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INFLUENCE OF DIFFERENT RICE ESTABLISHMENT METHODS AND WEED MANAGEMENT PRACTICES ON GROWTH AND YIELD OF RICE

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Abstract

To study the influence of different rice establishment methods and weed management practices on growth, and yield of rice crop, the field experiment was conducted during *kuruvai* season 2019-2020 at Experimental farm, Department of Agronomy, Annamalai University, Annamalai Nagar with five main plots as establishment methods and six weed management practices as subplots in split plot design on clay loam soil. The main treatments are M_1- Direct dry seeded rice in dry condition, M_2- Drum seeded rice, M_3- SRI transplanting, M_4- Machine transplanting, M_5- Conventional transplanting and sub treatments consisted of S_1- Unweeded contro l, S_2- Two hand weeding on 20 and 40 DAT/ DAS, S_3- Application of pre-emergence herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/ 7 DAS + hand weeding on 40 DAT/DAS, S_4- Application of pre-emergence herbicide pretilachlor 6% + pyrazosulfuron-ethyl 0.15 % GR @ 10 kg ha^{-1} on 3 DAT/ 7 DAS + hand weeding on 40 DAT/DAS, S_5- Application of pre-emergence herbicide bensulfuron methy l0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/7 DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{-1} on 20 DAT/ DAS, S_6- Application of pre-emergence herbicide pretilachlor 6% + pyrazosulfuron-ethyl 0.15 % GR@ 10 kg ha^{-1} on 3 DAT/ 7 DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{-1} on 20 DAT/DAS. Among the various establishment methods and weed management practices SRI transplanting and two hand weeding on 20 and 40 DAT/ DAS recorded higher growth and yield parameters. Rice establishment methods and weed management practices contributed significantly influence on growth and yield of rice. The growth characters and yield characters were significantly higher with SRI (M_3) method of rice establishment along with two hand weeding on 20 and 40 DAT/DAS and this treatment was on par with application of pre-emergence herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/7DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{-1} on 20 DAT/DAS.

Key words: Different rice establishment methods, weed management, growth and yield.

Introduction

Rice being staple food crop of the largest number of people on earth. Developing countries accounts for 94 per cent of the total production, with India and China alone responsible for nearly half of the world output. In India, rice cultivated on about approximately 42.75 m ha area with production of 156.2 million tonnes and productivity of 2.62 t ha^{-1} (USDA, 2017). Productivity of rice become reduced in India due to various reasons like improper establishment methods, water scarcity, weed infestation, unpredictable monsoon seasons, poor quality seeds, over irrigation and over fertilization and soil become less fertile etc. Manual transplanting under puddled condition is the most common practices of rice establishment (Baldev *et al*., 2013). Under the puddled condition throughout the cropping period the field was flooded until shortly before harvest. Transplanting has many methods like manual line and random planting, mechanical transplanting, system of rice intensification. Direct sown can be classify into wet direct seeding and dry direct seeding. Drum seeding is a method of direct sown rice system. Both these seeding are being performed by manual and mechanical methods. Transplanting and direct seeding are two common methods of rice establishment in the world. The assumption of direct seeded rice system is highly constrained as the crop face severe weed infestation. Rice yield may extremely declined in direct seeded rice system if weed management is not done properly. Poor weed control affect the rice grain yield under direct seeded

rice. But the weed problem is not a major issue in transplanted rice because of puddling of soil eliminates the weeds before transplanting. Increasing water scarcity and weeds are becoming real threat to rice cultivation. In such a situation it is a necessary to develop the water saving technology for rice cultivation. SRI method has found to save 22 to 38 per cent of water respectively during dry and wet season over other method of rice establishment (Singh *et al.,* 2015). The system of rice intensification is a one of the method of transplanted rice cultivation by manipulating the genetic potential of rice provides a favorable growing environment to rise the productivity and economic returns. Besides it enhance the soil health with reduction in inputs use such as seeds, water etc. (Shiv Singh Kirar *et al.,* 2018).

