REVIEW ARTICLE

INFLUENCE OF WEED INTERFERENCE PERIOD AND PLANTING SPACING ON THE WEED PRESSURE AND PERFORMANCE OF BORO RICE CV. BRRI DHAN29

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ABSTRACT

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To study the influence of weed interference period and planting spacing on the weed pressure and performance of Boro rice cv. BRRI dhan29 an experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University from December 2015 to May 2016. The experiment comprised six weed interference periods (viz. weed free, weed free up to 20 DAT, weed free up to 40 DAT and weed free up to 60 DAT, weed free up to 80 DAT and weedy condition) and three spacing of planting (viz. 25 cm × 15 cm, 25 cm × 10 cm, 25 cm × 20 cm) following randomized complete block design with three replications. The highest number of total tillers hill⁻¹ (14.98), effective tillers hill⁻¹ (12.98), filled grains panicle⁻¹ (117.9), grain yield (5.40 t ha⁻¹), straw yield (7.94 t ha⁻¹) and biological yield (40.53 t ha⁻¹) were found weed free up to 80 DAT. Considering cost and time consuming, best tillers hill⁻¹ (15.88), effective tillers hill⁻¹ (13.88), filled grains panicle⁻¹ (121.70) and grain yield (6.14 t ha⁻¹) were found in spacing 25 cm × 15 cm with weed free up to 80 DAT. Weed density and dry weight were increased with the increasing weed interference period but rice grain yield increased gradually with the decreasing weed interference period. Weed free up to 80 DAT can be recommended from economic view point following the spacing of 25 cm × 15 cm for better weed suppression and higher yield of BRRI dhan29.

KEYWORDS

Weed interference, planting spacing, yield contributing characters, BRRI dhan29.

1. INTRODUCTION

Bangladesh is striving hard for rapid development of its economy. The economic development of the country is mainly based on agriculture. Bangladesh agriculture involves food production for 163.65 million people from merely 8.75 million hectares of agricultural land (Salam et al., 2014). Adequate rice production is the key to ensure food security in Bangladesh. In fact, 'Rice security' is identical to 'Food security' in Bangladesh as in many other rice growing countries (Brolley, 2015). Rice safety is not just an economic issue but also an important parameter for determining social and political stability (Nath, 2015). Increasing crop density by narrowing row spacing enhances crop competitiveness against weeds. Narrow rows and higher plant density favor crop to compete with weeds and consequently produce higher yield (Anwar et al., 2011). Best spacing contributed maximum number of total tillers m⁻², maximum number of fertile tillers m⁻², which was reliant on temperature, moisture and other soil factors (Alam, 2006).

Weed is one of the most significant agricultural pests. Invasion of weed is one of the most important causes for low yield of rice. In Bangladesh, weed

infestation decreases the grain yield by 70-80% in Aus rice (early summer), 30-40% for transplanted Aman rice (autumn) and 22-36% for modern Boro rice cultivars (winter rice) (BRRI, 2008). A group researcher listed 18 usually growing weed species in aromatic Aman rice cv. Binadhan-9 and identified (Zannat et al., 2014). Islam observed 16 species of weeds belonging to 6 families to grow in connotation with transplant Aman rice (cv BRRI dhan49) (Islam, 2014). Jesmin listed 8 commonly growing weed species in Boro rice (Jesmin, 2006).

Weed intrusion period has a considerable influence on weeds and the associated crop performances. Khan observed that weeding rule had significant effect on all the parameters except 1000-grain weight (Khan, 2003). The highest grain yield (6.29 t ha⁻¹) was found from the weed free condition and it produces 37.33% higher yield than the no weeding condition. Some researchers reported that among the seven cultivars BR3 produced the highest yield and Ketchli Boro produced the lowest yield (Anwar et al., 1998). Average grain yield 4.95 t ha⁻¹ under weed free conditions, 3.89 t ha⁻¹ with farmers practice (hand weeding at up to 40 DAT) and 3.47 t ha⁻¹ in un-weeded controls. Aktaruzzaman reported that weeding regimes exerted significance influence on all the crop characters

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studied except panicle length (Aktaruzzaman, 2007). Malek observed that the highest plant height (98.04 cm), biological yield (10.79 t ha^{-1}), harvest index (40.88%), grains panicle⁻¹ (101.30), grain yield (4.48 t ha^{-1}), straw yield (6.36 t ha^{-1}), number of total tillers hill⁻¹ (15.32), effective tillers hill⁻¹ (10.91) were found from two weeding at 15 and 30 DAT (Malek, 2008).

In a study stated that crop received weed free treatment up to 60 DAT at which it recorded the least weed density and weed dry weight (Singh et al., 1999). Another group researcher observed that weeding interference period significantly affected all the plant characters (Bari et al., 1995). Researchers from Assam reported that different weed control practices significantly reduced the dry matter accumulation of weed and increased the rice yield over the un-weeded control in transplanted rice (Gogoi et al., 2000). A group researchers stated that hand weeding sowing to 40 DAT, weed free control and weedy control, grain yields were 1.86, 1.96 and 0.96 t ha^{-1} , respectively and weed dry weight was 93.8, 10.8 and 217.5 gm respectively (Mishra et al., 1985). Rahman reported that weed dry weight increased up to 40 DAT and was at a maximum between 30 to 40 DAT in unweeded plots, reducing the rice yield by 11.01% (Rahman, 1992). A group researcher stated that the highest plant height (111 cm) was produced due to weed free condition and the lowest (87.73 cm) plant height in control plot (Chowdhury et al., 1994).

A group researchers led an experiment with four spacing and found the highest plant height (112.57 cm) in $25 \text{ cm} \times 15 \text{ cm}$ and the lowest plant height (105.27 cm) in $20 \text{ cm} \times 10 \text{ cm}$. from the spacing of $25 \text{ cm} \times 15 \text{ cm}$ spacing (Tyeb et al., 2013). Haque observed that at 60 DAT, the highest plant height was recorded (82.16 cm) in $25 \text{ cm} \times 15 \text{ cm}$ and the lowest plant height was recorded (79.68 cm) in the spacing of $15 \text{ cm} \times 15 \text{ cm}$ (Haque, 2011). A group researcher worked with four spacing and reported that the highest no of total tillers hill⁻¹ and plant height (93.27 cm) were recorded from $20 \text{ cm} \times 10 \text{ cm}$ spacing (Bhowmik et al., 2012). Some scientist reported that out of three spacing ($10 \text{ cm} \times 15 \text{ cm}$, $20 \text{ cm} \times 15 \text{ cm}$, $30 \text{ cm} \times 15 \text{ cm}$) $20 \text{ cm} \times 15 \text{ cm}$ spacing gave the highest tillers (Kandil et al., 2010). A group researchers conducted an experiment with four spacing and four rice varieties (Tyeb et al., 2013). Spacing $25 \text{ cm} \times 15 \text{ cm}$ produced the highest number of effective tillers hill⁻¹ (13.46 cm), highest panicle length, highest grain yield 5.21 t ha^{-1} .

