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Impact of mulching on productivity of Chickpea (*Cicer arietinum* L.): A review

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Abstract

Chickpea (*Cicer arietinum* L.) is one of the most valuable pulse crops grown in arid and semi-arid regions. The use of mulching has proved beneficial in enhancing soil health and boost crop productivity in the context of climate change. The effect of various mulching materials such as organic mulches (crop residues, straw, leaves, farmyard manure) and inorganic mulches (plastic or synthetic mulches) shows increase in growth, yield and production level of chickpea. Mulching is used for moisture conservation, soil temperature regulation, reduction in soil moisture loss, weed suppression. Application of mulches enhances germination rate, plant height, nodulation, biomass and yield of chickpea especially in rain-fed condition. Organic mulches also help to accumulate soil organic matter and enhance soil fertility in the long-term. The benefits of mulching however will be dependent on the type of mulch, thickness, climate and soil. Although there are some disadvantages like the higher initial cost of mulches, and management issues of synthetic mulches, mulching is still a sustainable and climate adaptive approach in chickpea cultivation. The review on this integrated mulching technology in chickpea based cropping system concludes that better productivity, resource-use efficiency and environmental sustainability can be achieved by implementing appropriate mulching technologies within the cropping system.

Keywords: Mulching, soil moisture conservation, water use efficiency, rainfed agriculture, drought resilience

Introduction

Chickpea (*Cicer arietinum* L.) account for around 70% of global output and are mostly grown and consumed in India. Madhya Pradesh holds the first place in India in terms of area of chickpea (1.93 ha), yield (2.48 tonnes) and productivity (2.46 MMT) (Kumar *et al.*, 2021) ^[11]. This crop contributes 45% of the total pulse production of India and 35% of the total land under pulse in India. It is characterized with the ability to survive scarce water condition. The quality of the seed might be negatively impacted by excessive water stress throughout the crucial phases. Millions of smallholder farmers in India rely on rainfed agriculture, which accounts for more than 670% of the nation's net planted area (Munirathnam *et al.*, 2026) ^[15]. Mulch's primary objectives are water conservation and erosion prevention, particularly in arid and semi-arid regions. Around the world, mulching has been utilized as a management technique. It offers a climate that is more conducive to plant growth and development as well as effective crop production. Other uses for mulching include adjusting soil temperature, controlling weeds, conserving soil and adding nutrients for plants after decomposition of organic mulch, improve soil structure, increases crop quality and yield.

Constraints in Chickpea Production

In many nations in the Mediterranean basin, Central Asia, East Africa, Europe, Australia, and North and South America, Chickpea was mostly grown in dry and semi-arid environments. At different phases of growth during the productive season in these regions, they are particularly susceptible to abiotic constraints like heat and drought (Panda *et al.*, 2025) ^[19]. Over 90% of the Chickpea produced in underdeveloped nations are eaten locally. Increasingly malnutrition is prevalent affecting more than 2.3 billion or 30% of the global population and highly related to insufficient food intake and the nutritional value of the diet. To a rising world population,

Chickpea are a major source of protein, dietary fibre, vitamins and macro & micronutrients. In this respect, chickpea plays an important role in the balanced diet of major population around the world as well as helps to prevent various types of diseases, such as digestive disorders, diabetes, cardiovascular disease and certain types of cancer (Arriagada *et al.*, 2022) ^[12].

Nutrient Dynamics in Chickpea Cultivation

The nutritional composition of chickpea includes (12-31%) of protein, carbohydrates (60-65%), fat (6%) dietary fibre etc. It also contains a lot of vitamins and minerals such as potassium and phosphorus. It is an essential nutritional powerhouse especially in semi-arid areas because of its high concentration of proteins, complex carbohydrates and essential micronutrients (Tiwari *et al.*, 2026) ^[27]. The seeds have an average proportion of 20-25% protein, but normally low in sulphur amino acid such as methionine and cysteine. In addition to protein, Chickpea offers a considerable amount of dietary fibre and low-glycaemic index carbohydrates, which enhance gut health and metabolic balance. They contain high amounts of Iron (Fe), Zinc (Zn) and Magnesium (Mg). Antioxidant properties include the presence of flavonoids and phenolic compounds, even if the crop also contains anti-nutritional components like tannin and phytic acid, which are often reduced by germination or processing.

