Review Article

The Impact of Mulches and Biofertilizers on the Growth and Yield of Broccoli(*Brassica Oleracea L.* Var.*Italica*)- A Comprehensive Review

Abstract

Broccoli (*Brassica oleracea* var.*italica*) is a widely cultivated vegetable known for its nutritional benefits and economic importance. In present years there has been a growing interest in sustainable agricultural practices which enhances the productivity while minimizing the environmental impacts.

Mulching and biofertilization has become a promising and an impactful agro-technique to improve the soil health, nutrient availability and water retention.

This review aims to provide a comprehensive analysis of the impact of the mulches and biofertilizer on the growth and yield of broccoli. Various types of mulches including the organic (e.g. Straw, rice husk, saw dust etc.) and inorganic mulches (e.g. Plastic film) have been studied for their impact on soil temperature moderation, moisture conservation, suppression of weed and nutrient retention. Similarly, biofertilizers as Phosphorus Solubilising Bacteria, VAM,*Azotobacter chroococcum*, *A. vinelandi*, *Derxia*sp., *B. megaterium*, *B. lichenformis*, and *Bacillus subtilis* bacteria etc. have been investigated for their ability to enhance plant growth and yield.

This review underscores the importance of integrated approaches that harness the synergistic benefits of mulches and biofertilizers to maximize the growth and yield of broccoli while minimizing environmental footprints in agriculture. Such strategies hold promises for advancing sustainable food production systems and meeting the challenges of global food security and climate changes.

Keyword:Biofertilizers,*Brassica oleracea* var.*italica*, Mulches

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Introduction

Broccoli a Brassicaceae family crop originated from the Mediterranean region. The name broccoli is derived from the Latin word Brachium meaning an arm or branches. Broccoli with a terminal kind of head consisting of green buds and thick fleshy flower stalks that resemble morphologically cauliflower except the secondary head which is developed in the axils of the leaves and contributes up to 50% of the total yields.

According to the data the worldwide production of broccoli and cauliflower in the year 2020 reaches 25,531,274 tons, which are cultivated in an area of 1,357,186 hectare of lands (Annonymous,2020). In India, broccoli is cultivated primarily in states like Himachal Pradesh, Uttarakhand, Jammu and Kashmir, Punjab, Haryana, and parts of Uttar Pradesh.

People nowadays are moving towards healthy living, and for this reason, everyone is looking for vegetables with high nutritive values. As broccoli is one of such vegetable with high nutritive value, it is term as the "Crown jewel of Nutrition" the demand of these vegetables is increasing day by day. Broccoli has 130 times more vitamin A content as compared to Cabbage. it also contains some important Phyto chemical compounds, beta-carotene, ndole-3-carbinol which help in fighting against breast cancer and lung cancer(Anonymous,2006). It also contains a compound called sulphoraphane which prevents the growth of tumours and reduces the risk of cancer. Broccoli sprouts are rich source of glucosinolates which is the precursor of chemo-protective iso thiocyanate compound which is associated with the reducing of cancer(Aires *et.al*,2006) The nutritive values of Broccoli per 100 gram of edibles portion are listed as follows; water (89.3%), protein (3.6%), fat (0.2%), carbohydrates (5.5%), fibre (1.2%),vitamin A (900 I.U.), vitamin B (33 I.U.), vitamin C(137 I.U.), vitamin E (2.3 I.U.), vitamin K (3.5 I.U.), calcium(1.29 mg), manganese (20 mg), Iron (1.3 mg), phosphorus (0.79 mg), and sulphur (1.26 mg)(Browman *et.al*,1947).

With the increasing demand for this vegetable, farmers extensively used inorganic fertilizers to meet the demands, which as a result deteriorates the soils health adversely affecting the environment. So, as an alternative to this issue, biofertilizers, derived from microbial sources, offer an environmentally friendly solution. They enrich the soil with essential nutrients, promote beneficial microbial activity, and stimulate plant growth through the release of

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growth-promoting substances.Some biofertilizers namely phosphate solubilizing bacteria (PSB),Phosphate-solubilizing fungi, vesicular-arbuscular mycorrhizae(VAM), *Azotobacter chroococcum, A. vinelandi*, *Derxia*sp., *B. megaterium, B. lichenformis*, and *Bacillus subtilis* bacteria. Besides increasing phosphate levels, VAM is also known to increase the levels of important micronutrients like copper and zinc in the plants. The above-mentioned biofertilizer is organic in origin and are safe minimizing the cost of production and maintaining the soil healthChoudhary *et.al*(2006)

Mulches, comprising various organic materials like straw, leaves, and plastic films, plays multiple roles in agriculture. They contribute to soil moisture retention, temperature regulation, weed suppression, and nutrient conservation, thusfostering favourable conditions for plant growth.

Understanding the combined effects of mulches and biofertilizers on broccoli cultivation is crucial for devising sustainable farming practices. While individual studies have demonstrated the efficacy of these techniques, their synergistic impact on broccoli growth and yield remains a subject of ongoing research. This review aims to synthesize existing literature on the topic, examining the mechanisms underlying the influence of mulches and biofertilizers on broccoli production. By elucidating their interactions and effects on soil health, nutrient availability, and plant performance, this review seeks to provide insights into optimizing broccoli cultivation practices for sustainable agricultural systems.

