# PERFORMANCE OF FOUR AMAN RICE VARIETIES UNDER DIFFERENT PHOSPHORUS LEVELS IN THE TIDAL SALINE CONDITION OF SATKHIRA DISTRICT



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**Submitted to**

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**By**

**Sk. Mohibullah**

**Examination Roll No. MS 070805**

**In partial fulfillment of the requirement for the degree of MS in Agronomy**



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**THESIS**

The undersigned certify that they have read, and recommended to the Agrotechnology Discipline for acceptance, a MS in Agronomy Thesis entitled:

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**May, 2012**

# DECLARATION

This thesis is entirely based on the candidate's own investigation except for quotations and citations which have been duly acknowledged and no part of this paper has been accepted nor is it being previously or concurrently submitted for any degree.

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DEDICATED TO

MY

BELOVED PARENTS

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## Abstract

An experiment was conducted during aman season from June to December 2008 in a shrimp farm of the village Chhotokupot in Shyamnagor upazila of Satkhira District to evaluate the response of two high yielding and two local rice varieties to phosphorus. The soil was low in phosphorus, medium in nitrogen and high in organic matter. The experiment was laid out in a factorial Randomized Complete Block Design (Factorial) with three replications. Four aman rice varieties viz, $V_1$= BR 23, $V_2$ =BRRI dhan 41, $V_3$= Kalo dhan and $V_4$= Patnai dhan with four levels of phosphorus viz., $P_1$ = 0 kg $P_2O_5$ $ha^{-1}$, $P_2$ = 30 kg $P_2O_5$ $ha^{-1}$, $P_3$ = 60kg $P_2O_5$ $ha^{-1}$ and $P_4$ = 90 kg $P_2O_5$ $ha^{-1}$ used in the present study. Among the four varieties, BRRI dhan 41 produced highest panicle length (25.10 cm), total grain per panicles (113.50), filled grain per panicles (95.72), highest grain yield (3.59 t $ha^{-1}$) and highest harvest index (45.55 %). The results revealed that the effect of phosphorus was differed significantly. Among the four treatments, application of 90 kg $P_2O_5$ $ha^{-1}$ produced tallest plant (105.98 cm), total tiller per hill (15.65), maximum dry matter (428.93 g / $m^2$), highest effective tiller $hill^{-1}$ (11.66), highest panicle length (24.60 cm), total grain per panicles (105.40), filled grain per panicles (82.95), thousand grain weight (24.21 g), the highest grain yield (3.65 t $ha^{-1}$), straw yield (4.64 t $ha^{-1}$), biological yield (8.29 t $ha^{-1}$) and highest harvest index (44.13 %). The interaction effect of variety and phosphorus was varied significantly for effective tiller $hill^{-1}$, panicle length, total grain per panicles, filled grain per panicles, grain yield. The highest effective tiller $hill^{-1}$ (14.20) was recorded from local patnai dhan and 90 kg $P_2O_5$ $ha^{-1}$ treatment combination. The highest panicle length (25.73 cm) and total grain per panicles (116.40), filled grain per panicles (99.37) and highest grain yield (3.76 t $ha^{-1}$) was recorded from BRRI dhan 41 and 90 kg $P_2O_5$ $ha^{-1}$ treatment combination. The interaction effect of variety and phosphorus was not varied significantly for plant height, total tiller per hill, dry matter $m^{-2}$, 1000 grain weight, straw yield, biological yield and harvest index. The highest plant height (113.40cm) and dry matter (439.98 g $m^{-2}$) were recorded from patnai dhan and 90 kg $P_2O_5$ $ha^{-1}$ treatment combination. The highest total tiller per hill (19.60), straw yield (5.11 t $ha^{-1}$) and biological yield (8.40 t $ha^{-1}$) were recorded from kalo dhan and 60 kg $P_2O_5$ $ha^{-1}$ treatment combination. The highest harvest index (45.88 %) was obtained from BRRI dhan 41 and 90 kg $P_2O_5$ $ha^{-1}$ treatment combination. From the present study it may be concluded that local kalo dhan performed better in case of growth characters and BRRI dhan 41 performed better in case of yield and yield attribute characters. 90 kg $P_2O_5$/ha application performed better in both cases i,e growth and yield and yield attribute characters but economically 60 kg $P_2O_5$/ha

application was better because they were statistically similar to all parameters in both cases. So, BRRI dhan 41 can be selected for cultivation in the tidal saline condition in the shrims farms in the aman season. 60 kg $P_2O_5$/ha was found suitable as optimum dose for economic view point for the cultivation of the selected varieties.

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# Chapter I

## Introduction

Rice (*Oryza sativa* L.) is one of the best cereal crops. It is the most important cereal crop in the world in terms of area under cultivation and the number of people depending on the crop. Considering the total production, rice occupies the second place in the world. It is the most important food grain in the diet of more than half of the world's population in tropical and subtropical Asia, Africa and Latin America (Yoshida, 1981). Rice is the principal food crop of Bangladesh and about 90% or more of the population of Myanmar, Sri Lanka, Vietnam, Cambodia and Bangladesh depend on rice for their major food intake (Anonymous, 1981).

In Bangladesh, rice covers 76% of total cropped area with an average yield of 2.71 t $ha^{-1}$ (BBS, 2010). Total cultivated land of T. aman rice is 51.89 lakh hectares and total production is 116.41 lakh metric tons and yield is 2.5 to 6 ton $ha^{-1}$ (BBS, 2010). The population of Bangladesh is increasing very rapidly where as the total rice area is continuously declining due to urbanization and industrialization. Therefore, it is an urgent need to increase rice production through increasing yield. As per report of IRRI (1999), rice production must be increased by 70% over the next three decades to meet up the demand of the increasing population and to sustain global food security. As per report of FAO (2011), rice production must be increased by 100 % over the next three decades to meet up the demand of the increasing population and to sustain global food security.

The soil and climate of Bangladesh are favorable for rice cultivation throughout the year but the yield per unit area of this crop is much below the potential level. The reasons for low yield of rice are manifold, such as varietal, technological and climatic, etc. The newly developed modern varieties have higher yield potential as compared to exist other

modern varieties. High yield produced by the supply of growth factors such as seed, fertilizers, irrigation, pesticides, etc.

Bangladesh bounded on the south by the Bay of Bengal subjects to continuous tidal saline water inundation that penetrates up to 16 km inside the country affecting 13 districts and about 1 million hectares of cropland. The coastal and off shore lands constitute 30 % of the Net Cultivable Area (NCA) of the country. Out of 3.85 million hectares of the coastal and off shore lands, about 0.833 million hectares is affected by different degrees on salinity (Karim *et al,* 1990). In Khulna region, it was reported that 74% of the farmers grow only Aman rice in a year and 18% of the farmers grow an additional rice crop in Aus. Only 8% of the farmers grow a third crop, Rabi, mostly vegetables. About half of the farmers use lands for shrimp culture. Mass occupation of croplands under shrimp culture increased the soil salinity that adversely affected crop production (Panaullah, 1993).

Rice has been recommended as the crop best suited to saline soils because of the semi aquatic nature of its growth (Bhumbla and Abrol, 1978; Ponnamperuma, 1979). Many researchers reported that the rice plant is particularly susceptible to salinity at the early stage of its growth and it is advised that old seedlings be used in saline fields (Akbar and Ponnamperuma, 1982).

Rice cultivation in saline soils is restricted day by day due to unavailability of suitable salt tolerant varieties and appropriate production technology for year-round rice cultivation in such stress conditions. Judicious application of fertilizers may enhance the salinity tolerance of rice. From different studies, it was found that phosphorus availability is reduced in saline soils (Sharpley *et al.,* 1994). Soil salinity decreases the concentration of phosphorous in plant tissues. Some researches indicate salinity stress may increase the phosphorous requirement of soils (Awad *et al.*, 1990).

Phosphorus has late been found to limit rice production in many soil types. The behavior of phosphorus in water-logged soils growing rice was markedly different from that in upland soils. This behavior is of great practical significance in the application of phosohatic fertilizers in relation to its availability in soil and its uptake by the plants and the yield of the rice crop. Rice showed a marked response to phosphorus application at planting or at tiller initiation, or in two splits at these stages; where as the delaying of the phosphorus application up to the panicle initiation stage could not meet the phosphorus requirement of rice (Bhardwaj *et al.*, 1974). The application of saturate phosphorus fixing capacity is necessary so that the additional applied phosphate lead to a response (Qadar, 1995). Changes in $NaHCO_2$ extractable phosphorus in an alluvial soil and found an increase in the available phosphorus. During the period of crop growth as compared with the fallow period and that the availability is highest at puddling and lowest at flowering (Awad *et al.*, 1990).

Bangladesh has had a large number of rice cultivars and land races. With the introduction of high yielding varieties (HYV), the number of indigenous varieties under cultivation has dwindled drastically; but still the area occupied by those old varieties exceeds 50% of the total land under rice.

Local rice is very much important for its native area. It can survive in adverse ecological conditions like water lodging, salinity, ripe early and grain quality is high. On the other hand, it can protect pest and diseases, withstand adverse environmental condition like lack of water and fertilizer for long time. It is well adapted to its local environment and maintains its genetic heterogeneity. Above all its market value is high (Alam *et al.*, 1999).

Most of the farmers in Bangladesh are poor and not capable to adapt with modern technologies of crop cultivation in stress conditions due to poverty. Salinity stress inhibits

the year-round crop cultivation in coastal saline areas of Bangladesh and intensification of crop cultivation is being hampered here due to increased level of salinity in dry season. Adoption of HYV rice cultivars varied considerably in different salt affected regions. Some HYV coverage during Aman season in highlands of Khulna region is also found.

With the introduction of modern varieties, research efforts have been intensified for raising yield potentials but the traditional varieties somehow escaped, yield potentials of many of the traditional varieties have not been examined (Chowdhury and Bodiuzzaman, 1992). On the other hand in some problem soils of Bangladesh, especially in tidal flooded areas and saline zones, the rice yield remains low and tidal water submerges the fields regularly.



Many research works also have been conducted in the coastal saline areas of Bangladesh to develop salt tolerant high yielding varieties (HYVs) of rice. Soil Salinity is a major and most persistent threat to rice cultivation in coastal region. In Bangladesh, more than 30% of the net cultivable land is in the coastal areas; about 1.0 million ha of arable land are affected by varying degree of soil salinity (Karim *et al.*, 1990). The coastal saline soils of Bangladesh are at present mono cropped with rice. Mostly low yielding local varieties are grown by farmers during the wet season spanning July/August to November/December. About 60-100% of these local rice varieties are grown which yielded about 2-2.5 t/ha (Karim *et al.*, 1990). But a substantial increase in rice area and yields is possible in Aman season with the introduction of high yielding rice varieties, if continuous and responsible research work is conducted. In coastal region there are many big rivers where tidal water flows. Farmers use this river's water to culture shrimps. The shrimp farms remain fallow (without rice cultivation) round the year due to want of suitable rice variety and

cultivation procedure.

Under the above circumstances the present study has been undertaken to fulfill the following objectives.

1. To select and recommend suitable rice variety or varieties for cultivation in the tidal saline condition (Shrimp farms) in the aman season.
2. To determine the optimum dose of phosphorus for those varieties for obtaining maximum yield.

# Chapter II

## Review of literature

Rice has a wide adaptability to different environmental conditions, as it is evident from its world wide distribution. Research on rice has been extensively done throughout the world on various cultural practices. To observe the effect of phosphorus on yield performance of aman rice in a saline soil the experiment was conducted. Numbers of research works have been published relevant with the present study are discussed here.

