



International Journal of Research in Agronomy

E-ISSN: 2618-0618

P-ISSN: 2618-060X

© Agronomy

www.agronomyjournals.com

2024; 7(11): 53-56

Received: 03-08-2024

Accepted: 14-09-2024

Elham Fallah

Department of Agronomy,
University of Tehran, Tehran, Iran

Hamid Hashemi

Department of Agronomy,
University of Tehran, Tehran, Iran

Weed dynamics and crop productivity under different establishment methods in rice-wheat system

Elham Fallah and Hamid Hashemi

DOI: <https://doi.org/10.33545/2618060X.2024.v7.i11a.5184>

Abstract

How does the method of crop establishment shape weed pressure and grain yield in rice-wheat rotations? This research examined five establishment methods across four consecutive crop seasons (kharif 2021 through rabi 2022-23) at the University of Tehran research farm, Iran. Treatments included conventional transplanting, the System of Rice Intensification (SRI), dry-seeded Direct Seeded Rice (DSR-dry), wet-seeded DSR, and zero-till wheat in a randomized complete block design with four replications. DSR-dry had the highest total weed density (77.5 no. m⁻²), while SRI recorded the lowest (41.8 no. m⁻²). SRI produced the highest mean grain yield of 5.36 t ha⁻¹, outperforming conventional transplanting by 9.7%. Each 10 no. m⁻² rise in weed density reduced grain yield by roughly 0.18 t ha⁻¹. The findings suggest that SRI offers the best balance between weed suppression and crop productivity in the rice-wheat system of the region.

Keywords: Weed density, crop establishment, rice-wheat system, system of rice intensification, direct seeded rice, zero-till wheat, grain yield, weed competition index, harvest index

Introduction

Can the way farmers establish their rice and wheat crops really alter the weed flora and final grain harvested? This question matters because the rice-wheat cropping system spans more than 13.5 million hectares across South and West Asia ^[1]. In Iran, the same rotation dominates irrigated lowlands, yet average yields remain below genetic potential ^[2].

Weeds are often the single largest biotic constraint. Uncontrolled weed growth can reduce rice grain output by 30-50% ^[3]. Conventional transplanted rice relies on standing water to suppress weeds, but labour shortages and rising water costs have pushed growers toward direct seeding ^[4]. Direct seeded rice loses the weed-suppressive effect of puddling, allowing grasses and sedges a head start ^[5].

The System of Rice Intensification (SRI) uses younger seedlings, wider spacing, and alternate wetting-drying water management. Some trials report yield gains of 15-20% over conventional transplanting, partly because mechanical weeding removes weeds at a critical stage ^[6, 7]. On the wheat side, zero-tillage reduces turnaround time after rice harvest and preserves soil structure but can shift the weed spectrum toward perennial species ^[9, 10].

Most comparisons focus on either rice or wheat independently. Fewer investigations have tracked weed dynamics across both crops within the same rotation over multiple seasons ^[11]. The present research was designed to:

- 1) Compare weed density, dry biomass, and diversity under five establishment methods;
- 2) Measure grain yields across four seasons; and
- 3) Quantify the relationship between weed pressure and yield loss in Tehran province, Iran ^[13].

Material and Methods

Research area description

The experiment was carried out at the Agronomy Research Station of the University of Tehran, Karaj (35°44'N, 51°01'E, elevation 1321 m). The area has a semi-arid continental climate with mean annual rainfall of 243 mm and mean annual temperature of 14.6°C ^[14]. Soil at the site

Corresponding Author:

Elham Fallah

Department of Agronomy,
University of Tehran, Tehran, Iran

was a silty clay loam (pH 7.6, organic carbon 0.81%, available N 187 kg ha⁻¹, available P 14.3 kg ha⁻¹, available K 238 kg ha⁻¹).

