Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(1): 164-168
Received: 22-11-2017
Accepted: 24-12-2017

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Effect of establishment methods and weed management practices on the growth and yield of direct seeded rice (*Oryza sativa* L.)

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Abstract
The field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) during *Kharif* season of 2015 and 2016. The experiment was laid out in split-plot design with three replications taking four establishment methods *viz.*, Dry Seeding, Seeding through Drum Seeder (Wet) and Broadcasting (Wet) under puddled condition in main plot, and eight weed management practices *viz.* Bispyribac-Na @ 25g/ha at 25DAS (3-4 Leaf stage of rice crop), Pendimethaline @100g/ha at 0-2DAS fbBispyribac-Na@25g/ha at 25DAS (3-4 Leaf stage of rice crop), Oxadiargyl @100g/ha 0-2DASfb Bispyribac-Na@25g/ha at 25DAS (3-4 Leaf stage of rice crop), Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop), Pyrazosulfuran @ 20 g/ha at 0-2DAS fb ethoxysulfuran @18.75 g/ha at 25DAS (3-4 Leaf stage of rice crop), Manual Weeding (20,40,60 DAS), Weed free and weedy check were kept in sub-plot. The observations were recorded on weeds and on crop at successive stages of crop growth during both the years. The major weed flora recorded in the experiment were *E.crusgalli E. colona* and *P. maximum* of grassy, *Commelina benghalensis* L. and *Eclipta alba* of broad leaved group and Cyperus spp. of Sedges group. However, grassy weeds were dominant over other weeds species. Density and dry weight of total weeds, growth, and yield attributes as well as yield of grain and straw, N uptake by weeds and crop were significantly affected due to different treatments. Lower values of weed density and dry weight, N uptake and higher values of growth attributes, N uptake by crop, yield and yield attributes were recorded significantly due to manual weeding thrice (20, 40, 60 DAS), and Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop) being at par at all characters during both the years. However, weedy check treatment recorded significantly lower values of the entire growth characters yield and yields attributes at all the stages over rest of the weed control treatments. Both of the DSR (wet) drum seeding and broadcasting being at par recorded significantly lower values of weed density, weed dry weight and higher values of growth and yield attributes, grain and straw yield over dry seeding methods during both the years.
On the basis of two years experimentation, it may be concluded that higher values of grain yield may be obtained due drum seeding of establishment of rice along with integrated method of using weed management by Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop), while, DSR (wet) drum seeding and broadcasting showed the same response However, direct seeding of rice through drum along with Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop) proved superior (BCR values of Rs 2.12 per ha) over other methods of rice establishment under puddled condition.

Keywords: rice; establishment methods; weed management practices; growth; economics; yield

Introduction
Rice (Oryza sativa L.) is a member of Poaceae family and is relished as staple food by majority (more than 60%) of world's population. Rice plays a pivotal role in Indian agriculture, as it is the principal food crop for more than 70 per cent of the world population. Among the cereal crops, it serves as the principal source of nourishment for over half of the global population (Davla *et al*. 2013). Over 2 billion people in Asia alone derive 80% of their energy needs from, rice which contains 80% carbohydrates, 7-8% protein, 3% fat and 3% fiber. Until recently, rice was considered only a starch food and a source of carbohydrates and some amount of protein. Uttar Pradesh is the largest rice growing state only after West Bengal in the country, in which it is grown over an area of 5.54 million hectares with production and productivity of 11.70 million tonnes and 2.06 tonnes ha^{-1}, respectively. Though average productivity of rice in the state is nearly equal to national average, it ranks seventh after Punjab, Tamilnadu, Haryana, Andhra Pradesh, Karnataka and West Bengal. Crop established in rice largely affects the initial stand and uniformity. Although transplanting method of

