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Effect of N, P, K and Cowdung on the Growth and Yield of Panchamukhi Kachu (*Colocasia esculenta* var. *esculenta* Schott.)

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ABSTRACT

A field experiment was carried out during two consecutive cropping seasons of 2001-02 and 2002-03 at the Agricultural Research Station, Raikhali, Rangamati, to optimize fertilizer need for desirable yield of Panchamukhi Kachu (Colocasia esculenta var. esculenta Schott.). Fourteen combinations of treatments consisting four levels of N (0, 50, 100 and 150 kg/ha), five levels of P_2O_5 (0, 25, 50, 75 and 100 kg/ha), four levels of K_2O (0, 60, 120 and 180 kg/ha) and three levels of cowdung (0, 10, 20 and 30 t/ha) were tested. A positive impact of each nutrient and cowdung application was observed on vegetative growth and fresh yield of the crop. The highest yield (average of two years) of 35.20 t/ha (54% increase over control) was obtained with the application of 100 kg of N, 75kg P_2O_5, 180 kg, K_2O and 10t cowdung/ha. From the economic point of view, the combination of 100 kg of N, 75kg P_2O_5, 180 kg K_2O and 10 ton cowdung/ha was found to be the most suitable one which offered a gross return and gross margin of TK. 3.25 lakh/ha and Tk. 3.39 lakh/ha, respectively coupled with marginal rate of return as high as 3530.77%.

Key words: Panchamukhi kachu, growth, yield.

INTRODUCTION

Panchamukhi Kachu (*Colocasia esculenta* var. *esculenta* Schott.), a perennial herb grown as annual, belonging to the family Araceae is a popular indigenous vegetable in Bangladesh. The leaves, petioles, corms and cormels are edible portion. The corm and cormels are rich in starch, which contain 17-25% amylase (Bose and Som, 1986). Though at present the cultivation of the crop is mainly concentrated to the red soil areas of Madhupur and Bhawalghar including north-eastern hilly region (Rashid, 1999), it has a great potentiality to grow all over the country. It is very popular to tribal people (Ahmed and Shahjahan, 1993). The crop is extensively grown in summer season and is considered as an important vegetable, particularly in the months of September to November when the supplies of other vegetable are scarce in the market (Mannan and Rashid, 1983). The requirement of fertilizer for any crop varies with the cultivars and soil types in different agro-ecological zones (Mitra *et al*., 1990). Adequate supply of, nitrogen, phosphorus and potash are essential for maximizing the yield of the crop. Like other tuber crop it has a great response to chemical and organic fertilizer and its yield is greatly influenced by the fertility of the soil (Ahmed and Rashid, 1975). Due to imbalance fertilization, the hilly farmers are being deprived of the

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economic benefit from this crop. Research information regarding suitable dose of N, P, K and cowdung for the satisfactory production of Panchamukhi Kachu is almost lacking in Bangladesh. The present study was therefore, undertaken to determine the suitable combination of N, P and K along with cowdung in order to obtain satisfactory yield of Panchamukhi Kachu at the agro-ecological zone- 29 (AEZ- 29).

MATERIALS AND METHODS

The experiment was conducted in two consecutive cropping seasons of 2001-02 and 02-03 at the Hill Agricultural Research Station, Raikhali, Rangamati to find out the effect of N, P, K and cowdung on the growth and yield of Panchamukhi Kachu. The experimental field belongs to AEZ 29 and the soil was Piedmont plain having medium loamy to moderately fine textured (Sandy clay loam) (Zahirul, 1991) and low water holding capacity. The results of soil analysis before experiment was given in Table 1.

Table 1. Chemical properties of the soil of experiment plot

Name of the properties	Amount	
	2001-02	2002-03
Soil pH	5.4	5.5
OM (organic matter)	1.48%	1.51%
Total nitrogen (N)	0.078%	0.075
Available Phosphorus (P)	8.0 µg/g	8.5µg/g
Available potassium (K)	0.17meq/100g soil	0.19meq/100g soil

The experiment was laid out in a RCB design with three replications. The unit plot size was 3×3.2m. Fourteen combinations of treatment consisting four levels of N (0, 50, 100, and 150 and kg/ha), five levels of P_2O_5 (0, 25, 50, 75 and 100 kg/ha), and four levels of K_2O (0, 60, 120, and 180 kg/ha) and three levels of cowdung (0, 10, 20 and 30 t/ha) were used in the experiment.

