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FERTILIZER MANAGEMENT IN HYBRID MAIZE (*Zea mays* L.)-MUKHIKACHU (*Colocasia esculenta*) RELAY CROPPING SYSTEM

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Abstract

The experiment was conducted at the research field of Agronomy Division, BARI, Joydebpur, Gazipur and ARS, Burirhat, Rangpur during consecutive two years of 2009-10 and 2010-11 to find out optimum fertilizer dose for hybrid maize-mukhikachu relay cropping system. Five fertilizer combinations viz, Recommended fertilizer of hybrid maize (RFM) + 112 kg N/ha, RFM + 25% recommended fertilizer of mukhikachu (RFK), RFM + 50% RFK, RFM + 75% RFK and RFM + 100% RFK were tested on hybrid maize-mukhikachu relay cropping system. Sole crops of hybrid maize (cv. BARI Hybrid Maize-5) and mukhikachu (cv. Bilashi) with their respective recommended fertilizer dose (maize: 255-55-140-40-6-2 kg/ha NPKSZnB and mukhikachu: 112-32-95-22 kg/ha NPKS) were included for comparison. Grain yield of sole maize with recommended fertilizer practice was identical with other fertilizer combinations at both the locations. Yield and yield components of mukhikachu under different fertilizer management practices increased with the increase of fertilizer levels up to RFM + 50% RFK and then decreased at both the locations. Edible yield of sole kachu with recommended fertilizer practice was the highest but it was identical to RFM + 50% RFK at both the locations. The highest maize equivalent yield (Joy: 24.26 t/ha, Buri: 31.56 t/ha) and gross return (Joy: Tk 291120/ha, Buri: Tk 378720/ha) was recorded in RFM + 50% RFK. But the highest gross margin (Joy: Tk 207035/ha, Buri: Tk 291570/ha) was obtained from RFM + 25% RFK at Joydebpur and from RFM + 50% RFK at Burirhat. The highest benefit cost ratio (Joy: 3.69, Buri: 4.64) was found from RFM + 112 kg N/ha at both the locations. The results revealed that recommended fertilizer dose (255-55-140-40-6-2kg/ha NPKSZnB) of hybrid maize plus 112 kg N/ha (extra) might be economically profitable for hybrid maize mukhikachu relay cropping system at both the locations.

Keywords: Fertilizer management, hybrid maize-mukhikachu relay cropping.

Introduction

Mukhikachu (*Colocasia esculenta*) is an important edible aroid in Bangladesh as well as in some other countries of the world (Plucknett, 1970; Rashid and Mannan, 1984 and Ghosh *et al.,* 1988). The corms and cormels of mukhikachu are rich source of carbohydrate and also contain sufficient quantity of protein

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(Verma and Singh, 1996). It is extensively grown as summer vegetable and harvested at the time when there is a scarcity of vegetables in the market (Bhuiyan *et al.*, 1982; Siddique *et al.*, 1988 and Rashid, 1999). On the other hand, hybrid maize becomes popular to the farmers for its high yield potentiality and diversified uses. It is generally sown in November with wider spacing and harvesting goes up to May. The wider plant spacing of hybrid maize provides facility to other crops for growing as inter or relay cropping with it (Ahmed *et al.,* 2010). Mukhikachu may be successfully relayed with hybrid maize and time of relaying has been determined earlier (Islam *et al.,* 2010). Fertilizer management is an important agronomic practice for increasing system productivity of hybrid maize and mukhikachu relay cropping system. The literature relating this aspect is meagre. Hence, this experiment was conducted to find out economic fertilizer dose for hybrid maize and mukhikachu relay cropping system.

Materials and Method

The experiment was conducted at the research field of Agronomy Division, BARI, Joydebpur, Gazipur and ARS, Burirhat, Rangpur during consecutive two years of 2009-10 and 2010-11. The soil of the experimental field of Joydebpur was silty clay loam in texture belonging to Chhiata series under AEZ-28. On the contrary, the soil of the experimental field of Burirhat was silt loam in texture belonging to Gangachara series under AEZ-3. Initial soil samples at 0-20 cm depth were collected from experimental fields of both the locations and analyzed. The analytical results are presented in Table 1.

Table 1. Analytical results of soil of experimental fields of Joydebpur and Burirhat.

