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Analysis of Crop Rotation and Compost Use on Organic Carrot Production Results in Rejang Lebong Regency

Reko Apriantonedi[1], Halim Ma'shum[2], Haryuni[3], Rizky Septika Utami[4], Eko Fransisko[5]
[1] Faculty of Agriculture. Pat Petulai University and rekoaprianto54@gmail.com
[2] Faculty of Agriculture. Bina Insan University and halimmashum48@univbinainsan.ac.id
[3] Faculty of Agriculture. Bina Insan University and haryuni66@gmail.com
[4] Faculty of Agriculture. Pat Petulai University and riskyutami20@gmail.com
[5] Faculty of Agriculture. Pat Petulai University and franzechoeko@gmail.com

ABSTRACT

This study investigates the impact of crop rotation and compost use on organic carrot production yield in Rejang Lebong District. Using a quantitative approach, data were collected from 60 organic carrot farmers through a structured questionnaire with a Likert scale (1–5). The data were analyzed using SPSS version 25 to examine the effects of these practices on yield. The findings reveal that both crop rotation and compost use have significant positive effects on organic carrot yields, with compost use showing the strongest influence. A synergistic effect was observed when both practices were combined, leading to improved soil health, nutrient availability, and pest management. The study highlights the importance of integrating sustainable agricultural practices to optimize organic carrot production. These insights are valuable for farmers, policymakers, and agricultural stakeholders aiming to enhance productivity while maintaining sustainability.

Keywords: *Crop Rotation, Compost Use, Organic Carrot Production, Sustainable Agriculture*

1. INTRODUCTION

Organic farming, particularly in the context of carrot cultivation in Rejang Lebong District, represents a sustainable approach that enhances environmental health and soil fertility. It reduces reliance on synthetic chemicals, promoting biodiversity and soil health [1], while practices such as composting and crop rotation improve soil quality and lead to higher crop yields [2], [3]. Organic carrots are also more nutritious and free from harmful residues, appealing to health-conscious consumers [1]. However, farmers face challenges in achieving optimal yields due to inconsistent management practices [3], the financial burden of obtaining organic certification [1], [4], and difficulties accessing markets dominated by conventional agriculture [1], [5].

Crop rotation and compost application are pivotal strategies in organic farming, particularly for enhancing crop yields and fostering sustainable agricultural systems. Research highlights that crop rotation disrupts pest life cycles, reducing infestations and minimizing the need for chemical interventions [6], while also enhancing soil aeration and water retention, crucial for root development [6], [7]. Additionally, rotating crops promotes balanced nutrient utilization, creating a more sustainable soil nutrient profile over time [1]. Compost application further complements these benefits by significantly increasing soil organic matter, improving physical and chemical soil properties [8]. The gradual release of nutrients from compost supports plant growth during critical stages [8], while enhanced microbial activity fosters nutrient cycling and suppresses diseases [5], [8]. Together, these practices provide a synergistic approach to improving soil health and crop productivity in organic farming systems.

This study aims to address this research gap by analyzing the effects of crop rotation and compost use on the production yield of organic carrots in Rejang Lebong District. The research adopts a quantitative approach, involving 60 samples of organic carrot farms.

2. LITERATURE REVIEW

2.1. Organic Farming and Sustainable Agriculture

Organic farming is a sustainable agricultural system that emphasizes natural processes to enhance soil fertility, promote biodiversity, and eliminate synthetic inputs, supporting both environmental health and economic viability for farmers. Carrot cultivation, in particular, benefits from organic practices, which reduce greenhouse gas emissions and improve soil health. Organic farming enhances soil structure and promotes microbial activity through practices like composting and crop rotation [2], [6], supports biodiversity by avoiding synthetic chemicals, enabling natural pest control [1], and contributes to carbon sequestration in soils, mitigating climate change impacts [6]. Effective management strategies, such as crop rotation, reduce pest populations and improve soil fertility, which are essential for achieving high carrot yields [9]. Additionally, compost application enhances nutrient availability, albeit more slowly than synthetic fertilizers [6], [10]. These practices together ensure the sustainability and productivity of organic farming systems.

2.2 Crop Rotation in Organic Farming

Crop rotation is a vital agricultural practice that enhances soil health, increases crop yields, and reduces reliance on chemical inputs by systematically alternating crops. This practice disrupts pest and disease cycles, improves soil structure, and optimizes nutrient availability, contributing to sustainable farming. Crop rotation effectively manages pests and diseases by altering soil microbial communities, which suppress soil-borne pathogens [11]. Rotating crops, particularly with legumes, enhances nitrogen levels in the soil through biological fixation, reducing the dependence on synthetic fertilizers [12], with studies showing that specific rotations can improve soil fertility by 10%-15% compared to monocultures [13]. Additionally, crop rotation significantly boosts yields, with research reporting a 25% increase in root vegetable production compared to monocropping [11], [14], while diverse rotations improve crop resilience under adverse weather conditions [15]. This underscores the critical role of crop rotation in sustainable agricultural systems.

