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Effect of establishment method and different weed management practices on dry direct seeded rice (DDSR) at Rampur, Chitwan

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ABSTRACT

To evaluate most economical and efficient weed management practices in dry direct seeded rice, a field experiment was conducted at research block of AFU Rampur, Chitwan during the *Kharif* 2016 season. The treatments consisted of two establishment practices *viz*., zero till and conventional tillage and eight weed management practices such as weedy check, weed free, Pendimethalin followed by hand weeding at 20 DAS 1 kg a.i ha^{-1}, Pendimethalin followed by 2, 4-D ethyl ester at 25 DAS 1 kg a.i ha^{-1}, pendimethalin followed by bispyribac-Na at 25 DAS at 25 g a.i ha^{-1}, pendimethalin followed by ethoxysulfuron at 25 DAS 25 g a.i ha^{-1}, pendimethalin followed by penoxsulam at 25 DAS 25 g a.i ha^{-1}, pendimethalin followed by (ethoxysulfuron + bispyribac-Na. The experiment was conducted in split plot design with three replications. The result of experiment showed that non-significant difference was notice among the establishment method. However, significant difference was observed in weed management practices in all the traits expect number of weeds m^{-2}, number of weed species m^{-2}, and dry weight of broad leaf, narrow leaf and sedges weeds. The higher number of weeds m^{-2} was found in weedy check plot which resulted in higher weed infestation at all the stages as compared to other weed management practices. Application of pendimethalin followed by hand weeding at 20 DAS recorded higher weed control efficiency which reflected in higher yield of 4202 kg ha^{-1} was recorded under this treatment as compared to weedy check plot (1292.13 kg ha^{-1}) but rest of the treatments are statistically at par with other weed management practices.

Introduction

Rice (*Oryza sativa*) is the second most important crop being the major staple food for more than half of the world's population. The total paddy production in 2016 is forecasted to be 4,952,090 MT, 15% increase compared to the production level of 4,299,078 MT in (MoAD, 2015). Share of rice is

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20% to agriculture gross domestic product (AGDP) and contributes nearly 50% of the calorie requirement of Nepalese people. Productivity of rice is very low as compared to developed country. Weeds are a major constraint to the success of DSR in general and that to Dry-DSR in particular (Johnson and Mortimer, 2005; Singh et al. 2006; Rao et al. 2007). Availability of herbicides of different selectively and specificity has proved to be milestone for the success of DSR and switch from TPR. In DSR first 30-45 days after sowing is the critical period and weeds must be managed effectively in this period, failing which there will be much loss in the yield. Among various factors responsible for low paddy productivity, weed is one of the major factors which affect the productivity. Maity and Mukherjee (2008) reported that uncontrolled weeds reduced the yield by 96% in Dry - DSR and 61% in wet -DSR. Yield loss in rice due to uncontrolled weeds was 96 % in dry DSR, 61 % in wet DSR and 40 % in the machinery -transplanted crop (Kim and Pyon, 1998). Choubey et al. (2001) considering these facts, the experiment was conducted to study the effect of establishment method and different weed management practices on yield and weed controlling efficiency in dry direct seeded rice. The main aim of this research was conducted to evaluate effect of establishment method and different weed management practices on dry direct seeded rice at mid hill of Nepal.

Materials and Methods

Field experiment was conducted at AFU Agronomy Research Farm, Rampur, Chitwan, Nepal during main *Kharif* 2016. The site is located 9.8 km South-West from Bharatpur, headquarter of Chitwan district. This location is situated at 27^0 37' N latitude and 84^0 25' E longitudes with the elevation of 256 m above mean sea level. Geographically, the experimental location falls in the inner terai region of Central Development Region of Nepal. The experiment was laid out in split plot design with two factors and replicated thrice. The main factors were establishment method (zero and conventional tillage) and sub factors were weed management practice along these treatments weedy check, weed free, pendimethalin followed by hand weeding, pendimethalin followed by 2, 4-D ethyl ester, pendimethalin followed by bispyribac-Na, pendimethalin followed by penoxsulam, pendimethalin followed by ethoxysulfuron, pendimethalin followed by (bispyribac-Na + ethoxysulfuron) were also managed in each replication. The size of individual plot was 22.4 m^2 (7 x 3.2 m) with the total experimental area of 1391.2 m^2. Bund of 0.5 m width separated the two individual plots and each replication was separated by 1m bund. Rice was sown continuously in line with a row to row spacing of 20 cm. Altogether, 35 rows were made in each plot, of which the ten central rows for harvesting, 4 rows in each sides were used for biometrical observation recording and dry matter portioning. The following two factors were consisted in treatment combinations:

