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Weed dynamics of relay field pea as influenced by different establishment methods and weed management practices in rice

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ABSTRACT

A field experiment was conducted during the kharif-rabi seasons of 2023–24 and 2024–25 at Gossaigaon, Kokrajhar, Assam, located in the Lower Brahmaputra Valley Zone, to assess the residual effect of establishment methods and weed management practices in rice on weed dynamics in succeeding relay field pea. The experiment was laid out in a split-plot design with three replications, comprising three crop establishment methods in rice, viz., conventional transplanting (M_1), direct seeding by drum seeder (M_2) and direct seeding under 50% reduced tillage (M_3), as main-plot treatments and six weed management practices as sub-plot treatments. The weed management treatments included pretilachlor 750 g ha⁻¹ as pre-emergence (PE) (W_1), pretilachlor 750 g ha⁻¹ PE followed by paddy weeder at 30 DAS/DAT (W_2), pyrazosulfuron-ethyl 25 g ha⁻¹ PE followed by bispyribac-sodium 25 g ha⁻¹ at 30 DAS/DAT (W_3), paddy weeder at 20 and 40 DAS/DAT (W_4), weedy check (W_5) and weed-free check (W_6). The findings revealed that crop establishment methods did not significantly influence weed density or dry matter at any growth stage in either year. However, direct seeding by drum seeder (M_2) recorded the lowest weed density and dry matter during the later stages of relay field pea. Whereas, weed management practices in the preceding rice crop significantly influenced weed density and dry matter in relay field pea. The lowest weed density and dry matter were recorded under the weed-free treatment (W_6), which remained statistically at par with pyrazosulfuron-ethyl 25 g ha⁻¹ PE followed by bispyribac-sodium 25 g ha⁻¹ at 30 DAS/DAT (W_3) and pretilachlor 750 g ha⁻¹ PE followed by paddy weeder at 30 DAS/DAT (W_2). No significant interaction between crop establishment methods and weed management practices was observed. Thus, direct seeding by drum seeder (M_2) combined with pyrazosulfuron-ethyl 25 g ha⁻¹ PE followed by bispyribac-sodium 25 g ha⁻¹ at 30 DAS/DAT (W_3) may be considered the most promising practical treatment combination for suppressing weed infestation in relay field pea, although the interaction was non-significant.

Keywords: Crop establishment methods, Drum seeder, Weed dynamics, Residual effect, Relay field pea, Weed management

Introduction

Rice is the dominant cereal crop of Assam and occupies a central role in the state's agricultural production systems. The sustainability of rice-based cropping systems depends not only on the productivity of the main crop but also on efficient utilization of resources and appropriate weed management across successive crops. Hence, the inclusion of pulses in rice-based systems offers opportunities for crop diversification, improved land-use efficiency and enhanced system productivity. Field pea (*Pisum sativum* L.) is an important pulse crop in Assam, with approximately 12,500 hectares under cultivation, production of 10,650 tonnes and an average productivity of 852 kg ha⁻¹ (Borah *et al.*, 2026) [1]. Relay cropping of field pea in which the succeeding crop is sown before the harvest of standing crop (rice), is a promising strategy to utilize residual soil moisture and the available growing period (Sarmah *et al.*, 2024) [2]. However, weed infestation remains an important factor influencing the success of such cropping systems.

Weed dynamics in rice-based cropping systems are significantly influenced by crop establishment methods and weed management techniques. Differences in tillage, water regime and crop establishment methods can alter the emergence, density and composition of weed species. Kumar *et al.* (2011) [3] highlighted the importance of crop establishment techniques in direct-seeded rice, where weed management is a major challenge. Similarly, Ansari *et al.* (2017) [4] also reported that crop establishment practices substantially influence density and biomass in rice based cropping system and may have implications beyond the rice-growing season, particularly when a succeeding crop is established under relay conditions. A study conducted by Bhattacharjya *et al.*, 2024 [5] in rice-based cropping systems reflected that the crop establishment and tillage practices can alter weed population and weed seed bank composition in succeeding crops.

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The residual effect of weed management practices adopted in rice is another important consideration in understanding weed dynamics in the succeeding crop. Effective weed management practices can reduce weed growth and seed production, potentially influencing the weed seed bank and subsequent weed emergence. Furthermore, herbicides applied in rice may persist in soil for varying periods depending on their chemical properties, application rates, soil characteristics and environmental conditions.