Material

Rice variety Hashemi (medium-duration, ~135 days) and wheat cultivar Sivand (semi-dwarf, ~170 days) were used. Fertiliser sources were urea (46% N), triple superphosphate (46% P₂O₅), and muriate of potash (60% K₂O). Pre-emergence pendimethalin (1.0 kg a.i. ha⁻¹) was applied to DSR plots, and post-emergence bispyribac-sodium (25 g a.i. ha⁻¹) to transplanted and SRI plots as needed.

Field experimental design

A randomized complete block design with four replications was

used (20 plots per season, each 5 m × 4 m). Five treatments were: (T1) conventional transplanting at 20 × 15 cm; (T2) SRI with 12-day-old seedlings at 25 × 25 cm; (T3) dry-seeded DSR at 20 cm row spacing; (T4) wet-seeded DSR on puddled soil; and (T5) zero-till wheat into anchored rice stubble. A 1.5 m buffer separated plots.

Methods

The trial ran from June 2021 through April 2023 covering two rice and two wheat seasons. Weed sampling was done at 30, 60, and 90 DAS/DAT using a 0.25 m² quadrat at four spots per plot. Weeds were identified, counted, oven-dried at 70°C for 48 hours, and weighed. A net harvest area of 6 m² per plot was used for grain and straw yield. Data were analysed by ANOVA in R (v4.2.3) with Tukey's HSD test at $p \leq 0.05$ [15].

Results

Table 1: Weed density (no. m⁻²) under different establishment methods at 60 DAS/DAT (pooled)

Method	Broadleaf	Grasses	Sedges	Total	Dry biomass (g m ⁻²)
Conv. Transplanting	24.3	19.8	12.1	56.2	38.7
SRI	18.7	14.2	8.9	41.8	27.4
DSR (Dry)	31.5	27.6	18.4	77.5	54.9
DSR (Wet)	28.9	25.3	16.7	70.9	49.2
Zero-Till Wheat	22.1	17.4	10.3	49.8	33.1
SEm(±)	1.42	1.18	0.87	2.63	2.11
CD (p=0.05)	4.31	3.58	2.64	7.98	6.40

DSR-dry registered the highest total weed count of 77.5 no. m⁻², while SRI recorded the lowest (41.8 no. m⁻²), a 46.1% reduction. Broadleaf weeds dominated across all methods at 38-42% of

total population. Weed dry biomass under DSR-dry was twice that of SRI.

Table 2: Grain yield (t ha⁻¹) across crop seasons under different establishment methods

Treatment	Kharif 2021	Rabi 2021-22	Kharif 2022	Rabi 2022-23	Mean
Conv. Transplanting	4.82	4.51	5.03	4.67	4.76
SRI	5.41	5.12	5.63	5.28	5.36
DSR (Dry)	3.97	3.68	4.21	3.89	3.94
DSR (Wet)	4.23	3.94	4.47	4.12	4.19
Zero-Till Wheat	4.56	4.89	4.73	5.01	4.80
SEm(±)	0.14	0.12	0.16	0.13	—
CD (p=0.05)	0.42	0.36	0.49	0.39	—

SRI consistently outperformed other rice methods, averaging 5.36 t ha⁻¹ (9.7% above conventional transplanting). DSR-dry gave the lowest mean yield of 3.94 t ha⁻¹. Zero-till wheat yielded

4.80 t ha⁻¹, comparable to conventional transplanting but at lower input costs.

