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Review Article

Chickpea (*Cicer arietinum* L.): A Current Review

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Abstract

Chickpeas are a rich source of dietary protein and phenolic bioactives that promote human health, and they are widely used as food and culinary ingredients in current and ethnic cuisines around the world. Due to its natural drought and heat tolerance, chickpea will become increasingly important with climate change. Chickpea is an indeterminate crop flowering over a long period of time, with leaf and branch formation continuing during pod filling. The early stages of plant inflorescence growth are just as important as the later stages of floral development. During those early phases, certain properties, such as inflorescence architecture and flower developmental timings, are defined. A variety of climatic and environmental conditions influence chickpea growth, development, and grain yield. Chickpea production gets hampered by climatic extremes such as unpredictable rainfall, very hot and low temperatures, drought. Environmental factors like as salinity and nutrient deprivation have a significant impact on global chickpea productivity. Every year, Fusarium oxysporum f.sp. ciceris causes massive yield losses in chickpeas. Other effective biotic stress factors are root diseases (collar rot, and dry root rot), and foliar diseases (Ascochyta blight, Botrytis grey mold). In this review, some valuable information related to chickpea is extracted from international articles published mostly in last year and presented here.

Keywords: Chickpea, *Cicer arietinum*, breeding, agronomy, food

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a significant plant that provides nutritious food for the world's growing population. Due to its natural drought and heat tolerance, chickpea will become increasingly important with climate change. At the same time, it is the most significant cool-season food legume cultivated under rainfed circumstances in arid and semi-arid regions of the world (Eker et al., 2022). As the world's population grows, the demand for sustainably produced proteins, forcing a dietary shift toward plant-based proteins. In comparison to their animal-derived counterparts, vegetable proteins have a poorer digestibility and biological value (Nitride et al., 2022). Chickpea is an indeterminate dicotyledonous crop that flowers over a long period of time, with leaf and branch formation continuing during flowering and pod filling. Chickpea plants that are subjected to unfavorable conditions throughout the reproductive phase can lose their flowers, young pods, or developing seeds, and then begin flowering when the conditions improve (Peake et al. 2020). Food legume genetic resources must be characterized, maintained, and used in order to breed new varieties with increased adaptability, quality attributes, and nutritional value (Rocchetti et al., 2022). The early stages of plant inflorescence growth are just as important as the later stages of floral development. During those early phases, certain properties, such as inflorescence architecture and flower developmental timings, are defined. Various inflorescence designs in terms of meristem determinacy and the number of flowers per node have been identified in chickpea germplasm. It will be advantageous to manipulate flowering time and inflorescence architecture in chickpea and other legumes by understanding the major actors involved in the vegetative to reproductive stage transition and floral meristem growth (Basu et al., 2022). In rainfed areas characterized by terminal drought and heat stress, days to first flowering are a significant component of chickpea adaptability and yield (Lakmes et al., 2022).

Abiotic stress factors

A variety of climatic and environmental conditions influence chickpea growth, development, and grain yield (Richards et al., 2022). Depending on the crop species, soil type, and climate, increased atmospheric CO2 would alter soil–plant nutrient dynamics (Dutta et al., 2022). Chickpea production gets hampered by climatic extremes (unpredictable rainfall, very hot and low temperatures). To handle climate differences and achieve optimal yield, the best sowing timing is a critical aspect (Irshad et al., 2022). Environmental factors like as salinity and nutrient deprivation have a significant impact on global chickpea productivity. Drought is thought to be one of the most serious abiotic stresses, accounting for 40-45 percent of chickpea yield losses (La et al., 2022). Chickpea growth and productivity are affected by drought and high temperatures. In the field, these pressures frequently occur at the same time, resulting in a wide spectrum of molecular and metabolic adaptations (Yadav et al., 2022). Chickpeas are a low-cost source of protein and micronutrients for poor and vegetarian people in Southeast Asia and Sub-Saharan Africa. The crop is being exposed to severe drought and heat stress during its reproductive phase as a result of changes in climatic conditions and cropping systems, resulting in large yield losses and fluctuations in grain nutrient buildup. Heat stress reduces grain Fe and Zn levels as well as protein content