### 2.1 Effect of variety

Variety may have variable effect on different plant characters of rice. Ahmed *et al,* (1996) conducted an experiment with high yielding rice cv. BR 22, BR 23 and traditional *cv.* Nizersail and reported that the traditional *cv.* Nizersail was the longest and BR 22 was the shortest and the number of panicle per square meter was 243.1, 219.7 and 189.8, respectively for the three varieties.

Anonymous (1996a) showed that the highest number of total tillers per hill was observed in BR 10, followed by BR 11 and the lowest was found in BR 22. For total tillers per hill the variety BR 10 and BR 11 were statistically identical. The variable effect of variety on total tillers per hill was also reported by Hussain *et al.* (1991).

Sawant *et al.* (1986) conducted an experiment with the new rice *cv.* R-73-1-1. R-711 and the traditional *cv.* Ratna and reported that the traditional *cv.* Ratna was the shortest. Anonymous (1991) also reported that plant height differed among the varieties.

The number of effective tillers i.e. number of panicles per hill may also be influenced by the variety. Hossain and Alam (1991) found that the growth characters like total tillers per hill and the number of panicles per hill differed significantly among BR 3, BR 11, Pajam and Jaguli varieties in Boro season.

Anonymous (1996b) showed that the highest number of effective tillers per hill was produced by BR 10 (8.76) followed by BR 23 (8.45) and BR 10 (8.10). The variety BR 22 produced the lowest effective tillers per hill which was statistically identical to that of BR 11 but different from other two varieties.

Babiker (1986) carried out an experiment with rice *cv.* Giza 171 and Giza 180 and observed that total tillers per hill were significantly affected by the cultivars. He also reported that the panicle length differed among the varieties. Kamal *et al.* (1988) carried out an experiment with BR 3, IR 20 and Pajam 2. They found that the number of grains per panicle was 107.6, 123.0 and 170.9 respectively, for the three varieties. Kamal *et al.* (1988) and Samsuddin *et al.* (1988) also observed the variable effects of cultivars on number of panicles per hill.

Idris and Matin (1990) conducted an experiment with six different rice varieties and found that the panicle length differed among the varieties and it was greater in IR 20 than in indigenous high yielding varieties. They also reported that the total number of tillers per hill was identical among the varieties studied.

Different workers studied the effect of variety on panicle length and number of filled grains per panicle. Vergara *et al.* (1974) also reported about the variable effect of variety on the number of grains per panicle. Anonymous (1996) found that the highest number of field grains per hill was 663 produced by BR 22 and lowest number was 578 produced by BR 11.

Weight of 1000 grains may be influenced by the variety. Ahmed *et al.* (1996) reported that 1000-grain weight of three cultivars ranged from 16.55 g to 25.13 g. They observed that 1000-grain weight was the highest in Lalmota. Anonymous (1996) reported that 1000 grain weight of four cultivars ranged from 20.2 1 to 24.83.

Shamsuddin *et al.* (1988) conducted an experiment with nine different rice varieties and observed that plant height differed significantly among the varieties. Chowdhury and Ghosh (1978) carried out a number of field trials with 62 fine and scented rice cultivars and observed that 1000-grain weight was highly variable, ranging from 9.0 to 23.0 g but in some varieties 1000-grain weight was identical i.e. BR 3, BR 8 and IR 8 varieties.
Rafey *et al.* (1989) conducted an experiment with three different rice cultivars and reported that weight of 1000 grains differed among the cultivars studied. Kanungo and Roul (1994) conducted a field trial on rice *cv.* Parijat and Daya and with 3 doses of NPK. They observed that grain yield was highest in *cv.* Daya.

Different workers reported the effect of rice varieties on grain yield. Idris and Matin (1990) reported that the varieties BAU 29, BAU 92, BAU 110, BAU 128, BR 2 and IR 8 gave the different yield value.

Kamal *et al.* (1988) found that among three rice varieties, BR 3 produced the highest yield and Pajam yielded the lowest. Babiker (1986) reported that the grain yield was significantly influenced by rice cultivars. Cho and Han (1985) reported that grain yields of *cv.* IR 7167-33-2-3-3 and RPKN-2 were 6-10 and 5-8 t/ha, respectively.

Anonymous (1978) found that rice *cv.* IR 36 was the highest yielder among the 276 rice cultivars studied. However, another report indicated that *cv.* IR 8, IR 26 and IR 480-5-9, IR 8 gave the highest grain yield.

Miller (1978) found that among the 14 cultivars studied, grain yield ranged from 5.6 t/ha to 7.7 t/ha. He also reported that the grain yield was significantly influenced by rice cultivars. Anonymous (1996) showed that among four varieties BR 23 produced the highest yield (3.37 t/ha) and BR 11 yielded the lowest (2.64 t/ha).

Chowdhury and Bhuiyan (1991) observed that the grain yield was the highest in a promising line BR- 802-118-3-1 followed by BR 14, BR 3 and BR 1. Ahmed *et al.* (1996) found that among three rice varieties BR 23 produced the highest yield (5.08 t/ha) and Nizersail yielded the lowest (3.08 t/ha). They also reported that grain yield was significantly influenced by rice cultivars.

Khan (1991) conducted a green house pot experiment with rice *cv.* BR 6 and CSR4 and reported that yield was higher in *cv.* CSR4 than in BR 6. Yarosh and Lyakhovakin (1977) observed in a pot experiment that average grain yields were 10.4 and 17.5 g/pot for the Italian *cv.* Redi and lokal *cv.* Krasnodarskii 424, respectively.

Nizamuddin *et al.* (1995) conducted a field trial on rice *cv.* Haloi and Lalmota and given three rates of NFS. They observed that grain yield and straw yield were highest in *cv.* Lalmota. The highest straw yield (6.60 t/ha) was found in the variety BR 23 among three rice cultivars (Ahmed *et al.*, 1996). The harvest index is about 0.3 for traditional tall varieties (Yoshida, 1981).

kg N with 60 Kg $P_2O_5$/ha.

Ahmed and Talukder (1987) reported that the straw yield was increased with increasing phosphorus application up to 100 kg/ha.

Roy and Kanwar (1979) found the beneficial effect of phosphate fertilizer on grain yield. Velly (1972) found a great increase in grain yield with the application of 60 and increasing rates of $P_2O_5$ up to 300 Kg ha produced little addition to yield.

Mian and Eaqub (1980) reported that the effect of P application on grain yield was significant but that of N and K interaction was not significant. Raju and Reddy (1993) conducted a field experiment with rice cv. IR 64 and reported that yields increased with increasing N (40, 80 or 120 kg/ha) and P (0, 40 kg $K_2O$ on 80 kg $P_2O_5$) rates but were unaffected by K (0 or 40 kg $K_2O$) application.



**2.3 Effect of phosphorus application on saline soil**

Crop tolerance to salinity is reported to depend upon the availability of nutrients. The literatures reviewed here indicate that application of phosphoric fertilizers has considerable influence on cultivation of rice. In this view, a study was done to find the effect of phosphorus on yield of Boro rice in a saline soil.

Reyes and Ponnamperuma (1983) reported that coastal saline soils in the humid tropics are subject to frequent flooding by the brackish water. Therefore, they are usually well supplied with plant nutrients. Some studies also showed that the coastal saline soils are usually well supplied with N and have adequate supplies of phosphorus and potassium and no significant response to nitrogen fertilizer was found (Anonymous, 1982). On the other hand, Biswas *et al.*,(1982) reported that rice crops grown in saline soils of India generally do not respond to phosphorus and potassium but respond to nitrogen.

From different studies, it was found that phosphate availability is reduced in saline soils (Sharpley *et al.*, 1994). Addition of phosphorus increased crop salt tolerance resulting more production of crops in saline soil (Awad *et al.*, 1990).

Khalil *et al.* (1967) observed that the application of fertilizer nitrogen and phosphorus not counteract the adverse effects of salinity. They also showed that the increasing salinity did

have no influence on phosphorus contents.

Aslam *et al.* (1996) observed that the growth of all rice cultivars he studied was affected at different degrees by external Pi (inorganic phosphorus) in the presence of salt. External P concentration up to 100 um in the presence of NaCl increased all growth parameters (Shoot, root, and tillering capacity), while above this concentration Pi had an inhibitory effect. Salt induced P toxicity was exhibited at a much lower P concentration by the salt sensitive cultivar increasing the supply of phosphorus (from 1 to 100 M P) to the saline medium tended to decrease the concentrations of Na and Cl in all cultivars except IR 1561.

The literatures reviewed here indicate that application of phosphoric fertilizers has considerable influence on cultivation of rice. In this view a study was done to find the effect of phosphorus on yield of aman rice in a saline condition.

# Chapter III
# Materials and methods

This experiment was conducted during Aman season, June to December 2008 in a shrimp farm of the village Chhotokupot in Shyamnagor upazila of Satkhira District to evaluate the response of high yielding and local rice varieties to phosphorus fertilizer. The soil was low in phosphorus, medium in nitrogen and high in organic matter.

## 3.1 Description of the experimental site

The experimental field was typical rice growing medium high land of loamy soil belonging to the soil physiographic unit of Ganges Tidal Flood plain soil tract series. This place is situated in the Agro Ecological Zone (AEZ) 13. The chemical characteristics of the soil of the experimental plot have been presented in Appendix 1. The geographical situation of the experimental station is at latitude of $22^0 18'$ N and longitude of $89^0 06'$ E having subtropical climate. Moderately high temperature and heavy rainfall characterize the experimental site during May to October and scanty rainfall with moderately low temperature during the Rabi season (November to April). The monthly total precipitation, daily average maximum and minimum temperature, humidity and sunshine hours received at the experimental station during the study period have been presented in Appendix I.

## 3.2 Experimental design and treatments

### 3.2.1 Experimental design

The two factor factorial experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The total number of plot was 48 and each plot size was 4.0 m× 3.0 m (12 sq.m). Block to Block distance 1m and plot to plot distance 0.5 m.

### 3.2.2 Experimental treatments

The following two factors were included in the experiment

(a) Factor A: Variety - 4

(i) $V_1$ = BR23

(ii) $V_2$ = BRRI dhan41

(iii) $V_3$ = Kalo dhan

(iv) $V_4$ = Patnai dhan

(b) Factor B: levels of phosphorus

(i) $P_1$ = 0 kg $P_2O_5$/ha (Control)

(ii) $P_2$ = 30 kg $P_2O_5$/ha

(iii) $P_3$ = 60 kg $P_2O_5$/ha

(iv) $P_4$ = 90 kg $P_2O_5$/ha

### 3.2.3 Treatment

Four levels of $P_2O_5$ was used as treatment in the present experiment viz 0, 30, 60, 90 kg $P_2O_5$ $ha^{-1}$ as basal dose.

### 3.2.4 Plant materials

Four varieties were used in the experiment. Among them BR 23 and BRRI dhan41 were high yielding varieties and other varieties were Kalo dhan and Patnai dhan which were widely cultivated in the saline condition and localized in Shyamnagor region. The varieties were collected from same ecological regions of Bangladesh.

### 3.2.5 Fertilizer application

A blanket rate of fertilizers was applied as 60 kg N (131 Kg Urea), 40 kg $K_2O$ (66.67 kg MoP), and 3.5 kg Zn (14 kg $ZnSO_4$) per hectare. One third of urea along with other fertilizers were applied in each plot just before transplanting and mixed thoroughly with the soil. The rest of urea was top dressed in two equal splits.