The entire amount of cowdung and TSP and half of urea and MP were applied during land preparation. The rest of urea and MP were applied in three equal instalments at 30, 50 and 70 days after planting. The planting materials (each cormel 50±5g) of local cultivars were placed (one seed/hill) under 5-7.5cm in soil maintaining 60x40cm of spacing. Weeding, mulching, irrigation, etc were done as and when necessary. The crop was harvested when the pseudostem (succulent leaf sheath arise from underground rhizome) of the plant was almost dried. Data on yield and yield attributes were taken from 10 randomly selected plants from each plot. The plot yield was first recorded and then converted to per hectare yield. Length of leaf, leaf spread, plant heights, yields and yield attributes were calculated from the average of ten plants. The final data were compiled properly and analyzed statistically following the standard method. Economic analyses were done on the basis of prevailing market price of input and output. Economical analysis of different fertilizer combinations was done through partial budgeting and dominance analysis followed by marginal analysis of the cost undominated treatments as suggested by Perrins *et al*. (1979).

RESULTS AND DISCUSSION

Plant height was significantly influenced by different fertilizer treatments. Maximum plant height (107.0cm in 2001-02, 97.26 cm in 2002-03 and 120.13 cm in pooled data) was obtained from T_9 (N_{100} P_{100} K_{120} Kg/ha and Cowdung 10 t/ha) treatment and minimum for the same was obtained from control ($T_1 = N_0P_0K_0Cd_0$) treatment in both the years and in pooled condition. Plant height increased with increased rate of nitrogen application (Table 2). Nitrogen application at the rate of 50, 100 and 150 kg/ha in presence of other nutrient elements gave 8.35% to 23.64% higher plant height over N control treatment, respectively. Plant height also increased with the increase of phosphorus application in both the years and pooled data. It showed statistically similar result among 25, 50, 75 and 100 kg/ha dose of P in the first year and pooled data but significantly different from P control. Different levels of P did not significantly influence plant height in the 2nd year. Different levels of K also showed same trend like P in the 2nd year and in pooled result. Application of cowdung @ 10t/ha in presence of other nutrient elements and 20 and 30t/ha alone

also significantly produced higher plant than no cowdung (T_1) in both the years and in pooled data. Base girth of the plant was not significantly influenced due to different fertilizer treatment in the first year but this parameter varied significantly in response to different fertilizer treatments in the 2nd year and pooled data. Base girth was not significantly affected by different doses of N, P and K and cowdung, only significantly influenced by various dose of P in pooled data. Number of leaves/hill was significantly influenced by different fertilizer treatments (Table 2). Maximum number of leaves (34.24 and 33.50/hill in 2001-02, 2002-03 and pooled data, respectively) was recorded from T_{12} treatment, which was statistically similar to T_4, T_5, T_9 and T_{11}. Number of leaves/hill increased significantly up to 100 kg N/ha, 75 kg P_2O_5/ha and 120 kg K_2O/ha. The number of leaves/hill at 100 N, 75 kg P_2O_5 and 120 kg K_2O/ha was at par with 150 kg N, 100 kg P_2O_5 and 180 kg K_2O/ha.

