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REVIEW ARTICLE

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Impact of suboptimal land on shallot plant growth: mini review

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Abstract
The impact of suboptimal land conditions on the growth of shallot plants, and what strategies can be used to reduce the negative impacts have not been widely implemented. This study aims to review the impact of suboptimal land on the growth of shallot plants by integrating the latest findings from related scientific studies. A literature review was carried out by searching for related scientific publications using the Google Scholar and Scopus database (2020-2023). This review includes an evaluation of shallot plant growth parameters that are influenced by suboptimal land conditions, as well as land management strategies that can be used to increase plant productivity. This study confirms that suboptimal land can have a significant impact on the growth and yield of shallot plants. Through this comprehensive approach, it is hoped that this review will provide in-depth insight into the complexity of interactions between shallot plants and their growing environment.

KEYWORDS
suboptimal, land, shallot, growth, agriculture

1. INTRODUCTION

In recent decades, research into the impact of suboptimal land on plant growth has become a major focus in the field of agricultural environmental science (Sufardi, 2024; Surahman et al., 2018). The shallot plant (Allium cepa L.) is an important horticultural plant that has high economic value in various parts of the world, including Indonesia (Andayani et al., 2021; Sopha et al., 2024; Tori & Kholil, 2023). Shallot production is not only a source of income for farmers, but also plays an important role in meeting domestic food needs (Fadzil et al., 2022; Nigussie et al., 2015). Currently, shallots are also an integral part of the agricultural sector which makes a significant contribution to the domestic economy (Sihombing et al., 2023). However, the growth and production of shallots is often hampered by various environmental factors, including the quality of the land where the plant is grown (Murti et al., 2022; Rabinowitch, 2021).

Currently, shallots are also an integral part of the agricultural sector which makes a significant contribution to the domestic economy

Suboptimal land is agricultural land that has physical, chemical, or biological characteristics that do not support optimal plant growth (Bindraban et al., 2000; Samijan et al., 2023). Various factors can cause land to become suboptimal, including high soil acidity, low nutrient availability, poor soil texture, and moisture and drainage problems (Imanudin et al., 2021; Ondrasek et al., 2014). The impact of these suboptimal conditions can be very significant, inhibiting crop growth and reducing overall agricultural productivity (Garfansa et al., 2022; Wiryawan, 2023). Therefore, a deep understanding of the interactions between plants and their growing environment is crucial for developing effective land management strategies.

Previous research has revealed various impacts of suboptimal land on plant growth and productivity. The results of this research highlight the importance of a deep understanding of the interactions between plants and the conditions of the land where they grow (Bhat et al., 2020; Trivedi et al., 2020). Environmental factors such as soil pH, nutrient availability, and water availability, have a significant role in determining the response of plants to their growing environment (Barrow & Hartemink, 2023). Researchers have identified various land management strategies to overcome the impact of suboptimal land on shallot crop growth. Approaches such as proper fertilization, efficient water management, improving soil texture, and using varieties that are tolerant of certain environmental conditions, have proven effective in increasing the productivity and resistance of shallot plants to sub-optimal land conditions (Nordey et al., 2020).

Thus, through a comprehensive review of previous studies, we aim to present a comprehensive picture of the impact of suboptimal land on shallot plant growth. It is hoped that this review will provide valuable insights for researchers, farmers, and other stakeholders in efforts to increase the productivity and sustainability of shallot farming in the future.

2. METHODS

A literature review was carried out by searching for related scientific publications using the Google Scholar and Scopus database (2020-2023). This research is based on a literature review from various relevant sources, including scientific journals, textbooks, and the latest research reports. Searches were conducted using key terms such as “shallots”, “suboptimal land”, “crop growth”, and so on, to gather the necessary information. Relevant data was systematically extracted and analyzed to identify key findings related to the topic of this review.

