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Growth and Yield Performance of Hybrid and Inbred Boro Rice as Affected by Different Weed Control Methods

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ABSTRACT **Original Research Article**

Effective weed management is critical for reducing yield losses in rice caused by weed infestation. Although chemical weed control presents certain environmental and management concerns, it remains the most feasible option for large-scale rice cultivation, particularly when herbicides are applied at appropriate growth stages. This study assessed the growth and yield performance of selected hybrid and inbred Boro rice varieties under different weed management practices. The experiment was laid out in a randomized complete block design with three replications, involving three rice varieties—BRRI dhan29 and BRRI dhan58 (inbred) and BRRI hybrid dhan5 (hybrid)—and six weed control treatments, namely no weeding, weed-free condition, two hand weedings, pre-emergence herbicide application, early post-emergence herbicide application, and a sequential application of pre- and early post-emergence herbicides. Nine weed species belonging to five families were recorded in the experimental field, with *Echinochloa crus-galli* emerging as the most dominant species (SDR = 32.85) and *Oxalis corniculata* as the least dominant (SDR = 1.07). The combined application of pre- and early post-emergence herbicides resulted in superior weed suppression, reduced crop–weed competition, and enhanced crop performance, producing higher grain yield (6.33 t ha^{-1}), straw yield (7.31 t ha^{-1}), and harvest index (46.39%), closely comparable to the weed-free treatment. Among the tested varieties, BRRI hybrid dhan5 consistently recorded the highest grain yield (6.79 t ha^{-1}). Given the labor-intensive and impractical nature of maintaining weed-free fields, particularly under large-scale production systems, the combined herbicide approach in conjunction with hybrid rice cultivation is recommended as an effective and economically viable strategy for improving Boro rice productivity.

Keywords: Inbred, Hybrid, Growth, Yield, Weed, Boro Rice.

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Introduction

Rice (*Oryza sativa* L.) is the world's foremost staple food crop, providing the principal source of nourishment for over three billion people—more than half of the global population. It is cultivated across diverse agro-ecological zones worldwide and remains one of the most vital cereal crops for ensuring global food security (Asha et al., 2025). In Bangladesh, rice dominates the agricultural landscape, accounting for approximately 78.42% of the total cultivated land. The Bangladesh Rice Research Institute estimates that the country requires about 35 million tons of rice annually to meet domestic consumption demands (BRRI, 2020). Rice cultivation in Bangladesh occurs across three distinct seasons—Aus, Aman, and Boro—of which Boro rice occupies the largest proportion of cultivated area, representing about 41.37% of total rice-growing land (BBS, 2021). Notably, Boro rice contributes more than 55% of national rice production, underscoring its critical role in food availability (BBS, 2021).

Since the year 2000, substantial improvements in Boro rice productivity have been achieved through the adoption of modern cultivation practices, high-yielding varieties, and expanded access to groundwater irrigation (Jamal et al., 2022). As a result, average Boro rice yields have reached a record level of 4.29 t ha^{-1}, driven by favorable climatic conditions, improved crop management, government support initiatives, and widespread use of improved cultivars (MOA, 2021). Effective weed management during critical growth stages is essential for maximizing rice yield, as weeds represent the leading cause of yield losses in crop production. According to Abbas et al. (2018), weed infestation alone can reduce crop yield by up to 34%, surpassing losses attributed to insect pests (18%) and plant diseases (16%).

Weeds are widely recognized as the most destructive pests in crop production due to their rapid growth characteristics, including aggressive root and shoot development that enable them to outcompete cultivated crops for essential resources. Their strong competitive ability exerts a substantial negative impact on crop performance and is a major cause of significant yield losses in agricultural systems (Hossain et al., 2024; Fiza et al., 2024). Under prevailing climatic and soil conditions, numerous weed species proliferate in rice fields, where they compete intensely with rice plants for space, nutrients, water, light, and air (Islam et al., 2024). A range of weed management strategies is employed depending on weed morphology, crop characteristics, and prevailing management practices (Sadik et al., 2025). Effective weeding plays a critical role in enhancing crop growth and productivity, and weed control methods are more likely to be adopted by farmers when they are economically viable and yield-enhancing. Conversely, inadequate weed management remains one of the primary contributors to rice yield reduction, with losses varying according to weed species composition and infestation intensity (Humaira et al., 2025). In Bangladesh, weed infestation has been reported to reduce grain yield by 70–80% in Aus rice, about 30% in transplanted Aman rice, and 22–36% in Boro rice cultivars, posing a serious threat to food security in this food-deficit country (BRRI, 2008). Consequently, the adoption of effective and sustainable weed management practices is essential for improving rice productivity in Bangladesh.

