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Effect of integrated weed management practices on yield and yield attributes of dry direct seeded rice (*Oryza sativa* L.)

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Abstract
A field experiment was conducted during the *kharif* season of 2017 at the research farm of RPCAU, Pusa, Samastipur, Bihar to study the, Integrated weed management practices on yield attributes and yield of Dry Direct Seeded Rice. The research experiment was conducted in Randomized Block Design having ten treatments and three replications. Among all the weed management practices both hand weeding and herbicidal treatments had reflective effect on yield attributes and yield as well as reflected in their superiority over the weedy check. Hand weedings at 20, 40 and 60 DAS was found significantly superior over all the integrated weed management practices on growth and yield of dry direct seeded rice. Amongst herbicidal treatments Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* two hand weedings at 20 and 40 DAS was superior on to rest of all herbicidal treatments for dry direct seeded rice during the year of experimentation.

Keywords: Integrated weed, management practices, yield, yield attributes, *Oryza sativa* L

Introduction
Rice (*Oryza sativa* L.) is a leading food crop providing 22% calories and 17% proteins of the world. In Asia, irrigated rice consumes more than 40% of the world's fresh water that is used in agriculture. Almost 90% area and production of the world's rice produced and consumed in Asia. The world's total area under rice cultivation is 161.1 million ha and production is about 487.5 million tons along with the productivity of 3.03 ton/ha (STASTISTA –The Statics Portal 2017-18**).** In India, Rice is cultivated in 44.1 million hectare area with an annual production of 110.2 million tons and productivity is 2.5 ton/ha (India Stat–Advance Estimate, 2017-18). In Bihar, Rice is cultivated on 3.2 million ha area with the production of 6.8 million tons and the productivity is 2.1 ton/ha (Directorate of economics statistics, Govt. of Bihar, 2017-18). The declining availability and increasing cost of water threaten the traditional way of producing irrigated rice.

Hand-weeding is difficult at early stage because several grassy weeds resemble with rice seedlings morphologically. Application of selective herbicides can solve this problem for weed control during peak period. However, over dependence on herbicides for weed control can trigger evolution of herbicide resistant weeds and cause pollution of environment. Co-culturing of *sesbania* with rice and then knocking down with 2,4-D has been reported to smother various weed species and enhance yield of rice. Mulching has been reported to be very effective for weed control and conservation of soil moisture. A very large number of herbicides are there which have been observed to have effective control of weeds in direct seeded rice. However, selecting a particular herbicide or its combination with mechanical weed management and other herbicides require thorough probe. Random integration of certain weed management practices is not the solution for minimizing weed problems. It is imperative to identify effective weed management practices and work out their feasibility for integrating them for better weed control and higher yield.

Materials and methods
The experiment was laid out in Randomized block design with ten treatments and three replications *viz.* T_1:Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* Bispyribac-Na @ 25 g/ha at 20 DAS,T_2 : Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* two hand weedings at 20 & 40 DAS, T_3 : Stale seedbed using Glyphosate @ 1 kg/ha at 10 DBS *fb* Bispyribac-Na @ 25 g/ha at 20 DAS, T_4 : Stale seedbed using Glyphosate @ 1 kg/ha at 10 DBS *fb* Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* Bispyribac Na @ 25 g/ha at 20 DAS, T_5 : Mulch @ 5 t/ha (By wheat straw)

fb Bispyribac-Na @ 25 g/ha at 20 DAS *fb* one hand weeding at 40 DAS, T_6 : Stale seedbed using Glyphosate @ 1 kg/ha at 10 DBS *fb* Mulch @ 5 t/ha (by wheat straw) *fb* Bispyribac-Na @ 25 g/ha at 20 DAS, T_7 : Pendimethalin @ 1 kg/ha at 0-2 DAS &*Sesbania* co-culture *fb* 2,4-D Na salt @ 0.5 kg/ha at 20 DAS *fb* one hand weeding at 40 DAS, T_8 : Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* 2,4-D Na salt @ 0.5 kg/ha at 20 DAS *fb* one hand weeding at 40 DAS, T_9 : Weed free (By hand weedings at 20, 40 & 60 DAS) and T_{10} : Weedy check.

The seed rate of 60 kg/ha was used and fertilizer dose *viz.* 120-60-40 kg/ha N - P_2O_5 - K_2O were applied in experimental field. Nitrogen was applied through urea and DAP and Phosphorusthrough DAP whereas Potassium was applied through MOP. $^1/_3{}^{rd}$ dose of nitrogen and full dose of phosphorus and potassium were applied as basal dose at the time of sowing and remaining $^2/_3{}^{rd}$ dose of nitrogen was applied in two equal splits at 30 and 60 DAS. Crop seeds were treated with SAAF (Carbendazim + Mancozeb) @ 3 g/kgseed before sowing to protect the crops from seed borne diseases. Seed of *sesbania* was sowing in between rows just after seeding of rice for brown manuring and was knock down at 20 DAS with the help of 2,4-D. Using mulch by wheat straw at just after sowing and also applied stale seedbed technique. The application of pre-emergence herbicide with the help of Pendimethalin 0-2 DAS and post-emergence herbicides with the help of Bispyribac-Na and 2,4-D at 20 DAS. Manual weedings are applied at 20, 40 and 60 DAS.

