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Research Article

Yield and Grain Protein Content of Aromatic *Boro* Rice (cv. BRRI dhan50) as Influenced by Integrated Fertilizer and Weed Management

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Abstract

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during December 2014 to May 2015 to study the effect of integrated fertilizer and weed management on the yield and gain protein content of aromatic *Boro* rice (cv. BRRI dhan50). The experiment comprised six sets of fertilizer managements. 1. Negative control having no fertilizers and no manures, 2. Recommended dose of inorganic fertilizers (i.e. Urea, TSP, MoP, Gypsum, $ZnSO_4$ @ 250, 120, 120, 100, 10 kg ha^{-1}, respectively), 3. 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, 4. 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, 5. 50% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}, 6. 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}. Four weed managements 1. Control (no weeding), pre-emergence herbicide, 2. Panida 33 EC + one hand weeding at 35 DAT, 3. Post-emergence herbicide, Granite 240 SC + one hand weeding at 35 DAT and 4. Pre-emergence herbicide, Panida 33 EC + post-emergence herbicide, Granite 240 SC. The highest grain yield (6.40 t ha^{-1}), grain protein content (7.79%) and benefit cost ratio (2.20) were obtained from 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha^{-1} + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha^{-1} while their corresponding lowest values were found in weedy check without fertilization. Weed infestation reduced 58.28% grain yield in control plots due to crop-weed competition compared to plot receiving pre-emergence herbicide + post-emergence herbicide. It can be concluded that 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} combined with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha^{-1} + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha^{-1} may be used to obtain the highest grain yield and grain protein content of aromatic *Boro* rice (cv. BRRI dhan50).

Keywords: Aromatic *Boro* rice; integrated fertilizer and weed management; yield; grain protein

Introduction

Food security is a burning issue of the world at present. Increased rice production can play a vital role to address this issue successfully. Rice is consumed as the staple food in Bangladesh and has been given the highest priority in meeting the demands of its ever-increasing population. It is the most important food crop and a primary food source for more than one-third of world's population (Singh and Singh, 2008). Rice contributes 95% of total food production in Bangladesh. About 77.07% of cropped area of Bangladesh is used for rice production, with annual production of 33.83 million ton from 11.41 million ha of land, which contribute about 19.60% of the country's GDP (BBS, 2013). Aromatic rice contributes a small portion (10%) but an important subgroup of rice production. Total aromatic rice production is about 0.297 million tons in 2013 from 0.158 million ha of land in Bangladesh. In general, aromatic rice is classified by its length, thickness and aroma. However, the price of aromatic rice is 2-3 times higher than that of coarse rice (Chowdhury *et al.,* 1993). Sarkar *et al.* (2014) reported that Bangladesh has a bright prospect for export of fine rice thereby earning foreign exchange. The yield of fine rice is lower than that of coarse and medium rice varieties. The reason for low yield are mainly associated with selection of improved varieties and judicious fertilizer management especially of organic fertilizers like cowdung, poultry manure and/or their integration with inorganic fertilizers. In recent years, aromatic rice has been introduced to the global market. In Bangladesh, a number of fine rice cultivars are grown viz. Chinisagar, Badshabhog, Kataribhog, Kalizira, Tulsimala, Dulabhog, Basmati, BRRI dhan34, BRRI dhan37 and BRRI dhan38. Currently Bangladesh Rice

Research Institute (BRRI) developed a new aromatic rice variety having long grain namely, BRRI dhan50 (Banglamati) for *Boro* season.

Weeds are major causes of yield loss in upland rice and its control is labour intensive. The climate as well as the edaphic condition of Bangladesh is favourable for the luxuriant growth of weeds. So, the rice crops are usually infested heavily with weeds resulting in the reduction in grain yield. The yield loss due to weed competition are 68-100% in direct seeded *Aus* rice, 22% in modern *Boro* rice (Mamun, 1990), 40% in HYV transplant *Aman* rice (Haque *et al.*, 2012) and 28.16% in aromatic fine rice in *Aman* season (Zannat *et al.*, 2014). There is no doubt that maximum benefit for costly inputs like fertilizers and pesticides in rice can be fully derived when the crop is kept free from weed infestation.The traditional method of weed control is hand weeding which is very much laborious and time consuming. Mechanical weeding and herbicides are the alternative to hand weeding. Herbicides are effective in controlling weeds alone or in combination with hand weeding. Weed competition at early growth stage can be eliminated through pre-emergence and post-emergence herbicides like Panida, Ronstar 25 EC, Rifit 50 EC, Granite 240 SC and 2, 4-D amine which are good selective, pre-emergence and post-emergence herbicides (Ahmed *et al*., 2005).

