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Effect of Conservation Agriculture Practices on Chickpea Growth and Soil Health

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Abstract: -

Conservation agriculture has gained global attention as a sustainable approach to enhance crop productivity while preserving natural resources. Chickpea (Cicer arietinum L.), a major pulse crop cultivated largely under rainfed conditions, responds positively to conservation-based management practices. Conservation agriculture emphasizes minimum soil disturbance, permanent soil cover, and diversified cropping systems, which collectively improve soil health and crop performance. This article examines the effect of conservation agriculture practices on chickpea growth and soil health, focusing on soil physical, chemical, and biological properties. The role of residue retention, reduced tillage, and crop diversification in improving chickpea productivity and long-term system sustainability is also discussed.

Introduction:

Chickpea is one of the most important pulse crops, contributing significantly to dietary protein and soil fertility through biological nitrogen fixation. It is commonly grown in marginal environments where soil degradation, moisture stress, and declining fertility limit productivity. Conventional tillage practices often accelerate soil erosion, organic matter loss, and moisture depletion, thereby reducing crop growth and yield stability.

Conservation agriculture (CA) offers an alternative production paradigm that enhances resource use efficiency and ecosystem stability. The core principles of CA—minimal soil disturbance, soil surface residue cover, and crop diversification—are particularly relevant for chickpea-based systems. Adoption of conservation agriculture practices has the potential to improve chickpea growth, strengthen soil health, and promote sustainable pulse production.

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Conservation Agriculture and Chickpea Growth

Minimum tillage practices under conservation agriculture help maintain soil structure and reduce mechanical disturbance to soil aggregates. Improved soil structure enhances root penetration, aeration, and water infiltration, leading to better crop establishment and growth in chickpea.

Residue retention on the soil surface moderates soil temperature, reduces evaporative water losses, and protects seedlings from moisture stress during early growth stages. These favourable microclimatic conditions support improved vegetative growth, higher biomass accumulation, and enhanced nodulation in chickpea.

Crop diversification, including rotations and intercropping, improves nutrient availability and reduces biotic stress. When chickpea is grown under diversified systems, it benefits from improved soil nutrient balance and reduced pest and disease incidence, contributing to stable yields.

Impact on Soil Physical Properties

Conservation agriculture practices positively influence soil physical health. Reduced tillage preserves soil aggregates, decreases bulk density, and enhances porosity. Residue cover minimizes surface sealing and erosion, thereby improving water infiltration and retention.

Enhanced soil moisture availability under conservation agriculture is particularly beneficial for chickpea, which is sensitive to moisture stress during flowering and pod development stages. Improved soil physical conditions result in stronger root systems and improved crop resilience under variable climatic conditions.

Impact on Soil Chemical Properties

Residue retention and reduced soil disturbance increase soil organic carbon levels over time. Higher organic carbon improves nutrient-holding capacity and availability of essential elements such as nitrogen, phosphorus, and sulphur.

In chickpea-based systems, increased organic matter supports better biological nitrogen fixation by improving rhizosphere conditions. This reduces dependence on external nitrogen inputs and enhances overall nutrient use efficiency.

Impact on Soil Biological Properties

Soil biological activity is a key indicator of soil health under conservation agriculture. Reduced tillage and organic residue inputs create favourable conditions for soil microorganisms, including bacteria, fungi, and earthworms.

Enhanced microbial activity accelerates nutrient cycling and improves soil enzyme activity. In chickpea fields, improved microbial diversity supports effective root nodulation and nutrient uptake, leading to improved plant growth and soil fertility.

Long-Term Sustainability of Chickpea-Based Systems

The combined effects of improved soil physical, chemical, and biological properties under conservation agriculture contribute to long-term sustainability. Chickpea grown under CA systems exhibits improved yield stability, reduced production costs, and greater resilience to climatic stress.

By conserving soil and water resources, conservation agriculture strengthens the productivity of chickpea-based cropping systems while minimizing environmental degradation.

Conclusion

Conservation agriculture practices play a vital role in improving chickpea growth and enhancing soil health. Minimum tillage, residue retention, and crop diversification create a favourable soil environment that supports better crop establishment, efficient resource use, and sustained productivity. The adoption of conservation agriculture in chickpea cultivation offers a viable pathway toward sustainable pulse production, improved soil fertility, and long-term agricultural resilience. Promoting conservation-based practices can significantly contribute to environmentally sound and economically viable chickpea production systems.

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