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Dry Matter Partitioning in Hybrid and Inbred Rice Varieties under Variable Doses of Phosphorus

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Abstract: The experiment was carried out at the Agronomy Field of the Sher-e-Bangla Agricultural University, Dhaka during the period from December, 2006 to June, 2007 study the relative performance of inbred and hybrid rice varieties at different levels of phosphorus. Three varieties of inbred and hybrid rice (BRRI dhan 29, Aloron and Hira-2) and five levels of phosphorus (0, 24, 48, 72 and 96 Kg P_2O_5 haG^1) were the treatment variables. Dry matter partitioning in different plant parts varied significantly due to the variations of variety. The highest root dry weight was observed from the combination effect of V_3P_3 (2.49 g) which was statistically at par with V_3P_4 (2.42 g), V_1P_3 (2.42 g) and V_1P_4 (2.37 g). The highest dry weight of leaf blade was observed from the combination of V_1P_3 (2.64 g) and the lowest from V_1P_0 (1.68 g). At 50 DAT the lowest dry matter was found by V_1P_0 while V_2P_0 produced the lowest dry matter in leaf sheath at 75 DAT. The rapid increase in stem dry weight was observed at 100 DAT where the maximum dry weight was observed with V_3P_1 while the lowest dry matter was found with the combination of V_3P_0. The treatment combination V_3P_3 produced the highest dry matter in panicle (16.53 g) which was statistically similar with the combination of V_3P_4 (16.48 g). Total dry matter hillG^1 was observed highest with the treatment combination of V_3P_3 which was statistically at par with V_3P_4, V_3P_2, V_2P_3 and V_2P_4. The lowest total dry matter in this stage was observed with V_1P_0.

Key words: Rice % Dry matter % Growth % Leaf weight

INTRODUCTION

There are 111 rice-growing countries in the world that occupies about 146.5 million hectares more than 90% is in Asia [1]. It is the staple food for more than two billion people in Asia and many millions in Africa and Latin America. About 95% of the world rice is consumed in Asia [2]. In Bangladesh, majority of food grains come from rice (*Oryza sativa* L.). About 80% of cropped area of this country is used for rice cultivation, with annual production of 25.18 million tons from 10.29 million ha of land [3]. The average yield of rice in Bangladesh is 2.45 t haG^1 [4]. This average yield is almost less than 50% of the world average rice grain yield.

In 1989, IRRI started super rice breeding programme to give up to 30% more yield (13-15 t haG^1) than the current modern high yielding plant types [5]. Generally the yield of hybrid rice varieties is 10% - 15% more than the improved inbred varieties. It has great potentiality for food security of poor countries where arable land is scarce, populations are expanding and labour is cheap. In our country BRRI has started breeding programme for the development of super high yielding varieties with large panicles and high yield potentialities.

Proper fertilization is an important management practice which can increase the yield of rice. Judicious and proper use of fertilizers can markedly increase the yield and improve the quality of rice [6]. Phosphorus is essential nutrient for plant life. Without adequate supply of phosphorus plants can not reach its maximum yield. Among potential of three primary elements (NPK), phosphorus is relatively absorbed by the plants in smaller amount than the other two, but plays an equally important role. Phosphorus not only enhances the yield of rice but also reduce the spikelet sterility. Phosphorus (P) status in Bangladesh soil is quite low. Application of phosphatic

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fertilizers is essential to obtain higher yield. The chemical phosphatic fertilizers are also in short supply in the country since long. Every years Bangladesh has to import huge amount of triple superphosphate (TSP) or its raw materials to meet up the phosphorus requirement of the crops. But the main problem concerning phosphatic fertilizers is its fixation with soil complex within a very short period of application rendering mare than two-thirds unavailable [7]. So it is necessary to know the optimum dose of phosphorus fertilizer for maximum yield and to reduce spikelet sterility of rice.

In view of these facts, the present experiment was under taken to observe the performance of varieties and different phosphorus levels on the dry matter partitioning in winter rice.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The experimental site was under the Agro-ecological zone of Modhupur Tract-AEZ-28, situated at 23°41/ N latitude and 90°22/ E longitude at with an elevation of 8.6 m from the mean sea level. The experiment was laid out in a split plot design with three replications. Variety was randomly assigned to the main plots and fertilizer doses in the sub-plots. There were 15 treatment combinations. Two sets of treatments included in the experiment are as follows: Main Factor: Varieties {V_1= BRRI dhan29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)} and Sub-Factor: Levels of phosphorus (P_0= Control, P_1= 24 Kg P_2O_5 haG^1, P_2 = 48 Kg P_2O_5 haG^1, P_3 = 72 Kg P_2O_5 haG^1 and P_4 = 96 Kg P_2O_5 haG^1).

