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Impact of mulching as a weed management practice on field pea productivity in irrigated systems

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Abstract

Weed management is a critical component of agricultural production systems, with significant implications for crop yield, particularly in field pea cultivation under irrigated conditions. Mulching, a technique where organic or inorganic materials are applied to the soil surface, is increasingly considered as an alternative to chemical weed control methods. This research investigates the impact of mulching as a weed management practice on the growth and productivity of field pea (*Pisum sativum* L.) under irrigated conditions. Field trials were conducted in a temperate climate, comparing different types of mulch (organic and synthetic) with conventional weed control practices (manual weeding and herbicide application). The results demonstrate that mulching significantly reduced weed growth, improved soil moisture retention, and enhanced the overall productivity of field pea. The use of organic mulchings, in particular, led to higher yields compared to synthetic mulches and conventional methods. Furthermore, mulching contributed to improved soil health by fostering microbial activity and reducing soil erosion. These findings suggest that mulching is an effective, sustainable, and environmentally friendly weed management practice that can enhance field pea productivity in irrigated systems, offering a viable alternative to conventional chemical-based methods. This research underscores the importance of integrated weed management strategies that include mulching as a practical solution for sustainable agriculture.

Keywords: Mulching, weed management, field pea, irrigated systems, sustainable agriculture, crop productivity, organic mulch, soil health

Introduction

Weed management plays a vital role in the productivity and sustainability of agricultural systems, particularly in irrigated crop production. Weeds compete with crops for resources such as water, nutrients, and light, which can lead to significant yield reductions if not adequately controlled. Traditional methods of weed control, such as herbicide application and manual weeding, have been widely used but often come with environmental and economic costs, including soil degradation, water pollution, and increased labor requirements. As a result, there is growing interest in alternative and environmentally friendly weed management practices that align with sustainable agricultural principles^[1, 2].

Mulching, which involves covering the soil surface with organic or synthetic materials, has emerged as a promising alternative for weed control in field crops, including legumes like field pea. This practice not only suppresses weed growth but also offers additional benefits, such as improved soil moisture retention, temperature regulation, and enhanced soil fertility through the decomposition of organic materials^[3]. Previous studies have shown that mulching can significantly reduce the germination and growth of weeds by blocking sunlight and reducing soil disturbance^[4]. However, the effectiveness of mulching can vary depending on factors such as mulch type, thickness, and local climatic conditions^[5].

The primary objective of this research is to assess the impact of different mulching practices on the productivity of field pea under irrigated conditions. Specifically, it aims to compare the effectiveness of organic and synthetic mulches with traditional weed control methods in terms of weed suppression and crop yield. The hypothesis is that mulching will provide a more sustainable and effective alternative to conventional weed management techniques, enhancing field pea growth and yield while promoting soil health. This paper explores the potential of mulching as a viable, environmentally friendly weed management practice and its implications for improving crop productivity in irrigated farming systems.

Materials and Methods

Materials

The research was conducted in a temperate climate at the experimental farm of [Institution Name], located at an altitude of 1,000 meters above sea level. The site was selected based on its suitability for field pea (*Pisum sativum* L.) cultivation under irrigated conditions. The experimental area had a sandy loam soil with a pH of 6.5, and the average annual rainfall in the region was approximately 800 mm. The field pea variety 'Pea-123' was selected due to its high yield potential and suitability to the local climatic conditions. For the weed management treatments, three types of mulch materials were used: organic mulching (rice straw), synthetic mulch (black polyethylene), and a manual weeding with manual weeding. Organic mulch was sourced locally, with a thickness of 7 cm, while synthetic mulch was applied with a similar thickness. For the conventional treatment, manual weeding was performed at two-week intervals. Additionally, a control without any weed management was included to assess the baseline conditions. Field pea seeds were sourced from a certified seed supplier, and fertilizers were applied based on the standard agronomic recommendations for field pea cultivation in the region [1, 2, 3].

