Response of direct dry seeded rice (*Oryza sativa* L.) to seeding dates and seed rates

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Abstract

Field studies to access seed rate, seeding dates, and weed infestation in direct dry sseded rice (Khumal -4) were carried out under rice-wheat rotation system at Khumaltar during 2005/06 -2007/08. The broadleaf weeds: *Ageratum conyzoides, Commelina diffusa, Eclipta prostrata, Amaranthus veridis, Coronopus didymus, Lactuca* sp. the grassy weeds: *Echinochloa colona, Cynodon dactylon*, and *Paspalum distichum* and the sedges: *Cyperus difformis* and *C iria* were recorded. *E colona* was the dominant weed in the second year, however *A conyzoides* was pronounced in the first year. *A conyzoides* showed an increasing trend over years and became a dominant species ranging from 2-13/0.25m^2 in the 1st year and 53 -144/0.25m^2 in the 3rd year. Significant interaction effect on total weed number/0.25 m^2 was recorded in the 2nd seeding date in all seed rates. Significantly higher weed numbers were recorded in 2nd seeding date and 20 kg/ha seed rate in the 3rd year. There was no significant interaction between different seed rate and seeding date on the gall formation due to *Meloidogyne graminicola*. Plant height, tillers/m^2, number of seeds/panicle, and grain yield were not significantly affected due to seeding dates except plant height in 2005/06. Number of tillers/m^2 was significantly different among seed rates and showed slightly increasing trend with higher seed rates. But there was no significant different in grain yield among seed rates except in the year 2005/06. Dry straw weight did not show consistent results among seeding dates. The present study showed that rice seeding can be done in mid May with the seed rates 30–50 kg/ha.

Key words*:* Weed, tillage, seed, date, yield

Introduction

Rice transplanting is the main method of rice culture throughout Nepal. It's a traditional method and the farmer's are practicing from time immemorial. Rice transplanting is sometimes taken as a good occasion for social gathering with happiest mood and singing in the field. This method is quite good as it minimize many initial weeds due to piddling. But this practice is becoming very expensive because of labor scare during pick transplanting seasons. Studies had shown that soil texture will not be detoriated in non puddled soil compared to continuous puddled soil. It also minimizes the emissions of methane gas compared to transplanted rice fields. Puddling for rice transplanting also makes land preparation difficult for wheat crop in rice- wheat rotation resulting in cloddy soil structure, loss of soil moisture, delayed and inadequate seed soil contact (Sharma and De Datta, 1985).Weeds are one of the limiting factors in direct seeded rice in reducing the yield. Weed account for 50-80% yield reduction in rainfed uplands (Ranjit et al., 1989; Sinha et al., 1996). The yield losses caused by different weeds depend on the type of rice culture, weed infestation, density and weed species prevalent such as *Cyperus difformis* (12-50%), *Cyperus iria* (40%), *Cyperus rotundus* (50%), *Echinochloa colona* (85%), *E. crusgalli* (100%), *Fimbristylis littoralis* (50%), *Leptochloa chinesis* (40%), *Monochoria vaginalis* (85%), and *P distichum* (45%) (Ampong and De Datta, 1991).

Hand weeding is the most popular weeding method in Nepal as well as in many parts of the world. Besides hand pulling and hand weeding, a number of herbicides have been developed and tested for the direct seeded rice around the world. Herbicides such as butachlor, thiobencarb, pendimethalin, oxyfluorfen, propanil, quinclorac, ioxynil, 2,4-D, piperophos + sulfonylurea, bentazone, molinate, anilophos and nominee have been tested in direct seeded rice in the past research (Biswas et al., 1992; Crawford and Jordan, 1995; Ranjit et al., 1989; Ranjit and Suwanketnikom, 2005). Many factors and agroecological regions affect change of weed flora. Weed flora in the rainfed ecosystem have been reported most complex compared to irrigated rice, but the weed management is most important and can be filled up at least 15% yield gap in different growing conditions (Moody, 1982). Though transplanting is a common practice of rice seeding throughout Nepal, but direct seeding is getting importance due to social and economic factors such as there is no drudgery for land preparation, raising seedlings and transplanting. The looming water crisis and increasing labor cost inducing researchers to find out alternate ways of rice seeding. Direct seeding of germinating or dry seed is one of the alternatives to transplanting. But the appropriate plating methods depend on agro ecological region, soil type as well as cropping systems.

