

## Performance and Competitive Ability of Rice Cultivars to Weeds Under Direct Seeded Environment

Jagat Devi Ranjit and Rungsit Suwanketnikom

---

### ABSTRACT

Eleven rice cultivars having different plant heights and grain types were evaluated for their performance and competitive ability against weeds under direct dry seeded environment in lowland field in Agronomy farm, Khumaltar, Nepal. The cultivars were tested under uncontrolled weed growth, hand weeding two at 25 and 45 days after sowing and rice straw mulch @ 4t/ha. Common weeds were *Cyperus difformis*, *C. iria*, *Fimbristylis littoralis*, *Echinochloa colona*, *E. crusgalli*, *Paspalum distichum*, *Commelina diffusa*, *Monochoria vaginalis*, *Polygonum sp.*, *Dopatrium junceum*, *Lindernia sp.*, and *Eclipta prostrata*. Narrowleaf weeds were the dominant species. Straw mulch suppressed 100 percent of narrowleaf weeds compared with unweeded (control) at 4 weeks after rice sowing (WAS) but the number of these weeds increased in the later stage. Dry narrowleaf weed biomass at 8 WAS was significantly less in handweeding compared to mulch and unweeded control. Two cultivars namely Pokhreli masino and NR10274-10-2-1-1 gave comparable yield in handweeding and unweeded control showing their competitiveness to weeds. These might be due to these two cultivars are taller than the others. Furthermore, Pokhreli masino has the highest leaf area index.

**Key words:** rice cultivars, weeds, direct seeding, mulch, competitive ability

### INTRODUCTION

Weeds are important biotic factors that reduce the crop yield. With the introduction of modern crop varieties, the use of inputs has been increased getting a favorable environment to many pests. Most of the modern cultivars of rice (*Oryza sativa* L.) have less ability to compete with weeds and poor adaptation ability to weeds. Due to high weed competition, the rice growers in many parts of the world became more attractive towards the herbicides. Nepal is not separated with this problem. In much intensive rice growing areas, herbicide usage is increasing over time. Use of herbicide alone is not a perfect solution to eliminate the weed

problem. Hence, the need of environmentally sound and economically feasible alternative weed management practice has been realizing by the researchers and growers.

Competitive ability of crops can be expressed two ways first is the ability of the crop to compete with weeds reducing weed seed and biomass production. The second possibility is having crops tolerate competition from weeds while maintaining high yields. Initial biomass, crop growth rate, leaf area index, and biomass at tillering of *Oryza sativa* plants were associated with their competitiveness against weeds, whereas relative growth rate, net assimilation rate and tillering capacity of the plant were not. Biomass at

tillering was the best predictor of modern cultivars competitiveness against weeds (Ni, *et al.*, 2000). Cultivars of rice vary in their ability to compete with weeds. The modern high yielding rice cultivars are generally less competitive against weeds than the traditional cultivars. Some researchers have mentioned plant height as highly correlated with weed competitive ability of rice (Jennings and Jesus, 1968). The tall cultivars are generally known to be more competitive with weeds than the shorter, modern cultivars (Moody, 1979; Seavers and Wright, 1999). The minimum plant height needed to adequately suppress weeds was approximately 100 to 115 cm (Garrity, *et al.*, 1992). In one of the studies (Jennings and Aquino, 1968), tillering capacity and leaf area index (LAI) are correlated with competitive ability of rice. Rice cultivars having long lax leaves are more competitive than those with short, erect leaves (Jennings and Jesus, 1968; Jennings and Aquino, 1968). It showed that a number of combination effects on the competitive ability of rice to weeds.

Short weeds and weeds with conical leaf area densities (LAD's) were weakly competitive, regardless of other traits. For other weed types, interference with rice was positively related to maximum height, LAD skewness and more planophile leaves. All three traits were critical determinants of weed interference but no single morphological trait guaranteed competitiveness. All else being equal, a weed with highly skewed LAD's produced the most seed dry weight. Planophile leaves were particularly beneficial for short weeds giving other five times more seed dry weight than erectophile leaves (Caton, *et al.*, 2001).

Significant variation was observed in cultivar performance and also in the suppression of the grassy weed in one of the studies conducted by Ransinghe and Crabtree (1999) in Sri Lanka. Among the 24 rice cultivars tested for allelopathic effect on *E. crusgalli* few cultivars like Woo Co Chin Yu, AC 1423, Musashikogane, Taichung native 1, Takanenishiki, Tang Gan, Sakna 2, YH-

1 and Kouketsumuchi reduced more than 35 % shoot height of barnyardgrass after 8 weeks of direct dry seeding. Not only the shoot but root growth of barnyardgrass was also reduced from 70 to 80 percent in few traditional Korean cultivars (Kim, *et al.*, 2000; Kim and Shin, 1998). Various research teams have identified several hundred rice accessions which show indications of allelopathic compounds 60 of them showing allelopathic activity against one or more weeds (Olofsdotter *et al.*, 1995).

Research on screening the crop cultivars has been lacking under the weed competition environment in direct dry seeding in Nepal. Little focus has been made in the development of competitive crop cultivars for weed management. In most of the research system, rice cultivars are selected in the weed free situation resulting in cultivars that are less competitive against weeds compared to traditional ones. With identification of competitive rice cultivars, breeding programmes could be benefited for transferring the genes into other cultivars to enhance their weed suppressing ability thereby, minimising the reliance on herbicide use. In one study rice cultivars with coarse and fine grain yielded promising grain in direct dry seeded condition planted by Chinese Seed Drill (Ranjit, 1999). However, Fuji (1992) has reported Nepal no. 8 rice cultivar having allelopathic potential on *Lactuca sativa*.

The objective of this study was to evaluate the performance and competitive ability of eleven rice cultivars in direct dry seeding environment with different weed management system.

## MATERIALS AND METHODS

This study was initiated in the lowland field in Agronomy farm, Khumaltar, Nepal in a strip plot design replicated three times. The plot size was 2m × 3m with 20 cm row-to-row spacing. Line sowing was done. The main plot comprises the rice cultivars and sub plot comprises the weed

management levels. Soil test was done in the Soil Science Division, Khumaltar. The soil texture of the experimental field is silty with pH ranged from 5.5 to 6.0. The percent nitrogen ranged from 0.092 to 0.160. Phosphorus and potassium ranged from 88 to 111 kg/ha and 110 to 199 kg/ha respectively. The organic matter in the field ranged from 1.6 to 3.35 percent. Nitrogen, potassium and organic matter were in the medium range while phosphorus was in the high range. The cropping system of the experimental plot was Rice-Wheat. The weed history of the experimental plot was dominated by *Commelina diffusa*, *Cyperus iria*, *Cyperus* spp., and *Echinochloa* spp. Seed rate used was 90 kg/ha and chemical fertilizer was applied at the rate of 100:30:30 NPK kg/ha. Nitrogen was applied in a split dose. First half dose of nitrogen was applied as a basal during rice planting. And the second half dose of nitrogen was applied during top dressing after 6 weeks of rice sowing. Hand weeding were done at 25 and 45 days after seeding. Dry seed of rice was sown after 2 ploughing and 2 harrowing the field. Planting was done in second to third week of June and harvesting in fourth week of October to first week of November. Chopped rice straw mulch @ 4 t/ha was applied one day after rice seeding and left until harvest. Weed counts were done from 0.50m<sup>2</sup> quadrat at 4 & 8 weeks of rice planting. Weed biomass per 0.50 m<sup>2</sup> was recorded after cutting the root, of weeds at 8 WAS. Weeds were dried in oven at 80°C for 72 hrs. Leaf Area Index was recorded at tillering stage of rice in the field (non-destructive) with the AccuPAR Light Interception Device. Root length and biomass were recorded during the panicle initiation stage of rice. Roots were dried in the oven at 80°C for 72 hrs. LAI, Root length and root biomass was recorded during 2002/03. The treatments was as in Table 4. The mean of maximum and minimum temperature during the crop season ranged from 27.80°C and 19.63°C in June respectively and 26.08°C and 13.89°C in October respectively. Total rainfall recorded was 934.13 mm from June

to October.

The parentage, origin and the yield components of the tested cultivars under transplanting environment are presented in Table-1 (Shrestha & K C., 1980; Annual reports 1998/1999, 2000/2001). Among them Pokhrela Masino is a local cultivar. Khumal-4 is the popular variety in the mid-hill. NR10291-6-1 (Manjushree) is the recently released cultivar. Taichung - 176 is another popular variety especially in Kathmandu valley for its good quality for the beaten rice used for the snacks. Pokhrela masino, Khumal-4, Khumal-6, NR 10274-10-2-1, NR10276-9-3-3-3-2, NR20285-29-3-1 and NR10286-3-2-2 are the tall, Taichung -176 is intermediate and NR10291-6-1, NR10353-8-2-1 and NR10375-20-1-2 are semi-dwarf among the tested cultivars (Table 1).