1st top dressing: 15 Days after transplanting (corresponding to maximum tillering stage) for all varieties. 2nd top dressing: 35 Days after transplanting for all varieties.

### 3.2.6 A short description of the varieties used in the experiment is as follows:

#### 3.2.6.1 BR 23 (Disari)

This variety was released from Bangladesh Rice Research Institute (BRRI) in 1988. Its life cycle is 150 days. It is a high yielding variety. Its grain is fine and elongated, the panicle remains on the upper portion of the leaf at the time of blooming and the color of the flower is white. It is tolerate to water logging condition. Plant height is 120 cm. Average yields 5.5 t $ha^{-1}$.

#### 3.2.6.2 BRRI Dhan 41

This variety was also released from Bangladesh Rice Research Institute (BRRI) in 2003. Its life cycle is 148 days and it is a high yielding variety. The seedlings of 30-35 days can be transplanted for more yields. The height of matured plant is 120 cm. It is a saline resistant variety. The flower is white and the grain is elongated (Anonymous, 1999). Average yields 4.5 t $ha^{-1}$.

#### 3.2.6.3 Kalo Dhan

This is a local variety. It is cultivated in this region extensively for consumption. It grows well in medium low land. Its stem and leaf are dark green. The color of flower and grain is blackish. The grain is coarse and elongated.

#### 3.2.6.4 Patnai Dhan

This is also a local variety cultivated in this region extensively for consumption. It also grows well in medium low land. The stem and leaf are also dark green. The color of flower is white. The grain is fine and brownish.

### 3.3 Management of the crop

The crop in each treatment was raised under same level of management practices except phosphorus. The management practices followed is described below:

#### 3.3.1 Seed sprouting

Before sowing seeds in the nursery bed, they were immersed in water in bucket for 24 hours and then taken out of water and kept in gunny bags for 48 hours for sprouting.

#### 3.3.2 Seed bed preparation

Power tiller and ladder were used to prepare the seedbed. At first, four cross ploughing were

given with power tiller. The seedbed was irrigated. The seeds were sown on 14 July, 2008. The bed was kept wet by irrigation as and when required.

### 3.3.3 Land preparation

A power tiller opened the land of the experimental field 15 days before transplanting. It was then ploughed sufficiently in order to make the soil ready for transplanting. Weeds and stubble were removed and the field was then labeled by laddering. The experimental area was then divided into unit plots that were spaded one day before transplanting for incorporating the basal fertilizers.

### 3.3.4 Uprooting of seedlings

The seedbed was made wet by application of water before uprooting the seedlings. Thirty days old seedlings were uprooted from the wet seedbed without causing any mechanical injury to the roots, bundled with proper care, and distributed in the respective plots for transplanting.

### 3.3.5 Transplanting

Thirty days old seedlings were transplanted on 15 August, 2008 in rows 20 cm apart using 15 cm hill spacing and 3 seedlings per hill.

### 3.3.6 Gap filling

Necessary gap filling was done after 7 days of transplanting with the same aged seedling.

### 3.3.7 Application of fertilizers

Manures were applied as per experimental treatments.

### 3.3.8 Pest management

One-hand wedding was done to check weed infestation at 30 days after transplanting. No plant protection measure was taken, as there was no notable incidence of diseases and insects.

### 3.3.9 Water management

Cultivation was done in aman season, so irrigation was not important. But due to lack of water two times irrigation was used. Water was not applied just after transplanting. The application of water was started when field was dried. Water was applied two times, one was 45 DAT and another was 65 DAT. Canal water was used to irrigation. Salinity level of

different time of canal water has been presented in the appendix II.

### 3.3.10 Harvest and post harvest operations

The experimental crops were harvested plot wise at maturity in November 28, 2008 (Kalo dhan), December 03, 2008 (Patnai dhan), December 07, 2008 (BRRI dhan 41), and December 09, 2008 (BR 23). The harvested crops were threshed and processed, and necessary data were collected on various plant characters.

## 3.4 Sampling and data collection

Data on the following first eight parameters were recorded at harvest and data on the remaining parameters were recorded after drying the grains and straw of the individual plots. The grain and straw yields per plot are expressed on per hectare basis. Ten hills were selected randomly for sampling. After harvesting, the plants were washed thoroughly and at each sampling, the following data of yield components were recorded.

### 3.4.1 Plant height

Plant height was measured from the base of plant up to the tip of the tallest leaf or panicle after anthesis and the means were calculated.

### 3.4.2 Number of tillers

The number of tillers in 10 hills was counted and the means were recorded.

### 3.4.3 Effective tillers per hill

The number of effective tillers in 10 hills was counted and the means were calculated.

### 3.4.4 Panicle length

Panicle length was measured and the means were calculated.

### 3.4.5 Total grains per panicle

Grains of each panicle were counted and the numbers of filled and unfilled grains were separated. The counting of grains was done manually.

### 3.4.6 Filled grains per panicle

The numbers of filled grains per panicle were counted manually.

### 3.4.7 Thousand grain weight

Thousand clean dried grains from the seed stock of each central two square meter plot were counted separately and weighted by an electric balance and adjusted at 14 % moisture content (MC) by using following formula.

$$\text{Thousand grain weight at 14\% MC} = \frac{(100 - SampleMC) \times \text{Thousand grain weight at sample MC}}{(100-14)}$$

### 3.4.8 Grain yield

Grain yield was measured by using a electric balance and converted the yield into 14% moisture by using below mentioned formula and express in t $ha^{-1}$.

$$\text{Yield (at 14\% moisture content)} = \frac{10\,(100 - \text{FMC})}{(100-14)} \times \frac{\text{plot yield (g)}}{\text{plot area } (m^2)}$$

### 3.4.9 Straw yield

Total straw yield of the harvested area of each plot was determined. Sample straw of each plot was dried in an oven at 80 $^0$C for 48 hours and converted the sample into total straw yield and express in t $ha^{-1}$.



### 3.4.10 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.

### 3.4.11 Harvest index (%)

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

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

### 3.5 Data analysis

All the collected data were analyzed following the analysis of Variance (ANOVA) technique and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) using a computer operated program named MSTAT-C.

# Chapter IV

## Results and discussion

The experiment was conducted to compare the yield performance of local and HYV of aman rice varieties with different doses of phosphorus fertilization. In this experiment, the grain yield and the yield contributing characters were considered to evaluate the performance of the varieties. The results obtained from the study are presented and discussed in this chapter.

## 4.1 Plant growth characters

### 4.1.1 Plant height

The effect of variety on plant height differed significantly at 1% level (Appendix IV). The highest plant height (109.33 cm) was found in patnai dhan at harvest (Table 1). The lowest plant height (95.45 cm) was observed in BRRI dhan41 preceded by kalo dhan (100.99 cm) which was statistically similar to BR 23 (102.34 cm) at harvest. Anonymous (1991) also reported that plant height differed among the varieties.

The effect of phosphorus on plant height was statistically significant (Appendix IV). It was observed that the tallest plant (105.98 cm) was found at harvest from application of 90 kg $P_2O_5$ $ha^{-1}$ which was statistically similar to 60 kg $P_2O_5$ $ha^{-1}$ (103.77 cm) and 30 kg $P_2O_5$ $ha^{-1}$ (99.64 cm), the control treatment (0 kg $P_2O_5$ $ha^{-1}$) produced the shortest plant (95.73 cm) at harvest that differed significantly from 90 kg $P_2O_5$ $ha^{-1}$ treatment (Table 2). Abedin *et al,* (1985) conducted a field experiment with cv. Haloi and found that the treatment 60 kg N + 30 kg P + 20 kg S per hectare produced the highest number of tillers per hill and panicle length. The similar results were found in the variety Lalmota. They reported that the plant height increased with increasing rates of phosphorus application. They obtained the highest plant height when 90 kg $P_2O_5$/ha was applied. They observed that phosphorus application along with nitrogen and sulphur increased the plant height.

Interaction effect of variety and phosphorus on plant height did not differ significantly (Appendix IV). However, numerically the tallest plant (113.40 cm) was found at harvest from patnai dhan with 90 kg $P_2O_5$ $ha^{-1}$ treatment combination and BRRI dhan 41 with 0 kg $P_2O_5$ $ha^{-1}$ treatment combination produced the shortest plant (89.50 cm) at harvest (Table 3).

Table 4.1. Effect of varieties on plant height at different days after transplanting (DAT)

| Varieties | Plant height (cm) at | | | | | |
|---|---|---|---|---|---|---|
| | 30 DAT | 45 DAT | 60 DAT | 75 DAT | 90 DAT | Harvest |
| BR 23 | 38.93 d | 61.74 d | 81.35 c | 96.35 c | 96.76 c | 102.34b |
| BRRI dhan 41 | 51.68 c | 69.43 c | 82.87 b | 95.40 c | 95.82 c | 95.45c |
| Kalo dhan | 59.54 a | 85.06 b | 95.98 a | 101.07 b | 102.53 b | 100.99b |
| Patnai dhan | 58.29 b | 85.75 a | 96.34 a | 109.37 a | 109.14 a | 109.33a |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CV (%) | 2.01 | 1.39 | 1.44 | 1.49 | 1.50 | 2.15 |

In a column, figures bearing letter(s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly

CV= Coefficient of variation

Table 4. 2. Effect of phosphorus on plant height at different days after transplanting (DAT)

| $P_2O_5$ (kg/ha) | Plant height (cm) at | | | | | |
|---|---|---|---|---|---|---|
| | 30 DAT | 45 DAT | 60 DAT | 75 DAT | 90 DAT | Harvest |
| 0 | 49.29 c | 71.950 d | 85.38 d | 94.68 c | 95.58 d | 95.73 b |
| 30 | 51.14 b | 74.35 c | 88.52 c | 100.16 b | 99.88 c | 99.64ab |
| 60 | 53.63 a | 77.34 b | 90.78 b | 103.20 a | 103.70 b | 103.77 a |
| 90 | 54.38 a | 78.34 a | 91.88 a | 104.15 a | 105.10 a | 105.98 a |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CV (%) | 2.01 | 1.39 | 1.44 | 1.49 | 1.50 | 2.15 |

In a column, figures bearing letter(s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly

CV= Coefficient of variation

Table 4.3: Combined effect of variety and phosphorus on plant height at different days after transplanting (DAT)

| Treatment combination | Plant height (cm) at | | | | | |
|---|---|---|---|---|---|---|
| | 30 DAT | 45 DAT | 60 DAT | 75 DAT | 90 DAT | Harvest |
| $V_1P_1$ | 36.23 k | 58.47 o | 79.10 l | 89.73 h | 90.80 l | 93.90 |
| $V_1P_2$ | 38.03j | 60.33 n | 80.57 k | 96.73 fg | 96.27 gh | 97.63 |
| $V_1P_3$ | 40.43 i | 63.53 m | 82.17 j | 99.10 e | 98.90 e | 102.37 |
| $V_1P_4$ | 41.03 i | 64.63 l | 83.57 i | 99.83 e | 101.07 d | 103.47 |
| $V_2P_1$ | 48.73 h | 66.47 k | 80.03 k | 88.93 h | 89.30 j | 89.50 |
| $V_2P_2$ | 51.70 g | 69.47 j | 82.57 j | 95.63 g | 95.47 h | 95.23 |
| $V_2P_3$ | 52.87 f | 70.30 I | 83.70 I | 97.67 f | 98.17 ef | 97.83 |
| $V_2P_4$ | 53.43 f | 71.50 h | 85.17 h | 99.37 e | 100.37 d | 99.23 |
| $V_3P_1$ | 56.23 de | 78.37 g | 89.27 g | 96.20 g | 97.10 fg | 96.30 |
| $V_3P_2$ | 57.47 c | 81.93 f | 94.60 e | 100.13 e | 101.10 d | 100.17 |
| $V_3P_3$ | 61.80 a | 89.33 b | 99.77 a | 103.87 d | 105.67 | 103.67 |
| $V_3P_4$ | 62.67 a | 90.60 a | 100.30 a | 104.07 d | 106.27 b | 103.83 |
| $V_4P_1$ | 55.97 e | 84.50 f | 93.10 f | 103.83 d | 105.10 c | 104.20 |
| $V_4P_2$ | 57.37 cd | 85.67 d | 96.33 d | 108.13 c | 106.70 b | 107.53 |
| $V_4P_3$ | 59.43 b | 86.20 cd | 97.47 c | 112.17 b | 112.07 a | 112.20 |
| $V_4P_4$ | 60.40 b | 86.63 c | 98.47 b | 113.33 a | 112.70 a | 113.40 |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | NS |
| CV % | 2.01 | 1.39 | 1.44 | 1.49 | 1.50 | 2.15 |

In a column, figures bearing letter(s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly

Note:$P_1$ = 0 kg $P_2O_5$ $ha^{-1}$(as control), $P_2$ = 30 kg $P_2O_5$ $ha^{-1}$, $P_3$ = 60 kg $P_2O_5$ $ha^{-1}$, $P_4$= 90 kg $P_2O_5$ $ha^{-1}$.

