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Influence of Seed Rate and Days of Pendimethalin Application on Weed Dynamics and Yield of Dry Direct Seeded Rice (*Oryza sativa* L.)

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ABSTRACT

Dry Direct -Seeded rice is the sustainable alternative to the commonly transplanted rice that address the problems of water, labour and high production costs. However, the weed infestation causes heavy yield reduction in dry direct seeded rice (DDSR). The optimum seed rate and timing of pre-emergence herbicide application is also another crucial factors limiting production in DDSR.To evaluate optimum seed rate and days to pendimethalin application a field study was conducted in 2022 and 2023 in the experimental field of National Agronomy Research Centre, Khumaltar, Lalitpur, Nepal. The experiment was laid out in a split plot design with two seed rate (20 and 30 kg ha^{-1}) assigned to main plot factor and five different days of pendimethalin application (1,2, 3 ,4 and 5 days after sowing of rice) was assigned to as sub plot factor. The treatment was experimented in four replications. The plot size was 3 × 4 m and spacing was 20 cm between row and sown continuously in line. The fertilizers were applied at the rate of 120: 40: 40 kg N: P_2O_5:K_2O ha^{-1}. The full dose of P_2O_5: K_2O and one third dose of N was applied as basal. The remaining N was applied in two splits at tillering and booting stage. Observations in crop growth, weeds and yield and yield attributes were recorded**.** Seed rate of 30 kg ha^{-1} suppressed weeds efficiently and produced higher grain yield (7052 kg ha^{-1}) compared with 20 kg recording less weed density and biomass. In the different days of pendimethalin application applying it on same day of sowing of rice resulted in better weed management and higher yield (7439 kg ha^{-1}) compared with others days of it application.

Keywords: Dry direct seeded rice, Pendimethalin, Seed rate, Weed, Yield

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INTRODUCTION

Conventional transplanted rice faces major challenges from water scarcity, labor shortages, and rising production costs. And dry direct-seeded rice (DDSR) can be used as a promising alternative that addresses these constraints (Chaudhary et al 2025). Seed rate is a vital agronomic aspect in DSR which governs plant density, crop growth, and grain yield. Less crop establishment due to reduced seed rate produced poor plant density and yield in DSR (Majeed et al 2022). DSR with seed rate of 30 kg ha^{-1} produced improved crop parameters, such as plant biomass, leaf area, and high panicle length, panicle weight, filled grains and less unfiled grains (Chaudhary et al 2025).Pendimethalin is the effective and economically feasible option for weeds management in dry direct seeded rice (Bhurer et al 2013). Pendimethalin is a pre-emergence herbicide applied to the soil to create a protective barrier before weeds have a chance to emerge and it stop the growth of young weed seedlings, providing effective control of early-emerging grass and broadleaf weeds (Appleby and Valverde 1989).

Pendimethalin residues in DSR and transplanted rice (TPR) soils are minimal, and its proper use cause low risk to succeeding crops or the environment (Alister et al 2009). It is also used in dry direct seeded rice after sowing at germination stage to reduce weed competition. The application of pendimethalin at early stage produced high yield showing its effect on weeds selectivity and crop safety (Mounsiha and Menon 2020). Effect of pendimethalin exhibit best when weeds are at the germination stage, highlighting the importance of time of

application of pre-emergence herbicide (Singh et al 2019). The efficiency of pendimethalin to reduce weed competition in dry DSR depend on its application dose and time of application (Kaur et al 2025).

While many studies evaluated the benefits of pendimethalin treatment and seed rate independently in dry direct-seeded rice (DSR), there is little study on their combined study. Canopy closure and the crop's ability to compete with weeds are impacted by plant density, which can have an impact on the efficacy of herbicides and overall productivity. While higher densities might increase crop competitiveness and possibly change the effectiveness of herbicides, lower seed rates may increase reliance on chemical weed management. Pre-emergence herbicides and the ideal seed rate were combined to enhance crop growth and boost DSR grain yield. The combined effects of seed rate and pre-emergence herbicide management under particular agro-ecological conditions, however, have not yet been adequately empirically studied. In order to assess the combined impacts of varying seed rates and pendimethalin application on crop growth, weed dynamics, and grain yield of dry direct-seeded rice, the current study was conducted. The objective of this study was to find out the optimum seed rate and days of pendimethalin application in dry direct seeded rice.