Direct seeding might become popular in the coming days among the farmers as it is economical compared to transplanting. Past studies showed that yields are comparable with transplanted rice if crop is properly managed. Direct seeded rice (DSR) matures early than transplanted rice (TPR) but weeds become a constraint factor. Depending on the level of weed infestation in dry seeded rice the seed rate should also be increased. However, if conditions for rice seed germination and subsequent operations are favorable, the seed rate for dry seeding could be reduced (Farooq et al., 2006). There is no optimum seed rate for unweeded situation which was conducted with seed rates from 20 – 120 kg/ha. Any seed rate can be used in direct seeded rice depending on weed control practices used. Low seeding rate can be used because of plant compensation at later growth stages provided weed control is carried out. But best solution is to use seed rate at 60-80 kg/ha (Azmi, 1997). Studies on varietals performance were initiated in midhills with only one seed rate of 50 kg/ha (Ranjit et al., 2008). Direct dry seeding could be done by various methods such as broadcasting, Chinese seed drill, raised seed bed and manually (Annual report, 2005/06). Weed weight was affected by cultivars; row spacing or seed rates up to 160 kg/ha (Moody, 1982). Direct seeding is one of the resource conservation techniques too. It saves time and resource compared to transplanting. It avoids drudgery of land preparation, seedling raising and transplanting. It also saves water volume which is essential for puddling. Hence, research on direct dry seeding has been initiating since many years in Agronomy Division, Khumaltar, midhills condition of Nepal. But it is realized the lack of studies on seeding dates and seed rates for direct dry seeding environment. The objective of the study was to asses seeding dates and seed rates for direct dry seeded rice.

Methodology

Field studies on seeding dates and seed rates in direct dry seeded rice were initiated in rice – wheat systems in the same field during three years (2005/06 (2062/63), 2006/07 (2063/64), and 2007/08 (2064/65). The experiment was laid out in split plot design with minimum tillage (one pass by Chinese hand tractor) in the 2nd and 3rd year. The gross plot size was 3m x 4m (12m^2) with 20 cm row-to-row spacing .The main plot consists of 3 seeding dates (May 16, May 26 and June 5) and sub-plot consists of 5 seed rates (20, 30, 40, 50, and 60 kg/ha). Khumal-4 rice variety was used for this study. Chemical fertilizer was applied at 100:40:30 NPK kg/ha. Chemical fertilizer at 20:40:30 NPK kg/ha was applied during planting as basal. Rest dose of nitrogen was given in 2 split doses as 40:0:0 NPK kg/ha at tillering stage and 40:0:0 NPK kg/ha at panicle initiation stage. Butachlor @ 2l/ha was sprayed within 3 days of

rice seeding plus one hand weeding after 35-40 days of seeding to manage the weeds. Weeds were recorded from 0.25m^2 quadrat after 35-40 days of seeding. Gall formation due to *Meloidogyne graminicola* was also recorded.. Plant height, tillers/m^2, grains per panicle, thousand seed weight, and yield were recorded. Maximum, minimum temperature and rainfall were recorded during the experiment period.