establishment has been reported to be best amongst all the factors for higher productivity of rice, this method is not much profitable due to consumes a large quantity of water (Bouman and Tuong, 2001). Nowadays, water scarcity is a major concern in many regions of the world, as competition between agricultural and industrial consumption of water resources intensifies and climatic unpredictability increases (Hanjar and Quereshi, 2010; Mahajan *et al*., 2011 & 2012). Dry-seeded rice (DSR) has been developed as an alternative method of rice establishment that reduces labor requirements and other inputs while increasing or maintaining economic productivity and alleviating soil degradation problems (Ladha *et al*., 2009; Farooq *et al*., 2011). However, some studies reported a reduction in yield when shifting from puddled transplanted rice (PTR) to DSR using alternate wetting and drying (AWD) water management (Bhushan *et al*., 2007; Choudhury *et al*., 2007). The yield reductions were related to the management practices applied and the climatic conditions in the planting site (Belder *et al*., 2004; Gathala *et al*., 2006; Kato *et al*., 2009; Singh *et al*., 2011) [17]. Weed control is particularly challenging in DSR systems because of the diversity and severity of weed infestation, the absence of standing water layer to suppress weeds at the time of rice emergence, and no seedling size advantage of rice over the weed seedlings as both emerge simultaneously. Therefore, a systematic, efficient and effective weed management depends on timing and method of land preparation (Maity and Mukherjee 2008) [16], effectiveness of herbicides (Sinha *et al*., 2005), relative to the dominant weed species and soil conditions at the time of application (Street and Mueller 1993), effect of weather on weeds (Maity and Mukherjee 2008) [16] and effect of combining herbicides and manual weed control (Rao *et al*., 2007). A variety of herbicides have been screened and found effective for pre-plant/burn-down, pre-emergence, and post emergence weed control in direct drill-seeded rice systems (Singh *et al*., 2006; Anwar *et al*., 2012a). Application of different pre-emergence herbicides including thiobencarb, pendimethalin, butachlor, oxadiazon and nitrofen has been found to control weed satisfactorily in direct seeded rice (Moorthy and Manna, 1993; Pellerin and Webster, 2004). Among the post emergence herbicides, ethoxysulfuron, cyhalofop-butyl, pritilachlor, chlorimuron, metsulfuron, bispyribac sodium and penoxsulam effectively controlled weeds in direct seeded rice (Mann *et al*., 2007; Singh *et al*., 2008; Mahajan *et al*., 2009; Juraimi *et al*., 2010).

Material and Methods

The field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology Kumarganj, Faizabad (U.P.) during rabi season of 2013-14 and 2014-15. The farm is located 42 km away from Faizabad city on Faizabad- Raebareily road at 26.47˚ N latitude and 82.12˚ E longitude and about 113 metres above the mean sea level. The winter months are cold and occasional frost occurs during the period. Summer is hot and dry. Generally, the mean maximum temperature during the hottest month (May) vary from 33.0 to 41.7 0C and minimum during the coolest month (December and January) varies from 4.5 to 8.8 0C. The mean average precipitation of Kumarganj, Faizabad is 837.4 mm, most of which received during the period of June to September. The treatment was carried out with 24 treatment combination formed with four irrigation levels, two varieties and three sulphur levels, in wheat which were allocated in split plot design with three replications. The four irrigation levels (a) I_1; 0.6 IW/CPE ratio (b) I_2; 0.8 IW/CPE ratio (c) I_3; 1.0 IW/CPE ratio and (c) I_4; 1.2 IW/CPE ratio with two varieties namely PBW 343 and PBW 502 and three sulphur levels (a) Control (b) 20 kg/ha (c) 40 kg/ha.

The seed rate used was 100 kg/ha the crop was fertilised with an uniform dose viz. 100-60-40 kg N - P_2O_5 - K_2Oha^{-1} were applied in experimental field. Nitrogen was applied through urea and P_2O_5 as DAP whereas K_2O was applied through MOP (Singh *et al*., 2014). Nitrogen was applied in three equal splits (sowing time, active tillering stage and panicle initiation stage). Single basal dose of P and K was applied along with N in three equal splits. Herbicides were applied through knap-sac sprayer fitted with flat fan nozzle. Weed management was done as per treatments. From the individual plot the crop of net plot area was recorded on weed parameters and crop parameters. After air d harvesting and seed were cleaned. The final seed weight was recorded in kg per plot and converted in to qha^{-1}.