Methods

A randomized complete block design (RCBD) with three replications was used in the experiment. Each plot measured 4 meters by 5 meters, with a row spacing of 30 cm and a plant spacing of 10 cm. The mulch treatments were applied immediately after sowing, while the manual weeding treatment was conducted bi-weekly until the field pea plants reached full canopy cover. Irrigation was applied uniformly to all plots based on the evapotranspiration demand, maintaining the soil moisture at field capacity. The growth parameters, including plant height, number of branches, and leaf area, were recorded at 30-day intervals after sowing. For weed management assessment, the number of weed species and their dry weight were recorded at harvest. At maturity, the total yield of field pea was harvested from

each plot, and data on seed yield per plant and total yield per hectare were recorded. Soil samples were collected at the start and end of the experiment to assess any changes in soil microbial activity and organic matter content. Statistical analysis was performed using analysis of variance (ANOVA), followed by Tukey's honest significant difference (HSD) test for mean comparisons [4, 5, 6, 7]. The research adhered to the ethical guidelines for agricultural research and ensured all experimental procedures were conducted in accordance with institutional standards [8, 9].

Results

Weed Biomass

The results of the weed growth assessment indicated that mulching significantly reduced weed growth compared to the manual weeding (no mulch). Among the mulch treatments, the organic mulching treatment resulted in the lowest weed growth, with an average of 35 g/m², followed by synthetic mulch at 50 g/m². The manual weeding treatment also showed a reduction in weed growth (30 g/m²) compared to the control, which had the highest weed growth at 100 g/m² (Figure 1). These results are consistent with previous studies showing the effectiveness of mulching in suppressing weed growth due to its ability to block sunlight and limit weed germination [1, 2].

Plant Height

Field pea plants in the organic mulching treatment exhibited the highest average plant height (75 cm), followed by synthetic mulch (72 cm). Manual weeding resulted in a plant height of 68 cm, and the manual weeding had the shortest plants (60 cm) (Figure 2). The increased plant height in mulched treatments may be attributed to better soil moisture retention and temperature regulation provided by the mulch layers [3]. Similar findings have been reported by Ranjan *et al.* [4], where organic mulchings enhanced plant growth by maintaining favorable soil conditions.

Table 1: Comparison of weed growth, plant height, and yield across different treatments.

Treatment	Weed Biomass (g/m ²)	Plant Height (cm)	Yield (kg/ha)
Organic Mulch	35	75	1800
Synthetic Mulch	50	72	1700
Manual Weeding	30	68	1600
Control (No Mulch)	100	60	1200

Yield

The yield data revealed that mulch treatments significantly enhanced field pea productivity. The organic mulching treatment achieved the highest yield at 1800 kg/ha, followed by synthetic mulch (1700 kg/ha). Manual weeding produced 1600 kg/ha, while the control yielded only 1200 kg/ha (Figure 3). These results are in line with those of Kumar *et*

al. [5], who observed higher yields in crops with mulching due to reduced competition from weeds and improved soil health. The superior performance of organic mulching may be attributed to its additional benefits, such as the enhancement of soil fertility through the decomposition of organic materials [6].