MATERIALS AND METHODS

The experiment was carried out in the research field of National Agronomy Research Centre, Khumaltar, Lalitpur, Nepal during the summer season of 2022 and 2023.The experiment was set up in split plot design with three replications. The plot size was 12 m^2 (4 m × 3 m) and crop geometry with spacing 20 cm between row and seeding continues in line. After proper tillage rice seed was sown manually in line in 27 May in 2022 and May 31 in 2023.

Treatment combination: The trials was carried out in split plot design with four replications as given in the table 1.

Table 1. Treatments combination in the experiment in Khumaltar, Lalitpur in 2022 and 2023

Main Factor (Seed rate)	Sub Factor	Symbol
20 kg ha^{-1}	Pendimethalin application on the same day after sowing of rice	1 day
30 kg ha^{-1}	Pendimethalin application on the second day after sowing of rice	2 day
	Pendimethalin application on the third day after sowing of rice	3 day
	Pendimethalin application on the fourth day after sowing rice	4 day
	Pendimethalin application on the fifth day after sowing of rice	5 day

Agrometeorological conditions during the research periods:
During 2022 the maximum temperature (Tmax) was 34.6 mm in 15 July and the minimum temperature (Tmin) was 7.2 in 13 November in and total rainfall received during the crop season was 1122.6 mm. During 2023 maximum temperature (Tmax) was 32.2 mm in 6 September and minimum temperature (Tmin) was 7.8 in 9 November in and total rainfall was 947.1 mm during the crop season.

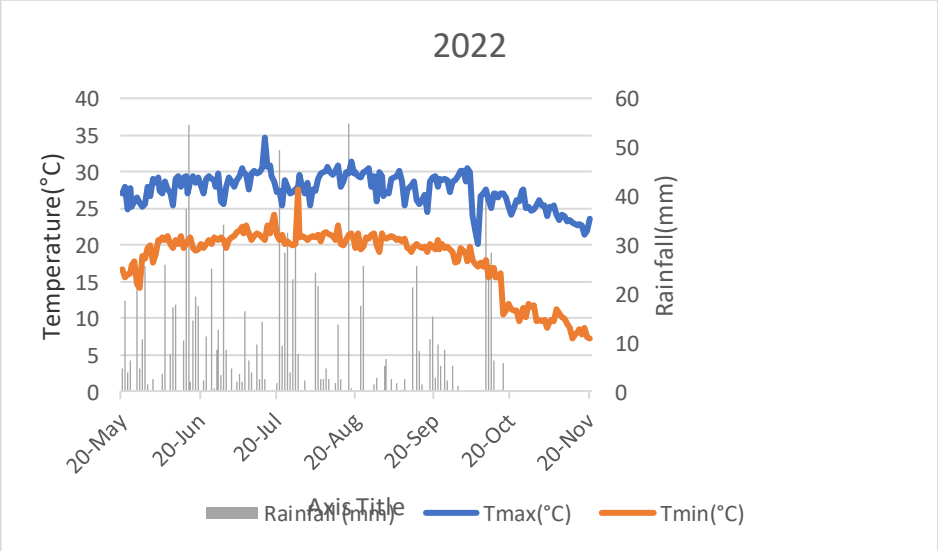

Fig 1. Daily temperature and rainfall during the research period in Khumaltar, Lalitpur in 2022

