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Crop Establishment technique in Redgram- A contingency measure for realizing higher productivity

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Abstract

Redgram (Cajanus cajan), a vital Kharif crop, frequently faces yield instability due to erratic rainfall and poor plant population survival. To address these challenges, a two-year field experiment (2022–2023) was conducted at Tamil Nadu Agricultural University (TNAU), Coimbatore, to evaluate the feasibility of transplanting as a contingency measure. The study examined the effects of nursery techniques (pro-trays vs. polyethylene bags), seedling age (20 vs. 25 days after sowing), and land configuration (flatbed vs. ridge transplanting) on crop productivity. Results indicated that transplanting significantly outperformed direct sowing, achieving an additional seed yield of 378 kg/ha (30.2%), primarily driven by a 21.6% increase in pods per plant. This yield advantage remained consistent regardless of seedling age or nursery material. Furthermore, seedlings raised in polyethylene bags and transplanted onto ridges yielded 15.5% higher than those on flatbeds. The study concludes that transplanting polyethylene bag-grown seedlings on ridges is a viable technology for stabilizing plant populations and maximizing redgram yields under the agro-climatic conditions of Tamil Nadu.

Keywords: *Transplanted redgram, Crop contingency, Economics, Ridge planting, Seed yield.*

Introduction

Redgram (*Cajanus cajan* L. Millsp) is the most vital Kharif pulse crop in India, predominantly cultivated under rainfed conditions. It occupies 3.89 million hectares, contributing 3.02 million tonnes to the national pulse pool; however, its average productivity remains stagnant at 776 kg/ha. The primary barrier to higher yields is low productivity during early growth stages, exacerbated by soil moisture stress and climatic aberrations in the Indian subtropics. During the monsoon, redgram is particularly sensitive to waterlogging, which restricts soil aeration, hinders nutrient uptake, and impairs root nodulation. These unfavorable conditions foster disease incidence and high seedling mortality, leading to a significantly sparse plant stand [1]. Strategically maintaining an optimal plant population in the face of these biotic and abiotic pressures is a major challenge for sustainable production. Furthermore, the late onset of rains often delays sowing, shortening the crop's vegetative window. To counteract these constraints, transplanting has emerged as a promising alternative. By raising seedlings in a nursery, typically in polyethylene bags and transplanting them into the main field once established, farmers can bypass early-season stressors and ensure a uniform plant stand [2, 3]. Established transplants exhibit rapid early growth and greater competitiveness against weeds compared to direct-sown crops. This technique essentially allows for "virtual" early sowing, enabling the crop to capitalize on the full growing season even when monsoon rains are delayed. However, research regarding optimized nursery protocols, ideal seedling age, and main field configurations is currently limited. Consequently, this study was undertaken to evaluate the feasibility and refine the technical and economic suitability of redgram transplanting for the agro-climatic conditions of Tamil Nadu.

Materials and Methods

A two-year field study (2022–2023) was conducted at the main farm of the Department of Agronomy, Tamil Nadu Agricultural University (TNAU), Coimbatore. The experimental site is characterized by a tropical sub-humid climate, featuring an average annual rainfall of 647 mm, with mean annual maximum and minimum temperatures of 33°C and 23°C, respectively. The study was conducted on double-cropped irrigated upland. Prior to the trial, the field followed a Rice–Blackgram rotation. The long-duration redgram variety 'CO 8' was utilized for the experiment across both years (2022 and 2023) to assess the efficacy of transplanting as a productivity-sustaining contingency measure. In the field experiments, two transplanting methods (flat-bed *vs* ridge-furrow) and 4 combinations of nursery raising techniques along with age of seedlings (*viz*., raising seedling in pro tray or polyethylene bags and transplanting these at 20 and 25 days after seeding; and a control involving in situ seeding in main field simultaneous transplanting with that in portrays and polyethylene bags, were laid out in a factorial RBD with 3 replications.

The long-duration variety 'CO 8' was selected for its moderate wilt resistance and suitability for the region. Sowing was initiated in mid-July for both experimental years.

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Prior to sowing, seeds were treated with Rhizobium and Phosphorus Solubilizing Bacteria (PSB) at a rate of 1 kg/ha each to enhance nitrogen fixation and nutrient availability. Transplanting of the long-duration 'CO 8' variety was synchronized with the onset of monsoon rains, occurring during the first fortnight of August in both 2022 and 2023. To evaluate the impact of land configuration on seedling establishment, two methods were employed: Flatbed Method, Pits were excavated to a depth of 15–20 cm at 30 cm intervals and Ridge Method, Seedlings were transplanted onto 30 cm high ridges. During transplanting, polyethylene bags were carefully removed to ensure the root zone and surrounding soil ball remained undisturbed, maintaining a uniform spacing of 120 x 30 cm across all treatments.

A basal fertilizer dose of 25:50:25:20 kg/ha of NPKS + Zn was applied to all plots. Water management was strictly monitored: Immediate irrigation after transplanting, followed by a life-saving irrigation at 10 days after transplanting (DAT). Supplemental irrigation was provided during the critical branching and pod development stages to mitigate rainfall deficits. The crop reached maturity and was harvested during the first week of March in both 2023 and 2024. Biometric data, including seed yield, yield attributes, and economic indicators, were recorded and subjected to rigorous statistical analysis to interpret the efficacy of the transplanting technology.

Results and Discussion

Seedling Age and Survival

The experiment highlighted the distinct advantage of utilizing 25-day-old seedlings as a robust crop contingency measure. Raising seedlings in polyethylene bags ensured a high density of healthy, vigorous plants, which effectively buffered against the initial field stresses that often diminish direct-sown populations.