In all the agricultural systems there is a loss of plant nutrients. Nutrient mining, depletion of soil organic matter and reduction in soil aggregates have been identified as reasons of yield stagnation or decline in the productivity of crops (Rahman and Yakupitiyage, 2006). Application of cow dung, poultry manure along with other inorganic fertilizers and weed management are the important means in augmenting the yield of crop. The efficient fertilizer and weed management may increase crop yield and at the same time reduces production cost. Therefore, the present study was undertaken to evaluate the effects of integrated fertilizer and weed management on the yield and grain protein content of aromatic *Boro* rice (cv. BRRI dhan50).

Materials and Methods

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from December 2014 to May 2015 to study the effect of integrated fertilizer and weed management on the growth, yield and quality of aromatic *Boro* rice (cv. BRRI dhan50). The experimental site belongs to the Sonatola series of the dark grey floodplain soil type under Old Brahmaputra Floodplain Agro-Ecological Zone (AEZ-9). The field was a medium high land with well drained silty-loam texture having pH 6.5 and 1.29% organic matter content. The experiment comprised six sets of fertilizer managements. 1. Negative control having no fertilizers and no manures, 2. Recommended dose of inorganic fertilizers (i.e. Urea, TSP, MoP, Gypsum, ZnSO4 @ 250, 120, 120, 100, 10 kg ha-1, respectively), 3. 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha-1, 4. 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha-1, 5. 50% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha-1, 6. 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha-1. Four weed managements viz. control (no weeding), pre-emergence herbicide, Panida 33 EC + one hand weeding at 35 DAT, post-emergence herbicide, Granite 240 SC + one hand weeding at 35 DAT, pre-emergence herbicide, Panida 33 EC + post-emergence herbicide, Granite 240 SC. The experiment was laid out in a factorial randomized complete block design with three replications.

The nursery beds were puddled with country plough, cleaned and levelled with ladder. Then the sprouted seeds were sown in the nursery beds on 07 December 2014. At the time of final land preparation, respective unit plots were amended with organic and inorganic fertilizers according to treatment specification. Urea was top dressed in three equal splits at 15, 35 and 55 DAT (panicle initiation stage). Full dose of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied at final land preparation. Thirty five-day old seedlings were transplanted on 10 January 2015 in the well puddled plot. Three seedlings were transplanted hill^{-1} with a spacing of 25 cm × 15 cm. The weed density and biomass of infesting weeds were recorded at 60 DAT with the help of a plant quadrate measuring 1 m × 1 m from each plot. The collected weeds were dried in an electric oven for 72 hours at a temperature of 85 ± 5°C. After drying, the dry weight of each plot was recorded by an electrical balance. Prior to harvest, five hills plot^{-1} were randomly selected excluding border hills and central 1 m^2 area from each unit plot for recording data on yield components. The crop of central 1 m^{2}harvest area of each plot was harvested at full maturity when 85% of the grain became golden yellow in color on 07 May 2015. The harvested crop of each plot was separately bundled, properly tagged and then threshed. Grains were then cleaned and sun dried to a moisture content of 14%. Finally the grain and straw yields plot^{-1} were recorded and converted into t ha^{-1}. Estimation of protein (%) in grains was done by Micro-Kjeldahl Method (AOAC, 1984). Collected data were analyzed following the analysis of variance (ANOVA) technique and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Table 1. Effect of integrated fertilizer management on yield and yield contributing characters of aromatic *Boro* rice (cv. BRRI dhan50)

