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Effect of Trinexapac-ethyl on Mitigation of Lodging in Rice Grown under *Terai* Region of Uttarakhand

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ABSTRACT

Lodging is an acute problem in high yielding rice cultivars reducing a huge loss of the yield. Considering this acute problem, an experiment was laid out in Norman E. Borlaug Crop Research Centre of GBPUA&T, Pantnagar. In this study, the effects of the plant growth regulator Trinexapac-ethyl (TE) on the plant height, lodging, and grain yield of rice (Oryza sativa L.) were evaluated over two growing seasons (2015 and 2016). The experiments were designed in a randomized complete block design with three replicates. Application of Trinexapac-ethyl 250 EC at 40 g a.i./ ha showed the minimum plant height of 93.6 and 95.5 cm. Trinexapac-ethyl 250 EC at 40 g a.i./ ha reduced the lodging of the crop by reducing its height which was statistically at par with Trinexapac-ethyl 250 EC at 30 g a.i./ ha. This treatment also exhibited the higher grain yield of transplanted rice due to reduction in lodging.

Keywords: Lodging, rice, trinexapac-ethyl, yield

Rice plays a major role in global food security, as it is the staple food for over the half of the world's population. Asia is the centre of the global food security with more than half of the world's population and one-thirds of global hungry and poor (Monika, 2013). Lodging has been a major constraint in cereal production (Hozyo and Oda, 1965 and Pinthus, 1973). It may cause great losses in both grain yield and quality, and also presents extreme problems in harvest operations (Cooper, 1971 and Day, 1957). In rice cultivation, management practices to increase yield such as high nitrogen fertilization often result in taller, weaker plants that easily lodge. Therefore comprehensive studies and techniques for the prevention of rice lodging have been conducted. In a high-yielding environment, lodging is the most important constraining factor on yield for most cereals crops, including rice (Setter *et al.* 1997). Lodging negatively impacts both grain yield and quality (Day, 1957; Weibel and Pendleton, 1964), in part through a 60%–80% reduction in rice canopy photosynthesis (Setter *et al.* 1997). More practically, lodging reduces working efficiency by about 25% by making machine harvesting difficult (Lim *et al.* 1997). Lodging in rice may occur as a result of strong winds, heavy rain, water management, planting density, or an excessive use of fertilizer (Min and Fei, 1984; Song *et al.* 1996; Back *et al.* 1998). Lodging resistance in a plant is determined by the relationship between the weight of the upper plant parts and the pushing resistance of the lower plant parts (Mulder, 1954). In the present study the efforts was made to prevent the lodging problem of rice by reducing the inter-nodal length of stem by applying Trinexapac-ethyl at different concentration.

MATERIALS AND METHODS

A field Experimental was conducted during 2015 and 2016 at Normal E. Borlaug Crop Research Centre, GB Pant University of agriculture and technology, Pantnagar (29° N, 79.3° E, 244 m MSL) to evaluate the Trinexapac-ethyl 250 EC in rice for lodging protection. The experiment was comprised of five treatments with four different doses of Trinexapac-ethyl 250 EC at 20, 30, 40 and 60 g a.i./ ha applied at 50% panicle initiation stage. The experiment was laid out in randomized complete block design (RCBD) with four replications. Treatments were applied by using a Knapsack sprayer (Aspee India Pvt. Ltd.) fitted with flat fan nozzle. Trinexapac-ethyl 250 EC was sprayed using water volume of 500 L/ ha. Recommended package of agronomic practices were followed to raise the crop. The data on plant height (cm), stem thickness (cm), length of all internodes (cm), lodging % and grain yield (kg/ ha) were recorded. Plant height was measured from soil surface to highest canopy point at 50 % AR (active ripening) stage. The stem thickness at top, middle and bottom of the plant was recorded at 80 % maturity stage. The length of internodes (all internodes 1,2,3,4 and 5) was measured from top to bottom. The lodging severity was recorded at 80 % maturity stage by visual observation. The plants of individual plots were grouped in three groups of scale 1, 2 and 3 as given below: Scale-1 (panicles remain at vertical position), Scale-2 (panicles bent to less than 90 degree- recoverable), Scale-3 (panicles bent to more than 90 degree -unrecoverable) Data regarding phytotoxicity was reeported using rating scale (0-10). The parameters on phytotoxicity were taken as chlorosis, necrosis, yellowing, epinasty & hyponasty at 1, 3, 5, 7 & 10 days after application using rating scale of 0-10 where, 0 indicates no effect and 10 indicates complete death of plant.

RESULTS AND DISCUSSION

There is a significant impact of different treatments of Trinexapac-ethyl 250 EC on the plant height of rice. Application of Trinexapac-ethyl 250 EC at 40 g a.i./ ha showed the minimum plant height of 93.6 and 95.5 cm which were statistically at par with the treatment of Trinexapac-ethyl 250 EC at 30 g a.i./ ha, whereas, the maximum values of plant height i.e. 114.4 and 118.5 cm were observed under untreated check during 2015 and 2016 respectively. The data representing the length of internodes of rice in Table 1 and Table 2 shows that all the doses of Trinexapac-ethyl 250 EC significantly decreased the internode elongations compared to untreated check. Trinexapac-ethyl 250 EC at 40 g a.i./ ha exhibited the shortest internodal length of 70.6 & 74.6 cm at 50 % AR stage which is statistically at the same level with Trinexapac-ethyl 250 EC at 30 g a.i./ ha (72.6 and 75.6 cm) followed by Trinexapac-ethyl 250 EC @ 20 g a.i./ ha (77.2 and 82.7 cm) and Chlormequat Chloride 50 % SL at 900 g. a.i./ ha (81.3 and 85.6). The maximum internodal length was recorded under the untreated check (86.5 and 93.3 cm) during 2015 and 2016 respectively. The stem thickness was the maximum i.e. 6.2 and 6.1 mm under the application of the maximum dose i.e. 40 g a.i./ ha of Trinexapac-ethyl 250 EC (Table 1 and 2) and this treatment was statistically at par with the application of Trinexapac-ethyl 250 EC at 30 g a.i./ ha, while, the minimum stem thickness was recorded under the untreated check during 2015 and 2016 respectively. In most of the cases, it was found that the plant height and thickness are inversely related. Average lodging scale was worked out and detailed in the Table 3. Rice plants with the minimum lodging were recorded under the application of Trinexapac-ethyl 250 EC at 40 g a.i./ ha at 80 % maturity and this treatment was closely trailed by the application of Trinexapac-ethyl 250 EC at 30 g a.i./ ha. Corbin *et al.* (2016) reported earlier that lodging can be mitigated through a decrease in plant height, increase in stem diameter, or delaying sheath senescence. Dunand (2003) observed between 4 and 17% reductions in plant height for rice treated with 15 or 30 g a.i./ ha applied at either internode initiation or booting stage.