Comparative Performance of Transplanting Methods

The crop exhibited significant variation in performance based on both the land configuration and the timing of transplanting. Seedlings transplanted on ridges showed superior root architecture and vegetative growth compared to those in flatbed pits, likely due to enhanced aeration and drainage. Variations in the yield attributes like number of pods per plant and grain weight were directly correlated to the seedling age at the time of field transfer. In respect to economic Viability, While transplanting requires an initial investment in nursery management, the resulting increase in seed yield and plant stand stability significantly improved the overall economics of cultivation compared to conventional methods [4].

The subsequent sections detail the quantitative data recorded over the two-year study period, focusing on the refined schedules that maximize redgram productivity in the Tamil Nadu region.

Impact of Land Configuration on Yield and Growth

The primary agronomic constraint in redgram productivity is suboptimal plant population, driven by delayed monsoon onset and high seedling mortality from waterlogging. This study demonstrates that land configuration is critical for mitigating these risks. Ridge transplanting achieved a 15.5% (210 kg/ha) yield increase over flat surfaces, regardless of seedling age or nursery method. The yield advantage on ridges is primarily attributed to a 15.6% increase in pods per plant, while 100-seed weight and seeds per plant remained consistent. Ridges provide superior drainage, maintaining soil aeration and nutrient uptake while preventing the negative impacts of waterlogging on nodulation and the rhizosphere micro-environment [8]. Consequently, plants on ridges exhibited more vigorous biometrics, including increased plant height, branch length, and biomass (Table 1), leading to a significantly improved Harvest Index (HI). These findings align with previous research [5, 6, 7] suggesting that raised-bed configurations are essential for redgram sustainability.

Optimization of Nursery Technique and Seedling Age

Seedling quality and age at transplanting were found to be pivotal for field success. Seedlings raised in black polyethylene bags outperformed those in pro-trays, likely due to more robust root development and the higher volume of nutrient-rich media (soil and vermicompost). A seedling age of 25 days proved superior to 20 days, resulting in enhanced plant height, branching, and dry matter accumulation. This maturity allows the plant to bypass early-season stressors and capitalize on the full monsoon period for vegetative growth, effectively simulating the benefits of "early sowing" even when rains are delayed.

Economic Viability and Sustainability

While transplanting is labor - intensive—with costs nearly double that of direct seeding [9, 10]—the investment is justified by the significantly higher crop performance. Ridge Planting recorded an additional net return of INR 9,600/ha compared to flatbeds, with a BCR of 2.63. The 25-day-old polybag-raised seedlings achieved the highest net returns (INR 53,913/ha) and a superior BCR of 2.72.Despite the higher manual labor costs associated with transplanting, the significant enhancement in pod bearing and total seed yield compensates for the expenditure, making it a viable contingency strategy for the agro-climatic conditions of Tamil Nadu.

Table 1. Growth and yield response of transplanted redgram as influenced by age of seedling and nursery raising methods

Treatments	Plant height (cm)	Branches /plant	Dry wt. / plant (g)	Pods /plant	Seeds /pod	100 seed wt. (g)	Survival at harvest (%)
Land configuration							
Flat	212	14.6	251	216	3.6	9.7	85.8
Ridges	232	19.2	314	256	3.7	10.0	92.6
C.D(p=0.05)	7.6	2.2	16.4	21	NS	NS	2.1
Nursery raising method and age of seedlings							
Polythene bags + 25 DAS	235	19.9	298	264	3.8	10.1	93.4
Polythene bags + 20 DAS	228	18.5	330	247	3.5	9.8	91.7
Pro tray + 25 DAS	219	15.3	235	222	3.7	9.8	88.2
Pro tray + 20 DAS	205	13.9	267	210	3.4	9.6	83.4
Direct sowing	173	12.9	252	185	3.4	9.5	81.5
CD (p=0.05)	15.8	3.2	28.3	23	NS	NS	3.7

Table 2. yield and economics response of transplanted redgram as influenced by age of seedling and nursery raising methods

Treatments	Seed yield (kg /ha)	Stalk yield (kg/ha)	HI (%)	Cost of cultivation (₹./ha)	Gross return (₹/ha)	Net return (₹./ha)	BCR
Land configuration							
Flat	1145	3172	26.5	29212	70292	41076	2.41
Ridges	1355	3509	27.8	31042	81717	50676	2.63
C.D(p=0.05)	178.2	288.4	1.2	-	-	-	-
Nursery raising method and age of seedlings							
Polythene bags + 25 DAS	1388	3428	28.8	31310	85223	53913	2.72
Polythene bags + 20 DAS	1273	3284	27.9	30773	78210	47438	2.54
Pro tray + 25 DAS	1182	2896	29.0	29415	72563	43148	2.47
Pro tray + 20 DAS	1108	2803	28.3	29018	68021	39003	2.35
Direct sowing	872	2293	27.5	27250	53594	26344	1.98
CD (p=0.05)	98.4	128.4	0.71	-	-	-	-

Conclusion

The study concludes that raising red gram seedlings in black polyethylene bags and transplanting them at 25 days after sowing (DAS) on ridges constitutes a superior and economically viable technology for the farming communities of Tamil Nadu. This methodology significantly improves productivity, yielding 30% more than direct sowing by ensuring a robust initial plant stand and maximizing the vegetative growth window. Beyond its use for primary crop establishment, this technology serves as a critical contingency measure for remediating poor stands through gap-filling in moisture-stressed dryland regions. By adopting this transplanting protocol, farmers can effectively mitigate the risks of delayed monsoons and waterlogging, ultimately stabilizing production and increasing net returns (BCR=2.72) in the face of climatic uncertainties.

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