

GROWTH AND PRODUCTIVITY OF SHORT DURATION AMAN RICE GENOTYPE

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Abstract

A field experiment was conducted at the research field of Agronomy Department of Bangabandhu Sheikh Mujibur Rahman Agricultural University during Aman season of 2014. Twenty four day old seedlings were transplanted in the main field in a randomized complete block design with three replications. The advanced rice line BU-9958-40-5-1 was compared with BRRI dhan56, BRRI dhan57, Binadhan-7 and BU dhan1. Results showed that rice var. BRRI dhan57 matured earlier [81 days after transplanting (DAT)] while the advanced line took the maximum days (90 DAT) to mature in the field. Although the tallest plant (113.80 cm) was observed in BRRI dhan56 but tiller number (12.22), leaf area index (4.67) and dry matter production (398.69 g m⁻²) were the highest in advanced line BU-9958-40-5-1. The advanced line produced the highest grain yield (5.98 t ha⁻¹) coupled with the highest biological yield (11.55 t ha⁻¹) but failed to show the highest harvest index. Thus it seemed that this line was not much efficient in converting total dry matter into grain which is the ultimate target of crop production. Therefore, this result can help physiologists and breeders to determine physiological and morphological features of the advanced line BU-9958-40-5-1 that contribute the most to increasing dry matter partition into grain.

Introduction

In Bangladesh, rice is main food for about 160 million people where it covers about 80% of total cropped area (BBS, 2013). In aman season, thousands of land races and cultivars are used all over the country. These races are mostly long duration which delay establishment of winter crops and reduce system productivity. Therefore, introduction of short duration aman rice is imperative to crop intensification as well as to enhance system productivity. Further, short duration aman rice can create opportunity to evolve even four crops in sequence in a year (Haque and Rashid, 2016). Besides, crop intensification and system productivity of yield improvement of short duration aman rice cannot be ignored. Yield improvement of aman rice can be done by breeding method with high yielding genotypes and short duration rice characteristics.

Very recently, Department of Genetics and Plant Breeding, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMARU) developed an advanced line (BU-9958-40-5-1) which is short duration, high zinc and iron content, mild aroma and expected to give higher yield than the released short duration varieties. Therefore, this line needs further test to compare yield performance with other released short duration rice varieties growing in aman season. Keeping these views in mind, the present study was aimed to evaluate yield potential of

advanced line (BU-9958-40-5-1) and compare to growth and productivity of different short duration aman rice.

Materials and Methods

The experiment was conducted at the Agronomy research field of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during aman season of 2014. It is located in Madhupur Tract under Agro Ecological Zone- 28 at geographic coordinate 24 05' North latitude and 90 16' East longitude with an elevation of 8.4 m above the mean sea level. The soil of the experimental site is silty clay in surface and silty clay loam in sub-surface region. The site is situated in the sub-tropical region characterized by heavy rainfall during monsoon at the months from May to September and scanty rainfall in the rest of the months of the year. The experimental variables consist of four short duration aman rice varieties viz. BRRI dhan56, BRRI dhan57, Binadhan-7, BUdhan1 and one advanced line BU-9958-40-5-1. The experiment was laid out in randomized complete block design with three replications. The unit plot size was 5 m × 4 m and spacing was 20 cm × 20 cm. Rice seedlings of 24 days old were transplanted on August 17, 2014 with two seedlings per hill on well puddle soil. Gap filling was done within two weeks after transplanting. Except nitrogen, the crop was fertilized with a blanket dose of fertilizers 60-50-40-20-4 @ N-P-K-S-Zn kg ha⁻¹ respectively at the time of final land preparation. Nitrogen was applied in the form of urea in two installments as top dressing. First top dressing was done at 15 days after transplanting (DAT) and second at 30 DAT. Two hand weedings were done at 15 and 30 DAT to prevent weed infestation. Furadan 5 G @ 10 kg ha⁻¹ was applied to control the infestation of stem borer at active filleting stage. After transplanting, sufficient amount of water was maintained in each plot by supplementary irrigation throughout the growing period. Standing water was maintained in the field at 2 to 4 cm until hard dough stage was reached.

