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Bio-efficacy of new post emergent herbicides with pre emergent herbicides in transplanted rice under hill zone of Karnataka

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Abstract
A field experiment entitled "Study on bio-efficacy of new post emergent herbicide molecules with pre-emergent herbicides in transplanted rice under hill zone of Karnataka" was conducted during *Kharif* season 2016 at Zonal Agricultural and Horticultural Research Station, Mudigere, to evaluate the suitable new post emergent herbicides along with pre-emergent herbicides in transplanted rice. The herbicides tested were two pre-emergent herbicides *viz.* Butachlor 50 EC, Bensulfuron methyl 0.6 + Pretilachlor 6 GR and five new post emergent herbicides *viz.* Bispyricbac sodium 10 SC, Metsulfuron methyl 20 WP, Ethoxy sulfuron 15 WDG, Chlorimuron ethyl+Metsulfuron methyl 20 WP, Fenoxyprop p ethyl 9.3 EC and old herbicide 2. 4 D Sodium salt. In addition to that, weed free up to 45 DAT and weedy check are also included to make a comparison. The experiment design was laid out in RCBD with ten treatments and three replication. The results revealed that among herbicide treatments sequential application of Butachlor 50 EC @ 1.25 kg a.i ha^{-1} at 3 DAT Fb Bispyricbac sodium 10 SC @ 20 g a.i ha^{-1} at 21 DAT significantly recorded lower weed count (22.32 /0.25 m^2), weed dry weight (3.08g /0.25 m^2), weed index (8.36 %) and higher weed control efficiency (71.16 %) without being phototoxic to the crop and as a result recorded in the higher grain yield (5165 kg ha^{-1}). However, these results were on par with Butachlor 50 EC @ 1.25 kg a.i ha^{-1} at 3 DAT fb hand weeding at 15 and 30 DAT followed by weed free up to 45 DAT (hand weeding).

Keywords: Bio-efficacy, pre and new post emergent, herbicide, rice, hill zone, Karnataka

Introduction
India occupies a pride place in rice production among the food crops cultivated in the world. India has the largest area (43.95 m ha) among rice growing countries and stands second in production (106.54 m t) with productivity of 2424 kg ha^{-1}. In Karnataka, it is grown in an area of 1.33 m ha with an annual production of 3.76 m t and a productivity of 2828 kg ha^{-1} (Anon, 2015) [1]. Now days, rice production is facing various constraints including a declining rate of growth and yield, depletion of natural resources, labour shortages, gender based conflicts, institutional limitations and environmental pollution. Among several factors responsible for low rice production, weeds are the major ones which cause a reduction in yield of rice production worldwide. Losses caused by weeds vary from one country to another depending on the predominant weed flora present in the field and the control methods practiced by farmers and one more important labour component in agriculture is becoming scarce, not available in time and higher wages paid for the labours. The farmers experience difficulty in managing weeds, as the available labour force is migrating to urban areas. Use of herbicides to manage weeds forms an excellent alternative to manual weeding to reduce the human drudgery. Usage of pre-emergence herbicides assumes greater importance in the view of their effectiveness from initial stages. As the weeds interfere during the later stage of the crop, post emergence herbicides at about 20-35 DAT may help in avoiding the problem of weeds at later stages.

Material and Methods
A field experiment was conducted during *Kharif* 2016 at Zonal Agricultural and Horticultural Research Station, Mudigere. The Experiment involves 10 treatments includes two pre-emergent herbicides Butachlor 50 EC and Bensulfuron methyl 0.6% G @ 60 g a.i. ha^{-1} + Pretilachlor 6% G @ 600 g a.i. ha^{-1} applied alone as pre-emergent at 3 DAT and three post emergent herbicides 2. 4 D Sodium salt 80, Fenoxyprop p ethyl 9.3 EC, Bispyribac sodium 10 SC @ 20g a.i. ha^{-1}, Metsulfuron methyl 20 WP @ 5 g ha^{-1}, Chlorimuron ethyl+Metsulfuron methyl 20 WP @ 8 g ha^{-1} and Ethoxysulfuron 15 WG @ 18.75g a.i. ha^{-1}.