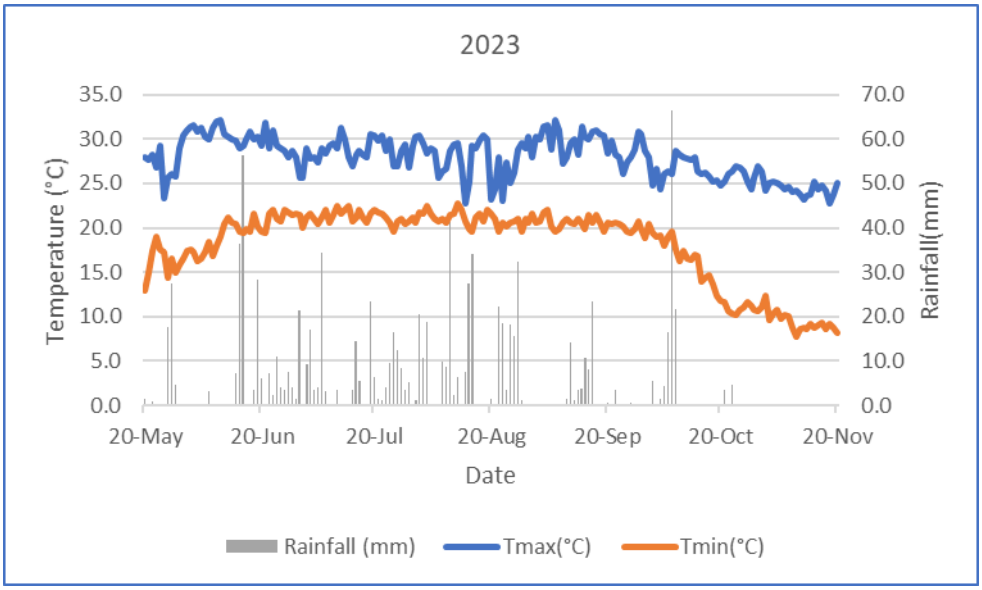

Fig 2. Daily temperature and rainfall during the research period in Khumaltar, Lalitpur in 2023

Crop management: Fertilizers was applied at the rate of 120: 40: 40 kg N: P_2O_5:K_2O kg ha^{-1}. Urea, DAP and MOP were used for supply N, P_2O_5 and K_2O.The full dose of P_2O_5 and K_2O and one third dose of N was applied as basal. The remaining N was applied in two splits at tillering and booting stage of rice. Weeding was done at 45-50 DAS. A total of five numbers of irrigation were applied. First light irrigation was applied after seven days of sowing for letting the seed to germinate. Second irrigation was applied at 25 days after sowing (during tillering stage) and before top dressing of N-fertilizer. Third irrigation was applied at the maximum tillering stage (50-60 DAS); fourth irrigation at the panicle initiation stage and fifth irrigation was applied at the flowering stage. In some stages rainfall fulfilled the water need. Rice smut was observed and managed by application of fungicide Native 75 %WG (Tebuconazole 50% + Trifloxystrobin (25%) at the rate of 1.0 g/litre of water at during P.I and heading stage. Crop was harvested manually with sickle when crop matured showing yellowing of plant and grains becomes hard with moisture around 20 % and threshed using a pedal thresher.

Data collection and analysis:
Weeds: Weed density and weed biomass. Weed population (density) were recorded from the quadrant of 50 × 50 cm at 30 and 90 DAS. The dry biomass was measured from the same weed population after oven dried at 70°C for 72 hours.

Crop parameters: Plant height, numbers of tillers, panicle length, filled grains, unfilled grains, thousand grains weight and grain yield .Plant height was measured from 10 random plants at maturity. Numbers of tillers were recorded from 1 m^2. Panicle length was measured from 10 random panicle from each plot. Filled and unfilled grains were counted from 10 random panicles from each plot.1000 grains were counted and weighed from each plot after threshing and cleaning. Grains yield was recorded from net plot area of 6.6 m^2 after cleaning and computed into a hectare. The calculation of grain yield was performed using the formula proposed by Paudel (1995).

$$\text{Grain yield (kg ha}^{-1}\text{) at 12\% moisture} = \frac{(100 - \text{MC}) \times \text{Plot yield (kg)} \times 10000}{(100 - 12) \times \text{Net plot area(m}^2\text{)}} \quad \text{.....Eq. 1}$$

All the parameters of weeds and plant for each plot were recorded and arranged in MS Excel. Data validation was performed using MS Excel-2010. Data analyzed using Genstat 18 edition. The Duncan's multiple range test (DMRT) and least significant difference (LSD) were used at significance levels of 1% or 5% to evaluate the differences among treatments.

