha^{-1}) but significantly different with T_1 ($N_0P_0K_0$ kg ha^{-1}). The result obtained from the present study was similar to the findings of Sen *et al.* (1999) and Noor *et al.* (2015); they reported that stolon yield significantly influence by N and P fertilizer and NPK combination to soil significantly contributed to maximum stolon production.

4.4 Nutrient content of post harvest soil

4.4.1 pH of post harvest soil

Non-significant variation was found for pH of post harvest soil (Table 4 and Appendix VII) due to different levels of N and P fertilizers. However, the T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) treatment showed the highest pH of post harvest soil (6.18) followed by T_6 ($N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) (6.16) whereas the lowest pH of post harvest soil (6.06) was recorded from the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}).

4.4.2 Organic carbon (OC) content

Different doses of N and P fertilizers shown in Table 4 and Appendix VII showed non-significant variation on organic carbon content of post harvest soil. However, the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) gave the highest organic carbon content of post harvest soil (0.66%) followed by T_6 ($N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) (0.65%) whereas the lowest organic carbon content of post harvest soil (0.46%) was given by the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}).

Table 4. Quality parameters (nutrient content of post harvest soil) of BARI panikachu-1 as influenced by different levels of nitrogen and phosphorus

Treatments	Quality parameters (pH and nutrient content of post harvest soil)			
	pH	Percent organic carbon (OC) content (%)	Available P (ppm)	Available S (ppm)
T_1	6.06	0.46	21.28	25.27 e
T_2	6.18	0.66	22.89	27.06 c
T_3	6.10	0.59	22.21	28.23 b
T_4	6.12	0.62	22.78	29.12 a
T_5	6.11	0.61	21.63	29.37 a
T_6	6.16	0.65	22.12	26.03 d
T_7	6.15	0.64	21.92	27.33 c
$LSD_{0.05}$	NS	NS	NS	0.652
CV(%)	3.09	4.04	3.47	2.38

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T_1 = control; $N_0P_0K_0$ kg ha^{-1}, T_2 = RFD ($N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}), T_3 = $N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_4 = $N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_5 = $N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_6 = $N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, T_7 = $N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}

4.4.3 Available phosphorus (P) content

Available phosphorus (P) content of post harvest soil was not differed significantly due to different doses of N and P fertilizers (Table 4 and Appendix X). However, the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) gave the highest P content (22.89 ppm) followed by T_4 ($N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) (22.78 ppm). The lowest P content of post harvest soil (21.28 ppm) was given by the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}).

4.4.4 Available sulphur (S) content

N and P fertilizers treatment at different levels had significant influence on available sulphur (S) content of post harvest soil (Table 4 and Appendix X). Results indicated the highest S content (29.37 ppm) was recorded from T_5 ($N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) and it was statistically identical to T_4 ($N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) (29.12 ppm) whereas the lowest S content (25.27 ppm) was given by the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) that was significantly different to other treatments.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was carried out during the period of February 2021 to July 2021 at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 to investigate the effect of N and P for the growth and development of BARI panikachu-1 (*Colocasia esculenta*). The experiment consisted of single factor with eight treatments *viz*. T_1 = control; $N_0P_0K_0$ kg ha^{-1}, T_2 = RFD ($N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}), $T_3 = N_{50}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, $T_4 = N_{50}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, $T_5 = N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}, $T_6 = N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1} and $T_7 = N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}. Cowdung @ 5 t ha^{-1} was added with each treatment excluding control. The experiment was laid out in randomized complete block design (RCBD) with three replications. Data on different growth, yield contributing parameters and yield of BARI panikachu-1 were recorded and analyzed statistically.

Growth parameters of panikachu-1 were affected significantly due to different doses of nitrogen (N) and phosphorus (P). Results revealed that the maximum plant height (87.50 cm), petiole length (28.97 cm), leaf breadth (23.54 cm) and plant base diameter (26.13 cm) were achieved by the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) followed by T_6 ($N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) and T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) whereas control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) showed the minimum plant height (51.43 cm), petiole length (16.20 cm), leaf breadth (13.97 cm) and plant base diameter (18.03 cm).

The treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) also showed significantly higher yield and yield contributing parameters such as the maximum length of stolon (89.23 cm), fresh weight of rhizome $plant^{-1}$ (693.30 g), fresh weight of stolon $palnt^{-1}$ (1238.00 g), rhizome yield (17.83 t ha^{-1}) and stolon yield (29.41 t ha^{-1}) followed by the treatment T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) in contrast the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) gave the minimum length of stolon

(65.37 cm), fresh weight of rhizome plant^{-1} (220.00 g), fresh weight stolon palnt^{-1} (652.80 g), rhizome yield (7.70 t ha^{-1}) and stolon yield (16.93 t ha^{-1}).

In case of pH and nutrient status in post harvest soil, available sulphur (S) content in soil varied significantly among the treatments. The maximum S content (29.37 ppm) of post harvest soil were found from the treatment T_5 ($N_{75}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) while the minimum (25.27 ppm) was recorded from control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}). pH, organic carbon (OC) content and available phosphorus (P) showed non-significant variation among the treatments. However, the highest pH (6.18), OC content (0.66%) and available P (22.89 ppm) content of post harvest soil were found from the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) whereas the lowest pH (6.06), OC content (0.46%) and available P (21.28 ppm) were recorded from the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}).

From the above result it can be concluded that the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) performed best regarding growth, yield and yield contributing parameters and also nutrient status in post harvest soil followed by T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) and T_6 ($N_{75}P_{30}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) while the control treatment T_1 ($N_0P_0K_0$ kg ha^{-1}) showed the minimum results for the mentioned parameters and differed significantly with other treatments. So, the treatment T_2 (RFD: $N_{100}P_{30}K_{100}S_{15}$ kg ha^{-1}) can be considered as the best and next to T_7 ($N_{100}P_{15}$ kg ha^{-1} + $K_{100}S_{15}$ kg ha^{-1}) under the present study for BARI panikachu-1 cultivation.

Recommendation

Further research works at different regions of the country are needed to be carried out for the confirmation of the present findings.

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APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location