Main factors: Establishment method: Zero tillage and Conventional tillage. Sub factors: Weed management practices: T1: Weedy check , T2: Weed free, T3: pendimethalin followed by hand weeding (1000 g a.i. ha^{-1}), T4: pendimethalin followed by 2, 4-D ethyl ester (500 g. a.i. ha^{-1} 38 % EC), T5: pendimethalin followed by bispyribac-Na (25 g a.i. ha^{-1} 10% SC), T6: pendimethalin followed by penoxsulam (25 g a.i. ha^{-1} 24 % SC), T7: pendimethalin followed by ethoxysulfuron(25 g a.i. ha^{-1} 15 % WG) , T8: pendimethalin followed by (bispyribac-Na + ethoxysulfuron) (25 g a.i. ha^{-1} + 25 g a.i. ha^{-1}).

Results and Discussion

Observation on number of weed species

Number of weed per m^2

The results revealed that there was no significant difference among the establishment methods on number of weeds m^{-2} and weed species recorded during *Kharif* 2016 season, however, numerically higher weeds were recorded under no till plot as compared to conventional till. Whereas, the effect of different weed management practices on number of weeds and species was also non-significant. The average number of weed per square meter was 73.19 and range from 31.50 to 152.83 among different weed management practices. The number of weed per square meter was not significantly influenced by weed management practices as well as by the establishment method and its interaction with management practices. No till resulted in comparatively higher than conventional tillage. The highest number of weed per square meter was obtained from weedy check plot. It was statically at par with other method of weed management practices (Table 1).

Number of weed species per m^2

The average number of weed species per square meter was 4.98 and range from 3.83 to 5.67 among different weed management practices. The number of weed species per square meter was not significantly influenced by weed management practices as well as by the establishment method and its interaction with management practices. Conventional till resulted in comparatively higher than no till (Table 1).

Table 1. Effect of establishment methods and weed management on number of weed and number of species per square meter of rice.

Treatment	Number of weeds per square meter	weed species per square meter
Establishment methods		
No till	87.71	4.58
Conventional Till	58.67	5.38
F-test	Ns	Ns
SEm (±)	16.10	0.35
LSD $^{(0.05)}$	69.23	2.19
Weed management practices		
Weedy check	152.83[a]	5.67[a]
Weed free	31.50[a]	5.67[a]
pend.*fb* hand weeding	82.83[a]	4.50[a]
pend. *fb* 2, 4-D ethyl ester	48.83[a]	5.50[a]
pend. *fb* bispyribac-Na	55.50[a]	3.83[a]
pend. *fb* penoxsulam	41.17[a]	4.83[a]
pend. *fb* ethoxysulfuron	117.00[a]	4.50[a]
pend. *fb* bispyribac-Na + ethoxysulfuron	55.83[a]	5.33[a]
F-test	Ns	Ns
SEm (±)	42.20	0.93
LSD $^{(0.05)}$	127.9	2.02
C V %	69.89	13.20
Grand Mean	73.00	4.98

pend. *fb:* pendimethalin followed by.

Observation on dry weight of weeds per m²

Broad leaf

The average broad leaf weeds dry weight of rice was 2.96 m^{-2} and range from 2.12 to 4.63 m^{-2} among different weed management practices. The broad leaf weeds dry weight per square meter was not significantly influenced by weed management practices and establishment method and its interaction with management practices. No till resulted in comparatively higher than conventional tillage. The highest broad leaf weeds dry weight was obtained from the weedy check plot. It was statistically at par with other weed management practices (Table 2).