Khisha conducted an experiment during Boro season and found the lowest number of 6.22 non-effective tillers hill⁻¹ in SRI practice, which was 8 day old single seedling with $40 \text{ cm} \times 35 \text{ cm}$ spacing compared to the conventional practice (Khisha, 2002). Hasan and Sarker conducted an experiment during the Aman season with the cv (Hasan and Sarker, 2002). BRRI dhan32 and found in $25 \text{ cm} \times 25 \text{ cm}$ spacing, the panicle length was higher (25.74 cm) compared to the conventional practice (23.83 cm). Sobhan et al. (2003) reported that the highest number of grains panicle⁻¹ was obtained from the spacing $25 \text{ cm} \times 20 \text{ cm}$ (Sobhan et al., 2003). A group researcher reported that the highest number of grains panicle⁻¹ was obtained at a spacing of $30 \text{ cm} \times 30 \text{ cm}$ than the spacing of $20 \text{ cm} \times 20 \text{ cm}$ and $20 \text{ cm} \times 25 \text{ cm}$ (Ghosh et al., 1998).

Aktar and Uddin who reported that plant spacing had no influence on grain size because grain size was mainly controlled by gene not by environment (Aktar, 2004; Uddin, 2003). Moniruzzaman used four seedling ages and three spacings and found highest and lowest grain yields 5.86 t ha^{-1} and 4.98 t ha^{-1} from $20 \text{ cm} \times 15 \text{ cm}$ and $30 \text{ cm} \times 30 \text{ cm}$ spacing, respectively (Moniruzzaman, 2003). Plant spacing has remarkable effect on straw yield. Uddin (2003) reported that $25 \text{ cm} \times 15 \text{ cm}$ spacing recorded the highest straw yield although the straw yield was not greater than other two wider spacings $25 \text{ cm} \times 25 \text{ cm}$ and $25 \text{ cm} \times 20 \text{ cm}$. Grain yield together with straw yield are regarded as biological yield. A group researcher reported that the maximum grain yield (4.22 t ha^{-1}) was observed at the spacing $25 \text{ cm} \times 10 \text{ cm}$ closely followed by $25 \text{ cm} \times 15 \text{ cm}$ (4.21 t ha^{-1}) (Salah uddin et al., 2009).

Hossain results revealed that the highest biological yield (11.65 t ha^{-1}) was obtained from SRI planting method which the spacing of $25 \text{ cm} \times 15 \text{ cm}$ and the lowest (7.49 t ha^{-1}) was in conventional planting method with the

spacing of $25 \text{ cm} \times 15 \text{ cm}$ (Hossain, 2002). From Hossain it is evident that weed interference period and plant spacing have strong influence on the productivity of rice (Hossain, 2002). That is why, it is important to examine the effect of weed interference period and plant spacing on the yield and yield contributing attributes of BRRI dhan29. Therefore, the present research work has been planned and conducted to determine the effect of weed interference period and plant spacing option on the growth, yield and yield contributing character of Boro rice cv. BRRI dhan29 under Bangladesh condition.

2. MATERIALS AND METHODS

2.1 Site and weather description

The experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from December 2015 to May 2016. Geographically the experimental area is located at $24^{\circ}75' \text{ N}$ latitude and $90^{\circ}50' \text{ E}$ longitudes at the elevation of 18 m above the sea level under the agro-ecological zone of Old Brahmaputra Floodplain (AEZ-9). The experimental field was medium high land having silty loam soil with pH 6.8. Physical characteristics of soil were sand 20%, silt 67% and clay 13%. Textural class was silt loam. Drainage system was moderate. Chemical characteristics of soil were pH (6.5), organic matter (1.78%), total N (0.14%), available P (1.98 ppm), Exchangeable K (0.10 me %)(Source: Department of soil science, Bangladesh Agricultural University, Mymensingh).

2.2 Experimental treatments & design

Two experimental factors were included in the study namely factor. Factor A: Weed interference period: (weed free, weed free up to 20 DAT, weed free up to 40 DAT and weed free up to 60 DAT, weed free up to 80 DAT and weedy condition) and Factor B : Plant spacing (viz. $25 \text{ cm} \times 15 \text{ cm}$, $25 \text{ cm} \times 10 \text{ cm}$, $25 \text{ cm} \times 20 \text{ cm}$) following randomized complete block design with three replications. Total numbers of unit plots were $3 \times 6 \times 3 = 54$ and each plot size was $4.0 \text{ m} \times 2.5 \text{ m}$. The distance maintained between the individual unit plots was 0.5m and that between the replications 1.0 m.

2.3 Description of the Cultivar (BRRI dhan29)

BRRI dhan29 is a high yielding variety of rice developed by the Bangladesh Rice Research Institute, Joydebpur, Gazipur from the Cross, BR4 $\times$ BR2264 and was released in 1994 for cultivation as transplant Boro crop. The plant is 80-100 cm in height. It matures within 140-160 days with yield of $5-6 \text{ t ha}^{-1}$. The grains are medium bold with white kernels. It is resistant to sheath blight, leaf blight, stem rot, tungro and blast diseases (BRRI, 1995).

2.4 Cultivation of BRRI dhan29

Seeds were collected from the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. Healthy seeds were selected by specific gravity method. Seeds were then immersed in water in bucket for 24 hours. Then seeds were taken out of water and kept thickly spread in gunny bags. The seeds started sprouting after 48 hours and got ready to sow. A piece of land was selected for raising seedlings. The land was puddle well with country plough followed by leveling with a ladder. The sprouted seeds were sown in the wet nursery bed on 10 December 2015. Proper care was taken to raise the healthy seedlings in the nursery bed. Weeds were removed and irrigation was given in the nursery bed as and when necessary. The field was opened with a power tiller and subsequently ploughed four times with country plough followed by laddering. The layout of the field was made after final land preparation. Weeds and stubbles were removed and cleaned from individual plots.

The land was fertilized with urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate as per recommendation of BRRI for BRRI dhan29 (BRRI, 2012). Variety BRRI dhan29 was fertilized with 280-100-70-60-10 kg ha⁻¹ urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate, respectively. The entire amounts of triple superphosphate, muriate of potash, gypsum and zinc sulphate were applied at the time of final land preparation. Urea was applied in three installments at 15, 30 and 45 days after transplanting (DAT). The nursery

bed was made wet by application of water one day before uprooting the seedlings. The seedlings were uprooted on 20 January 2016 without causing much mechanical injury to the roots and they were immediately transferred to the main field. After uprooting the seedlings were graded. Healthy and similar sized seedlings were selected for transplanting. Seedlings were transplanted in the well prepared puddle field on 20 January 2016 at the rate of three seedlings hill⁻¹, maintained row and hill distance of 25 cm × 15 cm, 25 cm × 10 cm and 25 cm × 20 cm respectively. The weeding was done manually as per treatment. Seedlings in some hills died off, and those were replaced by gap filling (after 1 week of transplanting) with the seedling from the same source. Experimental field was given flood irrigation to maintain a constant level of standing water up to 6 cm in early stage to enhance tillering and 10-12 cm in later stage to discourage late tillering. A total of two irrigations at 45 DAT and 75 DAT were needed throughout the growing season. The field was finally drained out before 15 days of harvest to enhance maturity. Plants were infested with rice stem borers and leaf hoppers which were successfully controlled by applying Basudin 10 G @ 20 kg ha⁻¹. The crop damage by diseases like blast and brown spot was negligible. Observations were regularly made and the field looked nice with normal green plants.

