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Narayana S Mavarkar
Depart of Agronomy, College of Agriculture, Shivamogga, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Irfan MM
Depart of Agronomy, College of Agriculture, Shivamogga, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Basavaraj M
Depart of Agronomy, College of Agriculture, Shivamogga, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Corresponding Author:
Narayana S Mavarkar
Depart of Agronomy, College of Agriculture, Shivamogga, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Studies on novel herbicides and their combination on effective weed control in direct seeded rice (DSR) in southern transition zone of Karnataka

Narayana S Mavarkar, Irfan MM and Basavaraj M

Abstract
A field experiment entitled "Studies on novel herbicides and their combination on effective weed control in direct seeded Rice (DSR) in Southern Transition Zone of Karnataka" was conducted during *kharif* 2018 at College of Agiculture, Navile, University of Agricultural and Horticultural Sciences, Shivamogga with seven treatment combination that include inter cultivation. Four hand weeding practices at 15 days interval. Herbicides (pretilachlor 30.7 EC, Pyrazo sulfuron ethyl 20% WG, Bensulfuron methyl 0.60 % + Pretilachlor 6% GR (Pre.em.-3 DAS) and pre-emergent along with post-emergent (Pre em. and post em.,) herbicides *viz.*, Metsulfuron-methyl (Pre.em.-3 DAS). and weedy check were included and the experiment was laid out in RCBD with three replication. The experimental results revealed that four hand weeding at 15 days interval recorded higher grain yield (5418 kg ha^{-1}) and straw yield (6105 kg ha^{-1}) as well as growth attributes. These results are on par with inter cultivation *fb* Hand weeding at 20 and 40 DAS and bensulfuron methyl 0.60 % + Pretilachlor 6% GR (Pre.em.-3 DAS) recorded higher growth and yield attributes without being phytotoxic to the crop.

Keywords: Direct Seeded Rice, Herbicides, Intercultivation and Yield.

Introduction
Rice is one of the three most important food crops in the world and major staple food for over 3 billion people. In India, rice is grown over 42.4 million ha area with the production of 104.4 million tons and a productivity of 2.46 tons ha^{-1}. Low productivity of rice in India is a major concern for food and nutritional security of more than 60% population that is dependent on rice (Ram *et al*. 2014) [6]. In Karnataka, it is grown in 1.33 m ha with total production of 3.52 m t and the average productivity of 2649 kg ha^{-1}. Demand for rice in India is increasing every year and it is estimated that by 2025 AD the increasing requirement would be 140 m t (Anonymous, 2017) [1].

Rice being important cereal food crop in most of the Southern Transition Zone of Karnataka due to availability of water resources. It occupies occupied more than 1.85 lakh hectares with average production of 2.95 lakh tons. In Southern Transition Zone of Karnataka, there is lot of scope for introduction of direct seeded rice. Change in the method of crop establishment from traditional manual transplanting of seedlings to direct- seeding has occurred in many Asian countries in the last two decades in response to rising production costs, especially for labour and water. The risk of crop yield loss due to competition from weeds by all seeding methods is higher than for transplanted rice because of the absence of the size differential between the crop and weeds and the suppressive effect of standing water on weed growth at crop establishment.

In direct seeded rice culture, weeds are one of the biggest problems because of the absence of flooding during early stages and presence of weed seed bank in the 2 to 3 cm of top soil. All types of weeds namely grasses, sedges and broadleaved weeds emerge simultaneously at high density along with rice seedlings and exerts early crop weed competition. This invites severe competition between weeds and rice thus reducing the crop yield on an average of 50 to 60 per cent. Losses can be severe in direct seeded rice as the rice and weed seedlings are at similar growth stages. The phenotypic appearance of grassy weeds, especially *Echinochloa colona* and *Echinochloa crusgalli*, closely resembles that of rice seedlings and it is difficult to differentiate at initial stage.

Management of weeds at early stage is most essential. The aerobic soil conditions and dry-tillage practices, besides alternate wetting and drying conditions, are conducive for germination and growth of highly competitive weeds, which cause grain yield losses to an extent of 50 to 91per cent (Prasad, 2011) [5].

