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Assessment of Different Weed Control Methods on Growth and Yield Performance of *T. Aus* Rice

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Abstract

An experiment was conducted in the Agriculture Field Laboratory, Noakhali Science and Technology University (NSTU) during the period of April-August 2019, for the assessment of different weed control methods on growth and yield performance of transplanting aus (early summer) rice. The experiment was carried out with four (4) weed control treatments viz. T_1 = No weeding (control); T_2 = Hand weeding at 15 and 30 DAT; T_3 = Pre-emergence herbicide (Acetachlore 14% + Bensulfuron methyle 4%); T_4 = Post-emergence herbicide (Pyrozosulfuran ethyle 10 %) using two aus varieties viz. BRRI dhan 83 and BRRI dhan 65. The experiment was carried out in a Randomized Complete Block Design with three replications. The result revealed pre-emergence herbicide (T_3) as the most effective and efficient method of weed control by increasing yield significantly. No weeding caused 37.46 % loss of yield in this experiment where the application of pre-emergence herbicide showed 96.26 % higher yield than no weeding followed by hand weeding 79.14 % and post-emergence herbicide 64.70 %. Post-emergence herbicide performed well in tillers hill^{-1} along with straw yield. No weeding showed worst performance in every growth and yield attributes also it resembled as liable for maximum sterile grains panicle^{-1}. Despite some offensive effects, no efficient alternative is currently available to shift the herbicidal weed control in aus rice as manual hand weeding is laborious and costly. Being efficient in controlling weeds, application of the pre-emergence herbicide may be used for effective weed control in aus rice.

Keywords: Aus rice, Weed control method, Herbicide, Yield

Introduction

Rice is the staple food of about 135 million people in Bangladesh [1]. Rice provides 20 % of the world's dietary energy supply, it provides about two-third of total calorie supply and about one-half of the total protein intake of an average person in Bangladesh [1]. During the year 2017-18 rice covered an area of 11614 thousand ha. with a production of 36279 thousand metric tons where Boro rice (winter rice) covers 4859 thousand ha. with a production of 19576 thousand metric tons, Aman rice (late summer) covers 5679 thousand ha. with a production of 13993 thousand metric tons, Aus rice (early summer) covers 1075 thousand ha. with a production of 2710 thousand metric tons [2]. It is observed that boro rice contributes 54 %, aman rice 39 % and aus rice contribute only 7 % of total rice production. Aus rice cultivation is neglected in our country. In 2018, world production of paddy rice was 782 million tones led by China (214.1 million tons) and India (172.6 million tons) with a combined around 50 % of this total. Other major producers were Indonesia, Bangladesh and Vietnam. Bangladesh ranked 4th position in that list & produced 56.4 million tons [3] although we have huge opportunities to increase our production. Population of Bangladesh is increasing day by day, two million every year and may increase by another 30 million over the next 20 years on the contrary total rice area will also shrink to 10.28 million hectares [1]. To feed the increasing population, therefore rice yield needs to be increased from the present 2.74 to 3.74 t ha^{-1}.

Bangladesh can easily uplift her production by emphasizing more on aus season rice cultivation as area under aus rice cultivation is decreasing day by day. The area of the aus rice