In relay field pea, the weed flora emerging during and after rice harvest may be influenced by the combined effects of the preceding crop's establishment method and weed management programme. Changes in weed species composition, density and dry matter accumulation may determine the extent of weed interference and the requirement for subsequent weed control. Although research has examined weed dynamics under different rice establishment and weed management systems, the carryover effects of these practices on weed populations in relay field pea under Assam's agroecological conditions needs to be assessed. Therefore, the present study was undertaken to evaluate the residual effects of different establishment methods and weed management practices in rice on weed dynamics in succeeding relay field pea, with the aim of identifying rice management practices that contribute to effective weed regulation across the rice-pulse sequence.

Materials and methods

A field experiment was conducted at Gossaigaon, Kokrajhar district, Assam (26°40' N latitude, 90°02' E longitude; 51.57 m above mean sea level), located in the Lower Brahmaputra Valley Zone of Assam during the *kharij-rabi* seasons of 2023–24 and 2024–25. The experiment was laid out in a split-plot design with three replications, comprising three rice establishment methods as main-plot treatments, *viz.*, conventional transplanting (M_1), direct seeding by drum seeder (M_2), and direct seeding under 50% reduced tillage (M_3), and six weed management practices as subplot treatments: pretilachlor 750 g ha⁻¹ as pre-emergence (PE) (W_1), pretilachlor 750 g ha⁻¹ PE followed by paddy weeder at 30 days after sowing/transplanting (DAS/DAT) (W_2), pyrazosulfuron-ethyl 25 g ha⁻¹ PE followed by bispyribac-

sodium 25 g ha⁻¹ at 30 DAS/DAT (W_3), paddy weeder at 20 and 40 DAS/DAT (W_4), weedy check (W_5); and weed-free check (W_6). The experiment was consisted of 18 treatment combinations per replication and 54 plots in total. Winter rice variety 'Numoli' was followed by relay field pea variety 'Aman', with pea seeds broadcast at 75 kg ha⁻¹, 15 days after flowering of rice, under the standing rice crop. No additional fertilizers or other inputs were applied specifically to the field pea crop to assess the residual effects of the preceding rice establishment methods and weed management practices on weed dynamics in relay field pea.

Weed flora was recorded in the weedy-check plots to identify the weed species associated with different rice establishment methods and their subsequent occurrence in relay field pea. Weed density was assessed at 30, 60, 90 and 120 days after sowing (DAS) of field pea by counting individual weeds in two randomly selected quadrats of 0.5 m × 0.5 m (0.25 m²) in each plot, and the mean density was expressed as plants m⁻². Weed samples collected from the quadrats were placed in perforated paper bags and oven-dried at 65 ± 5 °C until a constant weight was attained, and weed dry matter was expressed as g m⁻². The density and dry matter data were subjected to square-root transformation using $\sqrt{x + 0.5}$, where x represents the original observation, following Gomez *et al.* (1984) [6]. Data recorded during the two experimental years were subjected to analysis of variance (ANOVA) appropriate for a split-plot design, considering crop establishment methods as main-plot treatments and weed management practices as subplot treatments. Treatment means were compared at the 5% significance level using an appropriate mean-separation procedure.

Results and discussion

Weed flora

A total of 11 weed species were recorded during the crop growth period comprising of grasses, sedges and broad leaved weeds. Among the associated weed species, *Eleusine indica* among grasses, *Ageratum conyzoides* among broadleaved weeds and *Cyperus rotundus* (sedge) found dominant in relay field pea.

Table 1. Dominant weed flora associated with relay field pea

Sl No.	Common name	Scientific name	Family
a) Grasses			
1.	Bermuda grass	<i>Cynodon dactylon</i> (L.) Pers.	Poaceae
2.	Barnyard grass	<i>Echinochloa crusgalli</i> (L.) Beauv	Poaceae
3.	Indian goose grass	<i>Eleusine indica</i> (L.) Gaertn.	Poaceae
b) Sedges			
4.	Purple nutsedge	<i>Cyperus rotundus</i> L.	Cyperaceae
c) Broadleaved weeds			
5.	Billygoat-weed	<i>Ageratum conyzoides</i> L.	Asteraceae
6.	Slender pigweed	<i>Amaranthus viridis</i> L.	Amaranthaceae
7.	Common lambsquarter	<i>Chenopodium album</i> L.	Chenopodiaceae
8.	Asiatic pennywort	<i>Centralla asiatica</i> (L.) Urban	Apiaceae
9.	Indian sorrel	<i>Oxalis corniculata</i> L.	Oxalidaceae
10.	Tiny vetch	<i>Vicia hirsute</i> (L.) Gray.	Fabaceae
11.	Common vetch	<i>Vicia sativa</i> L.	Fabaceae