The flowering was uniform. All the grains matured almost at the same time. The weeded plots were more vigorous than the un-weeded. Maturity of crops was determined when 90% of the grains became golden yellow in color. Five hills (excluding border hills) were selected randomly from each unit plot and uprooted before harvesting for recording necessary data. After sampling the whole plot was harvested at maturity. The harvested crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. Threshing was done by pedal thresher. The grains were cleaned and sun dried to moisture content of 14%. Straws were also sun dried properly. Finally grain and straw yields plot⁻¹ were recorded and converted to t ha⁻¹.

2.5 Collection of Data

2.5.1 Data Collected on Rice

2.5.1.1 Plant height

Average plant height was recorded from randomly selected five hills in each plot. The plant height was measured from the base of the plant to the tip of the upper most spikelet of the panicle of the same plant.

2.5.1.2 Number of total tillers hill⁻¹

To get the total tillers hill⁻¹, whole tillers were counted from each sample and then average of five samples was taken. It includes both effective and non-effective tillers.

2.5.1.3 Number of effective tillers hill⁻¹

To get the effective tillers hill⁻¹ only the ear bearing tillers were counted from each sample and then average of five samples was taken.

2.5.1.4 Number of non-effective tillers hill⁻¹

Only the non-effective tillers were counted from each sample and then average of five samples was taken.

2.5.1.5 Panicle length

Length of panicle was measured from each panicle and then average was expressed in cm from the first node to the tip of the panicle.

2.5.1.6 Number of filled panicle⁻¹

From the above mentioned samples the unfilled grains were counted and then average of five samples was taken.

2.5.1.7 Number of un-filled grain grains panicle⁻¹

Five panicles were randomly selected from each sample. The grains were counted and then average of five samples was taken.

2.5.1.8 1000-grain weight

One thousand clean dried grains were counted randomly from the seed stock obtained from each plot and weighed by using an electrical balance.

2.5.1.9 Grain yield

Grains obtained from central 1 m² area of each unit plot were sun dried, weighed and their moisture content was determined using a moisture meter. Then the grain yield was adjusted at 14% moisture content and finally converted to t ha⁻¹.

2.5.1.10 Straw Yield

Straws obtained from central 1m² area of each unit plot were sun dried and weighed carefully. The dry weight of straw of 1m² area was finally converted to t ha⁻¹.

2.5.1.11 Biological yield

Grain yield and straw yield were altogether regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield = Grain yield + Straw yield.

2.5.1.12 Harvest Index (%)

The harvest index was computed by using the following formula:

$$\text{Harvest index (HI)} = \frac{\text{Grain Yield}}{\text{Biological Yield}} \times 100$$

2.5.2 Collection of Weed Related Data

2.5.2.1 Weed density (no. m⁻²)

Data on weed population were collected from each plot at vegetative growth stage of the rice plants by using 1 m² quadrat as per method described by Cruz et al. (1986). The quadrat was placed in three spots at random outside 1 m² central areas, kept for taking yield data. The weeds within the quadrat were counted species-wise and averaged.

2.5.2.2 Weed dry weight (g m⁻²)

After counting the weed density, the weeds inside each quadrat were uprooted, cleaned, separated species wise and dried first in the sun and then in an electrical oven for 72 h at a temperature of 80°C. The dry weight of each species was taken by an electrical balance and expressed in g m⁻².

2.5.2.3 Relative density of weed (%)

Relative density is the ratio of density of a given weed species and total weed density multiplied by 100 (Janiya and Moody, 1989).

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

2.5.2.4 Relative dry weight of weed (%)

Relative dry weight of weed is the ratio of dry weight of a given weed species and total weed dry weight and expressed as percentage (Janiya and Moody, 1989).

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

2.5.2.5 Summed dominance ratio (%)

Summed dominance ratio of every weed species was calculated according to the formulae used by Janiya and Moody (1989).

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

2.5.2.6 Statistical Analysis

Data were analyzed by MSTAT and mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Effect of plant spacing on Plant Height

Plant spacing meaningfully affected on plant height at all sampling dates (Figure 1). At 80 DAT, the tallest plant (94.92 cm) was produced by 25 cm × 10 spacing followed by plant height (94.87 cm) from 25 cm × 15 cm spacing and the lowest plant (92.21 cm) was obtained from 25 cm × 20 cm spacing. At harvest, plant height ranged from 86.92 to 89.75 cm and the tallest plant (89.75 cm) was produced by 25 cm × 10 spacing followed by 25 cm × 15 cm spacing (94.87 cm) and the lowest one (86.92 cm) was obtained from 25 cm × 20 cm spacing. Bhowmik et al. (2012) reported that the highest plant height (93.27 cm) was recorded from 20 cm × 15 cm spacing. This is due to plant competition and low uptake of nutrients.

Figure 1: Effect of plant spacing on plant height of rice at different sampling dates

3.1.2 Effect of weed interference period on plant height

The weed interference period applied significant influence on in plant height at all sampling dates (Figure 2). At the time of harvest, plant height ranged from 77.02 to 92.48 cm and the tallest plant (92.48 cm) was obtained from weed situations which was statistically identical to weed free up to 80 DAT and 60 DAT. The lowest plant (77.02 cm) was obtained from weedy conditions. Aktaruzzaman reported that the tallest plant was produced by weed free condition and the shortest plant was found in no weeding plot, which is in agreement with the present findings (Aktaruzzaman, 2007). Results revealed that plant height was greater in all weeded plots than in control plot indicating weeding at any growth stages of rice has positive effect on growth and development of rice. On the other hand, competition for nutrients in between weeds and plants was severe and resulted in the reduced plant height in control. Similar results were also reported in rice (Bari, 2004; Bhowmik, 2005). They reported that weeding within 20 to 60 DAT was the best for superior plant growth and development.

Figure 2: Effect of weed interference period on plant height of rice at different sampling dates

3.1.3 Effect of interaction between spacing and weed interference period on Plant Height

The communication effect of spacing and weed intrusion period did not produce any significant influence on plant height except at 40 DAT (Table

1). At 40 DAT, plant height ranged from 31.28 to 41.41 cm and the tallest plant (41.41 cm) was obtained from weed free up to 80 DAT with spacing of 25 cm × 15 cm followed by plant height (39.91 cm) from weed free conditions with 25 cm × 20 cm spacing. Similar result was found (Tyeb et al., 2013). The shortest plant (31.28 cm) was obtained from weedy conditions with 25 cm × 20 cm spacing which was statistically similar with weed free up to 20 DAT with the spacing of 25 cm × 20 cm.