Location	pH	OM (%)	Total N (%)	Avail-able P (µg/g)	Exchange -able K (meq/100 g)	Available S (µg/g)	Available Zn (µg/g)	Available B (µg/g)
BARI farm, Joydebpur	5.8	0.98	0.055	10.66	0.12	9.04	0.84	0.11
ARS, Burirhat	5.2	0.86	0.04	8	0.16	8	0.82	0.12
Critical levels	-	-	-	14	0.20	14	2	0.2

OM = Organic matter

Five fertilizer combinations viz, Recommended fertilizer dose (255-55-140-40-6-2 kg/ha NPKSZnB) of hybrid maize (RFM) + 112 kg N/ha, RFM + 25% recommended fertilizer dose (112-32-95-22 kg/ha NPKS) of mukhikachu (RFK), RFM + 50% RFK, RFM + 75% RFK and RFM + 100% RFK were tested on hybrid maize-mukhikachu relay cropping system. Sole crop of hybrid maize was grown with fertilizer @ 255-55-140-40-6-2 kg/ha NPKSZnB and that of mukhikachu with 112-32-95-22 kg/ha NPKS were included in this experiment for comparison. The experiment was laid out in a RCB design with 3 replications. The unit plot size was 4.5 m x 3 m. Seeds of BARI Hybrid Maize 5 were sown on 26 November 2009 and 30 November 2010 at Joydebpur, while at Burirhat on 22 November 2009 and 25 November 2010 maintaining 75 cm x 25 cm spacing in all plots. Double row (20 cm between two rows) of mukhikachu (cv. Bilashi) was planted on 22 March 2010 and 25 March 2011 at Joydebpur while on 17 March 2010 and 20 March 2011 at Burirhat in between two maize rows with a seed to seed distance of 45 cm. Sole mukhikachu was planted in double row system (within double row: 20 cm and between double row: 55 cm). Maize was fertilized with recommended dose of 255-55-140-40-6-2 kg/ha NPKSZnB. One third of N and full amount of PKSZnB were applied as basal and rest N was top dressed in two equal splits at 30 and 60 days after sowing (DAS) of maize followed by irrigation. In mukhikachu, full quantity of PKS was applied on the space between two maize rows followed by spading and N was top dressed in two equal splits at 40 and 100 DAS of mukhikachu as per treatments. A light irrigation was given after maize sowing for proper emergence. Irrigation and intercultural operations were done as and when required. Maize was harvested on 20 April 2010 (145 DAS) and 15 April 2011 (140 DAS) at Joydebpur, while on 02 May 2010 (161 DAS) and 04 May 2011 (160 DAS) at Burirhat. Mukhikachu was harvested on 20 October 2010 (212 DAS) and 15 October 2011 (207 DAS) at Joydebpur, while on 10 October 2010 (207 DAS) and 14 October 2011 (208 DAS) at Burirhat. Data on yield and other parameters of both the crops were recorded at the time of harvest. Plant population data for maize and mukhikachu were taken from randomly selected three places in each plot and yield components were taken from 10 plants in both the years. Yields of both the crops were taken from whole plot. Maize equivalent yield was computed by converting yield of intercrops on the basis of prevailing market price of individual crop following the formula of Bandyopadhyay (1984) as given below:

$MEY = Yim + \frac{Yik\, x\, Pk}{Pm}$ Where, Yim = Yield of intercrop maize, Yik = Yield of intercrop kachu, Pk = Market price of kachu, Pm = Market price of maize, Mey = Maize equivalent yield

Benefit-cost analysis was also done. The data of the experiment for two consecutive years showed similar trend. So, the collected data were pooled and means were adjudged by LSD test at 5% level of significance.

Results and Discussion

Effect on maize

Yield and yield components of hybrid maize in sole crop with recommended fertilizer management did not differ significantly from that of hybrid maize in relay cropping under different fertilizer management practices at both the locations (Table 2). However, the yield of hybrid maize in different treatments varied from 7.67 to 8.01 t/ha at Joydebpur and 8.97 to 9.25 t/ha at Burirhat. Grain yield of hybrid maize was higher at Burirhat than Joydebpur might be attributed to the prevalence of lower environmental temperature for longer period (Fig.1 and 2) which increases crop duration and favours accumulation of more dry matter resulting higher grain yield (Ahmed *et al*., 2010)

