WEED INFESTATION AND YIELD PERFORMANCE OF BORO RICE IN DIRECT SEEDING METHOD AS INFLUENCED BY GREEN GROWTH REGULATOR AND HERBICIDES

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ABSTRACT

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An experiment was carried out at the experimental field of Bangladesh Institute of Nuclear Agriculture, Mymensingh, during February to May 2005 to investigate the effect of green growth regulator (GGR-6) and herbicides on weed infestation and yield performance of boro rice (cv. Iratom-24) in direct seeding method. The concentration of GGR-6 was 0 (control) and 30 ppm of aqueous solution. The herbicides were Machete 5G and Ronstar 25 EC at the rate of 25kg ha^{-1} and 2 litre ha^{-1} respectively. The green growth regulator and herbicides had positive effect on weed infestation and yield performance. GGR-6 at 30 ppm and Machete 5G under direct seeding with plant spacing 25cm x 20cm was the best for total number weeds per m^{-2}, number of effective tillers $hill^{-1}$, number of filled grains $panicle^{-1}$ and 1000-grain weight were non-significant. The highest grain growth rate was found from direct seeding with plant spacing 25cm x 20cm and GGR-6 at 30 ppm. Interaction effect on direct seeding method, herbicides and GGR-6 on grain growth was non-significant. GGR-6 at 30 ppm and Machete 5 G under direct seeding method with plant spacing 20cm x 20cm possessed better yield contributing characters resulted in the highest grain yield (5.87 t ha^{-1}). GGR-6 at 30 ppm and Machete 5G under direct seeding with plant spacing 25cm x 20cm possessed the 2nd highest grain yield (5.41 t ha^{-1}). The broadcasting of seeds produced the least yield (2.30 t ha^{-1}) in all treatments. So it may be suggested that for enhancing yield of direct seeding method with plant spacing 20cm x 20cm, GGR-6 at 30 ppm and Machete 5G at the rate of 25kg ha^{-1} would be recommended in rice.

Key words: Weed infestation, growth regulator, herbicide

INTRODUCTION

Weeds are one of the most important agricultural pests. Most of the weeds compete more for their nourishment through rapid development and manifestation by quick root and shoot development than crop. For the competitive abilities weeds form a serious negative effect in crop production and responsible for marked losses in crop yield (Mamun *et al.*, 1993). The probable yield loss due to unrestricted weed competition was 28.28% in broadcast aman rice (Karim *et al.*, 1998). Weed competes with rice plants severely for space, nutrient, air, water and light. Weeds under adverse condition affects plant height, leaf architecture, tillering habit, shading ability, growth pattern and life duration of rice cultivars. Poor weed control is one of the major factors for yield reduction of rice depending on the type of weed flora and their intensity (Amarjit *et al.*, 1994). Weed growth reduced the grain yield by 68-100% for direct seeded aus rice, 16-48% for transplant aman rice and 22.36 % for modern boro rice (Mamun ., 1990; Mamun ., 1990). This loss is therefore, a serious threat for the food deficit countries like Bangladesh. So proper weed management is essential for rice production in Bangladesh. Now-a-days the chemical methods of weed control are gaining popularity all over the world because of its miraculous results in weed control efficiency. But most of the herbicides are very new. Ronstar 25 EC and Machete 5G are the good selective herbicides having both pre and post emergence activity against mono- and dicotyledonous weeds in rice field. Yields of rice raised in direct seeding method may be as good as or even higher than transplanting method (Talukdar, 1996). The average yield loss due to weeds is less for direct seeded rice than that for transplanted rice. Therefore, yield and economic advantage of direct seeded rice should be higher than those of transplanted rice when herbicide is used. Plant growth regulators (PGR_s) and other modern technologies might be a useful tool to increase rice production. Recently, there has been global realization of the increasingly important role of PGR_s in crop production especially in better growth of crops and in enhancing yield of different crops (Prasad and Paudel, 1994). Many developed countries like Japan, China, Russia, Poland, Korea etc. have long been using PGR_s to increase crop yield. The commercial plant growth regulators are used mainly for horticultural crops and next for rice (Park, 1995). This type of research is needed in Bangladesh. So, the present work was designed to study the effect of herbicides and green growth regulators on the weed infestation and yield performance of boro rice in direct-seeding methods in Bangladesh.