Treatment combinations

Main–plot; Date of seeding	Sub–plot; Seed rates
May 16 (Jestha 02)	20 kg/ha
May 26 (Jestha 12)	30 kg/ha
June 05 (Jestha 22)	40 kg/ha
	50 kg/ha
	60 kg/ha

Result and discussion

Treatment effect on weeds

Main weed species recorded from the experimental field are given in Table 1. *Ageratum conyzoides, Commelina diffusa, Eclipta prostrata, Amaranthus veridis, Coronopus didymus,* and *Lactuca* sp. were among the broadleaf while *Echinochloa colona,* and *Cynodon dactylon* were among the grass and similarly sedges were *Cyperus difformis* and *C iria.*

Weed trend

Among these weeds, *E colona* and *A conyzoides* were the main weeds in the experimental field. The number *E colona* was higher than *A conyzoides* in the beginning of the experiment. But *A conyzoides* showed an increasing trend over years and became a dominant species ranging from 2-13/0.25m^2 in the 1st year and 51-109/0.25m^2 in the 3rd year (Fig. 1)**.** Significant interaction effect on total weed number/0.25 m2 was recorded in the 2nd seeding date (May 26) in all seed rates. Significantly higher total weed numbers were recorded on May 26 seeding date and 20 kg/ha seed rate in the 3rd year. *Cyperus* sp population showed a stable trend. The population did not increase over years. The number of grass weed decreased in the 3rd year. Broadleaf weed showed an increasing trend over year. It has been expected that the major weed problem in R-W system in mid hill during summer season were annual grasses and sedges (Mallik, 1998). There were no significant differences in weed population in different seed rates during the 2005/06 and 2006/07. But in the 3rd year the weeds were significantly higher in the 2nd date of seeding (Table 1).There was no consistent difference of weed population in the 1st two years among the seed rates and seeding dates. But in the 3rd year broadleaf especially *A conyzoides* showed differences among seeding dates and seed rates. The number of this weed was higher in 2nd date of seeding and low seed rate of 20 kg/ha .The increased number of *A conyzoides* over years might be due to favorable conditions for emergence and growth. Total number of weeds also showed an increasing trend over time. The number was significantly different in the 3rd year for both seeding dates and seed rates. Lower seed rate has more weeds. It might be due favorable condition and spacing for growth of weeds, though *A conyzoides* was the major one among the total weeds.

Table 1. Weed species in date and seed rate at Khumaltar

Weed species	Vernacular name	2005/06	2006/07	2007/08
Broadleaf				
Ageratum conyzoides	Gandhe	√	√	√
Alteranthera alternifolia		√	-	
Amaranthus sp	Mothe	√	-	
Coronopus didymes	Chamsure jhar	-	√	√
Commelina diffusa	Kane	√	√	√
Cardamine pretense		-	-	
Eclipta prostrate	Bhringraj	√	√	√
Lactuca sp	Dudhe	-	√	
Lindernia sp		-	√	√
Stellaria media	Armale	-	√	
Solanum nigrum	Kaligedi			√
Grass				
Cynodon dactylon	Dubo	√	√	√
Digitaria adcendens	Chitre Banso	√	√	
Echinochloa colona	Sanwa			√
Sedges				
Cyperus sp	Mothe			√
Cyperus iria	"		√	
Cyperus differmis	"	√	-	

It is hard to conclude whether decreased number of *E colona* was because of the application of Butachlor or affect of seeding dates and rates. It needs further study to confirm this cause.

Response of yield attributes to date of seeding and seed rates

Plant height

Plant height in different seeding dates and seed rates showed the same range except in the 1st year. Comparatively plant height was less in the 1st year thought the variety was the same (Table 2). The season for this is not known. But it is difficult to conclude whether it was due to differences in rainfall patterns. Rainfall was less in the beginning of the rice growth in the 1st year than in the 2nd and 3rd year.

Tillers per meter square

The number of tillers was not significantly affected by seeding dates in all tested years. But the tiller number was comparatively higher (339-378/m^2) in the 3rd seeding date (June 05) in last two years. It showed that seeding dates have not much effected on tiller number (Table 2). Tillers/m^2 were significantly high (289-370/m^2) in high seed rate (60 kg/ha) and less (225-270/m^2) in low seed rate (20 kg/ha).

Thousand grain weight

Thousand grain weights were also not affected by seeding date and seed rates except in 2nd year. 1000 grain weight ranged from 17.9 to 19.9 g.