Data on different growth parameters, yield components and yield were recorded. Plant samples were collected at 10 days interval starting from 15 DAT till maturity. At each sampling, three hills were uprooted sequentially from a single row. To avoid border effect, plants were sampled from second and third rows at each sampling time. The above ground plant parts were segmented into different components as leaf, stem, leaf sheath and panicle. Leaf areas of sampling were measured by an automatic leaf area meter (AAM-8, Hayashi Dehno, Japan) immediately after sampling. The partitioned plant parts were then dried in an oven at 70°C for 72 hours and weighed. Grains and straw obtained from each unit plot were sun dried and weighed. The grain yield and straw yield was converted to ha⁻¹. Data on different parameters were statistically analyzed using procedure described by Gomez and Gomez (1984) and means were compared using least significant difference by LSD test.

Results and Discussion

Phenological events

Phenological events differed significantly among the aman rice genotypes (Table 1). Days to 50% flowering (45) and days to 100% flowering (49) were the least in BRRI dhan57 and it matured at 81 DAT which was statistically similar with BRRI dhan56. However, days to 50% flowering (57) and days to 100% flowering (61) were the longest in BU-9958-40-5-1 and it matured at 90 DAT. Other genotypes matured within intermediate times. Such variation in phenological events observed among the genotypes might be due to environmental factors as

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well as their genetic make-up. Sometimes, quick vegetative growth of plants resulted in early switch over to reproductive phase (Reddy, 2004). These findings are conformity with findings of Udayakumar (2005).

Soil Plant Analysis Development (SPAD) values

The SPAD measures the content of leaf chlorophyll pigment. The SPAD values differed significantly among the genotypes (Table 1). Numerically, the lowest SPAD value (26.62) was recorded from BRRRI dhan57. On the other hand, the advanced line BU-9958-40-5-1 gave the highest SPAD value (36.74). Higher photosynthesis rate in different variety is supported by leaf chlorophyll content in leaf blades (Miah *et al.*, 1997). In present study, higher SPAD value recorded in the advanced line BU-9958-40-5-1 indicated that this genotype possessed higher photosynthetic capacity and dry matter production than other genotypes.

Table 1. Phenological events and SPAD value of aman rice genotypes

Genotypes	50% flowering (DAT)	100 % flowering (DAT)	Maturity (DAT)	SPAD value
BRRRI dhan56	49	53	82	29.97
BRRRI dhan57	45	49	81	26.62
BINAdhan-7	53	58	85	32.70
BU dhan1	57	61	87	35.50
BU-9958-40-5-1	57	61	90	36.74
CV (%)	1.49	1.48	0.77	5.47
LSD (0.05)	1.46	1.58	1.24	3.33

Plant height

Irrespective of genotypes plant height of Aman rice increased progressively with the increased growth duration from transplanting to maturity (Fig. 1). The plant height also significantly affected among the rice genotypes. Results showed that the genotype BRRRI dhan56 produced the tallest plant at all sampling dates and it was the highest (113.80 cm) at harvest. The rice genotype Binadhan-7 produced the shortest plant (102.56 cm) which was statistically similar (104.45 cm) to BRRRI dhan57. BU-9958-40-5-1 (107.03 cm) and BU dhan1 (105.98 cm) produced the second highest plant height. This variation in plant height was probably due to the genetically make-up of the genotypes. These results were consistent with those of Naha (2007) and Kamal (2006).