cultivation dwindled around 10 lakh ha now, from 30 lakh ha in early 1980s [4]. There are many reasons behind the falling of aus rice cultivation among them weed infestation and extreme bird attack are the main. Weed is one of the major enemies of aus rice. Weeds grow profusely in rice fields and reduce crop yields drastically. In Bangladesh, weed infestation reduces the grain yield by 70-80 % in Aus rice, 30-40 % for transplanted (T) Aman rice and 22-36 % for modern Boro rice cultivars [5,6]. Therefore, weeding is an essential intercultural operation for the successful rice cultivation. In Bangladesh, the traditional methods of weed controls are hand weeding by hoe or hand pulling, preparatory land tillage and chemical methods include application of pre-emergence or post-emergence herbicides. Mechanical weed control method is rare in Bangladesh. Weed control in transplanted rice by mechanical and cultural is an expensive method especially at the time of peak period of labor crisis [7]. Production cost of rice also increased due to increases in weed control cost. That's whys use of herbicides is gaining much popularity in rice cultivation due to their rapid effects and less cost compared to traditional methods. But herbicidal weed controls have some negative impact on nature. So, it is one of the captivating topic to the enthusiast's researcher of Bangladesh to find out the most efficient weed control method in aus rice which will ensure an economic rice production. In Bangladesh few studies have attempted to establish the most suitable and economic weed management system in rice but this experiment was done in a simple and by using popular methods of weed control for T. aus rice.

Objectives of the Study

a. To find out the most effective weed control method for Aus rice.

b. To evaluate the performance of pre-emergence and post-emergence herbicides.

c. To estimate the crop damage cause by weeds.

Materials and Methods

The experiment was carried out in the Agriculture Field Laboratory, Noakhali Science and Technology University, Noakhali during the period from April to August 2019. Particle size constitution of the soil of that site is Sand: Silt: Clay = 40 %: 40 %: 20 %. The soil type is loam with organic matter (0.68 %), with total nitrogen of 0.04gkg^{-1}, available P of 27.79µg/g, and available K of 0.18meq /100 g soil with soil is p^{H} value 7.5. The soil index were determined before weeding. The average annual temperature is 25.6°C and the average annual rainfall is about 3,302mm. The experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The size of the unit plot was 3m × 2m with an area of 6m^2. Each of the replications represented a block in the experiment. Four treatment combinations were randomly assigned in each replication. Thus, the total number of the plot was 24 (3×2×4) for this experiment. The density of plant (156 plants/plot) was maintained in between the replications and unit plot respectively.

This experiment was conducted using 2 aus varieties viz. BRRI dhan 83 (V_1) and BRRI dhan 65 (V_2). There were four treatments including $\mathbf{T_1}$ = No weeding (control), $\mathbf{T_2}$ = Hand weeding at 2 times, 15 & 30 DAT, $\mathbf{T_3}$ = Application of pre-emergence herbicide Laal Teer 18 WP@750 gm. ha^{-1} (Acetachlore 14% + Bensulfuron methyle 4%), $\mathbf{T_4}$ = Application of post-emergence herbicide Sathi 10 WP @ 150 gm. ha^{-1} (Pyrozosulfuran ethyle 10%). Seeds were collected from Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh. The experimental land was first opened with a tractor. Later on, the land was prepared by plowing and repeated plowing and subsequently leveled by laddering. Pre-germinated seeds were broadcasted uniformly in a well-prepared nursery bed on 20 April 2019. The basal dose of fertilizer was Triple super phosphate (TSP), Muriate of potash (MoP) and Gypsum at every plot uniformly 7 days before transplanting through broadcasting at a rate of 100kg, 70 kg, 60 kg ha^{-1} respectively. Urea was applied at a rate of 150 kg ha^{-1} by top dressing in three equal splits at 15, 25 and 35 days after transplanting (DAT). Uprooted seedlings of 23 days old were transplanted in the main field according to the experimental design. Transplanting was done maintaining the spacing of 25 cm × 15cm (Row to Row and Plant to Plant) at the rate of 2 seedlings per hill.

Hand weeding was done at 15 and 30 DAT. Laal Teer 18 WP (Acetachlore 14 % + Bensulfuron methyle 4 %) at the rate of 750 gm ha^{-1} was applied as a pre-emergence herbicide at 7 days before transplanting and just after main land preparation at a time of basal dose of fertilizer application. Sathi 10 WP (Pyrozosulfuran ethyle 10 %) was applied at the rate of 150 gm ha^{-1} as a post-emergence herbicide at 7 days after transplanting. Herbicides were applied keeping 2-3inch standing water on plots. 2-3inch standing water layer was strictly maintained for 7-10 days after herbicide application. Artificial irrigation (5-6 times) were provided to the field as extreme drought condition exists in this season. At the milky stage of rice plants were found to be attacked by Rice Bug. To control insect Malathion 57 EC and Virtako as per recommended dose were used. Birds attacked severely at maturity stage. It creates serious trouble and causes serious yield loss although scarecrow was used, it reduced intensity but failed to stop bird attack completely.