## RESULTS AND DISCUSSION

The highest Leaf Area Index was recorded in the local cultivar Pokhrela masino followed by second and third highest in Khumal-6 and NR10276-9-3-3-3-2, NR10286-3-2-2 in 2002/03 (Table 2). Leaf area index was reported to be correlated with competitive ability of rice (Jennings and Aquino, 1968, Ni, *et al.*, 2000). The most important traits that determines competitive ability of *O. sativa* cultivars is relative growth rate of leaves early in the season (Kropff *et al.*, 1993; Rajan *et al.*, 1995). It has been reported by Okafor (1976) that an increase in both the LAI of rice and the dry weight of purple nutsedge resulted in increased competition for light and consequently in Light Transmission Ratio (LTR).

### Effect of cultivar and weed management on weeds

The types of weeds in the experimental field are given in Table 3. Among them narrow leaf weeds were more compared to broadleaf dicot and monocot. Narrow leaf weeds *C. diffomis*, *C. iria*, and *Fimbristylis littoralis* were the dominant

**Table 1** Parentage, origin and yield components of the tested cultivars under transplanting environment.

Cultivars	Year of release	Parentage	Origin	Plant height (cm)	Tillers /m <sup>2</sup>	1000 seed weight (g)	Yield (Kg/ha)	Straw weight (Kg/ha)	Remarks
Pokhrel masino		-	Nepal	147	205	21.9	7182	7052	Fine Tall
Taichung-176	1966	Tsai-yuan-Chung/Dee-geo-Woo-gen	Taiwan	114	253	29.7	7900	7104	Coarse Intermediate
Khumal-4	1987	IR28 / Pokhrel masino	Nepal	141	336	18.8	8368	7471	Fine Tall
Khumal-6	1999	IR13146-45-2-3/IR19735-5-2-3-2	Nepal	125	346	24.0	7800	7600	Fine Tall
NR 10274-10-2-1		NR10157-2b-12/ Himali	Nepal	148	304	23.0	7653	12421	Fine Tall
NR10276-9-3-3-3-2		Himali/ Khumal-4	Nepal	141	356	24.8	8226	7881	Fine Tall
NR10285-29-3-1		NR10078-100-3-3-1/ NR10163-2B-2	Nepal	138	348	20.0	8655	9578	Fine Tall
NR10286-3-2-2		NR10078-100-3-3-1/ NR10157-2B-12	Nepal	148	369	19.0	8317	10486	Fine Tall
NR10291-6-1 (Manjushree)	2002	Fuji 102 / NR10157-2B-12	Nepal	97	398	23.8	10085	7948	Fine Semidwarf
NR10353-8-2-1		Jumli Marsi / IR36	Nepal	108	358	25.1	8254	8917	Fine Semidwarf
NR10375-20-1-2		Akiyudaka / Barkat	Nepal	100	317	27.9	7327	5125	Coarse Semidwarf

species. The number of weeds per 0.5m<sup>2</sup> at 4 & 8 weeks after rice sowing was not significantly different in rice cultivars in all 3 years except in 2000/2001 during 8 weeks after sowing, where both narrow leaf and broadleaf weeds were

significantly different. The narrow leaf weeds per 0.5m<sup>2</sup> ranged from 151 to 184 and 97 to 121 at 4 & 8 weeks after rice sowing respectively. The mean broadleaf weeds per 0.5m<sup>2</sup> ranged from 21 to 27 and 26 to 31 at 4 & 8 weeks after rice sowing

**Table 2** Leaf area index (LAI), root length and root biomass of the tested cultivars in direct seeding 2002.

Cultivars	LAI	Root length (cm)	Root biomass (gm)	
			Fresh	Dry
Pokhreli masino	1.520	21.38	72.91	18.07
Taichung-176	0.900	20.48	74.17	13.74
Khumal-4	1.387	22.22	101.78	22.65
Khumal-6	1.477	22.02	107.79	18.70
NR 10274-10-2-1	1.227	23.26	127.46	27.52
NR10276-9-3-3-3-2	1.400	20.7	145.72	25.68
NR10285-29-3-1	1.377	21.8	126.10	19.36
NR10286-3-2-2	1.400	19.68	140.16	26.65
NR10291-6-1	1.040	20.38	101.25	21.59
NR10353-8-2-1	1.110	19.8	84.29	16.14
NR10375-20-1-2	0.867	22.46	162.94	23.07

**Table 3** Weed species in the experimental plot.

Narrow leaf	Family	Broadleaf	Family
<b>Grass</b>			
<i>Echinochloa colona</i>	Poaceae	<b>Monocot</b>	
<i>E. crusgalli</i>	Poaceae	<i>Commelina diffusa</i>	Commelinaceae
<i>Eluesine indica</i>	Poaceae	<i>Monochoria vaginalis</i>	Pontederaceae
<i>Digitaria ascendens</i>	Poaceae	<i>Murdania sp.</i>	Commelinaceae
<i>Paspalum distichum</i>	Poaceae	<b>Dicot</b>	
<i>Panicum meleacia</i>	Poaceae	<i>Ageratum conyzoides</i>	Compositae
<b>Sedge</b>		<i>Alternanthera philoxeroides</i>	Amaranthaceae
<i>Cyperus difformis</i>	Cyperaceae	<i>Ammania baccifera</i>	Lythraceae
<i>Cyperus iria</i>	Cyperaceae	<i>Dopatrium junceum</i>	Scrophulariaceae
<i>Cyperus sanguinolentus</i>	Cyperaceae	<i>Eclipta prostrata</i>	Compositae
<i>Fimbristylis littoralis</i>	Cyperaceae	<i>Lindernia procumbens</i>	Scrophulariaceae
<i>Scirpus joncooides</i>	Cyperaceae	<i>Rorripa indica</i>	Cruciferae
<i>Scirpus sps</i>	Cyperaceae	<i>Rotala rotundifolia</i>	Lythraceae
<i>Eriocaulan sp.</i>	Eriocaulaceae	<i>Polygonum sps.</i>	Polygonaceae

respectively. The weed density did not show any weed suppression ability of rice cultivars in both counts at 4 & 8 WAS (Table 4 & 5).

But there was a significant effect of weed management in all 3 years. Narrowleaf weeds were significantly different in both the counts (4 & 8 WAS) in all 3 years except in year 2002/03 at 4 WAS. Straw mulch showed promising effect that significantly suppressed the narrowleaf weeds at 4 WAS except the year 2002/2003. More than 100 % narrowleaf weeds was suppressed by the straw mulch at 4 WAS. But broadleaf weeds were not suppressed as much as compared to narrowleaf weeds due to mulch. Hand weeding treatment significantly suppressed both weeds at 8 WAS. The impact of mulching was quite impressive in suppressing the weed at 4 WAS as compared to 8 WAS. It showed that mulching has promising effect in suppressing many weeds for first four weeks of rice sowing.

No significant narrowleaf weed biomass was recorded in different cultivars except in year 2002/03. Weed weights were nearly in the same range. Significantly less fresh narrowleaf weed biomass (599 gm/0.5m<sup>2</sup>) was recorded in cultivar Pokharli masino with the highest (1075 gm/0.5m<sup>2</sup>) in NR 10375-20-1-2. Due to inconsistent result, it is difficult to interpret the cultivar effect on weed biomass (Table 6). Different allelochemicals have been identified in rice straw and decomposed straw (Kuwaitzuka and Shindo, 1973; Chou and Lin., 1976). But their production is affected by the biotic and abiotic factors. Variation in allelochemical production will occur in response to temperature, light, and soil conditions, microflora, plant age and nutrition status and herbicide treatment (Duke, 1985; Hoagland and Williams, 1985).

Significantly different weed biomass was found due to weed management except broadleaf weeds biomass in 2000/01. Hand weeding reduced weed biomass more than 100 percent compared to mulch and unweeded control. However, the straw

mulch did not reduce the weed biomass but gave the comparable result as unweeded control (Table 6). It might be the reason that the straw mulch has suppressed the initial flush of weed upto 4WAS but could not suppress the weeds that emerged in the later stage.

### Interaction effect

Significantly different interaction effect was found in narrowleaf at 4 WAS, narrowleaf fresh and dry biomass. In all the cultivars, the initial narrowleaf weed per 0.5m<sup>2</sup> at 4 WAS was less compared to unweeded control. The number of weeds ranged from 73 to 96 per 0.5m<sup>2</sup> in mulch as compared to 184 to 225 per 0.5m<sup>2</sup> in unweeded control. More than 100% narrowleaf weed was suppressed by mulch at 4 WAS in all the cultivars (Table 7). But it needs further study on the allelopathic effect of rice straw mulch on weeds. There have been many rice germplasms that were identified to have allelopathic potential to many weeds such as *E. crusgalli*, *C. difformis*, *C. iria* (preliminary results) *Lactuca sativa* (Fuji, 1992; Hassan *et al.*, 1994; Olofsdotter *et al.*, 1999; Yu *et al.*, 2001).

Regarding the weed management handweeding significantly reduced the narrowleaf weed biomass in all the cultivars. Although the weed biomass is slightly less in the mulch treatment compared to unweeded control, but still many times higher than in handweeding, in all the cultivars showing its ability to suppress weeds until 3-4 weeks of seeding (Table 7). The management practices showed that handweeding is the most effective weed control method for direct dry seeded rice. Mulch is also promising until the first few weeks but it might need additional cultural or chemical control to suppress the weeds after 3-4 weeks of rice sowing.