Narrow leaf

The average narrow leaf weeds dry weight of rice was 5.245 and range from 4.45 to 7.01 among different weed management practices. The narrow leaf weeds dry weight was not significantly influenced by weed management practices and the establishment method and its interaction with management practices. Conventional tillage resulted in comparatively higher than no till. The highest narrow leaf weeds dry weight was obtained from the weedy check plot. It was statistically at per with other weeds management practices (Table 2).

Table 2. Effect of establishment methods and weed management on dry weight of different categories of weeds per square meter (g) of rice.

Treatments	BLW	NLW	Sedges	Total dry weight
Establishment methods				
No till	15.78(3.47)	21.68(4.27)	1.68(1.17)	39.13(5.72)
Conventional Till	9.13(2.45)	44.72(6.22)	1.57(1.15)	55.42(7.00)
F-test	Ns	Ns	Ns	Ns
SEm (±)	0.55	0.624	0.082	0.864
LSD $^{(0.05)}$	3.34	3.796	0.502	5.266
Weed management practices				
Weedy check	26.10(4.63)^{a}	50.15(7.01)^{a}	0.93(1.07)^{a}	77.18(8.73)^{a}
Weed free	12.93(3.10)^{a}	39.02(6.22)^{a}	2.73(1.15)^{a}	54.68(7.34)^{ab}
pend.*fb* hand weeding	13.03(3.05)^{a}	19.57(3.91)^{a}	0.00(0.71)^{a}	32.60(5.03)^{b}
pend. *fb* 2, 4-D ethyl ester	9.90(2.41)^{a}	48.5(6.52)^{a}	3.47(1.57)^{a}	61.90(7.39)^{ab}
pend. *fb* bispyribac-Na	10.13(3.03)^{a}	24.53(4.49)^{a}	3.83(1.62)^{a}	38.50(5.92)^{ab}
pend. *fb* penoxsulam	9.30(2.79)^{a}	29.80(4.90)^{a}	0.43(0.88)^{a}	39.53(5.85)^{ab}
pend. *fb* ethoxysulfuron	7.43(2.12)^{a}	26.87(4.45)^{a}	0.03(0.73)^{a}	34.34(5.03)^{b}
pend. *fb* (Bispyribac-Na + Ethoxysulfuron)	10.80(2.55)^{a}	27.13(4.46)^{a}	1.53(1.18)^{a}	39.47(5.58)^{ab}
F-test	Ns	Ns	Ns	<0.001
SEm (±)	0.87	1.004	0.345	1.032
LSD $_{(=0.05)}$	2.65	3.046	1.045	3.130
CV,%	61.60	38	12.9	18.1
Grand Mean	2.96	5.25	1.62	6.36

pend. *fb:* pendimethalin followed by. BLW= Broad leaf weed, NLW= Narrow leaf weed.

Sedges

The average sedges dry weight of rice was 1.16 and range from 0.71 to 1.62 among different weed management practices. The sedges dry weight was not significantly influenced by weed management practices and the establishment method and its interaction with management practices. No till resulted in comparatively higher than conventional tillage. The highest sedges were obtained from the weedy check plot. It was statistically at par with other weeds management practices (Table 2).

Average total dry weight of weed

The average total dry weed weight of rice was 6.36 m^{-2} and range from 5.03 to 8.73 m^{-2} among different weed management practices (Table 2). The total dry weed weight per square meter was significantly influenced by weed management practices but not by the establishment method and its interaction with management practices. Conventional resulted in comparatively higher than no till. The highest total dry weed weight per square meter was obtained from weedy check method. It was significantly higher than pendimethalin followed by hand weeding and pendimethalin followed by Ethoxysulfuron but statistically at per with other weed management practices.