Ten hills were selected randomly from each unit plot and uprooted before harvesting for recording data. After sampling, crop was harvested when 80% grains turned golden yellow color. The harvested crops of each unit area were separately bundled, properly tagged and then brought to the threshing floor. The harvested crops were threshed by pedal thresher. Grains were then sun dried at 14 % moisture level and cleaned. Straws were also sun dried properly. Finally, straw and grain yield per plot were recorded and converted to ton per hectare.

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Analysis of variance was done with the help of MSTAT-C computer package program. The mean differences among the treatments were adjudged by DMRT test [8].

Results and Discussion

Effect of variety on growth and yield attributes of T. aus rice

The two varieties differ significantly in every growth parameter except sterile grains panicle^{-1} (Table 1). BRRI dhan 83 showed the plant height of 101.19cm where 86.61cm plant height was observed in BRRI dhan 65 (Table 1). According to BRRI fact sheet in optimum condition, the average plant height of BRRI dhan 83 and BRRI dhan 65 is respectively 100-105cm and 90-95cm [9,10]. BRRI dhan 65 showed very poor plant height in no weeding so it couldn't reach to the optimum height. The highest total number of tillers hill^{-1} (23.9) was found in BRRI dhan 65 and total number of tillers hill^{-1} in BRRI dhan 83 was 14. The highest number of effective tillers hill^{-1} (17.2) was found in BRRI dhan 65 where effective tillers hill^{-1} of BRRI dhan 83 was 9.95 (Table 1). Significant variations in number of effective tillers hill^{-1} among the different varieties were also reported by Islam *et al.*, [11]. The highest panicle length (22.56cm), number of grains panicle^{-1} (133.1), sterile grains panicle^{-1} (20.69) and 1000 grains weight (25.13gm) were obtained from BRRI dhan 83 and the lowest panicle length (20.53 cm), number of grains panicle^{-1} (77.82), sterile grains panicle^{-1} (19.64) and 1000 grains weight (22.31 gm) were obtained from BRRI dhan 65 (Table 1). Significant variation in panicle length, number of grains panicle^{-1} and 1000 grains weight were also reported by Mondal *et al.*, [12] among four aus rice varieties. Varietal differences might be occurred due to differences in genetic constituents.

Table 1: Effect of variety on growth and yield attributes of T. aus rice

Variety	Plant height (cm)	Total no. of tillers hill^{-1}	Effective tillers hill^{-1}	Panicle length(cm)	Number of grains panicle^{-1}	Sterile grains panicle^{-1}	1000 grains weight (gm)	Grain yield (tha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
BRRI dhan 83 (V_1)	101.19	14	9.95	22.56	133.1	20.69	25.13	3.33	5.81	36.09
BRRI dhan 65 (V_2)	86.61	23.9	17.2	20.53	77.82	19.64	22.31	2.65	6.76	28.08
CV (%)	6.4	13.85	16.56	6.01	7.89	17.44	3.53	10.49	15.03	15.17
LS	**	**	**	**	**	ns	**	**	*	**