**Table 4** Weed density at 4 weeks after sowing dry rice seeds under different weed management system.

Treatment	Weed density																																																																																																																																																																																																																																																					
	2000/2001			2001/2002			2002/2003			Mean																																																																																																																																																																																																																																												
	Narrowleaf	Broadleaf		Narrowleaf	Broadleaf		Narrowleaf	Broadleaf		Narrowleaf	Broadleaf																																																																																																																																																																																																																																											
	(Plants/0.5m <sup>2</sup> )																																																																																																																																																																																																																																																					
Cultivar													Pokhrel Masino	170	13		224	10		92	51		162	24		Taichung-176	179	9		250	9		87	44		172	21		Khumal-4	148	8		217	11		89	50		151	23		Khumal-6	186	10		255	10		103	55		181	25		NR 10274-10-2-1-1	156	8		255	11		93	51		168	23		NR 10276-9-3-3-2	172	13		242	10		106	60		173	27		NR 10285-29-3-1	133	10		256	11		102	59		163	27		NR 10286-3-2-2	166	9		227	11		97	59		163	26		NR 10291-6-1 (Manjushree)	161	11		244	13		99	57		168	27		NR 10353-8-2-1	131	10		236	10		100	57		156	26		NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS										
Pokhrel Masino	170	13		224	10		92	51		162	24		Taichung-176	179	9		250	9		87	44		172	21		Khumal-4	148	8		217	11		89	50		151	23		Khumal-6	186	10		255	10		103	55		181	25		NR 10274-10-2-1-1	156	8		255	11		93	51		168	23		NR 10276-9-3-3-2	172	13		242	10		106	60		173	27		NR 10285-29-3-1	133	10		256	11		102	59		163	27		NR 10286-3-2-2	166	9		227	11		97	59		163	26		NR 10291-6-1 (Manjushree)	161	11		244	13		99	57		168	27		NR 10353-8-2-1	131	10		236	10		100	57		156	26		NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS														
Taichung-176	179	9		250	9		87	44		172	21		Khumal-4	148	8		217	11		89	50		151	23		Khumal-6	186	10		255	10		103	55		181	25		NR 10274-10-2-1-1	156	8		255	11		93	51		168	23		NR 10276-9-3-3-2	172	13		242	10		106	60		173	27		NR 10285-29-3-1	133	10		256	11		102	59		163	27		NR 10286-3-2-2	166	9		227	11		97	59		163	26		NR 10291-6-1 (Manjushree)	161	11		244	13		99	57		168	27		NR 10353-8-2-1	131	10		236	10		100	57		156	26		NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																											
Khumal-4	148	8		217	11		89	50		151	23		Khumal-6	186	10		255	10		103	55		181	25		NR 10274-10-2-1-1	156	8		255	11		93	51		168	23		NR 10276-9-3-3-2	172	13		242	10		106	60		173	27		NR 10285-29-3-1	133	10		256	11		102	59		163	27		NR 10286-3-2-2	166	9		227	11		97	59		163	26		NR 10291-6-1 (Manjushree)	161	11		244	13		99	57		168	27		NR 10353-8-2-1	131	10		236	10		100	57		156	26		NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																								
Khumal-6	186	10		255	10		103	55		181	25		NR 10274-10-2-1-1	156	8		255	11		93	51		168	23		NR 10276-9-3-3-2	172	13		242	10		106	60		173	27		NR 10285-29-3-1	133	10		256	11		102	59		163	27		NR 10286-3-2-2	166	9		227	11		97	59		163	26		NR 10291-6-1 (Manjushree)	161	11		244	13		99	57		168	27		NR 10353-8-2-1	131	10		236	10		100	57		156	26		NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																					
NR 10274-10-2-1-1	156	8		255	11		93	51		168	23		NR 10276-9-3-3-2	172	13		242	10		106	60		173	27		NR 10285-29-3-1	133	10		256	11		102	59		163	27		NR 10286-3-2-2	166	9		227	11		97	59		163	26		NR 10291-6-1 (Manjushree)	161	11		244	13		99	57		168	27		NR 10353-8-2-1	131	10		236	10		100	57		156	26		NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																		
NR 10276-9-3-3-2	172	13		242	10		106	60		173	27		NR 10285-29-3-1	133	10		256	11		102	59		163	27		NR 10286-3-2-2	166	9		227	11		97	59		163	26		NR 10291-6-1 (Manjushree)	161	11		244	13		99	57		168	27		NR 10353-8-2-1	131	10		236	10		100	57		156	26		NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																															
NR 10285-29-3-1	133	10		256	11		102	59		163	27		NR 10286-3-2-2	166	9		227	11		97	59		163	26		NR 10291-6-1 (Manjushree)	161	11		244	13		99	57		168	27		NR 10353-8-2-1	131	10		236	10		100	57		156	26		NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																												
NR 10286-3-2-2	166	9		227	11		97	59		163	26		NR 10291-6-1 (Manjushree)	161	11		244	13		99	57		168	27		NR 10353-8-2-1	131	10		236	10		100	57		156	26		NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																																									
NR 10291-6-1 (Manjushree)	161	11		244	13		99	57		168	27		NR 10353-8-2-1	131	10		236	10		100	57		156	26		NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																																																						
NR 10353-8-2-1	131	10		236	10		100	57		156	26		NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																																																																			
NR 10375-20-1-2	180	10		250	9		92	52		174	24		Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																																																																																
Weed management													Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																																																																																													
Straw mulch @ 4 t/ha	45 <sup>b</sup>	9		120 <sup>b</sup>	13 <sup>a</sup>		92	64 <sup>a</sup>		86 <sup>b</sup>	28 <sup>a</sup>		Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																																																																																																										
Handweeding	224 <sup>a</sup>	11		307 <sup>a</sup>	8 <sup>b</sup>		93	34 <sup>b</sup>		208 <sup>a</sup>	17 <sup>b</sup>		Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																																																																																																																							
Control (unweeded)	217 <sup>a</sup>	11		298 <sup>a</sup>	11 <sup>ab</sup>		104	64 <sup>a</sup>		206 <sup>a</sup>	29 <sup>a</sup>		Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																																																																																																																																				
Cultivar	NS	NS		NS	NS		NS	NS		NS	NS		Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																																																																																																																																																	
Weed management	**	NS		**	*		NS	**		**	**		Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																																																																																																																																																														
Cultivar x weed management	NS	NS		NS	NS		NS	NS		*	NS																																																																																																																																																																																																																																											

a) Means within the same column and grouping followed by the same letter are not different according to Fisher's protected test P=0.05.

b) Treatments effects and interactions were significant at 5% (\*), significant at 1% (\*\*\*) or nonsignificant (NS)

**Table 5** Weed density at 8 weeks after sowing dry rice seeds under different weed management system.

Treatment	Weed density (Plants/0.5m <sup>2</sup> )									
	2000/2001		2001/2002		2002/2003		Mean			
	Narrowleaf	Broadleaf	Narrowleaf	Broadleaf	Narrowleaf	Broadleaf	Narrowleaf	Broadleaf	Narrowleaf	Broadleaf
Cultivar										
Pokhrel masino	95 <sup>abcd</sup>	18 <sup>bc</sup>	99	12	98	48	97	26		
Taichung-176	88 <sup>cd</sup>	16 <sup>c</sup>	105	12	165	59	119	29		
Khumal-4	89 <sup>cd</sup>	19 <sup>bc</sup>	103	14	102	43	98	26		
Khumal-6	102 <sup>abc</sup>	18 <sup>bc</sup>	111	16	148	48	121	27		
NR 10274-10-2-1-1	95 <sup>abcd</sup>	21 <sup>ab</sup>	103	14	113	49	104	28		
NR 10276-9-3-3-2	89 <sup>bcd</sup>	25 <sup>a</sup>	108	14	110	48	103	29		
NR 10285-29-3-1	94 <sup>abcd</sup>	20 <sup>bc</sup>	109	13	94	46	99	26		
NR 10286-3-2-2	107 <sup>a</sup>	18 <sup>bc</sup>	106	13	109	54	107	28		
NR 10291-6-1 (Manjushree)	83 <sup>d</sup>	17 <sup>bc</sup>	105	13	112	43	100	24		
NR 10353-8-2-1	88 <sup>d</sup>	20 <sup>abc</sup>	104	13	120	59	104	31		
NR 10375-20-1-2	104 <sup>ab</sup>	21 <sup>ab</sup>	102	14	147	58	117	31		
Weed management										
Straw mulch @ 4 t/ha	88 <sup>b</sup>	15 <sup>b</sup>	106 <sup>b</sup>	12 <sup>b</sup>	155 <sup>a</sup>	44 <sup>b</sup>	116 <sup>a</sup>	24		
Handweeding	86 <sup>b</sup>	8 <sup>b</sup>	82 <sup>c</sup>	4 <sup>c</sup>	70 <sup>b</sup>	71 <sup>a</sup>	79 <sup>b</sup>	28		
Control (unweeded)	108 <sup>a</sup>	35 <sup>a</sup>	127 <sup>a</sup>	24 <sup>a</sup>	135 <sup>a</sup>	36 <sup>b</sup>	123 <sup>a</sup>	32		
Cultivar	*	*	NS	NS	NS	NS	NS	NS	NS	NS
Weed management	**	**	**	**	**	**	**	**	**	**
Cultivar x weed management	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

a) Means within the same column and grouping followed by the same letter are not different according to Fisher's protected test P=0.05.