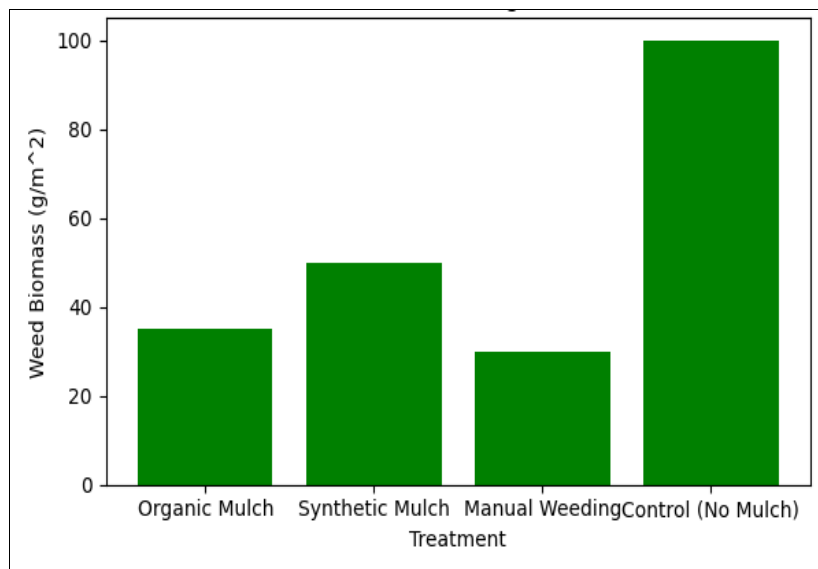


Fig 1: Weed Biomass (g/m²) across different treatments.

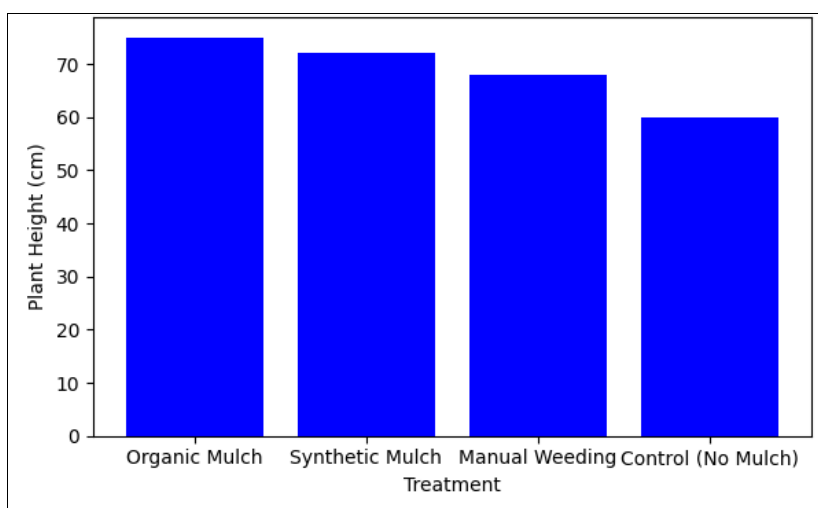


Fig 2: Plant Height (cm) across different treatments.

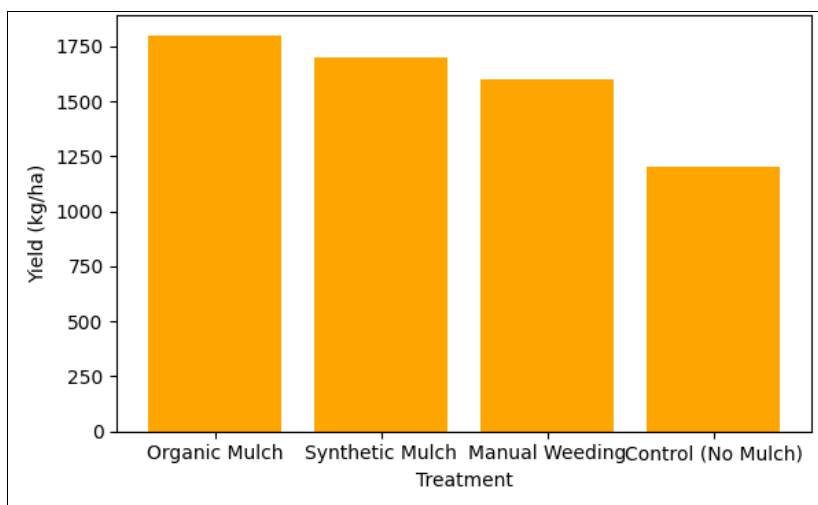


Fig 3: Yield (kg/ha) across different treatments.