MATERIALS AND METHODS

The experiment was conducted at the experimental field of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, during February to May 2005. The experimental field was a medium low land, fairly leveled with silty loam texture having a soil P^H value about 6.32 which includes in agro-ecological zone-9. The experiment was laid out in three factorial split–split plot design with three replications. Five different treatments were T_1 = direct seeding with 15cm x 20cm spacing, T_2 = direct seeding with 20cm x 20cm spacing, T_3 = direct seeding with 25cm x 20cm spacing, T_4 = broadcasting with a seed rate 80kg ha^{-1} and T_5 = transplanting with 15cm x 20cm spacing. The size of the main plot was 17m x 4m. The sub plot size was 3m x 4m. Distance among the sub plot 0.5m. the sub-sub size 3m x 1.75m and the distance between sub-sub plots 0.5m. For the preparation of solution of GGR-6, 0.1g powder was completely dissolved in one litre of distilled water. This solution gave the concentration of 100 ppm. From this 100 ppm solution, required concentration of GGR-6 i.e., 30 ppm was prepared by further diluting. Spraying was done in the direct seeding and transplanted crops at 35 days after sowing (DAS) and 42 DAS at noon using a hand sprayer. Herbicide (Ronstar 25 EC and Machete 5 G) were sprayed at 4 days after sowing and transplanting in presence of 3-5 cm standing water in the plots. Machete 5 G were mixed with sand and applied in the field. Ronstar 25EC was dissolved in water and sprayed in the experimental field. The fertilizers urea, TSP, MP and gypsum were applied @ 150, 100, 70 and 60 kg ha^{-1} respectively. At the time of the final land preparation full doses of TSP, MP and gypsum were applied. Urea was applied in three equal splits at 10, 30, 45 days after planting respectively (BARC, 1997).No weeding or stirring of soil was done after the application of herbicides. Irrigation was done from time to time in order to provide condition for proper growth and development of the crop. Seeds were soaked in water for 24 hours. The soaked seeds were then incubated in a warm and shady place for 72 hours for sprouting. After sprouting, the seeds were broadcast by hand in the well puddled plot (in case of direct seeded crop) as well as in the nursery bed (for transplanted crop) at the rate of 80 kg ha^{-1}. Sprouting seeds were sown by hand with spacing 15cm x 20cm, 20cm x 20cm and 25cm x 20cm, respectively on 14 February 2005. Transplanting was done with 20 days old seedlings on the puddled field after land preparation on 5th March 2005. Three seedlings $hill^{-1}$ were used with a spacing of 15cm x 20cm. Weed vegetation in boro rice were Panikochu (*Monochoria vagnialis*),Angta (*Panichum repens*), Khudey shama (*Echinochloa colonum*), Bara shama (*Echinochloa crus-gali*), Joina (*Finbristylis miliacea*), Nackphul (*Cyperus micheliamus*), Holdemutha (*Cyperus esculenta*), Chachra (*Sciepur juncoides*), Durba (*Cynodon dactylon*). The experimental crop was harvested plot wise at maturity. Data on weed infestation, total number of weeds m^{-2}, weeds weight m^{-2}, Number of effective tillers $hill^{-1,}$ 1000-grain weight (g), grain yield t ha^{-1}were collected and statistically analyzed to compare by Duncan's Multiple Rang Test (DMRT) according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Total number of weed m^{-2}

Effect of direct seeding methods

The effect of direct seeding on total number of weed m^{-2} area was found significant (Table1). The highest total number of weed 32.39 m^{-2} area was obtained from transplanting with plant spacing 15cm x 20cm. The lowest total number of weed 11.54 m^{-2} area was obtained from broadcasting with a seed rate 80kg ha^{-1}. From the experimental result it is evident that transplanting with plant spacing 15cm x 20cm allowed more weed population and broadcasting with a seed rate 80 kg ha^{-1} decreased weed population per unit area.