b) Treatments effects and interactions were significant at 5% (\*), significant at 1% (\*\*) or nonsignificant (NS)

**Table 6** Weed biomass at 8 weeks after sowing dry rice seed under different weed management system.

Treatments	Weed biomass (g/0.5m <sup>2</sup> )																
	2000/2001				2001/2002				2002/2003				Mean				
	Narrowleaf		Broadleaf		Narrowleaf		Broadleaf		Narrowleaf		Broadleaf		Narrowleaf		Broadleaf		
	Fresh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry	
Cultivar																	
Pokhrelli Masino	603.7	86.9	55.5	4.6	1196.0	131.0	67.2	6.0	599.6 <sup>c</sup>	89.1 <sup>c</sup>	209.8	21.8	799.8 <sup>c</sup>	102.3 <sup>cd</sup>	110.83	10.78	
Taichung-176	670.2	107.6	26.5	2.1	1347.0	155.3	70.6	6.8	1023.8 <sup>a</sup>	149.4 <sup>a</sup>	159.7	16.7	1013.5 <sup>ab</sup>	137.4 <sup>a</sup>	85.59	8.49	
Khumal-4	730.8	100.9	70.5	7.6	1272.6	141.4	74.0	7.6	640.7 <sup>de</sup>	94.4 <sup>c</sup>	191.6	15.9	881.4 <sup>bc</sup>	112.2 <sup>cd</sup>	112.04	10.37	
Khumal-6	668.9	100.1	40.1	3.5	1368.8	142.6	57.6	4.9	818.1 <sup>bc</sup>	112.2 <sup>bc</sup>	213.5	18.6	951.9 <sup>abc</sup>	118.3 <sup>abcd</sup>	103.71	8.99	
NR 10274-10-2-1-1	635.3	95.3	32.5	2.9	1485.9	169.8	48.4	4.6	638.5 <sup>de</sup>	89.0 <sup>c</sup>	186.8	15.5	919.9 <sup>bc</sup>	118.1 <sup>bed</sup>	89.25	7.65	
NR 10276-9-3-3-2	627.3	103.4	46.4	3.8	1422.2	161.7	76.6	7.5	656.6 <sup>cde</sup>	85.6 <sup>c</sup>	164.1	12.6	902.0 <sup>bc</sup>	116.9 <sup>bed</sup>	95.69	7.95	
NR 10285-29-3-1	542.6	81.1	28.7	2.7	1269.6	133.3	82.1	8.2	648.2 <sup>cde</sup>	90.1 <sup>c</sup>	203.2	13.9	820.1 <sup>c</sup>	101.5 <sup>d</sup>	104.69	8.27	
NR 10286-3-2-2	538.9	81.9	49.1	5.1	1276.2	132.7	68.3	6.1	627.6 <sup>de</sup>	86.6 <sup>c</sup>	275.8	32.0	814.2 <sup>c</sup>	100.4 <sup>d</sup>	131.08	14.39	
NR 10291-6-1 (Manjushree)	667.4	94.4	40.2	3.2	1197.8	128.2	54.9	4.9	944.1 <sup>ab</sup>	141.7 <sup>ab</sup>	245.9	23.7	936.5 <sup>bc</sup>	121.5 <sup>abc</sup>	113.67	10.6	
NR 10353-8-2-1	634.0	92.1	21.5	1.8	1264.3	149.0	72.6	6.7	800.9 <sup>bed</sup>	101.6 <sup>c</sup>	223.5	18.0	899.8 <sup>bc</sup>	114.2 <sup>cd</sup>	105.84	8.86	
NR 10375-20-1-2	799.6	96.2	48.7	4.5	1445.2	158.6	79.2	7.6	1075.1 <sup>a</sup>	147.8 <sup>a</sup>	184.6	17.2	1106.6 <sup>a</sup>	134.2 <sup>ab</sup>	104.08	9.79	
Weed management																	
Straw mulch @ 4 t/ha	836.6 <sup>a</sup>	144.5 <sup>a</sup>	71.5	6.8	1781.3 <sup>a</sup>	246.1 <sup>a</sup>	135.4 <sup>a</sup>	12.8 <sup>a</sup>	919.6 <sup>b</sup>	128.6 <sup>b</sup>	274.0 <sup>a</sup>	25.9 <sup>a</sup>	1179.2 <sup>b</sup>	173.1 <sup>a</sup>	160.29 <sup>a</sup>	15.09 <sup>a</sup>	
Handweeding	211.2 <sup>b</sup>	29.8 <sup>b</sup>	8.2	0.7	181.6 <sup>b</sup>	19.2 <sup>c</sup>	21.1 <sup>c</sup>	1.9 <sup>b</sup>	211.16 <sup>c</sup>	24.3 <sup>c</sup>	54.4 <sup>b</sup>	3.5 <sup>b</sup>	201.3 <sup>c</sup>	24.4 <sup>c</sup>	27.88 <sup>b</sup>	2.01 <sup>b</sup>	
Control (unweeded)	893.7 <sup>a</sup>	109.4 <sup>a</sup>	45.4	4.1	2004.1 <sup>a</sup>	172.1 <sup>b</sup>	48.5 <sup>b</sup>	4.7 <sup>b</sup>	1180.0 <sup>a</sup>	170.9 <sup>a</sup>	287.5 <sup>a</sup>	26.8 <sup>a</sup>	1359.3 <sup>a</sup>	150.8 <sup>b</sup>	127.26 <sup>a</sup>	11.85 <sup>a</sup>	
Cultivar	NS	NS	NS	NS	NS	NS	NS	NS	**	**	NS	NS	*	**	NS	NS	
Weed management	**	**	NS	NS	**	**	**	**	**	**	**	**	**	**	**	**	**
Cultivar x weed management	NS	NS	NS	NS	NS	NS	NS	NS	*	**	NS	NS	**	**	NS	NS	

a) Means within the same column and grouping followed by the same letter are not different according to Fisher's protected test P=0.05.

b) Treatments effects and interactions were significant at 5% (\*), significant at 1% (\*\*) or nonsignificant (NS)

**Table 7** Interaction of mean grass weed at 4 weeks and mean weed biomass at 8 weeks after sowing dry seeded rice under different weed management system.

Cultivar	Mean narrowleaf weed (plants/0.5m <sup>2</sup> )						Weed management Mean narrowleaf fresh biomass (g/0.5m <sup>2</sup> )						Mean narrowleaf dry biomass (g/m <sup>2</sup> )					
	Control (unweeded)		Hand weeding		Mulch		Control (unweeded)		Hand weeding		Mulch		Control (unweeded)		Hand weeding		Mulch	
Pokhrel masino	184	gh	213	a-f	90	i	1180	e-i	192.9	j	1026	i	126.6	jk	22.7	l	157.6	f-i
Taichung-176	221	a-d	223	abc	73	i	1540	ab	195.6	j	1305	def	184.7	bcd	22.1	l	205.4	ab
Khumal-4	181	h	193	e-h	80	i	1355	b-e	181.2	j	1108	hi	152.3	f-i	22.1	l	162.4	d-h
Khumal-6	219	a-e	235	a	90	i	1440	bcd	207.7	j	1208	e-i	161.3	e-h	27.2	l	166.5	c-f
NR 10274-10-2-1-1	219	a-e	205	b-h	80	i	1349	cde	171.6	j	1239	e-h	146.9	f-j	22.1	l	185.1	bcd
NR 10276-9-3-3-2	217	a-e	218	a-e	85	i	1293	d-g	226.5	j	1186	e-i	140.2	hij	27.2	l	183.5	b-e
NR 10285-29-3-1	208	b-g	198	c-h	85	i	1224	e-h	200.4	j	1036	i	137.9	ij	23.2	l	143.4	g-j
NR 10286-3-2-2	186	gh	208	b-g	96	i	1114	ghi	203.3	j	1125	f-i	109.4	k	24.0	l	167.7	c-f
NR 10291-6-1	220	a-d	198	d-h	87	i	1531	abc	215.4	j	1063	hi	185.5	bc	26.1	l	152.7	f-i
NR 10353-8-2-1	189	fgh	191	gfh	87	i	1300	def	226.1	j	1173	e-i	147.6	f-j	29.2	l	166.0	c-g
NR 10375-20-1-2	225	ab	208	b-g	89	i	1626	a	193.6	j	1501	abc	166.2	c-f	22.8	l	213.7	a
Cultivar x management			*						**						**			

a) Means within the same column and grouping followed by the same letter are not different according to Fisher's protected test P=0.05.

b) Treatments effects and interactions were significant at 5% (\*), significant at 1% (\*\*), or nonsignificant (NS)

## Effect of treatments on yield components

### Plant height

Plant height ranged from 90 cm to 125 cm. Pokhrelhi masino (125 cm) was the tallest among the tested cultivars. This cultivar was at par with Khumal-4, NR 10274-10-2-1-1 and NR 10286-29-3-1. Cultivars NR10291-8-2-1, NR10253-8-2-1 and NR 10375-20-1-2 are among the semidwarf having less than 100 cm. The rest of the cultivars were intermediate. There was no significant difference in plant height among different weed management except in 2000/01 (Table 8). Interaction between cultivars and weed management was significantly different in all 3 years. Cultivars Khumal-4, Khumal-6, NR10274-10-2-1-1, NR10276-9-3-3-3-2 NR10285-29-3-1, NR10286-3-2-2 and NR10353-8-2-1 were slightly taller in unweeded control compared to handweeding and mulch. It might be due to competition for light (Table 12). Tall cultivars were more competitive compared to short plant types. Few cultivars in the present study also resemble with the work done by Jennings *et al.* (1968). It has been reported in barley that morphological traits, namely large length of the two first internodes, long main shoot in the tillering stage and a small leaf angle may be important traits in competition for light (Didon, 2002). Canopy had more powerful competition than that of middle-stalked-medium canopy and short-stalked-small-canopy (Xu, 2000). Rapid leaf area development of *O. sativa* plants in the early stage is beneficial for light competition and suppression of weed growth.