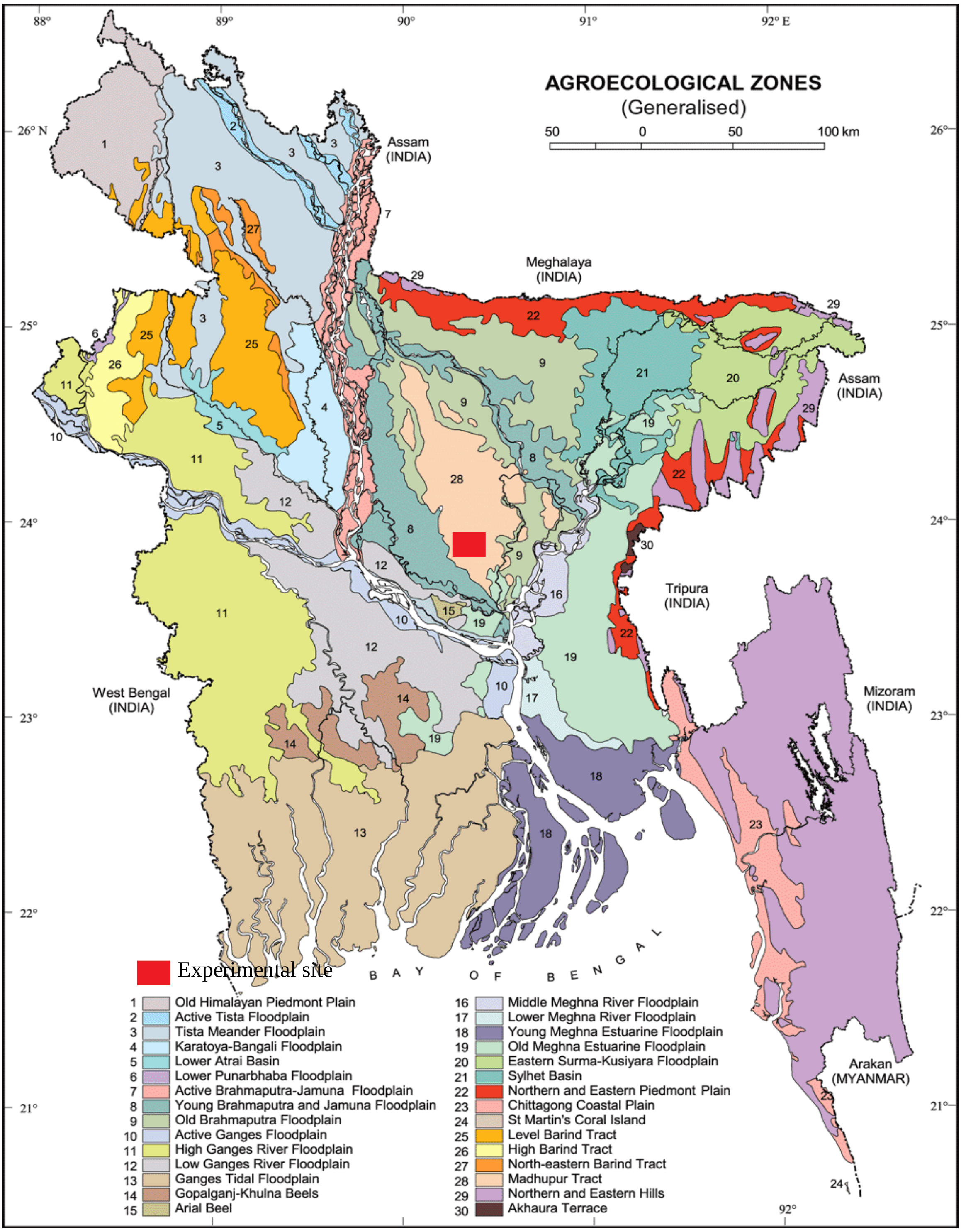

Figure 6. Experimental site

Appendix II. Monthly records of air temperature, relative humidity and rainfall during the period from February 2021 to July 2021

Year	Month	Air temperature (°C)			Relative humidity (%)	Rainfall (mm)
		Max	*Min*	*Mean*		
2021	February	22.75	14.26	18.51	37.90	0.0
2021	March	35.20	21.00	28.10	52.44	20.4
2021	April	34.70	24.60	29.65	65.40	165.0
2021	May	32.64	23.85	28.25	68.30	182.2
2021	June	27.40	23.44	25.42	71.28	190
2021	July	30.52	24.80	27.66	78.00	536

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III. Characteristics of experimental soil analyzed at Soil Science Laboratory, SAU, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Soil Science Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow Red Brown Terrace Soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	**Value**
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Clay Loam (USDA)
pH	6.2
Organic carbon (%)	0.62
Organic matter (%)	0.78
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	30

Appendix IV. Growth parameters of BARI panikachu-1 as influenced by different levels of nitrogen and potassium

Sources of variation	Degrees of freedom	Growth parameters			
		Plant height (cm)	Petiole length (cm)	Leaf breadth (cm)	Plant base diameter (cm)
Replication	2	14.456	1.003	0.220	0.332
Factor A	6	477.82*	66.15*	35.16*	32.52**
Error	12	4.067	1.183	1.042	0.392

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix V. Yield attributes of BARI panikachu-1 as influenced by different levels of nitrogen and potassium

Sources of variation	Degrees of freedom	Yield attributing parameters		
		Length of stolon (cm)	Fresh weight of rhizome plant^{-1} (kg)	Fresh weight stolon palnt^{-1} (g)
Replication	2	4.493	42.857	490.575
Factor A	6	203.65*	86587.30*	120570.48*
Error	12	1.743	103.968	297.457

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VI. Yield parameters of BARI panikachu-1 as influenced by different levels of nitrogen and potassium

Sources of variation	Degrees of freedom	Yield parameters	
		Rhizome yield (t ha^{-1})	Stolon yield of (t ha^{-1})
Replication	2	0.011	0.223
Factor A	6	39.454*	54.873*
Error	12	0.038	0.272

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VII. Chemical properties of post harvest soil of BARI panikachu-1 as influenced by different levels of nitrogen and potassium

Sources of variation	Degrees of freedom	Quality parameters (pH and nutrient content of post harvest soil)			
		pH	OC (%)	P (ppm)	S (ppm)
Replication	2	0.003	0.001	0.005	0.012
Factor A	6	0.052^{NS}	0.017^{NS}	3.011 ^{NS}	11.014*
Error	12	0.003	0.001	0.104	0.118

NS = Non-significant * = Significant at 5% level   ** = Significant at 1% level