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Effect of mulching on Growth and Yield Parameter

Mohammed *et.al*(2016) conducted an experiment and discovered that mulching with black polyethylene increased plant height, leaf area, leaf number/plant, and branch number/plant when compared to the control.Islam *et.al* (2014) conducted an experiment to determine the effect of several mulch materials on broccoli growth characteristics (M1= black polythene, M2= water hyacinth, and M3= rice straw mulch) with M0= control. At 20, 40, and 60 DAT, broccoli plant height, number of leaves plant^{-1}, leaf length, and leaf breadth were all significantly changed, this similar finding was also reported by Thentu*et.al* (2016).Singh and Kumar(2017) researched on theimpact of plastic mulch on Broccoli using two types of plastic mulch: black, silver, and non-mulch in which the treatment with black polythene mulch produced the most curds per plant followed by the silver color and the non-mulched treatment. The black polythene mulch produced the highest broccoli output (2475 kg/acre), followed by the silver mulch.

Ali(2004) conducted a field experiment and discovered that 220 kg N/ha with black polythene mulch produced the highest average yield (16.4 t/ha).Faruque (2004) discovered that utilising black polythene mulch coupled with organic and inorganic fertilisers resulted in the highest average production of 18.2 t/ha, whereas using no fertiliser or mulch resulted in the lowest output. Hashem (2005) conducted an experiment to determine the influence of manuring and mulching on broccoli yield metrics and discovered that organic and inorganic fertilisers with black polythene mulch produced the highest yield (17.6 t/ha).Diaz-Perez *et.al* (2010) studied the influence of mulching on total floret yield and individual floret weight in broccoli and discovered that the application of wheat straw mulch material resulted in the best results and the worst results.Kosterna (2014) examined the influenced of mulching on broccoli using straw from rye, corn, rape and buckwheat, discovered that mulching with all types of straw enhanced yield compared to plots without straw. When compared to other straw materials, the plot mulched with buckwheat straw had the highest yield.

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Effect of Biofertilizer on Growth and Yield of Broccoli

Miskoska-Milevska (2018) stated that the application of a biofertilizer that includes *Azotobacter chroococcum*, *A. vinelandi*, *Derxia*sp., *B. megaterium*, *B. lichenformis*, and *Bacillus subtilis* bacteria, either through foliar spray or drip irrigation, led to an augmentation in cauliflower leaf dimensions, both length and width.

Tanwar *et.al*, (2018) stated that the strain of *P. fluorescens*utilized showcase the potential to enhance broccoli growth, phosphatase activity, chlorophyll levels, nutrient absorption, and overall yield when utilized alongside the recommended fertilizer dosage.Altuntaş (2018) reported that the most substantial overall broccoli head harvest resulted from the application of *B. subtilis* inoculations.Sharma *et.al* (2008) revealed that when animal manure was combined with NPK in broccoli farming, it led to a notable rise in the macro-element levels within the biofertilizer (Azotobacter). Lal *et.al* (2015) noted that the application of Azotobacter and PSB (phosphate solubilizing bacteria) treatments resulted in a comparable boost in zinc levels in broccoli to that achieved by the use of chemical fertilizers. Tanwar *et.al* (2014) discovered that the *P. Flourescens*strain used had a beneficial role in increasing broccoli growth, phosphatase activity, chlorophyll content, nutrient uptake and yield and combined with the recommended dose of fertilizer.

Kizilkaya (2009) stated that Azotobacter increases germination rates by 20–30% and enhances the ability of the seed to germinate. Biofertilizers increase crop yield by 20–30% and replace chemical nitrogen and phosphorus by 25% in addition to encouraging vegetative development.Maheshwari *et.al* (2012) stated that the application of Azotobacter not only effective on the growth promotion, it is also associated with the suppression of pathogenic disease of plants.

Bashyal (2013) conducted a trial in which he found out that the maximum vitamin C content and most appealing curd colour were obtained by applying 60 kg of nitrogen and 2 kilograms of biofertilizer per hectare, without substantially altering the yields. Ahlawat *et.al* (2006) conducted a field trial examine the impact of spent mushroom substrate (SMS) on the vegetative development, yield, and quality features of cauliflower (*Brassica oleracea* var. *botrytis* cv. Pusa Snowball-1) after it had been recomposed using various techniques and combined with arable soil.Milevska*et.al* (2018) stated that biofertilizer containing *Azotobacter chroococcum, A. vinelandi, Derxia sp., B. megaterium, B. lichenformis, and*

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Bacillus subtilis bacteria when applied as foliar application or through drip irrigation increases the leaf length and width in cauliflower. Civelek (2017) incorporated in his thesis that the application of *Bacillus subtilis* RC63 and Pseudomonas fluorescens RC77 in combination with different organic and chemical fertilizers in cauliflower plants contributed significantly to the yield, plant growth, and nutritional properties. Sindhu *et.al* (2016) stated that B. megaterium is best known for its incorporative capability of Phosphorus and Potassium in the soil, Kamal *et.al* (2010) in support of the above finding *B. megaterium* strain BM18-2 increases the chlorophyll synthesis, root length, shoot length, biomass and dry weight, total nitrogen content ratio. It was also found that BM182 strain was cheap and an effective product at the commercial level and an efficient alternative of chemical fertilizer.Rather *et.al* (2018) disclosed in one of their research projects that the organic manures and biofertilizers directly affect the growth and yields of lettuce.Verma and Yadav (2008) conducted an experiment on cauliflower cv. Pusa Snowball K-1 and reported significant improvement in plant height, leaf length, leaf width, leaf weight per plant and head diameter with combination of PSB + 75% P + recommended dose of NK (120: 60 kg/ha) through chemical fertilizers.

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