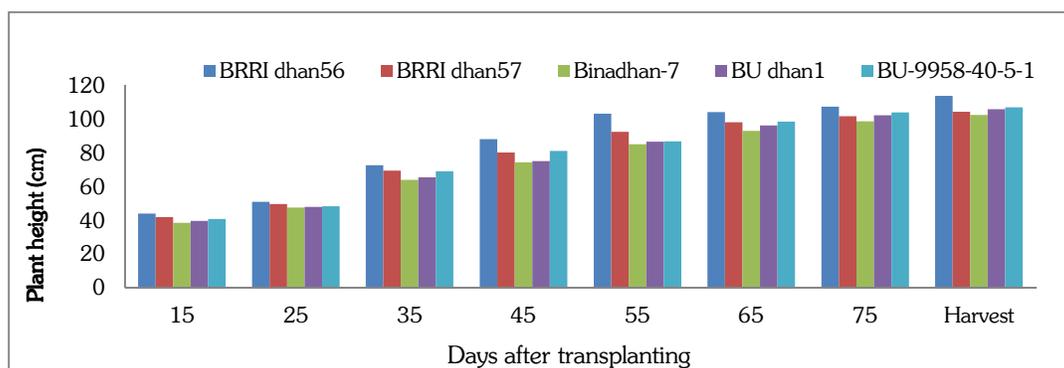


Fig. 1. Plant height of different aman rice genotypes over the growing period

Number of tillers hill⁻¹

Number of tillers hill⁻¹ was significantly influenced by the rice genotypes (Fig. 2). Number of tillers hill⁻¹ of aman rice increased over time. The highest number of tillers hill⁻¹ (12.22) was counted in BU-9958-40-5-1 and the lowest tillers hill⁻¹ (8.33) was observed in BRRRI dhan57 at harvest. BRRRI dhan56 had the second highest number (10.67) of tillers hill⁻¹. Binadhan-7 and BU dhan1 had the third highest number of tillers hill⁻¹ which was 10.44 and 10.44, respectively. Variable effect of variety on number of tillers hill⁻¹ was also reported by Guowei *et al.* (1998) who noticed that total tillers m⁻² differed significantly among the varieties in aman season. The variation in number of tillers hill⁻¹ might be due to varietal attributes and genetical characters.

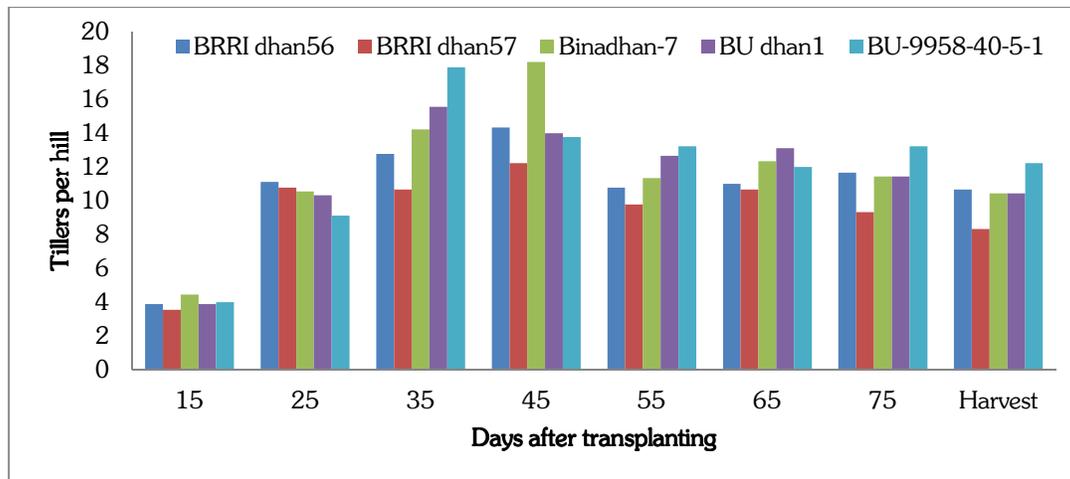


Fig. 2. Number of tillers hill⁻¹ of aman rice genotypes over the growing period

Leaf area index

Leaf area index (LAI) was significantly influenced by different rice genotypes. The LAI increased progressively up to 55 DAT but later the curve leaned downwards (Fig. 3). Such decline in LAI might be due to leaf senescence. The highest leaf area index (5.42) was found at 55 DAT in BU-9958-40-5-1 and it decreased to 4.67 at harvest. The lowest LAI (4.21) was recorded in BRRRI dhan57 which was statistically similar with BRRRI dhan56 at harvesting stage. The second highest LAI (4.57) was obtained in BU dhan1 and then LAI (4.46) of Binadhan-7. This result showed that genotypic variation in LAI was confirmed the finding of Reddy *et al.* (1995) who reported that rice genotypes differed markedly in LAI and net assimilation rate.

Dry matter partitioning

Variation in dry matter production in leaf, leaf sheath, stem and panicle was statistically significant over the rice genotypes (Fig. 3). The highest leaf blade, leaf sheath and stem dry matter was obtained from BU-9958-40-5-1 at all the growth stages. The highest panicle (398.69 g m⁻²) dry weight was also obtained from BU-9958-40-5-1 at all stages. In general, pattern of dry matter partitioning into leaf, stem, leaf sheath and panicle of rice was almost similar across the rice genotypes. Dry matter partitioning into leaf, stem and leaf sheath increased up to 55 days after transplanting while panicle dry weight continued to increase till maturity. Dry matter partitioning into vegetative organs decreased after 55 days after

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transplanting which indicated remobilization of assimilates from vegetative parts towards developing grain. Several authors (Barvestani and Pirdashti 2001; Ntanos and Koutroubus, 2002) showed that two physiological processes are involved in grain growth; utilization of photosynthates through current photosynthesis and remobilization and translocation of assimilates accumulated before anthesis. In present study, it seemed that stem had higher amount of dry matter remobilization than other vegetative organs of rice as reduction of stem reserve was more pronounced. This result was in consistent with the findings of Yang *et al.* (2003) and Kumar *et al.* (2006) and they reported that different rate of remobilization among the rice genotypes were reported to their agronomic and physiological characteristics.

