EFFECT OF DIFFERENT DOSES OF PHOSPHORUS ON THE GROWTH AND YIELD OF BRRI DHAN41

A Thesis

BY

Examination Roll No. MS-050804

A thesis submitted to the Agrotechnology Discipline of Khulna University, Khulna in partial fulfillment of the requirements for the degree of Master of Science (M.S.) in Agronomy

Agrotechnology Discipline

Khulna University

Khulna- 9208

FEBRUARY, 2010

EFFECT OF DIFFERENT DOSES OF PHOSPHORUS ON THE GROWTH AND YIELD OF BRRI DHAN41

A Thesis

By

Examination Roll No. MS-050804

Approved as to style and content

BY

(Prof. Dr. Md. Yasin Ali)

Supervisor

(Prof. Dr. Md. Sarwar Jahan)

Co-Supervisor

(Prof. Khan Golam Quddus)

Chairman

Examination Committee

DEDICATED TO

MY BELOVED

DAUGHTER ARIA CHOWDHURY

ACKNOWLEDGEMENT

The author expresses her sincere thanks to Almighty Allah, Who gave her wisdom, strength, courage, patience, determination and good health to finish her Master of Science program successfully.

The author also wishes to express her heartfelt gratitude and appreciation to her reverend research supervisor Dr. Md. Yasin Ali, Professor, Agrotechnology Discipline, Khulna University, Khulna for his invaluable advice, constructive criticism and scholarly suggestion, constant inspiration, and supervision during the research conduction and the preparation of this manuscript.

The author also expresses her deep respect and indebtedness to her co-supervisor Dr. Md. Sarwar Jahan, Professor, Agrotechnology Discipline, Khulna University, Khulna for his co-operation and kind help in research work.

The author expresses her heartfelt gratitude to her senior brother, for his patience, sacrifice, encouragement and help in conducting the experiment, data analyzing, as well as guidelines in the preparation of this manuscript without which this study would have not been successfully completed.

The author extends her sincere gratefulness and regard to all the respectable teachers of Agrotechnology Discipline, Khulna University for their direct and indirect help during the study period.

The author takes the opportunity to express her sincere thanks to Mr. Nivanon Kumar Roy, Skilled Farmer, Agrotechnology Discipline for his co-operation in the research work. She also expresses special thanks to Section Officer (Lab.) Md. Shamsul Alam for his cordial help.

Especially thanks are extended to Khulna University Library, Khulna and Bangladesh Agricultural University Library, Mymensingh, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, from where she bound valuable information to complete this research work.

She also expresses her boundless gratitude to her beloved parents, younger brother, all friends, and other members of her family whose scarifies, inspiration and continuous blessing opened the gate and paved the way for her higher studies.

February, 2010

The author

LIST OF TABLES

TABLE OF CONTENTS

ABSTRACT

A field experiment was conducted at the Field Laboratory of Agrotechnology Discipline, Khulna University, Khulna, during aman season, 2006 to study the effect of different doses of phosphorus on the growth and yield of BRRI dhan41. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. There were seven levels of phosphorus (T_1= 0 kg P/ha, T_2= 39 kg P/ha, T_3= 51 kg P/ha, T_4=77 kg P/ha, T_5= 19.5+19.5 kg P/ha, T_6=25.5+ 25.5 kg P/ha, T_7= 38.5+ 38.5 kg P /ha) which constitute the treatment. Phosphorus doses under treatments T_2, T_3 and T_4 were applied as single basal while treatments T_5, T_6 and T_7 were applied in two equal splits. Data on growth, yield and yield attributes were collected. The experimental result revealed that most of the growth and yield parameters were significantly affected by phosphorus doses. The highest grain yield (3.77 t/ha) was recorded in T_3 (51 kg P/ha) treatment and the lowest yield (1.99 t/ha) was recorded in T_1 (0 kg P/ha). Reduction in grain yield was observed at higher dose of phosphorus. Application of phosphorus fertilizer in split had no effect compared to their single basal application. Application of 51 kg P/ha as single basal found to be the most suitable dose for better growth and higher yield of T. aman rice *cv.* BRRI dhan41.

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATION

dS m^{-1} – Desi Simens per meter

RCBD- Randomized completely block design

t ha^{-1} – Ton per hectare

BRRI –Bangladesh Rice Research Institute

HI- Harvest Index

g- Gram

ha^{-1}= Per hectare

CHAPTER I

INTRODUCTION

Rice (*Oryza sativa* L.) is the principal food crop of Bangladesh. Bangladesh ranks third position in area and fourth in production among the rice growing countries of the world (BRRI, 1988). Rice covers 76% of total area with an average yield of 2.39 t ha^{-1} (BBS, 2004).

Rice is produced under both upland and lowland ecosystem with about 76% of the global rice produced from irrigated-lowland rice system. The anaerobic soil environment created by flooded-irrigation of lowland rice creates a unique and challenging environment for the efficient management of soil and fertilizer nutrients. Supplying essential nutrients in adequate rates, sources, application methods and application times are important factors that influence the productivity of rice.

Fertilizer is one of the most important components for sustainable agricultural production. In modern farming, fertilizer application contributes about 50% of the world's production (Pradhan, 1992). Thus, use of balanced fertilizer along with management practices can play a key role in sustaining higher yield of crops under different cropping patterns and also can preserve soil health on long term basis.

Among the nutrients, phosphorus stands prominent in raising rice yields. Among many factors, deficiency of phosphorus (P) is now considered as major reason for low yield of rice in some region of Bangladesh. Although the response of rice to the added phosphorus is almost universal, but the extent of response for maximum grain yield depends on the variety, soil and environmental condition.

Keeping it in mind of the above discussion an attempt has been made to observe the effect of different doses of phosphorus on BRRI dhan41 with the following objectives:

1) To find out the effect of phosphorus fertilizer on the yield and yield attributes of BRRI dhan41,
2) To find out the optimum dose of phosphorus fertilizer for higher yield of BRRI dhan41,
3) To observe the effect of phosphorus fertilizer by split application.

CHAPTER II

REVIEW OF LITERATURE

An extensive research has been carried out in the world on P nutrition of rice, yet the work on comparative performances of different P levels is limited particularly under Bangladesh situation. A brief review concerning the effects of P fertilizer on rice along with some fundamental functions of P in soil is presented in this chapter.