In spite of the variation in rice establishment, weeds are causing economic concerns are: *Echinochloa crusgalli* , *Echinochloa colona*, *Cyperus rotundus*, *Monochoria vaginalis*. Due to the the closer similarity to rice and *Echinochloa crusgalli* and *Echinochloa colona* are the most problematic weeds of rice. Grass are usually the most dominant at the time of early season, while broad leaved weeds and sedges are superior at later season. Two to three hand weeding is the effective method against all the types of weeds in rice crop (Duarg *et al.,* 2015) and also sequential application of pre-emergence followed by post-emergence herbicide could be more convenient in containing the weed menace. The present investigation was taken up to study the effect of different rice establishment methods and weed management practices on growth and yield of rice.

Materials and Methods

A field experiment was conducted at Experimental Farm, Department of Agronomy, Annamalai University during 2019-2020 to study the effect of different rice establishment methods and weed management practices on growth and yield of rice. The study area has mean annual rainfall of about 1500 mm, majority of which was received during North East Monsoon. The climate of the region is characterized by a tropical climate with a hot dry period (March-May), and extended wet period from November to February. The soil of the experimental field is moderately drained, clayey loam texture soil and soil is medium available in nitrogen (201.29 kg ha^{-1}), high available in phosphorus (20.67 kg ha^{-1}) and potassium (280.73 kg ha^{-1}) with a pH of 7.3.

The experiment was conducted in split plot design with three replications. The treatment comprised of five establishment method as main treatments *viz.,* (M_1)- Direct dry seeded rice in dry condition, (M_2)- Drum seeded rice, (M_3)- SRI transplanting, (M_4)- Machine transplanting, (M_5)- Conventional transplanting and six weed management practices as sub treatments *viz.,* (S_1)- Unweeded control, (S_2)- Two hand weeding on 20 and 40 DAT/ DAS, (S_3)- Application of pre-emergence herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/ 7 DAS + hand weeding on 40 DAT/DAS, (S_4)- Application of pre-emergence herbicide pretilachlor 6% + pyrazosulfuron-ethyl 0.15 % GR@ 10 kg ha^{-1} on 3 DAT/ 7 DAS + hand weeding on 40 DAT/ DAS, (S_5)- Application of pre-emergence herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/7 DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{--1} on 20 DAT/DAS, (S_6)- Application of pre-emergence herbicide pretilachlor 6% + pyrazosulfuron-ethyl 0.15% GR @ 10 kg ha^{-1} on 3 DAT/7 DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{-1} on 20 DAT/DAS. The variety taken for experiment CO 51 crop was raised during *kuruvai* 2019-2020. The plot size of experiment was 5×4 m. The sowing of direct dry seeded rice was done on 26 June 2019 using seeds @ 75 kg ha^{-1}. Drum sowing of rice was done on 27 June 2019 using seeds @ 40 kg ha^{-1}. Mat type of nursery was raised for machine transplanting. Sowing of nursery was done on 26 June 2019 using seeds @ 20 kg ha^{-1} and 100 m^2 ha^{-1} area was required for sowing a nursery. Fifteen days old nursery was used in machine transplanting and machine transplanting was done on 10 July 2019. Sowing of nursery for conventional transplanting was done on 26 June 2019 using seeds @ 40 kg ha^{-1} and 800 m^2 ha^{-1} area was required for sowing a nursery. Twenty days old nursery was used in conventional transplanting and conventional transplanting was done on 15 July 2019. Sowing of nursery for SRI transplanting was done on 26 June 2019 using seeds @ 8 kg ha^{-1} and 100 m^2 ha^{-1} area was required for sowing a nursery. Eighteen days old nursery was used in SRI transplanting and SRI transplanting was done on 13 July 2019. A fertilizer schedule of 120 : 40 : 40 NPK kg ha^{-1} was adopted as the common practice for the experiment. Full dose of phosphorous and half dose of nitrogen and potassium were applied basally. The remaining half dose of nitrogen and potassium were applied into two splits during maximum tillering and panicle primordium initiation (PPI) stage. Nitrogen, phosphorous and potassium were supplied through urea, single super phosphate, and muriate of potash respectively. As per the treatment schedule required quantity of herbicides was sprayed. The pre-emergence and post-emergence herbicide was sprayed with high volume Knapsack sprayer fitted with flood jet nozzle using 500 liters of water ha^{-1}. Pre-emergence

herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR and pretilachlor 6% + pyrazosulfuron-ethyl 0.15 % GR was sprayed on 3 DAT/ 7 DAS and post-emergence herbicides bispyribac sodium was sprayed on 20 DAT/ DAS.

Growth parameters were recorded at 30, 60 DAT/ DAS and harvest stage. Plant height was measured from the base of the plants to the tip of the longest leaf stretched and up to tip of the panicle and expressed in cm. Five hills were selected at random from each plot in sampling area. The collected samples were air dried, then oven dried at $70^0 \pm 5^0$ C for 72 hours. From the dry weight samples dry matter production ha^{-1} was calculated and expressed in kg ha^{-1}. From the measurement of the length and width, the leaf area was workout using 0.75 as the correction factors respectively. The number of tillers were counted in the five hills earmarked at random and the mean value was recorded as number $hill^{-1}$. The number of panicle per m^2 was conducted from the sample hills at the time of harvest and the mean value were recorded. The panicles was randomly chosen for recording number of filled grains $panicle^{-1}$. The differentiation of well filled and chaffy grains was made by pressing the grain with fingers and they are counted and recorded. The thousand grain weight was recorded by weighing the grains obtained from the sample panicle at 14 per cent moisture content for all the treatment and recorded in grams. Grain from each net plot were cleaned, sundried, weighed and adjusted to 14 per cent moisture content and the grain yield was expressed in kg ha^{-1}. After threshing the grains, the straw was sundried. The dried straw was weighed plot wise and computed to kg ha^{-1}.

Table 1: Effect of crop establishment methods and weed management practices on growth attributes of rice crop.

Treat ments	Plant height (cm)	Drymatter production (Kg ha^{-1})	LAI tillers	Effective m^2
Establishment methods				
M_1	63.6	8563	6.22	237
M_2	70.1	9112	6.57	268
M_3	94.4	10175	7.44	373
M_4	89.6	9708	6.86	350
M_5	88.3	9586	6.841	343
SEd	2.1	210	0.11	5
CD (p=0.05)	4.2	420	0.25	14
Weed management practices				
S_1	66.2	7599	6.1	234
S_2	93.1	10963	7.76	376
S_3	78.6	9147	6.66	304
S_4	72.6	8365	6.17	273
S_5	91.2	10617	7.50	365
S_6	85.3	9882	7.06	332
SEd	2.75	349	0.15	8
CD (p=0.05)	5.5	679	0.33	17

(M_1- Direct dry seeded rice in dry condition, M_2- Drum seeded rice, M_3- SRI planting, M_4- Machine transplanting, M_5- Conventional transplanting, S_1- Unweeded control, S_2-s Two hand weeding on 20 and 40 DAT/ DAS, S_3- Application of pre-emergence herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/ 7 DAS + hand weeding on 40 DAT/DAS, S_4- Application of pre-emergence herbicide pretilachlor 6% + pyrazosulfuron-ethyl 0.15 % GR@ 10 kg ha^{-1} on 3 DAT/ 7 DAS + hand weeding on 40 DAT/DAS, S_5- Application of pre-emergence herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/7 DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{-1} on 20 DAT/DAS, S_6- Application of pre-emergence herbicide pretilachlor 6% + pyrazosulfuron-ethyl 0.15 % GR@ 10 kg ha^{-1} on 3 DAT/ 7 DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{-1} on 20 DAT/DAS).