Weed density (No./m²)

Different crop establishment methods adopted in winter rice failed to show any significant difference in weed density at different growth stages of relay field pea during both the years of experimentation. However, least weed density was recorded under conventional transplanting (M_1) during the initial period up to 60 DAS in 2023-24 and up to 30 DAS in 2024-25. In the subsequent stages of relay pea the lowest weed density was observed under direct seeding by drum

seeder (M_2). There was significant variation in weed density noted in relay field pea due to adoption of different weed management practices in winter rice. The least weed density was found in the plots kept weed-free (W_6) during the previous crop and remained at par with that of pyrazosulfuron-ethyl 25 g/ha PE *f.b.* bispyribac-sodium 25 g/ha at 30 DAS/DAT (W_3) and pretilachlor at 750 g/ha PE *f.b.* paddy weeder at 30 DAS/DAT (W_2) in all the stages of relay field pea in both the years of study, and also with pretilachlor 750 g/ha PE (W_1) for the initial 60 DAS of pea during 2023-24. This could be attributed

to persistent effect of the weed management practices in winter rice which suppressed the weed growth till the later stages of the crop as well as continued its effect in relay field pea. This result is in agree-

ment with [Bhattacharjya et al. \(2024\)](#) [5]. No interaction effect was recorded on weed density in relay field pea at all the stages due to treatment combinations.

Table 2. Residual effect of crop establishment methods and weed management practices in rice on weed density in relay field pea

Treatments	Weed density (No./m ²)			
	2023-24			
	30 DAS	60 DAS	90 DAS	120 DAS
Main plot : Methods of crop establishment (M)				
M ₁ : Conventional transplanting	6.79 ^a (49.94) ^b	8.79 (81.61)	8.36 (74.61)	7.79 (66.61)
M ₂ : Direct seeding by drum seeder	7.50 (60.65)	8.86 (82.06)	7.84 (64.53)	7.52 (60.28)
M ₃ : Direct seeding with 50% reduced tillage	7.14 (55.64)	8.86 (82.06)	7.94 (67.83)	7.72 (64.22)
SEm (±)	0.25	0.22	0.28	0.16
CD (<i>p</i> = 0.05)	NS	NS	NS	NS
Sub plot: Weed management practices (W)				
W ₁ : Pretilachlor 750 g/ha PE	7.47 (57.71)	8.72 (77.78)	9.17 (83.83)	9.01 (81.56)
W ₂ : Pretilachlor 750 g/ha PE <i>f.b.</i> paddy weeder at 30 DAS/DAT	7.03 (51.14)	8.49 (72.89)	7.92 (63.39)	7.00 (50.22)
W ₃ : Pyrazosulfuron-ethyl 25 g/ha PE <i>f.b.</i> bispyribac-sodium 25 g/ha at 30 DAS/DAT	6.36 (42.40)	8.80 (77.22)	7.35 (56.72)	6.65 (46.89)
W ₄ : Paddy weeder at 20 and 40 DAS/DAT	8.33 (70.94)	9.57 (93.44)	9.26 (80.50)	8.99 (85.89)
W ₅ : Weedy check	9.92 (98.50)	11.71 (137.67)	10.45 (110.06)	10.05 (101.22)
W ₆ : Weed free check	3.77 (13.78)	5.74 (32.44)	4.42 (19.44)	4.11 (16.44)
SEm (±)	0.45	0.46	0.36	0.44
CD (<i>p</i> = 0.05)	1.30	1.32	1.03	1.26
Interaction (M x W)	NS	NS	NS	NS

DAS: Days after sowing, DAT: Days after transplanting, PE: Pre-emergence, NS: Non-significant, ^aSquare root ($\sqrt{x + 0.5}$) transformed value, ^bOriginal values in parentheses

Table 3. Residual effect of crop establishment methods and weed management practices in rice on weed density in relay field pea