(Samineni et al., 2022). Chickpea is the major pulse crop of India, grown in 10,6 Mha with an annual production of 11,4 Mt and average productivity of 1078 kg/ha. Chickpea is primarily grown in post-rice residual soil water on marginal farms in India. Low crop yield during reproductive phases due to terminal water and heat stress is a major problem, particularly in the rice-fallows of India's lower Gangetic plains (Mukherjee et al., 2022). Biochar, applied at a rate of 2–6%, is an excellent way to increase chickpea yield while also reducing water stress. Because of the little changes in performance within this application range, a 2% application is recommended (Pradhan et al., 2022). Heat-related features in chickpea are important for lowering the negative effects of heat stress, which is expected to rise in the coming years as a result of global warming caused by climate change. Under heat stress, kabuli chickpeas with several pods per peduncle and compound leaf features showed an undeniable advantage. A recent study indicated that plant shapes that nature has evolved over millions of years, which are usually seen in wild plants, have a greater fitness ability than plants sculpted by human hands (Eker et al., 2022). For the most important yet innately salt-sensitive grain legume, chickpea, salinity is becoming an important problem. During the reproductive period, chickpea is very susceptible to salinity. Chickpea has a lot of genetic diversity among improved cultivars, which produce higher yields in saline environments but still need to be improved for long-term crop production (Kaashyap et al., 2022). While salinity slows emergence and lengthens flowering time, differences in saline yields between genotypes were linked to aboveground biomass, filled pod number, and seed number at maturity, but not to the number of emerging plants that lived until maturity or the flowering delays. Chickpeas for dryland saline sites require phenotyping in appropriate environments. Dryland salt tolerance is associated with increased biomass and reproductive success (Turner et al., 2022). Use of salicylic acid-seed priming is an eco-friendly approach for improving salt tolerance and accomplishing sustainable production of chickpea genotypes in salt-affected soils (Kaur et al., 2022). Chilling temperatures and frost diminish chickpea yield and hinder adaptability throughout the reproductive period. Because it avoids cold temperatures, late heat, and drought stresses that can limit yield in early and late sowing, intermediate sowing maximizes yield (Anwar et al., 2022). When the minimum temperature is 5°C and the maximum day temperature is > 20°C, chickpeas can set pods (Singh et al. 2021). Zinc (Zn) deficiency and low soil fertility are the major factors responsible for low yield in chickpea. Zn seed priming along with "plant growth promoting bacteria" application may improve soil health and chickpea biomass in marginal soils (Ullah et al., 2022).

Biotic stress factors

Every year, *Fusarium oxysporum* f.sp. *ciceris* causes massive yield losses in chickpeas (Fatima et al., 2022). Chickpea disease *Fusarium oxysporum* f. sp. *ciceris* reduces chickpea productivity and quality, and can reduce yield by up to 15%. The growth of *Fusarium oxysporum* f. sp. *ciceris* was strongly inhibited by a newly identified, *Pseudomonas aeruginosa* strain A7. The high biocontrol potential and plant growth increase of this strain could make agricultural chickpea production a more ecologically friendly operation (Mozumder et al., 2022). By controlling plant hormones and establishing systemic resistance, endophytes aid plants in thriving under stress. Chickpea root bacterial endophytes *Priestia megaterium* (CRBE1), *Brucella haematophila* (CRBE3) and *Microbacterium paraoxydans* (CRBE7) exhibiting antagonistic activity could be incorporated in integrated disease management module against Fusarium wilt of chickpea (Khanna et al., 2022). Ethiopia is Africa's top producer, consumer, and exporter of chickpeas, accounting for 4,5 percent of the global market and more than 60% of the African market (Damte & Ojiewo, 2017). It is commonly cultivated in Ethiopia's highlands and semi-arid regions (Fite & Tefera, 2022). Ethiopia's national average chickpea yield is 1913 kg/ha (Keneni et al., 2011). Chickpea production in Ethiopia was hampered by many biotic and abiotic causes. Biotic factors such as diseases; root diseases (fusarium wilt, collar rot, and dry root rot), and foliar diseases (Ascochyta blight, Botrytis grey mold) (Getaneh et al., 2021), and insect pests mainly *Helicoverpa armigera* Hübner (*Lepidoptera: Noctuidae*) and *Callosobruchus chinensis* (L.) (*Coleoptera: Bruchidae*) (Damte & Mitiku, 2021). The later two insect pests were among the major factors affecting chickpea production in Ethiopia (Damte & Mitiku, 2021). Drought is a major factor in increasing the prevalence and severity of chickpea dry root rot. This is a financially destructive disease that has harmed chickpea yield in recent years as a result of irregular rainfall patterns. Dry root rot disease in chickpea plants is caused by *Macrophomina phaseolina* (previously *Rhizoctonia bataticola*). Drought stress exacerbates an infection that is already present by decreasing the endodermal barrier and overall defense (Irulappan et al., 2022).