Phosphorus occurs in soils in both inorganic and organic forms. The relative amount of these two forms vary greatly from soil to soil. The organic P content may vary 20 to 80% of the total P depending on the soil group (Brady, 1990).

Effects of phosphorus fertilizer on rice

Supply of phosphorus promotes the root development and elongation capability of rice plants. Due to lack of phosphorus, cell division slows down, the leaf color changes to dark green, stem becomes more slender, the whole plant becomes dwarfed, heading and ripening is also inhibited (Murayama, 1964).

Roy and Kanwar (1979) reported that the efficiency of N application in respect of grain yield was increased when it was applied along with P_2O_5.

In a field trial on alluvial soil at New Delhi, Raju *et al.* (1983) found that in split application, P uptake was greater from Diammonium Phosphate (DAP) than from Single Super Phosphate (SSP) and P uptake was greater from initial application than subsequent applications.

Plant absorbs P in the form of $H_2PO_4^-$, $HPO4^{=}$ and $PO_4^{\equiv}$. Adequate phosphorus nutrition enhances many aspects of plant physiology, including the fundamental process of photosynthesis, N-fixation, flowering (including seed production) and maturation. It is an essential of the organic compound often called the energy currency of living cell, adenosine triphosphate (ATP) (Brady and Weil, 1996).

Phosphorus is the second key plant nutrient. It is needed most by young, fast growing tissue and performs a number of functions related to growth, development, photosynthesis and utilization of carbohydrates (Tandon, 1987).

An adequate supply of P early in the life of a plant is important in the development of its reproductive parts. Large quantities of P are in seed fruit, and it is considered essential for seed formation. An adequate supply of P is associated with greater straw in cereals (Tisdale *et. al*, 1999). Moreover, sufficient P nutrition of rice is essential for production of optimum grain yield.

The rice crop was favorably influenced by fertilizer nutrients, particularly with respect to plant height, number of effective tillers/hill, panicle length, 1000-grain weight and yields of grain and straw. The effects of nitrogen, phosphorus and zinc were prominent as compared to other nutrients. The grain yield was increased over control from 16 to 20 percent due to application of phosphorus alone.

Effect of rate of application on rice growth and yield

Ghosh (1963) found that yield of rice increased progressively when the level of P_2O_5 was increased from 0-60 Ib/acre.

Nair *et al.* (1972) carried out an experiment with different phosphate fertilizers on rice. They pointed out that different phosphate fertilizers @ 30 and 60 kg P_2O_5/ha significantly increased the yield.

In a study Sahu and Dash (1972) obtained the similar yields of rice with equivalent rates of diammonium phosphate or ammonium phosphate. In another trail, Chowdhury and Mian (1978) reported that the number of tillers/plant, panicle weight and grain yield of rice increased with increasing levels of P from either triple super phosphate or rock phosphate applied at the rates of 15, 30, 45 kg P_2O_5/ha.

Subbian *et al.* (1989) carried out an experiment on rice applying 30, 60 or 90 kg P_2O_5/ha, obtained paddy yields of 4.85- 5.12, 5.10- 5.27 and 5.23 – 5.65 t/ha, respectively, compared with 3.90 – 4.06 t/ha without P. The increasing P rates increased N, P and K uptake. There was no significant difference in yields and nutrient uptake with P applied in three forms.

Sarkuman *et al.* (1998) carried out a pot experiment to find out the effect of P and S on the yield of rice under flooded condition on a P and S deficient sandy loam soil. The treatments were the combination of 4 levels of P (0, 25, 50 and 100 mg kg^{-1} soil) as ammonium phosphate and 4 levels of S (0, 10, 25 and 50 mg kg^{-1} soil) as ammonium sulphate. Increasing levels of P from 0 to 100 mg kg^{-1} progressively increased the grain yield from 16.90 to 42.50 g pot^{-1}. Sulpher added at 25 mg kg^{-1} resulted in 9% increase in grain yield. The treatment combination of 100 mg P and 10 mg S kg^{-1} soil gave significantly higher grain yield than the other treatments.

Alam and Azmi (1989) carried out an experiment with rice variety IR8 and IR6. Phosphorus fertilizer was applied @ 0, 40, 80 and 120 kg P/ha. They stated that dry matter yield/m^2, plant height and number of tillers were significantly increased with the increasing rate by P. They further reported that the concentration of N, P, K, Fe, Cu and Mn was increased significantly with P.

Singh *et al.* (1992) observed yield increase of pea seeds by application of P up to 50 kg P_2O_5/ha under rain fed condition in the valley of Kashmir.

Hassan *et al.* (1993) carried out an experiment to observe the yield response of Basmati 385 rice with 0, 33, 66, and 99 kg P/ha. They observed that yield increased significantly up to 33 kg P/ha.

Biomass production increased with the increasing doses from 0 to 50 kg P_2O_5 per ha (Enania and Vays, 1994). On the other hand, Rao (1995) reported that phosphorus applied @ 50 kg P /ha as Single Super Phosphate (SSP) increased the grain and straw yields significantly.

The highest uptake of N and P were obtained when 60 kg P_2O_5/ha was applied (Kalipada and Singh, 2003).

Field experiment were carried out by Singh *et al.* (1999) on the effect of sources of phosphate at three rates of P application (0, 30 and 60 kg P_20_5 /ha) on growth, grain yield and phosphorus use efficiency of rice and residual effects of the sources and rates of phosphorus on herbage yield of cowpea (dry season). Results revealed that P sources (superphosphate, diammonium phosphate, urea nitrate phosphate and ammonium poly phosphate) did not

influence significantly the grain yield of rice or the cowpea fodder yield. They reported that yields increased with up to 30 kg P_2O_5/ha.

The maximum yield was found at the dose 45 kg/ha P (Singh, 2001). Phosphorus plays a significant role on the dry matter production and plant height.

CHAPTER III
MATERIALS AND METHODS

Location

A field experiment was conducted at the Field Laboratory of Agrotechnology Discipline, Khulna University, Khulna during the aman season of 2006 to observe the effect of different doses of phosphorus on yield and yield attributes of BRRI dhan41.