Table 2. Treatment combinations of different fertilizer (Anon., 1969)

Treatment	Treatment combinations				Treatment	Treatment combinations			
	N (kg/ha)	**P_2O_5 (kg/ha)	***K_2O (kg/ha)	CD (t/ha)		N (kg/ha)	**P_2O_5 (kg/ha)	***K_2O (kg/ha)	CD (t/ha)
T_1	0	0	0	0	T_8	100	50	120	10
T_2	0	75	120	10	T_9	100	100	120	10
T_3	50	75	120	10	T_{10}	100	75	0	10
T_4	100	75	120	10	T_{11}	100	75	60	10
T_5	150	75	120	10	T_{12}	100	75	180	10
T_6	100	0	120	10	T_{13}	0	0	0	20
T_7	100	25	120	10	T_{14}	0	0	0	30

Note: ** P_2O_5 X 0.44 = P and *** K_2O X0.83 = K

Weight of cormel/plant varied significantly in response to different fertilizer treatments (Table 3). Maximum weight of cormel (511.0g/plant in 2001-02) was recorded from T_{11} treatment whereas in 2002-03 and in pooled data T_{12} treatment produced the highest cormel weight (437.3g/plant in 2003-03 and 442.15g/plant in pooled data. Different fertilizer treatments resulted in an increase in cormel weight/plant ranging from 29.27% to 55.20% over control (T_1) treatment in pooled condition. Weight of cormel/plant increased gradually with the increase of nitrogen, phosphorus and potassium levels. Applications of cowdung @ 20 & 30t/ha did not have significant influences on cormel weight/plant. Different fertilizer treatments significantly influenced weight of corm/plant. The highest weight of corm /plant (804g in 2001-02. 864.0g in 2002-03 and 825.0g in pooled data) was recorded from the T_{12} treatment and minimum values for the same from T_1 treatment. Different treatment combinations registered 34.41% to 53.80% higher corm weight/plant over control treatments in pooled data of two years. In both the years and pooled data corm weight/plant increased significantly with the increase of N levels up to 100kg/ha beyond which corm weight declined. Corm weight/hill increased up to the highest level of P and K levels. Number of cormel/hill was significantly affected by different fertilizer treatments. The highest number of cormel/hill (pooled) (13.10) was observed from T_{12} treatment closely followed by T_4, T_5, T_7, T_8, T_9, T_{11} and T_{14} treatments. Maximum fresh yield/plant (1251.0g in 2001-02, 1283.0g in 2002-03 and 1267.0g in pooled data) was obtained from T_{12} (N_{100} P_{75} K_{180} kg/ha and cd_{10}t/ha) treatment that was at par with T_3, T_4, T_5, T_7, T_8, T_9, T_{10}, T_{11} and T_{14} of 2001-02, T_4, T_5, T_8 and T_{10} of 2002-03 and T_4 T_5, T_7, T_8, T_9, and T_{11} in pooled data. The pooled data showed that different fertilizer treatments resulted in a increase in fresh yield/hill ranging from 33.57% to 54.31% over control treatments. In 2001-02, fresh yield /hill increased with the increase of N up to the highest levels (150kg/ha). But in 2002-03 and pooled data, the yield/hill increased up to 100kg/ha beyond which yield declined. Fresh yield/hill increased significantly with the increase of P levels up to 75 kg/ha beyond which it declined in both the years and pooled data. But the fresh yield /hill of the crop increased up to the highest levels of K (180kg/ha). Independent applications of cowdung @ 30t/ha performed significantly better than 20t/ha in respect of fresh yield/hill in the 2nd year and pooled data. Fresh yield /ha of Panchamukhi Kachu was significantly influenced by the application of N, P, K and cowdung (Table 3). Nitrogen application increased yield/ha significantly showing a linear response in the Ist year and pooled data (Table 3). The highest yield of 35.20t/ha (pooled of two years) was

recorded with the treatment T_{12} that was statistically at per with T_4, T_5, T_6, T_7, T_8, T_9 and T_{11}. The fresh yield increased with the increase of N up to 150kg/ha. Identical yields of 32.57 and 32.84t/ha at 100 and 150kg N/ha, respectively, resulted that N application had certain optimum range beyond which profitable yield is not increased. Application of P significantly increased fresh yield of Panchamukhi Kachu up to the highest level 100 kg P_2O_5 /ha in the first year but in the 2002-03 and pooled data, increased up to 75 kg/ha. The yield differences among 25, 50, 75 and 100 kg P_2O_5/ha was statistically identical in both years as well as in pooled data.. The pooled data showed that the yield at 75 kg P_2O_5 /ha was significantly different from no P_2O_5. Fertilization of K resulted in gradual increase in fresh yield of Panchamukhi Kachu up to the highest level of applied K (180 kg/ha) in both years as well as in pooled data (Table 3).