Effect of herbicides

Total of weeds m^{-2} was significantly influenced by herbicides (Table 2). The highest total number of weed m^{-2} area 29.03 was obtained by Ronstar 25 EC herbicides. The lowest total number of weed 18.92 m^{-2} area obtained from Machete 5 G. It is evident from the study that pre-emergence application of Machete 5G herbicide at the rate of 25 kg ha^{-1} was more effective for controlling weeds than Ronstar 25EC herbicide. Machete 5G herbicide may be used for effective weed control instead of Ronstar 25EC at peak period of labor to minimize the cost of production.

Effect of GGR-6

Total number of weed m^{-2} was significantly influenced by different concentration of GGR-6 (Table 3). The highest total number of weed (26.11) m^{-2} was obtained at 30 ppm and the lowest total number of weed (21.84 m^{-2}) was obtained from GGR-6 at 0 ppm.

Interaction effect of direct seeding methods, herbicides and GGR-6

The interaction between direct seeding methods, herbicides and GGR-6 had significant effect on total number of weed m^{-2} (Table 4). The highest total number of weed (40.09 m^{-2}) area was found from transplanting with plant spacing 15cm x 20cm Ronstar 25 EC and at 30 ppm of GGR-6. It was statistically similar to direct seeding with plant spacing 15cm x 20cm, 20cm x 20cm, Ronstar 25 EC and 30ppm of GGR-6 and it was also similar to transplanting with plant spacing 15cm x 20cm, Ronstar 25 EC and 0 ppm of GGR-6. The lowest total number of weed (9.33 m^{-2}) was found from broadcasting with a seed rate 80 kg ha^{-1} Machete 5G and 0 ppm of GGR-6 and at was statistically identical to broadcasting with a seed rate 80 kg ha^{-1}, Machete 5G and 30 ppm of GGR-6.

Total weed weight m^{-2} area

Effect of direct seeding methods

The effect of direct seeding methods on total weed weight (g m^{-2}) was found significant (Table 1). The highest total weed weight (28.64 g m^{-2} area) was obtained from transplanting with plant spacing 15 cm x 20 cm. The lowest total weed weight (14.00 g m^{-2}) was obtained from broadcasting with a seed rate 80 kg ha^{-1}. Weed dry weight was low in broadcasting with a seed rate 80 kg ha^{-1} than normal transplanting method due to high competition for nutrients, space, moisture, light etc. as a result total weed weight was low in broadcasting method.

Effect of herbicides

The total weed weight m^{-2} area was influenced Machete 5G and Ronstar 25 EC herbicides (Table 2). The highest total weight (28.83 g m^{-2}) was obtained form Ronstar 25 EC herbicides and the lowest total weed weight (17.99 g m^{-2} area) was obtained from Machete 5G herbicide. It was evident from the result that total weed weight was varied due to the effectiveness of herbicides. Machete 5G was more effective to control weeds than Ronstar 25EC.

Effect of plant growth regulator (GGR-6)

The total weed weight m^{-2} area varied significantly among different concentration (Table 3). The highest weed dry weight (27.05 g m^{-2} area) was observed at 30 ppm and the lowest weed dry weight (20.76 g m^{-2}) was found at 0 ppm.

Interaction effect of direct seeding methods, herbicides and GGR-6

The interaction between direct seeding methods, herbicides and plant growth regulator (GGR-6) had significant effect on total weed weight m^{-2} (Table 4). The highest total weed weight (42.18 g m^{-2}) was obtained from Ronstar 25 EC, transplanting with plant spacing 15 cm x 20 cm and GGR-6 at 30 ppm. It was statistically identical with direct seeding with plant spacing 15 cm x 20 cm and 20 cm x 20 cm, Ronstar 25 EC and 30 ppm of GGR-6. The lowest total weed weight (11.52 g m^{-2}) area was found broadcasting with a seed rate 80 kg ha^{-1}, Machete 5 G and 0 ppm (control) of GGR-6.