Treatments	Weed density (No./m ²)			
	2024-25			
	30 DAS	60 DAS	90 DAS	120 DAS
Main plot : Methods of crop establishment (M)				
M ₁ : Conventional transplanting	5.72 ^a (35.83) ^b	8.52 (80.31)	8.04 (67.44)	7.36 (57.61)
M ₂ : Direct seeding by drum seeder	6.77 (49.23)	7.79 (76.83)	7.86 (64.36)	7.24 (55.17)
M ₃ : Direct seeding with 50% reduced tillage	6.29 (45.14)	8.55 (80.94)	7.95 (66.50)	7.25 (56.94)
SEm (±)	0.22	0.32	0.11	0.18
CD (<i>p</i> = 0.05)	NS	NS	NS	NS
Sub plot: Weed management practices (W)				
W ₁ : Pretilachlor 750 g/ha PE	6.60 (44.38)	9.25 (85.94)	8.96 (79.94)	8.13 (66.22)
W ₂ : Pretilachlor 750 g/ha PE <i>f.b.</i> paddy weeder at 30 DAS/DAT	5.81 (34.99)	8.29 (70.28)	7.96 (63.83)	7.01 (50.11)
W ₃ : Pyrazosulfuron-ethyl 25 g/ha PE <i>f.b.</i> bispyribac-sodium 25 g/ha at 30 DAS/DAT	5.19 (29.28)	7.81 (63.50)	7.29 (54.61)	6.56 (45.67)

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Treatments	Weed density (No./m ²)			
	2024-25			
	30 DAS	60 DAS	90 DAS	120 DAS
W ₄ : Paddy weeder at 20 and 40 DAS/DAT	7.10 (53.94)	9.29 (86.28)	9.10 (94.39)	8.64 (74.44)
W ₅ : Weedy check	9.19 (84.72)	11.21 (126.28)	9.73 (94.39)	9.25 (86.56)
W ₆ : Weed free check	3.68 (13.11)	5.86 (33.89)	4.67 (21.33)	4.11 (16.44)
SEm (±)	0.44	0.41	0.39	0.43
CD (<i>p</i> = 0.05)	1.27	1.17	1.11	1.23
Interaction (M x W)	NS	NS	NS	NS

DAS: Days after sowing, DAT: Days after transplanting, PE: Pre-emergence, NS: Non-significant, ^aSquare root ($\sqrt{x + 0.5}$) transformed value, ^bOriginal values in parentheses

Weed dry matter (g/m²)

Crop establishment methods failed to show significant difference in dry matter of weeds in relay field pea during both the years of experimentation. However, least weed biomass was recorded under conventional transplanting (M₁) during the initial period up to 60 DAS and thereafter under direct seeding by drum seeder (M₂). The weed management practices adopted in the previous crop winter rice significantly influenced the dry matter accumulation in weeds at all the growth stages of field pea in both the years of investigation. The weed biomass collected during the growing season of relay pea was lowest

in the plots kept weed-free (W₆) for the whole growing season of the previous crop which, however, remained at par with all the weed management practices adopted in rice except weedy check (W₆). This could be due to effective controlled of different weed flushes during the critical period of crop weed competition and its long term effect up to later stages of rice and initial stages of relay field pea which resulted in lower dry matter (Bhattacharjya *et al.*, 2024) [5]. The interactions of crop establishment methods and weed management practices failed to produce any significant change in weed dry matter during the growing period of relay field pea.

Table 4. Residual effect of crop establishment methods and weed management practices in rice on weed dry matter in relay field pea

Treatments	Weed dry matter (g/m ²)			
	2023-24			
	30 DAS	60 DAS	90 DAS	120 DAS
Main plot : Methods of crop establishment (M)				
M ₁ :Conventional transplanting	4.34 ^a (20.09) ^b	7.48 (61.28)	6.59 (44.65)	6.15 (38.92)
M ₂ :Direct seeding by drum seeder	5.33 (30.75)	7.72 (62.28)	6.46 (42.61)	5.67 (33.49)
M ₃ : Direct seeding with 50% reduced tillage	5.05 (27.19)	7.58 (64.19)	6.52 (44.11)	5.88 (35.19)
SEm (±)	0.20	0.32	0.12	0.12
CD (<i>p</i> = 0.05)	NS	NS	NS	NS
Sub plot: Weed management practices (W)				
W ₁ : Pretilachlor 750 g/ha PE	5.05 (26.63)	7.67 (58.87)	6.86 (47.08)	6.21 (39.06)
W ₂ : Pretilachlor 750 g/ha PE <i>f.b.</i> paddy weeder at 30 DAS/DAT	5.23 (27.68)	7.10 (52.71)	6.61 (43.53)	6.00 (36.11)
W ₃ : Pyrazosulfuron-ethyl 25 g/ha PE <i>f.b.</i> bispyribac-sodium 25 g/ha at 30 DAS/DAT	4.96 (25.31)	6.95 (51.03)	6.58 (43.45)	5.99 (35.96)
W ₄ : Paddy weeder at 20 and 40 DAS/DAT	5.30 (28.54)	8.08 (69.21)	7.63 (58.15)	6.33 (39.81)
W ₅ : Weedy check	6.53 (42.82)	10.98 (122.28)	7.40 (54.59)	7.12 (50.60)
W ₆ : Weed free check	2.36 (5.09)	4.77 (22.29)	4.05 (15.93)	3.76 (13.66)
SEm (±)	0.30	0.51	0.21	0.25
CD (<i>p</i> = 0.05)	0.88	1.48	0.62	0.71
Interaction (M x W)	NS	NS	NS	NS