Table 3. Effect of N, P, K and Cowdung on the growth parameters of Panchamukhi Kachu

Treatment	Plant height (cm)			Base girth (cm)			Leaf number/hill		
	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled
T_1	82.3cd	46.19d	64.25f	19.33abc	14.38d	16.84c	16.12c	19.29d	17.71c
T_2	89.8bcd	75.93c	82.85de	22.20ab	20.57bc	21.39bc	21.60b	25.85c	23.73b
T_3	93.3a-d	91.19ab	92.25bc	23.70a	22.22abc	22.96ab	24.19b	28.95bc	26.57b
T_4	100.7ab	94.80ab	97.75ab	24.9a	25.40abc	25.15ab	31.98a	33.42ab	32.70a
T_5	107.6a	95.33ab	101.46a	22.7ab	25.02abc	23.86ab	32.22a	33.77ab	32.99a
T_6	80.8d	84.73abc	82.76de	19.6abc	23.35abc	21.48bc	24.12b	25.21c	24.66b
T_7	96.5a-d	89.47ab	92.99abc	22.5ab	25.53abc	24.02ab	24.50b	25.24c	24.69b
T_8	98.1abc	95.93a	97.02abc	24.3a	26.40ab	25.35a	24.15b	25.60c	25.05b
T_9	107.0a	97.26a	102.13a	26.4a	26.87a	26.14a	32.08a	33.52ab	32.80a
T_{10}	89.2bcd	75.53c	82.37de	25.8a	23.76abc	24.78ab	24.45b	25.55c	25.00b
T_{11}	98.2abc	88.67ab	93.43abc	25.2a	25.00abc	25.10ab	31.90a	33.33ab	32.61a
T_{12}	103.8ab	96.13a	99.97ab	23.7ab	26.63a	25.17ab	32.76a	34.24a	33.50a
T_{13}	83.9cd	74.53c	79.22e	24.3a	20.07c	22.50ab	24.01b	25.09c	24.55b
T_{14}	94.1a-d	82.80bc	88.45cd	23.7ab	24.40abc	24.05ab	24.05b	25.13c	34.59b
CV (%)	7.21	5.96	4.00	14.71	9.53	8.09	4.63	5.19	3.21

Note: Pooled data of 2001-2002 and 2002- 03. Means followed by uncommon letters in a column are significantly different from each other at 5% level of probability by DMRT

The variation of yield from 27.10 to 33.52t/ha is due to the application of different levels of K fertilizer. Independent application of Cowdung @ 30t/ha gave higher fresh yield than 20t/ha cowdung in both years. The average yield increase over control due to the application of individual nutrients is shown in Table 5. Fresh yield increased progressively with N rates up to 150kg/ha. Application of 50, 100 and 150kg N /ha increased by 15.96, 25.42 and 26.05% over control, respectively. It appears that application of 100 kg N/ha might be optimum for maximizing the fresh yield of Panchamukhi Kachu. Application of phosphorus @ 25, 50, 75 and 100 kg P_2O_5 /ha increased fresh yield by 12.35, 14.06, 15.93 and 12.27 % over control, respectively (Table 4). K application @ 180 kg K_2O/ha resulted maximum increase (23.01%) of yield. Cowdung application @ 30t/ha gave higher yield increase (41.98) of the crop than 20t/ha (Table 4).