Seedlings of 30 days old for BRRI dhan 29 and 25 days old hybrid varieties were uprooted from the nursery beds carefully. Seedlings were transplanted on January 11, 2007 in the well-puddled experimental plots. Spacing's were given 20cm × 15cm for BRRI dhan29 and 20cm × 20cm for hybrid varieties. Soil of the plots was kept moist without allowing standing water at the time of transplanting. Two seedlings for BRRI dhan29 and one seedling for hybrid varieties were transplanted hillG^1. A fertilizer dose of 250-120-70-10 kg N, K, S and Zn haG^1 as urea, muriate of potash, gypsum and zinc sulphate were applied in the field. Phosphorus fertilizer was need as per treatment from triple super phosphate. Full dose of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied as basal dose at the time of final land preparation and incorporated well into the soil. Besides, cowdung at the rate of 10 t haG^1 was applied before final ploughing. Urea was applied in three equal splits at 15, 30 and 55 days after transplanting (DAT) for all varieties. To minimize weed infestation, manual weeding through hand pulling was done three times during entire growing season. The first weeding was done at 15 days after transplanting (DAT) followed by second and third weeding were done at 15 days interval after first and second weeding. Irrigation was done by alternate wetting and drying from transplanting to maximum tillering stage. From panicle initiation (PI) to hard dough stage, a thin layer of water (2-3 cm) was kept on the plots. Water was removed from the plots during ripening stage. Plants were infested with rice stem borer and leaf hopper to some extent which were successfully controlled by applying three times of Diazinon® 60 EC on 15 and 25 March, 2007 and one times of Ripcord on 02 April 2007. Crop was protected from birds during the grain filling period.

Five hills from each plot were uprooted at each time period and oven dried at 85 ± 5°C for 72 hours from which the dry matter weight was recorded at 25 days interval up to 100 days. The sample was partitioned into root, stem, leaf and panicle. After completion of the data collection, efforts have been made to process and tabulated the collected data. The data was analyzed using MSTAT-C [8] programme. The mean differences among the treatments were compared by multiple comparison tests using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Dry Weight of Root: Root dry weight of rice varied significantly across varieties (Table 1). Root weight increased almost linearly with the advancement of plant age in all the varieties. The root dry matter was increased rapidly from 50 to 75 DAT. Significantly the highest dry weight of root was found with the variety BRRI dhan 29 and it was statistically similar with Aloron at 50 and 100 DAT. The variety Hira-2 produced the lowest dry weight of root. However, the maximum dry matter in root at harvest was observed from the variety BRRI dhan 29 (9.00 g) which was at par with Aloron (8.00 g). Hira-2 produced the lowest dry weight in root (7.80 g) at harvest.

Levels of phosphorus fertilizer exerted significant effect on the root dry matter at 25, 50 and 75 DAT (Table 1). No significant difference in root dry weight observed at 100 DAT due to variations of P levels. Root biomass increased progressively over time. The rate of increase, however, varied depending on the stage of growth and P fertilizer application. At 25 DAT the maximum dry weight of root hillG^1 (0.232 g) was observed

Table 1: Effect of variety and phosphorus on dry weight of root at different days after transplantation

	Dry weight of root hill^{-1} (g) at different DAT			
Treatments	25	50	75	100
Variety				
BRRI dhan29	0.247 a	2.23 a	7.20 a	9.00 a
Aloron	0.194 b	1.87 ab	6.98 b	8.00 ab
Hira-2	0.184 b	1.78 b	6.94 b	7.80 b
S0	0.011	0.13	0.03	0.29
CV (%)	6.43	6.43	8.46	3.56
Levels of Phosphorus				
P_0	0.188 b	1.66 d	7.07 b	8.47 a
P_1	0.198 b	1.72 d	7.17 ab	8.40 a
P_2	0.201 b	2.14 c	7.90 a	8.54 a
P_3	0.232 a	2.73 a	8.00 a	9.06 a
P_4	0.227 a	2.63 b	7.96 a	8.59 a
S0	0.006	0.02	0.26	NS
CV (%)	6.23	5.98	9.05	8.32

V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)
P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

Table 2: Effect of variety and phosphorus on dry weight of leaf blade different days after transplantation