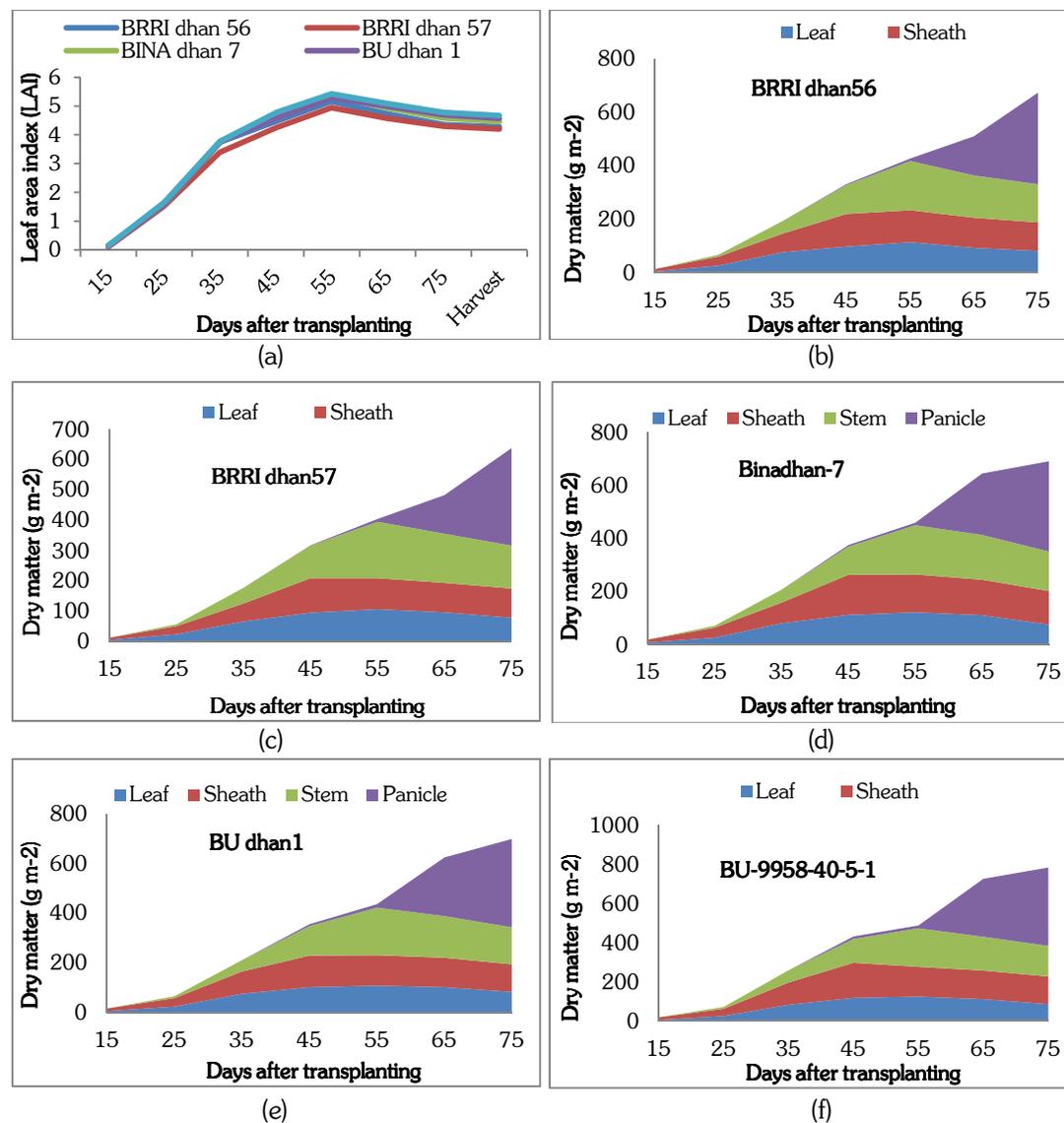


Fig. 3. Pattern of leaf area index (a) and dry matter partitioning to different parts of rice genotypes (b, c, d, e, and f) over the growing period.