The partial budget analysis of fertilizer use indicates that the gross return (GR) increased with the increase of N, P and K fertilizer up to 150, 75 and 180 kg/ha respectively (Table 5) Maximum gross return of Tk. 352.0 thousand, Tk. 328.7 thousand, Tk. 325.7 thousand/ha achieves from treatment T_{12}, T_5 and T_4 respectively. Similar trend was also observed in respect of gross margin. The highest net return (Tk. 294.0 thousand/ha) was obtained from T_{12} treatment closely followed by T_5 and T_4 treatment. Dominance analysis showed that T_2, T_3, T_7, T_8, T_9 T_{10}, T_{13} and T_{14} were dominated by cost factor and T_1, T_4, T_5, T_6, T_{11} and T_{12} were cost undominated. Marginal analyses of the cost undominated treatments (Table 6) reflected that the gross margin could be increased up to Tk. 294.0 thousand/ha along with a high marginal rate of return of 3530.77% through increased investment for fertilizer up to Tk. 13.0 thousand (T_{12}) (Table 7).

Table 4. Effect of N, P, K and Cowdung on the fresh yield of corm and cormel of Panchamukhi Kachu

Treatment	Weight of cormel/hill (g)			Weight of corm/hill (g)			Fresh yield /hill (g)			Cormel /hill (No.)*	Fresh yield (t/ha)		
	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled		2001-02	2002-03	Pooled
T_1	210d	186.0f	198.0e	475d	287.3g	381.15g	685d	472.7h	578.85f	5.85g	19.00d	13.13f	16.15g
T_2	304bcd	280.7e	292.35d	597cd	565.3ef	581.15f	901c	846.0fg	873.5e	9.05f	25.05c	23.50de	24.28f
T_3	326bcd	326.7cde	326.35cd	740abc	687.3cd	713.65bcd	1066abc	1014.0cde	1040.0bcd	10.75def	29.61c	28.17a-d	28.89b-e
T_4	353a-d	398.7abc	269.43bcd	801a	814.0ab	807.50abc	1154ab	1213.0ab	1183.5abc	11.79a-d	32.06ab	33.68a	32.57abc
T_5	435abc	377.3a-d	406.15abc	766ab	768.0abc	767.0a-d	1201a	1146.0abc	1173.5a	12.77ab	33.36a	31.83ab	32.84ab
T_6	370a-d	280.0e	325.0cd	608cd	720.0bc	664.0de	978bc	993.3def	985.65d	9.69ef	27.17bc	27.59a-e	27.38def
T_7	421abc	384.0a-d	402.5ab	720abc	767.3abc	743.65a-d	1141abc	1118.0bcd	1129.5ab	11.34a-e	30.02abc	32.46a	31.24a-d
T_8	417abc	409.3ab	413.15ab	722abc	783.3abc	752.65a-d	1140ab	1186.0ab	1163.0a	11.60a-d	31.67ab	32.04a	31.86abc
T_9	440abc	370.0a-d	405.0ab	747abc	785.3abc	766.15a-d	1187ab	1155.0abc	1171.0a	12.60a-d	32.97ab	29.44a-d	31.21a-d
T_{10}	447ab	287.3e	367.15bc	623bc	784.0abc	703.5ef	1080abc	871.3efg	975.56de	10.97cde	29.99abc	24.20cde	27.10def
T_{11}	511a	354.7b-e	432.85ab	650abc	745.0abc	697.5cd	1161ab	1100.0bcd	1130.5a	12.24abc	32.25ab	30.54abc	31.40a
T_{12}	447abc	437.3a	442.15a	804a	846.0a	825.0a	1251a	1283.0a	1267.0a	13.10a	34.75a	35.65a	35.20a
T_{13}	282cd	280.7e	281.35d	693abc	509.3f	601.0ef	978bc	764.7g	871.35e	11.00b-e	27.17bc	21.24e	24.21ef
T_{14}	351a-d	340.0de	345.5cd	736abc	613.3e	674.65cd	1087abc	917.3ef	1002.2cd	12.15a-d	30.19abc	25.48b-d	27.84c
CV (%)	8.41	9.54	8.05	9.17	6.24	4.62	8.11	6.06	4.20	6.50	8.10	9.33	5.62

Note: * Pooled of 2001-02 and 2002-03.