	Dry weight of root hill^{-1} (g) at different DAT			
Treatments	25	50	75	100
Variety				
BRRI dhan 29	0.32 a	2.47 a	6.82 b	9.00 b
Aloron	0.28 a	2.33 b	6.92 b	9.12 b
Hira-2	0.30 a	2.34 b	7.69 a	9.78 a
S0	NS	0.025	0.08	0.06
CV (%)	6.46	5.68	5.69	6.36
Levels of Phosphorus				
P_0	0.25 c	2.16 d	6.10 b	7.41 c
P_1	0.30 c	2.19 cd	7.00 ab	8.35 bc
P_2	0.31 c	2.32 bc	7.07 ab	8.53 ab
P_3	0.38 b	2.47 a	7.55 a	9.56 a
P_4	0.89 a	2.41 ab	7.40 a	9.53 a
S0	0.02	0.04	0.33	0.35
CV (%)	6.71	7.35	8.06	7.74

V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)
P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and
P_4 = 96 Kg P_2O_5 ha^{-1}

Table 3: Effect of variety and phosphorus on dry weight of leaf sheath at different days after transplantation

	Dry weight of root hill^{-1} (g) at different DAT			
Treatments	25	50	75	100
Variety				
BRRI dhan29	0.26 a	2.69 b	7.59 b	8.79 b
Aloron	0.28 a	2.92 a	7.89 b	9.79 a
Hira-2	0.29 a	2.90 a	7.91 a	9.81 a
S0	NS	0.04	0.03	0.09
CV (%)	6.46	5.46	6.49	7.36
Levels of Phosphorus				
P_0	0.20 b	2.01 c	8.24 b	9.41 b
P_1	0.30 ab	2.14 bc	8.64 ab	9.34 b
P_2	0.31 ab	2.24 b	9.22 ab	10.18 ab
P_3	0.35 a	2.70 a	9.28 a	10.95 a
P_4	0.34 ab	2.68 a	9.10 ab	10.25 ab
S0	0.04	0.06	0.31	0.40
CV (%)	5.35	9.98	8.87	7.56

V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)
P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and
P_4 = 96 Kg P_2O_5 ha^{-1}

by 72 kg P_2O_5 haG^{1} and was statistically identical with 96 kg P_2O_5 haG^{1} (0.227 g). Generally the highest root dry weight hillG^{1} (2.73 g) was attained by 72 kg P_2O_5 haG^{1} and the lowest in control (Without phosphorus). Further increase in phosphorus fertilizer treated to decrease the root biomass. The root dry weight with 48, 72 and 96 kg P_2O_5 haG^{1} was statistically similar at 75 DAT. Matsuo *et al*. [9] reported that root dry mater is disturbed due to lack of phosphorus.

The interaction effect of variety and phosphorus levels had a significant effect on the root dry weight of plant (Fig. 1). At 25 DAT the highest dry weight was found with V_1P_3 (0.28 g) and the lowest from V_3P_0 (0.17 g). 50 DAT, the variety V_3 (Hira-2) with 72 kg P_2O_5 haG^{1} (V_3P_3) produced the highest root dry weight (2.49 g) which was statistically at with V_3P_4, V_1P_3 and V_1P_4. The lowest dry weight of root hillG^{1} was observed at 50 DAT by V_1P_0. At 75 and 100 DAT the maximum root dry weight of 7.79 g and 10.88 g hillG^{1} respectively was observed from the interaction of V_1P_3 and the lowest from V_3P_0 treatment.

Dry Weight of Leaf Blade HillG^{1}: Leaf blade of rice is important parts which use the light energy for photosynthesis. Dry weight of leaf blade of rice increased progressively over time. However, the pattern of dry matter in leaf blade differed due to different levels of phosphorus. The highest rate dry weight of leaf blade was observed from 25 to 75 DAT. The dry matter of leaf blade was significantly affected by different varieties at all the growth stages except 25 DAT (Table 2). At 50 DAT the maximum dry matter in leaf blade was observed with BRRI dhan 29 while at 75 and 100 DAT Hira-2 had the higher leaf dry weight. These findings are in agreement with Obaidullah [10].

Different phosphorus levels also affected the leaf blade dry matter production (Table 2). Dry weight of leaf blade hillG^{1} increased progressively with the increase of advancement of plant age across the varieties At 50, 75 and 100 DAT the maximum dry weight was observed from 72 kg P_2O_5 haG^{1} which was statistically at par with 96 kg P_2O_5 haG^{1}. At all the growth stages, the lowest dry weight of leaf blade was observed where phosphorus was not applied. Tandon [11] also observed that the plant which uptake more P resulted more dry matter in leaf.

The interaction effect of variety and phosphorus revealed that there was a significant influence on dry weight of leaf blade (Fig. 2). Dry weight of leaf blade of rice increased with the advancement of time. However, initial rate of increase was very low but other 50 DAT there was a general trend of rapid increase of leaf blade weight up to 100 DAT across the varieties and P levels. At 50 DAT the highest dry weight of leaf blade was observed from V_1P_3 (2.64 g) and the lowest dry weight was observed from V_1P_0 (1.68 g). The effect was also very similar in respect of treatment combinations at 75 and 100 DAT. This result is supported by Shah [12] who reported that BRRI dhan 29 had high P use efficiency.