Integrated fertilizer management	**Plant height (cm)**	**No. of total tillers hill^{-1}**	**No. of effective tillers hill^{-1}**	**No. of non-effective tillers hill^{-1}**	**Panicle length (cm)**	**No. of total spikelets panicle^{-1}**	**No. of grains panicle^{-1}**	**No. of sterile spikelets panicle^{-1}**	**1000-grain weight (g)**	**Grain yield (t ha^{-1})**	**Straw yield (t ha^{-1})**	**Harvest index (%)**	**Grain protein content (%)**
F_0	75.22b	12.96c	10.83c	2.53a	20.92b	135.5c	113.6d	21.87b	18.96	2.90c	3.89d	38.84c	4.27e
F_1	81.38a	17.52b	15.03b	2.49ab	21.98a	144.1b	121.2c	23.43b	19.30	4.72b	6.12ab	41.65b	6.74c
F_2	80.86a	16.88b	14.74b	2.15d	22.17a	157.4a	129.0ab	28.33a	19.26	4.55b	5.47c	44.06b	5.94d
F_3	81.63a	16.82b	14.44b	2.38bc	21.96a	156.6a	128.9ab	27.61a	19.17	5.27a	6.27ab	43.09b	7.49a
F_4	81.84a	16.61b	14.26b	2.35c	21.90a	155.9a	126.4b	29.50a	19.28	4.78b	5.97b	42.97b	6.54c
F_5	82.75a	18.90a	16.36 a	2.16d	22.51a	162.1a	132.4a	29.63a	19.45	5.56a	6.56a	47.05a	7.69a
$S_{\bar{x}}$	0.778	0.295	0.291	0.044	0.225	2.31	1.79	0.775	0.121	0.130	0.183	0.764	0.154
Level of sig.	**	**	**	**	**	**	**	**	NS	**	**	**	**
CV (%)	3.35	6.18	7.06	6.69	3.57	5.27	4.97	10.05	2.17	9.68	11.15	6.05	4.65

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).
** =Significant at 1% level of probability
NS = Non-significant
F_0 = Control (no fertilizer and no manure)
F_1 = Recommended dose of inorganic fertilizer (Urea, TSP, MoP, Gypsum, $ZnSO_4$ @ 250, 120, 120, 100, 10 kg ha^{-1}, respectively).
F_2 = 50% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha^{-1}
F_3 = 75% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha^{-1}
F_4 = 50% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha^{-1}
F_5 = 75% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha^{-1}

Table 2: Effect of weed management on yield and yield contributing characters of aromatic *Boro* rice (cv. BRRI dhan50)

Weed management	Plant height (cm)	No. of total tiller $hill^{-1}$	No. of effective tillers $hill^{-1}$	No. of non-effective tillers $hill^{-1}$	Panicle length (cm)	No. of total spikelets $panicle^{-1}$	No. of grains $panicle^{-1}$	No. of sterile spikelets $panicle^{-1}$	1000-grain weight (g)	Grain yield (t ha^{-1})	Yield loss (%)	Straw yield (t ha^{-1})	Harvest index (%)	Grain protein content (%)
W_0	79.12b	11.64c	8.72c	2.470b	20.94b	132.2c	110.6c	21.65c	19.00b	2.34c	58.28a	4.24c	34.71b	4.23d
W_1	81.11a	17.90b	15.26b	2.639a	21.99a	153.3b	126.5b	26.80b	19.28ab	5.20b	7.31b	5.72b	46.96a	6.77b
W_2	80.45ab	17.96b	15.63b	2.328c	22.21a	159.2a	131.7a	29.41a	19.40a	5.48ab	2.32c	6.42a	46.08a	5.37c
W_3	81.76a	18.96a	16.49a	2.07d	22.48a	163.1a	130.3ab	29.07a	19.27ab	5.61a	0.00	6.41a	47.26a	7.51a
$S_{\bar{x}}$	0.636	0.241	0.238	0.036	0.184	1.88	1.46	0.632	0.099	0.106	0.674	0.149	0.624	0.112
Level sig.	*	**	**	**	**	**	**	**	*	**	**	**	**	**
CV (%)	3.35	6.18	7.06	6.69	3.57	5.27	4.97	10.05	2.17	9.68	9.74	11.15	6.05	4.65

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).
** = Significant at 1% level of probability.
* = Significant at 5% level of probability.
NS = Non-significant.
W_0 = control (unweeded)
W_1 = pre-emergence herbicide, Panida 33 EC @ 2.5 l ha^{-1} + one hand weeding at 35 days after transplanting (DAT)
W_2 = post-emergence herbicide, Granite 240 SC @ 93.70 ml ha^{-1} + one hand weeding at 35 days after transplanting (DAT)
W_3 = pre-emergence herbicide, Panida 33 EC @ 2.5 l ha^{-1} + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha^{-1}.