Description of the experimental site

The experimental field belongs to Agroecological Zone of Ganges Tidal Flood Plain (AEZ-13). It was a typical rice growing medium high land of loamy soils belonging to the soil physiographic unit of Ganges Tidal Flood Plain soil tract series. The geographical situation of the experimental station is at a latitude of $22^0$47 N′ and longitude of $89^0$34 E′ having subtropical climate. Moderately high temperature and heavy rainfall characterize the experimental site during Karif season (May to September) and scanty rainfall with moderately low temperature during the Rabi season (October to April). The soil was low in phosphorus and potassium, medium in sulphur and zinc, very low in nitrogen.

Climate

The total monthly rainfall and average maximum and minimum temperature and relative humidity data during the study period were recorded from the Meteorological Station , Gollamari, Khulna as has been presented in Appendix 1.

Planting material

BRRI dhan41 a high yielding variety of rice was used as test crop. The variety was developed by the Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur for use as a transplanted aman rice.

Seedling raising

A seedbed was prepared manually by puddling and leveling the soil using spade and hand leveler, respectively. The seedbed surface was smoothened towards the side to facilitate drainage. About 500 g of seeds of BRRI dhan41 was soaked and sprouted for 48 hours and was broadcast uniformly on the prepared seedbed. The seedbed was shallow irrigated when the seedlings were gradually increased from 2-3 cm high.

Experimental design and treatments

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The size of each unit plot was 4.0 m x 2.5 m. The space between blocks and plots were 1m and 50 cm, respectively. Seven levels phosphorus fertilizer applied as single basal or two equal splits consisted the experimental treatment as mentioned below:

T_1 = 0 kg P/ ha (control)

T_2 = 39 kg P/ ha

T_3 = 51 kg P/ ha

T_4 = 77 kg P/ ha

T_5 = (19.5+19.5) kg P/ ha

T_6 = (25.5+25.5) kg P/ ha

T_7 = (38.5+38.5) kg P/ ha

Full doses of phosphorus of T_2, T_3, T_4 treatments and half doses of T_5, T_6, and T_7 treatments were applied as basal at final land preparation. The remaining portion of phosphorus of T_5, T_6, and T_7 treatments were applied at 50 days after transplanting (DAT) with last dose of urea.

Fertilizer application

The experimental plots were fertilized with Urea (N), MoP (K), Gypsum and $ZnSO_4$ at the rate of 218, 80, 34, 5 kg/ha, respectively as recommended by BRRI. Full dose of K, S and Zn were applied at final land preparation. Nitrogen (N) was applied in three equal splits. One third of N was applied at basal dose, one third at 25 DAT and rest one third of N was applied at 50 DAT. Phosphorus was applied as per treatment.

Transplanting

The seedlings of rice variety BRRI dhan41 were transplanted at the age of 32 days, giving two seedlings in each hill. Row to row and hill to hill distances were 25 cm and 15 cm, respectively.

Intercultural operations

Water depth of 3-5 cm was maintained during the first week of transplanting for quick seedling establishment and was increased to 5-10 cm throughout the growing period.

Weeding

Experimental plots were infested with some weeds, which were uprooted from the field two times at 15 and 30 days after transplanting of the seedlings.

Harvesting

The crops were harvested at their full maturity when 90% of the grain turned golden yellow in color. Total harvesting was done on 12th December of 2006 within one day . Before harvesting 5 hills were uprooted randomly from each plot for taking yield component data. The harvested crop of each plot was bundled separately, tagged properly and brought to the clean threshing floor. Grain and straw yield were recorded from 2 m^2 area from the centre of the plot. The grain and straw weight of each plot recorded after proper drying in sun. The grain and straw yield were adjusted to 14% moisture level.

GROWTH PARAMETERS STUDIED

Five hills from each plot were selected randomly and marked to record the growth data. Growth data were recorded at 45, 60 and 75 DAT. The following growth parameters were studied.

Plant height

Plant height was measured from the base of the plant to the tip of the tallest leaf or panicle of each plant of the sample and the mean of five hills was taken.

Number of tillers

The number of tillers $hill^{-1}$ was recorded from 5 hills and the means were calculated.

Dry matter accumulation

Five hills were uprooted from each unit plot at 45, 60 and 75 (DAT); oven dried at 72^0C for 48 hours and weighed to calculate the total dry matter accumulation.

YIELD AND YIELD CONTRIBUTING CHARACTERS STUDIED

Number of tillers per hill

The numbers of tillers were counted from all the five hills and the means was calculated.

Panicle number per hill

The number of panicles in 5 hills were counted and the means were calculated.

Panicle Length

Panicle length was measured from the base of the panicle to the tip of each panicle and mean values were calculated.

Grain number per panicle

The number of grains of each panicle was counted from each sample and the mean value was calculated.

Unfilled spikelets per panicle

Unfilled spikelets of each panicle was counted and the mean value was calculated.

Thousand grains weight (g)

Thousand grains were randomly counted from the filled grain of each plot and weight was measured in electronic balance and adjusted at 14% moisture content.

Grain yield

Grain yield was measured from 2 m^2 area and converted to t/ha. The grain yield was adjusted at 14% moisture level.

Straw yield

Total straw yield of the central 2 m^2 harvested area of each plot was determined. Sample straw of each plot was dried in an oven at 48 hours and converted the sample into total straw yield.

Biological yield

Grain yield and straw yield are altogether regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield= Grain yield + Straw yield.

Harvest index (%)

It is the ratio of economic yield to biological yield and was calculated with the following formula:

Harvest index (%) = Grain yield/ Biological yield x 100.

Statistical Analysis

Data were statistically analyzed using the "Analysis of variance" technique with the help of statistical computer package program MSTAT-C. The mean differences were compared by Duncan's Multiple Range Test (Gomez and Gomez, 1984). Functional relationships between yield and yield components were done using simple regression analysis.

CHAPTER IV

RESULTS AND DISCUSSION

Results of the present study regarding the influence of phosphorus fertilizer on crop characters, yield and yield attributes of transplanted aman rice cv. BRRI dhan41 are presented and discussed below.