3. SUBOPTIMAL LAND CONDITIONS

Suboptimal land conditions generally include low or high soil pH, inappropriate soil texture, lack of nutrients, and other factors that can affect the growth of shallot plants. The acidity level or pH of the soil was one of the main factors that influences the growth and development of shallot plants (Budiono & Kurniasih, 2022; Dani et al., 2021; Girsang et al., 2021). Soil with a low (acidic) or high (alkaline) pH can inhibit the absorption of nutrients by plant roots, thereby disrupting optimal growth (Riaz et al., 2020). For example, in soil that is too acidic, the availability of important nutrients such as phosphorus and calcium can become limited, which has a negative impact on onion bulb formation (Amare, 2020). On the other hand, soil with a pH that was too high can also interfere with the availability of certain nutrients, such as iron and manganese, which were important for plant growth (Shrivastav et al., 2020). Therefore, managing soil pH is key in ensuring shallot plants can grow optimally.

Soil with a low (acidic) or high (alkaline) pH can inhibit the absorption of nutrients by plant roots, thereby disrupting optimal growth

Apart from that, soil texture also plays an important role in determining suboptimal land conditions for shallot growth (Purwaningsih et al., 2022). Soil that is too sandy tends to have fast drainage but is less able to store water and nutrients (Huang & Hartemink, 2020). On the other hand, clay soil can hold more water, but tends to suffer from poor drainage and can become hard when dry (Hills & Greene, 2024; Tang et al., 2023). Both conditions can inhibit root growth and soil aeration, which were essential for shallot plants (Askari-Khorasgani & Pessarakli, 2020). Apart from that, nutritional deficiencies are also often found in suboptimal land conditions (Talabi et al., 2022). Soil that is poor in nutrients such as nitrogen, phosphorus and potassium can cause the growth of shallot plants to be stunted and produce poor quality bulbs (Haryani et al., 2021). Therefore, a deep understanding of soil conditions was key in overcoming the challenges faced in growing shallot plants on suboptimal land.

4. IMPACT OF SUBOPTIMAL LAND ON SHALLOT GROWTH

The impacts of suboptimal land on shallot growth (Table 1). Table 1 was a summary of various studies on the impact of suboptimal land on shallot plant growth. Each row in the table presents information about the type of shallot plant studied, the growing media used, the impact of suboptimal land conditions, and relevant research references. For example, in research conducted by Sutardi et al. (2022), using the Tajuk variety and growing media in the form of clayey sandy soil. The application of complete N, P, K, Mg and S fertilizer to the soil succeeded in increasing shallot bulb production to 11.43 tons per hectare. Likewise, Apriliyanto (2021) examined the Lokananta variety planted on coastal sand land. Providing 180 kg of nitrogen fertilizer per hectare resulted in better plant height, as well as higher morning and evening stomata density, accompanied by a yield of fresh tubers of 8.48 tons per hectare.

Table 1. Impacts of suboptimal land on shallot growth.

Plant (Variety)	Growing media	Impact	Reference
Shallot (Tajuk)	Sandy loam soil	The complete N, P, K, Mg and S fertilizer application on sandy loam soil successfully increased shallot bulb production, achieving 11.43 t ha^{-1}.	(Sutardi et al., 2022)
Shallot (Lokananta)	Coastal sandy land	N fertilizer of 180 kg/ha produced higher plant height (25.78 cm), density of morning and evening stomata (71.86/mm^2 67.03/mm^2, respectively) with fresh tubers yield of 8.48 t/ha.	(Apriliyanto, 2021)
Shallot (Bauji)	Peatlands	KCl fertilizer dose of 150 kg/ha showed the best results on plant height, number of leaves, number of tillers, wet biomass weight, dry biomass, and tuber weight.	(Bhermana et al., 2021)
Shallot (Bima Brebes)	Tidal land	The use of chicken manure 10 tons/ha and 200 kg NPK/ha affected the growth of shallots on leaf length, root-shoot ratio, relative growth rate, bulb fresh weight and bulb dry weight.	(Susilawati et al., 2022)
Shallot (Trisula)	Dry land	Intercropping between chili and shallot is the best choice for chili cultivation on dry land. Intercropping can increase the productivity of cayenne pepper and shallots by 64.1 and 15.53%, respectively.	(Hayati et al., 2021)