Numbers of herbicides are recommended for rice crop, continuous application of herbicides to crop in the intensive cropping system may lead to residue accumulation in soil. This causes considerable health hazards and environmental pollution. Residue studies are essential to determine the duration of herbicidal efficacy and effect on residual crops. Bioassay is generally used as a means of quantitative measurement of biologically active concentration of an herbicide known to be present (Kaur *et al.,* 2014) [3]. The use of herbicides ensures effective weed control throughout crop growth period under labour shortage condition when weeding coincides with other farm activities. Rice being important cereal food crop in Southern Transition Zone of Karnataka. Keeping these points in view, an experiment was conducted on "Studies on novel herbicides and their combination on effective weed control in direct seeded Rice (DSR) in Southern Transition Zone of Karnataka". The experiment was carried out at University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka.

Material and Methods

The present investigation entitled Studies on novel herbicides and their combination on effective weed control in direct seeded Rice (DSR), University of Agricultural and Horticultural sciences, Shivamogga, Karnataka under irrigated condition during *kharif* 2018. The field experiment was conducted in College of Agiculture, Navile, Shivamogga, during *Kharif* 2018. The experimental field is situated at 14^0 to $14^0.1^I$ North latitude and $75^0.45^I$ to $75^0.42^I$ East longitude with an altitude of 650 meters above mean sea level and is located under Southern Transition Zone of Karnataka. The soil of the experimental site was an Alfisol. The soil topography was fairly uniform with a slope of one per cent in one direction. A composite sample was collected from the site at the depth of 0-30 cm before starting of the experiment to analyse the physico chemical characteristics to know the initial soil nutrient status. The soil is red sandy loam in texture, slightly acidic (5.66) and medium in electrical conductivity (0.75 dSm^{-1}). The organic carbon content was 0.42 per cent and low in available N (175.61 kg ha^{-1}), high in P2O5 (192.41 kg ha^{-1}) and K_2O (303.98 kg ha^{-1}) availability. The Rice are totally seven treatments combination. They are T_1= Pretilachlor 30.7 EC (Pre.em.-3 DAS) @ 0.3 kg a.i ha^{-1},T2= Pyrazo sulfuron Ethyl 10% WP (Pre.em.-3 DAS) @ 0.10 kg a.i ha^{-1}, T_3=Metsulfuron-methyl 20% WG (Pre.em.-3 DAS and Post.em.-30 DAS) @ 0.2 kg a.i ha^{-1},T_4=Bensulfuron methyl 0.60 % + Pretilachlor 6% GR (Pre.em.-3 DAS) @ 0.6 kg a.i ha^{-1},T_5= Weedy check,T_6= 4 Hand weeding at 15 days interval,T_7= Inter cultivation *fb* Hand weeding at 20 and 40 DAS. Data collected included growth and yield attributes of Rice crop.

Results and Discussion

The data pertaining to plant height (cm) and total dry matter (g $hill^{-1}$) recorded at harvest as influenced by different weed management practices is presented in Table 1.

The higher plant height (84.60 cm at harvest), number of leaves (70.25 at harvest), number of tillers per hill (25.39 at harvest) and total dry matte (71.93 g $hill^{-1}$ at harvest) recorded with treatment four hand weeding at 15 days interval (T_6), but, it remained stastiscally on par with treatment inter cultivation *fb* Hand weeding at 20 and 40 DAS (T_7; 79.42 cm, 66.52, 24.18 and 69.01 g $hill^{-1}$, respectively) and bensulfuron methyl 0.60 % + Pretilachlor (Pre.em.-3 DAS) 6% GR @ 0.6 kg a.i ha^{-1} (T_4; 77.96 cm, 64.45, 23.24 and 67.25 g $hill^{-1}$, respectively). Whereas lower plant height, number of leaves, number of tillers per hill and total dry matter production (63.25 cm, 49.65, 12.01 and 48.52 g $hill^{-1}$, respectively) was recorded under weedy check (T_5).

The increase in plant height and total dry matter was eventual due to more absorption of plant nutrients from the soil and increased root-shoot growth, increased number of greener leaves which produced greater amount of food material (photosynthates), resulting in more cell division, cell enlargement and finally rapid vegetative growth with the lapse of time. Significant increase in total dry matter accumulation $plant^{-1}$ was related to better partitioning of dry matter in stem, leaves and grain of plant. Considering the dry matter partitioning at harvest, the contribution was more towards reproductive part of growth. It might be due to the significant role of herbicide in controlling weeds, which in turn increased dry matter production. However, light, radiation, humidity, soil moisture, availability of nutrients dictate the dry matter production at large. Further, the reduced dry matter accumulation in weedy check situation was due to lower plant population results of severe weed competition. Similar report was made by Choudhary and Dixit (2018) [2].

The data pertaining to grain yield and straw yield (kg ha^{-1}) recorded at harvest as influenced by different weed management practices is presented in Table 2.