Effective weed control during critical growth stages is essential for achieving optimum rice growth and maximizing yield, as weed management efficiency is influenced by the method employed, timing of weeding, and the biological characteristics of both weeds and rice crops (Siddika et al., 2024). In Bangladesh, hand weeding remains the most commonly practiced weed control method; however, it is highly labor-intensive and costly, and its effectiveness is often constrained by labor shortages during peak periods (Islam et al., 2025). As a result, mechanical and chemical weed control methods have emerged as viable alternatives, with the use of chemical weed control increasing substantially in recent years (Ahmed et al., 2014). Crop variety also plays a crucial role in determining rice productivity, as significant yield variations have been observed among different cultivars, with high-yielding and hybrid rice varieties producing 15–30% higher yields than traditional inbred varieties (Abou-Khalifa, 2009; Julfiquar et al., 2009). Additionally, varietal characteristics influence weed infestation, with short-statured rice varieties generally experiencing higher weed pressure than taller cultivars (Mia et al., 2024). Therefore, selecting appropriate rice varieties alongside effective weed management practices is essential to minimize weed competition and enhance yield performance. Given that weeding regimes significantly affect Boro rice productivity, identifying weed management strategies that effectively suppress weeds while maximizing yield is critical; consequently, this study aimed to evaluate the response of selected inbred and hybrid Boro rice varieties in Bangladesh to different herbicide-based weed management practices.

Materials and Methods

Experiment Site

From 2022 through 2023, the Agronomy Field Laboratory of Bangladesh Agricultural University in Mymensingh served as the site of the field experiment. The location of the experiment is at an elevation of around 18 meters above sea level, on the south-western bank of the Old Brahmaputra River, at a coordinate system of 24°75″ N latitude and 90°50″ E longitude. Dark grey, non-calcareous floodplain soil is the official description of the ground under investigation. Temperatures were quite low from the beginning of November to the beginning of February, and then somewhat higher for the rest of the months of the trial period. Table 1 displays data on the experimental site's mean air temperature, relative humidity, rainfall, and sunlight length for each month of the study.

Table 1. Distribution of monthly average air temperature, relative humidity, rainfall and sunshine hours of the experiment site during the period from November 2022 to May 2023

Month	Air temperature (^{0}C)			Relative Humidity (%)	Rainfall (mm)	Monthly average sun shine (hrs)
	Maximum (^{0}C)	Minimum (^{0}C)	Average (^{0}C)			
November	30.4	18.3	24.4	81.6	0.0	8.8
December	26.4	14.7	20.6	84.8	0.0	6.1
January	24.4	12.3	18.3	83.5	0.0	5.4
February	27.9	16.3	22.1	78.6	11	6.1
March	29.9	19.8	24.8	76.7	110.2	6.3
April	34.1	22.6	28.3	74.2	15.5	8.7
May	36.3	25.9	31.1	72.3	242.1	7.7

Treatments and Design

A total of six weed management treatments were used in the experiment, including three different Boro rice varieties (BRRI dhan29, BRRI dhan58, and BRRI hybrid dhan5), as well as no weeding at all, two hand weedings, pre-emergence herbicide, early post-emergence herbicide, and a combination of the two. The pre-emergence herbicide was treated at a rate of 1000 ml ha^{-1} with pretilachlor, and the early post-emergence herbicide was a mixture of acetochlor and bensulfuron-methyl administered at 750 g ha^{-1}. Table 2 provides information about the herbicides, including their names, active ingredients, modes of action, selectivity, and when to apply them. The experimental setup consisted of three replications of a randomised complete block design (RCBD).