Effect of phosphorus fertilizer on growth of BRRI dhan41

Plant height

The effect of P on plant height was found non - significant in all days of recording (Table 1).The influence of phosphorus fertilizer on plant height is shown in Table 1. At earlier stages plant height was lower in all the treatments. From 60 DAT to 75 DAT the plant height was rapidly increased and from 75 to harvest it was increased slightly. The highest plant height was observed in 51 kg P/ha (T_3) and that was the lowest in control treatment (T_1) at all the sampling dates.

Table1. Effect of phosphorus levels on plant height of BRRI dhan41 at different days after transplanting (DAT)

Treatment	Plant height (cm) at different DAT			
	45 DAT	60 DAT	75 DAT	At harvest
T_1 (Control)	56.50	75.73	84.70	88.90
T_2 (39 kg P/ha)	63.17	78.93	87.70	90.30
T_3 (51 kg P /ha)	66.47	83.07	93.93	94.99
T_4 (77kg P /ha)	64.13	79.33	88.13	90.72
T_5 (19.5+ 19.5 kg P /ha)	63.23	75.73	87.83	90.43
T_6 (25.5+ 25.5 kg P /ha)	64.43	78.10	89.00	91.63
T_7 (38.5+ 38.5kg P /ha)	64.43	77.40	88.57	91.14
Level of significance	NS	NS	NS	NS
CV (%)	6.01	6.92	5.62	5.23

NS= Non significant; DAT= Days After Transplanting

Tiller number

Tiller production in time has been shown in Table 2. Tiller production was affected by basal and split application of phosphorus fertilizers. Tiller number in all the treatments increased almost exponentially up to 75 DAT. In all the treatments, a slightly decline in tiller number at harvest was found except T_6 and T_7 treatments. This might be due to the fact that mortality rate of secondary and tertiary tillers were much during the late phase of growth (Roy and Satter, 1992). Miller *et al.,* (1991) also reported that the number of actively growing tillers declined until reaching a constant tiller by heading. Higher tiller number per hill was recorded in 51 kg P/ha in all the stages while the highest (9.78) was at 75 DAT. Lower tillers were produced by the control treatment (T_1). The lowest (4.37) was found in 45 DAT. Treatment with single basal application showed better performance than splits application of phosphorus fertilizer.

Table 2. Effect of phosphorus levels on number of tillers per hill of BRRI dhan41 at different days after transplanting (DAT)

Treatment	Tillers per hill			
	45 DAT	60 DAT	75 DAT	At harvest
T_1 (Control)	4.37 b	6.84 b	7.50 c	7.35 b
T_2 (39 kg P /ha)	4.73 b	7.23 b	7.92 bc	7.62 b
T_3 (51 kg P /ha)	5.63 a	8.58 a	9.78 a	9.69 a
T_4 (77kg P /ha)	5.00 ab	7.59 b	8.88 ab	8.43 b
T_5 (19.5+ 19.5 kg P /ha)	4.63 b	7.41 b	8.13 bc	8.22 b
T_6 (25.5+ 25.5 kg P /ha)	4.53 b	7.23 b	7.95 bc	8.04 b
T_7 (38.5+ 38.5kg P /ha)	4.77 b	7.59 b	8.37 bc	8.46 ab
Level of significance	0.05	0.05	0.05	0.05
CV (%)	8.22	6.14	8.63	8.47

Figures bearing letter (s) in common do not differ significantly, whereas figures with dissimilar letter(s) differ significantly. DAT= Days after Transplanting

Total dry matter production

Total dry matter (TDM) is the sum of the dry matter accumulated in the various components of the plant namely leaf, petiole, stem and the reproductive parts of the plants. Applied phosphorus showed a marked influence on the total dry matter production.

Among the treatments, the highest dry matter was produced by T_3 (51 kg P/ha) in all growth stages. At 45 DAT the dry matter was lower. The trend of dry matter accumulation from 45 to 60 DAT was slowly increased; but from 75 DAT to harvest, the dry matter accumulation was rapidly increased (Table 3). It was due to higher rate of photosynthesis, dry matter accumulation was higher. There was no marked difference among the single and split application of P in total dry matter production.

The distribution of dry matter to the different components of the plant is an important consideration in achieving desirable yield. The production of economic yield is greatly determined by the production of total dry matter and its partitioning to the reproductive organ (Singh and Yadav, 1997).

Table 3. Effect of phosphorus on dry matter (g) production at different days after transplanting (DAT)

Treatment	Dry matter per hill(g)			
	45 DAT	60 DAT	75 DAT	At harvest
T_1 (Control)	4.06 c (109.62)	5.72 c (154.44)	9.06 d (244.62)	19.76 c (533.52)
T_2 (39 kg P/ha)	4.49 abc (121.23)	6.94 abc (187.38)	11.31 ab (305.37)	23.98 abc (647.46)
T_3 (51 kg P /ha)	4.83 a (130.41)	7.59 a (204.93)	11.97 a (323.19)	25.94 a (700.38)
T_4 (77kg P /ha)	4.78 ab (129.06)	7.07 ab (190.89)	11.53 a (311.31)	24.44 ab (659.88)
T_5 (19.5+ 19.5 kg P /ha)	4.16 c (112.32)	5.91 bc (159.57)	9.63 cd (260.01)	20.42 bc (551.34)
T_6 (25.5+ 25.5 kg P /ha)	4.20 bc (113.40)	6.22 bc (167.94)	10.14 bcd (273.78)	21.50 bc (580.50)
T_7 (38.5+ 38.5kg P /ha)	4.46 abc (120.42)	6.73 abc (181.71)	10.77 abc (290.79)	22.84 abc (616.68)
Level of significance	.0.01	0.01	0.01	0.01
CV (%)	5.67	7.61	4.56	7.55

Figures bearing letter (s) in common do not differ significantly, whereas figures with dissimilar letter(s) differ significantly; DAT= Days after Transplanting. Figures in the parenthesis indicate dry matter per square meter (g).

Effect of phosphorus fertilizer on the yield and yield attributes of BRRI dhan41

Tiller number

Tiller number varied significantly due to P doses. The highest number of tillers was obtained from the treatment T_3 (51 kg P/ha) with the value of 9.69 (Table 4). Other treatment produced statistically similar tiller number but the lowest (7.35) was in the control.