The effect of direct seeding methods, herbicides and plant growth regular and their interaction on yield and yield contributing characters

Number of effective tillers $hill^{-1}$

Effect of direct seeding methods

Number of effective tillers $hill^{-1}$ was remarkably influenced due to direct seeding methods (Table 5). The highest number of effective tillers $hill^{-1}$ (18.02) was recorded from direct seeding with wider spacing 25 cm x 20 cm. The broadcasting with a seed rate 80 kg ha^{-1} produced the lowest number of effective tillers $hill^{-1}$ (4.38). At harvest, effective tillers $hill^{-1}$ was decreased with low plants density probably due to competition for nutrients, space and ultimately surrounding tiller of the hill become unproductive, Result shows that effective tiller $hill^{-1}$ was decreased with low spacing.

Effect of herbicides

Number of effective tillers $hill^{-1}$ was statistically influenced by Machete 5 G and Ronstar 25 EC (Table 6). At the time of harvest, the highest number of effective tillers $hill^{-1}$ (13.09) was recorded from Machete 5G herbicide and the lowest number of fertile tillers $hill^{-1}$ (11.33) was produced with Ronstar 25 EC herbicide. Lower number of effective tillers $hill^{-1}$ with Ronstar 25EC was probably due to phytotoxic effect of herbicide on rice plants than Machete 5G herbicide,

Effect of plant growth regular (GGR-6)

The effect of different concentration of plant growth regulator on the effective tillers hill^{-1} was significant (Table 7). The highest number of fertile tillers^{-1} (13.12) hill^{-1} was found at 30 ppm. The plants under control produced the least fertile tillers. (11.30) hill^{-1}. GGR-6 at 30 ppm supported the increase of effective tillers hill^{-1}. Salam and Islam (1995) reported that the application of ABT rooting powder increased the number of effective tillers hill^{-1}.

Interaction effect between direct seeding methods, herbicides and GGR-6

Interaction between direct seeding methods different kinds of herbicide and plant growth regulator had significant influenced on the effective tillers hill^{-1} (Table 8). The highest number of effective tillers (19.79) hill^{-1} was found from direct seeding with wider plant spacing (25 cm x 20 cm), Machete 5 G and GGR-6 at 30 ppm. The lowest number of fertile tillers (3.40) hill^{-1} was recorded from broadcasting method with a seed rate 80 kg ha^{-1}, Ronstar 25 EC and no GGR-6 (control), which was statistically similar to broadcasting, Ronstar 25 EC and GGR-6 at 30 ppm. It was also similar to broadcasting method, Machete 5G and GGR-6 at 30 ppm and 0 ppm. This differential response of the treatment might be due to the reason that spacing allowed more facilities for normal and healthy growth of the plant and brought in less competition among the resulted in more effective tillers hill^{-1}.

Grains panicle^{-1}

Effect of direct seeding methods

The result showed that direct seeding methods had significant effect on number of total filled grains panicle^{-1} (Table 5). The maximum number of total filled grains panicle^{-1} (96.64) was found from direct seeding with plant spacing 25 cm x 20 cm and the minimum number of total filled grains panicle^{-1} was obtained (74.73) from broadcasting method with a seed rate 80 kg ha^{-1}. The direct seeding method with plant spacing 15 cm x 20 cm and transplanting was statistically identical. Evidently direct seeding with wider spacing induced greater number of filled grains panicle^{-1} than broadcasting method. Development of grains depends on environmental factors such as nutrients, moisture and light. Wider spacing possible facilitated to supply more food materials, moisture and light for the plant and ultimately for development of grains.

Effect of herbicides

The effect of different kinds of herbicide was obtained to be significant (Table 6). The highest number of total filled grains panicle^{-1} (91.58) was observed from Machete 5 G herbicide applied in the rice field and the lowest number of total filled grains panicle^{-1} (86.86) was observed from Ronstar 25 EC herbicide applied in the rice field.