Number of panicles m⁻²

Number of panicles m⁻² varied significantly among the rice genotypes. Results showed that the maximum panicles m⁻² (310.00) was produced by BU-9958-40-5-1 which was statistically similar with Binadhan-7 (273.25), BU dhan1 (268.25), and BRRI dhan56 (265.00). The rice genotype BRRI dhan57 produced the lowest number of panicles m⁻² (215.00) and it was statistically similar with BRRI dhan56, Binadhan-7 and BU dhan1 (Table 3). The variation in number of panicles m⁻² might be due to genetical characteristics of rice genotypes. Miller *et al.* (1991) observed that panicles m⁻² were the most important component of yield and accounted for 89% of the varieties in yield. The genotypic variation in panicles m⁻² was also similar to that which noted by Shamsuddin *et al.* (1988) under rainfed condition in aman season.

Panicle length

There was significant variation in panicle length of rice genotypes. The longest (28.40 cm) panicle was obtained from BU-9958-40-5-1 and the lowest (22.94 cm) in BRRI dhan57 (Table 2). Alam *et al.* (2002) also found varietal differences in panicle length of rice where the variety with the longest panicle contributed more spikelets per panicle. Thus, like other yield components, panicle length is also considered as important parameter of yield enhancement of rice.

Table 2. Grain yield and yield components of aman rice genotypes

Genotypes	Number of Panicles m ⁻²	Panicle length (cm)	Grains panicle ⁻¹	1000-grain weight (g)	Grain yield (t ha ⁻¹)
BRRI dhan56	265.00	26.36	155.68	22.56	4.12
BRRI dhan57	215.00	22.94	149.86	16.63	3.43
Binadhan-7	273.25	23.74	134.70	22.95	4.60
BU dhan1	268.25	24.53	116.58	26.60	5.14
BU-9958-40-5-1	310.00	28.40	127.17	24.14	5.98
CV (%)	15.48	1.50	9.16	2.19	6.91
LSD (0.05)	3.10	0.71	17.86	0.93	0.61

Number of grains panicle⁻¹

Aman rice genotypes differed significantly in respect of number of spikelets panicle⁻¹. Table 2 showed that BRRI dhan56 produced the maximum number of grains panicle⁻¹ (164.83) which was statistically similar with BRRI dhan57 and BU-9958-40-5-1. The lowest number of grains panicle⁻¹ (117.90) was observed with BU dhan1 which was statistically similar (127.50) to Binadhan-7. Singh and Gangwar (1989) also reported variable number of grains panicle⁻¹ among different rice genotypes. Shortage of assimilates may occur either due to limitation of source or deficiencies of any nutrient. Varietal differences regarding the number of grains panicle⁻¹ might be due to their genetic constitution that differentiated in photosynthetic assimilate accumulation especially after heading. Therefore, there is possibility to increase number of grains panicle⁻¹ by adopting proper agronomic manipulation.

1000-grain weight or test weight

Genotypes showed significant variation in 1000- grain weight. The highest test weight (26.60 g) was obtained from BU dhan1 and the lowest one (16.63 g) from BRRI dhan57 (Table 2). Rice genotype BU-9958-40-5-1 produced the second highest (24.14 g) test weight. Although

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1000-grain weight is genetically controlled but it might be changed to some extent due to changes in environmental condition. In the present study, variation in test weight was observed although non-significant variation in test weight of different modern rice varieties was observed by Islam *et al.* (1999).

Grain yield

Grain yield varied significantly among the rice genotypes which ranged from 3.43 to 5.98 t ha⁻¹ (Table 2). Among the genotypes, BU-9958-40-5-1 produced the highest grain yield, which was associated with its better yield components especially number of panicles hill⁻¹. Maximum contribution of number of panicles in improving grain yield was also confirmed by having strong correlation of this component with grain yield (Fig. 4). On the other hand, BRRI dhan57 produced the lowest grain yield. Such differences in production potential of rice were recorded by Naha (2007), Mumin (2002) and Biswas *et al.* (1998) who observed variable grain yield among rice varieties.