The recovery of grains from the total harvested produce was considered as harvest index. Harvest index of each experimental plot was calculated by using formula as described by Singh and Stockopf (1971).

$$H.I.(\%) = \frac{Grain\ yield\ (\frac{q}{ha})}{Total\ biological\ yield\ (\frac{q}{ha})} \times 100$$

Results and Discussion

The data pertaining to different moisture regimes and varieties, plant growth and yield given in Table 1 and 2 reveal that the weeds parameter, growth and yield of rice were affected by crop establishment methods and weed management practices.

Table 1: Effect of establishment methods and weed management practices on growth, yield attributes and yield of rice

Treatments	Plant height (cm)						Dry matter accumulation (gm^{-2})						Effective tillers (m^{-2})		Grain yield (qha^{-1})		Straw yield (qha^{-1})		Harvest index (%)	
	60 DAS		90 DAS		At harvest		60 DAS		90 DAS		At harvest									
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Methods of rice establishment																				
Dry seeding	47.28	49.88	64.04	66.53	62.49	64.55	307.79	303.50	618.99	651.52	709.52	763.74	204.49	209.17	26.02	29.62	37.13	41.44	40.85	41.33
Drum seeding	52.26	53.62	72.23	75.60	70.75	72.54	358.07	365.89	755.37	799.96	878.75	945.90	268.75	274.89	35.68	40.62	47.75	53.31	42.56	43.03
Broadcasting (wet)	55.20	58.25	75.14	78.18	74.56	77.63	341.19	348.64	714.00	767.83	838.21	899.45	255.47	262.88	32.36	36.84	45.05	50.28	41.15	41.62
SEm±	1.05	1.11	1.73	1.79	1.15	1.18	5.64	5.59	11.03	13.07	11.59	12.45	3.73	3.83	0.84	0.96	1.18	1.22	0.38	0.39
LSD (P=0.05)	4.14	4.37	5.32	5.06	4.52	4.62	22.15	21.95	43.30	51.33	45.51	48.87	14.64	15.03	3.30	3.76	4.36	4.52	NS	NS
Weed management practices																				
Bis.	46.43	48.16	62.68	64.32	60.56	62.47	315.47	323.56	649.44	703.67	749.60	826.30	236.77	239.07	26.67	30.36	38.30	42.76	40.85	41.32
Pendi. fbBis.	51.45	54.07	70.31	70.48	68.47	70.46	334.00	332.97	694.80	732.02	804.74	859.63	242.95	250.22	32.68	37.19	44.74	49.94	42.05	42.52
Oxadi.fbBis.	49.68	52.73	68.68	69.62	66.59	67.73	328.88	328.27	681.84	719.99	790.72	845.49	240.89	243.93	28.65	32.62	40.10	44.76	41.57	42.05
Preti.fbAlm.	52.33	55.22	71.93	74.49	71.32	73.05	348.99	351.01	727.20	773.25	843.05	908.11	250.38	259.36	36.23	41.24	48.99	54.69	42.49	42.97

Pyra.fbethox.	50.62	53.27	69.26	70.22	67.37	68.30	333.22	330.23	692.37	725.15	801.93	851.55	241.97	246.62	30.30	34.49	42.73	46.58	41.99	42.46
Manual weed.	56.60	59.61	75.93	76.61	75.30	76.05	359.64	361.60	749.89	799.62	869.22	939.12	259.35	267.45	38.46	43.78	51.12	57.07	42.88	43.36
Weed free	58.26	61.45	78.74	79.56	77.42	79.18	372.65	374.55	779.86	833.37	903.80	978.81	267.72	278.05	41.67	47.44	54.30	60.61	43.20	43.68
weedy	36.62	39.19	53.55	55.77	49.86	52.36	292.60	312.58	593.58	631.12	707.54	748.53	203.20	207.13	16.19	18.43	27.19	30.35	37.11	37.57
SEm±	1.46	1.54	2.56	2.47	1.59	1.55	7.45	7.52	15.08	16.21	17.82	19.10	5.39	5.54	1.47	1.68	1.61	1.63	0.91	0.93
LSD (P=0.05)	4.16	4.39	5.79	6.02	4.84	4.73	21.27	21.45	43.04	46.28	50.85	54.50	15.40	15.80	4.21	4.79	5.59	5.67	NS	NS

