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RESEARCH ARTICLE

Response of Direct Seeded Rice Under Different Formulation of New Generation Herbicides on Growth And Yield

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ABSTRACT

A field experiment was conducted during *kharif* season of 2022 to evaluate the growth and yield response of direct seeded rice under different formulation of new generation herbicides. The results revealed that, pre emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 7 DAS fb hand weeding on 40 DAS recorded broad spectrum of weed control. The highest crop growth attributes (tillers/hill, leaf area index and total dry matter), yield attributes (productive tiller, filled grains/panicle, panicle weight) and grain yield (6670 kg ha^{-1}), net returns (Rs.94991 ha^{-1}) and the highest returns per rupee invested (Rs.2.77) were recorded in pre emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 7 DAS fb hand weeding on 40 DAS, which was best broad spectrum effective herbicide in order to minimize the diverse weed flora in direct seeded rice.

Keywords: *Direct seeded rice, New generation herbicides, Growth, Yield*

INTRODUCTION

Rice (*Oryza sativa* L.) is a staple food crop which contributes enormously to food security and economy. India is an important rice producing country that comes in second behind China, contributing 22.5 per cent of overall world rice production. In worldwide, rice is grown on 164.1 million hectares in 120 countries, yielding 756.74 million tonnes of production and 4.6 t ha^{-1} of productivity annually. (FAO STAT, 2022). Transplanting is the traditional method of rice cultivation. Shortage of labour during peak period of transplanting, erratic supply of monsoon rain, decrease of underground water and rising production cost necessitate the search for an alternative to the conventional puddled transplanting of rice (Bhandari *et al.,* 2020). Thus, nowadays there is a shift towards direct seeding from transplanting. Direct seeded rice is a feasible alternative to conventional puddled transplanted rice as in the conventional system of transplanting of rice, puddling of the soil disturbs the soil aggregates, reduces the soil permeability and creates hardpans at shallow depths which adversely affect the soil structure (Bhardwaj and Sidana, 2019). Wet puddled drum seeded rice enables intercultural operations and optimal plant density (Hussainy and Arivukodi, 2020).

The weeds are considered threat to agriculture because they create intense competition for nutrients, moisture, solar radiation, and space against crop. Weeds compete more intensely with rice because weeds emerge almost concurrently with rice when it's direct seeded, which dominate crop habitat and lowering potential yield. Weeds can reduce rice yield by 40 to 100 per cent in direct seeded rice. Uncontrolled weeds decrease yield by 61 per cent in wet DSR and 96 per cent in dry DSR. (Rathika *et al.,* 2020). As weeds significantly decrease crop yield and quality, which in turn lowers productivity and profitability. Controlling weeds in rice crops is a challenging task for successful agricultural production.

The chemical method is an efficient option for the effective control of weeds in direct-seeded rice. Herbicide has become the most important tool

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for managing weeds as it offers timely, practical, economical, and effective method of controlling weeds (Sen *et al.,* 2020). The application of herbicides can be attributed to their efficacy to control wide spectrum of weeds (Dhaker *et al.,* 2023). Judicious selection of herbicide at right time, right dose and right method helps to effectively manage weeds and increase the crop yield. Application of single herbicide may not control the weeds effectively. Hence, sequential application of pre or post emergence herbicide with hand weeding was done effective. Applying pre emergence and early post emergence herbicides to control weeds during the early stages of crop growth is very important because it ceases weed seeds from germinating and hinders the growth of weeds. Later emerging and second flushes of weeds were effectively controlled by application of post emergence herbicides and hand weeding. Additionally, the new generation herbicide lowers the rate of use, reduces herbicide injury to crops, minimizes the cost of application, and lessens the problem of residual build with high efficiency.

The herbicide formulation has played a pivotal role in modern agriculture. The primary reason for formulating the herbicide is to allow the user to dispense it in a convenient carrier, such as water. The primary purpose of the carrier is to enable the uniform distribution of a relatively small amount of herbicide over comparatively large area. By formulating the herbicide, it is easy to handle and reduce phytotoxicity of the herbicide. Some formulation that have emerged in the farmers practice for applying herbicides in the field. The application of smaller amount of herbicides, which enhancements in stability and also result in higher water solubility, less environmental pollution and more targeted products (Mejias *et al*., 2023).