RESULTS AND DISCUSSION

Weed Dynamics and Growth

Weed density per 0.25m^2 at 30 days after sowing (DAS) in the seed rate (20 and 30 kg ha^{-1}) found to be 544 and 521 in 2022 (Table 2) while in the 2023 (Table 3) it was 331 and 240 weeds showing less weeds density in higher seed rate (30 kg ha^{-1}). The difference in the weed's density was significant. And in case of days of

pendimethalin application the weeds density ranged from 343 to 788 weeds from 1 day to 5 day and the mean difference were found to be significant (in 2022). While in 2023 weeds density ranged from 133 to 441 from 1day to 5 day with mean difference showing significant different (Table 3). In pooled data of two years (Table 4), seed rate 20 and 30 kg recorded 426 and 392 weeds and the mean difference was significantly differing among the days of pendimethalin application weeds density ranged from 238 to 614 from 1 day to 5 day, and mean difference were significantly different. There was no significant difference in the interaction effect between seed rate and days of pendimethalin application. At 90 DAS in the seed rate 20 and 30 kg ha^{-1} found to be 45.3 and 28.8 in 2022 while in 2023 it was 33.9 and 38.9 weeds showing less weeds density in higher seed rate (30 kg ha^{-1}). While the mean difference was not significant. In pooled data weed density found to be 39.6 and 33 in 20 and 30 kg ha^{-1} and the mean difference was significantly different. Low seed rate produced less plant population that give wider area for weed growth and high weeds density. Guillermo et al (2009) also reported seed rate affect weed density similarly. Among the days to pendimethalin application (DOP) weeds density ranged from 21.5 to 58.2 from 1 day to 5 day, and mean difference were significantly different. This suggest pendimethalin work more efficiently in controlling weeds when apply at earliest on the first day after sowing. The low weed population due to early applying of pendimethalin at 0-1 days in DSR were also reported by Mahajan and Chauhan 2015. Singh et al (2019) also found the best performance of pendimethalin when applied at germination stage of weeds. There was no significant difference in the interaction effect between seed rate and days of pendimethalin application.

Weed dry biomass at 30 DAS in 2022 (Table 2) in the seed rates 20 and 30 kg ha^{-1} found to be 66.1g and 61.9 g respectively and mean difference was non-significant. In 2023 (Table 3) weed dry biomass was 17.49 g and 13.55 g in 20 and 30 kg ha^{-1} and mean difference was significant. In case of days of pendimethalin application the weeds dry biomass from 34 to 195.9 g from 1 day to 5 day with mean difference showing significant different. In 2023 it ranged from 7.67 to 23.03 g from 1 day to 5 day and the mean difference were significantly different. In pooled data (Table 4) the weed dry biomass ranged from 20.8 to 64.5 g (1 day to 5 day) and the mean difference were significant. This result gives clear picture of controlled weed growth and biomass development with earliest pendimethalin sprayed compared with five days after sowing of rice. Mounisha and Menon (2020) found reduced in the weed biomass by early application of pre-emergence herbicides such as pendimethalin and penoxulam in DSR.

Weed dry biomass at 90 DAS in 2022, the seed rates 20 and 30 kg ha^{-1} found to be 5.03 g and 2.62 g respectively and mean difference was non-significant. In 2023 weed dry biomass was 2.31 g and 2.0 g in 20 and 30 kg ha^{-1} and mean difference was significant. In case of days of pendimethalin application the weeds dry biomass from 0.98 to 7.75 g from 1 day to 5 day with mean difference showing non -significant different. In 2023 it ranged 0.76 to 4.17 g from 1 day to 5 day and the mean difference were significantly different. In pooled data the weed dry biomass was 3.67 and 2.31g in the seed rate 20 and 30 kg ha^{-1} and in days to pendimethalin application it ranged from 0.87 to 5.96 g (1 day to 5 day) and the mean difference were significant. And there was no significant interaction between seed rate and the days of pendimethalin application.

Table 2. Effect of seed rate and days of pendimethalin application in DSR at Khumaltar during 2022

Treatments	Weed density/0.25m^2 at 30 DAS	Weed DW/0.25m^2 at30 DAS(g)	Weed density /0.25m^2 at 90 DAS	Weed dry weight at 90 DAS /0.25m^2	Plant height (cm)
Seed rate (S)					
20 kg	544	66.1	45.3	5.03	106
30 kg	521	61.9	28.8	2.62	107
LSD (<0.05)	ns	ns	ns	ns	ns
Days of pendimethalin application (D)					
1 day	343	34.0	21.8	0.98	108
2 day	448	48.4	31.5	1.62	102
3 day	486	61.2	36.0	3.34	107
4 day	597	70.6	43.3	4.95	107
5 day	788	195.9	52.5	7.75	108
LSD (<0.05)	114.6	17.81	9.57	1.85	ns
S × D	ns	ns	ns	ns	ns
CV (%)	17.6	16	21.1	39.7	16
G Mean	532	64.0	37	3.83	106