Grains/panicle

Grains per panicle did not show consistent result over years. Grains per panicle were not affected due to different seeding dates and increasing seed rates. However, filled grains /panicle were more in low seed rate (20 kg/ha). It might be due to less competition among the rice population and ultimately less sharing of inputs (Table 2).

Table 2 Effect of seeding dates and seed rates on weeds, and yield attributes of direct dry seeded rice in Khumaltar 2005/06 to2007/08

Treatments	# of weeds / 0.25m^2)				Plant height(cm)				# of Tiller/ m^2				1000 seed weight(g)			
Date of seeding (D)	**05/06**	**06/07**	**07/08**	**Mean**	**05/06**	**06/07**	**07/08**	**Mean**	**05/06**	**06/07**	**07/08**	**Mean**	**05/06**	**06/07**	**07/08**	**Mean**
May 16 (Jestha 02) D1	29	83	59 b	**47**	114 b	124	124	**121**	286	284	297	**289**	17.9	19.2	19.4	**18.8**
May 26 (Jestha 12) D2	35	88	155 al	**93**	118 al	121	122.	**120**	263	290	279	**277**	17. 9	19.2	19. 9	**19.0**
June 05 (Jestha 22) D3	31	69	49 a	**50**	123 a	123	127	**124**	233	378	338	**316**	18.2	18.9	19.8	**18.9**
Seed rate (R)																
20 kg/ha R1	44	77	127 a	**83**	118	126 a	125	**123**	225 c	245 c	274	**248**	18.0	18.7 c	19.9	**18.7**
30 kg/ha R2	27	76	87 b	**63**	118	126 a	124	**123**	242 b	274 bc	290	**269**	18.0	19.2 abc	19.6	**18.9**
40 kg/ha R3	29	77	70 b	**59**	119	123 ab	124	**122**	278 a	333 c	272	**294**	17.9	18.8 b	19.7	**18.8**
50 kg/ha R4	28	75	68 b	**57**	117	117 c	126	**120**	269 abc	366 ab	328	**321**	17.9	19.3 a	19.7	**18.8**
60 kg/ha R5	31	94	87 b	**71**	121	121 bc	124	**122**	289 a	370 a	362	**340**	18.0	19.4 a	19.6	**19.0**
Date of seeding (D)	-	-	54		6	-	-		-	-	-		-	-	-	
Seed Rate ®	-	-	31		-	4.5	-		44	74	51		-	0.49	-	
D x R	-	-	53		-	-	-		-	-	-		-	-	-	
cv%	49	42	35		4	4	9		18	24	17		2.3	2.7	1.9	

Mean followed by same letter in a column are not significantly different at P< 0.05

Grain yield

Grain yield was not significantly affected by seeding dates. Comparatively fewer yields were recorded in the 2nd year than in 1st and 3rd year. Tillers/m^2 also did not affect to rice yield (Table 3). Significantly different grain yield due to seed rate was recorded in the 2nd year. Rest of other seed rates gave comparable yield. Though, grain yield was not significantly different among the seed rates in 2nd and 3rd year, but less grain yield was recorded in lower seed rate (20 kg/ha) in all years. Though the seed rates had not much affect on grain yield, but still 30-60 kg/ha seed rates gave higher grain yield than that of 20 kg/ha. Interaction effect also showed low grain yield in 20 kg/ha seed rate in all dates (Table 3).

Table 3. Effect of seeding dates and seed rates on yield attributes of dry direct seeded rice in Khumaltar 2005/06 (2062/63) to 2007/08 (2064/65)