Dry Weight of Leaf Sheath HillG^{1}: Different variety produced variable amount of leaf sheath dry matter at different ages in boro season which ranged between 0.26 and 9.81 g. Dry weight of leaf sheath of rice varieties increased with age reaching a maximum at 100 DAT. The trend was similar in all the varieties (Table 3). Hybrid varieties produced more leaf sheath dry matter at all the growth stages, but at initial stage, the effect was not statistically significant. Two hybrid varieties Aloron and Hira-2 produced statistically similar dry matter in leaf sheath. The maximum dry matter at 100 DAT was 9.81 g with Hira-2 and the lowest was produced by BRRI dhan 29 (8.79 g) trend was reported by Obaidullah [10].

Different levels of phosphorus also significantly affected the dry matter production in leaf sheath (Table 3). Dry weight of leaf sheath increased with the increase in plant age due to P levels. At all the growth stage, the highest dry weight of leaf sheath was found with 72 kg P_2O_5 haG^{1} and it was statistically identically with 24 96 kg P_2O_5 haG^{1}. Plants grown without fertilizer had lowest dry weight of leaf sheath irrespective of growth stages. Addition of P fertilizer beyond 72 kg haG^{1} decreased dry weight of leaf sheath. Similar results of applied phosphate fertilizer to rice were reported by Shah [12].

Interaction of variety and phosphorus levels showed significant influence on the dry matter accumulation in leaf sheath (Fig. 3) at all the growth stage except 25 DAT. The accumulation of dry matter in leaf sheath varied depending on growth stages and levels of P fertilizer in all the three varieties of rice. At 50 and 75 DAT the highest dry weight of leaf sheath was observed by the combined effect of Hira-2 and 72 kg P_2O_5 haG^{1}. At 50 DAT the lowest dry matter was produced by V_1P_0 while V_2P_0 produced the lowest dry matter in leaf sheath at 75 DAT. The treatment combination did not significantly affect the dry accumulation at 100 DAT (Fig. 3).

Dry Weight of Stem HillG^{1}: Among the three sampling dates the effect of variety on the dry matter accumulation in stem was significant only at 75 and 100 DAT (Table 4). At 50 DAT the effect of different variety was statistically identical. Both at 75 and 100 DAT the highest dry matter

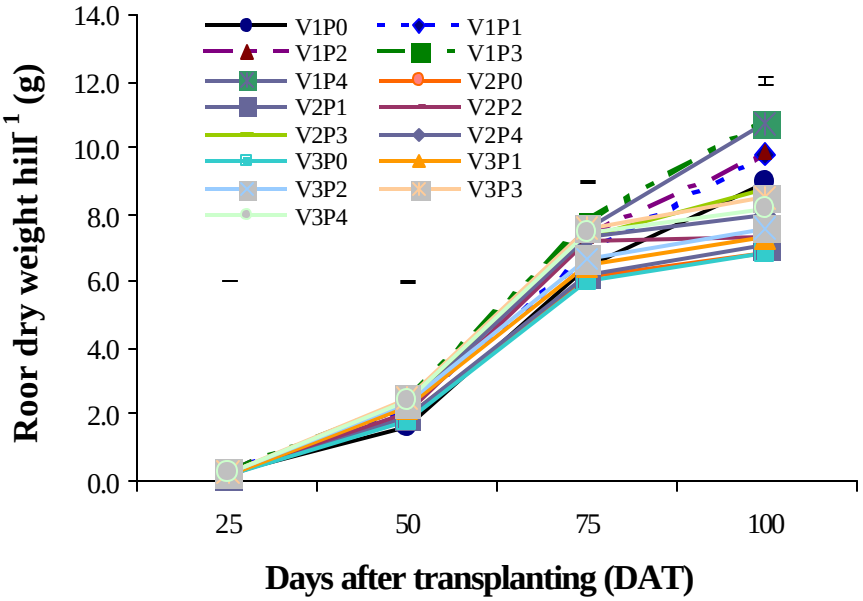

Fig. 1: Interaction effects of variety and phosphorus on root dry weight hill^{-1} different days after transplantation (Vertical bars indicate the standard errors or means at P=0.05)
V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)
P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