LSD = Least significant difference, CV=Coefficient of variation, ns= Not significant at p<0.05

Table 3. Effect of seed rate and days of pendimethalin application in DSR at Khumaltar during 2023

Treatments	Weed density/0.25m^2 at 30 DAS	Weed DW/0.25m^2 at 30 DAS	Weed density /0.25m^2 at 90 DAS	Weed dry Weight at 90 DAS /0.25m^2	Plant height (cm)
Seed rate(S)					
20 kg	331	17.49	33.9	2.31	105
30 kg	240	13.55	38.9	2.0	105
LSD (<0.05)	83.8	3.5	ns	0.33	ns
Days of pendimethalin application (D)					
1 day	133	7.67	21.2	0.76	105
2 day	217	12.50	26.2	1.28	105
3 day	282	15.70	30.3	1.85	104
4 day	355	18.72	40.5	2.70	105
5 day	441	23.03	63.8	4.17	105
LSD (<0.05)	69	3.7	15.5	0.93	ns
S × D	ns	ns	ns	ns	ns
CV (%)	19.8	19.7	34.8	35.7	2.6
G Mean	286	15.52	36.4	2.15	105

LSD = Least significant difference, CV=Coefficient of variation, ns= Not significant at p<0.05

Table 4. Effect of seed rate and days of pendimethalin application in DSR at Khumaltar during 2022 and 2023(pooled)

Treatments(S)	Weed density/0.25m^2 at 30 DAS	Weed DW/0.25m^2 at 30 DAS	Weed density /0.25m^2 at 90 DAS	Weed dry weight/0.25m^2 at 90 DAS	Plant height (cm)
Seed rate (S)					
20 kg	426	39.7	39.6	3.67	105.4
30 kg	392	39.8	33.9	2.31	106.1
LSD (<0.05)	18.8	ns	1.63	ns	ns
Days of pendimethalin application (D)					
1 day	238	20.8	21.5	0.87	106.31
2 day	333	30.4	28.8	1.45	103.89
3 day	384	38.4	33.2	2.84	105.77
4 day	476	44.6	41.9	3.83	106.15
5 day	614	64.5	58.2	5.96	106.38
LSD (<0.05)	65.1	9.69	7.77	0.87	ns
S × D	ns	*	ns	ns	ns
CV (%)	26.6	31.8	33.1	24	2.4
G Mean	409	39.8	36.7	2.99	105.7

LSD = Least significant difference, CV=Coefficient of variation, *=Significant at p<0.05, ns = Not significant at p<0.05

Common weed emerged in the experimental field: The common weeds that emerged in most of the experimental plots irrespective of the treatments were (Table 5.) Barnyard grass (*Echinochloa crusgalli (*L.) P. Beauv , Jungle rice (*Echinochloa colona* (L.) Link.,Prostrate False Pimpernel (*Lindernia procumbens* Krock Philcox),Para cress(*Acmella paniculata* Wall ex DC) , Hairy Bittercress (*Cardamine hirsute* L.), Globe fringerush (*Fimbristylis litoralis* Gaud),Umbrella sedge (*Cyperus iria* L.), Smallflower umbrella sedge(*Cyperus difformis* L),Spreading day flower(*Commelina diffusa* Burm F.) ,Day flower (*Commelina benghalensis* L.) and Seed box(*Ludwigia hissopifolia* (G.Don) Excell). Mahajan and Chauhan (2013) also observed similar species of weeds in DSR.