Table 2. Description of the Used Herbicides

Trade Name	Generic Name	Mode of Action	Selectivity	Time of Application
Super hit 500 EC	Pretilachlor	Systemic	Rice	Pre-emergence
Livina 18 WC	Acetochlor 14% + Bensulfuron methyl 4%	Systemic	Rice	Early post-emergence

Crop Husbandry

The Agronomy Field Laboratory of Bangladesh Agricultural University (BAU) in Mymensingh provided seeds for BRRI dhan29. The Bangladesh Rice Research Institute (BRRI) in Gazipur provided seeds for BRRI dhan58 and BRRI hybrid dhan5. The specific gravity method was used to choose healthy seeds. Then, the seeds were immersed in water for 24 hours, taken out, and put in gunny bags to help them sprout. After 48 hours, the seeds began to germinate, and after 72 hours, the germinated seeds were planted in nursery beds. On November 29, 2022, each type was planted in its own nursery bed. Weed removal and watering were done as needed as part of necessary nursery management. Repeated ploughing, cross-ploughing and puddling prepared the main field. Then, urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate were added in the necessary amounts. All of the fertilisers except urea were mixed in during the final land preparation. Three equal splits of urea were used as top dressing 30, 45, and 60 days after transplanting (DAT). On January 5, 2023, thirty-six-day-old seedlings were moved to a new location with a distance of 25 cm × 15 cm between each hill. As needed, routine intercultural tasks like filling in gaps and draining were done. A little infestation of green leaf hoppers was seen and well managed with a single application of Karate 2.5 EC (lambda-cyhalothrin @ 1 mL L^{-1}) at 25 DAT. There were no disease control measures taken because the incidence of diseases like blast and brown spot was still very low.

Data Recording and Statistical Analyses

Weed species in the experimental field were identified, and their summed dominance ratio (SDR) was calculated using the approach outlined by Janiya and Moody (1989).

$$\text{Summed dominance ratio (\%)} = \frac{\text{Relative density} + \text{Relative dry weight}}{2} \times 100$$

Where,

$$\text{Relative density of weed (\%)} = \frac{\text{Density of given weed species}}{\text{Total weed density}} \times 100$$

$$\text{Relative dry weight of weed (\%)} = \frac{\text{Dry weight of given weed species}}{\text{Total weed dry weight}} \times 100$$

Before harvesting, five hills from each plot, not including the border rows, were chosen at random and pulled up so that data on yields could be collected.

We used the Statistix 10 statistical software tool to do an analysis of variance (ANOVA). We used the Least Significant Difference (LSD) test at the 5% level of probability to find differences between treatment means, using the method provided by Gomez and Gomez (1984).

Results and Discussion

Weed Composition

The experimental field had nine different types of weeds from five different plant groups. Based on their morphological and reproductive characteristics, the weeds were classified into three groups: grasses, broad-leaved species, and sedges. Of the nine species recorded, five were grasses, three were broad-leaved weeds, and one was a sedge. Details of the scientific names, families, morphological types, relative density (RD%), relative dry weight (RDW%), and summed dominance ratio (SDR%) of the weed species observed in the weedy plots (mean values) are presented in Table 3. The results showed that grass weeds accounted for the highest proportion, contributing 37.0% to relative density and 75.45% to relative dry weight, followed by sedges with 35.77% RD and 12.73% RDW, while broad-leaved weeds contributed 27.21% RD and 11.77% RDW (Figures 1 and 2). Based on SDR values, the grass weed *Echinochloa crus-galli* was identified as the most dominant species in the weedy plots with an SDR of 32.85, followed by the sedge *Eleocharis atropurpurea*, which had an SDR of 24.27. In contrast, the least dominant weed species were the broad-leaved weeds *Oxalis corniculata* (SDR = 1.07) and *Eclipta prostrata* (SDR = 1.23). Juraimi et al. (2011) reported similar variations in SDR among weed species, whereas Rashid (2011) identified *Paspalum scrobiculatum*, *Echinochloa crus-galli*, *Digitaria sanguinalis*, *Leersia hexandra*, and *Echinochloa colonum* as predominant weed species at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh.

Table 3. Weed composition found in untreated weedy plot of the experimental field with their summed dominance ratio (SDR)

SL No	Scientific Name	Family	Morphology	RD (%)	RDW (%)	SDR (%)
1	*Echinochloa crusgalli*	Poaceae	Grass	8.72	56.98	32.85
2	*Eleocharis atropurpurea*	Cyperaceae	Sedge	35.77	12.78	24.27
3	*Monochoria vaginalis*	Pontederiaceae	Broad leaved	23.92	10.47	17.20
4	*Cyperus difformis*	poaceae	Grass	15.87	6.41	11.14
5	*Leersia hexandra*	Poaceae	Grass	4.02	7.51	5.77
6	*Digitaria sanguinalis*	Poaceae	Grass	5.37	2.60	3.98
7	*Paspalum scrobiculatum*	Poaceae	Grass	3.02	1.95	2.48
8	*Eclipto prostrata*	Amaranthaceae	Broad leaved	1.84	0.62	1.23
9	*Oxalis corniculata*	Oxalidaceae	Broad leaved	1.45	0.68	1.07