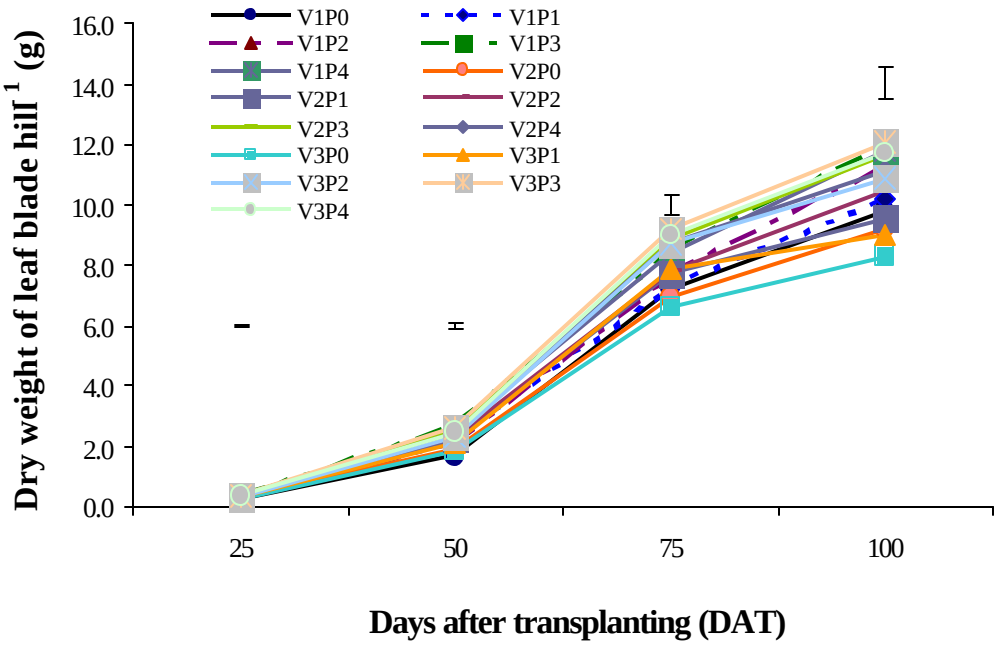

Fig. 2: Interaction effect of variety and phosphorus dose on dry weight of leaf blade at different days after transplantation (Vertical bars indicate the standard errors or means at P=0.05)
V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)
P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

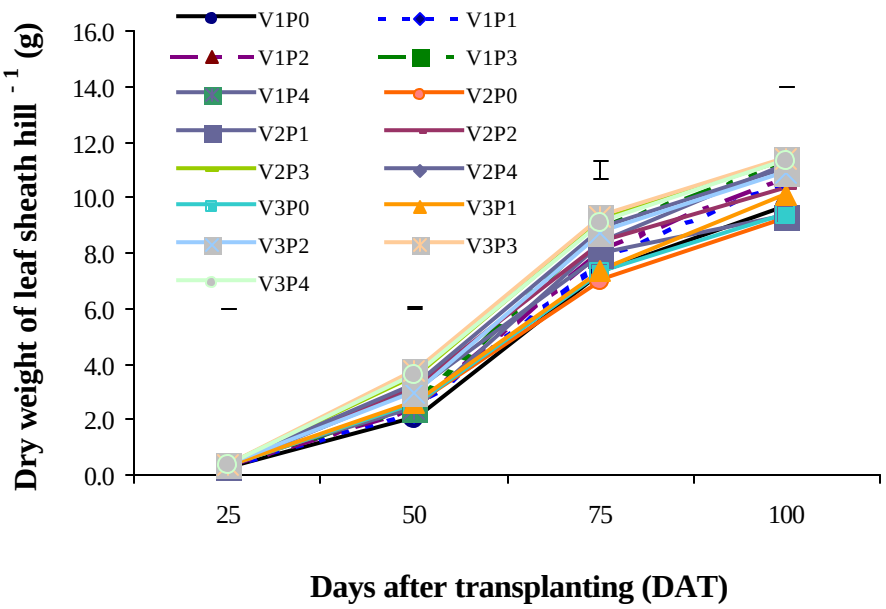

Fig. 3: Interaction effect of variety and phosphorus on dry weight of leaf sheath at different days after transplantation (Vertical bars indicate the standard errors or means at P=0.05)
V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)
P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