Table 2: Effect of establishment methods and weed management practices on total weed density (no. m^{-2}) and total weed dry weight (g m^{-2}) at different stage of crop growth of rice

Treatments	Total weed density (no. m^{-2})						Total weed dry weight (g/ m^2)					
	60 DAS		90 DAS		At harvest		60 DAS		90 DAS		At harvest	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Methods of rice establishment												
Dry seeding	(65.14) 8.10	(57.43) 7.61	(60.87) 7.83	(56.22) 7.53	(57.76) 7.62	(51.07) 7.18	(37.53) 5.81	(37.13) 5.79	(39.00) 5.92	(38.00) 5.85	(42.96) 6.20	(39.54) 5.96
Drum seeder	(44.19) 6.68	(38.97) 6.27	(41.19) 6.46	(38.05) 6.21	(38.96) 6.28	(34.56) 5.92	(25.25) 5.26	(25.13) 5.23	(26.37) 5.29	(25.15) 5.23	(29.04) 5.61	(26.73) 5.43
Broadcasting (wet)	(55.45) 7.48	(48.88) 7.03	(51.81) 7.23	(47.85) 6.95	(49.00) 7.04	(43.47) 6.63	(31.94) 5.38	(31.58) 5.36	(32.83) 5.46	(32.33) 5.42	(36.53) 5.74	(33.62) 5.52
SEm±	1.15	1.10	1.12	1.10	1.02	1.40	0.03	0.04	0.05	0.05	0.06	0.05
LSD (P=0.05)	0.82	0.25	1.87	1.81	1.62	2.16	0.14	0.15	0.19	0.20	0.21	0.19
Weed management practices												
Bis.	(63.08) 7.97	(55.61) 7.49	(53.31) 7.71	(49.25) 7.41	(50.42) 7.50	(44.73) 7.07	(37.38) 6.17	(38.76) 6.28	(39.01) 6.30	(37.84) 6.21	(42.96) 6.60	(39.54) 6.34
Pendi. fbBis.	(44.06) 6.73	(38.84) 6.32	(41.17) 6.51	(38.03) 6.26	(38.93) 6.33	(34.54) 5.97	(29.41) 5.49	(30.12) 5.56	(30.49) 5.59	(29.78) 5.53	(33.58) 5.86	(30.91) 5.63
Oxadi.fbBis.	(57.06) 7.59	(50.30) 7.13	(46.57) 7.34	(43.01) 7.05	(44.40) 7.14	(39.07) 6.73	(32.02) 5.73	(31.57) 5.69	(33.31) 5.84	(32.42) 5.76	(36.68) 6.12	(33.76) 5.88
Preti.fbAlm.	(34.57) 6.68	(28.97) 6.27	(31.91) 6.46	(29.91) 6.21	(39.39) 6.28	(33.39) 5.92	(18.29) 4.39	(17.32) 4.28	(19.49) 4.53	(16.87) 4.23	(22.68) 4.87	(19.10) 4.48
Pyra.fbethox.	(49.84) 7.10	(43.94) 6.67	(41.84) 6.86	(38.65) 6.60	(39.57) 6.67	(35.11) 6.29	(32.75) 5.79	(31.26) 5.66	(34.06) 5.90	(33.15) 5.83	(37.51) 6.18	(34.52) 5.94
Manual weed.	(26.00) 5.15	(22.92) 4.84	(24.30) 4.98	(22.44) 4.79	(22.98) 4.85	(20.39) 4.57	(15.61) 4.06	(15.45) 4.04	(16.22) 4.13	(15.80) 4.09	(17.86) 4.33	(16.44) 4.16
Weed free	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00
weedy	(154.32) 12.44	(136.06) 11.69	(144.20) 12.03	(133.19) 11.56	(136.37) 11.70	(120.99) 11.02	(67.52) 8.25	(64.13) 8.04	(69.10) 8.34	(68.35) 8.30	(77.09) 8.81	(70.95) 8.45
SEm±	0.48	0.41	1.44	1.40	1.33	1.28	0.06	0.06	0.08	0.07	0.09	0.09
LSD (P=0.05)	1.93	1.82	2.24	2.16	2.04	1.93	0.18	0.18	0.24	0.19	0.25	0.24