Results and Discussion

Growth characters of rice

SRI planting was recorded significantly higher plant height of 94.4 cm. Because of increase in the size of panicle and length of leaves till harvest. The tallest plants under SRI mainly due to optimum plant population and square geometry which led to availability of more growth resources to plants. The increase height in SRI was due to open plant structure giving more coverage to the ground area. Further, the lower angle of inclination of leaves in case of SRI results in more spread than other establishment methods (Thakur *et al.,* 2011). SRI recorded significantly higher plant height it may be due to adequate supply of moisture, alternate wetting and drying which induced synchronous maturity. This might help in diversion of photosynthetes in plant growth (Suresh kumar and Baradhan 2013). Dry matter production was also higher in SRI planting (7770 kg) because of increased the plant height, tillers m^{-2} indicating higher photosynthetic efficiency which in turn resulted in higher dry matter accumulation m^{-2}. Similar result was found by Singh *et al.,* (2015). Leaf area index (7.4) and effective tillers m^{-2} (373) was significantly higher in system of rice intensification as compared to other establishment method of rice cultivation. Because of wide spacing each individual crop could have effectively utilized more available resources such as space, foraging area of root system, better root spread, more light interception etc. resulting in enhanced tiller production (Thavaprakash *et al.,* 2008). Planting a younger seedlings with optimal growing conditions is responsible for accelerated growth rate in SRI plants as these make possible to complete more phyllochrons before entering into their reproductive

phase. Completion of more phyllochrons at early seedlings stage resulted in more number of tillers and effective tillers per hill. Invariably, shorter plant height and less DMP was observed under direct dry seeded rice. Because of weeds are major constraints for direct dry seeded rice productivity, having greater impact on growth of the rice crop. Similar result was observed by (Jagmohan Kaur and Avtar Singh 2017). Hand weeding on 20 and 40 DAT/DAS produced taller plants (93.1 cm), higher dry matter production (7698 kg/ha), LAI (7.76) and effective tillers per m^2 (359) was produced which might be due to the reason that in manual weeding, manual labourers possess greater knowledge to identify and remove all types of weeds especially grassy weeds which had grown along with rice seedlings in same hill with close resemblance of rice and it was on par with application of pre-emergence herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/7 DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{-1} on 20 DAT/ DAS, The result was in agreement with the findings of Moshiur Rahman (2016).

Table 2: Effect of crop establishment methods and weed management practices on yield and yield attributes of rice crop.

Treatments	Test weight (g)	Number of panicles /m^2	Number of grains $panicle^{-1}$	Grain yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})
Establishment methods					
M_1	15.8	20.1	119	3440	4376
M_2	15.8	22.6	134	3814	4761
M_3	16.0	28.4	163	5368	6906
M_4	15.9	25.9	147	5063	6605
M_5	15.9	25.3	146	4983	6535
SEd	0.5	0.9	3.0	83	99
CD (p=0.05)	NS	2.4	6.4	232	275
Weed management practices					
S_1	15.8	20.3	109	3160	4504
S_2	16.1	27.7	168	5472	6694
S_3	15.9	23.9	138	4453	5756
S_4	15.9	22.0	120	4075	5342
S_5	16.0	27.1	165	5285	6566
S_6	16.0	25.6	151	4757	6157
SEd	0.3	0.7	4.1	148	174
CD (p=0.05)	NS	1.4	8.2	296	349

(M_1- Direct dry seeded rice in dry condition, M_2- Drum seeded rice, M_3- SRI transplanting, M_4- Machine transplanting, M_5- Conventional transplanting, S_1- Unweeded control, S_2- Two hand weeding on 20 and 40 DAT/ DAS, S_3- Application of pre-emergence herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/ 7 DAS + hand weeding on 40 DAT/DAS, S_4- Application of pre-emergence herbicide pretilachlor 6% + pyrazosulfuron-ethyl 0.15 % GR@ 10 kg ha^{-1} on 3 DAT/ 7 DAS + hand weeding on 40 DAT/DAS, S_5- Application of pre-emergence herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/7 DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{-1} on 20 DAT/DAS, S_6- Application of pre-emergence herbicide pretilachlor 6% + pyrazosulfuron-ethyl 0.15 % GR@ 10 kg ha^{-1} on 3 DAT/ 7 DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{-1} on 20 DAT/DAS).