Effect of different concentration of GGR-6

The number of total filled grains panicle^{-1} was found highly significant at 30 ppm in comparison to control (Table 7). It was observed that 30 ppm produced the highest number of total filled grains panicle^{-1} (91.60) and the lowest number of total filled grains panicle^{-1} (88.83) was found in control. Guoping (1992) explained the cause of increase of grain due to the improvement of the root by ABT first, than the absorption and transportation were enhanced and than exuberant growth of the above ground part appeared. Furthermore, at each crucial stage of the differentiation period of the panicles, adequate nutrient is supplied to the plant to meet the need to maintain the vigorous physiological and biochemical metabolism and finally the process of normal differentiation become smoothly. Besides the huge root system absorbs sufficient nutrients and waster to be supplied for conversion and hence the number of grains per panicle is increased.

Interaction effect of direct seeding methods, herbicides and GGR-6

The interaction effects between direct seeding methods, herbicides and GGR-6 were significant on the number of total filled grains panicle^{-1} (Table 8). The highest number of total filled grains panicle^{-1} was obtained from direct seeding with plant spacing 25 cm x 20 cm, Machete 5 G and GGR-6 at 30 ppm. The lowest number of total filled grains panicle^{-1} was obtained from broadcasting with a seed rate 80 kg ha^{-1}, Ronstar 25 EC and no GGR-6 which was statistically similar to broadcasting with a seed rate 80 kg ha^{-1}, Machete 5 G and no GGR-6. It was evident that, interaction between 25 cm x 20 cm spacing, Machete 5G at rate of 25 kg ha^{-1} and GGR-6 at 30 ppm were produced the highest number of filled grains panicle^{-1} might be due to presence of favourable condition for plant growth.

1000-grain weight

Effect of direct seeding methods

The direct seeding methods had significant effect on 1000-grain weight (Table 5). The highest 1000-grain weight (30.94 g) was found from direct seeding with plant spacing 25 cm x 20 cm. The lowest 1000-grain weight (28.26 g) was obtained from broadcasting with a seed rate 80 kg ha^{-1}. From the direct seeding with plant spacing 15 cm x 20 cm and transplanting with plant spacing 15 cm x 20 cm, was statistically similar. Such variation might be due to the variation of supply of food material, moisture and light for proper development of grain.

Effect of herbicides

It was observed that Machete 5G and Ronstar 25 EC herbicides had no significant on 1000-grain weight (Table 6).

Effect of plant growth regulator (GGR-6)

Concentration effect of plant growth regulator (GGR-6) was found significant (Table 7). The result showed that as the concentration increased the weight of grains was also increased. The concentration 30 ppm produced the highest 1000-grain weight (29.87 g) and the lowest 1000-grain weight (28.82) in the control condition. Seeds weight is a genetically controlled character which was not influenced by PGRs.

Interaction effect of direct seeding methods, herbicides and GGR-6

The result showed that interaction effect of direct seeding methods, different kinds of herbicide and different concentration (control, 30 ppm) of GGR-6 had no significant effect on 1000-grain weight (Table 8).

Grain yield (t ha^{-1})

Effect of direct seeding methods

Grain yield was remarkable influenced due to direct seeding methods (Table 5). The highest grain yield (5.28 t ha^{-1}) was found from direct seeding with plant spacing 20 cm x 20 cm. The lowest grain yield (2.68 t ha^{-1}) was obtained from broadcasting with a seed rate 80 kg ha^{-1}. Apparently, for direct seeding with plant spacing 25 cm x 20 cm, the growth and yield components was higher than that for direct seeding with planting spacing 20 cm x 20 cm, but actually there was an increased yield for later spacing as there was a high number of total hill ha^{-1}. Due to proper plant spacing, plants got proper light and no competition for nutrients than broadcasting method and also it might be due to the fact that the number of effective tiller $hill^{-1}$ and number of grains $panicle^{-1}$ were increased significantly in direct seeding (line sowing) method than broadcasting method. BRRI (1999) observed that line sowing method with 20 cm x 20 cm spacing gave comparatively better grain yield than broadcasting.

Effect of herbicides

Grain yield was significantly influenced by herbicides (Table 6). The highest yield (4.65 t ha^{-1}) was found by using Machete 5 G herbicide and the lowest grain yield (4.29 t ha^{-1}) was found by Ronstar 25 EC. Machete 5G herbicide killed many weeds and less weeds were grown through the crop growing period in the Machete 5G herbicide treated plot than Ronstar 25 EC treated plot, which favoured the significant growth development and also in yield.