Here, RD- Relative density, RDW- Relative dry weight, SDR- Summed dominance ratio

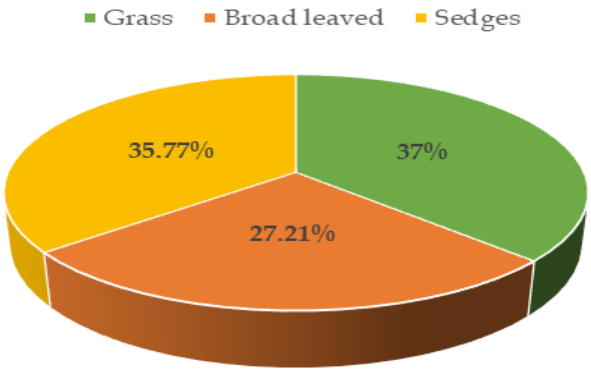

Figure 1: Relative density of different weed groups

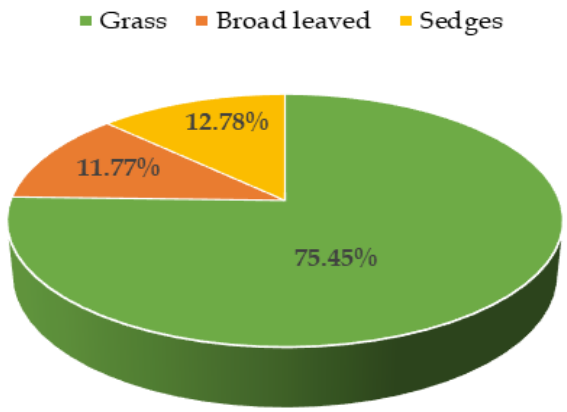

Figure 2: Relative dry weight of different weed groups

Weed Density and Weed Dry Weight

The different weed management methods used (Table 4) caused the weed density and weed dry weight to change a lot from one sampling date to the next. Weed growth was entirely stopped in the plots that were weed-free, hence weed density and dry weight were not measured at any point. In the remaining treatments, the season-long weedy plots consistently had the most weeds and the most dry weight, while the combined use of pre-emergence herbicide (Pretilachlor) followed by early post-emergence herbicide (Acetochlor + bensulfuron-methyl) had the least. The weedy treatment had the highest weed density (56.56 m^{-2}) and dry weight (42.34 g m^{-2}) at 30 days after transplanting (DAT). The combination herbicide treatment had the lowest weed density (26.56 m^{-2}) and dry weight (12.76 g m^{-2}). At 60 DAT, the last observation, the weedy plots had the most weeds (33.56 m^{-2}) and the most dry weight (48.60 g m^{-2}). The combined pre- and post-emergence herbicide treatment had the least weeds (12.89 m^{-2} and 20.40 g m^{-2}, respectively) (Table 2). These results align with previous studies conducted by Bhuiyan et al. (2011) and Kalhirvelan and Vaiyapuri (2003), while Phukan et al. (2021) also noted markedly elevated weed densities in unweeded fields.

Yield Contributing Characters

Rice variety, weed control strategies, and the interaction between the two had a substantial impact on the number of effective tillers per hill (Tables 5, 6, and 7). Tables 5, 6, and 7 show that different rice varieties had different effects on thousand-grain weight, panicle length was affected only by varietal variations, and weed management techniques had no effect on either variety or their interaction. Table 5 shows that, according to Jannatul (2014), the inbred variety BRRI dhan29 had the lowest number of effective tillers per hill at 8.11, while the hybrid BRRI hybrid dhan5 had the highest number at 9.92. While the weed-free treatment yielded 9.55 effective tillers per hill, the combined pre- and post-emergence herbicide application yielded 2.65 tillers per hill, and the weedy plot yielded 7.74 tillers per hill, the lowest number, because of the intense weed competition under no-weeding conditions (Table 6). According to Table 7, the interaction effect showed that BRRI hybrid dhan5 and the weed-free treatment had the maximum number of effective tillers per hill (11.66), whereas BRRI dhan29 had the lowest number of tillers per hill (6.66) when grown under weedy circumstances. Consistent with the results of Sarkar et al. (2014), who found longer panicles in BRRI dhan34 compared to BRRI dhan37 and BRRI dhan38, Table 7 shows that panicle length varied significantly among varieties, with BRRI hybrid dhan5 producing the longest (23.17 cm) and BRRI dhan58 producing the shortest (21.38 cm). Tables 6 and 7 show that weed control strategies and their interactions with rice types did not significantly alter panicle length.