### Tillers per square meter

Significantly different tiller per square meter was recorded in both years (2000/01 and 2002/03). The highest tiller per square meter (266) was found in NR10353-8-2-1. Other cultivars such as Pokhrelhi masino, Khumal-4, Khumal-6, NR10285-29-3-1 and NR10286-3-2-2 produced more than 200 tillers per square meter. The rest of

other cultivars produced less than 200 tillers per square meter. Among the weed management, significantly higher tillers per square meter was recorded in handweeding than in mulch and unweeded control (Table 8). Interaction between the cultivars and weed management on tillers per square meter was significantly different in both years. All the cultivars produced higher tillers per square meter in handweeding compared to mulch and control. However, few cultivars such as Pokhrelhi masino, Khumal-4, NR10285-29-3-1, NR10286-3-2-2 and NR10291-6-1 produced slightly high tillers per square meter in control than in mulch (Table 11). Probably these cultivars could compete with weeds by producing higher number of tillers. Ni *et al.* (2000) has reported that biomass at tillering has direct effect on weed biomass.

### Thousand seed weight

Thousand seed weight was significantly different in all 3 years among the cultivars. The thousand seed weight was higher in Taichung 176 and NR 10375-20-1-2 with lowest in Khumal-4 and Khumal-6. Weed management did not effect on thousand seed weight (Table 8). The interaction of thousand seed weight was not significantly different (Table 10).

### Grain yield

Data pertaining to grain yield, straw weight and tillers per square meter are not included for the year 2001-02 because of poor germination due to continuous rain after rice sowing. Grain yield was significantly different among the rice cultivars and weed management in both years. The yield trend showed that the coarse grain type cultivars such as Taichung-176 and NR10375-20-1-2 yielded less than 3000 kg/ha compared to other fine cultivars. Significantly highest yield was recorded in NR 10276-9-3-3-3-2 (4784 kg/ha). Cultivars Pokhrelhi masino, Khumal-4 Khumal-6, NR 10285-29-3-1, NR 10286-3-2-2 yielded more

**Table 8** Yield components of direct dry seeded rice under different weed management system 2000/01-2002/03.

Treatment	Yield			Plant height			Tillers			1000 seed weight				
	2000/01	2002/03	Mean	2000/01	2001/02	2002/03	Mean	2000/01	2002/03	Mean	2000/01	2001/02	2002/03	Mean
	(kg/ha)			(cm.)			(tiller/m <sup>2</sup> )			(gm)				
<b>Cultivar</b>														
Pokhrel masino	3795 <sup>a</sup>	4899 <sup>abc</sup>	4347 <sup>ab</sup>	120.5 <sup>a</sup>	121.7 <sup>a</sup>	134.0 <sup>a</sup>	125.4 <sup>a</sup>	221 <sup>c</sup>	277 <sup>ab</sup>	249 <sup>ab</sup>	22.4 <sup>cd</sup>	23.0 <sup>cde</sup>	23.8 <sup>b</sup>	23.1 <sup>c</sup>
Taichung-176	2284 <sup>c</sup>	3174 <sup>de</sup>	2729 <sup>d</sup>	107.8 <sup>e</sup>	94.27 <sup>e</sup>	111.9 <sup>bcd</sup>	104.6 <sup>d</sup>	177 <sup>e</sup>	190 <sup>c</sup>	184 <sup>e</sup>	26.6 <sup>a</sup>	27.7 <sup>a</sup>	26.7 <sup>a</sup>	27.0 <sup>a</sup>
Khumal-4	3735 <sup>a</sup>	5348 <sup>ab</sup>	4542 <sup>ab</sup>	119.4 <sup>ab</sup>	123.2 <sup>a</sup>	128.6 <sup>a</sup>	123.8 <sup>ab</sup>	264 <sup>ab</sup>	213 <sup>bc</sup>	239 <sup>ab</sup>	19.3 <sup>f</sup>	20.3 <sup>g</sup>	19.4 <sup>f</sup>	19.7 <sup>e</sup>
Khumal-6	4122 <sup>a</sup>	4327 <sup>abcde</sup>	4224 <sup>ab</sup>	113.2 <sup>d</sup>	111.0 <sup>c</sup>	121.0 <sup>abc</sup>	115 <sup>c</sup>	287 <sup>a</sup>	182 <sup>c</sup>	235 <sup>abc</sup>	22.7 <sup>bcd</sup>	23.4 <sup>bcd</sup>	24.1 <sup>b</sup>	23.4 <sup>bc</sup>
NR 10274-10-2-1-1	3633 <sup>ab</sup>	3771 <sup>bcd</sup>	3702 <sup>bc</sup>	117.2 <sup>bc</sup>	121.1 <sup>a</sup>	131.7 <sup>a</sup>	123.3 <sup>ab</sup>	193 <sup>de</sup>	185 <sup>c</sup>	189 <sup>de</sup>	21.9 <sup>de</sup>	22.0 <sup>ef</sup>	21.5 <sup>de</sup>	21.8 <sup>d</sup>
NR 10276-9-3-3-2	4049 <sup>a</sup>	5519 <sup>a</sup>	4784 <sup>a</sup>	114.3 <sup>cd</sup>	106.0 <sup>d</sup>	124.6 <sup>ab</sup>	115 <sup>c</sup>	205 <sup>cd</sup>	187 <sup>c</sup>	196 <sup>cde</sup>	22.6 <sup>bcd</sup>	22.6 <sup>def</sup>	23.8 <sup>b</sup>	23.0 <sup>c</sup>
NR 10285-29-3-1	4120 <sup>a</sup>	4842 <sup>abc</sup>	4481 <sup>ab</sup>	115.7 <sup>cd</sup>	108.1 <sup>cd</sup>	130.4 <sup>a</sup>	118.1 <sup>bc</sup>	203 <sup>cd</sup>	216 <sup>bc</sup>	210 <sup>bcd</sup>	21.3 <sup>e</sup>	21.64 <sup>f</sup>	22.0 <sup>cd</sup>	21.6 <sup>d</sup>
NR 10286-3-2-2	4097 <sup>a</sup>	4695 <sup>abcd</sup>	4396 <sup>ab</sup>	120.5 <sup>a</sup>	115.4 <sup>b</sup>	127.6 <sup>a</sup>	122.2 <sup>ab</sup>	250 <sup>b</sup>	201 <sup>bc</sup>	226 <sup>bcd</sup>	18.4 <sup>f</sup>	20.3 <sup>g</sup>	20.0 <sup>ef</sup>	19.6 <sup>e</sup>
NR10291-6-1(Manjushree)	2823 <sup>bc</sup>	3543 <sup>cde</sup>	3183 <sup>cd</sup>	85.5 <sup>g</sup>	87.4 <sup>f</sup>	99.9 <sup>d</sup>	90.9 <sup>e</sup>	209 <sup>cd</sup>	146 <sup>c</sup>	178 <sup>e</sup>	23.6 <sup>b</sup>	24.4 <sup>b</sup>	24.0 <sup>b</sup>	24.0 <sup>b</sup>
NR 10353-8-2-1	4102 <sup>a</sup>	3601 <sup>cde</sup>	3852 <sup>bc</sup>	89.2 <sup>f</sup>	86.9 <sup>f</sup>	109.7 <sup>cd</sup>	94.9 <sup>e</sup>	205 <sup>cd</sup>	327 <sup>a</sup>	266 <sup>a</sup>	23.2 <sup>bc</sup>	23.9 <sup>bc</sup>	23.4 <sup>bc</sup>	23.5 <sup>bc</sup>
NR 10375-20-1-2	2199 <sup>c</sup>	2969 <sup>e</sup>	2584 <sup>d</sup>	91.5 <sup>f</sup>	89.1 <sup>f</sup>	109.6 <sup>cd</sup>	99.4 <sup>e</sup>	191 <sup>de</sup>	151 <sup>c</sup>	171 <sup>e</sup>	26.3 <sup>a</sup>	27.2 <sup>a</sup>	27.3 <sup>a</sup>	26.9 <sup>a</sup>
<b>Weed management</b>														
Straw mulch @ 4 t/ha	2972 <sup>b</sup>	3128 <sup>b</sup>	3050 <sup>b</sup>	109.8 <sup>b</sup>	105.5	121.8	112.0	210 <sup>b</sup>	179 <sup>b</sup>	194 <sup>b</sup>	22.6	23.0 <sup>a</sup>	23.1 <sup>b</sup>	22.9
Hand weeding	4920 <sup>a</sup>	5504 <sup>a</sup>	5213 <sup>a</sup>	103.9 <sup>c</sup>	106.3	121.8	110.3	233 <sup>a</sup>	277 <sup>a</sup>	255 <sup>a</sup>	22.7	23.7 <sup>b</sup>	23.5 <sup>a</sup>	23.2
Control (unweeded)	2733 <sup>b</sup>	4100 <sup>ab</sup>	3417 <sup>b</sup>	111.8 <sup>a</sup>	105.4	120.9	112.7	213 <sup>b</sup>	165 <sup>b</sup>	189 <sup>b</sup>	22.3	23.2 <sup>a</sup>	23.2 <sup>b</sup>	23.0
<b>Cultivar</b>	**	*	**	**	**	**	**	**	**	**	**	**	**	**
<b>Weed management</b>	**	*	**	**	NS	NS	NS	*	**	**	NS	**	*	NS
<b>Cultivar x management</b>	NS	*	**	**	**	*	*	**	**	**	NS	**	*	NS