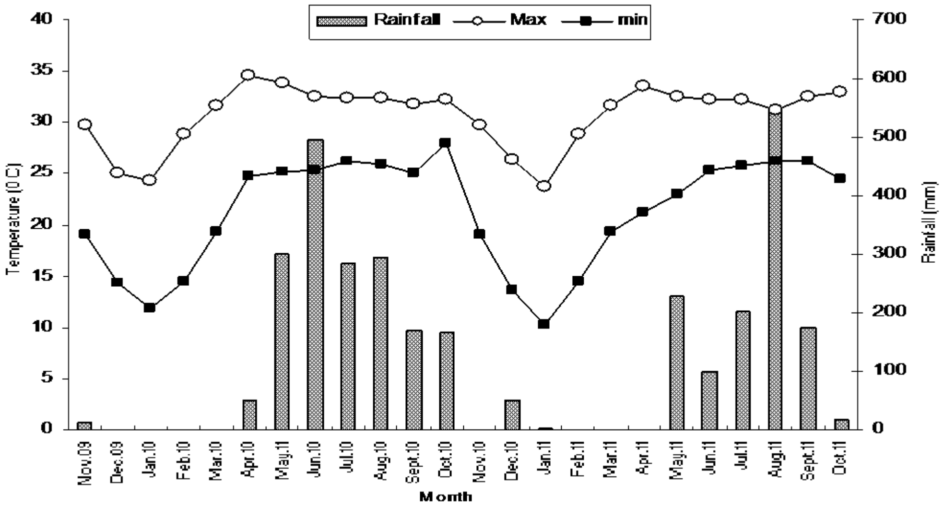

Fig. 1. Average monthly maximum, minimum temperature and monthly total rainfall of Joydepbur during November 2009 to October 2011.

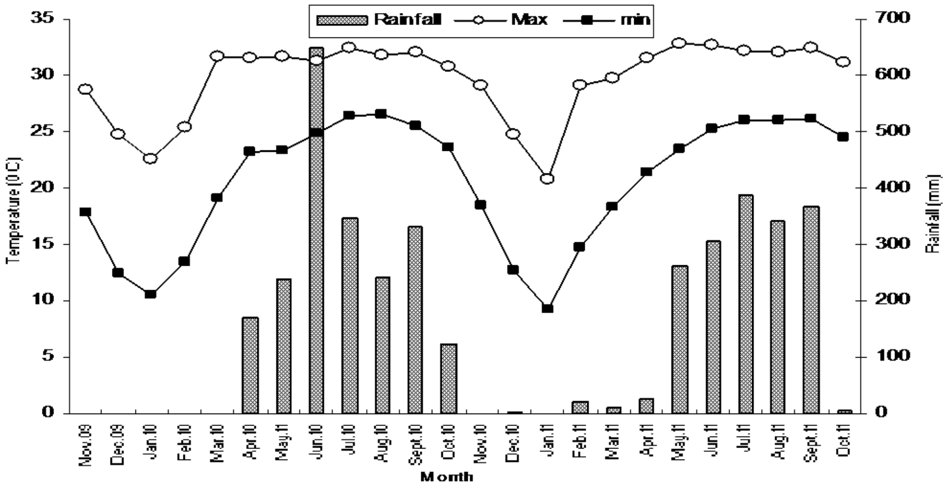

Fig. 2. Average monthly maximum, minimum temperature and monthly total rainfall of Burirhat during November 2009 to October 2011.

Table 2. Yield and yield components of hybrid maize in maize mukhikachu relay cropping under different fertilizer management at Joydebpur and Burirhat (pooled data of two years).

Treatment	Cobs/m^2 (no.)		Grains/cob (no.)		1000-grain wt (g)		Grain yield (t/ha)	
	Joy.	Buri.	Joy.	Buri.	Joy.	Buri.	Joy.	Buri.
RFM + 112 kg N/ha	6.33	6.38	486	497	347.6	350.3	7.67	8.97
RFM + 25% RFK	6.36	6.39	485	499	348.9	352.3	7.71	8.99
RFM + 50% RFK	6.40	6.43	487	495	344.5	354.9	7.69	9.22
RFM + 75% RFK	6.34	6.47	492	492	345.3	353.9	7.74	9.10
RFM + 100% RFK	6.37	6.40	491	497	346.0	355.0	7.76	9.15
Sole maize with RF	6.42	6.48	487	499	347.5	356.3	8.01	9.25
Sole kachu with RF	-	-	-	-	-	-	-	-
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	10.7	7.3	5.9	7.1	4.5	6.5	13.2	8.7