Table 1: Combined effect of weed interference period and plant spacing on plant height of BRRI dhan 29 at different sampling dates						
Weed interference period x plant spacing		Plant height (cm) at different DAT and Harvest				
		20		20		20
Weed Free (WF)	25 cm × 15 cm	18.83	37.41bc	61.33	97.37	91.43
	25 cm × 10 cm	18.60	36.18 cd	62.66	96.25	95.34
	25 cm × 20 cm	18.30	39.91ab	60.74	95.83	90.67
WF Up to 20 DAT	25 cm × 15 cm	21.25	35.50cde	54.67	94.43	87.67
	25 cm × 10 cm	19.00	33.4 def	55.83	96.83	88.78
	25 cm × 20 cm	18.75	32.93ef	53.67	95.25	88.24
WF Up to 40 DAT	25 cm × 15 cm	21.50	35.43cde	56.33	96.57	88.42
	25 cm × 10 cm	20.41	34.47cde	57.67	88.63	89.33
	25 cm × 20 cm	19.50	33.93def	55.83	85.26	87.84
WF Up to 60 DAT	25 cm × 15 cm	21.16	39.33ab	59.33	97.73	90.33
	25 cm × 10 cm	21.11	35.47cde	60.73	98.88	91.67
	25 cm × 20 cm	20.00	34.93 cde	58.66	96.44	89.33
WF Up to 80 DAT	25 cm × 15 cm	19.75	41.41a	60.46	98.37	90.89
	25 cm × 10 cm	19.66	36.25cd	61.83	102.7	94.79
	25 cm × 20 cm	19.30	34.98cde	60.42	97.84	89.63
Weedy	25 cm × 15 cm	20.58	32.83 ef	51.67	84.73	76.68
	25 cm × 10 cm	20.38	32.96 ef	55.33	86.21	78.57
	25 cm × 20 cm	19.75	31.28 f	50.73	83.24	75.82
LSD _{0.05}		1.61	2.65	3.31	5.21	5.13
Level of sig.		NS	**	NS	NS	NS
CV (%)		4.88	4.51	3.46	3.34	3.51

Mean values in a column having the same letter(s) do not differ significantly whereas mean values having different letter(s) differ significantly as per DMRT. **= Significant at 1% level of probability, NS= Not significant, CV= Co-efficient of variance

3.1.4 Effect of plant spacing on number of total tillers hill⁻¹

Number of total tillers hill⁻¹ exhibited significant differences due to plant spacing at all sampling dates (Figure 3). At 80 DAT, the highest one (14.07) was produced by 25 cm × 20 spacing followed by total tillers hill⁻¹ (13.19) from 25 cm × 15 cm spacing and the lowest one (12.07) was obtained from the spacing of 25 cm × 10 cm. A study reported that out of three spacing (10 cm × 15 cm, 20 cm × 15 cm, 30 cm × 15 cm) 20 cm × 15 cm spacing gave the highest tillers (Kandil et al., 2010). At harvest, total tillers hill⁻¹ ranged from 11.12 to 13.01 and the highest total tillers hill⁻¹ (13.01) was produced by 25 cm × 20 cm spacing which was statistically identical from 25 cm × 15 cm spacing (12.49) and the lowest one (11.12) was obtained from the

spacing of 25 cm × 10 cm. A study reported that the spacing had a significant effect on the total number of tillers hill⁻¹ (Mobasser et al., 2007). This is due to plant competition and low uptake of nutrients.

Figure 3: Effect of plant spacing on number of total tillers hill⁻¹ at different sampling dates

3.1.5 Effect of weed interference period on number of total tillers hill⁻¹

The weed interference period showed significant changes on total tillers hill⁻¹ in all sampling dates (Figure 4). At 80 DAT, the highest total tillers hill⁻¹ (16.37) was obtained from weed free condition followed by total tillers hill⁻¹ (15.57) from weed free up to 80 DAT and the lowest total tillers hill⁻¹ (10.18) was obtained from weedy conditions. At the time of harvest, total tillers hill⁻¹ ranged from 9.433 to 15.72 and the highest one (15.72) was obtained from weed free conditions followed by total tillers hill⁻¹ (14.98) was obtained from weed free up to 80 DAT. Islam observed that the highest grain yield and effective tillers hill⁻¹ were obtained under always weed free condition (Islam, 2003). The lowest total tillers hill⁻¹ (9.433 cm) was got from weed free up to 20 DAT. Number of total tillers hill⁻¹ was reduced at harvest due to senescence of tillers at later phases of growth.

Figure 4: Effect of weed interference period on number of total tillers hill⁻¹ at different sampling dates

3.1.6 Effect of interaction between spacing and weed interference period on number of total tillers hill⁻¹

The interaction effect of spacing and weed interference period did not produce any significant influence on total tillers hill⁻¹ except at 20 DAT and 40 DAT (Table 2). At 20 DAT, highest total tillers hill⁻¹ (2.93) was obtained from weed free condition with spacing of 25 cm × 20 cm followed by total tillers hill⁻¹ (2.73) was obtained from weed up to 40 DAT with spacing of 25 cm × 15 cm. The lowest total tillers hill⁻¹ (2.00) was obtained from weed up to 80 DAT with 25 cm × 15 cm spacing. At 40 DAT, total tillers hill⁻¹ ranged from 6.33 to 10.84 and the highest total tillers hill⁻¹ was obtained from weed free condition with 25 cm × 20 cm spacing (10.84) followed by total tillers hill⁻¹ (10.75) was obtained from weed up to 80 DAT with spacing of 25 cm × 20 cm. This result is supported by Ang et al. (2002). The lowest one (6.33) was obtained from weed free up to 20 DAT with spacing of 25 cm × 10 cm.