a) Means within the same column and grouping followed by the same letter are not different according to Fisher's protected test P=0.05.  
 b) Treatments effects and interactions were significant at 5% (\*), significant at 1% (\*\*), or nonsignificant (NS)

**Table 8** Continued....

Treatment	Fresh straw weight			Dry straw weight		
	2000/01	2002/03	Mean	2000/01	2002/03	Mean
	(kg/ha)					
Cultivar						
Pokhrel masino	17783 <sup>a</sup>	21556 <sup>a</sup>	19669 <sup>a</sup>	5139 <sup>a</sup>	6981 <sup>a</sup>	6060 <sup>a</sup>
Taichung-176	8928 <sup>de</sup>	11556 <sup>cd</sup>	10242 <sup>cd</sup>	3433 <sup>cd</sup>	4410 <sup>bcd</sup>	3922 <sup>cde</sup>
Khumal-4	14989 <sup>ab</sup>	15333 <sup>bcd</sup>	15161 <sup>b</sup>	5533 <sup>a</sup>	4928 <sup>bcd</sup>	5231 <sup>ab</sup>
Khumal-6	14333 <sup>b</sup>	16444 <sup>abc</sup>	15389 <sup>b</sup>	5000 <sup>a</sup>	5930 <sup>ab</sup>	5465 <sup>ab</sup>
NR 10274-10-2-1-1	12467 <sup>bc</sup>	17444 <sup>ab</sup>	14956 <sup>b</sup>	4556 <sup>abc</sup>	5436 <sup>ab</sup>	4996 <sup>abc</sup>
NR 10276-9-3-3-3-2	13989 <sup>b</sup>	13111 <sup>bcd</sup>	13550 <sup>bc</sup>	5067 <sup>a</sup>	4840 <sup>bcd</sup>	4953 <sup>abc</sup>
NR 10285-29-3-1	13589 <sup>b</sup>	16556 <sup>abc</sup>	15072 <sup>b</sup>	5150 <sup>a</sup>	5171 <sup>bc</sup>	5161 <sup>ab</sup>
NR 10286-3-2-2	13644 <sup>b</sup>	13111 <sup>bcd</sup>	13378 <sup>bc</sup>	4922 <sup>ab</sup>	5456 <sup>ab</sup>	5189 <sup>ab</sup>
NR 10291-6-1 (Manjushree)	7089 <sup>de</sup>	10000 <sup>d</sup>	8544 <sup>d</sup>	2567 <sup>d</sup>	3257 <sup>d</sup>	2912 <sup>e</sup>
NR 10353-8-2-1	9500 <sup>cd</sup>	13222 <sup>bcd</sup>	11361 <sup>cd</sup>	3589 <sup>bcd</sup>	5222 <sup>bc</sup>	4806 <sup>bcd</sup>
NR 10375-20-1-2	6022 <sup>e</sup>	10556 <sup>d</sup>	8289 <sup>d</sup>	3167 <sup>d</sup>	3687 <sup>cd</sup>	3427 <sup>de</sup>
Weed management						
Straw mulch @ 4 t/ha	11588 <sup>b</sup>	13182 <sup>b</sup>	12385 <sup>b</sup>	3803 <sup>b</sup>	4499 <sup>b</sup>	4151 <sup>b</sup>
Hand weeding	14479 <sup>a</sup>	19667 <sup>a</sup>	17073 <sup>a</sup>	5318 <sup>a</sup>	6669 <sup>a</sup>	5994 <sup>a</sup>
Control (unweeded)	10024 <sup>c</sup>	10485 <sup>b</sup>	10255 <sup>b</sup>	4003 <sup>b</sup>	3918 <sup>b</sup>	3961 <sup>b</sup>
Cultivar	**	*	**	**	*	**
Weed management	**	*	**	**	*	*
Cultivar x weed management	**	NS	**	NS	NS	NS

a) Means within the same column and grouping followed by the same letter are not different according to Fisher's protected test  $P=0.05$ .

b) Treatments effects and interactions were significant at 5% (\*), significant at 1% (\*\*) or nonsignificant (NS)

than 4000 kg/ha and were at par (Table-8). The cultivars having plant height less than 105 cm such as NR10375-20-1-2, NR10353-8-2-1, NR10291-6-1 and Taichung-176 yielded less than 4000 kg/ha except in NR 10274-10-2-1. The Japonica cultivar has been reported as less competitive to weeds (Jennings and Aquino, 1968). In this study also the Japonica cultivar (Taichung-176) showed less competitive ability to weeds.

Significantly higher yield (5213) was recorded in hand weeding. But the yield was at par in mulch (3050 kg/ha) and unweeded control (3417 kg/ha) (Table 8). Interaction of grain yield and weed management was significantly different. All the cultivars yielded higher in handweeding compared to mulch and unweeded control. Cultivars NR10286-3-2-2, NR 10276-9-3-3-3-2,

NR10285-29-3-1, and Khumal-4, yielded in the same range from 5831 to 6281 kg/ha in handweeding treatment (Table 9). Mulching has no significant impact on grain yield of all the cultivars. However, some cultivars, such as Khumal-6, NR 10291, Taichung 176 and NR10375-20-1-2 yielded slightly higher than in unweeded control although it is not significantly different. Cultivar Khumal-4, Pokhrel masino, NR10274-10-2-1, NR10276-9-3-3-3-2, NR10285-29-3-1, NR10286-3-2-2 and NR10353-8-2-1 yielded higher in unweeded control than in mulch (Table 9). Two cultivars Pokhrel masino and NR10274-10-2-1 produced comparable yield in handweeding and unweeded control (Table 9).

Compared to dry weed biomass and yield, all the cultivars yielded higher in handweeding

**Table 9** Interaction of rice cultivar and weed management on grain yield

Cultivar	Weed management								Mean
	2000/01				2002/03				
	Control (unweeded)	Hand weeding	Mulch	Control (unweeded)	Hand weeding	Mulch	Control (unweeded)	Hand weeding	
	(kg/ha)								
Pokhrel masino	3403.3	4926.1	3054.2	5869.1 <sup>ab</sup>	4633.6 <sup>b-e</sup>	4194.2 <sup>c-g</sup>	4636.2 <sup>cde</sup>	4779.8 <sup>bcd</sup>	3624.2 <sup>f-j</sup>
Taichung-176	1395.5	3314.2	2141.7	2451.9 <sup>ij</sup>	4750.7 <sup>b-e</sup>	2318.2 <sup>ij</sup>	1923.7 <sup>mn</sup>	4032.5 <sup>d-h</sup>	2229.9 <sup>lmn</sup>
Khumal-4	2873.1	5096.0	3235.2	5650.9 <sup>abc</sup>	6567.0 <sup>a</sup>	3827.0 <sup>e-i</sup>	4261.9 <sup>d-g</sup>	5831.5 <sup>a</sup>	3531.1 <sup>g-k</sup>
Khumal-6	3560.1	5233.5	3573.2	3628.6 <sup>e-i</sup>	5614.3 <sup>a-d</sup>	3737.1 <sup>e-i</sup>	3594.3 <sup>f-j</sup>	5423.9 <sup>abc</sup>	3655.2 <sup>f-j</sup>
NR 10274-10-2-1-1	2974.6	4564.6	3358.4	4576.9 <sup>b-e</sup>	4096.6 <sup>d-h</sup>	2639.3 <sup>hij</sup>	3775.8 <sup>e-i</sup>	4330.6 <sup>d-g</sup>	2998.8 <sup>i-l</sup>
NR 10276-9-3-3-2	2965.0	5338.8	3841.9	5586.5 <sup>a-d</sup>	6776.8 <sup>a</sup>	4195.0 <sup>c-g</sup>	4275.7 <sup>d-g</sup>	6057.8 <sup>a</sup>	4018.5 <sup>d-h</sup>
NR 10285-29-3-1	3744.1	5313.7	3294.6	4847.8 <sup>b-e</sup>	6620.9 <sup>a</sup>	3056.7 <sup>f-j</sup>	4300.9 <sup>d-g</sup>	5967.3 <sup>a</sup>	3175.7 <sup>b-k</sup>
NR 10286-3-2-2	3173.9	5774.7	3341.6	4791.9 <sup>b-e</sup>	6787.9 <sup>a</sup>	2504.3 <sup>ij</sup>	3982.9 <sup>d-h</sup>	6281.3 <sup>a</sup>	2922.9 <sup>i-l</sup>
NR 10291-6-1 (Manjushree)	1581.0	4464.9	2422.3	2981.55 <sup>f-j</sup>	4751.8 <sup>b-e</sup>	2897.1 <sup>g-j</sup>	2281.3 <sup>lmn</sup>	4608.3 <sup>cde</sup>	2659.7 <sup>klm</sup>
NR 10353-8-2-1	3450.8	5768.0	3088.5	2756.3 <sup>g-j</sup>	5455.6 <sup>a-d</sup>	2590.1 <sup>hij</sup>	3103.5 <sup>i-l</sup>	5611.8 <sup>ab</sup>	2839.3 <sup>jkl</sup>
NR 10375-20-1-2	935.4	4320.2	1342.4	1963.1 <sup>j</sup>	4491.7 <sup>b-f</sup>	2451.9 <sup>ij</sup>	1449.3 <sup>n</sup>	4405.9 <sup>def</sup>	1897.1 <sup>mn</sup>
Cultivar x weed management	NS				*				**