Observation on yield attributes

Effective tiller per m^2

The average number of effective tiller of rice was 258.815 m^{-2} and range from 187.5 to 301.67 m^{-2} among different weed management practices (Table 3). The effective tillers per square meter were significantly influenced by weed management practices but not by the establishment method and its interaction with management practices. No till resulted in comparatively higher than conventional tillage. The highest effective tillers per square meter were obtained from pre-emergence application of Pendimethalin followed by hand weeding. It was significantly higher than weedy check but statistically at par with other weed management practices. The pre-emergence application of Pendimethalin followed by either 2, 4-D ethyl ester, Bispyribac Na or Ethoxysulfuron resulted the similar number of effective tillers per square meter as compared to weedy check.

Number of grain per panicle

The average number of grains per panicle of rice was 152.07 m^{-2} and range from 115.93 to 171.61 m^{-2} different weed management practices (Table 3). The number of grains per panicle was

significantly influenced by weed management practices. Whereas, the establishment method and its interaction with management practices were not significant. Conventional tillage resulted in application of pendimethalin followed by hand weeding. It was significantly higher than weed check but statistically at per with other weed management practices. The pre-emergence application of pendimethalin followed by either 2, 4-D ethyl ester, Bispyribac Na or Ethoxysulfuron resulted the similar number of grains per panicle as compared to weedy check.

Thousand grain weight

The average number of thousand grain weight of rice was 14.665 and range from 13.34 to 16.85 among different weed management practices (Table 3). The thousand grain weight was significantly influenced by weed management practices but not by the establishment method and its interaction with management practices. No till resulted in comparatively higher than conventional tillage. The highest thousand grain weight was obtained from pre-emergence application of Pendimethalin followed by Ethoxysulfuron. It was significantly higher than weed free, Pendimethalin followed by hand weeding and pendimethalin followed by 2, 4-D ethyl ester but statistically at par with other weed management practices. The pre-emergence application of Pendimethalin followed by penoxsulam, pendimethalin followed by bispyribac-Na, pendimethalin followed by bispyribac Na + ethoxysulfuron and weedy check resulted in similar number of thousand grain weight as compared to weed free.

Sterility percentage

The average sterility percentage of rice was 13.09 and range from 9.64 to 24.26 different weed management practices (Table 3). The sterility percentage was significantly influenced by weed management practices. Whereas the establishment method and its interaction with management practices were not significant. No till resulted in comparatively higher than conventional tillage. The higher sterility percentage was obtained in the plots of weedy check .It was significantly higher than other weed management practices. Except weedy check method of weed control all other are statistically similar.

Table 3. Effect of establishment methods and weed management on yield attributes of rice.

Treatments	Effective tillers m^{-2}	Number of grains per panicle	Thousand grain weight	Sterility percentage
Establishment methods				
No till	261.28	147.06	14.76	14.62
Conventional Till	256.35	157.08	14.57	11.56
F-test	Ns	Ns	Ns	Ns
SEm (±)	17.53	7.03	0.243	1.408
LSD (=0.05)	106.67	42.75	1.478	8.566
Weed management practices				
Weedy check	187.50^{b}	115.93^{b}	15.46^{ab}	24.26^{a}
Weed free	279.03^{a}	165.34^{a}	13.34^{b}	10.38^{b}
pend. *fb* hand weeding	301.67^{a}	171.61^{a}	13.48^{b}	10.57^{b}
pend. *fb* 2, 4-D ethyl ester	224.58^{ab}	125.05^{ab}	14.05^{b}	14.71^{b}
pend. *fb* bispyribac-Na	268.19^{ab}	164.23^{a}	14.28^{ab}	13.03^{b}
pend. *fb* penoxsulam	278.75^{a}	153.92^{ab}	14.76^{ab}	10.56^{b}
pend. *fb* ethoxysulfuron	239.72^{ab}	150.43^{ab}	16.85^{a}	9.64^{b}
pend. *fb* (bispyribac-Na + ethoxysulfuron)	291.11^{a}	170.08^{a}	15.10^{ab}	11.54^{b}
F-test	<0.05	<0.05	<0.05	<0.05
SEm (±)	26.01	14.38	0.825	2.498
LSD (=0.05)	78.88	43.63	2.391	7.578
CV %	23.10	21.56	13	19.67
Grand Mean	258.82	152.07	14.67	13.09

pend. *fb:* pendimethalin followed by.