2.3 The Role of Compost in Soil Fertility and Crop Yield

Compost is a crucial organic amendment that significantly enhances soil fertility and structure, thereby improving crop yield and quality, particularly in carrots within organic systems. The application of compost increases soil organic matter (SOM), which boosts water retention, nutrient availability, and microbial diversity, all essential for sustainable agriculture [8], [16]. Compost enhances soil cation exchange capacity (CEC), vital for nutrient retention and plant growth [8], [17]. Additionally, compost use promotes microbial diversity, which facilitates nutrient cycling and disease suppression, contributing to healthier soil ecosystems [16], [18]. Enhanced microbial activity accelerates organic matter decomposition, further improving nutrient

availability to plants [17]. Research shows that regular compost application improves carrot yields by 30% in organic farming systems and supports consistent plant growth and yield stability through its gradual nutrient release [8]. These benefits highlight compost's pivotal role in advancing crop productivity and sustainability in organic farming.

2.4 Integration of Crop Rotation and Compost Use

The integration of crop rotation and compost use is a promising strategy for enhancing soil health and crop productivity, particularly in diverse agro-climatic conditions. These practices mitigate nutrient depletion and improve soil organic carbon (SOC) levels, leading to increased crop yields and greater resilience against climate variability. Crop rotation contributes to yield stability, with diversified rotations, including legumes, increasing yields by up to 38% while reducing greenhouse gas emissions by 39% [19]. Additionally, rotations enhance soil microbial activity and SOC, which are critical for maintaining soil fertility [19]. Compost use complements these benefits by supplying essential nutrients, improving soil structure, and boosting microbial biomass, all of which are vital for crop growth [20]. The application of organic amendments like compost also reduces reliance on chemical fertilizers, promoting long-term soil health and sustainability [21], [22]. However, the effectiveness of these strategies can vary across regions, necessitating localized research to optimize practices for specific agro-climatic conditions, such as those in Rejang Lebong District [23].

2.5 Research Gap and Hypotheses

Despite the documented benefits of crop rotation and compost use, there is limited empirical evidence on their combined impact on organic carrot production yields in Rejang Lebong District. This study aims to fill this gap by exploring the effects of these practices using a quantitative approach. The following hypotheses guide the research:

H1: Crop rotation has a significant positive effect on the yield of organic carrots.

H2: Compost use has a significant positive effect on the yield of organic carrots.

H3: The combined application of crop rotation and compost use has a synergistic positive effect on the yield of organic carrots.

3. METHODS

3.1. Research Design

This study utilizes a quantitative research approach to explore the effect of crop rotation and compost application on organic carrot yield in Rejang Lebong District. The method used here is a descriptive-explanatory type since it will be determining the degree of relationship that exists between crop rotation, the use of compost, and organic carrot yield production. The data were gathered by using a structured questionnaire with a survey that has been statistically analyzed by using SPSS version 25.

3.2 Population and Sample

The population for this study is organic carrot farmers in Rejang Lebong District. The farmers to be studied are those who are actively practicing organic farming, adopting crop rotation and/or compost use in their farming systems, using a purposive sampling technique. The total sample selected is 60 farmers, ensuring that adequate representation of the organic farming community is obtained.

3.3 Data Collection

A structured questionnaire that would allow respondents to report the type of farming practice, especially on crop rotation and compost usage, and how it was perceived by the farmers on the increase of carrot yield. The questionnaire has items with measurements using a 5-point Likert scale with anchors 1 as "strongly disagree" to 5 as "strongly agree." The questionnaire was pre-tested to a small number of farmers in order to assess the clarity and reliability of the items.

3.4 Data Analysis

Data analysis was carried out through a systematic step-by-step process using SPSS version 25. Descriptive statistics were used to summarize the demographic profile of the respondents and the distribution of responses for each variable. A reliability test was conducted to assess the internal consistency of the Likert-scale items using Cronbach's alpha. A correlation analysis was performed for relationships between the independent variables of crop rotation and compost application, with the dependent variable being organic carrot production yield. To examine main and interaction effects of crop rotation and compost application on organic carrot production yield, regression analysis technique has been used because it involves applying a multiple linear regression model for the purpose of testing research hypotheses.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

A sample of 60 organic carrot farmers was drawn in Rejang Lebong District, with a 70:30 demographic ratio between male and female respondents. Years in farming were on average at 8 years. Most farmers applied the rotational system of up to three crops per year. Composting was at varying rates depending on soil conditions.