$V_1$ = BR 23, $V_2$ = BRRI dhan 41, $V_3$= Kalo dhan , $V_4$ = Patnai dhan.

CV= Coefficient of variation, NS= Non significance

### 4.1.2 Total tiller

The number of tillers $hill^{-1}$ was significantly influenced by varieties (Appendix IV). The maximum number of tillers $hill^{-1}$ (17.96) was recorded from kalo dhan which was statistically similar to patnai dhan (17.60) and the minimum tillers (11.58) was found in

the variety BR 23 which was statistically similar to BRRI dhan 41 (12.17) (Table 4). Anonymous (1996) showed that the highest number of total tillers per hill was observed in BR 10, followed by BR 11 and the lowest was found in BR 22. For total tillers per hill the variety BR 10 and BR 11 were statistically identical. The variable effect of variety on total tillers per hill was also found by Hussain *et al.* (1991).

The number of tillers hill$^{-1}$ was significantly influenced by phosphorus application (Appendix IV). The highest number of tillers hill$^{-1}$ (15.65) was recorded from the application of 90 kg $P_2O_5$ ha$^{-1}$ which was statistically similar to 60 kg $P_2O_5$ ha$^{-1}$ (15.63) and the minimum tillers hill$^{-1}$ (13.08) was found where phosphorus was not applied (Table 5). The results showed that number of tillers hill$^{-1}$ was increased with increasing rate of phosphorus. Similar result was reported by Mandal *et al.* (1999); they observed that tillering was the greatest with the application of phosphorus fertilizer.



The interaction effect of variety and phosphorus on total tiller was not significant at harvest (Appendix IV). The results showed that total tiller per hill ranged from 10.93 to 19.60 (Table 6). The highest and lowest total tiller per hill at harvest was observed from BR 23 with 0 kg $P_2O_5$ ha$^{-1}$ and kalo dhan 60 kg $P_2O_5$ ha$^{-1}$ treatment combinations, respectively.

Table 4.4. Effect of varieties on total tillers per hill at different days after transplanting (DAT)

| Varieties | Total tillers per hill at | | | | | |
|---|---|---|---|---|---|---|
| | 30 DAT | 45 DAT | 60 DAT | 75 DAT | 90 DAT | Harvest |
| BR 23 | 8.30 c | 9.71 c | 11.39 b | 12.02 c | 11.77 c | 11.58 b |
| BRRI dhan 41 | 9.27 b | 9.81 c | 11.71 b | 12.63 c | 11.92 c | 12.17 b |
| Kalo dhan | 10.85 a | 16.35 a | 18.52 a | 19.01 a | 18.43 a | 17.96 a |
| Patnai dhan | 8.975 b | 15.32 b | 18.23 a | 18.08 b | 17.74 b | 17.60 a |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CV (%) | 3.03 | 1.90 | 1.96 | 2.38 | 1.93 | 3.34 |

In a column, figures bearing letter(s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly

CV= Coefficient of variation

Table 4.5. Effect of phosphorus on total tillers per hill at different days after transplanting (DAT)

| $P_2O_5$ (kg/ha) | Total tillers per hill at | | | | | |
|---|---|---|---|---|---|---|
| | 30 DAT | 45 DAT | 60 DAT | 75 DAT | 90 DAT | Harvest |
| 0 | 8.07 c | 11.15 c | 13.27 d | 14.33 b | 13.60 c | 13.08 b |
| 30 | 9.02 b | 12.04 b | 14.44 c | 14.88 b | 14.43 b | 14.39 a |
| 60 | 9.95 a | 13.87 a | 15.71 b | 15.93 a | 15.67 a | 15.63 a |
| 90 | 10.36 a | 14.13 a | 16.43 a | 16.60 a | 16.15 a | 15.65 a |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CV (%) | 3.03 | 1.90 | 1.96 | 2.38 | 1.93 | 3.34 |

In a column, figures bearing letter(s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly,

CV= Coefficient of variation.

### 4.1.3 Dry matter accumulation

The effect of variety on dry matter at different days after transplanting was found to be statistically significant at 1% level (Appendix IV). The maximum weight of dry matter (427.15 g / $m^2$ ) was found at harvest in kalo dhan which was statistically similar to patnai dhan (426.73) and minimum amount of dry matter was produced by BRRI dhan 41 (402.32) at harvest (Table 7). Similar results were found by Singh and Arya (1992).

The effect of phosphorus on dry matter production at different DAT was found to be statistically significant (Appendix IV). It was observed that dry matter increased progressively in time up to harvest due to application of different levels of phosphorus fertilizer (Table 8). The maximum weight of dry matter (428.93 g/$m^2$) was found at the time of harvest from the application of 90 kg $P_2O_5$ $ha^{-1}$ and control (0 kg $P_2O_5$ $ha^{-1}$ ) treatment produced minimum amount of dry matter (401.97 g/$m^2$).

Table 4.6. Interaction effect of variety and phosphorus on total tiller at different days after transplanting (DAT)

| Treatment combination | Total tiller per hill at | | | | | |
|---|---|---|---|---|---|---|
| | 30 DAT | 45 DAT | 60 DAT | 75 DAT | 90 DAT | Harvest |
| $V_1P_1$ | 7.60 h | 8.70 g | 10.43 I | 11.10 I | 10.67 g | 10.93 |
| $V_1P_2$ | 7.67 gh | 8.97 g | 10.80 hi | 11.63 hi | 11.23 g | 11.37 |
| $V_1P_3$ | 9.07 e | 10.43 f | 11.83 fg | 12.40 gh | 12.37 f | 12.30 |
| $V_1P_4$ | 8.87 ef | 10.73 f | 12.50 ef | 12.93 fg | 12.80 ef | 11.90 |
| $V_2P_1$ | 8.27 fg | 8.63 g | 10.40 I | 11.90 hi | 10.83 g | 11.47 |
| $V_2P_2$ | 9.07 e | 9.13 g | 11.40 gh | 12.10 gh | 11.13 g | 11.23 |
| $V_2P_3$ | 9.43 de | 10.57 f | 12.30 ef | 12.80 g | 12.33 f | 12.83 |
| $V_2P_4$ | 10.30 bc | 10.90 f | 12.73 e | 13.73 f | 13.37 e | 12.63 |
| $V_3P_1$ | 9.43 de | 14.50 d | 16.17 d | 17.63 d | 16.20 d | 16.57 |
| $V_3S_2$ | 10.43 b | 15.27 c | 18.07 c | 18.63 c | 18.00 b | 17.33 |
| $V_3P_3$ | 11.53 a | 17.60 a | 19.63 ab | 19.67 ab | 19.53 a | 19.60 |
| $V_3P_4$ | 12.00 a | 18.03 a | 20.23 a | 20.10 a | 19.97 a | 18.57 |
| $V_4P_1$ | 6.97 I | 12.77 e | 16.10 d | 16.70 e | 16.70 d | 16.17 |
| $V_4P_2$ | 8.90 ef | 14.80 cd | 17.50 c | 17.17 de | 17.37 c | 16.87 |
| $V_4P_3$ | 9.77 cd | 16.87 b | 19.07 b | 18.83 bc | 18.43 b | 18.30 |
| $V_4P_4$ | 10.27 bc | 16.86 b | 20.23 a | 19.63 ab | 18.47 b | 18.03 |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.05 | 0.01 | NS |
| CV % | 3.03 | 1.90 | 1.96 | 2.38 | 1.93 | 3.34 |

In a column, figures bearing letter(s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly

Note: $P_1$ = 0 kg $P_2O_5$ $ha^{-1}$ (as control), $P_2$ = 30 kg $P_2O_5$ $ha^{-1}$, $P_3$ = 60 kg $P_2O_5$ $ha^{-1}$, $P_4$= 90 kg $P_2O_5$ $ha^{-1}$

$V_1$ = BR 23, $V_2$ = BRRI dhan 41, $V_3$ = Kalo dhan , $V_4$ = Patnai dhan

CV=Coefficient of variation,

NS= Non significance

Table 4.7. Effect of varieties on dry matter at different days after transplanting (DAT)

| Varieties | Dry matter ($g/m^2$) at | | | | | |
|---|---|---|---|---|---|---|
| | 30 DAT | 45 DAT | 60 DAT | 75 DAT | 90 DAT | Harvest |
| BR 23 | 93.51 d | 201.32 b | 315.69 b | 373.42 b | 414.71 a | 415.86b |
| BRRI dhan 41 | 98.85 c | 182.03 c | 300.18 c | 361.55 c | 401.80 b | 402.32c |
| Kalo dhan | 114.03 b | 211.60 a | 326.06 a | 383.82 a | 427.23 a | 427.15a |
| Patnai dhan | 123.86 a | 210.44 a | 325.63 a | 384.20 a | 418.53 a | 426.73a |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CV (%) | 1.23 | 1.38 | 1.65 | 1.53 | 3.48 | 3.08 |

In a column, figures bearing letter(s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly

Note: $V_1$ = BR 23, $V_2$ = BRRI dhan 41, $V_3$ = Kalo dhan , $V_4$ = Patnai dhan

CV= Coefficient of variation,

Table 4.8. Effect of phosphorus on dry matter at different days after transplanting (DAT)

| $P_2O_5$ (kg/ha) | Dry matter ($gm^{-2}$) at | | | | | |
|---|---|---|---|---|---|---|
| | 30 DAT | 45 DAT | 60 DAT | 75 DAT | 90 DAT | Harvest |
| 0 | 102.37 c | 195.67 d | 308.51 c | 364.11 c | 401.36 b | 401.97c |
| 30 | 107.00 b | 199.44 c | 313.86 b | 374.78 b | 408.82 a | 417.29b |
| 60 | 109.08 ab | 203.35 b | 320.91 a | 380.29 a | 423.36 a | 423.86ab |
| 90 | 111.80 a | 206.93 a | 324.29 a | 383.81 a | 428.73 a | 428.93a |
| Level of significance | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CV (%) | 1.23 | 1.38 | 1.65 | 1.53 | 3.48 | 3.08 |