Panicle number per hill

Result presented in Table 4 showed a significant effect of different rates of phosphorus on panicle number per hill. The highest number of panicles (8.52) was produced in the treatment with P @ 51 kg /ha followed by 7.30 was produced in the treatment with P (19.5+19.5 kg/ha) and the lowest (5.97) was produced from control treatment.

Panicle length

Panicle length of BRRI dhan41 was not influenced significantly by different P rates. Values of panicle length of the present study due to different treatments varied from 20.53 to 20.13 cm (Table 4). Maximum panicle length (23.00 cm) was obtained from the treatments T_4 and T_6 and the lowest value of panicle length (20.13 cm) was produced from the treatment T_7.

Grain number per panicle

The number of grains per panicle of BRRI dhan41 ranged from 55.61 to 79.12 (Table 4). All the treatments except T_1 produced significantly higher number of filled grains per panicle over the control. The highest value was produced by T_3 treatment and the lowest value by the control. Number of grains per panicle depends on the sink size (spikelet number); the ability of grains to accept carbohydrates and the translocation of assimilates from leaves to spikelet (Yoshida, 1981). As the experiment was conducted using similar management practices except P rates, therefore, similar trend of grains per panicle was produced as of panicle number per hill. These results are similar to those findings of Wada (1969).

Table 4. Effect of phosphorus on yield and yield attributes of BRRI dhan41

Treatment (Phosphorus)	Tiller number per hill (no.)	Panicle number per hill (no.)	Panicle length (cm)	Grain number per panicle (no.)	Unfilled spikelets per panicle (no.)	1000 grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Biological Yield (t/ha)	Harvest Index (%)
T_1 (Control)	7.35 b	5.97 c	20.53	55.61 b	12.51 a	19.80	1.99 c	2.48 c	4.48 d	44.35
T_2 (39 kg P /ha)	7.62 b	6.32 bc	20.80	66.61 ab	10.74 ab	20.20	2.57 bc	2.98 bc	5.55 c	46.26
T_3 (51 kg P /ha)	9.69 a	8.52 a	22.60	79.12 a	7.55 c	20.37	3.77 a	3.84 a	7.61 a	49.56
T_4 (77 kg P/ha)	8.43 b	6.29 bc	23.00	73. 04 a	8.41 bc	20.37	2.80 b	3.25 ab	6.05 bc	46.29
T_5 (19.5+19.5 kg P /ha)	8.22 b	7.30 ab	22.23	71.43 a	9.20 bc	19.87	3.11 ab	3.31 ab	6.42 b	48.32
T_6 (25.5+25.5 kg P/ha)	8.04 b	6.47 bc	23.00	73.33 a	7.87 bc	20.13	2.84 b	3.25 ab	6.09 bc	46.76
T_7 (38.5+38.5 kg P/ha)	8.46 b	6.23 bc	20.13	73.47 a	8.59 bc	20.30	2.79 b	3.02 bc	5.81 bc	47.99
Level of significance	*	*	NS	**	**	NS	**	**	**	NS
CV (%)	8.47	10.78	8.31	8.01	13.36	4.46	7.07	6.79	9.21	4.91

NS= non significant, **= significant at the 0.01 level, *= significant at the 0.05 level
Figures bearing letter (s) in common do not differ significantly, whereas figures with dissimilar letter(s) differ significantly

Unfilled spikelet per panicle

Unfilled spikelet per panicle of BRRI dhan41 ranged from 7.55 to 12.51 (Table 4). Lowest unfilled spikelet was produced in T_3 (51 kg P/ha) followed by T_6 (25.5 + 25.5 kg P/ha) and the highest was produced in control treatment.

1000 grain weight

The 1000-grain weight of BRRI dhan41 varied from 19.80 to 20.37 g (Table 4) and exhibited no differences among the treatments. Yoshida (1981) mentioned that 1000- grain weight is a stable varietal character because the grain size is rigidly controlled by the size of hull. Hence, grain can not grow to size greater than that permitted by hull no matter of favorable weather condition and nutrient supply. As the values of 1000 – grain weight are almost similar among the treatments, increase in number of panicle per hill and grain number per panicle contributed for higher yield irrespective of P rate.

Grain yield

The grain yield was significantly influenced by P application. The results presented in Table 4 showed that the application of 51 kg P/ha as single basal dose gave the highest grain yield (3.77 t/ha) followed by 3.11 t/ha , while control treatment gave the lowest grain yield (1.99 t/ha). It was observed that very high dose of P reduced grain yield. Because due to higher dose may create toxicity. There was no impact of split application of P on grain yield.

Straw yield

The influence of different P treatment on straw yield was significant. The highest straw yield (3.84 t/ha) was found in treatment T_3 and the lowest value (2.48 t/ha) was observed in control (Table 4).

Biological Yield

Biological yield was significantly influenced by the treatments. The highest biological yield (7.61 t/ha) was found in the treatment T_3 (51 kg P/ha) followed by (6.42 t/ha) was found in the treatment T_5 (19.5 + 19.5 kg P/ha) and the lowest biological yield (4.48 t/ha) was found in the treatment T_1 (control). Chatham (1985) reported that biomass production is essential for maximizing grain yield. The better result of biological yield might be due to the significant increase in grain and straw yield, as reported by Hoque and Hobbs (1978).

Harvest index (HI)

Harvest index was not influenced by P treatment. Control treatment showed the lowest (44.35%) harvest index. T_3 treatment exhibited the highest harvest index (49.56%) followed by T_5 (48.32%) treatment. All other treatment showed almost similar harvest index (Table 4).

Functional relationship between grain yield and yield attributes due to P levels

Yield is complex character which results from the interaction of various parameters such as grain number per panicle, 1000- grain weight, panicle length, biological yield and harvest index. Hence, an attempt was made to examine the extent of contribution of various parameters to grain yield. Simple linear regression showing the relationship of grain yield with other parameters was found out.

Relationship between tiller number per hill and grain yield

Tiller number per hill showed significantly positive relationship with grain yield (t/ha). In this case the regression equation is $y = 0.6621x - 2.6284$; $R^2 =$

0.8581 indicates that more than 85% grain yield is satisfied by tiller number per hill (Fig. 1).