Post emergent herbicide applied as alone and each was post emergent herbicides was preceded by pre emergent herbicides which were compared with hand weeding twice at 20 and at 40 DAP and unweeded check which was laid out under the randomized block design with three replication. The main field was puddled and leveled and seedlings were transplanted at the age of 21 days. The data on weed population and dry matter were recorded at 30, 60, 90 DAP and at harvest with quadrate measuring 50 × 50 cm and expressed number /0.25 m^2 and g/0.25 m^2, respectively. The data were subjected to square root transformation using the formula $\sqrt{X + 0.5}$ and statistical analysis was done as suggested by Gomez and Gomez (1984) [4]. Weed control efficiency by Mani *et al.* (1973) [6] and weed index by Gill and Kumar (1969) [1] were calculated as per the standard formulae.

$$WCE\ (\%) = \frac{DMC - DMT}{DMC} \times 100$$

Where
WCE = Weed control efficiency (%)
DMC = Dry matter of weeds in un weeded control Plot
DMT = Dry matter of weed in treated plots

$$Weed\ index\ (\%) = \frac{X - Y}{X} \times 100$$

Where
X = Grain yield of weed free plot (weed free up to 45 DAT)
Y = Grain yield from the treatment plot

The treatment combinations are as follows:

- **T_1:** Butachlor 50 EC @ 1.25 kg a.i ha^{-1} at 3 DAT followed by (fb) hand weeding at 15 and 30 DAT
- **T_2:** Butachlor 50 EC @ 1.25 kg a.i ha^{-1} at 3 DAT fb 2. 4 D Sodium salt 80 @ 2.5 kg ha^{-1} at 21 DAT
- **T_3:** Butachlor 50 EC @ 1.25 kg a.i ha^{-1} at 3 DAT fb @ Fenoxyprop p ethyl 9.3 EC 1250 ml ha^{-1} at 21 DAT
- **T_4:** Butachlor 50 EC @ 1.25 kg a.i ha^{-1} at 3 DAT fb Bispyribac sodium 10 SC @ 20 g a.i ha^{-1} at 21 DAT
- **T_5:** Butachlor 50 EC @ 1.25 kg a.i ha^{-1} at 3 DAT fb Metsulfuron methyl 20 WP @ 5 g ha^{-1} at 21 DAT
- **T_6:** Butachlor 50 EC @ 1.25 kg a.i ha^{-1} at 3 DAT fb Ethoxysulfuron 15 WDG @ 15 g ha^{-1} at 21 DAT
- **T_7:** Butachlor 50 EC @ 1.25 kg a.i ha^{-1} at 3 DAT fb Chlorimuron ethyl+Metsulfuron methyl 20 WP @ 8 g ha^{-1} at 21 DAT
- **T_8:** Bensulfuron methyl 0.6 +Pretilachlor 6 GR @ 12.5 kg a.i ha^{-1} fb Fenoxyprop p ethyl 9.3 EC @ 1250 ml ha^{-1} at 21 DAT
- **T_9:** Weedy check
- **T_{10}:** Weed free check up to 45 DAT

Note: DAT- Days after transplanting**,** a.i: active ingredient, fb: followed by

Table 1: Weed density, dry matter, weed control efficiency (WCE) and weed index are influenced by different herbicide application

Treatments	Weed density No. 0.25 m^{-2})	Total weed dry matter (g)	WCE (%)	Weed index (%)	Grain yield (kg ha^{-1})
T_1	4.41(18.99)	1.83(2.85)	72.35	3.56	5,441
T_2	5.24(26.99)	2.42(5.37)	51.80	28.17	4,056
T_3	5.52(29.98)	2.51(5.78)	46.16	31.58	3,863
T_4	4.77(22.32)	1.89(3.08)	71.16	8.36	5,165
T_5	5.22(26.84)	2.23(4.48)	54.33	25.07	4,297
T_6	5.15(26.06)	2.12(4.01)	58.12	22.60	4,370
T_7	5.09(25.44)	2.12(3.98)	59.85	20.78	4,511
T_8	4.98(24.33)	2.07(3.98)	61.17	16.41	4,720
T_9	8.45(63.32)	3.16(9.50)	0.00	52.61	2,674
T_{10}	4.02(15.60)	1.55(1.91)	82.33	0.00	5,647
S.Em±	0.26	0.08	3.78	3.13	172.47
C.D at 5%	0.78	0.24	11.34	9.39	517.41

Note: Data subjected to $\sqrt{X + 0.5}$ transformation and figures in parentheses indicate original values;

Result and Discussion

The predominant weed flora observed in the experimental field was *Panicum tripheron, Panicum repens, Echinochloa colonum* among grasses, *Cyperus differmis, Cyperus procerus, Euriocolon sp*. are among the sedges and *Monochoria vaginalis, Ammannia baccifera* and *Marsilea quadrifolia* and *Ludwigia parviflora* among the broadleaved weeds. Similar weed species under transplanted rice were also reported by Purushotam Singh *et al.* (2007) [7] and Singh Mandhata and Singh (2010) [8].