In a column, figures bearing letter(s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly

CV=Coefficient of variation,

Table 4.9. Interaction effect of variety and phosphorus interaction on dry matter at different days after transplanting (DAT)

| Treatment combination | Dry matter ($gm^{-2}$) at | | | | | |
|---|---|---|---|---|---|---|
| | 30 DAT | 45 DAT | 60 DAT | 75 DAT | 90 DAT | Harvest |
| $V_1P_1$ | 89.67 l | 196.57 g | 307.600 | 360.00 f | 395.07 | 396.17 |
| $V_1P_2$ | 93.03 k | 199.87 f | 314.200 | 372.90 de | 416.30 | 417.23 |
| $V_1P_3$ | 94.50 jk | 201.03 f | 319.067 | 378.90 bc | 422.07 | 422.70 |
| $V_1P_4$ | 96.83 hij | 207.80 d | 321.900 | 381.87 b | 425.40 | 427.33 |
| $V_2P_1$ | 95.93 ijk | 176.87 j | 291.433 | 348.30 g | 386.70 | 386.73 |
| $V_2P_2$ | 97.90 hi | 181.23 I | 295.567 | 363.33 f | 402.03 | 402.77 |
| $V_2P_3$ | 99.80 gh | 184.23 h | 305.167 | 364.03 f | 406.80 | 407.53 |
| $V_2P_4$ | 101.77 g | 185.80 h | 308.567 | 370.53e | 411.67 | 412.23 |
| $V_3P_1$ | 109.93 f | 205.17 e | 317.433 | 375.60 cd | 413.60 | 414.90 |
| $V_3S_2$ | 113.73 e | 208.67 d | 323.767 | 380.80 b | 423.67 | 423.67 |
| $V_3P_3$ | 115.10 de | 215.10 b | 329.867 | 388.10 a | 432.43 | 432.07 |
| $V_3P_4$ | 117.33 d | 217.47 a | 333.167 | 390.77 a | 439.23 | 439.97 |
| $V_4P_1$ | 113.93 e | 204.07 e | 317.567 | 372.53 de | 410.07 | 411.07 |
| $V_4P_2$ | 123.33 c | 208.00 d | 321.900 | 382.07 b | 393.27 | 412.50 |
| $V_4P_3$ | 126.90 b | 213.03 c | 329.533 | 390.13 a | 432.13 | 433.20 |
| $V_4P_4$ | 131.27 a | 216.67 ab | 333.533 | 392.07 a | 438.63 | 439.98 |
| Level of significance | 0.01 | 0.01 | NS | 0.01 | NS | NS |
| CV % | 1.23 | 1.38 | 1.65 | 1.53 | 3.48 | 3.08 |

In a column, figures bearing letter(s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly,

Note: $P_1$= 0 kg $P_2O_5$ $ha^{-1}$ (as control), $P_2$= 30 kg $P_2O_5$ $ha^{-1}$, $P_3$= 60 kg $P_2O_5$ $ha^{-1}$, $P_4$= 90 kg $P_2O_5$ $ha^{-1}$.;
$V_1$ = BR 23, $V_2$ = BRRI dhan 41, $V_3$ = Kalo dhan , $V_4$ = Patnai dhan.
CV: Coefficient of variation, NS= Non Significant

The interaction effect of variety and phosphorus on dry matter at different days after transplanting was not found to be statistically significant. The maximum weight of dry matter (439.98 g / $m^2$) was found at harvest from the variety patnai dhan with 90 kg $P_2O_5$ $ha^{-1}$ treatment combination (Table 9) and the treatment combination BRRI dhan 41 with 0 kg $P_2O_5$ $ha^{-1}$ produced minimum amount (386.73 g/$m^2$) of dry matter at harvest (Table 9)

## 4.2 Yield and Yield Attributes

### 4.2.1 Effective tillers per hill

The number of effective tillers per hill was significantly influenced by the variety (Appendix V). The number of effective tillers per hill ranged from 9.94 to 13.53 (Table 10). The highest number of effective tillers per hill was observed in patnai dhan (13.53), followed by BRRI dhan 41 (10.79) and the lowest were found in BR 23 (9.94). For total effective tillers per hill the variety Kalo dhan, BR 23 dhan and BRRI Dhan 41 were statistically identical. The variety patnai dhan was different from other threes varieties. Anonymous (1996) also reported the variable effect of variety on total tillers per hill.

The effect of phosphorus on effective tillers per hill was found to be statistically significant (Appendix V). It was observed that the number of effective tillers per hill ranged from 10.40 to 11.66 (Table 11). The highest number of effective tillers per hill was observed in 90 kg $P_2O_5$/ ha (11.66) which was statistically similar to 60 kg $P_2O_5$/ ha (11.57), followed by 30 kg $P_2O_5$/ ha (10.90), and 0 kg $P_2O_5$/ ha (10.40). These results indicated that the application of $P_2O_5$ up to 90 Kg/ha with the recommended doses of inorganic fertilizers increased the effective tillers per hill. Tao and Fan (1986) and Anonymous (1996) reported similar results. They found that total tillers per hill differed significantly among the phosphorus treatments and increasing rate of phosphorus application increased the effective tillers per hill and the lowest rate of phosphorus application decrease the total tillers per hill.

The number of effective tiller per hill was significantly affected by the interaction of the variety and phosphorus (Appendix V). The effective tiller per hill ranged from 9.30 to 14.20 (Table 12). The maximum effective tillers $hill^{-1}$ (14.20) was recorded from patnai dhan with 90 kg $P_2O_5$/ha treatment combination and the minimum effective tillers $hill^{-1}$ (9.30) was recorded from BR 23 with 0 kg $P_2O_5$/ ha treatment combinations.

### 4.2.2 Panicle length

Panicle length was significantly influenced by the variety (Appendix V). The length of panicle ranged from 22.63 cm to 25.10 cm. The highest panicle length was recorded from BRRI dhan 41 (25.10 cm) which was statistically similar to BR 23. The variety Patni dhan produced the lowest panicle length (23.63cm).

Table 4.10. Effect of varieties on yield and yield attribute

| Varieties | Yield and yield attribute | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Effective tiller hill-1 | Panicles length(cm) | Total grain panicles$^{-1}$ | Filled grain penicles$^{-1}$ | 1000 grain weight (g) | Grain Yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) | Biological yield (t ha$^{-1}$) | Harvest index (%) |
| BR 23 | 9.94b | 24.16ab | 107.4b | 89.45a | 22.86b | 3.57a | 4.31b | 7.88a | 45.32a |
| BRRIdhan 41 | 10.79b | 25.10a | 113.5a | 95.72a | 20.89c | 3.59a | 4.28b | 7.86a | 45.55a |
| Kalo dhan | 10.26b | 22.88b | 101.3c | 73.76b | 25.32a | 3.45b | 5.01a | 8.46a | 40.89b |
| Patnai dhan | 13.53a | 22.63b | 83.57d | 56.50c | 25.29a | 3.26b | 4.39b | 7.65b | 42.54a |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CV (%) | 2.71 | 1.87 | 1.18 | 1.69 | 1.49 | 1.32 | 4.69 | 2.65 | 2.66 |

In a column, figures bearing letter(s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly

$V_1$ = BR 23, $V_2$ = BRRI dhan 41, $V_3$ = Kalo dhan , $V_4$ = Patnai dhan

CV= Coefficient of variation

Table 4.11. Effect of phosphorus on yield and yield attributes

| $P_2O_5$ (kg/ha) | Yield and yield attributes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Effective tiller $hill^{-1}$ | Panicles length (cm) | Total grain $panicles^{-1}$ | Fill grain $penicles^{-1}$ | 1000 grain weight (g) | Grain Yield (t $ha^{-1}$) | Straw yield (t $ha^{-1}$) | Biological yield (t $ha^{-1}$) | Harvest index (%) |
| 0 | 10.40b | 22.43b | 97.06c | 73.81b | 22.82b | 3.20c | 4.29b | 7.49b | 42.80b |
| 30 | 10.90b | 23.24ab | 99.43bc | 76.94ab | 23.36b | 3.42b | 4.45b | 7.86a | 43.50ab |
| 60 | 11.57a | 24.48ab | 103.80ab | 81.72a | 23.96a | 3.60ab | 4.61a | 8.21a | 43.89ab |
| 90 | 11.66a | 24.60a | 105.40a | 82.95a | 24.21a | 3.65a | 4.64a | 8.29a | 44.13a |
| Level of significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.05 |
| CV (%) | 2.71 | 1.87 | 1.18 | 1.69 | 1.49 | 1.32 | 4.69 | 2.65 | 2.66 |

In a column, figures bearing letter(s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly

CV= Coefficient of variation

NS= Non significant

Table 4.12. Interaction effect of variety and phosphorus on yield and yield attributes

| Treatment combination | Yield and yield attributes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Effective tiller hill$^{-1}$ | Panicles length (cm) | Total grain panicles$^{-1}$ | Filled grain penicle$^{-1}$ | 1000 grain weight (g) | Grain Yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) | Biological yield (t ha$^{-1}$) | Harvest index (%) |
| $V_1P_1$ | 9.30 j | 22.70 gh | 104.50 f | 84.43 d | 21.93 | 3.39 fgh | 4.05 | 7.44 | 45.56 |
| $V_1P_2$ | 9.77 hij | 23.87 ef | 106.20 ef | 86.07 d | 22.43 | 3.55 cde | 4.25 | 7.80 | 45.46 |
| $V_1P_3$ | 10.27 fgh | 24.93abd | 108.80 de | 93.40 c | 23.44 | 3.64 abc | 4.45 | 8.09 | 44.98 |
| $V_1P_4$ | 10.43 fg | 24.93 abc | 109.90 cd | 93.90 bc | 23.64 | 3.70 ab | 4.47 | 8.17 | 45.28 |
| $V_2P_1$ | 10.40 fg | 24.50 cde | 110.50 cd | 92.13 c | 20.10 | 3.30 h | 4.06 | 7.36 | 44.81 |
| $V_2P_2$ | 10.13 ghi | 24.73bcde | 112.20 bc | 94.03 bc | 20.51 | 3.53 cde | 4.20 | 7.72 | 45.66 |
| $V_2P_3$ | 11.43 d | 25.43 ab | 115.00ab | 97.33 ab | 21.17 | 3.74 a | 4.41 | 8.15 | 45.85 |
| $V_2P_4$ | 11.23 de | 25.73 a | 116.40a | 99.37 a | 21.79 | 3.76 a | 4.44 | 8.20 | 45.88 |
| $V_3P_1$ | 9.57 ij | 21.10 j | 96.83 h | 69.77 f | 24.59 | 3.31 gh | 4.85 | 8.16 | 40.67 |
| $V_3P_2$ | 10.13 ghi | 22.37 h | 100.90 g | 73.60 e | 25.31 | 3.43 efg | 4.97 | 8.40 | 40.90 |
| $V_3P_3$ | 10.57 fg | 24.07 def | 103.40 fg | 75.43 e | 25.62 | 3.52 cde | 5.11 | 8.64 | 40.88 |
| $V_3P_4$ | 10.77 ef | 23.97 ef | 104.10 fg | 76.23 e | 25.77 | 3.55 cde | 5.09 | 8.64 | 41.12 |
| $V_4P_1$ | 12.33 c | 21.43 ij | 76.33 k | 48.90 i | 24.68 | 2.80 j | 4.18 | 6.98 | 40.15 |
| $V_4P_2$ | 13.57 b | 22.00 hi | 78.40 k | 54.07 h | 25.20 | 3.16 i | 4.36 | 7.52 | 41.98 |
| $V_4P_3$ | 14.03 ab | 23.50 fg | 88.13 j | 60.73 g | 25.63 | 3.49 def | 4.47 | 7.96 | 43.82 |
| $V_4P_4$ | 14.20 a | 23.57 f | 91.43 i | 62.30 g | 25.65 | 3.60 bcd | 4.54 | 8.13 | 44.22 |
| Level of significance | 0.05 | 0.05 | 0.01 | 0.01 | NS | 0.01 | NS | NS | NS |
| CV (%) | 2.71 | 1.87 | 1.18 | 1.69 | 1.49 | 1.32 | 4.69 | 2.65 | 2.66 |

In a column, figures bearing letter (s) in common do not differ significantly, whereas figures with dissimilar letter (s) differ significantly

Note: $P_1$ = 0 kg $P_2O_5$ ha$^{-1}$ (as control), $P_2$ = 30 kg $P_2O_5$ ha$^{-1}$, $P_3$ = 60 kg $P_2O_5$ ha$^{-1}$, $P_4$= 90 kg $P_2O_5$ ha$^{-1}$.