RFM = Recommended fertilizer of maize (255-55-140-40-6-2 kg/ha NPKSZnB)
RFK = Recommended fertilizer of kachu (112-32-95-22 kg/ha NPKS)
Joy =Joydebpur, Buri =Burirhat and NS=Not significant

Effect on mukhikachu

Number of hills/m^2, secondary corm weight/hill and cormel weight/hill of mukhikachu in hybrid maize mukhikachu relay cropping systems under different fertilizer management practices were influenced significantly at both the locations (Table 3). The highest number of hills/m^2 (Joy: 8.0 and Buri: 7.9) was observed in sole mukhikachu with recommended fertilizer management while lower (Joy: 6.2-6.5 and Buri: 6.4-6.8) in relay cropped treatment with different fertilizer management practices. The significant difference in number of hills/m^2 of mukhikachu in sole and in relay cropped treatment with different fertilizer management practices was observed due to planting system of mukhikachu. Secondary corm weight/hill of mukhikachu under different fertilizer management practices increased with the increase of fertilizer levels up to RFM + 50% RFK and then decreased at both the locations. However, the highest secondary corm weight/hill (212.6 g) was recorded in sole mukhikachu with recommended fertilizer management practice which was at par with RFM + 25% RFK (188.1g), RFM + 50% RFK (196.6g) and RFM + 75% RFK (189.8g) at Joydebpur location. But at Burirhat, significantly the highest secondary corm weight/hill (190.8g) was obtained from sole mukhikachu with recommended fertilizer management practice. Similar to secondary corm weight/hill, cormel weight/hill of mukhikachu under different fertilizer management practices progressively increased with increasing fertilizer levels up to RFM + 50% RFK and then declined at both the locations. Maximum cormel weight/hill of mukhikachu was observed in sole crop which was statistically identical with other treatments except RFM + 112 kg N/ha at both the locations. These results happened might be due to development of large leaf area and accumulation of substantial amounts of dry matter in the corms and cormels under optimum fertilizer level. But excessive fertilization favored top growth, reduced the proportion of dry matter allocated to the corms and cormels resulting lesser weight. Similar results are reported by Manrique (1994) and Salam *et al.* (2003).

Table 3. Yield and yield components of mukhikachu in maize mukhikachu relay cropping under different fertilizer management at Joydebpur and Burirhat (pooled data of two years).

Treatments	Hill/m^2 (no.)		Secondary corm wt/hill (g)		Cormel wt/hill (g)		Edible yield (t/ha)	
	Joy	Buri	Joy	Buri	Joy	Buri	Joy	Buri
RFM + 112 kg N/ha	6.4	6.5	181.1	158.3	243.2	465.8	14.94	20.28
RFM + 25% RFK	6.5	6.5	188.1	162.2	264.2	490.3	16.17	21.21
RFM + 50% RFK	6.4	6.8	196.6	164.5	274.2	492.6	16.57	22.34
RFM + 75% RFK	6.4	6.6	189.8	161.9	265.5	489.7	16.03	21.50
RFM + 100% RFK	6.2	6.4	184.4	156.7	260.8	481.4	15.18	20.42
Sole maize with RF	-	-	-	-	-	-	-	-
Sole kachu with RF	8	7.9	212.6	190.8	288.9	512.7	18.89	23.91
LSD (0.05)	1.2	1.0	25.2	24.4	42.1	40.0	2.67	2.39
CV (%)	10.0	8.2	7.2	8.1	8.7	4.5	9.0	6.1

RFM = Recommended fertilizer of maize (255-55-140-40-6-2 kg/ha NPKSZnB),
RFK = Recommended fertilizer of kachu (112-32-95-22 kg/ha NPKS) and S= Secondary
Joy =Joydebpur, Buri =Burirhat

Edible yield of mukhikachu differed significantly in maize mukhikachu relay cropping system under different fertilizer management practices at both the locations (Table 3.). The highest edible yield of mukhikachu (Joy: 18.89 t/ha; Buri: 23.91 t/ha) was recorded in sole mukhikachu with recommended fertilizer dose which was statistically identical to RFM + 75% RFK at both the locations. On the contrary, under relay cropping situation, the highest edible yield (Joy. 16.57 t/ha; Buri. 22.34 t/ha) was observed in RFM + 75% RFK and it was at par with other fertilizer combinations. The lowest edible yield of mukhikachu (Joy. 14.94 t/ha; Buri. 20.28 t/ha) was found from RFM + 112 kg N/ha. The higher edible yield of mukhikachu in aforesaid treatment was attributed to the cumulative effect of higher yield components. This result is in agreement with the findings of Mohankumar *et al.* (1990), Kundu *et al.* (2008), and Faisal *et al.* (2009). Edible yield of mukhikachu at Burirhat was higher than that of Joydebpur might be due to suitable physical properties of the soil.