Table 5. Lists of major weed species recorded in the experimental field in 2022 and 2023 at Khumaltar

SN	Common Name	Scientific Name	Local Name
1	Barnyard grass	*Echinochloa crusgalli (*L.) P. Beauv	Sawa
2	Jungle rice	*Echinochloa colona* (L.) Link	Banso
3	Prostrate False Pimpernel	*Lindernia procumbens* Krock Philcox	NA

SN	Common Name	Scientific Name	Local Name
4	Para cress	*Acmella paniculata* Wall ex DC	Laato ghaans/Maroti
5	Hairy Bittercress	*Cardamine hirsute* L.	Ban tori
6	Globe fringerush	*Fimbristylis litoralis* Gaud	Jhiruwa/Jwane
7	Umbrella sedge	*Cyperus iria* L.	Chatare mothe
8	Smallflower umbrella sedge	*Cyperus difformis* L	Mothe
9	Spreading day flower	*Commelina diffusa* Burm F.	Kane
10	Day flower	*Commelina benghalensis* L.	
11	Seed box	*Ludwigia hissopifolia* (G.Don) Excell	Lwang

Plant height: In 2022 plant height in 20 and 30 kg ha^{-1} found to be 106 cm and 107 cm (Table 2) and among the days of pendimethalin application plant height ranged from 102 to 108 cm and the mean difference were not significant. There was not significant difference in the interaction between seed rate and days of pendimethalin applications. In 2023 there was no significant difference in plant height (105 cm) in the 20 and 30 kg ha^{-1} seed rates and in the days to pendimethalin application where it ranged from 104 to 105 cm. In pooled data plant height range from 105.4 and 106.1 (Table 4) in seed rates and in the days to pendimethalin application it was found to range from 103 .89 to 106.38 cm and the mean difference were non-significant. Similar, finding of non-significant difference in plant height due to variation in seed rate in DSR was also reported by Naeem et al (2025).

Tillers per meter square: In 2022 the numbers tillers in the seed rates 20 kg and 30 kg ha^{-1} were 306 and 330 respectively. Among the days of pendimethalin application the highest tillers numbers were 332 in 2 day and lowest was 306 in 5 day and the mean difference was not significant in seed rate and days of pendimethalin application (Table 6). In 2023 it was 267.3 in 20 kg and 269.9 in 30 kg ha^{-1} and the highest tillers numbers 264.2 was in 1 day and lowest tillers numbers (301.2) in 5 day of pendimethalin application. And there is no significant difference in the seed rate and days of pendimethalin application and also in the interaction between seed rate and days of pendimethalin application. In the pooled data analysis (Table 8), there found significant difference in the seed rate and days of pendimethalin application and in the interaction. The highest numbers of tillers (299.9) were found in the seed rate 30 kg ha^{-1} and in 1 day (303.6) in days of pendimethalin application and the mean difference were statistically significant in seed rate, days of pendimethalin application and in the interaction. The increased tillers number with seed rate of 30 kg than 20 kg ha^{-1} was also found by Joshi et al 2021.

Yield and yield attributes

Panicle length

Panicle length was found to be 25.95 cm and 25.88 cm in the seed rate 20 and 30 kg ha^{-1} and it ranged from 25.65 cm to 26.20 cm in days of pendimethalin application in 2022 (Table 6). No significant difference was found among in seed rate and days of pendimethalin application in panicle length. There was no interaction effect between Seed rate and in days of pendimethalin application. In 2023(Table 7) the panicle length was 25.74 and 25.61 cm in the seed rate 20 and 30 kg ha^{-1} and in the days of pendimethalin application it ranged from 25.58 to 25.77 cms and the mean difference were insignificant both in seed rate, days of pendimethalin application and the interaction. In the pooled data (Table 8) the mean difference was not significant and it was 25.74 cm and 25.61 cm in 20 and 30 kg ha^{-1} and ranged from 25.58 cm to 25.77 cm among the day of pendimethalin application. Small increased in panicle length was exhibited in the low seed rate might be due to less competition between the plants due to less plant population. Such small increased in panicle length in low seed rate compared to higher seed rate was also found by Naeem et al 2025.