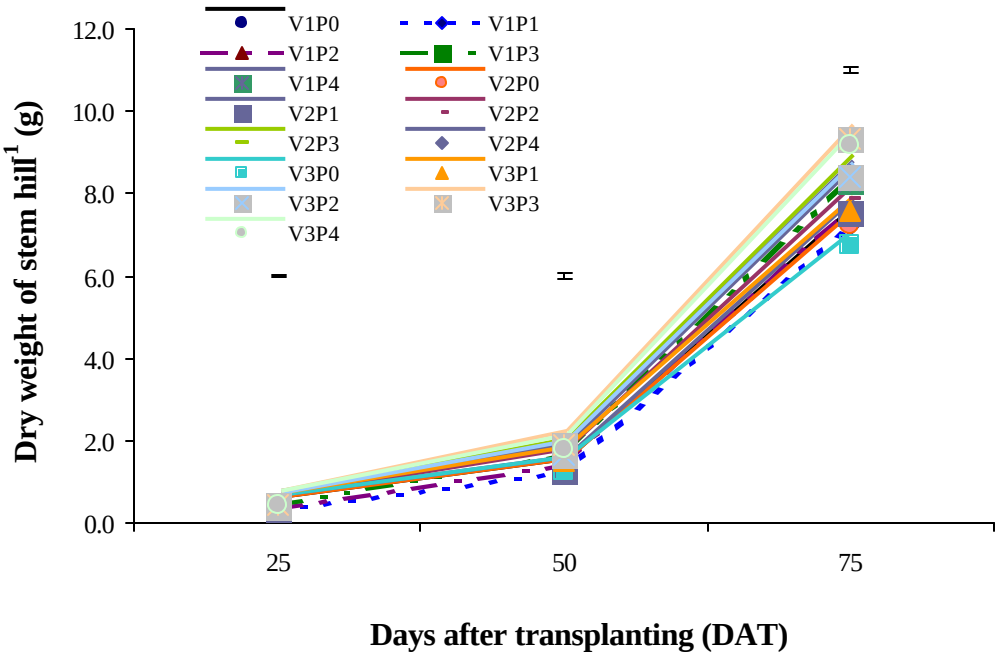

Fig. 4: Interaction effect of variety and phosphorus and on dry weight of stem at different days after transplantation (Vertical bars indicate the standard errors or means at P=0.05)
V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)
P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

Table 4: Effect of variety and phosphorus on dry weight of stem at different days after transplantation

	Dry weight of root hill^{-1} (g) at different DAT		
Treatments	50	75	100
Variety			
BRRI dhan29	0.36	1.48 b	6.38 ab
Aloron	0.39	1.54 b	6.14 b
Hira-2	0.40	1.68 a	7.16 a
S0	NS	0.02	0.98
CV (%)	6.46	9.65	6.35
Levels of Phosphorus			
P_0	0.34	1.49 b	5.44 c
P_1	0.36	1.50 b	5.77 bc
P_2	0.38	1.62 ab	6.15 a-c
P_3	0.39	1.77 a	6.96 a
P_4	0.40	1.68 ab	6.62 ab
S0	NS	0.08	0.33
CV (%)	7.35	6.53	5.79

V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)

P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

Table 5: Effect of variety and phosphorus on dry weight of panicle at 100 days after transplantation

Treatments	Dry weight of panicle hill^{-1} (g)
Variety	
BRRI dhan29	10.52 b
Aloron	14.84 a
Hira-2	15.46 a
S0	0.40
CV (%)	6.43
Levels of Phosphorus	
P_0	12.35 b
P_1	12.73 ab
P_2	13.01 ab
P_3	14.00 a
P_4	13.63 ab
S0	0.47
CV (%)	7.98

V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)

P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

was observed from the variety Hira-2. At 75 DAT BRRI dhan29 produced the lowest dry matter in stem while at 100 DAT it was found the lowest dry matter with the variety Aloron.

Like the variety phosphorus also did not affected the dry matter production in stem at 50 DAT. But significant differences were observed at 75 and 100 DAT (Table 4). At 75 DAT maximum dry matter (1.77 g) was produced by 72 kg P_2O_5 ha^{-1} (P_3) which was statistically similar with P_2 (48 kg P_2O_5 ha^{-1}) and P_4 (96 kg P_2O_5 ha^{-1}). At 100 DAT the maximum dry matter in stem was observed with 72 kg P_2O_5 ha^{-1} (6.96 g) and it was statistically identical with 48 kg P_2O_5 ha^{-1} (6.15 g) and 96 kg P_2O_5 ha^{-1} (6.62 g). This result is in agreement with Fageria and Barabosa-Filho [13].

The interaction effect of variety and phosphorus had the significant effect on the stem dry weight (Fig 4). Stem dry weight increased progressively with time reaching the peak at 75 DAT regardless of treatment. At 50 DAT the highest dry weight of stem was observed from the treatment combination of V_1P_3 (0.44 g). At 75 DAT the highest dry weight was found with V_3P_3 (1.89 g). The rapid increase in stem dry weight was observed at 100 DAT where the maximum dry weight was observed with V_3P_1. The lowest dry matter was found with the combination of V_1P_0 at 50 and 75 DAT while at 100 DAT it was observed with V_3P_0.

Dry Weight of Panicle Hill^{-1}: Hybrid varieties were more response to produce more dry weight in panicle than the inbred variety (Table 5). Maximum dry weight in panicle was observed with Hira-2 (15.46 g) which was statistically at par with Aloron. BRRI dhan 29, however, produced the lowest dry matter in panicle. Obaidullah [10] observed similar result.