Table 3: Effect of interaction between integrated fertilizer and weed management on yield and yield contributing characters of aromatic *Boro* rice (cv. BRRI dhan50)

Integrated fertilizer × weed management	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tillers hill^{-1}	Panicle length (cm)	No. of total spikelet panicle^{-1}	No. of grains panicle^{-1}	No. of sterile spikelet panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	BCR
$F_0 \times W_0$	72.67	8.38m	5.47h	3.12a	19.90	122.0l	104.3j	17.67h	18.90	1.85l	3.65i	34.35hi	1.01
$F_0 \times W_1$	74.13	13.89ij	11.20g	2.69d	21.14	131.7jkl	109.7ij	22.00gh	18.87	2.09ij	3.93h	36.72 g	1.02
$F_0 \times W_2$	76.00	13.33jk	11.53fg	1.81k	21.68	143.3ghij	120.3fghi	23.07g	19.06	2.17i	4.04h	39.24cdefg	1.06
$F_0 \times W_3$	78.10	17.22efg	14.13e	3.09b	20.95	145.0ghij	120.3fghi	24.73defg	19.02	2.20gh	4.60gh	37.06defg	1.09
$F_1 \times W_0$	82.10	13.22jk	11.13g	2.09hijk	21.71	131.3jkl	110.0ij	21.33gh	19.02	2.32kl	4.29h	28.60j	1.02
$F_1 \times W_1$	84.17	18.78cdef	16.40bcd	2.38fgh	22.51	155.7defg	129.7cdefg	26.00cdefg	19.52	6.21abc	7.87cde	48.19bcd	2.19
$F_1 \times W_2$	78.97	21.00ab	17.60abc	2.40fjk	21.72	147.4fghi	124.0efgh	23.40fg	19.40	5.52bcdefg	6.85cde	45.95cdefg	1.96
$F_1 \times W_3$	80.27	17.10fg	15.00de	2.10hij	21.95	142.0ghij	121.0fghi	23.00g	19.25	5.39cdefg	7.20abc	42.87fg	1.93
$F_2 \times W_0$	77.00	9.17l	7.33h	1.83jk	20.97	133.0ijkl	111.4ij	21.60gh	19.16	2.39kl	4.03h	32.44ij	1.03
$F_2 \times W_1$	80.67	20.20abcd	17.53abc	2.67de	22.82	153.0efgh	129.0defg	24.00efg	19.23	5.08defgh	6.49cde	44.48defg	1.81
$F_2 \times W_2$	83.10	19.11bcde	16.87abc	2.24ghi	22.53	163.4cde	134.3abcde	28.73bcde	19.28	5.32cdef	6.61cde	49.14bcdf	1.90
$F_2 \times W_3$	82.65	19.05bcde	17.21abc	1.84jk	22.35	161.3cdef	141.3abc	38.01a	19.36	5.06fgh	6.40fgh	49.05bcdef	1.81
$F_3 \times W_0$	81.11	12.61jk	10.27g	2.34fgh	20.93	139.5hijk	117.1hi	22.40gh	18.96	3.04h	5.00def	43.32fg	1.25
$F_3 \times W_1$	80.75	13.78ij	11.53g	2.25ghi	22.95	153.4efgh	123.6efgh	29.80bc	19.17	6.18abc	7.84efg	49.08bc	2.11
$F_3 \times W_2$	82.67	20.33abcd	18.07ab	2.263ghi	22.45	170.3abcd	138.4abcd	31.93b	19.23	5.62abcdef	7.18abcd	43.88efg	1.94
$F_3 \times W_3$	82.00	20.55abc	17.89abc	2.67de	21.51	163.0cde	136.7abcd	26.33cdefg	19.33	5.90abc	7.51cde	48.70abcde	2.03
$F_4 \times W_0$	80.55	11.78k	9.77g	2.00ijk	20.13	125.0kl	102.0j	23.00g	18.90	2.59jkl	4.56h	32.35ij	1.12
$F_4 \times W_1$	82.28	20.99ab	17.93abc	3.050bc	22.39	160.5cdef	129.8cdefg	30.67bc	19.38	4.99efgh	6.16cde	44.78defg	1.77
$F_4 \times W_2$	80.28	15.17hi	13.31ef	1.86jk	22.57	175.3abc	132.0abcdef	32.33b	19.64	5.78abcde	6.32cde	47.79abcdef	2.04
$F_4 \times W_3$	84.25	18.52def	16.00cd	2.520defg	22.49	162.7cde	130.7bcdefg	32.00b	19.22	5.92abc	8.00bcd	46.95bcdef	2.13
$F_5 \times W_0$	81.31	15.67gh	13.33ef	2.330fgh	22.01	142.7ghij	118.8ghi	23.87efg	19.06	3.19jk	4.62i	37.20h	1.29
$F_5 \times W_1$	84.67	19.78abcd	16.98abc	2.80cd	23.05	165.3bcde	137.0abcd	28.33bcdef	19.49	5.88abcd	7.68efg	51.06a	2.02
$F_5 \times W_2$	81.68	18.80cdef	16.40bcd	2.40efg	22.33	179.0ab	142.7a	37.00a	19.82	6.24abc	8.116ab	49.50b	2.15
$F_5 \times W_3$	83.32	21.30a	19.50a	1.80l	22.65	179.12a	142.0ab	29.33bcd	19.45	6.40a	8.22 a	47.31bcde	2.20
$S_{\bar{x}}$	1.55	0.591	0.583	0.089	0.451	4.62	3.59	1.55	0.241	0.260	0.366	1.52	
Level of sig.	NS	**	**	**	NS	**	**	**	NS	**	**	**	
CV (%)	3.35	6.18	7.06	6.69	3.57	5.27	4.97	10.05	2.17	9.68	11.15	6.05	