Sample plants were selected at random in net plot area and tagged for recording observations. Almost all the yield attributes and yield parameters were recorded at harvest stage. The total number of panicles bearing tillers/m^2 were counted at the time of harvesting from the net plot area with the help of quadrant (0.50 m^2) placed randomly at three places in each plot and were counted and then converted as per square meter. Five panicles were randomly selected from the tagged plants harvested separately. The lengths of panicles were measured in cm from the neck node to its tip and finally the average length of panicle was worked out. Total number of grains per panicle was calculated by adding the numbers of filled grain. To avoid biasness, handful seeds were taken from each net plot and thousand seeds were counted randomly and weighed.

Grain yield was determined from the net plot area and was weighed in kg and converted into q/ha. Grains were harvested, dried and weighed, and grain weight is adjusted to a moisture content of 0.14 g H_2O, g/ha fresh weight the sun dried straw obtained from net plot area were weighed plot wise in kg and converted into quintal per hectare separately at 10 per cent moisture level and the harvest index was calculated by using the formula as described by Singh and Stockopf (1971) [6].

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (grain yield)}}{\text{Biological yield (grain + straw yield)}} \times 100$$

Result and discussion

Effect of different weed management practices on yield and yield attributes

Yield attributes

The yield attributes like number of panicle/m^2, length of panicle (cm), number of grains/panicle and 1000 grain weight are the major yield attributing characters which affect the grain yield of rice crop. The yield attributing characters were affected significantly due to integrated weed management practices. Among all the treatments, hand weeding thrice at 20, 40 and 60 DAS recorded highest yield attributes *viz.* number of panicles/m^2 (234.44), length of panicle (23.35 cm), number of grains per panicle (138) and 1000 grain weight (24.58 g). The increased yield attributing character under weed free condition might be due to favourable effect of hand weedings at 20, 40 and 60 DAS on tillering and reduction of weed competition facilitating greater absorption of nutrients.

Application of pendimethalin *fb* two hand weedings at 20 and 40 DAS (T_2), recorded significantly higher yield attributes *viz* number of panicles/m^2 (230.19), length of panicle (22.89 cm), number of grains/panicle (134) and 1000 grain weight (24.39 g). The higher yield attributes under T_2 might be due to reduced weed density, weed biomass and higher weed control efficiency as it controlled the weeds effectively starting from early stage of crop growth to the period of critical weed competition stage leading to better crop establishment found maximum no. of tillers, maximum plant height and maximum dry matter production. The minimum yield components in unweeded check is the result of severe weed competition by uncontrolled weed growth. Similar findings were also reported by Gogoi *et al.* (2000) [2].

Grain yield, straw yield and Harvest Index (%)

Grain and straw yields of dry direct seeded rice were influenced significantly by different weed control treatments. The weed free treatment by three hand weedings at 20, 40 and 60 DAS recorded significantly higher grain (38.79 q/ha) and straw yield (60.05 q/ha). The weedy check treatment produced significantly lowest grain yield of 21.25 q/ha and straw yield of 33.62 q/ha among all the treatments. In herbicidal treatment T_2 - Pendimethilin at 0-2 DAS *fb* two hand weedings at 20 and 40 DAS was significantly superior over all other treatments, recorded grain yield (37.35 q/ha) and straw yield (58.05 q/ha). The treatment T_9 and T_2 recorded 182.54% and 175.76% higher yield over weedy check. Similar findings of hand weeding recording highest grain and straw yield of upland rice was reported by Mukherjee *et al.* (2008) [4].

Among chemical method of weed control, considerably higher grain yield of 37.35 q/ha was produced with application of pendimethalin @ 1.0 kg/ha at 0-2 DAS *fb* manual weeding twice at 20 and 40 DAS, was statistically at par with treatment T_8 - Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* 2,4-D Na salt @ 0.5 kg/ha at 20 DAS *fb* one hand weeding at 40 DAS (35.26 q/ha), T_5 - Mulch @ 5 t/ha (By wheat straw) *fb* Bispyribac Na @ 25 g/ha at 20 DAS *fb* one hand weeding at 40 DAS (34.89 q/ha) and T_4 - Stale seedbed using Glyphosate @ 1 kg/ha at 10 DBS *fb* Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* Bispyribac Na @ 25 g/ha at 20 DAS (34.02 q/ha) in case of grain yield.