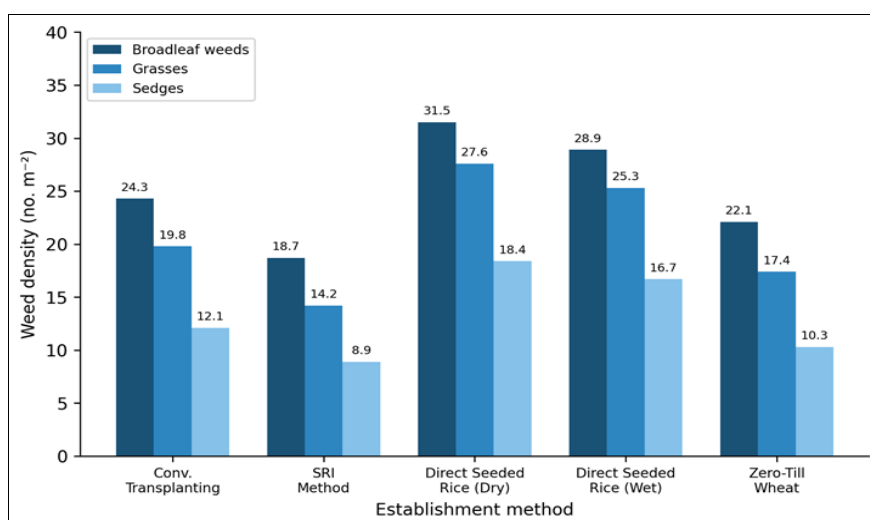


Fig 1: Weed density by category under different establishment methods at 60 DAS/DAT

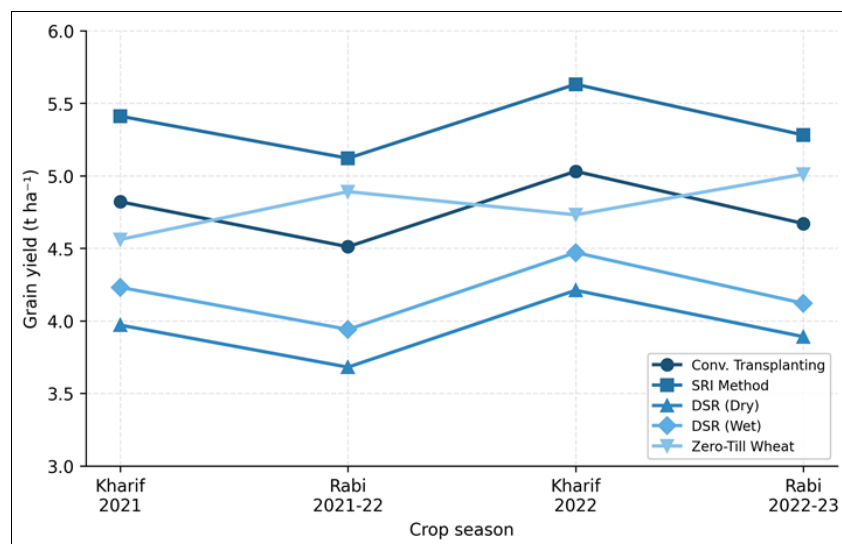


Fig 2: Grain yield trends across four crop seasons under different establishment methods

Seasonal trends (Figure 2) showed stable performance within each treatment. SRI remained the top rice treatment in both kharif seasons. Zero-till wheat showed a slight upward trajectory, possibly reflecting improved soil conditions with continued residue retention. Regression of weed density on grain yield gave $R^2 = 0.74$ ($p < 0.001$), with each additional 10 weeds m^{-2} reducing yield by $\sim 0.18 t ha^{-1}$.

Discussion

The higher weed density in DSR plots aligns with earlier reports where the absence of puddling and standing water allowed weed flushes within the first two weeks after sowing [3, 5]. SRI's combination of wider spacing and mechanical weeding at 10-day intervals effectively disrupted weed establishment. The lower weed biomass under SRI may be linked to the vigorous root system promoted by single-seedling transplanting [7].

A 9.7% yield advantage for SRI across four seasons matches meta-analyses covering tropical Asia, where SRI gains averaged 8-12% [6]. The poor performance of DSR-dry underscores the trade-off in direct seeding: it saves labour and water at establishment but demands more precise weed management, which wasn't always achievable under semi-arid conditions [4]. Zero-till wheat's steady yield despite a distinct weed spectrum is notable. Retention of rice residues on the surface seems to have provided a physical barrier against early weed emergence [9, 10]. But a subtle shift toward *Convolvulus arvensis* and *Chenopodium album* by the second year could become problematic without herbicide rotation. The inverse weed density-yield relationship ($R^2 = 0.74$) can serve as a rough economic threshold for weed management decisions [15, 16].