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT). ** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Non-significant

F_0 = Control, F_1 = Recommended dose of inorganic fertilizer (Urea, TSP, MoP, Gypsum, $ZnSO_4$ @ 250, 120, 120, 100, 10 kg ha^{-1},respectively), F_2 = 50% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha^{-1}, F_3 = 75% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha^{-1}, F_4 = 50% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha^{-1}, F_5 = 75% of recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha^{-1}, W_0 = control (unweeded), W_1 = pre-emergence herbicide (Panida 33 EC) + one hand weeding at 35 DAT, W_2 = post-emergence herbicide (Granite 240 SC) + one hand weeding at 35 DAT, W_3 = pre-emergence herbicide (Panida 33 EC) + post-emergence herbicide herbicide (Granite 240 SC).

Results and Discussion

Effect of Integrated Fertilizer Management

Table 1 shows that crop-characters, yield-contributing characters and yield were significantly influenced by fertilizer management. The application of 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} showed superiority in terms of the highest plant height (82.75 cm). Number of total tillers $hill^{-1}$ (18.90), number of effective tillers $hill^{-1}$(16.36), panicle length (22.51 cm), number of grains $panicle^{-1}$ (132.4), grain yield (5.56 t ha^{-1}), straw yield (6.56 t ha^{-1}) and harvest index (47.05%). The second highest of the same parameters was found in 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, which was statistically at par with 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}. Pal *et al.* (2016) found that number of grains $panicle^{-1}$ increased with combined application of organic and inorganic fertilizers. Roy *et al.* (2015) reported that integrated nutrient can increase grain yield of *Boro* rice. Probably combined application of inorganic fertilizers withmanure provided adequate nutrients to the plants and exhibited the best performance due to absorption of more nutrients and moisture. These results are in agreement with that of Kabir *et al.* (2004) who found differences in yield and yield contributing characters increased due to different levels of fertilizer management. The treatment control (no fertilizer and manure) gave the lowest values for the same parameters due to lack of proper nutrient uptake. The lowest number of non-effective tillers $hill^{-1}$ (2.15) was found from the treatment 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}. The highest grain protein content (7.69%) was found when fertilized with 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}, which was statistically identical to the grain protein content (7.49%) obtained from 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}. This might be due to availability and uptake of adequate nitrogen from the soil. The lowest grain protein content (4.27%) was observed in control (no fertilizer and no manure). Biswas *et al.* (2016) and Sarkar *et al.* (2014) reported the similar increasing trend of grain protein content in case of aromatic fine rice. Grain protein content increased significantly at higher amount of nitrogen application was reported elsewhere (Chandel *et al*., 2010 and Ray *et al.*, 2015).