Table 6: Effect of variety and phosphorus on total dry weight of plant at different days after transplantation

	Total Dry weight of plant hill^{-1} (g) at different DAT			
Treatments	25	50	75	100
Variety				
BRRI dhan29	0.59	5.53	15.91 b	34.70 b
Aloron	0.56	5.64	16.06 b	39.91 a
Hira-2	0.60	5.64	17.28 a	42.22 a
S0	NS	NS	1.12	2.36
CV (%)	6.30	5.68	9.36	6.44
Levels of Phosphorus				
P_0	0.45 b	4.53 b	15.83 b	34.61 d
P_1	0.60 a	4.71 b	17.15 ab	36.20 cd
P_2	0.62 a	4.94 b	17.92 a	37.87 bc
P_3	0.74 a	5.57 a	18.61 a	41.48 a
P_4	0.74 a	5.51 a	18.19 a	40.03 ab
S0	0.04	0.18	0.62	0.86
CV (%)	6.43	8.36	5.86	6.45

V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)

P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

Dry weight of panicle hill^{-1} also varied significantly due to variation of P fertilizer. Increasing rates of applied phosphorus up to 72 kg P_2O_5 ha^{-1} produced the maximum dry matter in panicle (14.00 g) and it was statistically identical with 24 and 96 kg P_2O_5 ha^{-1}. Addition of phosphorus fertilizer beyond 72 kg P_2O_5 ha^{-1} decreased dry matter in panicle. Plants growth without P fertilizer produced the lowest dry matter. Increase in dry matter of panicle with increased P doses was also reported by Dobermann and Fairhust [14].

The interaction effect of variety and phosphorus had the significant effect on the accumulation of dry matter in panicle (Fig. 5). The treatment combination V_3P_3 produced the highest dry matter in panicle (16.53 g) which was statistically similar with V_3P_4 (16.48 g). The lowest dry matter in panicle was observed with V_1P_0 (6.92 g) in this study.

Total Dry Matter Plant^{-1}: The significant effect of variety on total dry matter production in plant was observed at 75 DAT and 100 DAT (Table 6). At 25 and 50 DAT, dry matter plant^{-1} was influence non-significantly across the varieties. But numerically the highest dry matter of plant was observed with the variety Hira-2 and the lowest from BRRI dhan 29 at all the growth stages except 25 DAT. At 75 DAT the maximum dry weight (17.28 g) was found with Hira-2 variety followed by Aloron (16.06 g). At 100 DAT the highest dry weight was obtained by Hira-2 (42.2 g) which was statistically similar with Aloron (39.91 g). Main [15] also observed that hybrid rice produced more dry matter in plant than inbred varieties.

In case of different phosphorus levels, a significant variation was found in the total dry matter accumulation at different growth stages (Table 6). Accumulation of dry matter increased progressively over time attaining the highest at 100 DAT. The rate of increase, however, varied depending on variety and the stage of growth. At 25 DAT except the control all the levels of P has no significant difference to accumulate the total dry matter in rice plant. At 50 DAT the significantly higher total dry matter was found with 72 (5.57 g) and 96 kg P_2O_5 ha^{-1} (5.51 g). Plants grown without P fertilizer (P_0) produced the lowest dry matter yield which was statistically similar with P_1 and P_2. At 75 DAT, 24 kg to 96 kg P_2O_5 ha^{-1} gave identical results, where the lowest dry matter was observed with control (15.83 g). At 100 DAT, the highest dry matter was observed from P_3 treatment which was at par with P_4. The second highest dry matter was found with 48 kg P_2O_5 ha^{-1}. Generally the control treatment where no phosphorus was applied produced the lowest dry matter. Positive influence of phosphorus on total dry matter in rice was also reported by Gupta and Bhadra [16] and Sarkar and Chowdhury [17].