**=Significant at 1% level of probability, * =Significant at 5% level of probability, ns = Non-significant.

Grain yield, straw yield and harvest index were significantly influenced by variety (Table 1). The grain yield of BRRI dhan 83 was 3.33 t ha^{-1} and grain yield of BRRI dhan 65 was 2.65 t ha^{-1}. The highest grain yield in BRRI dhan 83 might be due to the result of highest number of grains panicle^{-1} and highest 1000 grains weight. The significant difference in grain yield might be due to the genetic characteristics of varieties. Extreme birds attack impedes this experiment to get satisfactory grain yield. Birds attack severely in aus (early summer) season as maximum crop field remained fellow in that time. Straw yield of BRRI dhan 65 was significantly higher 6.76 t ha^{-1} than BRRI dhan 83 (5.81 t ha^{-1}). The highest straw yield obtained from BRRI dhan 65 might be due to the huge variation in tillers hill^{-1} between two varieties. Harvest index of 36.09 % was obtained from BRRI dhan 83 where harvest index of BRRI dhan 65 was 28.08 % (Table 1). Varieties had a great influence on harvest index was reported by Tyeb *et a.*, [13].

Effect of different weed control methods on growth and yield attributes of T. aus rice

Different weed control methods had significant effect on total number of tillers hill^{-1}, effective tillers hill^{-1}, number of grains panicle^{-1}, sterile grains panicle^{-1}, 1000 grains weight where plant height and panicle length remained non-significant in this experiment (Table 2). The tallest plant was found in hand weeding at 15 & 30 DAT (95.56cm) and shortest plant was observed in no weeding (91.78cm). Weed competition was severe in no weeding condition and thus plant height of rice was reduced. Chowdhury *et al.*, [14] observed that the highest plant height was produced due to weed free condition and the lowest plant height was in no weeding condition. The highest total number of tillers hill^{-1} (22.47) was found in post-emergence herbicide (T_4) and lowest total number of tillers hill^{-1} (16.28) was found in no weeding treatment (Table 2). No weeding gave statistically inferior effective tillers hill^{-1} than other weed control treatment. The maximum number of effective tillers hill^{-1} (15.39) was found in post-emergence herbicide (T_4) treatment and minimum effective tillers hill^{-1} (11.06) was found in no weeding (Table 2). De Datta [15] reported that effective weed control increased number of effective tillers hill^{-1} because of more availability of nutrients, light and water. Panicle length remained non-significant in different weed control treatment. The tallest panicle was seen in post-emergence (T_4) treatment. The highest number of grains panicle^{-1} (112.06) was observed in

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pre-emergence (T_3) treatment which was statistically similar with T_2 and T_4 (Table 2). The lowest number of grains panicle^{-1} (96.87) was found in no weeding treatment (Table 2). It clearly indicates that weed checked condition produced more number of grains panicle^{-1} as plant grow vigorously without crop weed competition. The number of sterile grains panicle^{-1} in no weeding treatment (24.73) was statistically superior to other (Table 2). The lowest sterile grains panicle^{-1} (16.23) was observed in (T_2) hand weeding twice. Crop weed competition might be the reason of maximum sterile grains panicle^{-1} in no weeding condition. This result are in close agreement with Ferdous *et al.,* [16] and Mondal *et al.,* [12] they found the highest sterile grains panicle^{-1} in no weeding and lowest from weed free treatment. The weight of 1000 grains were highest (24.48gm) in hand weeding twice (T_2) and lowest weight of 1000 grains (22.94) were found in no weeding treatment (Table 2). Identical result was found by Mondal *et al.,* [12] who found highest weight of 1000 grains in hand weeding twice and lowest in no weeding.

Table 2: Effect of different weed control methods on growth and yield attributes of T. aus rice.