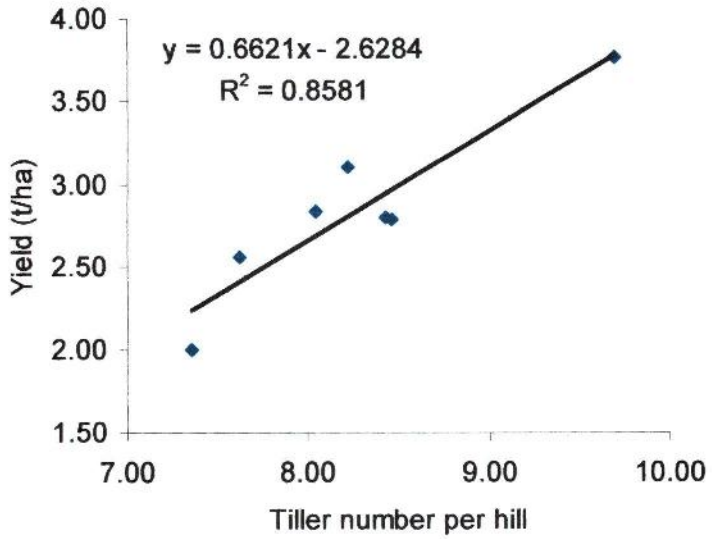

Fig. 1. Functional relationships between tiller number per hill and grain yield of rice.

Relationship between panicle per hill and grain yield

Panicle per hill showed positive relationship with grain yield (t/ha). In this case regression equation is y = 0.5462x- 0.8355; R^2 = 0.8238 indicates that more than 82% grain yield is satisfied by panicle number per hill (Fig. 2).

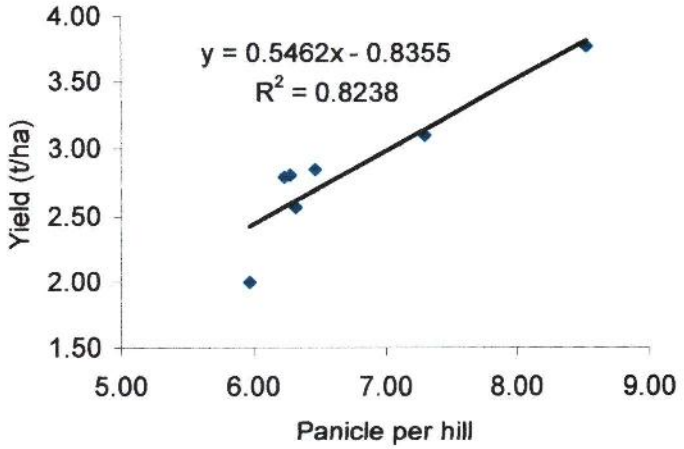

Fig. 2. Functional relationship between panicles per hill and grain yield of rice.

Reltionship between grains per panicle and grain yield

There was a positive linear relationship between number of filled grains per panicle and grain yield of rice. The regression equation $y = 0.065x - 1.7352$; $R^2 = 0.81$ indicates than 81% grain yield can be satisfied by grains per panicle (Fig. 3).

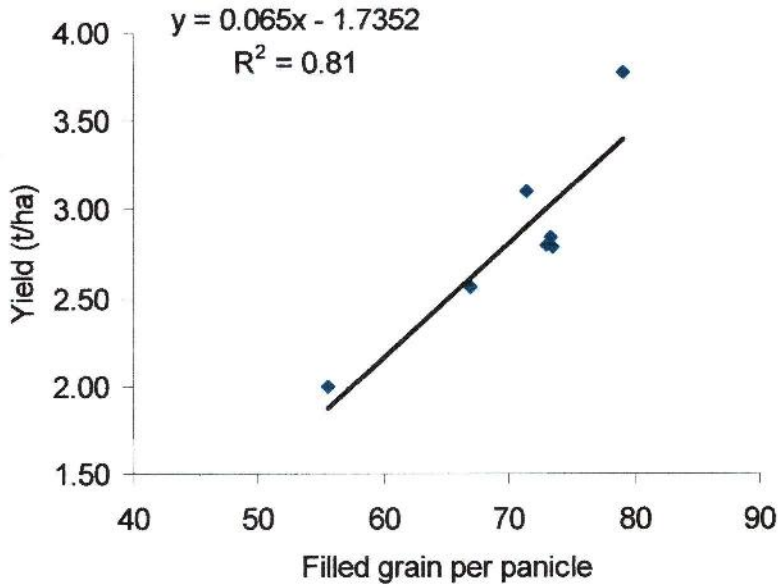

Fig. 3. Functional relationship between filled grain per panicle and grain yield of rice.

Relationship between phosphorus dose and grain yield of rice

Regression analysis between treatments and grain yield indicates that grain yield increased with increasing basal dose of phosphorus. But in case of splits of the same dose phosphorus the grain yield of rice decreased.

