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Original Article

Agronomic Perspectives on Production Technology of Lentil (*Lens culinaris*) for Enhanced Productivity

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INTRODUCTION

Lentil (*Lens culinaris*) is one of the earliest domesticated legume crops, valued for its high nutritional content and adaptability to diverse agroclimatic conditions. Particularly in impoverished nations, lentils are a crucial source of plant-based protein, dietary fiber, vitamins, and essential minerals, contributing to food and nutritional security. They are essential to low-input, sustainable agricultural systems because they can fix atmospheric nitrogen through symbiotic interactions with rhizobia, thereby improving soil fertility.

Lentil farming benefits rural communities and promotes agricultural sustainability, as well as its nutritional and agronomic value. It thrives in rainfed areas and needs few resources, making it ideal for marginal land. The rising demand for nutrient-dense, climate-resilient crops offers lentil farming significant potential to improve food security, sustainability, and economic stability. It possesses a well-developed taproot system, with numerous fibrous lateral roots, which enhance nutrient and water absorption. The plant generally attains a height of about 25–40 cm and bears light green to bluish-green foliage. Its seeds are typically lens-shaped, a feature that gives the crop its name. The genus Lens includes four important wild species, namely Lens orientalis, L. nigricans, L. ervoides, and L. montbretii, which are considered significant for genetic diversity and crop improvement programs.

Geographical coverage and distribution

The lentil is an important pulse crop with global significance, cultivated over approximately 5.5 to 6.2 million hectares in the 2025-26 growing season. The total production of red lentils in major exporting countries like Canada, Australia, India, Turkey, and the USA is projected to reach around 5.33 million tonnes during the same period, with yields varying from 227 kg per hectare. Lentils are primarily cultivated in temperate and subtropical climates. India leads in cultivated area, largely due to its importance in traditional cuisines and suitability for rainfed agroecosystems.

The largest area under cultivation is approximately 1.5-1.9 million hectares, and production for the 2025-26 crop year is projected at 1.744 million metric tonnes (MMT), marking an increase of 80000 tonnes over the past year, especially in states like Uttar Pradesh, Madhya Pradesh, Bihar, and West Bengal.

Soil Requirements

Lentils are grown on different types of soils ranging from deep, well-drained loamy soils with a neutral soil pH during chilly, dry winters, which achieve high yields, as they are extremely sensitive to waterlogging.

Field Preparation

Ensure the seedbed is friable and weed-free. Place seeds at a uniform depth of 3–4 cm. For heavy soils, plough deeply once, then harrow 2–3 times across. In some regions, minimize or skip tillage to conserve soil moisture, especially when planting after rice.

Climate Requirements

The cool-season pulse crop lentil is mostly farmed in temperate and subtropical climates as a rabi crop. For optimal germination and early development, the temperature during vegetative growth must be between 18 and 30°C. While too much heat lowers yield, somewhat warmer temperatures (20–25°C) are appropriate for flowering and pod development. The crop is susceptible to waterlogging and thrives in regions with low to moderate rainfall (30–45 cm). At maturity, a dry environment guarantees higher-quality seeds and reduces the risk of illness. In general, lentils thrive in cold, dry, well-drained conditions. They can withstand a reasonable amount of dryness, but they are vulnerable to extreme frost.

Varieties

Lentil (Lens culinaris) cultivars should be selected carefully based on crop duration, resistance to major pests and diseases, and current agro-climatic conditions. Selecting high-yielding, regionally tailored cultivars reduces production risks, ensures efficient resource use, and improves adaptation to local conditions. In field pea production systems, these well-adapted cultivars support consistent yields, enhanced crop performance, and general sustainability. Table 1.1 Recommended Varieties are given below.

Varieties	Releasing Year	Releasing Center	Yield (q/ha)	Maturity (Days)	State	Special Characters
IPL-341 (Jagriti)	2025	IIPR, Kanpur	19-20	110	Madhya Pradesh	Tolerance to rust and fusarium wilt, bold-seeded
IPL-342 (Uttam)	2025	IIPR, Kanpur	19-20	112	Madhya Pradesh	Disease resistant
Pant Lentil 12 (PL 245)	2023	GBPUA&T, Pantnagar	13-16	143-183	Uttarakhand	Rust-resistant, sustainable for irrigated & rainfed
VL Masoor 150	2023	VPKAS, Almora	8-12	156-160	Uttarakhand	Moderately resistant to wilt
IPL-230	2023	IIPR, Kanpur	12-14	112-115	Uttar Pradesh	Resistant to rust and wilt, suitable for rainfed
IPL-534	2020	IIPR, Kanpur	14–16	100–107	Madhya Pradesh	resistant to major diseases
IPL-220	2018	IIPR, Kanpur	14–18	119–122	Eastern India	Rich in Fe & Zn, disease resistant
KLB 345 (Shekhar-4)	2018	CSAUA&T, Kanpur	18-22	112	Uttar Pradesh	High Yield