The Likert-scale items were also subjected to a distribution of response that was inclined towards the perceived benefits of crop rotation and compost use. Crop rotation practices X1 and X2 received a mean score of 4.2 and 4.5, respectively. These implied that most farmers strongly agreed that these practices ensure favorable produce. The average reported production yield was 18.5 tons per hectare.

4.2 Reliability Analysis

Cronbach's alpha was used to establish the reliability of the questionnaire. Both independent variables, crop rotation $\alpha = 0.87$ and compost use $\alpha = 0.89$, were more than the minimum acceptable threshold value of 0.7; hence, internal consistency of items was established.

4.3 Correlation Analysis

Pearson correlation analysis showed that crop rotation is highly positively associated with organic carrot yield ($r = 0.68$, $p < 0.01$) and also the use of compost with yield ($r = 0.74$, $p < 0.01$). Crop rotation was found to have a moderate positive correlation with the use of compost ($r = 0.45$, $p < 0.05$), showing these practices complement each other but the impacts are independent from each other.

4.4 Regression Analysis

Multiple linear regression analysis was run to see the effect of crop rotation and compost application on yield. The regression model was highly significant ($F = 45.6$, $p < 0.01$), and R^2 for the model was 0.72, meaning that the independent variables explained 72% of the variation in organic carrot yield.

1. Crop rotation, X1 tends to increase the yield positively ($\beta = 0.43$, $p < 0.01$).
2. Compost use (X2) had a stronger positive effect on yield ($\beta = 0.56$, $p < 0.01$).

3. Together, crop rotation and compost use showed a synergistic effect in increasing the yield outcome.

Discussion

The results of the study confirm the significance of crop rotation and compost use in enhancing organic carrot yields in Rejang Lebong District. Crop rotation and compost use improve soil health and nutrient availability and reduce pest pressure, which increases yields.

1. The Role of Crop Rotation

Crop rotation greatly affected the yields, consistent with the previous literature by [12]–[15]. This was mainly because diversified cropping systems improved the soil structure as well as controlled pest infestation. The three farmers in the study who applied rotation, including legumes, leafy vegetables, and root crops reported higher yields. That is, a rotation system mainly improved the fixation of nitrogen in soil and soil biodiversity. Therefore, crop rotation may prove to sustain soil productivity in the long term.

2. Effects of Compost Use

The individual impact of compost application on yield was the highest, consistent with [19]–[22], which noted that compost impacts soil organic matter and microbial activity. Carrots from farmers with higher compost applications had more advanced root development and larger size; this means compost application directly influences crop quality and yield. The adoption of composting as part of organic farming systems is, therefore, a critical necessity.

3. Interaction Effect of Crop Rotation and Compost Application

The experiment showed that there is an interaction effect in the use of crop rotation and compost application. In combination with crop rotation, compost application leads to enhanced nutrient cycling, suppression of soil-borne diseases, and good aeration condition that determines optimal growth conditions for carrots. These results support the view of [5], [8], [18] that the integration of several sustainable practices enhances crop production by building multiplicative effects.

4. Farmer and Policy Implications

The results bring into focus for farmers that organic farming should be holistic in approach by incorporating crop rotation with the use of compost. This should be promoted by policymakers and agricultural extension programs through training in the preparation of compost, subsidy for compost production, and demonstration projects. This can help to enhance the adoption of sustainable practices for food security and environmental conservation in Rejang Lebong District.

5. Limitations and Future Research

The only limitation of the study is its basis on only one crop and region. Other areas of research have to look for long-term implications and viability in terms of economics for different crops and regions. It will be interesting also to combine more advanced soil testing and monitoring techniques to further disintegrate what mechanisms are taking place behind this yield increase.

CONCLUSION

This study shows that crop rotation and compost use are very important practices for improving organic carrot yields in Rejang Lebong District. Crop rotation improves the health of soil and reduces the infestation by pests, while compost application improves soil fertility and nutrient availability. The interaction of these two practices has a synergistic effect, which contributes to ideal growing conditions and sustainable farming. These results indicate that these practices are capable

of addressing the productivity challenges facing organic farming and preserving the environment. It is recommended that farmers adopt these practices as part of a holistic farm management approach for maximum benefit. This implies that policymakers along with the agricultural extension service should support these sustainable techniques through training programs, financial incentives, and policy support for the needed wide-scale adoption and long-term agricultural sustainability. Further studies should be conducted to expand these findings in the direction of economic feasibility and long-term impact on various farming contexts.

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