Yield parameters of rice

Among the crop establishment methods, SRI planting produced more number of grains $panicle^{-1}$ (257), higher test weight (28.3) and more number of panicle per m^2 (28.4) was observed this may be attributed to adequate availability and supply of resources and their translocation along with other nutrients to the sink. Similar trends was observed by Thavaprakash *et al.,* (2008). It was followed by machine transplanted rice. Among the weed management practices number of grains $panicle^{-1}$ (168), test weight (28.2) and number of panicle per m^2 (27.7) was registered under hand weeding on 20 and 40 DAT/ DAS. Because of effective and timely management of weeds facilitated the crop plants to have sufficient space, light, nutrient and moisture and thus the yield components like number of panicle m^{-2}, and number of filled grains $panicle^{-1}$ was increased. It was on par with application of pre-emergence herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/ 7 DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{-1} on 20 DAT/ DAS. Lesser number of productive tillers m^{-2} and number of grains $panicle^{-1}$ was noticed under unweeded control. Due to the increased weed infestation, the plants deprive from nutrients and other environmental components. These findings are in agreement with Kankal (2015).

Grain and straw yield

Among the five establishment methods, SRI transplanting recorded higher grain yield of 5368 kg ha^{-1} and straw yield of 6906 kg ha^{-1}. Because of adequate supply of resources which contributed towards higher dry matter accumulation and better partitioning of photosynthate resulting in higher grain yield and better vegetative growth which contributed the higher dry matter production resulting significantly higher straw yield. Similar result was found by Singh *et al.,* (2015). Where as, direct dry seeded rice recorded significantly lesser grain yield of 3440 kg ha^{-1} and straw yield of 4376 kg ha^{-1} which may be due to uneven or poor crop establishment, higher weed competition. Similar result was observed by Jagmohan Kaur and Avtar Singh (2017). SRI transplanting recorded higher yield than machine transplanting followed by conventional

transplanting, drum seeded rice and direct dry seeded rice.

Weed management practices greatly influenced the rice grain yield. Among the weed management practices, hand weeding on 20 and 40 DAT/DAS (S_2) recorded higher grain and straw yield of 5472 kg ha^{-1} and 6694 kg ha^{-1}, respectively. Whereas, unweeded control plot recorded lowest grain and straw yield of 3160 kg ha^{-1} and 4504 kg ha^{-1} respectively. The increased yield might be due to favorable growing condition and weed free environment of the crop which consecutively resulted in higher grain and straw yield. The result were in agreement with the finding of Moshiur Rahman (2016).

Interaction effect was found to exist between crop establishment methods and weed management practices with respect to rice grain and straw yield. SRI transplanting with hand weeding at 20 and 40 DAT/DAS registered higher straw yield. Invariably, lowest straw yield was recorded under direct dry seeded rice with unweeded control.

Conclusion

Among the crop establishment methods and weed management practices SRI transplanting along with two hand weeding on 20 and 40 DAT/DAS was recorded higher growth, yield and yield attributes of rice. This was followed by machine transplanting rice and hand weeding on 20 and 40 DAT/DAS which was on par with application of pre-emergence herbicide bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10 kg ha^{-1} on 3 DAT/7 DAS + application of post-emergence herbicide bispyribac sodium 10% SC @ 200 ml ha^{-1} on 20 DAT/ DAS. SRI transplanted rice is a sustainable and very feasible alternative to other method of rice establishment and saves the cost of production. When the labour scarcity increase hand weeding is not possible on particular period of crop establishment at that time sequential application of pre-emergence and followed by post-emergence herbicide application is the better way to control broad leaf weeds, sedges, and grass in both direct seeded and transplanted rice.

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