Table 4. Maize equivalent yield (MEY) and benefit cost analysis of maize mukhikachu relay cropping under different fertilizer management at Joydebpur and Burirhat (average of two years).

Treatments	MEY (t/ha)		*Gross return (Tk/ha)		**Total cost of production (Tk/ha)		Gross margin (Tk/ha)		Benefit cost ratio	
	Joy	Buri	Joy	Buri	Joy	Buri	Joy	Buri	Joy	Buri
RFM + 112 kg N/ha	22.61	29.25	271320	351000	73450	75700	197870	275300	3.69	4.64
RFM + 25% RFK	23.88	30.2	286560	362400	79525	81775	207035	280625	3.60	4.43
RFM + 50% RFK	24.26	31.56	291120	378720	84900	87150	206220	291570	3.43	4.35
RFM + 75% RFK	23.77	30.6	285240	367200	90275	92525	194965	274675	3.16	3.97
RFM + 100% RFK	22.94	29.57	275280	354840	95650	97900	179630	256940	2.88	3.62
Sole maize with RF	8.01	9.25	96120	111000	47250	49500	48870	61500	2.03	2.24
Sole kachu with RF	18.89	23.91	226680	286920	66900	69150	159780	217770	3.39	4.15

RFM = Recommended fertilizer of maize (255-55-140-40-6-2 kg/ha NPKSZnB),
RFK = Recommended fertilizer of kachu (112-32-95-22 kg/ha NPKS)
Joy =Joydebpur, Buri =Burirhat

Market price (Tk./kg): Maize grain 12/- and mukhikachu 12/-
* Includes return from maize grain and edible yield of mukhikachu
** Includes cost of land preparation, seeds, fertilizers, insecticides, irrigation and labours

System productivity

At both the locations, total yield in terms of maize equivalent yields (MEY) in hybrid maize mukhikachu relay cropping system under different fertilizer management practices were higher (Joy. 22.61-24.26 t/ha; Buri. 29.25-31.56 t/ha) than either of the sole crop with recommended fertilizer managements (Table 4).

The highest MEY was obtained from RFM + 50% RFK (24.26 t/ha) at Joydebpur and it decreased with further increase or decrease of fertilizer levels. The highest MEY in RFM + 50% RFK was contributed due to the higher yield of component crops. Similar results were cited by Saha *et al*. (2001). The MEYs at Burirhat followed similar trend as observed at Joydebpur. Gross return is directly related to MEY. The highest gross return (Joy. Tk. 291120/ha, Buri: 378720/ha) was recorded in RFM + 50% RFK, which was closer to RFM +112 kg N/ha (Joy. Tk.271320/ha, Buri. Tk. 351000/ha) with minimum investment at both the locations. The cost of production varied mainly with the variation in fertilizer cost as well as involvement of labour for management practices. The highest cost of production (Jo. Tk 95650/ha; Buri. Tk 97900/ha) was found in RFM + 100% RFK. In spite of the highest gross return in RFM + 50% RFK, the highest gross margin was obtained from RFM + 25% RFK (Tk. 207035/ha) at Joydebpur and from RFM + 50% RFK (Tk. 291570/ha) at Burirhat might be due to lower cost of production. Similar results were mentioned by Ahmed *et al.* (2009). The gross margin in RFM +112 kg N/ha (Joy. Tk.197870/ha, Buri. Tk. 275300/ha) was closer to the highest gross margin with lesser cost of production. Benefit cost ratio in hybrid maize mukhikachu relay cropping system under different fertilizer management practices was higher than either of the sole crop with recommended fertilizer practice. The highest benefit cost ratio (Joy. 3.69, Buri. 4.64) was recorded in RFM +112 kg N/ha at both the locations.

The results revealed that recommended fertilizer dose (255-55-140-40-6-2kg/ha NPKSZnB) of hybrid maize plus 112 kg N/ha (extra) might be economically profitable for hybrid maize mukhikachu relay cropping system at both the locations.

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