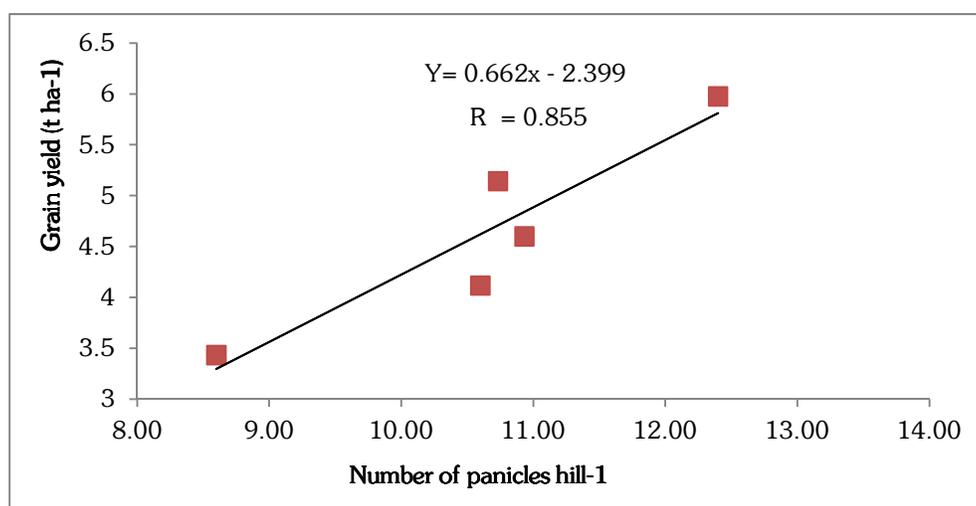


Fig. 4. Relationship between number of panicles hill⁻¹ and grain yield of aman rice genotypes

Straw yield

Data regarding straw yield showed significant variation among the rice genotypes (Table 3). It was evident that the maximum straw yield (5.79 t ha⁻¹) was produced by BU dhan1 which was statistically similar to BU-9958-40-5-1 and Binadhan-7. BRRI dhan57 had given the second highest straw yield (4.17 t ha⁻¹) which was statistically identical (3.81) to BRRI dhan56. These results were consistent with those of Khisha (2002) and Chowdhury *et al.*, 1995 who also observed significant variation in straw yield among the varieties.

Biological yield

The highest biological yield (11.55 t ha⁻¹) was obtained from BU-9958-40-5-1 which was statistically similar (10.74 t ha⁻¹) with BU dhan1 and Binadhan-7. The genotypes which had higher straw and grain yield that in turn increased the biological yield Islam *et al.*, 2014. The lowest biological yield (7.61 t ha⁻¹) was obtained from BRRI dhan57 which was statistically similar (7.93 t ha⁻¹) with BRRI dhan56. Lamberts *et al.* (2007) also observed similar result and concluded that different varieties of transplant Aman rice show variation in biological yield.

Harvest index

Rice genotypes exerted significant effect on harvest index (Table 3). The maximum harvest index (52.31%) was observed in BRRI dhan56 which was statistically similar with Binadhan-7, BU dhan1 and BU-9958-40-5-1. The lowest (45.63%) was recorded in BRRI dhan57 which was statistically identical to Binadhan-7, BU dhan1 and BU-9958-40-5-1. It is the genetically attributes that showed variation in harvest index of different rice genotypes. Tyeb (2012) observed the similar results and concluded that harvest index depends on inherent genetical attributes and the prevailing environmental condition of the growing season.

Table 3. Straw yield, biological yield and harvest index of aman rice genotypes

Genotypes	Straw yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)	Harvest index (%)
BRRI dhan56	3.81	7.93	52.31
BRRI dhan57	4.17	7.61	45.63
Binadhan-7	5.26	9.86	46.96
BU dhan1	5.79	10.94	47.28
BU-9958-40-5-1	5.58	11.55	51.80
CV (%)	16.99	11.56	6.86
LSD (0.05)	1.58	2.09	6.30

Conclusion

Results of the present study indicated that there was variability in performance of short duration Aman rice genotypes. Among the rice genotypes, BRRI dhan57 was earlier (81 DAT) while the advanced line BU-9958-40-5-1 took the maximum days (90 DAT) to mature. However, the advanced line produced the highest grain yield (5.98 t ha⁻¹) coupled with the highest biological yield (11.55 t ha⁻¹) but failed to show the highest harvest index. Thus it seemed that this line was not much efficient in converting total dry matter into grain which is the ultimate target of crop production. Therefore, this result can help physiologists and breeders to determine physiological and morphological features of the advanced line BU-9958-40-5-1 that contribute most to increasing dry matter partition into grain.

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