Soil and Nutrient Interaction

The symbiotic association of chickpea with *Mesorhizobium* bacteria is associated with its nutritional quality. Chickpea, through biological nitrogen fixation (BNF) is capable of meeting up to 70% of their nitrogen needs, which have a direct impact on the protein contents of the grain (Kumar *et al.*, 2021) ^[11]. Moreover, phosphorus uptake plays a crucial role in ATP production and root growth which indirectly determines the capacity of the plant to move other micronutrients to the growing seed. Soil moisture content was not significantly influenced by weed control treatments, however paddy straw mulch at the rate of 5 t/ha had significantly higher soil moisture (15.75 and 22.63% respectively) at 30 DAS in chickpea. Proper covering of open space decreases the direct impact of sun light and air decreases water loss due to evapo-transpiration in the soil profile leads to more storage of soil moisture in the soil (Sahu *et al.*, 2023) ^[22].

Organic mulches

Among all the agronomic treatments undertaken for soil improvement, Organic mulches have proven to be effective for promoting health, as well as for conserving water. The application of organic mulches to the crops has been in practice since ancient times though a range of materials for organic mulches has been changed from current farming practices. In the past pebbles, gravel and volcano ash have been used, whereas hay, straw (crop residue mulch) are now used. The most available and affordable mulching materials to use in the semi-arid areas in cultivating chickpea include crop residues like wheat straw, paddy straw, maize stubble, etc. These residues produce a protective layer when used at 4-10 t/ha in the young vegetative stage and reduce soil evaporation by 15-35% and diurnal temperature oscillation by 2-5°C, thus ensuring a favourable rhizosphere to root development and *Rhizobium* activity. The straw mulch physical barrier inhibits light penetration and also the emergence of broadleaf, grassy weeds leading to weed control efficiencies (70-80%) and considerable amount of weed dry matter reduction compared with no-mulch control. Although there are definite advantages, high C:N ratio

residues such as straw can lead to short-term nitrogen immobilization and dry mulches can lead to increased termite presence unless soil moisture is controlled. Crop residue and straw mulches are an inexpensive and sustainable alternative to the two-fold limitation of moisture deficit and weed competition in rainfed chickpea. Mulching also enhances the amount of N₂ available by adding biomass that had N and enhances the symbiotic fixation of nitrogen as quantified by the activity of nitrogenase.

Crop residue mulching

Crop residues include straw, stalks, leaves, and stubbles left after the harvest of a crop and are spread over the surface of the soil for protection and improvement. This conserves soil moisture due to low evaporation losses from soil, retains weed growth and prevents erosion by wind and water. The residues breakdown enriches the soil with organic matter and nutrients, thus enhancing soil fertility and structure. Crop residue mulching also helps maintain the soil temperature and activates the earthworms and good microbes. This is regarded as one of the essential practices in sustainable agriculture as it eliminates the burning of crop residues, helps to minimize environmental pollution and improves the productivity of crops.

Effect on Soil Properties

As Mulching helps in regulating higher soil temperature, Organic mulches generally reduce soil temperature during summer and maintain warmth during winter. Black polythene mulch increases soil temperature, promoting early crop growth, while reflective mulches can reduce excessive heat stress. Mulching significantly reduces evaporation losses from the soil surface and enhances water retention. By serving as protective barriers, organic mulches minimize wind speed and reduces direct sunlight over soil's surface.

It also enhance soil moisture level by 10–30% when compared to untreated soil (Madurapperumage *et al.*, 2021) ^[12].

Inorganic mulches

Non-living materials like plastics, gravel, etc. are employed as inorganic mulches for a number of agronomic purposes, including weed control, protecting soil from erosion and extreme heat, and minimizing water loss from arable land. In response to the management of water shortage in agricultural systems, which is a major obstacle to sustainable economic growth, the whole area of farmland covered with plastic mulch has emerged worldwide in recent decades. Effective utilization of limited water resources is crucial for agricultural growth, especially in dry areas with little soil moisture. In its arable systems, China, the world's biggest buyer of plastic film for agricultural products, employs plastic mulch as a major water-saving method (Sofi *et al.*, 2020) ^[26].