Thousand grains weight (TGW)

The thousand grains weight (TGW) was 29.25 cm and 26.73 cm in the seed rate 20 and 30 kg ha^{-1} and it ranged from 28.65 g to 29.48 g in days to pendimethalin application in 2022 (Table 6) and in 2023 (Table 7) was 31.3 g and 31.0 g in the seed rate 20 and 30 kg ha^{-1}and in days to pendimethalin sprayed it ranged 30.6 g to 32.7 g and there was no mean significant difference among the treatments. In the pooled data (Table 8) TGW was 30.28 g and 29.86 g in the seed rate 20 and 30 kg ha^{-1} and in the days to pendimethalin application it ranged from 29.18 g to 31.09 g. The mean difference is significant difference in the days to pendimethalin spray. The slightly higher TGW in 20 ha^{-1} than 30 ha^{-1} seed rate might be more utilization of light due to less plant population and higher transfer of photosynthates from source to sink (Table 8). Similar finding was also reported by Joshi et al (2021). There is mean significant difference among the treatment in the days to pendimethalin spray only.

Filled grains per panicle

In 2022 the numbers of filled grains were found to be 155.6 and 147.9 in the seed rate 20 and 30 kg ha^{-1} and in days of pendimethalin application it ranged from 139.7 to 149.3 (Table 6). The mean difference was not significant in both seed rate and days of pendimethalin application. In 2023 the numbers of filled grains were 146.7 and 143.0 in the seed rate 20 and 30 kg ha^{-1} and in days of pendimethalin application it ranged from 139.7 to 149.3 (Table 7). There is no mean significant difference in seed rate. In pooled data (Table 8) the numbers of filled grains were found to be 146.7 and 143.0 and in the seed rate and in the days of pendimethalin application it ranged from 139.7 to 149.3. And the mean difference was found to be significant in in the days of pendimethalin application.

Unfilled grains per panicle

In 2022 (Table 6), the unfilled grains per panicle was 20 and 18.7 in the seed rate 20 and 30 kg ha^{-1} and in in the days of pendimethalin application it ranged from 15.5 (5 day) to 22.5 (1 day). There was also interaction effect between seed rate and in the days of pendimethalin application. In 2023 (Table 7), similar trend was found as that of in 2022, the unfilled grains were 26.1 and 23.9 in the seed rate 20 and 30 kg ha^{-1} and 22.5 (4 day) to 27.4 (5 day) in the days of pendimethalin application. In the pooled data (Table 8), similar trend with that of the 2022 and 2023 were found.

Grains yield

The grains yield in 2022 was 6875 and 7013 kg ha^{-1} in the seed rate 20 and 30 kg ha^{-1} and in the days of pendimethalin application it ranged from 6615 to 7355 (Table 6). The mean difference was not significant in the seed rate however it was significant in days of pendimethalin application. In 2023 (Table 7) the grain yield was 6841 kg ha^{-1} and 7091 kg ha^{-1} in seed rate 20 and 30 kg ha^{-1} respectively. In days of pendimethalin application it ranged from 6665 kg ha^{-1} (5 day) to 7523 kg ha^{-1}(1 day). The mean difference were significant only in the days of pendimethalin application. There was no interaction effect between seed rate and days of pendimethalin application. In the pooled data (Table 8) the grains yield in the seed rate 20 and 30 kg ha^{-1} was 6858 kg and 7052 kg ha^{-1} respectively and in the days of pendimethalin application it ranged from 6697 kg (5 day) to 7439 kg (1 day) and the mean difference among the treatments in days to pendimethalin application were only significant The increased yield under early pendimethalin application (one day after sowing) showed its efficiency in controlling weeds and enhancing yield attributes and yield. Mounisha and Menon (2020) also reported similar finding of high weed controlled by application of pendimethalin in early period of DSR.

Table 6. Effect of seed rate and days of pendimethalin application in DSR at Khumaltar during 2022

Treatments	Tillers m^{-2}	Panicle length(cm)	1000 grain wt.(g)	Filled grains per panicle	Unfilled grains per panicle	Grain Yield (kg ha^{-1})
Seed rate (S)						
20 kg	306	25.95	29.25	155.6	20.0	6875
30 kg	330	25.88	26.73	147.9	18.7	7013
LSD (<0.05)	ns	ns	ns	ns	ns	ns
Days of pendimethalin application (D)						
1 day	326	26.20	29.48	149.3	22.5	7355
2 day	332	25.65	29.07	147.1	21.8	6960
3 day	308	26.06	28.88	145.3	19.9	6929
4 day	317	25.85	28.65	142.9	17.0	6862
5 day	306	25.81	28.87	139.7	15.6	6615
LSD (<0.05)	ns	ns	ns	7.43	ns	375.5
S × D	ns	ns	ns	ns	ns	ns
CV (%)	117.5	16	16	10.4	29.1	4.4
G Mean	318	25.91	28.99	144.9	19.4	6944