$V_1$ = BR 23, $V_2$ = BRRI dhan 41, $V_3$ = Kalo dhan , $V_4$ = Patnai dhan

CV= Coefficient of variation, NS= Non significant

The effect of phosphorus on panicle length was statistically significant (Appendix V). It was observed that panicle length ranged from 22.43 to 24.60 cm due to the effect of phosphorus (Table 11). The highest panicle length was found from the application of 90 Kg $P_2O_5$ $ha^{-1}$ (24.60 cm) which was statistically similar with 60 Kg $P_2O_5$ $ha^{-1}$ and 30 Kg $P_2O_5$ $ha^{-1}$.The lowest panicle length (22.43) was recorded in 0 Kg $P_2O_5$ $ha^{-1}$ (as control). Similar result was found by Talukder (1973).

Length of panicle was significantly influenced by interaction effect of variety and phosphorus (Appendix V). Length of panicle ranged from 21.10 to 25.73 cm (Table 12). The maximum panicle length (25.73) was recorded from BRRI dhan 41 with 90 kg $P_2O_5$/ha treatment combination and the minimum panicle length (21.10) was recorded from kalo dhan with 0 kg $P_2O_5$/ ha treatment combinations.

### 4.2.3 Total grains per panicle

The variation due to variety was significant for total grains per panicle (Appendix V). The number of total grains per panicle ranged from 83.57 to 113.5. The highest number being produced by BRRI dhan 41 (113.5) followed by BR 23 (107.4) and the lowest were found in patni dhan (83.57) (Table 10). Vergara *et al.* (1974) also reported about the variable effect of variety on the number of grains per panicle.

The effect of phosphorus on total grains per panicle was significant. It ranged from 97.06 to 105.40 (Appendix V). The highest number of total grains per hill was observed in 90 kg $P_2O_5$/ha treatment combination (105.40) which was statistically significant to 60 kg $P_2O_5$/ha and the lowest number was found (97.06) in 0 kg $P_2O_5$/ha (as control) (Table 11).

The combined effect of variety and phosphorus on grains per panicle was significant at 1% level (Appendix V). Total grains per panicle ranged from 76.33 to 116.40. The highest grains per panicle (116.40) was recorded from BRRI dhan 41 with 90 kg $P_2O_5$/ha treatment combination which was similar to that of BRRI dhan 41 with 60 kg $P_2O_5$/ha treatment combination and different from the others. The lowest grains per panicle are (76.33) being produced by patnai dhan with 0 kg $P_2O_5$/ha treatment combination (Table12).

### 4.2.4 Filled grains per panicle

The effect of variety on number of filled grains per panicle was significant (Appendix V). The highest number of filled grains per panicle was 95.72 produced by BRRI dhan 41 which was statistically similar with BR 23 (89.45) and the lowest number (56.50) was recorded from patnai dhan (Table 10).

The number of filled grains per panicle was significantly influenced by the different doses of phosphorus (Appendix V). The number of filled grains per panicle ranged from 73.81 to 82.95. The highest number of filled grains per panicle was produced by 90 kg $P_2O_5$/ha treatment combination whish was statistically similar to 60 kg $P_2O_5$/ha (81.72) and 30 kg $P_2O_5$/ha treatment combination (76.94).The lowest number was recorded from 0 kg $P_2O_5$/ha treatment combination (73.81) (Table 11). This result showed that the application of 90 kg/ha $P_2O_5$ increased number of filled grains per panicle and without application of $P_2O_5$, decreased the number filled grains. Mian and Eaqub (1976) and Anonymous (1996) also reported similar result. They found that increasing rate of phosphorus application increased the field grains per panicle and those are differed significantly among phosphorus treatments.

The interaction effect of variety and phosphorus on filled grains per panicle was statistically significant (Appendix V). Filled grains per panicle ranged from 48.90 to 99.37. The highest filled grains per panicle was coming from BRRI dhan 41 with 90 kg $P_2O_5$/ha treatments combination which was statistically similar to BRRI dhan 41 with 60 kg $P_2O_5$/ha treatments combination (115.00). The lowest grains per panicle were (48.90) being produced by patnai dhan with 0 kg $P_2O_5$/ha treatments combination which was statistically similar to patnai dhan with 30 kg $P_2O_5$/ha treatments combination (78.40) (Table 12).

### 4.2.5 Weight of thousand grains

The effect of variety on weight of thousand grains was significant (Appendix V). The highest weight of thousand grains was 25.32 g produced by kalo dhan which was statistically identical to patnai dhan (25.29 g). The lowest weight of thousand grains was 20.89 g found in BR 23 (Table 10). Rafey *et al.* (1989) conducted an experiment with three different rice cultivars and reported that weight of 1000 grains differed among the cultivars studied.

The effect of phosphorus fertilizer on weight of thousand grains was found highly significant which ranged from 22.82 g to 24.21 g (Table11). The highest weight of

thousand grains (24.21 g) came from application of 90 kg/ha $P_2O_5$ ($P_4$) which was statistically similar to 60 kg/ha $P_2O_5$. The lowest thousand grains weight (22.82 g) was found in 0 kg/ha $P_2O_5$ treatment which was statistically similar to 30 kg/ha $P_2O_5$ treatments (23.36 g). This result is supported by Islam *et al.* (1996).

Weight of thousand grains did not vary by the interaction effect of variety and phosphorus fertilizer on which ranged from 20.10 g to 25.77 g (Table12). The highest weight of thousand grains (25.77 g) came from the combination of kalo dhan with 90 kg $P_2O_5$/ha treatments combination and the lowest (19.65 g) was found from BRRI dhan 41 with 0 kg $P_2O_5$/ha treatments combination

### 4.2.6 Grain yield

The effect of variety on grain yield was significant (Appendix V). The highest grain yield was recorded from BRRI dhan 41 (3.59 t/ha) which was statistically identical to BR 23 (3.57 t/ha). The lowest grain yield (3.26 t/ha) was recorded from patnai dhan which was statistically similar to kalo dhan (3.45 t/ha) (Table 10). Ahmed *et al.* (1996) found that among three rice varieties BR 23 produced the highest yield (5.08 t/ha) and Nizersail yielded the lowest (3.08 t/ha). They also reported that grain yield was significantly influenced by rice cultivars.

Grain yield was highly significant due to phosphorus levels. It was observed that grain yield ranged from 3.20 to 3.65 t $ha^{-1}$ (Table 11). The highest grain yield (3.65 t $ha^{-1}$) was obtained from application of 90 kg/ha $P_2O_5$ that is statistically similar to 60 kg/ha $P_2O_5$ (3.60 t $ha^{-1}$).The lowest (3.20 t $ha^{-1}$) was found in 0 kg/ha $P_2O_5$. The highest grain yield was obtained with 60 kg N + 60 kg $P_2O_5$/ha application and the application of phosphorus alone increased the grain yield by 12-17% (Islam and Bhuiyan, 1995).

The interaction effect of variety and phosphorus on grain yield was significant. The grain yield ranged from 2.80 to 3.76 t/ha. The highest grain yield was observed in BRRI dhan 41 with 90 kg $P_2O_5$/ha treatments combination which was statistically identical to BRRI dhan 41 with 60 kg $P_2O_5$/ha, BR 23 with 90 kg $P_2O_5$/ha and BR 23 with 60 kg $P_2O_5$/ha treatments combination. Lowest grain yield was recorded from patnai dhan with 0 kg $P_2O_5$/ha treatments combination (Table 12).

### 4.2.7 Straw yield

The influence of variety on straw yield was highly significant (Appendix V). The highest straw yield was found in kalo dhan (5.01 t/ha) followed by patnai dhan (4.39 t/ha) which was statistically similar to BR 23 (4.31 t/ha) and BRRI dhan 41(4.28 t/ha) (Table 10).

The effect of phosphorus on straw yield was significant (Appendix V). The straw yield ranged from 4.29 t/ha to 4.64 t/ha (Table 11). The highest straw yield was observed in 90 kg $P_2O_5$/ha treatment (4.64 t/ha) which was statistically similar to 60 kg $P_2O_5$/ha (4.61 t/ha) treatment and the lowest was observed in 0 kg $P_2O_5$/ha (4.29 t/ha) which was statistically identical to 30 kg $P_2O_5$/ha (4.45 t/ha) treatment combination. Ahmed and Talukder (1987) reported that the straw yield was increased with increasing phosphorus application up to 100 kg/ha. This result indicated that the straw yield increases with the increases of applied phosphorus

The interaction effect of variety and phosphorus on straw yield was not significant (Appendix V). The range of straw yield was 4.05 to 5.11 t/ha. The highest and lowest straw yield was recorded from kalo dhan with 60 kg $P_2O_5$/ha (5.11 t/ha) and BR 23 with 0 kg $P_2O_5$/ha (4.05 t/ha) treatment combination, respectively (Table 12).

### 4.2.8 Biological yield

The effect of variety on biological yield was significant (Appendix V). The highest biological yield was recorded from kalo dhan (8.46 t/ha) which was statistically identical to BR 23 (7.88 t/ha) and BRRI dhan 41 (7.86 t/ha). The lowest biological yield (7.65 t/ha) was recorded from patnai dhan (Table 10).

There was significant difference in biological yields due to different doses of phosphorus (Appendix V). It was found that the biological yield ranged from 7.49 to 8.29 t/ha (Table 11).The highest biological yield (8.29 t/ha) was observed from 90 kg $P_2O_5$/ha treatment which was statistically identical to 60 kg $P_2O_5$/ha (8.21 t/ha) and 30 kg $P_2O_5$/ha.treatment. The treatment 0 kg/ha $P_2O_5$ produced the lowest biological yield (7.49 t/ha).

The interaction effect of variety and phosphorus on biological yield was not significant (Appendix V). The biological yield ranged from 6.98 to 8.64 t/ha. The highest biological yield (8.64 t/ha) was observed from kalo dhan with 90 kg $P_2O_5$/ha and kalo dhan with 60 kg $P_2O_5$/ha treatment combination. The lowest biological yield (6.98 t/ha) was observed in patnai dhan with 0 kg $P_2O_5$/ha treatment combination (Table 12).

