Seedling Transplanting Protocols for Sustainable Pigeonpea Production in Semi-Arid Tropics

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Background

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is a protein-rich leguminous crop that fits well in diverse cropping systems and contributes significantly in enhancing soil fertility and nutrient cycling. Pigeonpea is grown in 82 countries worldwide, covering a total area of 5.4 mha and yielding 4.49 mt annually. India occupies 90% of the global pigeonpea cultivation area (4.53 mha) and produces 85% of the total output (3.89 mt of production).

Despite the large area under cultivation, its national productivity is very low i.e., 850-900 kg ha^{-1}, primarily due to non-adoption of good agronomic management practices and suitable genotypes. To address these challenges, ICRISAT's long-term strategic research has demonstrated that transplanting pigeonpea (3-4 week seedlings raised in a nursery), using region-specific genotypes, effective planting geometry, and suitable landform management practices can achieve higher pigeonpea productivity on a sustainable basis. The research findings confirm that transplanted pigeonpea is a potential climate-resilient technology that enhances early crop establishment, optimises water use, and increases system productivity by 20-38% in rainfed agro-ecosystems.

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Advantages of Transplanting Pigeonpea

- **Timely sowing**: Enables farmers to sow pigeonpea on time, utilizing the first rainwater.
- **Resilience to erratic rainfall:** Well-established root system helps seedlings sustain erratic rainfall after transplanting.
- **Good vigour:** Improved nutrient and water uptake due to the well-developed root system.
- **Reduce crop duration:** By 12-15 days, and early crop maturity, thus minimizing the effect of low soil moisture during the post-rainy season
- **Yield and economics:** Productivity enhancement by 20-38% with increased net returns
- **Second crop opportunity:** Early maturity allows smallholder farmers to take a second crop in the post-rainy season under protective irrigation

Suitable Ecologies

- **Regions with variable rainfall:** Regions vulnerable to climate change, especially due to erratic rainfall patterns, where direct seeding often fails.
- **Smallholder farming systems:** Regions where pigeonpea is a major crop, important source of income and nutrition among smallholder farmers.

Scientific Protocols for Pigeonpea Seedling Preparation

Standardized seedling raising is the cornerstone of climate-resilient pigeonpea production. By transitioning from direct seeding to raising pigeonepa seedlings in a low-cost nursery, farmers can ensure robust plant establishment in field and optimize system productivity. The following protocols details the scientific requirements for raising high-quality seedlings.

1. Nursery Infrastructure and Media Selection

- The nursery must provide an optimal environment for early root development and vegetative vigor.
- **Site selection:** The nursery should be situated on a well-drained site with a reliable water source. It must be protected from external threats such as flooding or grazing.
- **Containerization:** Use protrays to facilitate individual seedling growth, which prevents root entanglement and minimizes transplanting shock.
- **Growing media:** Fill protrays with sterile cocopeat. This media is selected for its superior aeration, and high water-holding capacity, which promotes healthy root architecture.

2. Seed Management and Sowing Technicalities

Precision during the sowing phase ensures a uniform plant stand and high germination rates.

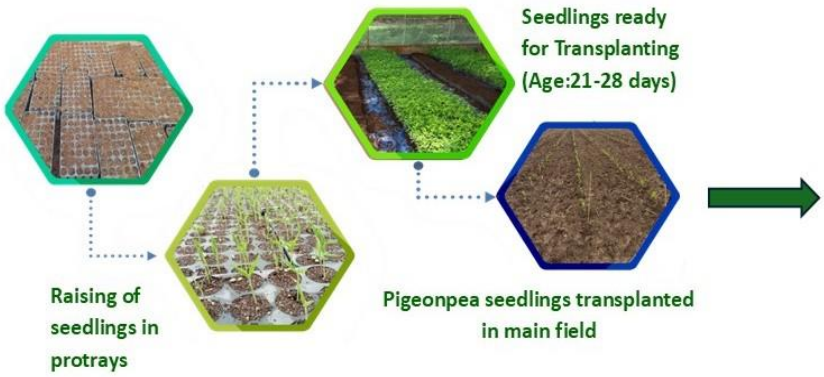
- **Genotype selection:** Utilize climate-resilient, medium-to-long duration genotypes, as these have demonstrated the highest grain yields and water productivity in transplanting systems.
- **Seed treatment:** To prevent soil-borne fungal infections, treat the seed with carbendazim or mancozeb @ 2g per kg of seed before sowing.
- **Sowing density:** Scientifically, sowing 1-2 seeds per cavity of protray is recommended to guarantee a full plant population, accounting for natural variation in germination.
- **Sowing depth:** Place seeds in portrays at a uniform depth of 2-3 cm to ensure uniform germination and consistent emergence.

3. Precision Nursery Management

Maintaining physiological health during the 21-28th day nursery period is critical for field survival.

- **Irrigation protocol:** Seedlings require optimal moisture without saturation. Watering twice a week using watering can is generally sufficient for avoiding excess moisture, which can cause root rot.
- **Environmental regulation:** In conditions of extreme heat or dryness, provide partial shade using shade nets or locally available materials, particularly during the first week of germination.

- **Nutrient supplementation:** In case of delayed transplanting (i.e. more than 30 days), if seedlings exhibit chlorosis (pale leaves), apply a 1% of urea once.
- **Sanitation:** Regularly rogue out any seedlings that appear diseased or weak to maintain the health of the entire batch.
- **Seedling production cost**: INR 8000-10000 per ha




Transplanted Pigeonpea in the field

4. Readiness for Transplanting

A seedling is considered scientifically ready for transplanting in the main field when it reaches specific developmental stages:

- **Chronological age:** 21-35 days after sowing.
- **Morphological stage:** The presence of 4-6 fully opened leaves with a sturdy stem.
- **Root integrity:** The root system must be well-developed, holding the cocopeat ball intact without being "root-bound".

Pre-transplanting Note: Provide light watering to the nursery 1-2 hours prior to transplanting. This ensures the cocopeat adheres to the roots, providing a moisture buffer and physical protection during the transition to the field.

Key findings

- **Optimal seedling age*:*** Transplanting seedlings of 21-28 days resulted in higher grain yield (GY), net return (NR), water productivity (WP), and economic water productivity (EWP), which was followed by seedling of 35 days.
- **Genotype performance:** Medium to long duration genotypes outperformed short duration genotype in terms of GY, NR, WP and EWP.
- **Interaction effect** (Age of Seedling x Genotypes): 21 day seedlings of medium to long duration genotypes recorded the highest GY, NR, WP and EWP.
- **Findings of on-station trials:** Transplanting pigeonpea recorded significantly higher yields (~30 q ha^{-1}) versus direct seeding (~25 q ha^{-1}), with an increment of 20% under the climate change scenario.