LSD = Least significant difference, CV=Coefficient of variation, ns=Not significant

Table 7. Effect of seed rate and days of pendimethalin application in DSR at Khumaltar during 2023

Treatments	Tillers m^{-2}	Panicle length(cm)	1000 grain wt.(g)	Filled grains per panicle	Unfilled grains per panicle	Grain Yield (kg ha^{-1})
Seed rate (S)						
20 kg	286.8	25.74	30.28	146.7	23.08	6858
30 kg	299.9	25.61	29.86	143.0	21.32	7052
LSD (<0.05)	50.21	ns	ns	ns	ns	ns
Days of pendimethalin						

Treatments	Tillers m^{-2}	Panicle length(cm)	1000 grain wt.(g)	Filled grains per panicle	Unfilled grains per panicle	Grain Yield (kg ha^{-1})
application (D)						
1 day	303.6	25.66	31.09	149.3	24.22	7439
2 day	297.9	25.58	30.53	147.1	24.21	7044
3 day	296.1	25.71	29.18	145.3	21.32	6831
4 day	288.4	25.66	29.82	142.9	19.75	6764
5 day	280.7	25.77	29.72	139.7	21.48	6697
LSD (<0.05)	13.52	ns	0.887	7.43	ns	476
S ×D	*	ns	ns	ns	ns	ns
CV (%)	18.8	2.5	4.0	10.4	26.4	10.2
G Mean	293.3	25.67	30.07	144.9	22.20	6955

LSD = Least significant difference, CV=Coefficient of variation, *=Significant at p<0.05, ns=Not significant at p<0.05

Table 8. Effect of seed rate and days of pendimethalin application in DSR at Khumaltar during 2022 and 2023 (pooled)

Treatments	Tillers m^{-2}	Panicle length(cm)	1000 grain wt.(g)	Filled grains per panicle	Unfilled grains per panicle	Grain Yield (kg ha^{-1})
Seed rate (S)						
20 kg	286.8	25.74	30.28	146.7	23.08	6858
30 kg	299.9	25.61	29.86	143.0	21.32	7052
LSD (<0.05)	50.21	ns	ns	ns	ns	ns
Days of pendimethalin application (D)						
1 day	303.6	25.66	31.09	149.3	24.22	7439
2 day	297.9	25.58	30.53	147.1	24.21	7044
3 day	296.1	25.71	29.18	145.3	21.32	6831
4 day	288.4	25.66	29.82	142.9	19.75	6764
5 day	280.7	25.77	29.72	139.7	21.48	6697
LSD (<0.05)	13.52	ns	0.887	7.43	ns	476
S ×D	*	ns	ns	ns	ns	ns
CV (%)	18.8	2.5	4.0	10.4	26.4	10.2
G Mean	293.3	25.67	30.07	144.9	22.20	6955

LSD = Least significant difference, CV=Coefficient of variation, *=Significant at p<0.05, ns=Not significant at p<0.05

CONCLUSION

Selecting the right seed rate for direct seeded rice along with timing of pre-emergence herbicides like pendimethalin is very pivotal for achieving weed control and optimum yield. Seed rate of 30 kg ha^{-1} suppressed weeds efficiently and produced higher grain yield (7052 kg ha^{-1}) compared with 20 kg ha^{-1} recording less weed density and biomass. In the different days to pendimethalin application applying it on same day of sowing of rice resulted in better weed management and higher yield (7439 kg ha^{-1}) compared with others days of it application.

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AUTHORS' CONTRIBUTION

Rajendra Kumar Bhattarai**:** Writing manuscript, editing, analysis and conceptualization.
Bhimsen Chaulagain, Reshama Neupane, Sangita Kaduwal, Bigyan KC, Aashray Bhandari[1], Sweekriti Chand and Jiban Shrestha: Data curation, visualization, methodology development, supervision, conceptualization. Subindra Balami: Layout preparation and Asha Rana Magar: Conduction of experiment, data collection

CONFLICT OF INTEREST

The author declares no conflict of interest related to this study.

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