Effect of plant growth regulator (GGR-6)

The concentration of plant growth regulator (GGR-6) showed highly significant 30 ppm produced the highest grain yield (4.77 t ha^{-1}) and the lowest grain yield (4.17 t ha^{-1}) in control (Table 7). Salam and Islam (1995) reported that ABT application showed significant increase in grain yield. The application of plant growth regulator produced the highest grain yield at 30 ppm concentration in Iratom-24. The increase in the effective tillers $hill^{-1}$, panicle length, grains $panicle^{-1}$ due to the effect of plant growth regulator (GGR-6) resulted in cumulative effect to produce higher grain yield in all plants treated with hormone.

Interaction effect of direct seeding methods, herbicides and GGR- 6

The interaction among direct seeding methods, herbicides and plant growth regulator (GGR-6) had remarkable effect on grain yield (Table 8). The highest grain yield (5.87 t ha^{-1}) was found from direct seeding with plant spacing 20 cm x 20 cm, Machete 5G and GGR-6 at 30 ppm. The lowest grain yield was (2.30 t ha^{-1}) found from broadcasting with a seed rate 80 kg ha^{-1}, Ronstar 25 EC and no GGR-6 (control) which was statistically similar to broadcasting with a seed rate 80 kg ha^{-1}, Machete 5 G and without hormone (GGR-6).

Table 1. Effect of direct seeding methods in different spacing on total number of weed and total weed weight

Treatment	Total number of weed m^{-2} area	Total weed weight m^{-2} (g)
T_1	25.40 c	22.36 b
T_2	27.65 b	22.89 b
T_3	22.88 d	21.66 b
T_4	11.54 e	14.00 c
T_5	32.39 a	28.64 a
LSD at 5%	2.15	2.13
CV(%)	11.50	10.89

Figure(s) in a column having common letter(s) do not differed significantly at 5% level of probability as per DMRT

Table 2. Effect of herbicide on total number of weed and total weight of weed

Herbicides	Total number of weed m^{-2} area	Total weed weight m^{-2} (g)
Machete 5G	18.92b	17.99b
Ronstar 25 EC	29.03a	28.83a
LSD at 5%	0.99	0.49
CV(%)	11.50	10.89

Figure(s) in a column having common letter(s) do not differed significantly at 5% level of probability as per DMRT

Table 3. Effect of GGR-6 on total number of weed and total weight of weed

Concentration of GGR-6	Total number of weed m^{-2} area	Total weed weight m^{-2} (g)
Control	21.84b	20.76b
30 ppm	26.11a	27.05a
LSD at 5%	3.06	2.65
CV (%)	11.50	10.89

Figure(s) in a column having common letter(s) do not differed significantly at 5% level of probability as per DMRT

Table 4. Interaction effect of direct seeding methods, herbicides and GGR-6 on total number of weed and total weight of weed

Herbicides	Treatment	GGR-6	Total number of weed m^{-2}	Total weed weight m^2 (g)
Machete 5G	T_1	Control	17.32e	12.51ghi
		30 ppm	19.94de	18.88ef
	T_2	Control	18.31de	14.27ghi
		30 ppm	20.17de	21.02def
	T_3	Control	18.73de	16.85fg
		30 ppm	20.39de	21.63cde
	T_4	Control	9.33f	11.52i
		30ppm	12.38f	13.33ghi
	T_5	Control	23.36cd	16.58fgh
		30 ppm	29.32b	32.29b
Ronstar 25 EC	T_1	Control	26.41bc	19.22def
		30 ppm	37.95a	39.84a
	T_2	Control	30.27b	17.89efg
		30 ppm	41.88a	38.50a
	T_3	Control	25.93bc	22.19cde
		30 ppm	26.50bc	25.97c
	T_4	Control	11.95f	13.22hi
		30ppm	12.50f	16.95fg
	T_5	Control	36.82a	23.53cd
		30 ppm	40.09a	42.18a
LSD at 5%			4.69	4.06
CV (%)			11.50	10.89