Comparative Economics and Sustainability

The source of mulch, its application cost and its combination with other practices are very important in explaining the economic returns and long-term sustainability of mulching in chickpea. Organic crop residue mulches like wheat straw, paddy straw and karanj leaf are most practical in smallholder systems since they use locally available biomass and they do not require additional cost of 1-2 manual weeding which saves labour cost (Iqbal *et al.*, 2020) ^[10]. The efficiencies of sawdust and straw mulches (5 to 10%) were 77- 92% in terms of weed control and 1.82 and 2.06 t/ha in terms of grain yield, respectively, which means that the combination of the mulch with cheap bio inputs

improves the profitability without herbicides or additional fertilizers. In terms of sustainability, organic mulches increase the quantity of decomposing biomass to the soil by 0.815 t/ha, which enhances soil organic carbon, structure and water retention across seasons. Once mulching is combined with broad bed and furrow or narrow bed land set up, yield and water use

efficiency increases even further indicating that the economic and environmental advantages are optimized under integrated management. Thus, in case of rainfed chickpea in semi-arid tropics, the optimal trade off in terms of yield increase (Panchal *et al.*, 2017) ^[18].

Table. 1: Comparison of Mulching and No-Mulch Data over Years

Year	Treatment	Plant Height (cm)	Grain Yield (q ha ⁻¹)	References
2026	Organic residue mulching	48.6	16.51	(Tiwari <i>et al.</i> , 2026) ^[3]
	No mulch	41.2	12.78	
2022	Straw mulching	43.6	13.19	(Das <i>et al.</i> , 2022) ^[7]
	No mulch	36.2	9.80	
2021	Plastic mulch + Drip irrigation	44.9	29.54	(Rao <i>et al.</i> , 2021) ^[21]
	No mulch	41.4	17.40	

Future Research Directions

Despite the benefits of mulching that are well established in the chickpea systems, there are several frontiers that need to be investigated, which will ensure a massive adoption and sustainability. In the first place, the urgent necessity to take a shift in the priorities to the traditional polyethylene films towards the high-performance, yet affordable biodegradable alternatives that would help reduce plastic residues impact on the environment (Arriagada *et al.*, 2022) ^[2]. The incorporation of mulching together with precision agriculture solutions like sensor-based irrigation and mechanized soluble mulch application needs to be considered in future studies as a means of reducing labour intensity which better utilizes resources. In addition, research needs to investigate further the long-term impacts of continuous mulching to the microbiome of the soil and its impacts on the symbiotic relationship between *Rhizobium* and chickpea roots in different climatic conditions. Developing the synergy between the different forms of mulch and nano-fertilizers may also open new horizons of efficiency in the utilization of nutrients (Verma *et al.*, 2025) ^[29].

Conclusion

As per the above details, this review highlights that mulching is not just a surface cover, but one of the management practices, which alternate the productivity of chickpea. Mulching with the use of both organic and synthetic properties of mulches, such as trapping moisture, boosting crop levels and promoting good soil health. Regulating soil temperature (also reduces surface run-off & reduces moisture in soil) where there are visible signs of water scarcity in the coming future loss. It is an effective method to follow for conserving water, as many new mulches are being developed and the biodegradable film can replace conventional mulches. Plastic mulch, organic mulch helps to add organic matter to the soil and increase the soil properties. Like application of paddy and wheat straw mulch shows significantly lowered weed density and dry weight, with higher weed control and yield were observed (Sahu *et al.*,2023) ^[22] In this way, both the organic and inorganic mulches might help farmers and can be useful in boosting their crop production.

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Source: <https://eorganic.org/pages/65025/organic-mulching-materials-for-weed-management>

Fig 1: Straw Mulch



Source: khetivyapar.com/en/farmer

Fig 2: Inorganic and Organic Mulching

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