Values in parenthesis are Original values, X=√x+0.5 transformation was used

Effect on weeds

The density of the different weed species weed density were recorded at 60, 90 days and at harvest stages of crop growth. The density of the individual weed species and other weeds as well as total weeds was affected significantly due to different establishment methods of rice. Direct seeding of rice (Dry seeding and drum seeding) treatments recorded the presence of different weed species. However, dry seeding of rice (DSR) recorded significantly higher weed density of grassy, BLWs and sedges as compared to drum seeding treatment. Where number of weed species under broad casting being at par with drum seeding at all growth stage during both the year of experimentation.

As far as the various weed control treatments were concerned, lower weed density was recorded due to various weed management practices over weedy check. Manual weeding thrice (20, 40 & 60 days of seeding) and Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop) being at par recorded significantly less weed density over bispyribac-Na 25g ha-1 as PoE application alone and weedy check treatments. Weed population of individual species and other species as well as total weed species less in sole post emergence application bispyribac-Na 25g ha-1 as PoE application alone then control weedy check. The combination of pre and post application of herbicide were significantly more effective in compression with sole application of bispyribac-Na 25g ha-1 as PoE application alone. Similarly manual weeding at 25 days after sowing next only to Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop) being at par to each other. It is also clear from the data that lower density of weeds due to bispyribac-Na 25g ha-1 as PoE application alone was proved significantly superior with respect to controlling the weeds over weedy check treatment at all growth stage of the crop during both the years of experimentation.

The dry matter accumulation produced by total weeds was increased with the advancement of crop age and recorded higher at harvest stage of the rice irrespective of the treatments. The dry matter accumulation of the total weed species was affected significantly due to different establishment methods of rice. Among all the treatments of rice establishment, drum seeding recorded fewer weeds due to which lower weed dry weight was recorded at successive stages of crop growth e.g. 60, 90 and at harvest stages, both the DSR (wet) methods of establishment being at par recorded significantly lower weed dry weight over dry seeding methods. However, drum seeding method of rice establishment recorded significantly less total weed dry weight over dry seeding of rice establishment during the years of 2015 & 2016.

The weed management practices also influenced the dry weight of total weeds significantly at 60, 90, and at harvest stages of crop growth during both the years. Higher dry weight of weeds was recorded under weedy check plot followed by bispyribac-Na 25g ha-1PoE alone at all the stages of crop growth. Manual weeding thrice (20, 40 and 60 DAS) and Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop) being at par recorded significantly less total weed dry weight as compared to bispyribac-Na 25g ha-1PoE alone as well as weedy check. It is very clear data given in Table 2 that a combination of two herbicide and manual weeding recorded significantly lower values of weed dry weight. At harvest manual weeding being at par with Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop) recorded significantly less dry weight (17.86 and 16.44) respectively both the year of experimentation. The efficacy of herbicides and their combination are interplay of weed flora present under varying establishment methods as explained by Singh and Paikra (2014). The combination capable of covering the maximum diversity of weed flora performed comparatively better. The results as regards to weed population and their bio-mass accumulation are in close conformity with the results reported earlier by Verma *et al*. (2015) [11] Singh and Tongpong (2002) and Ravi Shankar *et al*. (2008) [20].

Effect on crop

The data given in Table1 revealed that plant height was influenced significantly due to establishment methods at all the stages of crop growth. The plant height recorded at 60 and 90 days after seeding and at harvest stage, both the DSR (wet) methods recorded significantly more plant height over dry seeding methods. It is also clear from the data given the Table that both of the DSR (wet) methods (Drum and broad casting) being at par recorded significantly more plant height over dry seeding treatments. However, broadcasting treatments recorded numerically higher values of plant height over drum seeding method, respectively, but statically similar to DSR wet method at all the stages.

As far as the various weed management practices were concerned, plant height was influenced significantly at all the stage of crop growth due to various weed management practices. The plant height at successive stage that manual weeding thrice (20, 40 and 60 days) and Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop) being at par recorded significantly more plant height over bispyribac-Na alone and weedy check treatments, Likewise, all pre and post herbicide combination also recorded being at par to each other. However, weedy check treatment recorded significantly lower plant height over rest of the weed control treatments during both the years.