Table 2: Combined effect of weed interference period and plant spacing on number of tillers hill ⁻¹ of BRRI dhan 29 at different sampling dates						
Weed interference period x plant spacing		Number of tillers hill ⁻¹ at different sampling dates				
		20		20		20
Weed Free (WF)	25 cm × 15 cm	2.53 bc	9.750c	17.57	16.85	16.04 ab
	25 cm × 10 cm	2.40 c	8.730 d	15.83	14.84	13.86 cd
	25 cm × 20 cm	2.93a	10.84 a	18.43	17.42	17.26 a
WF Up to 20 DAT	25 cm × 15 cm	2.60 bc	7.000 fg	11.25	10.84	9.40 hi
	25 cm × 10 cm	2.53 bc	6.330 h	10.45	9.730	8.07 i
	25 cm × 20 cm	2.43 c	7.750e	11.83	11.72	10.83 g
WF Up to 40 DAT	25 cm × 15 cm	2.73ab	7.630 e	13.82	12.73	11.20 fg
	25 cm × 10 cm	2.60 bc	6.470 gh	12.73	11.47	10.40 gh
	25 cm × 20 cm	2.40 c	8.630 d	13.84	13.32	12.28 ef
WF Up to 60 DAT	25 cm × 15 cm	2.53 bc	7.720 e	13.93	12.84	13.40 de
	25 cm × 10 cm	2.00 d	6.840 fgh	13.35	12.43	11.60 fg
	25 cm × 20 cm	2.41 c	10.25 bc	15.82	14.57	12.40ef
WF Up to 80 DAT	25 cm × 15 cm	2.00 d	8.870 d	16.45	15.42	15.88b
	25 cm × 10 cm	2.40 c	7.420 ef	15.33	14.73	14.20cd
	25 cm × 20 cm	2.40 c	10.75 ab	17.25	16.57	14.87bc
Weedy	25 cm × 15 cm	2.40 c	5.270i	9.850	10.47	9.04 i
	25 cm × 10 cm	2.40 c	4.330 j	9.230	9.240	8.60 i
	25 cm × 20 cm	2.40 c	7.250 ef	10.75	10.83	10.42gh
LSD _{0.05}		0.210	0.542	0.887	1.27	1.27
Level of sig.		**	**	NS	NS	*
CV (%)		5.20	4.15	3.89	5.87	6.27

Mean values in a column having the same letter(s) do not differ significantly whereas mean values having different letter(s) differ significantly as per DMRT. **= Significant at 1% level of probability, *= Significant at 5% level of probability, NS= Not significant, CV= Co-efficient of variance

3.2 Yield Contributing Characters on Yield

3.2.1 Effect of plant spacing on yield contributing characters on yield

Plant spacing significantly influenced the number of effective tillers hill⁻¹, non-effective tillers hill⁻¹, panicle length, filled grains panicle⁻¹, unfilled grain panicle⁻¹, thousand grain weights, grain yield, straw yield, biological yield and harvest index (Table 3). Number of effective tillers hill⁻¹ ranged from 9.358 to 10.97. The highest no of effective tillers hill⁻¹ (10.97) was found from spacing of 25 cm × 20 which was statistically alike to 25 cm × 15 cm spacing (10.67). A group researcher found the highest no of effective tillers hill⁻¹ from spacing of 25 cm × 15 cm (Tyeb et al., 2013). Maximum number of non-effective tillers hill⁻¹ (2.045) was found in 25 cm × 20 cm plant spacing and minimum one (1.763) was recorded from the spacing 25 cm × 10 cm which is statistically identical to 25 cm × 15 cm (1.823). Spacing had significant effect on panicle length (Table 3). The length of the panicle ranged from 17.95 to 22.36 cm and the longest panicle (21.65 cm) was observed at the spacing 25 cm × 15 cm. Number of filled grains panicle⁻¹

was significantly influenced by plant spacing and weed interference period (Table 3).

The number of filled grains panicle⁻¹ was ranged from 90.94 to 109.1. From Table 1 it was observed that the highest number of filled grains panicle⁻¹ was found in the spacing of 25 cm × 20 cm followed by no. of filled grains panicle⁻¹ (103.8) in the spacing of 25 cm × 15 cm. This result is agreement with the findings of Salahuddin et al. (2009). The highest number of unfilled grain panicle⁻¹ (20.43) was observed in spacing 25 cm × 20 cm followed by no. of unfilled grains panicle⁻¹ (18.46) was observed in spacing of 25 cm × 15 cm. The lowest number of unfilled grain panicle⁻¹ (16.90) was observed in 25 cm × 10 cm spacing. Thousand grain weights were meaningfully influenced by spacing (Table 3). Thousand grain weights were ranged from 20.42 to 21.74g. It was observed that the highest 1000 grain weight (21.74g) was found in spacing of 25 cm × 20 cm followed by 1000 grain weight (21.25g) was obtained from the spacing of 25 cm × 15 cm.

The lowest 1000 grain weight (20.42 g) was found in 25 cm × 15 cm spacing. Grain yield was ranged from 4.032 to 5.142 t ha⁻¹. It was observed that the highest grain yield (5.142 t ha⁻¹) was found in 25 cm × 15 cm followed by grain yield (4.587 t ha⁻¹) was obtained from 25 cm × 10 cm. The lowest grain yield (4.032 t ha⁻¹) was found in spacing 25 cm × 20 cm. Differences in number of grain yield due to varieties were also reported by BRRI (1995). Straw yield was ranged from 5.767 to 7.647 t ha⁻¹. It was observed that the highest straw yield (7.64 t ha⁻¹) was found in 25 cm × 15 followed by straw yield (6.96 t ha⁻¹) in 25 cm × 10 cm. The lowest straw yield (5.76 t ha⁻¹) was found in spacing 25 cm × 20 cm. The highest biological yield (12.79 t ha⁻¹) was found in 25 cm × 15 cm followed by biological yield (11.55 t ha⁻¹) was found in 25 cm × 10 cm. The lowest biological yield (9.79 t ha⁻¹) was found in 25 cm × 20 cm. Harvest index was not significantly influenced by spacing. Harvest index was ranged from 39.69 to 41.37%. It was observed that the highest harvest index (41.37%) was found in 25 cm × 20 cm which was statistically identical to harvest index (40.39%) was found in 25 cm × 15 cm spacing. Uddin found that harvest index was increased by dense planting (Uddin, 2003).

Table 3: Effect of plant spacing on yield and yield contributing characters of BRRI dhan 29

Plant spacing	No. of effective tiller hill ⁻¹	No. of non effective tiller hill ⁻¹	Length of panicle (cm)	No. of filled grains panicle ⁻¹	No. of unfilled grains panicle ⁻¹	1000 grain weight (g)	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)	Harvest index (%)
25 cm × 15 cm	10.67a	1.82b	21.65a	103.8b	18.46b	21.25b	5.14 a	7.64a	12.79 a	40.39ab
25 cm × 10 cm	9.358b	1.76b	17.95b	90.94c	16.90 c	20.42c	4.58b	6.96b	11.5 b	39.69b
25 cm × 20 cm	10.97a	2.04a	22.36a	109.1a	20.43a	21.74a	4.03c	5.76c	9.79 c	41.37a
LSD _{0.05}	0.363	0.137	0.824	3.37	0.337	0.488	0.135	0.216	0.254	1.13
Level of significance	**	**	**	**	**	**	**	**	**	**
CV (%)	5.19	10.79	5.89	4.91	2.68	3.41	4.35	4.71	3.31	4.12

Mean values in a column having the same letter(s) do not differ significantly whereas mean values having different letter(s) differ significantly as per DMRT.