According to Table 5, the hybrid variety BRRI hybrid dhan5 had the maximum number of filled grains per panicle at 153.03, while the inbred variety BRRI dhan29 had the lowest number at 135.70. It is the innate genetic potential of the

different types that causes these variations in grain output per panicle. When it came to weed control, the weed-free treatment yielded the highest number of full grains per panicle (149.49), which was statistically similar to the 149.07 achieved by combining pre-emergence and early post-emergence herbicides (Table 6). One possible explanation for the increased grain yield under these conditions is that the rice plants were able to access more nutrients, water, and other growth resources due to less crop-weed competition. The no-weeding treatment, on the other hand, had the fewest full grains per panicle (128.53) because of the severe weed competition. These results are in line with those of Karim and Ferdous (2010), who found that the density of weeds had a negative correlation with the quantity of filled grains per panicle. The interaction effect also showed that, under weedy conditions, BRRI dhan29 yielded the lowest number of filled grains per panicle (122.79), whereas the combination of BRRI hybrid dhan5 and weed-free treatment yielded the maximum number (161.61) (Table 7).

The inbred variety BRRI dhan29 had the lowest thousand-grain weight (21.36 g), whereas the hybrid variety BRRI hybrid dhan5 had the highest (32.80 g) (Table 5). Environmental variables have little to no effect on thousand-grain weight, making it a good trait for using in rice varietal selection and yield estimation (Iqbal et al., 2008). According to Table 6, the weed-free conditions yielded the highest thousand-grain weight (26.44 g), whereas the no-weeding treatment yielded the lowest weight (25.16 g). Previous research by Khan and Tarique (2011), Hassan et al. (2010), and Raju et al. (2003) similarly found that weeding regimes significantly affected the thousand-grain weight of rice. Table 7 shows that there was no statistically significant effect of the interaction between rice types and weed management strategies on thousand-grain weight.

Table 4. Weed density and weed dry weight at different sampling date in Boro rice as influenced by treatment

Weed management	**Weed density (no. m^{-2})**			**Weed dry weight (gm^{-2})**		
	30 DAT	**45 DAT**	**60 DAT**	**30 DAT**	**45 DAT**	**60 DAT**
No weeding	56.56a	47.11a	33.56a	42.34a	59.05a	48.60a
Weed free	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e
Hand weeding	42.56b	24.89b	21.11b	28.79b	45.77b	37.19b
Pre-emergence herbicide	35c	19.78cd	17.56c	18.09c	34.44c	30.07c
Early post-emergence herbicide	38.22bc	22.56bc	18.89bc	21.72c	37.05c	31.78c
Pre + early post-emergence herbicide	26.56d	16.78d	12.89d	12.76d	26.26d	20.40d
Level of sig.	**	**	**	**	**	**
CV (%)	11.62	11.22	12.54	13.33	10.71	9.84

In a column, mean values that share the same letter are not substantially different. On the other hand, values that have distinct letters show statistically significant differences according to Duncan's Multiple Range Test (DMRT). **= Significant at 1% level of probability

Table 5. Effect of variety on yield contributing characters of Boro rice

Variety	**No. of effective tillers $hill^{-1}$**	**Panicle length (cm)**	**No. of grains $panicle^{-1}$**	**1000-grain weight (g)**	**Harvest index (%)**
BRRI dhan29	8.11c	22.49b	135.70c	21.36c	45.33c
BRRI dhan58	8.50b	21.38c	138.64b	23.50b	45.98b
BRRI hybrid dhan5	9.92a	23.17a	153.70a	32.80a	46.86a
Level of sig.	**	**	**	**	**
CV (%)	5.55	3.12	1.56	1.56	1.02

According to Duncan's Multiple Range Test (DMRT), mean values in the same column that are followed by the same letter are not significantly different, while mean values that are followed by different letters are. ** means that the difference is significant at the 1% level of probability, and CV stands for the coefficient of variation.