a) Means within the same column and grouping followed by the same letter are not different according to Fisher's protected test P=0.05.

b) Treatments effects and interactions were significant at 5% (\*), significant at 1% (\*\*\*) or nonsignificant (NS)

**Table 10** Interaction of rice cultivar and weed management on seed weight.

Cultivar	Weed management												Mean
	2001/01			2001/02			2001/03			Control (unweeded)	Mulch	Hand weeding	
	Control (unweeded)	Mulch	Hand weeding	Control (unweeded)	Mulch	Hand weeding	Control (unweeded)	Mulch	Hand weeding				
	(gm/1000 seeds)												
Pokhrel masino	22.5	22.7	22.0	23.1 f-i	22.4 hijkl	23.6 efg	23.9de	23.6 de	23.7 de	23.2	22.9	23.1	
Taichung-176	26.0	27.2	26.7	26.6 c	28.6 a	27.9 ab	27.1 abc	26.7 abc	26.2 bc	26.6	27.5	26.9	
Khumal-4	18.0	18.5	18.2	20.7 mno	19.6 o	20.5 no	19.9 jk	19.3 k	19.1 k	19.6	19.1	20.4	
Khumal-6	22.2	23.2	22.7	22.6 g-k	23.9 ef	23.7 efg	24.2d	24.1 de	23.9 de	23.0	23.7	23.4	
NR 10274-10-2-1-1	21.8	21.5	22.4	21.3 lmn	22.2 f-i	22.5 g-k	21.4hi	21.5 hi	21.5 hi	21.5	21.7	22.2	
NR 10276-9-3-3-3-2	23.2	22.5	22.2	21.8 j-m	23.3 f-i	22.7 f-j	23.9 de	23.5 de	24.1 de	23.0	23.1	23.0	
NR 10285-29-3-1	21.0	21.8	20.2	21.4 k-n	21.3 lmn	22.2 f-i	21.9gh	21.9 gh	22.2 fgh	21.4	21.7	21.8	
NR 10286-3-2-2	18.7	18.2	18.5	20.3 no	20.3 no	20.3 no	19.7 jk	20.6 ij	19.7 jk	19.6	19.7	19.5	
NR 10291-6-1 (Manjushree)	23.5	24.0	23.0	25.4d	24.7 de	23.2 f-i	22.8 efg	25.9c	23.3 def	24.0	24.9	23.2	
NR 10353-8-2-1	22.8	23.7	23.2	24.6 de	23.4 fgh	23.9 ef	22.9 efg	24.0 de	23.3 def	23.5	23.7	23.4	
NR 10375-20-1-2	26.0	27.0	25.7	27.0 bc	27.9 ab	26.6 c	27.5 a	27.4 ab	27.1 abc	26.8	27.4	26.5	
Cultivar x weed management	NS			**			*			NS			

a) Means within the same column and grouping followed by the same letter are not different according to Fisher's protected test  $P=0.05$ .

b) Treatments effects and interactions were significant at 5% (\*), significant at 1% (\*\*), or nonsignificant (NS)



**Table 12** Interaction of rice cultivar and weed management on plant height.

Cultivar	2001/01			2001/02			2001/03			Mean		
	Control (unweeded)	Hand weeding	Mulch	Control (unweeded)	Hand weeding	Mulch	Control (unweeded)	Hand weeding	Mulch	Control (unweeded)	Hand weeding	
Pokhrel masino	122.3 ab	119.3 bc	119.9 abc	116.5 cd	125.2 a	123.3 a	135.5 a	132.1 ab	134.3 ab	124.8 ab	125.5 ab	125.8 a
Taichung-176	105.9 gh	109.7 efg	107.0 fgh	93.9 i	94.4 i	94.5 i	110.0 hij	109.0 hij	116.6 fj	103.2 h	104.4 h	106.0 h
Khumal-4	123.5 ab	122.0 ab	112.8 def	123.1 a	123.7 a	122.9 a	127.7 a-e	125.5 a-f	132.6 ab	124.8 ab	123.7 ab	122.8 abc
Khumal-6	119.1 bc	106.2 gh	114.1 cde	113.1 de	109.2 efg	110.7 ef	117.6 e-i	126.2 a-f	119.1 dh	116.6 efg	113.9 fg	114.7 efg
NR 10274-10-2-1-1	122.0 ab	109.0 e-h	120.7 ab	118.8 bc	121.9 ab	122.5 ab	134.5 ab	132.7 ab	128.0 ae	125.1 ab	121.2 bcd	123.7 ab
NR 10276-9-3-3-2	119.1 bc	104.9 gh	118.9 bcd	108.3 fg	104.2 h	105.5 gh	125.0 b-f	127.4 ae	121.3 eg	117.5 def	112.2 g	115.2 efg
NR 10285-29-3-1	125.8 a	103.6 h	117.7 bcd	109.3 efg	108.3 fg	106.7 gh	133.5 ab	130.4 abc	127.3 ae	122.9 abc	114.1 fg	117.3 def
NR 10286-3-2-2	120.0 abc	120.5 ab	121.0 ab	115.0 cd	116.5 cd	114.8 d	128.6 a-d	133.5 ab	120.7 eg	121.2 bcd	123.5 ab	118.8 cde
NR 10291-6-1 (Manjushree)	88.8 jkl	80.6 m	87.0 kl	89.3 j	86.7 jk	86.2 jk	92.9 k	94.4 k	112.4 gj	90.4 kl	87.2 l	95.2 ij
NR 10353-8-2-1	94.1 ij	80.5 m	93.1 ijk	84.1 k	89.6 k	84.2 k	114.5 g-j	107.0 j	107.8 ij	97.6 i	92.3 jk	95.0 ij
NR 10375-20-1-2	89.2 jkl	86.4 lm	95.9 i	88.5 j	89.9 j	88.9 j	109.6 hij	110.1 hij	109.0 hij	95.8 ij	95.5 ij	97.9 i
Cultivar x weed management	**	**	**	**	**	**	*	*	*	*	*	*

a) Means within the same column and grouping followed by the same letter are not different according to Fisher's protected test  $P=0.05$ .

b) Treatments effects and interactions were significant at 5% (\*), significant at 1% (\*\*), or nonsignificant (NS)

where the dry narrowleaf weed biomass ranged from 22 to 29g per 0.5m<sup>2</sup>. In all the cultivars the dry narrowleaf weed biomass was more than 5 times higher in unweeded control than in handweeding. It might be the reason that all the cultivars yielded low in unweeded control than in handweeding. But, the cultivar Pokhrelhi masino and NR10274-10-2-1 gave comparable yield in unweeded control and handweeding showing their competitive ability with weeds. The competitive ability of Pokhrelhi masino might be due to higher LAI and taller plant stature compared to other tested cultivars. It has also indicated that the plant height and LAI are correlated with competitive ability of rice to weeds (Jennings and Jesus, 1968; Moody, 1979; Jennings and Aquino, 1968).

Yield trend of all the tested rice cultivars was low in direct dry seeding compared to transplanting (Table 1 and 8). Although most of the cultivars yielded more than 3000 kg/ha in direct dry seeding but still less compared to transplanting. One of the reasons behind the low yield in direct dry seeding is weed and the other reason might be the cultivars. All these cultivars were selected in transplanting environment with two handweedings. But in transplanting weed competition is less compared to direct seeding in the initial stage. Because, high water level can suppress many annual weeds (Ampong-Nyarko and De Datta, 1991).

### Straw weight

Dry straw weight was significantly different among the cultivars and weed management in both years. Pokhrelhi masino produced the highest dry straw weight (6060 kg/ha). Cultivar Khumal-6, Khumal-4, NR10285-29-3-1, and NR10286-3-2-2 produced more than 5000 kg/ha. Handweeding also produced highest dry straw weight than mulch and unweeded control (Table 8).

