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Weed management measures in transplanted rice and its residual impact on succeeding moong bean (*Vigna radiata*)

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ABSTRACT

A field investigation to ascertain bio-assay of rice herbicides on subsequent pulse crop was taken up at College Farm, College of Agriculture, PJTSAU, Rajendranagar, during the kharif-2019 with twelve treatments in randomized block design and repeated three times. From the experiment it was confirmed that, there was no phytotoxicity symptoms in transplanted rice after imposition of all novel herbicide compounds and there was no carryover effect on subsequent crop recorded in terms of germination percentage, height of plant and crop dry weight production. All the herbicides used in the study were also found safe without any residual effect and minimal environmental impact on succeeding crop making them a fit choice in rice-based cropping systems.

***Keywords*:** Moong bean, herbicide residues, transplanted rice, bio-assay, phyto-toxicity

In India, the rice-moong bean system is the most common cropping system which is in practice from years. In general, transplanted rice fields are susceptible to weed infestation by a diverse weed flora and cause loses up to 65 per cent of yield (Rana *et al*., 2018). Hand weeding is the conventional and most effective way of weed control in rice, although it is more expensive and often became difficult to keep the crop weed-free during the vital period (critical crop-weed competition) due to labour shortage. It has forced the farmers to continuously use traditional herbicides as a default option to control weeds. Continuous use of herbicide with same mode of action leads appearance of more notorious weeds (Mohapatra *et al*., 2021). To avoid such disaster, it is advised to use novel herbicide molecules with several modes of action to manage this composite weed flora in rice (Gangireddy and Subramanyam, 2020). Because of its short lifespan, deep root structure and ability to be cultivated with residual moisture and minimum irrigation, rabi moong bean has a lot of potential in India after harvesting *kharif* transplanted rice.

Herbicides applied at recommended rates may have a positive impact. However, even at recommended doses, some herbicides may not breakdown fast and can persist in the soil for weeks, months and sometimes years after treatment and inhibiting the growth of subsequent crops (Rani *et al*., 2021). To limit the danger of harmful impacts on subsequent crops and the environment, it is necessary to optimize the use of these herbicides. In terms of environmental safety herbicide residue analysis is becoming pivotal. Bioassay is one of the most important, practical and cost-effective methods for evaluating herbicide residue in soil (Sridhara *et al*., 2018). There are few field investigations on the residue durability and effect of new generation herbicide compounds on subsequent crops. With the foregoing circumstances in mind, an investigation was conducted to determine the residual influence of weed management measures taken up in previous transplanted rice on subsequent moong bean crop.

A field investigation was taken up at College Farm, College of Agriculture, PJTSAU, Rajendranagar, during *kharif*-2019 and succeeding *rabi* season with the goal of determining the most economically viable and safe weed management method in the rice-moong bean cropping sequence. The farm is located at an elevation of 542.3 meters above MSL and is located at 17^{0}19' 16.4" North latitude and 78^{0} 24' 43" East longitude. It is classified as semi-arid tropics by troll's climatic categorization (SAT). The study has planned with twelve treatments repeated three times in a randomized block design.

Phyto-toxicity scoring was taken in both rice crop and moong bean crop by adopting a scale (range of 1-9) where scoring 1 means no injury and no reduction in plant population, 9 means complete crop destruction. Moong bean(WGG-37) was sown in undisturbed plots of previous experiment without land preparation based on residual moisture immediately after the harvest of *kharif* transplanted rice to determine the most suitable and safe weed management approach for subsequent growing of moong bean. Moong bean seeds were dibbled at uniform depth in every plot of previous layout for bioassay investigation (2-2.5 cm). Each treatment was

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tested three times. At 10 DAS, the germination count was obtained, and the plant height, dry weight readings were taken at 30 DAS and finally the moong bean yield was measured and conquered suitable statistical analysis for drawing valid conclusions for above results *i.e*., randomized block design (Gomez and Gomez, 1984).

Table 1: Residual impact of weed management measures carried out in preceding transplanted rice on subsequent moong bean

