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Short communication

Booster for mitigating the effect of ALS inhibiting herbicides on rice yield

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Weed control is a major cultural operation in rice cultivation. Weeds emerge simultaneously with crop seedlings and grow more quickly in moist soil resulting in severe competition for resources (Chauhan 2012), and yield losses may be ranged from 50 to 90%.

ALS inhibitors are a group of post-emergent herbicide which are popularly used by the farmers for weed control in the rice field. Their mode of action is by inhibiting synthesis of branched chain amino acids. As these groups of herbicides affect the protein metabolic pathway, a slight reduction in yield has been noticed by farmers. Studies by Ramanaraya (2014) has shown that the reduction in yield may be due to inhibition of photosynthetic rate, stomatal conductance, reduction in nitrate reductase enzyme activity and IAA content. This necessitates management interventions. Some of the hormones like NAA and micronutrients also have a pivotal role in the overall development of the rice plant. Molybdenum, is a co-factor of the key enzymes of assimilatory nitrogen metabolism in plants. Zinc is an essential element for tryptophan synthesis which is the precursor of IAA (Taiz and Zeiger 2010). Application of boron is helpful in cell growth and further development of plants. These chemicals and their combinations were tried to develop a management technology to improve the physiological efficiency of the rice after the application of the post-emergent ALS inhibiting herbicides.

An experiment using the rice cultivar '*Manupriya*' was conducted during *Kharif* season of 2015 at Agricultural Research Station, Mannuthy in Thrissur district in Kerala. The experimental soil was medium in fertility and having pH 5.0. The experiment was laid out in randomized block design with 11 treatments, replicated thrice.

Before starting the experiment, soil samples were collected from the experimental site and analyzed for basic properties like pH, EC and macro and micro nutrients. The area was ploughed, puddled and levelled. The plot size adopted was 15 m^2 (5 x 3 m). Plots of 5 x 3 m were made by taking bunds of 20 cm width and height. After levelling, fertilizers N:P:K was applied as 70:35:35 kg/ha. Secondary and micronutrients were applied as per soil test data except in treatments T2, T4, T7 and T9, where zinc, boron and molybdenum was given as spray. Urea, factamphos, muriate of potash, borax and magnesium sulphate were used for supplying the nutrients. Full dose of P was applied basally. N, K, B, Mg were applied in two equal splits during land preparation and panicle initiation stages. After basal fertilizer application, the seeds were dibbled at a spacing of 15×10 cm at the rate of 150 g/plot (90 kg/ha). Hand weeding was done at 20 and 40 DAS. Both the herbicides were sprayed at 15 DAS using knapsack sprayer at the recommended doses and all nutrients were sprayed at 35 DAS at the recommended doses.

Micro nutrient spray contained 1gm each of zinc sulphate, borax and 0.01 gm of molybdic acid/litre. NAA was applied 100 ppm. Observation of yield attributes and yield were recorded after harvesting. Results were analyzed statistically.

Maximum number of tillers were observed in tank mix applied plots (330.67) followed by T_2 (bispyribac-sodium *fb* micronutrient spray). All other treatments recorded lesser number of productive tillers/m^2 as compared to other treatments (Table 1). Minimum number of tillers was recorded in the treatments T_{10} (azimsulfuron + water spray at 35 DAS) and T_6 (azimsulfuron + 1% urea spray at 35 DAS) which were at par with each other. Spikelets/panicle varied in different mitigating treatments. The maximum number of spikelets (120.33) were observed in treatment T_4. Treatment T_{10} recorded least number of spikelets (97.67) followed by the treatment T_{11}. The maximum number of filled grains was noticed in treatment T_4 (116.33) followed by the treatment T_2 (109.67) and T_3. High percentage of chaff content was recorded in hand weeded control (9.14) followed by water spray (8.08) in azimsulfuron applied plots. Bispyribac-sodium applied plots recorded higher yield and yield attributes

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Table 1. Effect of mitigating treatments on yield parameters