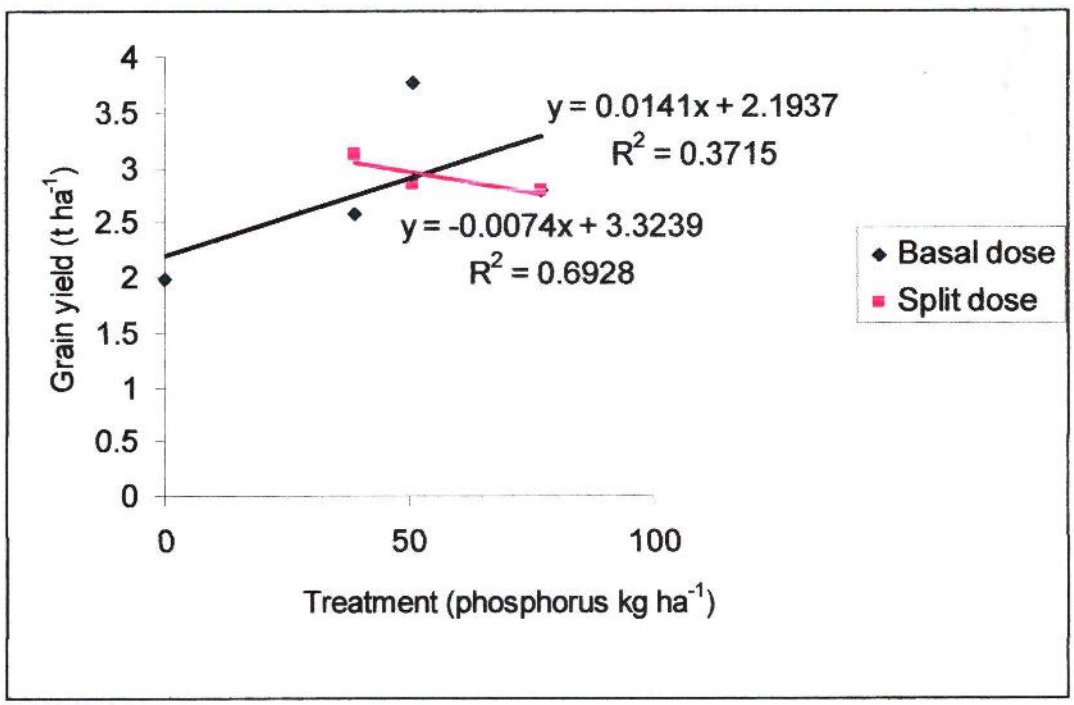

Fig. 4. Functional relationship between phosphorus and grain yield of rice.

CHAPTER V

SUMMARY AND CONCLUSION

A field experiment was conducted during aman season of 2006 at the Field Laboratory of Agrotechnology Discipline, Khulna University, Khulna to evaluate the effect of phosphorus fertilizer on the yield and yield attributes of BRRI dhan41. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Seven different doses of phosphorus applied as single basal or in splits were used as the treatment variables.

There were seven treatments viz. T_1 : 0 kg P/ha, T_2 : 39 kg P /ha, T_3 : 51 kg P/ha, T4 : 77 kg P /ha, T_5 : (19.5+19.5) kg P /ha, T6 : (25.5+25.5) kg P /ha and T_7 : (38.5+38.5) kg P /ha. Thirty two days old seedlings of BRRI dhan41 were transplanted on 28 August 2006. Intercultural operation such as weeding, irrigation, etc. were done as and when required. Crop was harvested on 15 December 2006.

The results of the present study showed that phosphorus fertilizer had significant effect on most of the growth and yield parameters except plant height, panicle length, 1000 grain weight and harvest index. No variation in plant height was observed among the treatments. Tiller production differed in various doses of phosphorus fertilizer. The highest number of tiller (9.69) was found in 51 kg P/ha (T_3) applied as basal application. There was significant effect of phosphorus fertilizer on panicle number. The highest panicle number (8.52) was produced by 51 kg P /ha (T_3) as basal application. There is no significant effect of phosphorus fertilizer on panicle length. Basal application of phosphorus fertilizers influenced grains per panicle

significantly. The highest number of grains per panicle (79.12) was produced by 51 kg P /ha (T_3) applied as basal application. Variation in unfilled spikelet was observed among the treatments. The lowest unfilled spikelets was produced by 51 kg P/ha (T_3) as basal application of phosphorus fertilizer. Thousand grain weight did not vary significantly among the treatment. Among the treatments 51 kg P/ha (T_3) applied as basal application resulted highest grain yield (3.77 t/ha). Straw yield was found to be significantly varied by phosphorus fertilizer. The best result in straw yield (3.84 t/ha) was observed in 51 kg P/ha (T_3) applied as basal application. The highest biological yield (7.61 t/ha) was found as 51 kg P/ha (T_3) applied as basal application. There was no significant effect of phosphorus fertilizers on harvest index was found. However, phosphorus @ 51 kg/ha applied as single basal produced the highest tiller no, panicle no. grain no. per panicle as well as grain yield and biological yield. There is a reduction in yield was found due to higher dose of phosphorus. Treatment of without P produced the lowest values. There had no impact of split application of phosphorus fertilizers. From the study it may be concluded that

1. Phosphorus doses had significant effect on the growth and yield of BRRI dhan41.
2. Phosphorus fertilizer at the rate of 51 kg/ha applied as single basal is the appropriate dose for better growth and higher yield of T. aman rice *cv.* BRRI dhan41.
3. Split application of phosphorus fertilizers had no effect on yield and yield attributes of BRRI dhan41.

CHAPTER VI
REFERENCES

Alam, S.M. and Azmi, A. R. 1989. Effects of phosphorus on growth and rice plant nutrient content. Intl. Rice Res. Newsl., 14(1): 20

Arulandoo, X. and Mohammad, A. M. 1987. The need for phosphorus fertilizer application in Muda project area . Teknologi Padi, MARDI 3, 13 -18. Cited from Field Crop Abst. (1989) 42(10): 956.

Aziz , M. A. and Khan , N. H. 1993. Effect of sulphur and silicon with high and low levels of NPK Fertilization on T.Aman rice. Bangladesh Agron. J., 5(1&2): 1-4.

Bangladesh Bureau of Statistics (2004). Monthly Statistical Bulletin of Bangladesh. Bangladesh Bur. Stat., Min. Plan., Govt. Peoples's Republic. Bangladesh. October, 2004. P. 57.

BARC (Bangladesh Agricultural Research Council). 1997. Fertilizer Recommendation Guide. Soils Pub. 41, Bangladesh Agric. Res. Council, Farmagate, Dhaka.

Bhardwaj, V. and Tyagi, V.V. (1994). Impact of continuous manuring on crop yields and uptake of nitrogen, phosphorus and potassium. J. Potassium Res., 10(3): 290-293.

Brady, N. C. 1990. The Nature and Properties of Soils. 11thed^{n}., Macmillan Publishing Co. Inc., NewYork.

Brady, N.C. and weil, R.R. (1996). The Nature and Properties of Soil (11th ed.). Prentice-Hall Inc. United States of America.

BRRI (Bangladesh Rice Research Institute). 1988. Annual Internal Review. Nitrogen response for T. Aman varieties. pp. A 14 –A 15.

Buckman , H. O. and Brady, N. C. 1980. The Nature and Properties of Soils, Eurosia Publishing House (p) L td. New Delhi – 1110055, pp. 456-457.

Chatham, C. J. 1985. The growth, development and modification of barley seed crops. Ph. D. Thesis: 290.