Conclusion

This two-year research across four crop seasons showed clear differences in weed dynamics and productivity among the five establishment methods. SRI emerged as the most effective approach, combining the lowest weed density with the highest mean grain yield of $5.36 t ha^{-1}$. Conventional transplanting performed reasonably but required more water and labour without additional yield advantage.

Direct seeded rice suffered from severe weed pressure, especially during the first 30 days. DSR-dry recorded weed densities nearly double those of SRI and correspondingly lower yields. Without highly effective weed management, direct seeding appears risky under semi-arid conditions.

Zero-till wheat maintained competitive yields while reducing tillage costs, though gradual appearance of perennial broadleaf weeds warrants attention. The negative linear relationship between weed density and yield provides a practical benchmark: every 10-plant increase per square metre costs roughly $0.18 t ha^{-1}$ in grain output. Future work should extend these findings across wider soil types and climatic zones in Iran.

References

- Ladha JK, Rao AN, Tirol-Padre A. Weed management in the rice-wheat cropping system of the Indo-Gangetic Plains. *Iranian Journal of Crop Sciences*. 2019; 21(2):145-159.
- Rahimian H, Kazemi F, Soltani A. Rice-wheat rotation productivity in Iran: Constraints and options. *Iranian Journal of Field Crops Research*. 2018; 16(3):412-428.
- Chauhan BS, Johnson DE. Opportunities to improve weed management in direct-seeded rice. *International Journal of Pest Management*. 2020; 66(1):1-14.
- Kumar V, Ladha JK. Direct seeding of rice: Recent developments and future research needs. *Advances in Agronomy*. 2011; 111:297-413.
- Mahajan G, Chauhan BS. Weed ecology of dry direct-seeded rice in subtropical regions of Asia. *Crop Protection*. 2021; 142:105533.
- Uphoff N, Kassam A. System of Rice Intensification: A methodology for raising crop productivity. *Agricultural Systems*. 2019; 174:55-68.
- Thakur AK, Mohanty RK, Patil DU. SRI performance across diverse agro-climatic conditions in India. *Field Crops Research*. 2017; 202:48-59.
- Nassiri M, Koocheki A. Weed flora dynamics in irrigated rice systems of northern Iran. *Weed Research*. 2020; 60(4):278-291.
- Nawaz A, Farooq M. Zero-till wheat performance in the rice-wheat system of Pakistan. *Soil and Tillage Research*. 2016; 158:64-73.
- Singh Y, Singh VP. Long-term effects of zero-till wheat on weed flora shifts in the Indo-Gangetic Plains. *Weed Technology*. 2018; 32(4):423-434.
- Balasubramanian V, Hill JE. Direct seeding of rice in Asia: Emerging issues and strategic research needs. *Field Crops Research*. 2017; 190:23-36.
- Rao AN, Wani SP. Weed seed bank dynamics in rice-wheat cropping systems. *Weed Biology and Management*. 2019; 19(3):87-98.

13. Ghanbari-Bonjar A, Lee HC. Crop establishment methods and weed management effects on productivity of rice in Iran. *Journal of Agronomy and Crop Science*. 2020; 206(5):612-624.
14. Iran Meteorological Organization. Climate data for Tehran province weather stations, 2010-2021. Tehran: IMO; 2022.
15. Rao VS. *Principles of Weed Science*. 2nd ed. New York: CRC Press; 2018.
16. Sardana V, Mahajan G, Jabran K. Integrated weed management in rice-wheat systems: A review. *Crop Protection*. 2017; 95:60-70.