The better grain yield with these treatments is due to reduced weed density, weed biomass and better weed control efficiency along with enhancement in yield attributes like number of panicles/m^2, panicles length, number of grains/panicle and 1000-grain weight. This is similar with the findings of Gogoi *et al.*, 2000 and Singh *et al.*, 2005 [2, 5].

Different weed management practices observed non-significantly effect on Harvest Index. Harvest Index is the key factor in determining the success of yield. The highest harvest index value of 39.93%, were obtained with the treatment T_5 - Mulch @ 5 t/ha (By wheat straw) *fb* Bispyribac Na @ 25 g/ha at 20 DAS *fb* one hand weeding at 40 DAS and lowest Harvest Index value 38.73%, were obtained under treatment T_{10} - Weedy check. The higher values of the Harvest Index of the concerned treatment were due to higher grain yield compared to weedy check treatment.

Table 1: Effect of different weed management practices on yield and yield attributes

Treatments	No. of panicles/m^2	Length of panicle (cm)	No. of grains/panicle	1000 grain weight (g)	Grain Yield (q/ha)	Straw Yield (q/ha)	Harvest Index (%)
T_1	207.41	20.55	121	23.71	32.55	50.45	39.22
T_2	230.19	22.89	134	24.39	37.35	58.05	39.16
T_3	203.43	20.08	119	23.65	31.87	48.63	39.59
T_4	225.78	21.09	129	23.97	34.02	51.38	39.84
T_5	227.55	21.35	130	24.05	34.89	52.49	39.93
T_6	211.56	20.88	124	23.74	32.93	50.98	39.23
T_7	214.13	20.45	125	23.85	33.35	51.05	39.51
T_8	229.96	22.65	133	24.28	35.26	53.68	39.76
T_9	234.44	23.35	138	24.58	38.79	60.05	39.13
T_{10}	160.03	18.29	96	22.64	21.25	33.62	38.73
SEm±	1.37	0.62	1.55	0.41	1.22	1.32	0.80
CD (P=0.05)	4.50	1.85	5.11	NS	3.58	3.94	NS

T_1:Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* Bispyribac-Na @ 25 g/ha at 20 DAS,T_2 : Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* two hand weedings at 20 & 40 DAS, T_3 : Stale seedbed using Glyphosate @ 1 kg/ha at 10 DBS *fb* Bispyribac-Na @ 25 g/ha at 20 DAS, T_4 : Stale seedbed using Glyphosate @ 1 kg/ha at 10 DBS *fb* Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* Bispyribac Na @ 25 g/ha at 20 DAS, T_5 : Mulch @ 5 t/ha (by wheat straw) *fb* Bispyribac-Na @ 25 g/ha at 20 DAS *fb* one hand weeding at 40 DAS, T_6 :Stale seedbed using Glyphosate @ 1 kg/ha at 10 DBS *fb* Mulch @ 5 t/ha (by wheat straw) *fb* Bispyribac-Na @ 25 g/ha at 20 DAS, T_7 : Pendimethalin @ 1 kg/ha at 0-2 DAS &*Sesbania* co-culture *fb* 2,4-D Na salt @ 0.5 kg/ha at 20 DAS *fb* one hand weeding at 40 DAS, T_8 : Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* 2,4-D Na salt @ 0.5 kg/ha at 20 DAS *fb* one hand weeding at 40 DAS, T_9 : Weed free (By hand weedings at 20, 40 & 60 DAS) and T_{10} : Weedy check

Conclusion

The maximum number of panicle/m^2, number of grains/panicle and longest panicle length (cm) highest grain yield of dry direct seeded rice were recorded by treatment T_9 - Weed free (By hand weedings at 20, 40 and 60 DAS) which was statistically at par with treatment T_2 - Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* two hand weedings at 20 & 40 DAS and T_8 - Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* 2,4-D Na salt @ 0.5 kg/ha at 20 DAS *fb* one hand weeding at 40 DAS. Among herbicidal treatments the all the yield attributes and grain yield were recorded by treatment T_2 - Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* two hand weedings at 20 & 40 DAS which was statistically at par with treatment T_8 - Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* 2,4-D Na salt @ 0.5 kg/ha at 20 DAS *fb* one hand weeding at 40 DAS, T_5 - Mulch @ 5 t/ha (By wheat straw) *fb* Bispyribac Na @ 25 g/ha at 20 DAS *fb* one hand weeding at 40 DAS and T_4 - Stale seedbed using Glyphosate @ 1 kg/ha at 10 DBS *fb* Pendimethalin @ 1 kg/ha at 0-2 DAS *fb* Bispyribac Na @ 25 g/ha at 20 DAS. Different weed management treatments had exerted non-significant effect on 1000-grain weight of Rajendra Bhagwati, did not show any variation due to weed management practices.

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