Treatments	Plant height (cm)	Total no. of tillers hill^{-1}	Effective tillers hill^{-1}	Panicle length (cm)	Number of grains panicle^{-1}	Sterile grains panicle^{-1}	1000 grains weight (gm)	Grain yield (t ha^{-1})	Straw yield (t ha-1)	Harvest index (%)
No weeding (T_1)	91.78	16.28 b	11.06 b	21.33	96.87 b	24.73 a	22.94 c	1.87 c	5.46	25.69 c
Hand weeding twice (T_2)	95.56	18.44 b	14.45 a	21.16	107.78 a	16.23 b	24.48 a	3.35 ab	6.28	34.98 ab
Pre-emergence herbicide (T_3)	93.06	18.61 b	13.39 ab	21.28	112.06 a	19 b	24.13 ab	3.67 a	6.29	37.17 a
Post-emergence herbicide (T_4)	95.22	22.47 a	15.39 a	22.39	105.15 ab	20.69 ab	23.34 bc	3.08 b	7.1	30.48 bc
LSD0.05	ns	3.25	2.78	ns	10.3	4.36	1.04	0.39	ns	6.02
CV (%)	6.4	13.85	16.56	6.01	7.89	17.44	3.53	10.49	15.03	15.17
LS	ns	**	*	ns	*	**	*	**	ns	**

In a column, values having similar letter do not differ significantly whereas values with dissimilar letter differ significantly as per DMRT. **=Significant at 1% level of probability, * =Significant at 5% level of probability, ns = Non-significant.

Grain yield influenced significantly in different weed control methods (Table 2). The highest grain yield (3.67 t ha^{-1}) was obtained from pre-emergence (T_3) herbicide which was statistically similar with hand weeding twice (T_2) as a result of less weed crop competition and the lowest (1.87 t ha^{-1}) was found from no weeding treatment. This result is in conformity with M. Hasanuzzaman *et al.,* [17] who reported maximum grain yield produced in application of pre-emergence herbicide + one hand weeding which was statistically identical with hand weeding twice and lowest yield was found in no weeding. Different weed control methods had non-significant effect on straw yield. The highest straw yield of 7.1 t ha^{-1} was found in post-emergence herbicide (T_4) application and the lowest straw yield was obtained from no weeding (5.46 t ha^{-1}) (Table 2). This result has similarity with Islam *et al.,* [11] where post-emergence application of pyrazosulfuron ethyl also performed well for straw yield. The highest harvest index was obtained from pre-emergence (T_3) herbicide (37.17 %) which was statistically identical with hand weeding twice and lowest (25.69 %) harvest index was found in no weeding (Table 2).

Interaction effect of variety and different weed control methods on growth and yield attributes of T. aus rice

Interaction effect had significant effect only on effective tillers hill^{-1} (Table 3). The tallest plant 104.44 cm was observed in BRRI dhan 83 at post-emergence herbicide application (T_4V_1) and the shortest plant 81.22 cm was observed from BRRI dhan 65 at no weeding treatment (T_1V_2) (Table 3). The highest total number of tillers hill^{-1} (26.82) was observed in BRRI dhan 65 for post emergence herbicide (T_4V_2) application and lowest total number of tillers hill^{-1} (10.67) was observed in BRRI dhan 83 for no weeding treatment (T_1V_1) (Table 3). Effective tillers hill^{-1} was affected significantly by the interaction between variety and different methods of weed control. The highest number of effective tillers hill^{-1} (19.78) was observed in BRRI dhan 65 for hand weeding (T_2V_2) and lowest effective tillers hill^{-1} (6.78) was observed in BRRI dhan 83 for no weeding treatment (T_1V_1) (Table 3). The highest length of panicle (23cm) was observed in BRRI dhan 83 at post-emergence herbicide application (T_4V_1) and the lowest length of panicle (19.78 cm) was observed from BRRI dhan 65 at pre emergence treatment (T_3V_2) (Table 3). The highest number of grains panicle^{-1} (139.45) was observed in BRRI dhan 83 both at hand weeding and pre emergence herbicide application and the lowest grains panicle^{-1} (73.97) was observed from BRRI dhan 65 at no weeding treatment (T_1V_2) (Table 3). The maximum number of sterile grains panicle^{-1} (28.02) was observed in BRRI dhan 83 at no weeding treatment (T_1V_1) the lowest number of sterilegrains panicle^{-1} (14.68) was observed from BRRI dhan 83 at hand weeding treatment (T_2V_1) (Table 3). Highest weight of thousand grains (26.27gm) was found in hand weeding for BRRI dhan 83 (T_2V_1) and the lowest 1000 grains weight (21.15gm) was observed in no weeded plots of BRRI dhan 65 (T_1V_2) (Table 3).