MATERIALS AND METHODS

The experiment was conducted during *Kharif* season of 2022 Annamalai University Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai Nagar, Tamil Nadu. The soil of the field was clay loam and neutral in pH (6.5), EC (0.15 ds m^{-1}), low in organic carbon content, low in nitrogen, medium in phosphorus and high in potassium. The experiment consists of eight treatments comprising of unweeded control, weed control methods viz., twice hand weeding on 20 and 40 DAS, pre emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 7 DAS fb hand weeding on 40 DAS and pretilachlor 37% EW @ 1500 ml ha^{-1} on 7 DAS fb hand weeding on 40 DAS, early post emergence application of triafamone 20% + ethoxysulfuron 10% WG @ 225 g ha^{-1} on 12 DAS fb hand weeding on 40 DAS and ethoxysulfuron 15% WDG @ 125 g ha^{-1} on 12 DAS fb hand weeding on 40 DAS, post emergence application of fenoxaprop-p-ethyl 9.3% EC @ 625 ml ha^{-1} on 20 DAS fb hand weeding on 40 DAS and bispyribac sodium 10% SC @ 250 ml ha^{-1} on 20 DAS fb hand weeding on 40 DAS. The experiment was laid out in randomized block design with three replications. Pre germinated seeds of short duration rice variety ADT 37 was sown at 20 X 10 cm spacing on well puddled and leveled field with a seed rate of 40 kg ha^{-1}. The crop was fertilized with 120:40:40 kg $N:P_2O_5:K_2O$ ha^{-1}. The entire quantity of phosphorus was applied as basal dose in all the plots. Nitrogen and potassium fertilizers were applied in three equal splits at basal, tillering and panicle initiation stages of crop. Pre emergence herbicides were bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} was applied with dry sand @ 50 kg ha^{-1} and pretilachlor 37% EW @ 1500 ml ha^{-1} was applied by direct application in field on 7 DAS and other herbicides were sprayed with flat fan nozzle with 500 litres volume of water per hectare using knapsack sprayer. The data on weed density and weed dry weight (at 30 and 60 DAS) were recorded with the help of quadrate (0.5 x 0.5 m). The normality of distribution was not seen in case of observation on weeds hence, the values were subjected to square root transformation ($\sqrt{(x+0.5)}$ prior to statistical analysis to normalize their distribution. Data on grain yield and straw yield were recorded. The weed control efficiency was worked out on the basis of weed population using the formula suggested by (Mani *et al.,* 1973). All the data obtained in the study were statistically analyzed using F-test, the procedure given by (Gomez and Gomez 1984), critical difference values at p=0.05 were used to determine the significance of differences between means.

RESULTS AND DISCUSSION

Growth attributes

Pre emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR on 7 DAS fb hand weeding on 40 DAS recorded the highest crop growth attributes *viz.,* tillers $hill^{-1}$ (13.59), leaf area index (6.24) and total dry matter (7,103 and 10,901 kg ha^{-1}) on 30 and 60 DAS respectively (Table 1). The increased

Table 1. Efficacy of new generation herbicides on tillers hill^{-1}, leaf area index and total dry matter on 30 and 60 DAS in direct seeded rice

Treatments	Number of tillers hill^{-1}	LAI	Total dry matter	
			30 DAS (kg ha^{-1})	60 DAS (kg ha^{-1})
T_1-Unweeded Control	6.19	2.93	2,086	3,169
T_2-Twice hand weeding on 20 and 40 DAS	11.48	5.76	6,541	10,348
T_3-Pre emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR on 7 DAS *fb* hand weeding on 40 DAS	13.59	6.24	7,103	10,901
T_4-Pre emergence application of pretilachlor 37% on 7 DAS *fb* hand weeding on 40 DAS	8.10	4.21	5,282	8,135
T_5-Early post emergence application of triafamone 20% + ethoxysulfuron 10% WP on 12 DAS *fb* hand weeding on 40 DAS	11.76	5.87	6,690	10,473
T_6-Early post emergence application of ethoxysulfuron 15% WDG on 12 DAS *fb* hand weeding on 40 DAS	10.10	5.21	6,225	9,582
T_7-Post emergence application of fenoxaprop-p-ethyl 9.3% EC on 20 DAS *fb* hand weeding on 40 DAS	9.07	4.76	5,901	9,063
T_8-Post emergence application of bispyribac sodium 10% SC on 20 DAS *fb* hand weeding on 40 DAS	12.05	5.95	6,788	10,567
SEm±	0.44	0.12	145.71	150.22
CD (p=0.05)	0.93	0.25	306.01	315.48

growth parameter with pre emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR on 7 DAS fb hand weeding on 40 DAS might be owing to the fact that maximum dry matter production might be owing to higher plant height and a great number of tillers. The results are in harmony with the findings of Choudhary *et al.,* (2018). The highest LAI recorded may be attributed to appropriate combination of herbicides along with appropriate seeding method, that killed the weeds at their germination stage and ensured the plant's for effective utilization of moisture, nutrients and light that helped in the production of greater amount of photosynthates thereby producing larger leaf area. The highest number of tillers might be due to the excellent weed control acquired on 30 DAS, which fell within the crop-weed competition period from 15-45 DAS in rice (Mounisha *et al.,* 2021).