Treatments	Germination (%) at 10 DAS	Plant height (cm) at 30 DAS	Dry weight (kg ha $^{-1}$) at 30 DAS	Yield (kg ha^{-1})
T_1 - Penoxsulam 0.97 per cent + butachlor 38.8% SE 820 g ha^{-1} (PE) *fb*HW at 30 DAT	85.0	19.0	121	888
T_2 - Pyrazosulfuron-ethyl 0.15 per cent + pretilachlor 6 per cent GR 600g ha^{-1} (PE) *fb* HW at 30 DAT	90.3	19.7	124	919
T_3- Orthosulfamuron + pretilachlor 6 per cent GR 600g ha^{-1} (PE) *fb* HW at 30 DAT	86.0	20.0	117	875
T_4 - Ipfencarbazone 25 per cent SC 156.25 g ha^{-1} (PE)*fb* HW at 30 DAT	85.0	19.7	123	850
T_5- Penoxsulam 2.65 per cent OD 25 g ha^{-1} (PoE) *fb* HW at 40 DAT	84.0	18.3	123	848
T_6 - Penoxsulam 1.02% + cyhalofop butyl 5.1per cent OD 150 g ha^{-1} (PoE) *fb* HW at 40 DAT	90.0	22.0	121	947
T_7- Pretilachlor 50 per cent EC 0.75 kg ha^{-1} (PE) *fb*2,4 D WP 1.0 kg ha^{-1} (PoE)	82.7	19.0	119	824
T_8- Bispyribac sodium 10 per cent SC 25 g ha^{-1} (PoE) *fb* HW at 40 DAT	83.7	18.7	121	832
T_9- Flopyrauxifen- benzyl + penoxsulam 12 per cent EC 40.64 g ha^{-1} (PoE) *fb* HW at 40 DAT	88.0	22.7	133	952
T_{10}- Flopyrauxifen- benzyl + cyhalofop butyl 10per cent EC 150 g ha^{-1} (PoE) *fb* HW at 40 DAT	89.0	24.0	123	939
T_{11}- HW at 20 and 40 DAT	90.7	26.7	130	958
T_{12} - Unweeded control	88.0	24.3	121	702
SEm(±)	**2.9**	**2.89**	**4.02**	**46.1**
LSD (0.05)	**NS**	**NS**	**NS**	**NS**

Table 2 : Phytotoxicity ratings recorded after herbicide spraying on transplanted rice and succeeding moong bean crop as influenced by weed control measures

Treatments	*kharif*, 2019 (Transplanted rice) Days after treatment imposition (DATI)				*rabi*, 2019-20 (Moong bean) Days after sowing (DAS)			
	3	6	9	12	10	20	30	40
T_1	1	1	1	1	1	1	1	1
T_2	1	1	1	1	1	1	1	1
T_3	1	1	1	1	1	1	1	1
T_4	1	1	1	1	1	1	1	1
T_5	1	1	1	1	1	1	1	1
T_6	1	1	1	1	1	1	1	1
T_7	1	1	1	1	1	1	1	1
T_8	1	1	1	1	1	1	1	1
T_9	1	1	1	1	1	1	1	1
T_{10}	1	1	1	1	1	1	1	1
T_{11}	-	-	-	-	-	-	-	-
T_{12}	-	-	-	-	-	-	-	-

Due to varied weed management measures applied in the transplanted rice crop, the germination percentage of the next moong bean crop did not differ significantly (Rani *et al*., 2021). Moong bean is an indicator plant which is very sensitive for residues, despite the fact that pesticide residues have no effect on its rate of germination. That means there was no longer any herbicide persistence in the soil due to rapid degradation of herbicides. As a result, the herbicides and herbicide mixtures used in the experiment were found to be safe to use in the rice-moong bean cropping system. Similar observations were discovered by others as well (Sridhara *et al*.,2018).

At 30 days after sowing of moong bean crop, observations on growth parameters such as plant height and dry matter production were noted and the results revealed that, there was no discernible variation between the various weed management methods. This could be because of herbicide persistence lasts only until 30-40 days after transplanting, after which weeds were suppressed by crop growth. As a result of herbicide degradation such as leaching and microbial attack, there is no carryover impact for subsequent moong bean crop (Saranraj *et al*., 2018). The yield data presented in Table 1 clearly shown that there was no influence of any herbicide residues on yield of succeeding crop, but the lower yields recorded in the weedy check compared to the other weed management methods is the indication of the nutrient depletion by weeds during the previous crop season resulting in lower yields in succeeding moong bean crop.

On the crop, there were no signs of any phytotoxicity like yellowing, curling, epinasty, hyponasty, necrosis, stunting and wilting. None of the herbicides induced phytotoxicity. Dhanapal *et al*. (2018) and Yadav *et al*. (2018) have also opined similar conclusions. The phytotoxicity investigation of novel herbicides and herbicide combinations did not cause any phytotoxicity symptoms at 3, 6, 9 and 12 days after herbicide application in transplanted rice during *kharif* and 10, 20, 30 and 40 days after sowing of moong bean, as per the given data (Table 2). During the *rabi* season, this crop showed no signs of phytotoxicity. So, the above-mentioned pre and post-emergence herbicides were highly selective to rice crops for effective weed control and minimal environmental damage, while also allowing for the growth of any subsequent crop, even sensitive ones.

From above outcome finally we can conclude that use of pre or post emergence broad spectrum herbicides and herbicide mixtures are very safe to transplanted rice based cropping system with no residual effect, least environmental impact and without any deleterious effect on succeeding crop.

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