**= Significant at 1% level of probability, *= Significant at 5% level of probability, NS= Not significant, CV= Co-efficient of variance

3.2.2 Effect of weed interference on yield contributing characters on yield

The number of effective tillers hill⁻¹, non-effective tillers hill⁻¹, panicle length, filled grains panicle⁻¹, unfilled grain panicle⁻¹, thousand grain weights, grain yield, straw yield, biological yield and harvest index were significantly influenced by weed interference (Table 4). The number of effective tillers hill⁻¹ was ranged from 13.93 to 7.01 and highest no. of effective tillers hill⁻¹ (13.93) was obtained from weed free conditions followed by no. of effective tillers hill⁻¹ (12.98) was obtained from weed free up to 80 DAT (Aktaruzzaman, 2007). The highest no. of non-effective tillers hill⁻¹ (2.340) was obtained from weedy conditions followed by no. of non-effective tillers hill⁻¹ (2.067) was obtained from weed free up to 60 DAT which was statistically identical to no. of non-effective tillers hill⁻¹ (2.00) from weed free up to 80 DAT and the lowest one (1.333) was obtained in weed free conditions (Aktaruzzaman, 2007). The length of the panicle ranged from 16.16 to 24.55 cm. The highest panicle length (24.55cm) was obtained from weed free conditions and the lowest panicle length was obtained (16.16 cm) from weedy condition.

The number of filled grains panicle⁻¹ was ranged from 60.47 to 119.7 and the highest no. filled grains panicle⁻¹ (119.9) was obtained from weed free up conditions which was statistically identical to no. filled grains panicle⁻¹ (117.9) from weed free up to 80 DAT. The lowest number of filled grains panicle⁻¹ (60.47) was found in weedy treatment. Weed competition was severe in no weeding condition and thus lower number of filled grains panicle⁻¹ produced and supported (Malek, 2008). The number of unfilled grains panicle⁻¹ was ranged from 13.84 to 21.38 and the highest number of unfilled grains panicle⁻¹ (21.38) was obtained from weed free conditions which was statistically identical to number of unfilled grains panicle⁻¹ (21.11) was obtained from weed free up to 80 DAT and the lowest one (13.84) was obtained from weedy conditions. Weight of thousand grains was not significantly influenced by weed interference period (Table 4).

Thousand grain weight was ranged from 16.50 to 23.56 g. Khan observed that weeding regime had significant effect on all the parameters except 1000-grain weight. Grain yield was ranged from 2.94 to 5.660 t ha⁻¹ (Khan, 2003). The Highest grain yield (5.660 t ha⁻¹) was found in weed free treatment and the lowest grain yield (2.94 t ha⁻¹) was found in weedy treatment (Anwar et al., 1998; Islam, 2003).

Weed competition was severe in no weeding condition and thus lower grain yield was produced. On the other hand, in weed free treatment higher grain yield was produced because of no weed competition, less insect and disease infestation and high moisture supply due to no or less weed attack. Straw yield was ranged from 4.24 to 8.25 t ha⁻¹ and the highest straw yield (8.25 t ha⁻¹) was found in weed free treatment which was statistically identical to straw yield (7.94 t ha⁻¹) in weed free up to 80 DAT followed by straw yield (7.56 t ha⁻¹) in weed free up to 60 DAT. The lowest straw yield (4.24 t ha⁻¹) was observed in weedy treatment. Weed competition was severe in no weeding condition so less tillering occurred which results lower straw yield. Govinda and Singh (1985) found that weeding up to 45 DAT decreased the crop weed competition and gave yields similar to that of weed free condition. On the other hand, in weed free treatment throughout the crop growth period, because of high tillering ability higher straw yield was produced. Biological yield was ranged from 7.18 to 13.91 t ha⁻¹ and the highest biological yield (13.91 t ha⁻¹) was found in weed free treatment followed by biological yield (13.35 t ha⁻¹) in weed free up to 80 DAT. The lowest one (7.18 t ha⁻¹) was obtained from weedy conditions. Harvest index was significantly affected by weed interference period (Table 1). Harvest index was ranged from 35.89 to 44.24% and highest harvest index (44.24%) was found in weed free up to 40 DAT followed by harvest index (40.76%) in weed free treatment. The lowest harvest index (35.89%) was found in weed free up to 60 DAT. A group researcher observed that weeding interference period significantly affected all the plant characters (Bari et al., 1995).

Table 4: Effect of weed interference period on yield and yield contributing characters of BRRI dhan 29

Weed interference period	No. of effective tiller hill ⁻¹	No. of non effective tiller hill ⁻¹	panicle length (cm)	No. of filled grains panicle ⁻¹	No. of unfilled grains panicle ⁻¹	1000 grain weight (g)	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)	Harvest index (%)
Weed Free (WF)	13.93 a	1.79 c	24.55a	119.7a	21.38a	23.56a	5.66 a	8.25 a	13.91a	40.76b
WF Up to 20 DAT	8.10e	1.33d	17.94d	81.50c	17.38d	19.79d	3.86e	5.74d	9.64 e	40.18b
WF Up to 40 DAT	9.56d	1.733c	20.20c	112.0b	18.56 c	21.29c	4.53d	7.00 c	11.54 d	44.24a
WF Up to 60 DAT	10.40c	2.06b	22.02b	116.1ab	19.30 b	22.54b	5.11 c	7.56b	12.68 c	35.89 c
WF Up to 80 DAT	12.98b	2.00 b	23.04b	117.9a	21.11a	23.13ab	5.40b	7.93a	13.35b	40.53 b
Weedy	7.01f	2.340a	16.16e	60.47d	13.84e	16.50e	2.94f	4.24e	7.18f	41.29b
LSD _{0.05}	0.514	0.194	1.17	4.76	0.477	0.690	0.191	0.306	0.359	1.59
Level of significance	**	**	**	**	**	**	**	**	**	**
CV (%)	5.19	10.79	5.89	4.91	2.68	3.41	4.35	4.71	3.31	4.12

Mean values in a column having the same letter(s) do not differ significantly whereas mean values having different letter(s) differ significantly as per DMRT, **= Significant at 1% level of probability, CV= Co-efficient of variance

3.2.3 Effect of interaction between plant spacing and weed interference period on number of effective tillers hill⁻¹

Interaction between plant spacing and weed interference period significantly influenced the number of effective tillers hill⁻¹, non-effective tillers hill⁻¹, panicle length, filled grains panicle⁻¹, unfilled grain panicle⁻¹, thousand grain weights, grain yield, straw yield, biological yield and harvest index (Table 5). The number of effective tillers hill⁻¹ was ranged from 6.400 to 14.87 and the highest number of effective tillers hill⁻¹ (14.87) was produced by weed free with the spacing of 25 cm × 20 cm which is statistically identical to no. effective tillers hill⁻¹ (14.24) was obtained from weed free condition with 25 cm × 15 cm spacing (Table 5). The lowest one (6.400) was produced by 25 cm × 10 cm spacing with weedy conditions. The number of non-effective tillers hill⁻¹ were ranged from 1.18 to 2.60. The highest number of non-effective tillers hill⁻¹ (2.60) was produced by weedy conditions with spacing 25 cm × 20 cm which was statistically identical to the of non-effective tillers hill⁻¹ (2.39) obtained from weed free treatment with spacing 25 cm × 20 cm (Khisha,2002).