Chowdhury, S. U. and Mian, M. H. 1978. Effect of P fertilizers on rice yield. Thai J. Agric. Sci., 2(2): 111-119.

Das, P.C. (1996). Manures and fertilizers. Pp.6.

Enania, A.R. and Vays, A. K. 1994. Effect of phosphorus and zinc application on growth, biomass and nutrient uptake by chickpea in calcareous soil. Annals of Agricultural Research., 15(4): 397-399.

Ghosh, S. K. 1963. Effect of phosphorus fertilizers on the yield of paddy and soil condition in different regions of West Bengal. J. Indian Soc. Soil Sci., 11: 129-135.

Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedure for Agricultural Research. 2nd Edition. Jhon Wiley and Sons, New York, pp. 97-111.

Hassan, G., Chaudhury, E.H., Mian. S. M., Gill. K. H. and Shikh, A. A. 1993. Yield response of Basmati rice to applied P at different soil P values. Int. Rice Res. Newsl., 18(4): 25.

Hoque. M.Z. and Hobbs, P.R. 1978. Response of rice crops of added sulphur at BRRI and nearly project areas. Proc. S nutr. Rice. Bangladesh Agricultural Research Institute. Pp. 15-19.

Hoque, M.S., Jariruddin, M. and Rahman, M.M. (1983). Comparative study on the use of Urea+TSP and DAP in rice production. Bangladesh J. Agric. Sci., 10 (2): 163-168.

Islam, M.R. and Bhuiya, Z.H. (1995). Effects of nitrogen and phosphorus on the growth, yield and nutrient uptake of deepwater rice. Bangladesh J. Agric. Sci., 24(2): 93-96.

Kalipada, H. and Singh, R. K. 2003. Effect of levels of phosphorus application with and without biofertilizer on yield and nutrient uptake by chickpea (Cicer arietinumL.). Annals of Agricultural Research, 24(4): 768-775.

Kamal, A. M. A., Azam, M. A. and Islam, M.A. (1988). Effect of cultivar and NPK combinations on the yield contributing characters of rice. Bangladesh J. Agril. Sci. 15(10: 105-1109.

Latchanna, A.,Narsimhulu, H and Satyanarayaanan, V. 1989. Effect of rates and sources of phosphorus on wetland rice. Indian J. Agron., c 34(2): 243- 245.

Miller, B.C., Hill, J.E. and Roberts, S.R. (1991). Plant population effect on growth and yield in water seeded rice. Agorn. J., 83 (2): 291-297.

Murayama, N. (1964). The influence of mineral nutrition on the characteristics of plant organs. In the mineral nutrition of Rice plant. IRRI, Manila, Philippines. pp. 147-172.

Nair, M.G. and Gupta, P.G. 1981. Effect of sulphur on the yield and chlorophyll and nutrient contents of rice on alkaline calcareous soils. Indian J. Agril. Sci., 18(4): 217-219.

Pradhan, L. 1992. Effect of N,P,K and Zn on rice in cultivators fields of Bolangir district, Orissa under rainfed condition. Orissa J. Agril. Res., 4 (1-2): 30-33.

Raju, A. S., Kamath, M. B. and Goswami, N. N. 1983. Phpsphorus utilization by rice (Oryza sativa) in alluvial soil of Delhi, Madras Agric.J., 70 (9): 590-594.

Rao, A S., Ganeshamurthy, A. N., Sammi Reddy, K. and Takkar, P. N. 1995. Evaluation of some phosphate carries for their efficiency in Vertisol Ustochrept to sustain high productivity of wheat and rice J. Indian Soc. Soil Sci. 43(3): 386-391.

Reddy, M.D., Sharma, and Panda, M.M. (1991). Flood tolerance of rice grown under intermediate deepwater conditions (15-50 cm) as affected by phosphorus fertilization. J. Agri. Sci. Cambridge, 117: pp 319-324.

Roy, B.C. and Satter, S.A. (1992). Tillering dynamics of transplanted rice as influenced by seedling age. Trop. Agril. (Trinidad), 69: 355-357.

Roy, R.N. and Kanwar, J.S. (1979). Fertilizer News, 1. 24: 12.

Sahu, S. K. and Dash, G. C. 1972. Note on relative efficiency of phosphatic fertilizers in high yielding paddy in Sambalpur district. Indian J. Agron., 17(4): 357-358.

Sarkuman, V. Misra, A. K. and Mohapatra, A. R. 1998. Effect of P and S on yield and uptake of P and S by rice. J. Indian Soc. Sci., 46(3): 476-477.

Singh, V. P., Yadav D.S. and Sukla, S. 1997. Effect of irrigation , sources and levels of phosphorus on moisture depletion pattern, consumptive use, water use efficiency and economics of chickpea . Indian Journal of Pulses Research ., 11(2): 49-55.

Singh, S. P., Sreedevi, B. and Pillai, K. V. 1999. Effect of sources and rates of phosphorus on growth and yield of rice – cowpea sequence. Oryza, 36(40): 380-381.

Singh, T., K. N. and Vaid , K. L. 1992. Response of 'Rachna' field pea to notrigen and phosphorus fertilization under rainfed conditions in Kashmir vally . Indian Journal of Agronomy, 37(3): 619-620.

Singh, B.P. (2001). Effects of lac mud, farmyard manure and inorganic fertilizers on growth and yield of rice (*Oryza sativa*). Agril. Sci. Digest, 21 (1): 21-24.

Subbian, P., Raja. S. M. and Palaniappan, S. P. 1989. Effect of levels and sources of phosphorus on yield and nutrient uptake of rice. Oryza., 26 (3): 312-314.

Tandon, H. L. S. 1987. Phosphorus Research and Agricultural Production in India. Fertilizer Development and Consultation Organization, New Delhi. 160.

Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Havlin, J.L. (1999). Soil Fertility and Fertilizers. Prentice Hall of India. 6th edu., 319-346.

Wada, G. 1969. The effects of nitrogenous nutrition on the yield determining process of rice plant. Bull. Natl. Inst. Agric. Sci., 16: 27-167.

Yoshida, S. 1981. Fundamentals of Rice Crop Sciences. Intl. Rice Res. Inst.Manila, Philippines, pp. 1-3, 178.