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Table 3: Interaction effect of variety and different weed control methods on growth and yield attributes of T. aus rice

Interactions	Plant height (cm)	Total no. of tillers hill^{-1}	Effective tillers hill^{-1}	Panicle length (cm)	Number of grains panicle^{-1}	Sterile grains panicle^{-1}	1000 grains weight (gm)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
T_1V_1	102.33	10.67	6.78 e	22.33	119.78	28.02	24.72	1.91	5.09	27.35
T_1V_2	81.22	21.89	15.33 bc	20.33	73.97	21.44	21.15	1.83	5.84	24.02
T_2V_1	99.22	11.78	9.11 de	22.11	139.45	14.68	26.27	3.84	5.46	41.28
T_2V_2	91.89	25.11	19.78 a	20.22	76.11	17.78	22.7	2.83	7.09	28.7
T_3V_1	98.78	15.44	12.33 cd	22.78	139.45	17.57	24.73	4.12	5.84	41.55
T_3V_2	87.33	21.78	14.45 c	19.78	84.67	20.44	23.53	3.22	6.73	32.78
T_4V_1	104.44	18.11	11.56 cd	23	133.74	22.48	24.8	3.46	6.83	34.16
T_4V_2	86	26.82	19.22 ab	21.78	76.56	18.89	21.87	2.69	7.38	26.8
CV(%)	6.4	13.85	16.56	6.01	7.89	17.44	3.53	10.49	15.03	15.17
LS	ns	ns	*	ns	ns	ns	ns	ns	ns	ns

In a column, values having similar letter do not differ significantly whereas values with dissimilar letter differ significantly as per DMRT. **=Significant at 1% level of probability, * =Significant at 5% level of probability, ns = Non-significant.

Maximum grain yield (4.12 tha^{-1}) was observed in BRRI dhan 83 at pre-emergence herbicide (T_3V_1) application and the lowest grain yield (1.83 tha^{-1}) was observed at no weeding in BRRI dhan 65 (T_1V_2) (Table 3). The maximum straw yield (7.38 tha^{-1}) was observed in BRRI dhan 65 at post-emergence herbicide application (T_4V_2) and the minimum straw yield (5.09 tha^{-1}) was observed at no weeding in BRRI dhan 83 (T_1V_1) (Table 3). The maximum harvest index (41.55 %) was observed in BRRI dhan 83 at pre-emergence herbicide (T_3V_1) application and the minimum harvest index (24.02 %) was observed at no weeding in BRRI dhan 65 (T_1V_2) (Table 3).

Conclusion

Weeds always compete with the crop for resources like light, water, nutrient which are needed for plant growth and to produce more yield that's why no weeding plots gave significantly inferior growth and yield response than weed checked plots. In this study, greater weed infestation in the unweeded plots resulted in the lowest grain yield. Controlling weed is a challenging task in agriculture to maintain crop yield and to increase production. Farmers hardly follow the appropriate methods of weed control that's why aus rice production in Bangladesh still falling behind. Among the tested weed control methods pre-emergence herbicide (Acetachlore 14% + Bensulfuron methyle 4%) performed very well in controlling weeds compared to other methods of weed control. Despite some offensive effects on nature, no efficient alternative is currently available to shift the herbicidal weed control in aus rice as manual hand weeding is laborious and costly. So more emphasis is needed to develop biodegradable, eco-friendly herbicides. However, to attain a final decision more research work on Aus rice with the same treatment should be done in different Agro-ecological Zones (AEZs) of Bangladesh.

Conflict of Interest

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

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