Effect of Weed Management

Weed management influenced significantly crop characters, yield contributing characters and yield (Table 1). The tallest plant (81.76 cm), number of total tillers $hill^{-1}$ (18.96), number of effective tillers $hill^{-1}$ (16.49), panicle length (22.48 cm), number of grains $panicle^{-1}$ (131.7), grain yield (5.61 t ha^{-1}), straw yield (6.41 t ha^{-1}) and harvest index (42.26%) were recorded in pre-emergence herbicide, Panida 33 EC @ 2.5 l ha^{-1} + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha^{-1}. The second highest of the same parameters was found in pre-emergence herbicide, Panida 33 EC + one hand weeding at 35 DAT, which was statistically identical with post-emergence herbicide, Granite 240 SC + one hand weeding at 35 DAT. The treatment control (unweeded) gave the lowest values for the same parameters under unweeded condition. Weed competed with the crop for nutrition, water, air, sunlight and space thus reducing yield. The grain yield reduced 58.28% in control plots followed by (7.31 %) pre-emergence herbicide, Panida 33 EC @ 2.5 l ha^{-1} + one hand weeding at 35 DAT over pre-emergence herbicide, Panida 33 EC @ 2.5 l ha^{-1} + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha^{-1}. The increased yield in weeded crops was contributed by higher number of effective tillers $hill^{-1}$ and higher number of grains $panicle^{-1}$ over no weeding treatment. This might be due to the fact that the weeding kept the land clean and soil was well aerated which facilitated the crop for better absorption of nutrients, moisture and solar radiation for higher yield. Effective weed management enhanced production of effective tillers $hill^{-1}$and grains $panicle^{-1}$, which ultimately increased grain yield of rice. Zannat *et al*. (2014) found that weed infestation reduced 28.16% yield in control plots compared to three weedings in aromatic fine rice.

Effect of Interaction between Integrated Fertilizer and Weed Management

The interaction effect of integrated fertilizer and weed management was significant on yield and yield contributing characters of aromatic *Boro* rice (cv. BRRI dhan50) (Table 3). The highest number of total tillers $hill^{-1}$ (21.30), number of effective tillers $hill^{-1}$ (19.50), panicle length (22.65cm), grain yield (6.40 t ha^{-1}) and straw yield (8.22 t ha^{-1}) were recorded in the interaction between 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha^{-1} + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha^{-1}. The lowest values of these parameters were found in the interaction between control fertilizers under unweeded condition, which was statistically identical to the treatment 50% of recommended dose of inorganic fertilizer + cowdung @ 5 t ha^{-1} with unweeded. The highest harvest index (51.06%) was found in the interaction between 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} with pre-emergence herbicide, Panida 33 EC. The highest grain protein content (7.79%) was recorded in the interaction of 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha^{-1} + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha^{-1} while the lowest grain protein content (4.37%) was observed in control fertilizer under unweeded condition. Application of inorganic fertilizer with organic manure increased protein content ability of fine rice was reported elsewhere (Sarkar *et al.*, 2014; Pal *et al.*, 2016 and Biswas *et al.*, 2016). As like as grain yield and protein content the highest benefit cost ratio (2.20) was found in the interaction of 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} with pre-emergence herbicide, Panida 33 EC @ 2.5 l ha^{-1} + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha^{-1} .

Relationship between Weed Biomas Production at 60 DAT and Grain Yield

A negative relationship between weed dry matter production and grain yield of aromatic *Boro* rice (cv. BRRI dhan50) was observed, which indicated that higher the weed dry matter production lower the grain yield. The response of weed dry matter production to the grain yield of rice followed a linear negative relationship that could be adequately described by regression equation. The regression equation indicates that an increase in weed dry matter production would led to a decrease in the grain yield of rice (Fig. 1).