Table 1.1 (Recommended Varieties)

Time of sowing

The rabi season crop, lentil, has different sowing timings depending on the area and climate. In northern India, especially in states like Uttar Pradesh, Bihar, and Madhya Pradesh, the best period to seed is often between mid-October and mid-November. Early seeding helps prevent terminal heat stress throughout maturity and guarantees appropriate vegetative growth at ideal temperatures.

While late sowing (after November) frequently results in reduced yield due to high temperatures during the flowering and grain-filling phases, early sowing (before mid-October) may lead to excessive vegetative growth and increased insect pressure. Therefore, keeping the ideal sowing window is essential to improving crop performance and output.

Seed Treatment

For effective crop establishment, seeds should be treated strictly following the FIR sequence (Fungicide–Insecticide–Rhizobium) to protect against seed- and soil-borne pathogens and early insect pests, and to enhance biological nitrogen fixation.

Fungicidal treatment: Treat seed with Thiram @ 2 g + Carbendazim @ 1 g per kg of seed to manage wilt and root rot.

Insecticidal treatment: Thiamethoxam 70 WP @ 3 g/kg seed for protection against early-season insect pests.

Biofertilizer and micronutrient treatment: Subsequently, inoculate seeds with Rhizobium culture @ 5 g/kg seed and Phosphate Solubilizing Bacteria (PSB) @ 5 g/kg seed to enhance nodulation and nitrogen fixation.

Seed Rate and Spacing

By using a higher seed rate and closer spacing, yield loss might be minimized. Rows should be planted 30 centimeters apart. Either a fertilized drill or sowing behind a desi (country) ploughing system may achieve this. For a typical crop, a seed rate of 30–40 kg/ha is ideal. In the event of late sowing, the seed rate should be raised to 50–60 kg/ha. For a late-sown crop, row spacing should also be reduced to 20–25 cm. Sowing lentil seeds at a shallower depth (3–4 cm) is recommended

Manure and Fertilizers

Soil testing is the first and most essential step in planning efficient nutrient management for lentil (Lens culinaris). A pre-sowing soil analysis helps determine the availability of major nutrients (N, P, K), as well as secondary nutrients such as sulfur and micronutrients like zinc and boron, which are crucial for optimal lentil growth and nodulation. This assessment enables precise, site-specific fertilizer recommendations, ensuring balanced nutrition, improved yield, and sustainable lentil production. As a leguminous crop, lentil (Lens culinaris) also fixes atmospheric nitrogen through symbiosis with Rhizobium bacteria. This process does not start immediately after sowing; nodulation generally begins within 10–15 days, and active nitrogen fixation becomes significant around 20–25 days. Proper seed inoculation with Rhizobium ensures early and effective nodulation, leading to better plant growth and reduced dependence on nitrogen fertilizers. For lentils, the standard recommended NPK fertilizer dosage is 20–25 kg of nitrogen (N), 40–60 kg of phosphorus (P2O5), and 20–30 kg of potassium (K2O) per hectare. To improve yield, 20–30 kg of sulfur (S) is often applied, particularly in sulfur-deficient soil.

Water Management

Most of the time, the crop is farmed without irrigation. It can withstand drought conditions to a certain degree. Higher yields can be achieved by applying one or two irrigations, especially when winter precipitation is unevenly distributed. After 45 days of sowing, the first watering should be applied, and if necessary, again while the pods are full. Increased irrigation may negatively affect crop performance.

Weed Management

Preventive measures involve clean cultivation practices, use of certified weed-free seed, weed-free seedbeds, well decomposed organic manures, weed-free bunds and irrigation channels, and clean farm tools and machinery and preventing weed seed production by controlling weeds prior to the reproductive stage (Bahadur *et al.,* 2015), (Gaurav *et al.,* 2016). Efficient weed management in chickpea during the critical crop–weed competition phase (30–45 DAS) is crucial to reduce resource depletion, improve nutrient uptake efficiency, and foster optimal crop growth and yield achievement.

Table 1.2 presents the recommended herbicides and application times for effective weed suppression.