Among the all the herbicidal treatments, the sequential application of Butachlor at 3 DAT fb Bispyribac sodium 10 SC @ 20 g a.i ha^{-1} at 21 DAT recorded lower weed density (22.32 /0.25 m^2), total dry weight (3.08g /0.25 m^2), weed index (8.36 %) as a result of higher weed control efficiency (71.36 %) which were followed by sequential application of Butachlor at 3 DAT fb Chlorimuron ethyl+Metsulfuron methyl 20 WP @ 8 g ha^{-1} at 21 DAT and Bensulfuron methyl 0.6 +Pretilachlor 6 GR @ 12.5 kg a.i ha^{-1} fb Fenoxyprop p ethyl 9.3 EC @ 1250 ml ha^{-1} at 21 DAT recorded significantly the lower weed population and dry weight of weeds *viz.*, monocots, dicots and sedge weeds. Further, results revealed that, sequential application of herbicides was more effective in controlling monocots, dicots and sedges weed species, which coupled with the record of the lower dry weight of weeds resulting in higher weed control efficiency and lower weed index. Similar results were reported by Mallikarjaun *et al.* (2014), Sreedevi *et al*. (2016) [9] and Kaur and Singh (2015) [4]. However, application of Butachlor at 3 DAT fb Bispyribac sodium 10 SC @ 20 g a.i ha^{-1} at 21 DAT which were on par with weed free up to 45 DAT followed by application of Butachlor 50 EC @ 1.25 kg a.i ha^{-1} at 3 DAT fb hand weeding at 15 and 30 DAT. The better weed control and lesser dry weight of the weeds by the sequential application of pre-emergent herbicide (Butachlor) and broad spectrum new post-emergent herbicide such as Bispyribac sodium which controlled total or the most of the weeds very effectively. The rapid absorption of herbicides molecules by the shoots and

roots of weeds are responsible for inhibition of protein synthesis activity. Sequential application of these herbicides ensured that the reliable control of most of the grasses, sedges and broadleaved weeds throughout the crop growth period as evidenced by lowest weed population and dry weight of the weeds due to better control of weeds and higher weed control efficiency during early stage of crop growth which resulted in better utilization of available nutrients, moisture and light. Weedy check recorded the significantly the highest weed population (63.32 /0.25 m^2) and dry weight (9.5 g/ 0.25m^2) of weeds which results in lower weed control efficiency (0.00 %) and higher weed index over rest of the treatments. This may be attributed to no weed control in weedy check plot lead to severe crop weed competition resulted in poor crop growth and yield. The reduction in crop yield due to crop weed competition was indicated by weed index values (52.61 %).

Conclusion

The sequential application of Butachlor at 3 DAT fb Bispyribac sodium 10 SC @ 20 g a.i ha^{-1} at 21 DAT is effective in weed control as a resulted obtained better yield under hill rice ecosystem of Karnataka. However this treatment was on par with sequential application of Butachlor at 3 DAT fb Chlorimuron ethyl +Metsulfuron methyl 20 WP @ 8 g ha^{-1} at 21 DAT and Bensulfuron methyl 0.6 +Pretilachlor 6 GR @ 12.5 kg a.i ha^{-1} fb Fenoxyprop p ethyl 9.3 EC @ 1250 ml ha^{-1} at 21 DAT. Hence farmer can choose any one of the above herbicidal combinations. However, these results were on par with Butachlor 50 EC @ 1.25 kg a.i ha^{-1} at 3 DAT fb hand weeding at 15 and 30 DAT followed by weed free up to 45 DAT. But due to labour scarcity we can't go for hand weeding under labour scares area in hill zone of Karnataka.

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