Grain yield of rice was significantly influenced by the different treatments. The highest grain yield were recorded under the application of Trinexapac-ethyl 250 EC at 40 g a.i./ ha and this treatment was statistically at par with Trinexapac-ethyl 250 EC At 30 g a.i./ha, while, the lowest grain yield was recorded under the untreated check. Application of Trinexapac-ethyl 250 EC reduced the lodging of the plant and escalated the grain yield (Table 3). Data presented in Table 4 and 5 revealed that Trinexapac-ethyl 250 EC at 30 and 60 g a.i./ ha was found safe on rice without showing any phytotoxicity and growth suppression symptoms viz. chlorosis, necrosis, stunting, vein clearing, yellowing, epinasty & hyponasty recorded at 1, 3,5,7 & 10 days after application. All these results are in agreement with

Table 1: Effect of Trinexapac-ethyl 25 % EC on plant height and stem thickness in rice during 2015 & 2016

Treatment	Plant height (cm) at 50% AR stage		Stem thickness (mm) at 80% HA (Harvest) stage	
	2015	2016	2015	2016
Untreated check	114.4	118.5	4.9	4.8
Trinexapac-ethyl 25% EC at 20 g a.i./ ha	98.7	101.5	5.8	5.5
Trinexapac-ethyl 25% EC at 30 g a.i./ ha	95.4	97.5	6.0	5.9
Trinexapac-ethyl 25% EC at 40 g a.i./ ha	93.6	95.5	6.2	6.1
Chlormequat Chloride 50% SL 900 g a.i./ ha	106.5	108.5	5.0	5.4
LSD (P<0.05)	3.16	2.35	0.27	0.48

Table 2: Effect of Trinexapac-ethyl 25% EC on internode length of rice during 2015 & 2016

Treatments	Internode length(cm) at 50% Active Ripening stage 2015						Internode length(cm) at 50% Active Ripening stage 2016					
	N1	N2	N3	N4	N5	Total length (cm)	N1	N2	N3	N4	N5	Total length (cm)
Untreated check	28.6	22.2	19.5	11.5	4.7	86.5	30.3	23.3	20.5	13.2	5.7	93.3
Trinexapac-ethyl 25% EC at 20 g a.i./ ha	27.2	18.2	17.1	10.1	4.6	77.2	28.4	19.3	18.7	11.4	4.9	82.7
Trinexapac-ethyl 25% EC at 30 g a.i./ ha	26.4	15.2	15.9	10.3	4.8	72.6	26.9	16.3	16.9	10.6	4.9	75.6
Trinexapac-ethyl 25% EC at 40 g a.i./ ha	26.9	14.3	15.4	9.1	4.9	70.6	27.3	15.9	16.2	10.2	4.7	74.6
Chlormequat Chloride 50% SL 900 g a.i./ ha	28.7	19.8	17.8	10.7	4.3	81.3	29.7	21.1	18.5	11.6	5.2	85.6
LSD (P<0.05)	1.50	2.42	0.6	1.20	0.34	2.40	0.90	0.84	0.76	0.91	0.33	1.60

N1, N2, N3 and N4 indicate 1st, 2nd, 3rd and 4th internode, respectively.

Table 3: Effect of Trinexapac-ethyl 25% EC on crop lodging and yield in rice during 2015 & 2016

Treatment	Lodging rate of panicles (1–3 Scale) at 80% harvest stage		Rice grain yield (kg/ ha)	
	2015	2016	2015	2016
Untreated check	64.5	68	4710	4380
Trinexapac-ethyl 25% EC at 20 g a.i./ ha	15.2	17.6	5335	5220
Trinexapac-ethyl 25% EC at 30 g a.i./ ha	7.0	8.6	5780	5610
Trinexapac-ethyl 25% EC at 40 g a.i./ ha	6.8	8.0	5810	5690
Chlormequat Chloride 50% SL 900 g a.i./ ha	49.2	51.2	5180	4980
LSD (P<0.05)	2.2	2.6	99.19	116.57

findings previously recorded by Norman *et al.* (2000); Slaton *et al.* (2003); Bond *et al.* (2008); Unan *et al.* (2013) and Corbin *et al.* (2016).

CONCLUSION

On the basis of results from the two years field experiments, it can be concluded that the best lodging prevention was found with Trinexapac-ethyl 250 EC at 40 g a.i./ ha which was statistically at par with Trinexapac-ethyl 250 EC at 30 g a.i./ ha. Thereby, this treatment was the best in terms of yield improvement of rice. No phytotoxicity symptoms to paddy crop were observed up to the higher dose of Trinexapac-ethyl 250 EC @ 60 g a.i./ ha.

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