Table 5. Effect of direct seeding methods in different spacing on yield attributes and yield

Treatment	Effective tillers hill^{-1}	Grains panicle^{-1}	1000- grain weight (g)	Grain yield (t ha$^{-1)}$
T_1	10.94 d	90.78c	28.98c	4.69c
T_2	15.11b	92.97b	29.62b	5.28a
T_3	18.02a	96.64a	30.94a	4.92b
T_4	4.38e	74.73d	28.26d	2.68d
T_5	12.60c	90.96c	28.93c	4.78c
LSD at 5%	0.605	1.570	0.580	0.112
CV(%)	5.78	4.38	2.75	4.68

Figure (s) in column having common letter (s) do not differed significantly at 5% level as per DMRT

Table 6. Effect of herbicides on yield attributes and yield

Herbicides	Effective tillers hill^{-1}	Grains panicle^{-1}	1000- grain weight (g)	Grain yield (t ha$^{-1)}$
Machete 5G	13.09a	91.58a	29.52	4.65a
Ronstar 25 EC	11.33b	86.86b	29.17	4.29b
LSD at 5%	0.250	1.654		0.175
CV(%)	5.87	4.38	2.75	4.68

Table 7. Effect of Plant growth regulator (GGR-6) on yield attributes and yield

Concentration of GGR-6	Effective tillers hill^{-1}	Filled grains panicle^{-1}	1000- grain weight (g)	Grain yield (t ha^{-1})
Control	13.30b	86.83b	28.82b	4.17b
30 ppm	13.12a	91.60a	29.87a	4.77a
LSD at 5%	0.784	2.361	0.895	0.131
CV(%)	5.78	4.38	2.75	4.68

Figure (s) in a column having common letter (s) do not differed significantly at 5% level as per DMRT

Table 8. Interaction effect of direct seeding methods in different spacing, herbicides and GGR- 6 on yield and yield components

Herbicides	Treatment	GGR-6	Effective tiller hill^{-1}	Grains panicle^{-1}	1000- grain wt. (g)	Grain yield (t ha^{-1})
Machete-5 G	T_1	Control	11.10gh	90.77ef	28.69	4.63gh
		30 ppm	12.97f	95.33bc	29.92	5.24bcd
	T_2	Control	14.49e	9053ef	29.13	5.09cde
		30 ppm	17.16bc	98.68b	30.20	5.87a
	T_3	Control	17.51b	96.89bc	30.29	4.77fg
		30 ppm	19.79a	101.25a	32.04	5.41b
	T4	Control	4.81j	74.50i	28.07	2.61l
		30ppm	5.24j	79.00h	28.87	3.09k
	T_5	Control	12.33fg	9089ef	28.77	4.60gh
		30 ppm	15.52de	96.07bc	29.24	5.29bc
Ronstar-25 EC	T_1	Control	9.48i	86.25g	27.97	4.21j
		30 ppm	10.22hi	90.89ef	29.35	4.70gh
	T_2	Control	12.69f	89.67efg	29.03	4.76fg
		30 ppm	16.12cd	93.02cde	30.13	5.39b
	T_3	Control	16.78bcd	91.33de	30.07	4.49hi
		30 ppm	18.01b	95.11bcd	31.37	5.07de
	T4	Control	3.40k	70.82i	27.69	2.30m
		30ppm	4.10jk	74.60i	28.44	2.77l
	T_5	Control	10.41hi	86.78fg	28.53	4.30 ij
		30 ppm	12.14fg	90.22ef	29.18	4.94ef
LSD at 5%			1.202	3.620		0.201
CV (%)			5.78	4.38	2.75	4.68

Figure(s) in a column having common letter(s) do not differed significantly at 5% level of probability as per DMRT

CONCLUSION

It may be concluded that, interaction effect between direct seeding methods, herbicides and plant growth regulator was significant for almost all plant growth characters except plant height, number of total tillers hill^{-1} at 60 DAS. The result showed that the direct seeding with plant spacing 25cm x 20cm along with Machete 5 G and concentration of GGR-6 at 30 ppm gave the highest values in respect of growth parameter and grain yield.

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