Table 6. Effect of weed management on yield contributing characters of Boro rice

Weed management	**No. of effective tillers $hill^{-1}$**	**Panicle length (cm)**	**No. of Grains $panicle^{-1}$**	**1000-grain weight (g)**	**Harvest index (%)**
No weeding	7.74d	22.34	128.53d	25.16c	45.15d
Weed free	9.55a	22.67	149.49a	26.44a	46.69a
Two hand weeding	8.96bc	22.27	139.52c	25.86b	45.77c
Pre-emergence herbicide	8.70c	22.14	143.25b	25.70bc	46.31ab
Early post-emergence herbicide	8.85bc	22.26	144.89b	25.95ab	46.04bc
Pre + early post-emergence herbicide	9.26ab	22.38	149.07a	26.22ab	46.39ab
Level of sig.	**	NS	**	**	**
CV (%)	5.55	3.18	1.56	1.56	1.02

According to Duncan's Multiple Range Test (DMRT), mean values that share the same letter do not differ significantly, while values that have different letters do. ** means significance at the 1% level of probability, * means significance at the 5% level of probability, NS means not significant, and CV means the coefficient of variation.

Table 7. Interaction effect of variety and weed control methods on yield and yield contributing characters of Boro rice

Interaction		No. of effective tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw Yield (t ha^{-1})	Harvest index (%)
Variety	Weed management							
BRRI dhan29	No weeding	6.66h	22.26	122.79h	20.66	4.96j	6.26k	44.20h
	Weed free	8.44efg	23.06	142.02c	21.82	5.96ef	7,05e	45.79def
	Two hand weeding	8.33fg	22.56	130.74fg	21.41	5.24i	6.45j	44.81gh
	Pre-emergence herbicide	8.33fg	22.09	133.49efg	21.23	5.78gh	6.90fgh	45.60ef
	Early post-emergence herbicide	8.33fg	22.18	140.38cd	21.35	5.77gh	6.91fgh	45.51fg
	Pre + early post-emergence herbicide	8.56efg	22.77	144.79c	21.67	5.96ef	6.97efg	46.11cdef
BRRI dhan58	No weeding	7.89g	22.17	128.09gh	23.17	5.01j	6.24k	44.55h
	Weed free	8.56efg	21.73	144.83c	23.88	6.04e	6.83hi	46.96ab
	Two hand weeding	8.89def	20.85	134.95def	23.05	5.71h	6.75i	45.83def
	Pre-emergence herbicide	8.56efg	21.27	140.74cd	23.58	5.91efg	6.92efgh	46.08cdef
	Early post-emergence herbicide	8.44efg	21.38	138.85cde	23.66	5.88fg	6.86ghi	46.16cdef
	Pre + early post-emergence herbicide	8.67efg	20.90	144.38c	21.68	6.04ef	7.00ef	46.29bcde
BRRI hybrid dhan5	No weeding	8.67efg	22.59	134.71defg	31.65	6.03ef	6.88fghi	46.70abc
	Weed free	11.66a	23.23	161.61a	33.61	7.48a	8.32a	47.34a
	Two hand weeding	9.66cd	23.42	152.88b	33.11	6.55d	7.49d	46.66abc
	Pre-emergence herbicide	9.22cde	23.07	155.52ab	32.29	6.92bc	7.73c	47.25a
	Early post-emergence herbicide	9.78bc	23.23	155.43ab	32.84	6.76c	7.80c	46.45bcd
	Pre + early post-emergence herbicide	10.55b	23.48	158.04ab	33.31	6.98b	7.94b	46.77abc
Level of significance		**	NS	**	NS	**	**	*
CV (%)		5.55	3.12	1.56	1.56	1.22	1.59	1.02

According to Duncan's Multiple Range Test (DMRT), mean values that are followed by the same letter do not differ significantly, while those that are followed by different letters do. ** means significance at the 1% level of probability, * means significance at the 5% level of probability, NS means not significant, and CV means the coefficient of variation.