Observation on yield

Grain yield

The average grain yield of rice was 3459.67 kg ha^{-1} and range from 1292.13 to 4202.15 kg ha^{-1} among different weed management practices. Relationship between grain yield and number of grains per panicle is presented in figure 1. The grain yield was significantly influenced by weed management practices whereas the establishment method and its interaction with management practices were not significant. Conventional tillage resulted in comparatively higher than No till. The highest yield is obtained in the plots of pre-emergence application of Pendimethalin followed by hand weeding. It was significantly higher than weedy check but statistically at per with other weed management practices.

The efficacy of Pendimethalin alone is high reported by several authors (Moody, 1991; Valverde and Gressel, 2005) or in combination with hand weeding was reported so effective in controlling weeds in dry direct seeded rice (Ramamoorthy et al. 1998; Singh et al. 2006; Bhurer et al. 2013).

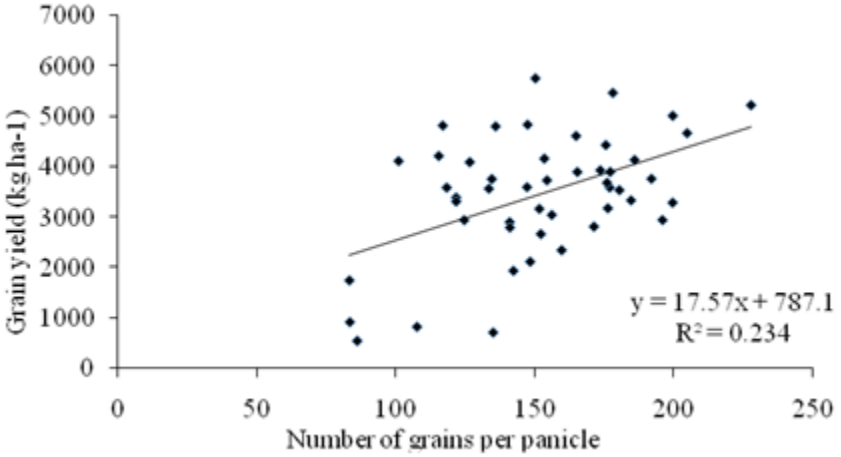

Figure 1. Relationship between grain yield and number of grains per panicle of DDSR at AFU, Rampur, Chitwan.

Straw yield

The average straw yield was 4672.78 kg ha^{-1} and range from 1205.52 to 5679.37 kg ha^{-1} among different weed management practices. Relationship between grain yield and straw dry weight is presented in figure 2. The straw yield was significantly influenced by weed management practices whereas the establishment methods and its interaction with management practices were not significant. Conventional tillage resulted in comparatively higher than No till. The highest straw yield is obtained in the plots of pre-emergence application of Pendimethalin followed by hand weeding. It was significantly higher than weed check but statistically at per with other weed management practices.

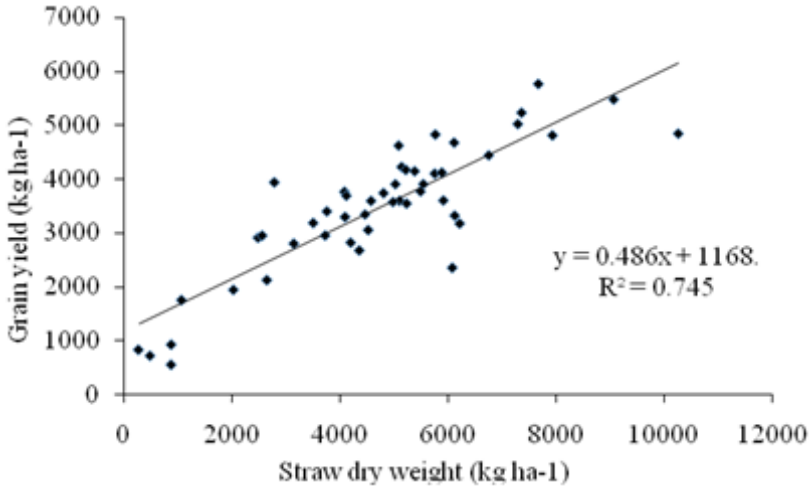

Figure 2. Relationship between grain yield and straw dry weight of DDSR at AFU, Rampur, Chitwan.