Nitrogen fixation

Chickpeas, like most legumes, have specialized structures called root nodules. The symbiotic connection with rhizobium bacteria is enabled by these nodules. *Mesorhizobium* species cause chickpeas to nodulate. The rhizobia give the plant with useable fixed atmospheric nitrogen. Because of their symbiotic association with nitrogen-fixing rhizobium bacteria, which increases soil nitrogen and improves soil fertility, they are frequently employed as rotation crops (Frailey et al., 2022). The variety and dispersion of *Mesorhizobia* communities, on the other hand, may be influenced by their adaptation to soil conditions (Muleta et al., 2022). Recently, a series of research papers have shown that a variety of leguminous plants can form tripartite symbiotic associations with nodule-inducing rhizobia and other plant beneficial microorganisms, such as arbuscular mycorrhiza fungi, fungal endophyte *Phomopsis liquidambari*, mineral phosphate-solubilising bacteria, endophytic *Bacillus*, *Methylobacterium oryzae* and *Micromonospora* strains to enhance plant growth, nodulation and N2-fixation (Xu et al., 2022).

Functional foods

Chickpeas are a rich source of dietary protein and phenolic bioactives that promote human health, and they are widely used as food and culinary ingredients in current and ethnic cuisines around the world. Chickpeas are a good source of functional food components for high-value and health-focused food and nutraceutical applications because of this (Klongklaew et al., 2022). Chickpeas are a type of pulse that is consumed all over the world and is high in protein, as well as fat, fiber, and other carbs. As the world's population grows, so does demand for the protein component of this pulse, and several methods for extracting it have been proposed and developed. The principal dry and wet protein enrichment approaches, resulting in protein concentrates and isolates, include air classification, alkaline/acid extraction, salt extraction, isoelectric precipitation, and membrane filtration. Chickpea proteins exhibit good functional properties such as solubility, water and oil absorption capacity, emulsifying, foaming, and gelling. During protein enrichment, the functionality of protein can be enhanced in addition to primary processing (e.g., germination and dehulling, fermentation, enzymatic treatments). More researches may be useful to improve applications of the specific coproducts that result from the extraction of chickpea proteins, thereby leading to more sustainable processes (Grasso et al., 2022). Pulse flours are increasingly being used as an alternative for traditional staples (such as pasta and bread) (Palchen et al., 2022). Dough rheological behavior, as well as textural qualities and bread staling, were unaffected by formulations containing 10% roasted chickpea flour. Furthermore, a trained panel found that replacing 10% of wheat flour with roasted chickpea flour resulted in complete masking of the "grass-like" off-flavor elements in breads, as well as reduced "beany" and "earthy" off-flavor notes, indicating a product with good overall acceptance (Kotsiou et al., 2022). Chickpea flours have intriguing nutritional qualities and can be used in layer cakes (Gallego et al., 2022). The use of 30% chickpea in biscuits could be a good technique to create a nutritious, low-digestibility biscuit with desirable quality qualities (Lu et al., 2022). Chickpea flours were added to rice-based gluten-free loaves to increase their technological and nutritional qualities (Kahraman et al., 2022). Chickpea bread is a classic bread made from fermented chickpeas (Boyaci Gunduz & Erten, 2022).

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