Yield

Tables 5, 6, and 7 show that different varieties of rice, different methods of weed control, and the interplay between the two had a substantial impact on Boro rice grain output. According to Figure 3, the hybrid BRRI hybrid dhan5 had the highest grain yield (6.79 t ha^{-1}), while the inbred variety BRRI dhan29 had the lowest yield (5.61 t ha^{-1}). These results are in line with those of Mia et al. (2023), who found that hybrid rice varieties had better yield performance than inbred types. In terms of weed control, the treatment without weeds produced the highest grain yield (6.49 t ha^{-1}), while the combination of pre-emergence and early post-emergence herbicides produced the second-highest yield (6.33 t ha^{-1}). In contrast, the weedy plot had the lowest yield (5.33 t ha^{-1}) because of the intense competition from weeds (Figure 4). In comparison to other treatment combinations, the interaction effect showed that the combination of BRRI hybrid dhan5 and weed-free treatment resulted in the highest grain production (7.48 t ha^{-1}). On the other hand, according to Table 7, the BRRI dhan29 treatment with no weeding produced the lowest yield (4.96 t ha^{-1}), which was statistically similar to the yield reported in the BRRI dhan58 × weedy plot treatment (5.01 t ha^{-1}). According to Mahajan and Chauhan (2013), the results show that applying herbicides before weeds emerge and again after they have emerged is more successful at controlling weed flushes in the early and late stages. This, in turn, leads to an increase in rice output.

Varieties of rice, methods of weed control, and the interplay between the two greatly affected straw yield. Figure 3 shows that the hybrid variety BRRI hybrid dhan5 had the highest straw yield at 7.69 t ha^{-1}, whereas the inbred variety BRRI dhan29 had the lowest at 6.76 t ha^{-1}, and BRRI dhan58 came close behind at 6.77 t ha^{-1}. Figure 4 shows that the weedy plot had the lowest straw yield of 6.46 t ha^{-1}, owing to intense weed competition, while the weed-free treatment had the highest (7.40 t ha^{-1}) and the combined application of pre-emergence and early post-emergence herbicides the second-highest (7.31 t ha^{-1}). Layla (2014) and Salam et al. (2022) also found that weed-free environments resulted in superior straw yields. Under weedy conditions, the lowest straw yield was recorded in BRRI dhan58 (6.24 t ha^{-1}), followed closely by BRRI dhan29 × weedy plot (6.26 t ha^{-1}), according to the interaction effects. In contrast, the combination of BRRI hybrid dhan5 and weed-free treatment produced the highest straw yield (8.32 t ha^{-1}).