The interaction between plant spacing and weed interference period did not show any significant effect on panicle length (Table 5). The number of filled grains panicle⁻¹ was ranged from 54.75 to 128.70 and the highest number of filled grains panicle⁻¹ (128.70) was produced by weed free up to 40 DAT with spacing of 25 cm × 20 cm followed by no. filled grains panicle⁻¹ (127.20) in weed free conditions with 25 cm × 20 cm and no. of filled grains panicle⁻¹ (126.40) in weed free up to 80 DAT with 25 cm × 20 cm spacing respectively. The lowest number of grains panicle⁻¹ (54.75) was produced by weedy conditions with 25 cm × 10 cm spacing. This result is agreement with Islam (2000). The number of unfilled grains panicle⁻¹ was ranged from 10.42 to 24.35. The highest unfilled grains panicle⁻¹ was produced by weed free treatment with spacing 25 cm × 20 cm followed by unfilled grains panicle⁻¹ (23.43) was obtained from weed free up to 80 DAT with the spacing of 25 cm × 20 cm (Verma et al., 2002). The lowest unfilled

grains panicle⁻¹ (10.42) was produced by weedy conditions with the spacing of 25 cm × 10 cm. Weight of thousand grains was not significantly affected by interaction between spacing and weed interference period (Table 3).

Thousand grain weight was ranged from 15.83 to 24.24 g. The grain yield was ranged from 2.57 to 6.23 t ha⁻¹. The highest grain yield (6.23 t ha⁻¹) was in the spacing of 25 cm × 20 cm with weed free conditions which is statistically identically to grain yield (6.14 t ha⁻¹) was produced in spacing of 25 cm × 15 cm with weed free up to 80 DAT. Yield variations in rice due to weeding were also observed by many researchers (Chowdhury et al., 1994; Ahmed et al., 1998; Hossain et al., 2002; Islam et al., 2003). Straw yield was ranged from 3.13 to 9.26 t ha⁻¹ and the highest straw yield (9.26 t ha⁻¹) was produced by 25 cm × 15 cm spacing with weed free conditions which is statistically identical to straw yield (8.84 t ha⁻¹) in 25 cm × 15 cm spacing with weed free up to 80 DAT. A group researcher finding were same to the result (Sobhan et al., 2003). The lowest Straw yield (3.13 t ha⁻¹) which was produced by 25 cm × 15 cm spacing with weedy conditions.

Biological yield was ranged from 5.70 to 15.49 t ha⁻¹ and the highest biological yield (15.49 t ha⁻¹) in spacing of 25 cm × 15 cm with weed free treatment which was statistically identical to biological yield (14.98 t ha⁻¹) was produced in spacing of 25 cm × 15 cm with weed free up to 80 DAT and followed by to biological yield (14.49 t ha⁻¹) in 25 cm × 15 cm spacing with weed free up to 60 DAT. This result is supported by Hossain (2002). The lowest biological yield (5.70 t ha⁻¹) was produced in 25 cm × 20 cm spacing with weedy conditions. Harvest index percentage was ranged from 34.65 to 46.11 and the highest harvest index (46.11%) was produced in 25 cm × 10 cm spacing with weed free up to 40 DAT which statistically identical to harvest index (45.09%) was produced 25 cm × 20 cm spacing with weedy treatment. Uddin (2003) found that harvest index was increased by dense planting. The lowest harvest index (34.65%) was found from the spacing of 25 cm × 15 cm with weed free upto 60 DAT.

Table 5: Combined effect of weed interference period and plant spacing on yield and yield contributing characters of BRRI dhan 29

Table 2. Combined effect of weed interference, period and plant spacing on yield and yield contributing characters of Boro paddy											
Weed interference period x plant spacing		No. of effective tiller hill ⁻¹	No. of non effective tiller hill ⁻¹	Length of panicle (cm)	No. of filled grains panicle ⁻¹	No. of unfilled grains panicle ⁻¹	1000 grain weight (g)	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)	Harvest Index (%)
Weed Free (WF)	(25x15)cm	14.24ab	1.80def	25.23	124.70ab	19.48efg	23.86	6.23a	9.26a	15.49a	40.22def
	(25x10)cm	12.68c	1.18hi	21.22	107.30c	20.32cde	22.57	5.48bc	8.35bc	13.84c	39.60defg
	(25x20)cm	14.87a	2.39ab	27.19	127.20ab	24.35a	24.24	5.27cd	7.14e	12.41e	42.47bcd
WF Up to 20 DAT	(25x15)cm	8.40 gh	1.00i	18.82	83.32d	17.26jk	19.62	4.28f	6.27gh	10.55g	40.57de
	(25x10)cm	6.67 i	1.40gh	15.33	74.75e	16.44kl	19.43	3.87g	5.82h	9.69h	39.94def
	(25x20)cm	9.23 fg	1.60efg	19.67	86.42d	18.43hi	20.33	3.43h	5.14i	8.573i	40.02def
WF Up to 40 DAT	(25x15)cm	9.28fg	1.92cde	21.42	107.80c	18.67gh	21.43	5.02de	7.93cd	12.95de	44.48abc
	(25x10)cm	8.60fgh	1.80def	16.34	99.44c	17.33j	20.62	4.73e	6.83ef	11.56f	46.11a
	(25x20)cm	10.80de	1.48fgh	22.83	128.70a	19.67def	21.83	3.86g	6.25fgh	10.11gh	42.14bcd
WF Up to 60 DAT	(25x15)cm	11.40d	2.00cd	23.33	119.20b	19.83cdef	22.89	5.76b	8.73ab	14.49b	34.65i
	(25x10)cm	9.40f	2.20bc	19.54	103.80c	17.62ij	21.73	5.33cd	7.68d	13.01de	36.36hi
	(25x20)cm	10.40e	2.00cd	23.20	125.40ab	20.45cd	23.00	4.26f	6.27fgh	10.53g	36.66ghi
WF Up to 80 DAT	(25x15)cm	13.88b	2.00cd	23.86	121.70ab	20.67c	23.24	6.14a	8.84ab	14.98ab	40.99de
	(25x10)cm	12.40c	1.80def	20.43	105.60c	19.24fgh	22.33	5.27cd	8.33bc	13.60cd	38.74efgh
	(25x20)cm	12.67c	2.20bc	24.82	126.40ab	23.43b	23.82	4.80e	6.67efg	11.47f	41.85cde
Weedy	(25x15)cm	6.820i	2.22bc	17.24	66.32f	14.87m	16.43	3.42h	4.84i	8.26i	41.40de
	(25x10)cm	6.400 i	2.20bc	14.82	54.75g	10.42n	15.83	2.84i	4.76i	7.60j	37.37fghi
	(25x20)cm	7.820h	2.60a	16.43	60.33fg	16.23l	17.25	2.57i	3.13j	5.70k	45.09ab
LSD _{0.05}		0.890	0.336	2.02	8.25	0.826	1.250	0.332	0.529	0.623	2.76
Level of sig.		**	**	NS	**	**	NS	**	**	**	**
CV (%)		5.19	10.79	5.89	4.91	2.68	3.41	4.35	4.71	3.31	4.12

Mean values in a column having the same letter(s) do not differ significantly whereas mean values having different letter(s) differ significantly as per DMRT. **= Significant at 1% level of probability, NS= Not significant, CV= Co-efficient of variance

3.3 Weed Parameters

3.3.1 Weed Composition of the Experimental Field

Ten weed species belonging to four different families were observed in weedy plots, among which two were broadleaves, six grasses and two sedges (Table 6).