Dry matter accumulation is directly related to the growth pattern of the crop, which influences the grain yield directly. The crop dry matter accumulation (gm-2) was increased significantly due to various rice establishment methods at different growth stages during both the years. Both the DSR (wet) methods at all the growth stages being at par recorded significantly more dry matter accumulation over dry seeding methods. In case of direct seeding of rice treatments, drum seeding treatment recorded significantly more dry matter accumulation as compared to broad-casting of rice (DSR) treatments at all the stages of crop growth during both the years of experimentation.

As far as the various weed management practices were concerned, dry matter accumulation was influenced at all the crop growth stage due to various weed management practices. Manual weeding thrice (20, 40 and 60 days) and Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop) being at par recorded significantly more dry matter accumulation over bispyribac-Na 25g ha-1 as post emergence application alone and weedy check treatments, except 30 DAS stage. However, weedy check treatment recorded significantly less dry matter accumulation over rest of the weed control treatments, likewise two herbicide combination also being at par to each other at all the stages of crop growth during both the years.

Effect on yield

Among the various establishment methods, broad-casting and drum seeding method being at par recorded significantly higher values of effective shoot (m^{-2}) over dry seeding. The yield attributes viz., number of effective shoots (m^{-2}) was influenced significantly with different weed management practices during both the years (Table-4.1) Manual weeding thrice (20, 40 and 60 days) and Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop) being at par recorded significantly higher values of these yield attributes over bispyribac-Na 25g ha^{-1} as PoE alone and weedy check treatments. However, weedy check treatment recorded significantly lower values of yield attributes over rest of the weed control treatments. This might because of the treatments which were able to control effect only gave poor crop-weed competition and results to which higher values of yield attributes and yield. The results are in agreement with the findings of Khattak *et al.* (2006) and Aslam *et al.* (2008).

Grain and straw yield were also influenced significantly by various crop establishment methods during both the years. Drum seeding being at par with broadcasting (wet) produced significantly higher grain and straw yields over all other establishment methods during both the years. Yield is the functions of complex inter relationship of growth in vegetative phase and yield attributes. Higher yield under drum seeding was due to better crop growth and devolvement resulting into higher values of yield attributes which increase the grain yield. Higher straw yield under drum seeding was probably due to more dry matter production per unit area caused by better nutrient absorption from soil, increased rate of metabolic processes, rate of light absorption, photosynthetic activity and more number of leaves. Harvest index was not appreciably influenced by crop establishment methods. This might be due to almost similar increase in grain and straw yield under each method.

As far as the various weed management practices were concerned, Manual weeding thrice (20, 40 and 60 days) and Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop) recorded significantly higher values of grain and straw yield as compared to bispyribac-Na 25g ha^{-1} at 30 days stage alone and weedy check. However, bispyribac-Na 25g ha^{-1} alone recorded significantly higher values of grain and straw yield over weedy check. Weedy check produced significantly lower grain and straw yield as compared to all the weed management practices during both the years of experimentation. Such type of results with respect to grain and straw yield were recorded on the lines of growth and yield attributes recorded with the respective treatment. Lower harvest index under weedy check condition may be explained on the basis that the menace of weeds go on increasing with increase in age. Hence, the vegetative growth was affected

comparatively less than the reproductive growth of rice plants lowering the harvest index. These results was in coordination with the earlier findings of Tamilselvan and Budhar (2002) [22], Jayadeva *et al*. (2009) [14] and Pramanick *et al*. (2014) [19].

Conclusions

On the basis of two years experimentation, it may be concluded that higher values of grain yield and net return may be obtained due drum seeding methods of establishment of rice along with integrated method of using weed management by Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop), while, broadcasting (wet) showed the same response However, direct seeding of rice through drum along with Pretilachlore @ 750g/ha at 0-2DASfbAlmix @ 4 g/ha at 25DAS (3-4 Leaf stage of rice crop) proved superior (BCR values of Rs 2.12 per ha) over other methods of rice establishment under puddled condition.

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