### 4.2.9 Harvest Index

Harvest index differed significantly by varieties at 1% level (Appendix V) and ranged from 40.89 to 45.55 %. The highest harvest index was found in the variety of BRRI dhan 41 (45.55 %) which was statistically identical to BR 23 (45.32 %) and patnai dhan (42.54 %). The lowest harvest index (40.89 %) was found in kalo dhan (Table 10)

The effect of phosphorus fertilization on harvest index was significant (Appendix V). The harvest index from different fertilization ranged from 42.80 to 44.13 %. The highest harvest index was found from 90 kg $P_2O_5$/ha treatment (44.13 %) which was statistically identical to 60 kg $P_2O_5$/ha (43.89 %) and 30 kg $P_2O_5$/ha (43.50 %). The lowest harvest index was found from 0 kg $P_2O_5$/ha (42.80 %) treatment (Table 11).

The interaction effect of variety and phosphorus on harvest index was not significant (Appendix V). The harvest index ranged from 40.15 to 45.88 %. The highest harvest index (45.88 %) was observed from BRRI dhan 41 with 90 kg $P_2O_5$/ha and the lowest harvest index was found (40.15%) from patnai dhan with 0 kg $P_2O_5$/ha treatment combination (Table 12).

## 4.3 Interpretation of results

### 4.3.1 Relationship between effective tiller per hill and grain yield of rice

From the regression analysis it is evident that there was a positive linear relationship between number of effective tillers per hill and grain yield (t/ha).The regression equation is $y = 0.3407x - 0.3252$ ($R^2 = 0.9871$) i. e. for every one unit increase of effective tillers per hill there was a yield increase of 0.3407 t/ha (Fig.1)

### 4.3.2 Relationship between panicles length and grain yield of rice

The panicles length also showed positive linear relationship with grain yield (t/ha). In this case the regression equation is $y = 0.1941x - 1.1291$ ($R^2 = 0.9793$) which indicates that for every centimeter increase of panicles length there was a yield increase of 0. 1941 t/ha (Fig.2)

### 4.3.3 Relationship between filled grain per panicles and grain yield of rice

Grain per panicles showed positive linear relationship with grain yield (t/ha). In this case the regression equation is $y = 0.0475x - 0.275$ ($R^2 = 0.9774$) which indicates that for every increase of grain per panicles there was a yield increase of 0. 0475 t/ha (Fig.3)

### 4.3.4 Relationship between thousand grain weight and grain yield of rice

There was a positive linear relationship between thousand grain weight and grain yield (t/ha).The regression equation is $y = 0.3248x - 4.1939$ ($R^2 = 0.9876$) which indicates that for every gram increase of thousand grain weight there was a yield increase of 0. 3248 t/ha (Fig.4)

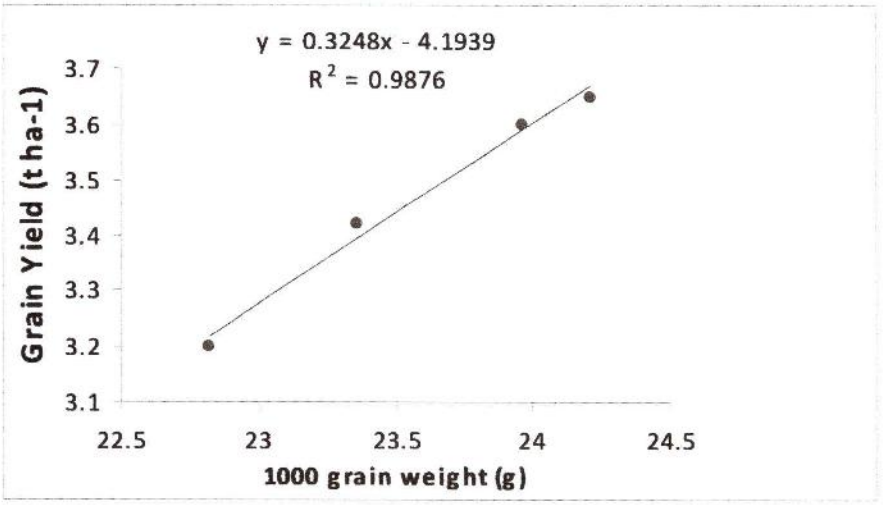


Fig. 4.4. Functional relationship between thousand grain weight and grain yield.

### 4.3.5 Relationship between biological yield and grain yield of rice

There was a positive linear relationship between biological yield and grain yield (t/ha).The regression equation is $y = 0.5564x - 0.9628$ ($R^2 = 0.9989$) which indicates that for every ton increase of biological yield there was a yield increase of 0.5564 t/ha (Fig.5)

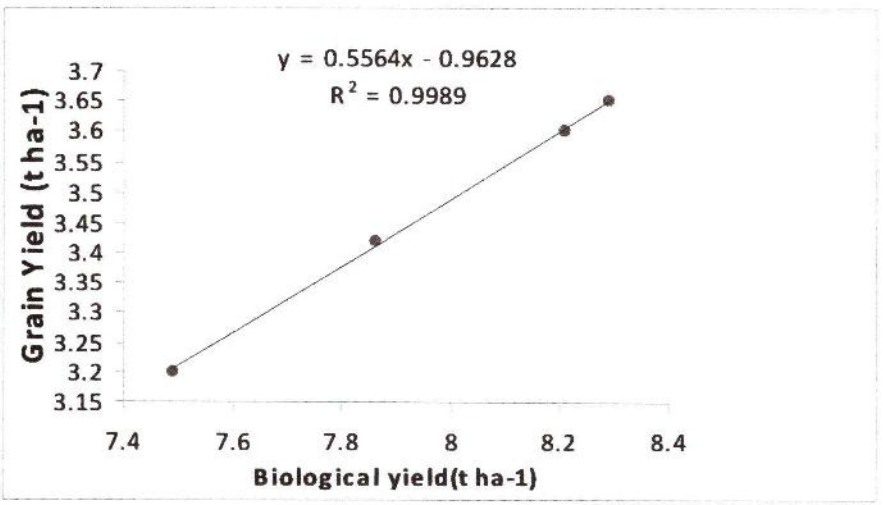


Fig. 4.5. Functional relationship between biological yield and grain yield.

### 4.3.6 Relationship between harvest index and grain yield of rice

Harvest index also showed positive linear relationship with grain yield (t/ha).The regression equation is $y = 0.3492x - 11.752$ ($R^2 = 0.9913$) which indicates that for every increase harvest index there was a yield increase of 0.3492 t/ha (Fig.6)

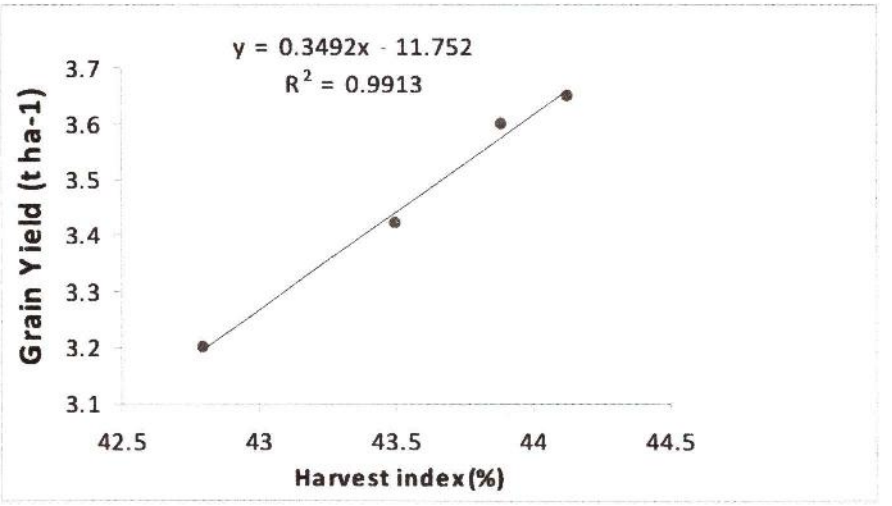


Fig. 4.6. Functional relationship between harvest index and grain yield

### 4.3.7 Relationship between $P_2O_5$ and effective tiller hill $^{-1}$ of rice

$P_2O_5$ also showed positive linear relationship with effective tiller. The regression equation is $y = 0.0148x + 10.465$ ($R^2 = 0.9338$) which indicates that for every unit increase of $P_2O_5$ there was a effective tiller hill$^{-1}$ increase of 0.0148 (Fig.7)

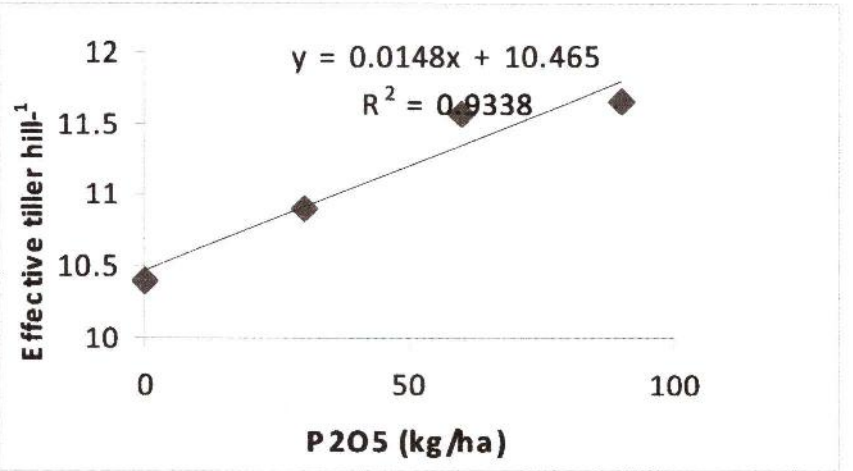


Fig. 4.7. Functional relationship between $P_2O_5$ and effective tiller hill$^{-1}$

### 4.3.8 Relationship between $P_2O_5$ and filled grain per panicle

$P_2O_5$ also showed positive linear relationship with filled grain per panicle. The regression equation is y = 0.1073x + 74.025 ($R^2$ = 0.9583) which indicates that for every unit increase of $P_2O_5$ there was filled grain per panicle increase of 0.1073 (Fig.8)

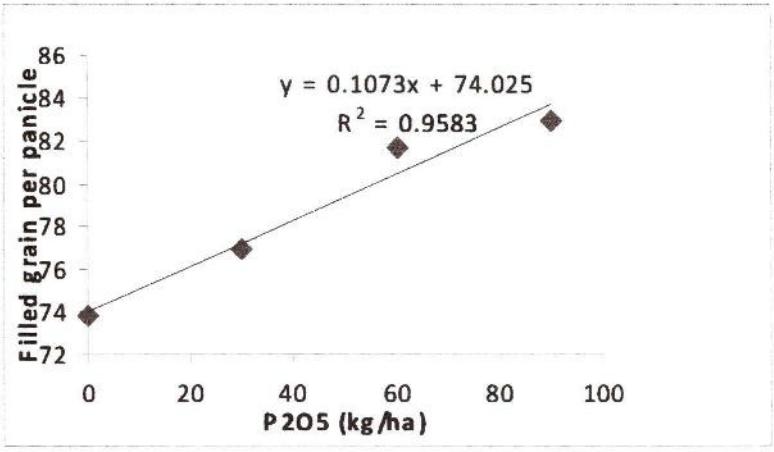


Fig. 4.8. Functional relationship between $P_2O_5$ and filled grain per panicle

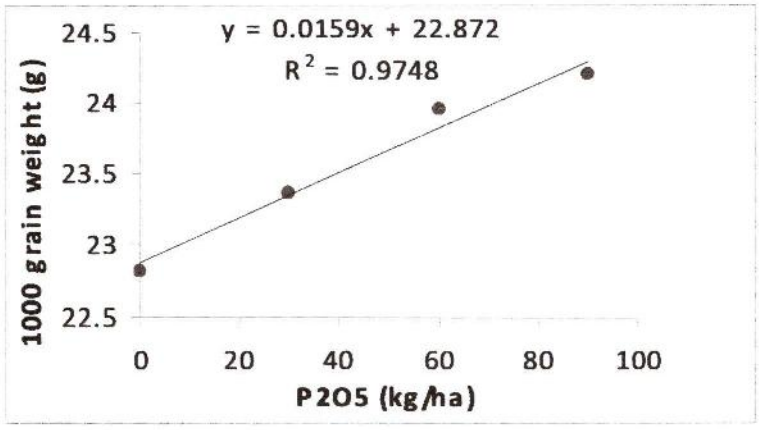




Fig. 4.9. Functional relationship between $P_2O_5$ and 1000 grain weight

### 4.3.9 Relationship between $P_2O_5$ and 1000 grain weight

$P_2O_5$ also showed positive linear relationship with 1000 grain weight (g). The regression equation is y = 0.0159x + 22.872 ($R^2$ = 0.9748) which indicates that for every unit increase of $P_2O_5$ there was 1000 grain weight increase of 0.0159 (g) (Fig.9).

