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Possible Constraints and Remedies in Chickpea Production

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INTRODUCTION

Chickpea (Cicer arietinum L.) is an important grain legume that plays a vital role in global food and nutrition security, especially in semi-arid regions. Known for its high protein content and ability to fix atmospheric nitrogen, chickpea improves human nutrition and soil health, encouraging sustainable farming practices.

However, despite its importance in agriculture and the environment, chickpea yields still lag behind their genetic potential. This yield gap results from a complex mix of environmental, biological, farming, and socio-economic challenges. These factors often intensify each other, creating significant barriers to consistent and improved production.

Possible Major Constraints in Chickpea Production

1. Abiotic Constraints (Environmental Limitations)

Drought Stress:

Drought is the biggest and most widespread factor limiting chickpea yields, especially in rainfed farming systems that rely heavily on stored soil moisture. Terminal drought stress during flowering greatly impacts crop health.

A lack of moisture causes stomata to close, leading to less carbon intake and reduced photosynthesis. At the same time, levels of abscisic acid (ABA) rise, which speeds up reproductive loss, especially of flowers and immature pods. This hampers resource allocation, resulting in poor seed filling and reduced grain weight. Research indicates that drought stress alone can cut yields by 40–60%, underscoring its critical role (Devasirvatham et al., 2018; Kashiwagi et al., 2015).

Thermal Stress:
Temperature fluctuations, especially during the flowering stage, are crucial for chickpea yields. Temperatures above 30–35°C hinder enzyme activity and diminish pollen viability, resulting in failed fertilization and less pod formation. Heat stress also shortens the grain-filling period, producing smaller seeds and lower overall yields. Conversely, freezing temperatures can damage plant cells by disrupting membranes and forming ice crystals. This results in flower damage, pod loss, and lower reproductive success. The increasing occurrence of heat and cold stresses led by changing climates poses a major threat to chickpea farming systems (Varshney et al., 2014).

Soil-Related Constraints

Poor soil fertility severely affects chickpea productivity, particularly in marginal lands where the crop is most often grown. Deficiencies in macronutrients like phosphorus and sulfur negatively impact root growth, energy transfer, and protein production. Micronutrients such as zinc and boron are vital for enzyme functions and reproduction, and their shortages can lead to problems with flowering and seed set. Furthermore, high salinity and alkalinity create osmotic and ionic stress, disrupting water absorption and nutrient balance. These conditions also hinder nodulation and biological nitrogen fixation, reducing the plant's natural advantages as a legume (Vadez et al., 2007; Varshney et al., 2014).

2. **Biotic Constraints (Biological Stress Factors)**

Insect Pests

Among the various insect pests that harm chickpea, the pod borer (Helicoverpa armigera) is clearly the most damaging. The larvae feed voraciously on seeds inside pods, causing considerable losses in both quantity and quality. This pest can lead to yield declines of 10-60% by attacking leaves and pods. Other significant pests include cutworms (Agrotis ipsilon), termites, aphids, and bruchids during storage.

Minor and Regional Pests:
• Whitefly (Bemisia tabaci) and Thrips: Sucking pests that cause damage during warmer and drier periods.
• Wireworms and False Wireworms: Soil pests that attack seeds and roots.
• Blue Butterfly (Lampides boeticus): A pod borer that causes losses in some regions.
The pest's ability to consume many types of plants, rapid reproduction, and growing resistance to conventional insecticides complicate management efforts. In severe cases, it can lead to yield losses of 70–80%, emphasizing its economic impact (ICRISAT, 2012).

Diseases

Chickpea is prone to several harmful diseases that greatly affect yield stability.
Fusarium wilt (Fusarium oxysporum f. sp. ciceri) is a soil-borne pathogen that infects vascular tissues, leading to wilting and plant death. Ascochyta blight (Ascochyta rabiei) creates necrotic spots on plant parts, lowering photosynthesis. Botrytis gray mold (Botrytis cinerea), common in humid conditions, can cause rapid crop decline, and in severe cases, total yield loss. The occurrence of these diseases largely depends on environmental conditions, demanding close management (Pande et al., 2005; ICRISAT, 2012).

Weed Infestation

Weed competition is especially harmful during the early stages of growth (20–40 days after sowing) when chickpea grows slowly.
Weeds aggressively compete for critical resources like nutrients, water, and light, stunting crop growth and development. Unchecked weed populations can reduce yields by 40–60%, depending on the severity and type of weeds.

3. Agronomic Constraints

Poor farming practices significantly widen the yield gap in chickpea. Continuing to use traditional, low-yielding varieties with limited

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tolerance to stress lowers productivity. Low seed replacement rates and subpar seed quality also weaken crop establishment. Delayed planting exposes crops to late-season heat stress, while poor plant spacing disrupts canopy formation and resource use. Additionally, improper fertilization practices, especially overuse of nitrogen, stifle nodulation and biological nitrogen fixation, negatively affecting yields.

4. Socio-Economic Constraints

Socio-economic issues are a key but often neglected aspect of challenges in chickpea production. Limited access to quality inputs, weak extension services, and a lack of awareness about better practices hold back the adoption of improved technologies. Market instability, such as price changes and uncertain procurement processes, makes farmers hesitant to invest in chickpea farming.Moreover, small and fragmented landholdings hinder mechanization and efficient use of resources, worsening productivity issues (Phiri et al., 2023).

Possible Remedies and Management Interventions

1. Climate-Resilient Crop Management

Developing and promoting drought- and heat-tolerant varieties is essential for climate-resilient chickpea farming. These plants have traits like better root structure and improved water efficiency. Timely planting helps crops avoid late-season heat stress, while supplementary irrigation during critical growth stages, especially flowering and pod filling, can greatly stabilize yields.

2. Soil Fertility and Nutrient Management

Sustainable chickpea farming requires a thorough approach to managing soil health. Soil testing should guide tailored nutrient management plans. Balanced fertilization, including phosphorus, sulphur, and key micronutrients, is vital for optimal growth. Using biofertilizers such as Rhizobium and phosphate-solubilizing bacteria improves nutrient availability and boosts biological nitrogen fixation.

3. Integrated Pest and Disease Management (IPM & IDM)

An integrated strategy for managing pests and diseases is crucial for sustainable production. This involves using resistant varieties, crop rotation, and seed treatments to reduce disease occurrence. Biological control methods and pheromone traps are effective for monitoring and controlling pests, while chemical treatments should be used carefully based on economic thresholds.

4. Improved Agronomic Practices

Implementing well-researched farming practices can noticeably boost productivity. Using certified seeds, maintaining optimal plant density, and spacing the plants appropriately enhances resource use. Seed priming methods improve germination rates and early plant vigor, while managing weeds on time minimizes competition during key growth phases.

5. Socio-Economic and Policy Interventions

Bolstering support systems is vital for enhancing chickpea production. Effective extension services can connect research findings with real-world practices. Ensuring timely access to quality inputs, availability of credit, and crop insurance can motivate farmers to adopt better technologies. Additionally, stable market policies, like a minimum support price (MSP), can provide economic assurances to farmers.

CONCLUSION

Chickpea production faces a range of environmental, biological, farming, and socio-economic challenges. However, these obstacles can be overcome. A comprehensive and integrated approach, which includes genetic improvements, scientific farming methods, and strong policy support, is key to realizing the crop's full potential. With ongoing efforts and targeted strategies, chickpea can become a resilient, high-yielding crop that significantly contributes to global food security and sustainable agriculture.

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