Herbicide	Time of Application	Dose (g ai/ha)	Remark
Chlorimuron-ethyl	Pre-Planting Incorporation	4 g/ha	Selective and systemic type herbicide, controlling for broad-leaf weeds and sedges.
Pendimethalin	Pre-emergence	0.75-1.0 kg/ha	Dinitroaniline group herbicide controlled for annual grasses and broad-leaf weeds in the crop
Oxyfluorfen	Pre-emergence	240 g/lit.	Used to control early broad-leaf weeds and grassy weeds, contact herbicide with residual soil activity
Imazethapyr	Post-emergence	37.5-50 g/ha	Selective and systemic herbicide used for controlling broad-leaf and grassy weeds
Quizalofop-ethyl	Post-emergence	50 g/ha	Selective and systemic herbicide used to control narrow-leaf grasses

Table 1.2 (Recommended herbicide for Weed Control)

Plant Protection

1. Disease Control

If left untreated, major lentil diseases, including wilt, rust, and root rot, can significantly reduce yields. Crop rotation, the use of resistant cultivars, and good field cleanliness can all help reduce these diseases. Fungicides such as Thiram or Carbendazim can be applied to seeds to help prevent the spread of soil- and seed-borne diseases. Maintaining adequate drainage and applying the appropriate fungicides at the right time further reduces disease incidence and enhances crop health.

Table 1.3 below provides descriptions of disease control strategies and symptoms.

Disease	**Causal Organism**	**Disease Symptom**	**Chemical Control**	**Non-Chemical Control**
Seedling Mortality	*Fusarium oxysporum f.sp.lentils and Sclerotium rolfsii*	Poor or patchy germination; young seedlings collapse at the soil surface; seedlings dry up and die soon after emergence.	Seed treatment with fungicide Carbendazim or Thiram (2–3 g/kg seed).	Use disease-free, healthy seeds, crop rotation, and avoid excess irrigation.
Wilt	*Fusarium oxysporum f.sp.lentils*	Leaves start yellowing, plants start drying, and finally die	Seed treatment with Vitavax+thiram @ 4 g/kg seed	Clean the field or crop rotation in three years, and use healthy seeds
Rust	*Uromyces fabae*	Small, orange-to-brown, powdery pustules appear on leaves, stems, and pods, which rupture to release rust-colored spores, giving the appearance of dust.	Spray fungicides like **Mancozeb @ 2.5 g/L in 3 liters of water, or Propiconazole @ 1 ml/L in 3 liters of water**. Repeat the spray at **10–15-day intervals if the** infection persists.	Grow tolerant varieties and follow crop rotation. Remove and destroy infected plant parts to reduce the spread.

Table 1.3

2. Insect Control

Aphids, pod borer, and cutworms are major insect pests of lentil that can significantly reduce productivity. Timely planting, field cleanliness, and the adoption of resistant genotypes can all help control their incidence. Effective, long-lasting pest control is facilitated by integrated pest management techniques, such as biological control and monitoring. **Table 1.4** below provides a description of insect control strategies and symptoms.

Insect	**Symptoms**	**Chemical control**	**Non-chemical control**
Hairy caterpillar *Spilosoma obliqua*	Irregular holes on leaves, **Defoliation** when severe attack then leaf loss	Cypermethrin 10 EC @ 650 ml or indoxacarb 15.8 @ 300 ml	Hand picking & destruction, deep ploughing, Light traps, Pheromone traps release parasitoids like Trichogramma spp.
Semilooper *Chrysodeixis acuta*	Irregular holes on leaves, Defoliation	Same as hairy caterpillar	Same as a hairy caterpillar

Table 1.4

Harvesting and threshing

To ensure optimal seed maturity and minimal losses, the lentil crop should be picked when 80–90% of the pods have turned brown, and the plants are dry. Pod cracking can be minimized by timely harvesting, either in the morning or evening. Before being threshed, the harvested plants are sun-dried for a few days to reduce their moisture content. To reduce seed damage and losses, threshing can be more effectively accomplished with mechanical threshers or with more conventional techniques such as pounding or trampling. For improved storage and quality, seeds must be properly cleaned and dried to safe moisture levels.

Yield

Under average Climatic conditions, lentil yield potential typically ranges from 20 to 25 quintals per hectare**,** especially when improved cultivars and appropriate agronomic practices are adopted. With effective crop management, including balanced nutrition, timely irrigation, and proper pest control, yields can be further optimized. Key factors influencing productivity include varietal selection, soil fertility, moisture availability, and plant protection measures**.**

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