Yield attributes

Pre emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR on 7 DAS fb hand weeding on 40 DAS recorded the highest yield attributes *viz.,* productive tiller (325/m^2), filled grains panicle^{-1} (97.31), panicle weight (23.45) (Table 2). This might be due to that effective and timely weed management under the herbicidal treatments during critical crop-weed competition period reduced the density and biomass of weeds which facilitated the crop plants to have sufficient space, light, nutrient and moisture and thus the number of effective tillers m^{-2}, number of filled grains panicle^{-1} and finally the yield was increased in a sustainable manner to the desired level (Priya *et al.,* 2017) and (Quadri *et al.,* 2023).

Grain and straw yield

Pre emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR on 7 DAS fb hand weeding on 40 DAS recorded the highest grain and straw yield of 6670 kg ha^{-1} and 8605 kg ha^{-1} respectively (Table 2). The increased grain yield with pre emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR on 7 DAS fb hand weeding on 40 DAS might be due to timely control of weeds in critical period of crop weed competition has enhanced the availability of nutrients, light and moisture to the crop and also increase the crop yield with timely application of these broad spectrum herbicides

Table 2. Efficacy of new generation herbicides on productive tiller, filled grains panicle^{-1}, panicle weight, and yield (kg ha^{-1}) in rice in direct seeded rice

Treatments	Number of productive tillers m^{-2}	Number of filled grains panicle^{-1}	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1-Unweeded Control	257	50.28	23.39	2,619	3,704
T_2-Twice hand weeding on 20 and 40 DAS	316	92.89	23.43	6,236	8,086
T_3-Pre emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR on 7 DAS *fb* hand weeding on 40 DAS	325	97.31	23.45	6,670	8,605
T_4-Pre emergence application of pretilachlor 37% on 7 DAS *fb* hand weeding on 40 DAS	281	78.04	23.40	4,895	5,875
T_5-Early post emergence application of triafamone 20% + ethoxysulfuron 10% WP on 12 DAS *fb* hand weeding on 40 DAS	317	93.62	23.43	6,310	8,137
T_6-Early post emergence application of ethoxysulfuron 15% WDG on 12 DAS *fb* hand weeding on 40 DAS	301	87.47	23.41	5,831	7,797
T_7-Post emergence application of fenoxaprop-p-ethyl 9.3% EC on 20 DAS *fb* hand weeding on 40 DAS	296	82.73	23.41	5,445	7,334
T_8-Post emergence application of bispyribac sodium 10% SC on 20 DAS *fb* hand weeding on 40 DAS	319	94.19	23.43	6,377	8,252
SEm±	2.60	1.34	0.04	139.05	167.61
CD (p=0.05)	5.45	2.81	NS	292	352

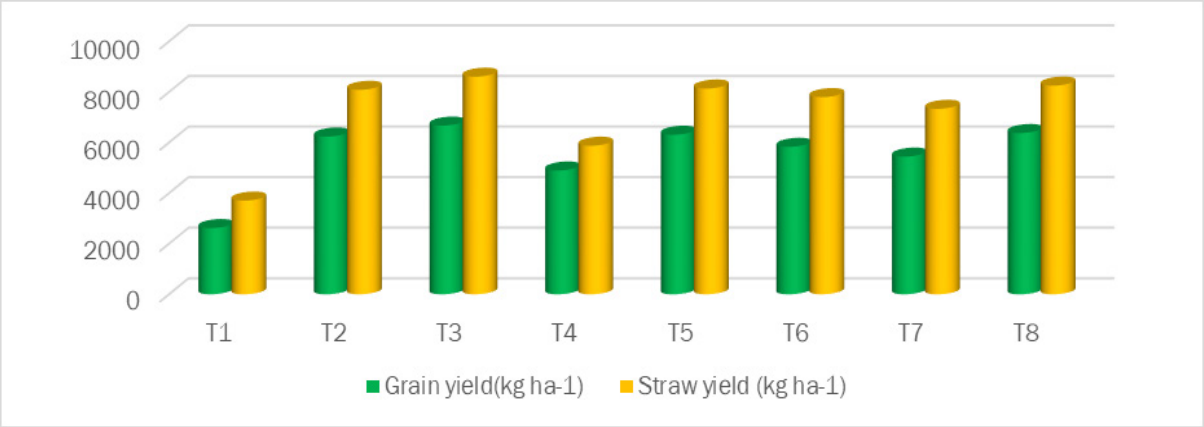

Figure 1. Efficacy of new generation herbicides on yield (kg ha^{-1}) in rice in direct seeded rice

combination. The similar results reported by (Rao *et al.,* 2019). The lowest grain yield in unweeded control might be due to season long weed competition exerted by the weeds at the critical stages of crop growth. These results are in conformity with that of (Guru *et al.,* 2020).

CONCLUSION

It can be concluded that weeds are the major constraints in direct seeded rice system which may results in severe losses in terms of yield and economic returns. Hence, the pre emergence application of herbicide is must for direct seeded rice and the application of bensulfuron methyl 0.6% + pretilachlor 6% GR on 7 DAS fb along with hand weeding on 40 DAS was found to be the ideal combination for managing the weeds under direct seeded condition, that will result in higher grain yield and economic returns.

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