Table 6: Dominant weed species with family name, type, relative density (RD), relative dry weight (RDW) and summed dominance ratio (SDR) (averaged over all weedy plots)						
Common name	Scientific name	Family name	Weed type	RD (%)	RDW (%)	SDR (%)
Shama	Echinochloa crusgalli L.	Poaceae	Grass	24.86	57.67	41.26
Pani kachu	Monochoria vaginalis	pontederiaceae	Broad leaf	25.24	16.58	20.91
panichase	Eleocharis atropurpurea	cyperaceae	Sedge	17.42	1.32	9.37
Khudey Aonguli	Digitaria iscaemum L.	Poaceae	Grass	10.50	0.52	5.51
Angta	Panicum distichum L.	Poaceae	Grass	2.42	0.69	1.56
Durba	Cynodon dactylon L.	Poaceae	Grass	9.12	4.85	6.99
Arail	Leersia hexandra	Poaceae	Grass	1.61	8.28	4.94
Khude shama	Echinochloa colonum L.	Poaceae	Grass	5.73	5.77	5.75
Kanai bashi	Commelina bengalensis	Commelinaceae	Broad leaf	1.1	1.04	1.07
Mutha	Cyperus rotundus L.	Cyperace	Sedge	2.00	3.28	2.64

Based on summed dominance ratio (SDR), the five most dominant weed species encountered were Echinochloa crusgalli L., Monochoria vaginalis, Eleocharis atropurpurea, Cynodon dactylon L., and Echinochloa colonum. Broadleaf weeds contributed 26% relative density and 18 % relative dry weight weed compared to grasses (55% and 78 %, respectively) and sedges (19% and 4%, respectively) (Table 7) (Zannat et al., 2014; Islam, 2014; Zafar, 1988; Malik et al., 1992).

Table 7: Relative density and dry weight of different weed groups		
	Relative density (%)	Dry weight (%)
Broadleaf	26	18
grasses	55	78
sedges	19	4

3.3.2 Effect of interaction between plant spacing and weed interference period on weed density

The interaction effect between plant spacing and weed interference period was significant on weed density (Table 8). The highest weed density (479.9 no. m⁻²) was observed in closest spacing in 25 cm × 20 cm with weedy condition. The lowest weed density (16.44 no. m⁻²) was found in 25 cm × 10 cm spacing with weed free up to 80 DAT. A study stated that hand weeding resulted significant decrease in total number of weeds and their dry matter as compared to weedy check (Singh et al., 1999).

3.3.3 Effect of interaction between spacing and weed interference period on weed dry weight

The interaction effect between plant spacing and weed interference period was significant on dry weight of weeds (Table 8). Weed dry weight was ranged from 5.350 to 216.3 g m⁻² and the highest weed dry weight (216.3 g m⁻²) was observed in 25 cm × 20 cm spacing with weedy conditions. A group researcher from Assam reported that different weed control practices significantly reduced the dry matter accumulation of weed and increased the rice yield over the un-weeded control in transplanted rice (Gogoi et al., 2000). The lowest weed dry weight (5.350 g m⁻²) was obtained from 25 cm × 10 cm spacing with weed free up to 80 DAT. Rafiquddualla observed that the weed dry weight at 20, 40 and 60 DAT was significantly affected by weeding regimes (Rafiquddualla, 1999).

Singh and Kumar also reported that maximum weed dry weight and the lowest grain yield were observed in the un-weeded control in the scented rice variety Pusa Basmati-I (Singh and Kumar, 1999).

Table 8: Combined effect of weed interference period and plant spacing on weed density and weed dry weight at 80 DAT			
Weed interference period x plant spacing		Weed density (No .m ⁻²)	Weed Dry weight (g m ⁻²)
Weed Free (WF)	25cm × 15cm	-	-
	25cm × 10cm	-	-
	25cm × 20cm	-	-
WF Up to 20 DAT	25cm × 15cm	338.7c	149.8 cd
	25cm × 10cm	318.6d	139.7e
	25cm × 20cm	351.6c	155.4 c
WF Up to 40 DAT	25cm × 15cm	200.2e	88.12f
	25cm × 10cm	157.9 f	64.86g
	25cm × 20cm	351.6c	155.4c
WF Up to 60 DAT	25cm × 15cm	59.81g	26.41h
	25cm × 10cm	47.48g	18.20i
	25cm × 20cm	66.33g	29.72h
WF Up to 80 DAT	25cm × 15cm	19.92 hi	8.80jk
	25cm × 10cm	16.44hi	5.35 kl
	25cm × 20cm	25.11h	12.44ij
Weedy	25cm × 15cm	399.1b	176.3b
	25cm × 10cm	344.8 c	148.2d
	25cm × 20cm	479.9 a	216.3a
LSD _{0.05}		18.679	6.51
Level of significance		5309.24**	1146.06**
CV (%)		6.38	5.07

Mean values in a column having the same letter(s) do not differ significantly whereas mean values having different letter(s) differ significantly as per DMRT. **= Significant at 1% level of probability, CV= Co-efficient of variance

4. CONCLUSION

Plant spacing, weed interference exerted significant effect on growth, yield and yield components. The effect of communication of weed interference period and spacing were found significant for all characters except plant height, length of panicle and 1000 grain weight. Weed density and dry weight were increased with the increasing weed interference period but rice grain yield increased regularly with the decreasing weed interference period. Closest spacing of 25 cm × 10 cm was the most effective in terms of weed suppression but the recommended spacing of 25 cm × 15 cm was found the best in terms of rice yield. Since weed free and weed free up to 80 DAT produced alike grain yield, therefore weed free up to 80 DAT can be suggested from economic view point following the spacing of 25 cm × 15 cm for better weed clampdown and higher yield of BRRI dhan29.

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AUTHOR'S CONTRIBUTION

Md. Hafizur Islam conducted the research and analyzed the data Md. Parvez Anwar and Md. Rashedur Rahman designed and supervised the whole experiment. Md. Sohanur Rahman contributed in research conduction, data analysis, searching journal for publication and finally manuscript writing & processing of this article. This article was read and approved by all authors for final Publication. Fakhar Uddin Talukder and Md. Tipu Sultan helped in research conduction and manuscript writing.

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