The higher grain yield (5418 kg ha^{-1}) and straw yield (6105 kg ha^{-1}) recorded with treatment four hand weeding at 15 days interval (T_6), but, it remained stastiscally on par with treatment inter cultivation *fb* Hand weeding at 20 and 40 DAS (T_7; 5365 and 6035 kg ha^{-1}) and bensulfuron methyl 0.60 % + Pretilachlor (Pre.em.-3 DAS) 6% GR @ 0.6 kg a.i ha^{-1} (T_4; 4785 and 5517 kg ha^{-1}). Whereas lower grain and straw yield (1723 and 2012 kg ha^{-1}) was recorded under weedy check (T_5). Further, harvest index found non significant.

The variation in the yield could be explained in terms of yield attributes. The excellence of these herbicide combination treatments could be ascribed to higher values of yield attributing characters such as number of panicle, panicle length, number of filled grains *etc.*, reduced weed density, weed biomass, better weed control efficiency, better plant growth and dry matter accumulation supported for higher yield attributes observed with those treatments increased yield. The increasing straw yield in the above treatments is evidenced by better growth of the plant during initial stages of the crop growth is mainly due to non-competition from the weeds, which resulted in increased leaf area and efficient utilization of resources and resulted in better growth component and dry matter production. The treatment weedy check (T_1) recorded lowest straw yield. The lower straw yield was mainly due to higher competition of weeds for the available resources. These findings are in agreement with that of Mahajan and Timsina (2011) [4] and Sandeep *et al*. (2014) [7].

Table 1: Growth parameters of Rice as influenced by different weed management practices at different growth stages of direct seeded rice

Treatment	Plant height at harvest (cm)	Number of leaves at harvest	Number of tillers per hill at harvest	Total dry matter (g hill^{-1}) at harvest
T_1= Pretilachlor 30.7 EC (Pre.em.-3 DAS) @ 0.3 kg a.i ha^{-1}	70.85	61.24	20.60	60.27
T_2= Pyrazo sulfuron Ethyl 10% WP (Pre.em.-3 DAS) @ 0.10 kg a.i ha^{-1}	72.83	61.65	21.68	63.10
T_3=Metsulfuron-methyl 20% WG (Pre.em.-3 DAS and Post.em.-30 DAS) @ 0.2 kg a.i ha^{-1}	74.52	62.41	22.42	64.98
T_4=Bensulfuron methyl 0.60 % + Pretilachlor 6% GR (Pre.em.-3 DAS) @ 0.6 kg a.i ha^{-1}	77.96	64.45	23.24	67.25
T_5= Weedy check.	63.25	49.65	12.01	48.52
T_6= 4 Hand weeding at 15 days interval.	84.60	70.25	25.39	71.93
T_7= Inter cultivation *fb* Hand weeding at 20 and 40 DAS.	79.42	66.52	24.18	69.01
S.Em ±	2.94	2.04	0.82	2.13
CD (P=0.05)	8.88	5.95	2.40	6.25

Table 2: Grain and straw yield of Rice as influenced by different weed management practices at different growth stages of direct seeded rice

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index
T_1= Pretilachlor 30.7 EC (Pre.em.-3 DAS) @ 0.3 kg a.i ha^{-1}	4182	4875	0.46
T_2= Pyrazo sulfuron Ethyl 10% WP (Pre.em.-3 DAS) @ 0.10 kg a.i ha^{-1}	4561	5152	0.46
T_3=Metsulfuron-methyl 20% WG (Pre.em.-3 DAS and Post.em.-30 DAS) @ 0.2 kg a.i ha^{-1}	4625	5263	0.46
T_4=Bensulfuron methyl 0.60 % + Pretilachlor 6% GR (Pre.em.-3 DAS) @ 0.6 kg a.i ha^{-1}	4785	5517	0.46
T_5= Weedy check.	1723	2012	0.46
T_6= 4 Hand weeding at 15 days interval.	5418	6105	0.46
T_7= Inter cultivation *fb* Hand weeding at 20 and 40 DAS.	5365	6035	0.47
S.Em ±	213.35	203.42	0.04
CD (P=0.05)	660.41	598.78	NS

Conclusion

Inter cultivation *fb* hand weeding at 20 and 40 DAS was effective in influencing the growth and yield of rice. Among herbicidal combination treatment, Bensulfuron methyl 0.60 % + Pretilachlor 6% GR (Pre.em.-3 DAS) @ 0.6 kg a.i ha^{-1} was effective in enhancing the growth and yield of direct seeded rice.

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