Treatments	# Seeds/panicle								Grain Yield (kg/ha)				Dry straw (kg/ha)			
	Filled				Unfilled											
Date of seeding (D)	**05/06**	**06/07**	**07/08**	**Mean**	**05/06**	**06/07**	**07/08**	**Mean**	**05/06**	**06/07**	**07/08**	**Mean**	**05/06**	**06/07**	**07/08**	**Mena**
May 16 (Jestha 02) D1	122	154	126	**134**	8	12	7	**9**	4287	3932	4763	**4327.3**	6670	6789 b	7873 a	**7110.7**
May 26 (Jestha 12) D2	132	135	114	**127**	6	11	13	**10**	4733	3920	4350	**4334.3**	6573	9137 a	6277 b	**7329**
June 05 (Jestha 22) D3	133	147	119	**133**	6	11	11	**9**	4429	4077	5190	**4565.3**	6545	11224 a	7723 b	**8497.3**
Seed rate (R)																
20 kg/ha R1	139	166 a	122	**142**	8	16 a	13	**12**	3964 c	3642	4649	**4085**	5352	7510 c	6653	**6505**
30 kg/ha R2	131	154 ab	119	**135**	7	11 b	11	**10**	4582 ab	4090	4678	**4450**	6766	8442 bc	7106	**7438**
40 kg/ha R3	134	142 bc	132	**136**	8	10 b	12	**10**	4291 bc	4202	4997	**4496.7**	6436	9461 ab	7108	**7668.3**
50 kg/ha R4	120	130 c	112	**121**	6	10 b	11	**9**	4563 ab	3906	4680	**4383**	6853	9559 a	7927	**8119**

Treatments	# Seeds/panicle								Grain Yield (kg/ha)				Dry straw (kg/ha)			
	Filled				Unfilled											
Date of seeding (D)	05/06	06/07	07/08	Mean	05/06	06/07	07/08	Mean	05/06	06/07	07/08	Mean	05/06	06/07	07/08	Mena
60 kg/ha R5	120	134 bc	112	**122**	**6**	12 ab	7	**8**	5015 a	4042	4824	**4627**	7573	10278 a	7660	**8503.7**
Date of	-	-	-		-	-	-		-	-	-		-	2131	86	
seeding (D)	-	23.8	-		-	4.1	-		566	-	-		1350	10.91	-	
Seed Rate ®	-	-	-		-	-	-		-	-	-		-	-	-	
D x R	17	16.9	15		40	36.4	54		13	11.2	11		21	12.4	15	
cv%																

Mean followed by same letter in column are not significantly different at P< 0.05

Dry straw weight

Dry straw weight did not show consistent result among seeding dates. But increasing trend of straw weight was recorded among seed rates. Dry straw wt. was higher in the 2nd year increasing trend was recorded with seed dates. Higher seed rate same more straw yield than lower seed rate. However, 60 kg/ha seed rate same higher straw yield than others in all the years. There was no significant interaction between different seed rates & seeding dates on the gall formation due to *Meloidogyne graminicola* (Table 4).

Table 4. Effect of date of seeding with respect to different seed rate on the gall formation due to *Meloidogyne graminicola* in rice field at Khumaltar.

Date of seeding	Gall Index (0-10)				
	Seed Rate (kg/ha)				
	20	**30**	**40**	**50**	**60**
16 May	5.19a	4.60a	4.81a	3.92a	5.07a
26 May	4.43a	4.74a	2.31a	2.90a	4.3a
05 June	4.27a	2.79a	2.62a	5.61a	4.0a
CV (%)	14.60	14.77	27.9	22.4	23.33
LSD (P< 0.05)	1.53	2.10	2.74	1.98	1.35

Mean followed by same letter are not significantly different at P< 0.05 by Duncan's Multiple Range Test (DMRT).

Conclusion

All categories of grass, sedge and broadleaf weeds were recorded in the experimental field. The number of species differed over time. Among different species *A conyzoides* and *E colona* were the major weeds. The number of *E colona* decreased over years. But *A conyzoides* increased over years showing weed shift due to rice culture. The total number of weed was higher in low seed rate (20 kg/ha) and second seeding date (26 May). There was no significant interaction between different seed rates and seeding dates and gall formation due to *Meloidogyne graminicola* (Sharma *et al.*2008). The present study showed that rice seeding can be done in mid May with seed rates 30–50 kg/ha. However, varietals performance to seed rates, weed species and environmental interaction were the researchable issues under diverse situations. Because most of the rice varieties used in the direct seeding are selected under transplanting condition.

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