Plant (Variety)	Growing media	Impact	Reference
Shallot (Sanren, Lokananta, and Tuk-Tuk)	Regosol soil	Seedling at six weeks was the best seedling that provided higher productivity for Tuk Tuk, Lokananta, and Sanren varieties (23.03 tonnes. ha^{-1}).	(Annisa et al., 2022)
Shallot (Bima Brebes, Trisula, Tuk Tuk, and Sanren)	Red yellow latosol soil	In dry conditions with farmers have not mastered yet on shallot cultivation by using true shallot seed (TSS) as planting material, the productivity only reaches 20-40% of the production capacity	(Devy & Setiyani, 2020)
Shallot (Bima Brebes)	Low-Organic Sandy-Clay Soil	The diameter of the shallot bulb produced fell into category 1 (size over 2.5 cm) by as much as 31.0%, category 2 (between 2.0-2.5 cm) by 38.0%, and category 3 (between 1.5-2.0 cm) by 17.8%.	(Karenina et al., 2023)
Shallot (-)	Peatlands	The shallot dry weight production ranged from 9.60 to 15.49 t ha^{-1}. The physical and chemical characteristics of the soil were enhanced on all treatments by applying mineral soil, dolomite, and manure. These improvements included increases in bulk density, mineral content, pH, Ca, Mg, K, base saturation, and P. As a result, the improved soil conditions were able to sustain the growth of shallots.	(Maswar et al., 2021)
Shallot (-)	Ultisol soil	The increase in vermicompost dose was followed by an increase in plant growth and yield, whereas biourine application had no significant effect on shallot growth and yield.	(Hasanudin et al., 2021)
Shallot (Bima Brebes)	Ultisol soil	Providing 67.5 – 90 ml^{-1} liquid organic fertilizer from Kampar River fish waste applied four times can increase plant height, number of leaves, age of tuber formation, number of tubers, wet tuber weight and dry tuber weight.	(Sutriana et al., 2023)
Shallot (Bima Brebes, Tajuk, Bauji, Manjung, Sakato)	Water Saturated Cultivation	Providing actinobacterial-enriched ameliorant affects the nutrient uptake of N, P, and K. Fe and Al can be chelated by providing actinobacterial-enriched	(Haitami & Ghulamahdi, 2023)

Plant (Variety)	Growing media	Impact	Reference
		ameliorant so that shallots can produce quite good production.	
Shallot (Bima Brebes, Crok Kuning)	Suboptimal land	Increasing the dosage of zeolite for varieties significantly affected plant height, number of leaves, fresh weight of tubers and leaves per hectare, sun-dried dry weight per hectare, and number of tubers per hill.	(Rajiman et al., 2020)

Data like this provide a clear picture of how various types of suboptimal land affect the growth and production of shallot plants, as well as the efforts that have been made to optimize crop yields under these conditions. By considering various factors such as soil type, plant varieties, and the type of fertilizer used, farmers can make better decisions in managing their land to get optimal results..

5. ENVIRONMENTAL FACTORS

Environmental factors other than soil conditions also play an important role in the impact of suboptimal land on shallot plant growth. Water availability was one of the key factors that can influence plant productivity, especially in areas with uneven rainfall or long dry seasons (Bedeke, 2023). Onion plants require a consistent water supply for optimal growth, so a lack of water can cause stress to the plant and inhibit bulb formation (Ratnarajah & Gnanachelvam, 2021). On the other hand, excess water or waterlogging can cause root disease and tuber rot (Pandey et al., 2021). Apart from that, temperature, and light intensity also play an important role in plant growth (Driesen et al., 2020). Extreme temperatures, either too hot or too cold, can disrupt photosynthesis and plant metabolism, while low light intensity can reduce energy production needed for growth and tuber formation. Therefore, environmental management including appropriate irrigation arrangements, protecting plants from extreme temperatures, and increasing access to sunlight can help reduce the negative impacts of suboptimal land conditions (Kaur et al., 2020).