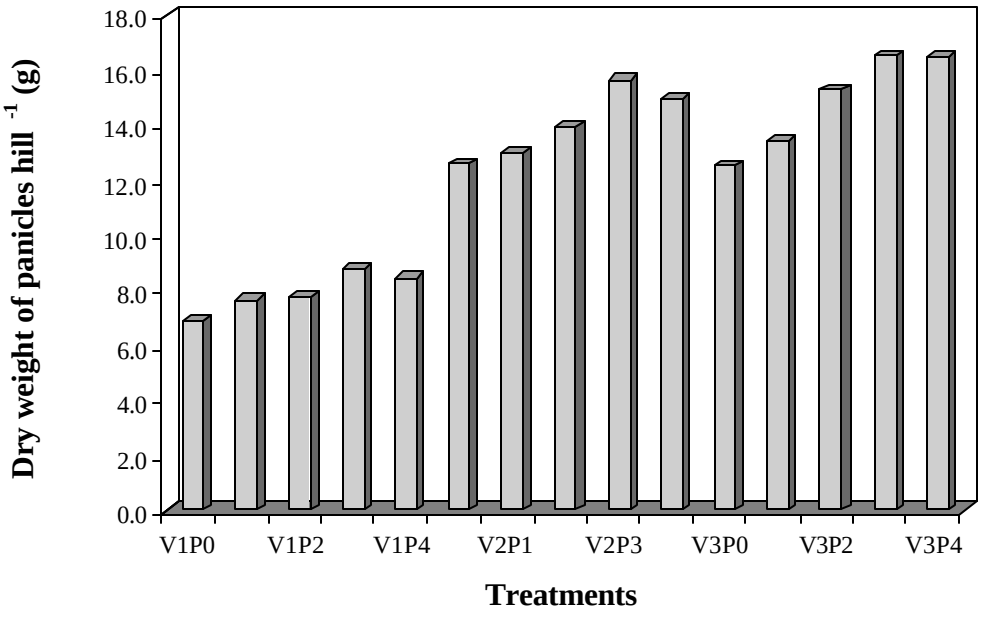

Fig. 5: Interaction effect of variety and phosphorus on dry weight of panicle at 100 days after transplantation ($S_{\bar{x}}$ =0.5859)
V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)
P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

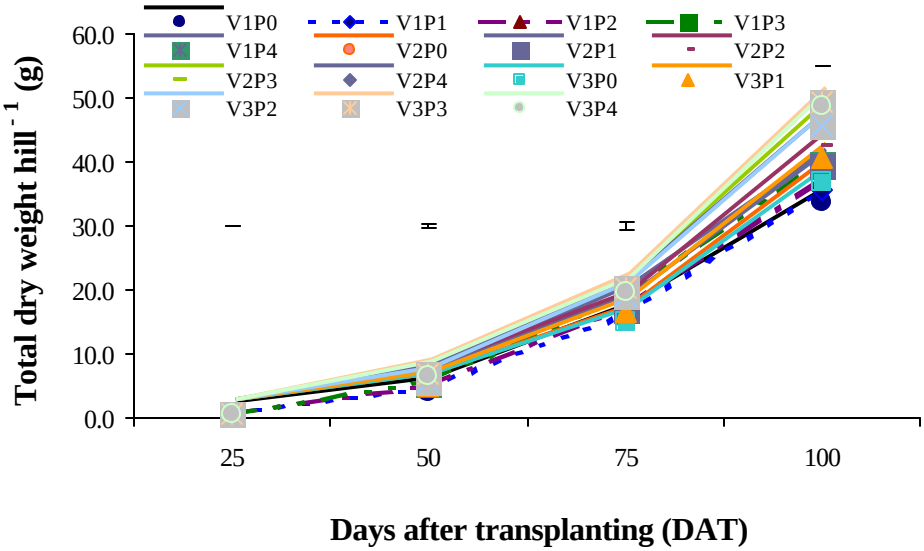

Fig. 6: Interaction effect of variety and phosphorus on total dry weight of plant at different days after transplantation ($S_{\bar{x}}$ = 0.0577, 0.435, 1.072 and 1.692 at 25, 50, 75 and 100 DAT, respectively)
V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)
P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

Significant interaction effect of variety and phosphorus was observed to accumulate dry mater in plant at all the growth stages (Fig. 6). Regardless of the treatment difference, TDM increased progressively over time. In the beginning of the growth cycle, the difference in TDM was not significant due to varieties and P levels. Sharp differences among the varieties in TDM emerged from 50 DAT and it progressively irrespective of P levels. At all the growth stages significantly highest total dry matter was observed with the treatment combination of V_3P_3. At 25 DAT the highest total dry matter was obtained with V_3P_3 (0.72 g) which was statistically similar with all other treatments except V_1P_0 and V_3P_0. At 50 DAT the highest total dry matter (6.74 g) was found with V_3P_3, where the lowest dry matter was found with V_1P_0. Significantly highest dry matter accumulation was also observed at 75 DAT with V_3P_3 (20.36 g) while the lowest dry matter was noticed with V_3P_0. At 100 DAT highest total dry matter was observed with V_3P_3 (49.33 g) which was statistically at par with V_3P_4, V_3P_2, V_2P_3 and V_2P_4. The lowest total dry matter in this stage was observed with the interaction of V_1P_0. Sarkar and Chowdhury [17] observed more dry matter with increased P doses combined with hybrid varieties.

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