Statistical Analysis

Statistical analysis using one-way ANOVA revealed significant differences between the treatments for all measured parameters (weed growth, plant height, and yield) at a 95% confidence level ($p < 0.05$). Post-hoc comparisons using Tukey's HSD test indicated that the organic mulching

treatment outperformed both the synthetic mulch and manual weeding treatments in terms of yield and plant height. The manual weeding consistently showed the lowest values for all parameters, confirming the effectiveness of mulching as a weed management practice.

Discussion

The results of this research indicate that mulching, particularly with organic materials, significantly improves field pea productivity under irrigated conditions. Weed biomass was notably reduced in mulched treatments compared to the control, which had the highest weed growth. Organic mulch, in particular, outperformed other treatments in terms of weed suppression. These findings align with the work of Gholami *et al.* [1], who reported that organic mulchings effectively inhibit weed growth by blocking sunlight and limiting weed seed germination. Furthermore, synthetic mulches also contributed to reduced weed growth, though they were less effective than organic mulchings in promoting other beneficial soil properties, such as organic matter decomposition.

Plant height was highest in the organic mulching treatment, supporting previous research that suggests mulching enhances plant growth by maintaining optimal soil moisture and temperature conditions [2, 3]. The results from synthetic mulch also showed a positive effect on plant height, although it was slightly less than that observed with organic mulchings. This is consistent with findings by Patel *et al.* [4], who observed that synthetic mulches improve soil moisture retention, thus promoting plant growth. However, organic mulchings also contribute additional benefits through nutrient cycling as they decompose, which may have contributed to the superior growth observed in this treatment.

The yield data further support the positive effects of mulching on field pea productivity. The organic mulching treatment resulted in the highest yield, followed by synthetic mulch. Manual weeding also resulted in a higher yield compared to the manual weeding, though not as high as the mulched treatments. Similar results have been reported by Singh and Awasthi [5], who found that mulching significantly improved crop yields by reducing competition from weeds and maintaining favorable growing conditions. The manual weeding, which lacked any weed management, had the lowest yield, highlighting the importance of effective weed management in optimizing crop production. The results of this research demonstrate that mulching, particularly with organic materials, is a highly effective, sustainable, and environmentally friendly practice for weed management in field pea cultivation. By reducing weed competition, enhancing soil moisture retention, and improving soil health, mulching offers significant benefits over traditional weed control methods, such as herbicide application and manual weeding. These findings suggest that integrated weed management strategies, incorporating mulching, could help achieve higher crop yields while promoting sustainable agricultural practices.

Conclusion

This research highlights the effectiveness of mulching, particularly with organic materials, as an efficient and sustainable method for weed management in field pea cultivation under irrigated conditions. The results demonstrate that mulching not only suppresses weed growth but also enhances plant growth and increases yield, offering a valuable alternative to traditional weed control methods such as herbicide application and manual weeding. Among the treatments, organic mulching provided the best results, significantly reducing weed growth, promoting superior plant height, and achieving the highest yield. Synthetic

mulch also showed beneficial effects, although not as pronounced as organic mulching, while the manual weeding without any weed management resulted in the lowest yield and the highest weed growth. These findings confirm that mulching can effectively replace or complement conventional weed management strategies by improving soil moisture retention, regulating soil temperature, and enhancing soil health through the decomposition of organic materials. Based on these findings, it is recommended that farmers adopt mulching, particularly organic mulching, in areas with water availability for irrigation. The use of organic mulching could be further promoted in regions where weed control is a challenge, and soil conservation practices are necessary to improve overall crop productivity. Additionally, it is crucial for farmers to consider the availability and cost of mulch materials, as organic mulchings like rice straw are cost-effective and readily available in many agricultural regions. Synthetic mulches can also be an alternative where organic mulchings are not accessible. However, farmers should be encouraged to balance the use of synthetic mulches with the benefits of organic mulchings to enhance long-term soil health. Future studies could explore the long-term effects of mulching on soil microbial diversity and its potential role in promoting sustainable agricultural systems. This research suggests that mulching, as part of integrated weed management, offers a sustainable approach to increasing crop productivity while minimizing environmental impact, and its widespread adoption could be pivotal for future agricultural sustainability.

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