## CONCLUSION

Narrowleaf weeds were the dominant species. The number of weeds at 4 and 8 WAS were not significantly different in rice cultivars. However, different weed management significantly suppressed weeds in 4 and 8WAS. The impact of mulching was quite impressive in suppressing narrowleaf weeds upto 100 percent for first 3 to 4 weeks of rice sowing. The management practices showed that handweeding is the most effective weed control method for direct dry seeded rice. Future experiment needs to be conducted to determine the combination of mulch and other weed control method. Different weed management did not affect yield components such as plant height and thousand seed weight. These components were significantly different among the cultivars. The tall cultivars Pokhrelhi having higher LAI produced comparable yield with handweeding even in unweeded control. All the cultivars produced high tillers per square meter in handweeding compared to mulch and unweeded control. Among the tested cultivars, course grain type such as Taichung-176 and NR 10375-20-1-2 yielded less than 3000 kg/ha. But with handweeding almost all the cultivars produced from 4000kg/ha to 6000kg/ha. Two cultivars Pokhrelhi masino and NR 10274-10-2-1-1 produced comparable grain yield in handweeding and unweeded control showing their competitiveness to weeds.

From this experiment, it can be concluded that most of the cultivars could be planted in direct dry seeding with proper weed management besides transplanting which minimize the cost of seed bed preparation and puddling. Pokhrelhi masino and NR10274-10-2-1-1 showed some competitiveness with weeds. The allelopathic potential of these cultivars needs to be explored in the future. Very little focus has been given in the development of competitive crop cultivars to weeds for weed management. So this study may help to push the researchers, breeders, and related personnel for

developing the competitive agronomical and horticultural crop cultivars in the future.

### ACKNOWLEDGEMENTS

The authors are thankful to Nepal Agricultural Research Council and SMCRSP, Cornell university (first two years) for the support in initiating this research works. We are very thankful to chief agronomist and the staffs of Agronomy Division, Nepal for providing the field and other necessary helps and Mr. R. Ghimere for assisting throughout the research period.

### LITERATURE CITED

- Ampong-Nyarko, K. and S. K. De Datta. 1991. **A Handbook for Weed Control in Rice**. IRRI, International Rice Research Institute, Los Banos, Philippines 113 p.
- Agricultural Botany Division, 1998/1999. **Annual report**, Nepal Agricultural Research Council, Khumaltar, Nepal, 91 p.
- Agricultural Botany Division, 2000/2001. **Annual report**, Nepal Agricultural Research Council, Khumaltar, Nepal, 99 p.
- Caton, B. P., A. M. Mortimer, T. C. Foin, J. E. Hill, K. D. Gibson, and A. J. Fisher. 2001. Weed shoot morphology effects on competitiveness for light in direct-seeded rice. **Weed Res.** 41 : 155-163.
- Chou, C. H. and H. J. Lin. 1976. Autotoxication mechanism of *Oryza sativa*. I. Phytotoxic effects of decomposing rice residues in soil. **Journal of Chemical Ecology** 2(3) : 353-367.
- Didon, U. M. E. 2002. Variation between barley cultivars in early response to weed competition. **Jour. Agro. and Crop Sci.** 188(3) : 176.
- Duke, S. O. 1985. Biosynthesis of phenolic compounds-Chemical manipulation in higher Plants, pp.113-131. *In* A. C. Thompson (ed.).
- The Chemistry of Allelopathy: Biochemical interactions among plants. **Amer. Chem. Soc. Symp.** Series No. 268.
- Fujii, Y. 1992. The potential biological control of paddy weeds with allelopathic effect of some rice varieties, pp. 305-320. *In* **Proceedings of the International Symposium on Biological Control and Integrated Management of Paddy and Aquatic Weeds in Asia**.
- Garrity, D. P., M. Movillon and K. Moody. 1992. Differential weed suppression ability in upland rice cultivars. **Agron. J.** 84 : 586-591.
- Hassan, S.M., A. N. Rao, A. O. Bastawisi, and I. R. Aidy. 1994. Weed management in broadcast seeded rice in Egypt, pp. 257-269. *In* **Proceedings of an International Workshop on: Constraints, Opportunities and Innovations for Wet-Seeded Rice**. 31 May – 3 June 1994, Bangkok, Thailand.
- Hoagland, R. E. and R. D. Williams. 1985. The influence of secondary plant compounds on the association of soil microorganism and plant roots. The Chemistry of Allelopathy: Biochemical Interactions Among Plants, pp.301-325. *In* A. C. Thompson (ed.). **Amer. Chem. Soc. Symp.** Series No. 268.
- Jennings, P. R. and J. D. Jesus. 1968. Studies on competition in rice I: competition in mixtures of varieties. **Evolution** 22 : 119—124.
- Jennings, P. R. and R. C. Aquino. 1968. Studies on competition in rice III: The mechanism of competition among phenotypes. **Evolution** 22 : 529-542.
- Kim, K.U., D. H. Shin, I. J. Lee and H. Y. Kim. 2000. Rice Allelopathy in Korea, pp. 57-28. *In* K. U. Kim and D. H. Shin (eds.). **Rice Allelopathy. Proceedings of the Workshop in Rice Allelopathy, 17-19 Aug 2000**. Taegu. (Korea) Kyungpook National University.
- Kim, K.U. and D. H. Shin. 1998. Rice Allelopathy Research in Korea, pp. 39-44. *In* M. Olofsson (ed.). **Allelopathy in Rice. Proceedings of the Workshop on**

- Allelopathy in Rice, 25-27 Nov. 1996**, IRRI.
- Kropff, M. J., L. A. P. Lotz and S E Weaver. 1993. Practical application, pp. 149-168. *In* M. J. Kropff and H. H. Van Laar (eds.). **Modelling Crop- Weed Interactions**. Wallingford, U. K: CAB International.
- Kuwatsuka, S. and H. Shindo. 1973. Behavior of phenolic substances in the decaying process of plants identification and quantitative determination of phenolic acids in rice straw and its decayed product by gas chromatography. **Soil Sci. and Plant Nutri.** 19(3) : 219-227.
- Moody, K. 1979. Exploiting cultivar's differences to improve weed control, pp. 1-8. **Paper presented at the International Rice Research Conference April 16-20. Int. Rice Res. Inst.** Los Banos, Philippines.
- Ni, H., K. Moody, R. P. Robles, E. C. Paller jr. and J. S. Lales. 2000. *Oryza sativa* plant traits conferring competitive ability against weeds. **Weed Sci.** 48 : 200-204.
- Okafor L. I. and S. K. De Datta 1976. Competition between upland rice and purple nutsedge for nitrogen, moisture and light. **Weed Sci.** 24 : 43-46.
- Olofsson, M., D. N. Navarez, M. Rebulnan and J. C. Streibig. 1999. Weed-suppressing rice cultivars-does allelopathy play a role. **Weed Res.** 39(6) : 441-454.
- Olofsson, M., D. Navarez and K. Moody. 1995. Allelopathic potential in rice (*Oryza sativa* L.) germplasm. **Annals of Appl. Biol.** 127 : 543-560.
- Rajan, A., S. Singh, Y. Ibrahim and W. S. Wanharum. 1995. Applications of INTERCOM model in plant breedings- model validation and effect of early leaf area growth on crop- weed competition in direct seeded rice, pp. 67-74. *In* P. K. Agrawal, R. B. Matthews, M. J. Kropff and H. H. Van Laar (eds.). **SARP Research Proceedings Applications of Systems Approaches in Plant Breeding**, Los Banos, Laguna, Philippines: April 18-May 6, 1994.
- Ranjit, J. D. 1999. Performance of three rice varieties planted by Chinese seed drill under different weed management, pp. 246-250. *In* **Proceedings (IA) 17<sup>th</sup> Asian Pacific Weed Science society Conference.**
- Ransing, L.L. and G.D. Grabtree. 1999. Plant characteristics associated with rice (*Oryza sativa* L.)–Barnyardgrass (*Echinochloa crusgalli* L. Beauv.) competition, pp. 99-104. *In* **Proceedings (IA) 17<sup>th</sup> Asian Pacific Weed Science Society Conference.**
- Seavers, G. P. and K. J. wright. 1999. Crop canopy development and structure influence weed suppression. **Weed Res.** 39(4) : 319-328.
- Shrestha, K. P. and H. B. K. C. 1980. Rice varietal improvement work for hills. *In* **Proceedings 7<sup>th</sup> Rice Improvement Workshop held in Parawanipur, Nepal from 24-27 Feb., 1980.**
- Wu, H., J. Pratley, D. Lemerle and T. Haig. 1999. Crop cultivars with allelopathic capability. **Weed Res.** 39(3) : 171-180.
- Xu, Z. H. and L. Q. Yu. 2000. Ecological control of barnyardgrass by different morphological type rice. **Chinese Jour. of Rice Sci.** 14(2) : 125-128
- Yu, L. Q., Z. H. Xu, and S. W. Huang. 2001. Studies on allelopathy of rice (*Oryza sativa*) for barnyardgrass control, pp. 198-202. *In* **Proceedings 18<sup>th</sup> Asian Pacific Weed Science Society Conference.**