Table 5. Single effect of N, P, K and cowdung on the yield of Panchamukhi Kachu

Nutrients added	Average yield of two years (t/ha)	Yield increase over control (%)
Nitrogen (kg N/ha)		
0	24.28	-
50	28.89	15.96
100	32.57	25.42
150	32.84	26.05
Phosphorous (kg P_2O_5/ha)		
0	27.38	-
25	31.24	12.35
50	31.86	14.06
75	32.57	15.93
100	31.21	12.27

Nutrients/ Organic manure added	Average yield of two years (t/ha)	Yield increase over control (%)
Potassium (kg K_2O/ha)		
0	27.10	-
60	31.40	13.69
120	32.57	16.79
180	35.20	23.01
Cowdung (t/ha)		
0	16.15	-
20	24.21	33.29
30	27.84	41.98

Table 6. Partial budget and dominance analysis for the different fertilizer treatments tested on Panchamukhi Kachu

Treatments	Average yield of two years (t/ha)	Gross return ('000' Tk./ha)	Variable cost ('000' Tk./ha)	Gross margin ('000' Tk./ha)	Remarks
T_1*	16.15	161.5	45.00	116.50	CUD
T_2	24.28	242.8	55.39	187.41	CD
T_3	28.89	288.9	56.05	232.85	CD
T_4	32.57	325.7	5670	269.00	CUD
T_5	32.84	328.7	57.35	271.05	CUD
T_6	27.38	273.8	53.90	219.90	CUD
T_7	31.24	312.4	63.74	248.66	CD

Treatments	Average yield of two years (t/ha)	Gross return ('000' Tk./ha)	Variable cost ('000' Tk./ha)	Gross margin ('000' Tk./ha)	Remarks
T_8	31.86	318.6	64.67	253.93	CD
T_9	31.21	312.1	66.53	245.57	CD
T_{10}	27.10	271.0	54.10	216.90	CD
T_{11}	31.40	314.0	55.40	258.60	CUD
T_{12}	35.20	352.0	58.00	294.00	CUD
T_{13}	24.21	242.1	55.00	187.10	CD
T_{14}	27.84	278.4	60.00	218.40	CD

Note: * As in Table 1, CUD = Cost Undominated, CD = Cost Dominated

Price of - Panchamukhi kachu = Tk. 10.00/kg, Urea = Tk. 6/kg-N, TSP = Tk. 17.00/kg-P_2O_5, MP = Tk. 13.00/kg-K_2O, Cowdung (Cd) = Tk. 0.50/kg

Table 7. Marginal analyses of cost undominated fertilizer treatments tested on Panchamukhi Kachu

CUD Treatment	Variable cost ('000' Tk.)	Gross margin ('000' Tk.)	Marginal variable cost ('000' Tk.)	Marginal return ('000' Tk.)	Marginal rate of return (MRR %)
T_{12}	58.00	339.00	0.65	22.95	3530.77
T_5	57.35	316.05	0.65	2.05	315.38
T_4	56.70	314.00	1.30	10.40	800.00
T_{11}	55.40	303.60	1.50	38.70	2580.00
T_6	53.90	264.90	8.90	103.40	1161.80
T_1	45.00	161.50	-	-	-

Note: T_1 = $N_0P_0K_0$ kg/ha and *CD_0t/ha, T_4 = $N_{100}P_{75}K_{120}$ kg/ha and CD_{10}t/ha, T_4 = $N_{150}P_{75}K_{120}$ kg/ha and CD_{10}t/ha, T_6 = $N_{100}P_0K_{120}$ kg/ha and CD_{10}t/ha, T_{11} = $N_{100}P_{75}K_{60}$ kg/ha and CD_{10}t/ha, T_{12} = $N_{100}P_{75}K_{180}$ kg/ha and CD_{10}t/ha. *CD = Cowdung.

From the investigation, it is appeared that application of 100kg N, 75kg P_2O_5, 180kg K_2O and 10tons of cowdung /ha are the most suitable fertilizer dose for the production of Panchamukhi Kachu in the south-eastern hilly region of Bangladesh (AEZ-29).

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