### 4.3.10 Relationship between $P_2O_5$ and grain yield

$P_2O_5$ also showed positive linear relationship with grain yield (t/ha). The regression equation is $y = 0.0051x + 3.238$ ($R^2 = 0.9388$) which indicates that for every unit increase of $P_2O_5$ there was a yield increase of 0.0051 t/ha (Fig.10)

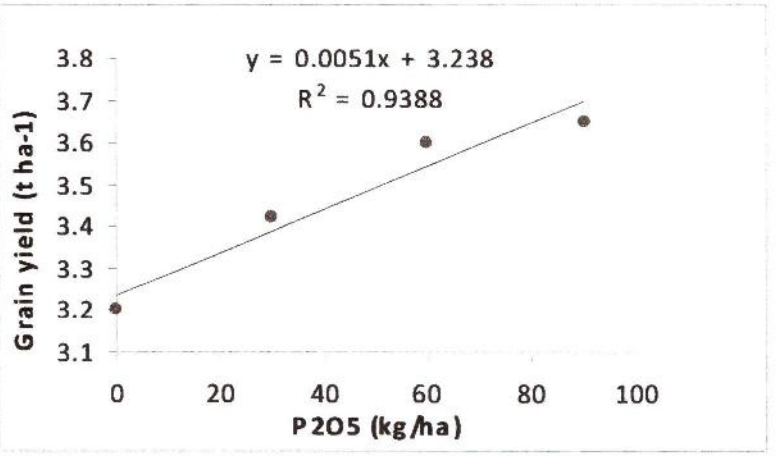


Fig. 4.10. Functional relationship between $P_2O_5$ and grain yield

## CHAPTER V

## SUMMARY

This experiment was conducted during Aman season (June to December 2008) in a shrimp farm at Shyamnagor upazila (Shrimp farm) of Satkhira District to evaluate the response of high yielding and local rice varieties to phosphorus. The soil was low in phosphorus, medium in nitrogen and high in organic matter. The experiment was laid out in a Randomized Complete Block Design (Factorial) with three replications. Four aman rice varieties viz, $V_1$= BR 23, $V_2$=BRRI dhan 41, $V_3$= kalo dhan and $V_4$= patnai dhan and four levels of phosphorus viz., $P_1$ = 0 kg $P_2O_5$ $ha^{-1}$(control), $P_2$ = 30 kg $P_2O_5$ $ha^{-1}$, $P_3$ = 60kg $P_2O_5$ $ha^{-1}$ and $P_4$ = 90 kg $P_2O_5$ $ha^{-1}$. The total number of experimental units was 4 x 4 x 3 = 48. The unit plot size was 4 m x 3 m = $12m^2$. Block to block distance was 1m and plot to plot distance was maintained by 0.5m. The experimental land was fertilized with Urea, Muriate of potash (MoP) and Zinc sulphate as the sources of N, K, and Zn, respectively. Urea, MoP and Zinc sulphate were applied at the rate of 131, 67, and 14 kg $ha^{-1}$, respectively as recommended by BRRI. Phosphorus fertilizer was applied to the plots as per treatment in the form of TSP (21.12 % P). All fertilizers except urea was applied and thoroughly mixed with the soil at the time of final land preparation. Urea as a source of nitrogen (N) was applied in two equal installments, first at tillering stage (15 DAT) and $2^{nd}$ at 35 DAT. The seedlings of rice varieties were transplanted on $15^{th}$ August, 2008 at the age of 31 days, giving three seedlings per hill. Row to row and hill to hill distance were 20 cm and 15 cm, respectively. The rice variety Kalo dhan, BRRI dhan 41, local patnai dhan and BR23 were harvested on $02^{nd}$, $04^{th}$, $08^{th}$ and $10^{th}$ December, 2008, respectively. The following data were recorded during growth such as plant height, tiller number $hill^{-1}$ and dry matter ($gm^{-2}$) and after harvest the data such as,effective tiller $hill^{-1}$, panicle length, number of grain $panicle^{-1}$, thousand grain weight, grain yield, straw yield, biological yield and harvest index was recorded.

The effect of variety was differed significantly at 1% and 5% level. Among the four varieties, BRRI dhan 41 produced the longest panicle (25.10 cm), the highest total grain per panicles (113.5), number of filled grain per panicles (95.72), the highest grain yield (3.59 t $ha^{-1}$) and the highest harvest index (45.55 %). On the other hand, lokal patnai dhan produced the tallest plant (109.33 cm), the highest effective tiller $hill^{-1}$ (13.53) and

lokal kalo dhan produced the maximum total tiller per hill (17.96), maximum dry matter (427.15 g / $m^2$), the highest thousand grain weight (25.32 g), the highest straw yield (5.01 t $ha^{-1}$), the highest biological yield (8.46 t $ha^{-1}$).

The results revealed that the effect of phosphorus was differed significantly at 1% and 5% level. Among the four treatments, application of 90 kg $P_2O_5$ $ha^{-1}$ produced the tallest plant (105.98 cm), total tiller $hill^{-1}$ (15.65), the highest effective tiller $hill^{-1}$ (11.66), total grain $panicles^{-1}$ (105.40), maximum dry matter (428.93 g / $m^2$), thousand grain weight (24.21 g), the highest grain yield (3.65 t $ha^{-1}$), the highest straw yield (4.64 t $ha^{-1}$), the highest biological yield (8.29 t $ha^{-1}$) and the highest harvest index (44.13 %), the highest panicle length (24.60 cm) and filled grain per panicles (82.95).

The interaction effect of variety and phosphorus was varied significantly for all parameters of yield and yield attributes except thousand grain weight, straw yield, biological yield and harvest index. The interaction effect of variety and phosphorus was varied significantly for all characters of different DAT except harvest of growth stage. Maximum effective tiller $hill^{-1}$ was found from patnai dhan with 90 kg $P_2O_5$ $ha^{-1}$ treatment combination. The tallest panicle length, total grain $panicle^{-1}$, filled grain and grain yield were found from BRRI dhan 41 and 90 kg $P_2O_5$ $ha^{-1}$ treatment combination.

## Conclusion and Recommendation

From the findings of the present study it might be concluded that application of phosphorus showed significant difference in case of growth and yield attribute characters. Varietals variation also significance in both cases i,e growth and yield attribute characters.

From the present study it may be concluded with the following heads

- ❑ Local kalo dhan performed better in case of growth characters
- ❑ BRRI dhan41 performed better in case of yield and yield attribute characters.
- ❑ 90 kg $P_2O_5$/ha application performed better in both cases i,e growth and yield and yield attribute characters but economically 60 kg $P_2O_5$/ha application was better because they were statistically similar of all parameters in both cases.
- ❑ So, BRRI dhan 41 can be selected for cultivation in the tidal saline condition in the shrims farms in the aman season.
- ❑ 60 Kg $P_2O_5$/ha was found suitable as optimum dose for economic view point for the cultivation of the selected varieties.
- ❑ Further research is needed regarding other varieties with different level of phosphorus and other fertilizers application in aman season in the shrimp farm of saline condition.

# Chapter VI

## References


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## Appendix III

Appendix 3. Meteorological data during the study period from June to December, 2008

| Month | Temperature ($^0$C) | | Rainfall (cm) | Relative humidity (%) |
|---|---|---|---|---|
| | Maximum | Minimum | | |
| June | 33.5 | 26.9 | 380 | 86.0 |
| July | 32.6 | 26.1 | 540 | 89.2 |
| August | 32.9 | 26.6 | 209 | 87.4 |
| September | 31.7 | 25.8 | 357 | 85.44 |
| October | 31.4 | 24.5 | 157 | 83.32 |
| November | 30.1 | 20.8 | 149 | 80.23 |
| December | 25.3 | 14.7 | 00 | 78.33 |

**Source:** Weather Station, Satkhira.

## Appendix IV

Appendix 4. Analysis of variance for vegetative growth characters of rice varieties

| Source of variation | Degree of freedom (df) | Mean Sum of Square (MSS) | | | |
|---|---|---|---|---|---|
| | | Plant height (cm) | Total tiller hill$^{-1}$ | Number of leaves hill$^{-1}$ | Dry matter (gm$^{-2}$) |
| Replication | 2 | 0.896 | 0.306 | 10.501 | 145.206 |
| Variety (A) | 3 | 391.241** | 133.667** | 620.681** | 1340.483** |
| Phosphorus (B) | 3 | 212.755** | 9.319 ** | 238.181** | 1926.042** |
| A×B | 9 | 2.440 $^{NS}$ | 0.381 $^{NS}$ | 33.101$^{NS}$ | 216.616 $^{NS}$ |
| Error | 30 | 1.377 | 0.247 | 0.487 | 209.703 |
| Total | 47 | | | | |

**: Significance at 1 % level
NS: Non-significanc

## Appendix V

Appendix 5. Analysis of variance for yield and yield contributing characters of rice varieties

| Source of variation | Degree of freedom (df) | Mean Sum of Square (MSS) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective tiller hill-1 | Panicles length(cm) | Total grain panicles$^{-1}$ | Fill grain penicles$^{-1}$ | 1000 grain weight (g) | Grain Yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) | Biological yield (t ha$^{-1}$) | Harvest index (%) |
| Replication | 2 | 0.379 | 0.708 | 15.739 | 38.776 | 0.018 | 0.081 | 0.292 | 0.084 | 22.042 |
| Variety (A) | 3 | 32.250** | 16.024** | 2000.20** | 3689.167** | 54.802** | 0.262** | 1.424 ** | 1.455** | 60.849** |
| Phosphorus (B) | 3 | 4.222** | 12.951** | 179.550** | 216.542** | 4.658 ** | 0.497 ** | 0.320** | 1.615 ** | 4.022 * |
| A×B | 9 | 0.234* | 0.434 * | 17.650** | 9.073** | 0.147 NS | 0.039 ** | 0.004 NS | 0.045 NS | 2.510NS |
| Error | 30 | 0.091 | 0.197 | 1.428 | 1.767 | 0.123 | 0.002 | 0.044 | 0.044 | 1.348 |
| Total | 47 | | | | | | | | | |

**: Significance at 1 % level
*: Significance at 5 % level
NS: Non-significance