Treatment	No. of productive tillers/ m^2	No. of spikelets/ panicle	No. of filled grains/panicle	Chaff percentage	1000 grain weight (g)
T_1	316.00^{bc}	109.67 ^{b}	102.33^{cd}	6.81 ^{bcd}	31.17^{bc}
T_2	324.33^{ab}	117.00^{a}	109.67 ^{b}	6.23 ^{cd}	30.90 ^{bcd}
T_3	315.67 ^{c}	110.67 ^{b}	104.33 ^{c}	5.71 ^{d}	31.51^{b}
T_4	330.67 ^{a}	120.33^{a}	116.33 ^{a}	3.35 ^{e}	33.06 ^{a}
T_5	309.67 ^{cde}	104.33^{cd}	97.67 ^{ef}	6.32 ^{cd}	29.81^{ef}
T_6	301.67 ^{ef}	103.00^{d}	95.00 ^{fg}	7.77 ^{abc}	29.67 ^{ef}
T_7	305.33 ^{def}	105.00^{cd}	99.33 ^{de}	5.47 ^{d}	30.08 ^{def}
T_8	305.33 ^{def}	101.33^{de}	93.67 ^{fgh}	7.56 ^{bc}	29.28 ^{fg}
T_9	311.00 ^{cd}	108.00^{bc}	101.33^{cde}	6.33 ^{cd}	30.43 ^{cde}
T_{10}	299.33^{f}	97.67 ^{e}	90.00^{h}	8.08 ^{ab}	28.73^{g}
T_{11}	302.00 ^{ef}	101.00 ^{de}	92.00^{gh}	9.14 ^{a}	29.47^{fg}
LSD (P=0.05)	8.51	4.47	4.00	1.54	0.90

In a coloumn, means followed by common letters do not differ significantly at 5% level by DMRT

compared to azimsulfuron applied plots. Grain yield was higher in combined application of urea, micronutrients and NAA applied plots in both bispyribac-sodium and azimsulfuron applied plots (Table 2). But the straw yield was higher in urea application of both bispyribac-sodium (10.88) and azimsulfuron (12.44) applied plots.

When the grain and straw yield of water sprayed treatments were compared with the hand weeded control, there was a 3% reduction in grain yield in the bispyribac-sodium applied plots while 6% reduction was noticed in the azimsulfuron applied plots. Straw yield showed 5.0 and 0.83% reduction in bispyribac-sodium and azimsulfuron applied plots, respectively compared with hand weeded control. Ramanarayana (2014) had also reported that there was a 5-17% reduction in grain yield and 6-17% reduction in straw yield by the application of ALS inhibiting herbicides. The mitigation treatments, urea, micronutrients and NAA spray improved the yield by 21.5- 9.9% in azimsulfuron and bispyribac-sodium applied plots, respectively over the control. 22% improvement in grain yield was observed when treatment T_4 of the bispyribac-sodium applied plots was compared with T_5 where only water spray was given after bispyribac-sodium application. In case of azimsulfuron, 6% increase in grain yield was obtained when the treatment T_9 was compared with T_{10} (water spray).

The effect of Zn application on yield components of rice has been reported by Brown *et al.* (1993), Zn has higher effect on yield rather than vegetative growth. Boron has been identified as an element that increases tillering in rice which may be due to its positive influence on photosynthate translocation through vascular bundles of petioles (Ali *et al.* 1996). These might be the factors which have contributed to an increase in the productivity of rice.

Table 2. Effect of mitigating treatments on yield (t/ha)

Treatment	Grain yield	Straw yield
T_1	5.40 ^{b}	10.88 ^{abc}
T_2	5.46 ^{b}	10.33 ^{bc}
T_3	5.44 ^{b}	9.77 ^{c}
T_4	6.22 ^{a}	10.33 ^{bc}
T_5	5.12 ^{c}	9.88 ^{c}
T_6	5.37 ^{b}	12.44 ^{a}
T_7	6.04 ^{a}	10.44 ^{bc}
T_8	5.33 ^{b}	11.77 ^{ab}
T_9	5.60 ^{b}	10.33 ^{bc}
T_{10}	5.28 ^{c}	9.33 ^{abc}
T_{11}	4.97 ^{c}	10.77 ^{c}
LSD(P=0.05)	0.312	1.67

In a coloumn, means followed by common letters do not differ significantly at 5% level by DMRT

Study showed that the initial growth suppression due to application of post- emergent ALS inhibiting herbicides can be overcome with mitigation treatments given on the 35th day and among the treatments combined application of Urea, NAA and micronutrients gave the best results.

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