DAS: Days after sowing, DAT: Days after transplanting, PE: Pre-emergence, NS: Non-significant, ^aSquare root ($\sqrt{x + 0.5}$) transformed value, ^bOriginal values in parentheses

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Table 5. Residual effect of crop establishment methods and weed management practices in rice on weed dry matter in relay field pea

Treatments	Weed dry matter (g/m ²)			
	2024-25			
	30 DAS	60 DAS	90 DAS	120 DAS
Main plot : Methods of crop establishment (M)				
M ₁ : Conventional transplanting	4.26 ^a (19.44) ^b	7.35 (56.59)	6.50 (43.66)	5.89 (35.71)
M ₂ : Direct seeding by drum seeder	4.91 (25.89)	7.57 (59.82)	6.25 (40.38)	5.34 (29.22)
M ₃ : Direct seeding with 50% reduced tillage	4.48 (21.35)	7.46 (58.26)	6.39 (42.33)	5.51 (31.08)
SEm (±)	0.20	0.28	0.19	0.21
CD (<i>p</i> = 0.05)	NS	NS	NS	NS
Sub plot: Weed management practices (W)				
W ₁ : Pretilachlor 750 g/ha PE	4.83 (23.53)	7.87 (62.61)	6.76 (45.45)	5.80 (33.53)
W ₂ : Pretilachlor 750 g/ha PE <i>f.b.</i> paddy weeder at 30 DAS/DAT	4.56 (20.82)	7.86 (62.82)	6.61 (43.44)	5.56 (30.82)
W ₃ : Pyrazosulfuron-ethyl 25 g/ha PE <i>f.b.</i> bispyribac-sodium 25 g/ha at 30 DAS/DAT	4.27 (19.08)	7.83 (62.47)	6.37 (40.87)	5.36 (29.08)
W ₄ : Paddy weeder at 20 and 40 DAS/DAT	5.01 (25.18)	7.95 (64.30)	6.88 (47.14)	5.94 (35.18)
W ₅ : Weedy check	6.32 (39.98)	8.81 (77.77)	7.88 (62.11)	7.07 (49.98)
W ₆ : Weed free check	2.30 (4.79)	4.46 (19.35)	3.77 (13.72)	3.73 (13.43)
SEm (±)	0.27	0.24	0.23	0.22
CD (<i>p</i> = 0.05)	0.79	0.67	0.65	0.63
Interaction (M x W)	NS	NS	NS	NS

DAS: Days after sowing, DAT: Days after transplanting, PE: Pre-emergence, NS: Non-significant, ^aSquare root ($\sqrt{x + 0.5}$) transformed value, ^bOriginal values in parentheses

Conclusion

Crop establishment methods in winter rice did not significantly influence weed density or weed dry matter in relay field pea during either year of experimentation. However, direct seeding by drum seeder (M₂) recorded the lowest weed density and dry matter during the later stages of relay field pea, indicating its favourable residual effect on weed suppression. In contrast, weed management practices in the preceding rice crop exerted a significant residual influence on weed dynamics in relay field pea. Pyrazosulfuron-ethyl 25 g ha⁻¹ as PE followed by bispyribac-sodium 25 g ha⁻¹ at 30 DAS/DAT (W₃) consistently recorded lower weed density, closely approaching the weed-free check (W₆) and remaining statistically at par with pretilachlor 750 g ha⁻¹ PE followed by paddy weeder at 30 DAS/DAT (W₂). Weed dry matter was lowest under the weed-free check (W₆), followed by W₃. Considering the performance of crop establishment methods and the consistent weed-suppressing effect of W₃, the combination of drum-seeded rice (M₂) with pyrazosulfuron-ethyl 25 g ha⁻¹ PE followed by bispyribac-sodium 25 g ha⁻¹ at 30 DAS/DAT (W₃) may be considered the most promising practical treatment combination for reducing weed infestation in relay field pea. Nevertheless, as the interaction between crop establishment methods and weed management practices was non-significant, this combination should be interpreted as superior rather than statistically superior. 49(6): 1015-1021. 49(6): 1015-1021. 49(6): 1015-1021.

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