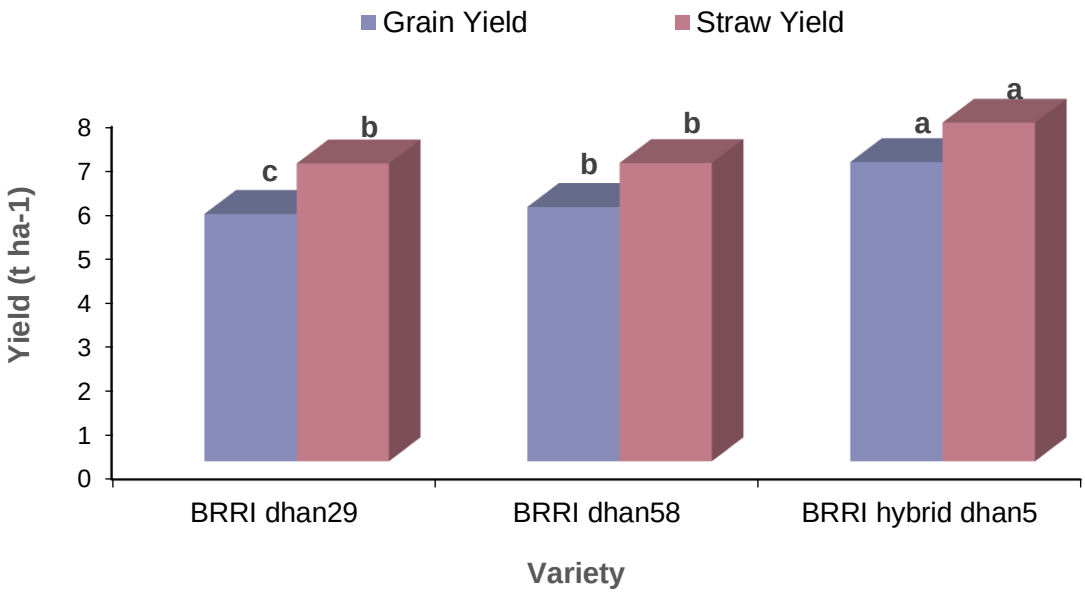

Figure 3: Effect of variety on grain and straw yield (t ha^{-1}) of Boro rice

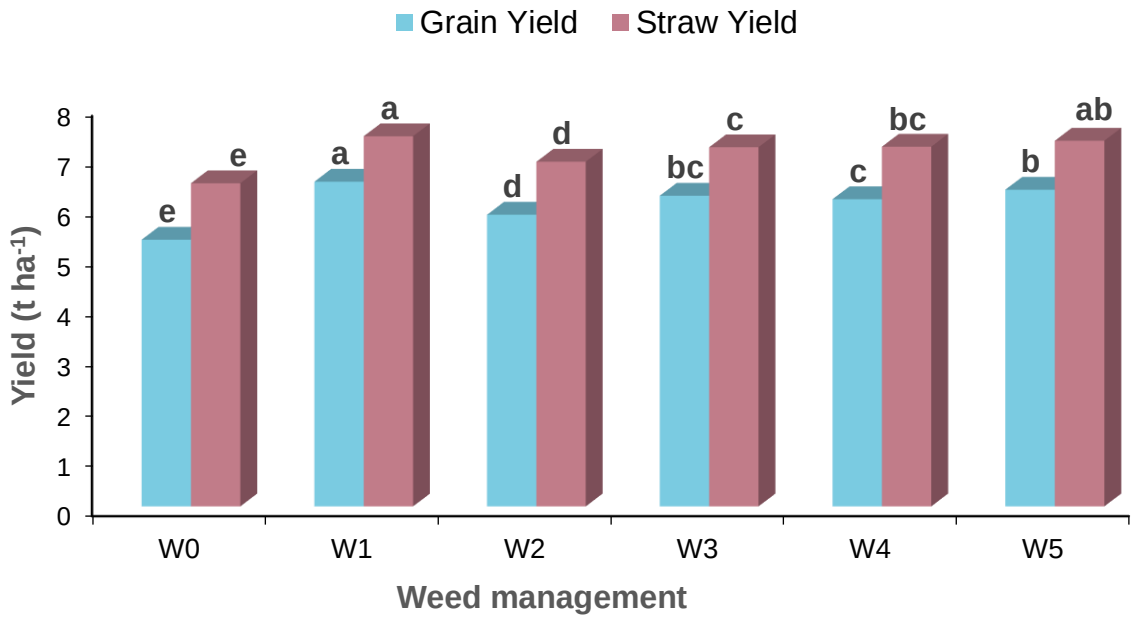

Figure 4: Effect of weed control methods on grain and straw yield (t ha^{-1}) of Boro rice

According to Duncan's Multiple Range Test (DMRT), values in the figure that share a letter do not differ significantly, whereas values that have separate letters suggest various levels of significance. In this context, W_0 denotes a weedy plot (i.e., one without weed control), W_1 means a weed-free treatment, W_2 means two-handed weeding, W_t means pre-emergence herbicide, W_4 means early post-emergence herbicide, and W_5 means pre-emergence herbicide with early post-emergence herbicide.

Harvest Index (%)

The harvest index was similarly affected by rice variety, weed management strategies, and the interaction effects of the two (Tables 5, 6, and 7), just as other yield-contributing variables. The hybrid BRRI hybrid dhan5 had the highest harvest index of 46.66%, whereas the inbred variety BRRI dhan29 had the lowest index of 45.33% (Table 5). According to Table 6, the harvest index was at its highest (46.69%) in the weed-free treatment and at its lowest (45.15%) under the no-weeding conditions. The interaction analysis showed that the combination of BRRI hybrid dhan5 and weed-free treatment yielded the greatest harvest index (47.34%), which was statistically similar to the combination of BRRI hybrid dhan5 with pre-emergence herbicide treatment (47.25%). In contrast, BRRI dhan58 with no weeding (44.55% harvest index) and BRRI dhan29 (44.20% harvest index) were the two varieties that showed the lowest harvest index under no-weeding conditions (Table 7).

Conclusion

Effective weed management is essential for maximizing the yield and productivity of Boro rice. The findings of this study demonstrate that the application of integrated weed control strategies—combining cultural, mechanical, and chemical methods adapted to local conditions—can substantially reduce weed-related yield losses. The results further revealed that the hybrid rice variety outperformed the inbred varieties in terms of yield potential. Among the weed control options evaluated, the sequential application of pre-emergence followed by early post-emergence herbicides proved to be the most effective in suppressing weed infestation compared with other management practices. However, as this experiment was conducted at a single location over one growing season, the results should be interpreted with caution. Therefore, multi-location and multi-year trials are recommended before formulating broad recommendations for farmers. Additionally, potential environmental implications associated with herbicide use should be carefully considered. Overall, the findings of this study are expected to contribute to addressing emerging production challenges and supporting the sustainable cultivation of Boro rice in the future.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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