Total biomass

The average biomass was 7648.81 kg ha^{-1} and range from 2316.75 to 9293.22 kg ha^{-1} among different weed management practices (Table 4). The average biomass was significantly influenced by weed management practices. Whereas the establishment method and its interaction with management practices was not significant. Conservation tillage resulted in comparatively higher than No till. The higher biomass is obtained in the plots of pre-emergence application of pendimethylin followed by hand weeding .It was significantly higher than weed check but statically at per with other weed management practices.

Table 4. Effect of establishment methods and weed management on grain yield (kg ha^{-1}), straw yield (kg ha^{-1}), biomass weight (kg ha^{-1}) and harvest index (%).

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Total Biomass (kg ha^{-1})	HI
Establishment methods				
No till	3335.17	4168.20	7036.45	45.89
Conventional Till	3584.17	5177.36	8259.75	40.53
F-test	Ns	ns	Ns	Ns
SEm (±)	318.00	905.6	873.7	4.47
LSD (=0.05)	1935.00	5510.7	5316.6	27.18
Weed management practices				
Weedy check	1292.13^{b}	1205.52^{b}	2316.75^{b}	27.73
Weed free	3640.90^{a}	4847.12^{a}	7978.29^{a}	39.30
pend. *fb* hand weeding	4202.15^{a}	5679.37^{a}	9293.22^{a}	57.72
pend. *fb* 2, 4-D ethyl ester	3701.24^{a}	4641.86^{a}	7824.92^{a}	54.29
pend. *fb b*ispyribac-Na	3780.03^{a}	5450.29^{a}	8701.11^{a}	38.82
pend. *f b* penoxsulam	3282.43^{a}	5068.67^{a}	7891.56^{a}	35.95
pend. *fb* ethoxysulfuron	3638.40^{a}	5335.03^{a}	8464.05^{a}	36.97
pend. *fb* (Bispyribac-Na + ethoxysulfuron)	4140.09^{a}	5154.40^{a}	8714.88^{a}	41.90
F-test	<0.001	<0.001	<0.001	Ns
SEm (±)	302.20	928.4	973.6	6.41
LSD $_{(0.05)}$	916.70	2815.9	2953	19.45
CV %	34.41	47.02	40.84	39.77
Grand Mean	3459.67	4672.78	7648.10	43.21

Harvest index

The average harvest index was 43.21%and range from 27.73 to 57.72% among different weed management practices (Table 4). The harvest index was non-significantly influenced by weed management practices. Whereas the establishment method and its interaction with management practices was not significant. No till resulted in comparatively higher than conservation tillage. The higher harvest index was obtained in the plots of pre-emergence application of pendimethylin followed by hand weeding. It was statically at par with other weed management practice.

Conclusion

The grain yield, straw yield, and biomass was significantly influenced by weed management practices in which highest yield is obtained in the plot of pre emergence application of pendimethalin followed by hand weeding which was significantly higher than weedy check but statistically at par with other weed management practices. The Harvest index was not significantly influenced by weed management practices in which higher value was obtained in the plot of pre emergence application of pendimethalin followed by hand weeding and was statically at par with other weed management practices. The effective tiller per m^2 and number of grain per panicle were significantly influenced by weed management practices. This was higher in pre emergence application of pendimethalin followed by hand weeding. This was significantly higher than weedy check but statically at par with other weed management practices. The pre emergence application of pendimethalin followed by either 2, 4-D ethyl ester, Bispyribac-Na or ethoxysulfuron resulted similar effect on effective tiller. Whereas pendimethalin followed by 2, 4-D ethyl ester, pendimethalin followed by penoxsulam and pendimethalin followed by ethoxysulfuron have same effect on number of grain per panicle. Sterility percentage was significantly influenced by weed management practices. The higher sterility percentage were obtained in the plot of weedy check except weedy check plot other weed control method are statistically similar.

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Conflict of Interest

No conflicts of interest have been declared.

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