Conclusion

From the present study, it can be concluded that application of 75% is the recommended dose of inorganic fertilizers and poultry manure @ 2.5 t ha^{-1} along with pre-emergence herbicide. Panida 33 EC @ 2.5 l ha^{-1} + post-emergence herbicide, Granite 240 SC @ 93.70 ml ha^{-1} may be used to obtain the highest grain yield and grain protein content of aromatic *Boro* rice (cv. BRRI dhan50).

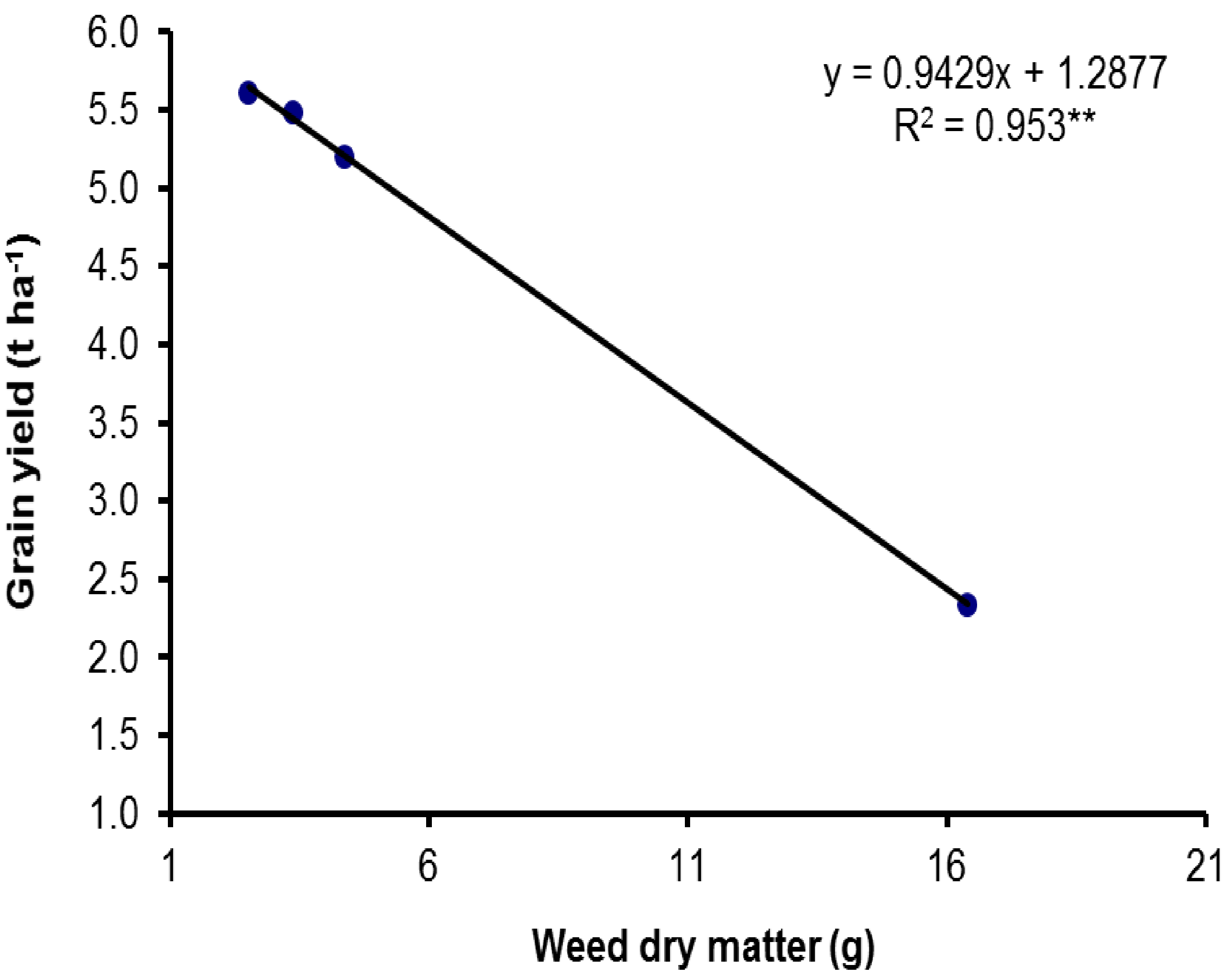

Fig 1: Relationship between weed dry matter production at 60 DAT and grain yield of aromatic *Boro* rice (cv. BRRI dhan50)

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