Apart from abiotic factors such as water, temperature and light, biotic factors also play a role in the impact of suboptimal land on the growth of shallot plants. Pest and disease attacks are a serious threat to plants, especially on land with suboptimal conditions which tend to weaken plant resistance (Bokor et al., 2021; Zagorchev et al., 2021). Some pests and diseases that commonly attack shallot plants include thrips, thrips, fusarium, and soil bacteria (Dutta et al., 2022). In addition, competition with weeds can also be a serious problem on suboptimal land, because shallot plants will have difficulty competing for water, nutrients, and light with more adaptive weeds. Therefore, controlling pests, diseases and weeds was an important step in managing suboptimal land for the growth of shallot plants. Strategies such as crop rotation, use of varieties that are resistant to pests and diseases, and good sanitation practices can help reduce the negative impact of biotic factors on the growth of shallot plants on suboptimal land (Zagorchev et al., 2021).

6. MANAGEMENT STRATEGY

To reduce the negative impact of suboptimal land conditions on shallot plant growth, various land management strategies can be implemented. One important strategy was appropriate fertilization according to plant needs and soil conditions (Bindraban et al., 2020). Optimal fertilization can help compensate for the lack of nutrients in the soil, such as nitrogen, phosphorus, and potassium, which ware important for the growth of shallot plants

(Silva et al., 2021). Apart from that, liming can also be done to regulate soil pH that was too low or too high, thereby creating soil conditions that ware more suitable for plant growth (Huang et al., 2021). Good irrigation management was also an important strategy in managing suboptimal land. By managing irrigation efficiently, farmers can ensure sufficient water supply for plants without causing waterlogging which has the potential to damage plant roots. Good drainage is also needed to avoid waterlogging on land with poor soil texture, so that shallot plants can grow optimally without being disturbed by excess water (Gupta et al., 2022).

Apart from that, selecting plant varieties that ware tolerant to certain conditions was also an important strategy in managing suboptimal land. Varieties that have been adapted to grow in less-than-optimal soil conditions can provide better yields than varieties that ware sensitive to environmental conditions (Reddy, 2013). For example, shallot varieties that ware tolerant of drought or soil acidity will be more suitable for planting on suboptimal land. Using these varieties, farmers can reduce the risk of crop failure and increase the productivity of shallot plants. With a combination of various appropriate land management strategies, farmers can optimize the growth and yield of shallot plants even in sub-optimal land conditions (Rejekiningrum et al., 2022).

7. CHALLENGES and OPPORTUNITIES

The challenges in managing suboptimal land for the growth of shallot plants are very diverse. One of them is the difficulty in adapting to different soil conditions, ranging from low or high pH to inappropriate soil texture. Soil that was poor in nutrients was also a serious challenge because it can inhibit plant growth and development. Additionally, drainage and irrigation management becomes more complicated on suboptimal land, which can cause problems such as waterlogging or drought. Apart from that, additional costs to improve land conditions are also an obstacle for farmers, especially in areas that have large areas of suboptimal land. However, amidst these challenges, there are also opportunities to increase the productivity and quality of shallot plants. One way was by developing agricultural technology that can help overcome problems related to suboptimal land conditions, such as using appropriate fertilizer according to plant needs and using plant varieties that ware more resistant to non-ideal environmental conditions. Apart from that, agroecological approaches and sustainable agricultural practices can also provide solutions to optimize the productivity of shallot plants in suboptimal land conditions by paying attention to ecosystem balance and utilizing local resources more efficiently.

CONCLUSION

This research confirms that suboptimal land can have a significant impact on the growth and yield of shallot plants. However, with proper land management, this negative impact can be reduced, thereby increasing the productivity and quality of shallots. Further research was needed to better understand the mechanisms involved and develop more effective land management strategies.

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CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Erni Hawayanti: Writing – original draft, Conceptualization, Writing – review & editing. Jabal Tarik Ibrahim: Conceptualization, Methodology, Supervision, Writing – review & editing. Adi Sutanto: Data curation, Conceptualization, Writing – review & editing. Muchtaruddin Muchsiri: Conceptualization, Methodology, Supervision.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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