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Onion Varieties (*Allium Ascalonicum L.*) Test With Application Of Several Kinds Microbia Consortium Its Influence On Growth and Yield

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Abstract

Shallots represent a crucial agricultural commodity within Indonesia, necessitating attention for optimal cultivation practices. Utilizing bacterial consortia in shallot farming holds promise in enhancing soil fertility through intricate biochemical mechanisms. This study endeavors to assess the impact of various microbial consortia on the growth and yield of distinct shallot varieties. Employing a Split Plot Design methodology, the experiment incorporates two primary factors: the shallot variety (V1: indigenous rubber variety; V2: local white variety; V3: Javanese indigenous variety) and the decomposing plant types representing microbial consortia (P0: Control; P1: M21; P2: EM4; P3: Beka Decomposer). Findings reveal significant disparities across multiple parameters including plant height, leaf count, stover weight, tuber diameter, and tuber yield per plot among different varieties. However, no substantial differences were observed in the number of bulbs per plant or per plot. Furthermore, the interaction between microbial consortia and shallot varieties exhibited varying outcomes, notably influencing leaf count and bulb diameter. Nonetheless, factors such as plant height, stover weight, tuber yield, and others remained unaffected. Notably, the most favorable yield was recorded with the V2P1 combination, featuring the local white shallot variety paired with the M21 microbial consortium, yielding an average of 150.27 g/plot (equivalent to 16,905 kg/ha or 16.9 tons/ha).

Keywords: Shallots, microbial consortium

Introduction

Shallots represent a pivotal horticultural commodity essential to the populace of Indonesia. Presently, the demand for shallots persists in an upward trajectory, evidenced by substantial imports and volatile pricing dynamics within the market. Statistical evidence from the Central Statistics Agency (BPS) indicates that shallots are poised to dominate vegetable production in the year 2022, with aggregate production nearing 2 million tons across all Indonesian provinces. Nonetheless, this output marks a decline compared to the 2021 yield, which stood at 2,004,590 tons. This reduction aligns with a corresponding shrinkage in shallot cultivation area, diminishing by 10,189 hectares to 184,386 hectares in 2022. The heightened production levels have yet to satisfy public demand, prompting consideration of intensification and extensification strategies as viable avenues to bolster both the quantity and caliber of shallot output. (Kurniasih and Huda Ramdan, 2022)

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In Indonesia, the cultivation of shallot plants has long been established as a lucrative agricultural endeavor among farmers. However, the escalating demand for shallots, which consistently rises annually, has not been met with a corresponding increase in production. This discrepancy can be attributed to various constraints in plant cultivation, encompassing soil diversity, pest, disease, and weed management, fertilization practices, and post-harvest protocols. Fluctuations in yield, stemming from environmental instabilities, underscore the intricate dynamics governing plant resilience. Efforts in shallot plant development are oriented towards optimizing the harmonization of environmental variables. In this context, the availability of cultivars well-suited to local conditions, exhibiting high-yield potential, emerges as a pivotal determinant influencing both yield outcomes and varietal adaptability.

Cow manure stands out as a prominent organic input extensively employed in shallot cultivation. Its application confers several benefits to agricultural plots, including soil structure enhancement, provision of plant nutrients, augmentation of soil microbial activity, and fortification against erosion. Notably, the utilization of organic fertilizers, such as cow manure, necessitates a protracted decomposition period compared to synthetic counterparts, leading to a gradual release and uptake of nutrients by plants. Mitigation strategies to address this temporal lag involve the inoculation of decomposer microbes, such as Trichoderma, into organic substrates utilized in plant cultivation (Khatoon et al., 2017).

Efforts that can be taken to increase shallot production are to intensify cultivation, especially in areas suitable for shallot development. The obstacle that is often faced in cultivating shallots is low production due to the carrying capacity of the land, especially low soil fertility. Various strategies and approaches are taken to maintain or increase soil fertility on shallot cultivation land, including by rotating cultivated plants or by supplying inorganic fertilizer. Apart from that, this is also done by applying organic materials and enriching decomposer microorganisms in shallot cultivation media (Mahfud et al., 2021)

Enhancing shallot production can be achieved through refining cultivation methodologies and employing organic fertilization practices. The utilization of organic fertilizers offers several benefits, encompassing enhancements in soil's physical, chemical, and biological attributes, along with mitigating residual effects to prevent adverse environmental repercussions (Laude & Hadid, 2007).

A bacterial consortium is a combination of two or more bacterial isolates grown in the same medium (Triyanto, 2009). The microbial consortium can increase the growth rate which triggers increased enzyme production from each isolate to synthesize the IAA hormone. Bacterial consortia can provide more optimum results because of the mutually supporting metabolic activities of each bacterial isolate. (Jadhav et al., 2008 in Anggraeni, 2014).

The employment of a bacterial consortium (referred to as bioboost herein) within rice cultivation holds promise for enhancing soil fertility through the facilitation of soil biochemical processes. The supplementation of microorganisms alongside chemical fertilizers, organic manure, or compost stands poised to significantly augment land productivity, thereby fostering an enhancement in agricultural yield encompassing both the qualitative and quantitative aspects of crop production. Notably, the bacterial consortium's constitution encompasses a diverse array of bacteria that play instrumental roles in the facilitation of plant growth processes (cf. Wuriesyliane et al., 2013).

Method

The investigation took place between December 2022 and March 2023 in Samiran village, Selo, Boyolali Regency, Central Java, focusing on brown lithosol soil. A Split Plot Design incorporating two treatment factors, namely variety and decomposer (microbial consortium), was employed. The variety treatment, serving as the main plot, included three variations: 1) V1: Local Karet variety of shallots; 2) V2: Local White variety of shallots; and 3) V3: Local Javanese variety of shallots. The second factor, concerning the application of the microbial consortium, constituted the sub plot and encompassed four variants: 1) P0 = Control; 2) P1 = M21; 3) P2 = EM4; and 4) P3 = Beka Decomposer. This arrangement resulted in 12 treatment combinations, each replicated three times for robust analysis.

Observation parameters include growth and yield

The parameters under investigation encompass the vertical stature of vegetation (measured in centimeters), leaf count (quantified in leaves), mass of freshly harvested plant residue (expressed in grams), mass of desiccated plant residue (also in grams), quantity of subterranean storage structures per individual plant (counted in units), aggregate quantity of subterranean storage structures per experimental unit (also counted in units), dimensions of subterranean storage structures (measured in millimeters), fresh mass of subterranean storage structures (recorded in grams), fresh mass of subterranean storage structures within a specific cluster (assessed in grams), desiccated mass of subterranean storage structures within a specific cluster (measured in grams), and desiccated mass of subterranean storage structures per experimental unit (quantified in grams).

Result And Discussion

Effect of Microbial Consortium Application on the Growth of Several Shallot Varieties

In elucidating the outcomes derived from the examination of growth metrics pertaining to shallots (Allium ascalonicum L.), encompassing parameters such as plant stature (measured in centimeters), leaf count, fresh biomass (measured in grams), and desiccated biomass (measured in grams), an analysis of variance at the 5% significance level was conducted, as delineated in Table 1.

Table 1. 5% t test (LSD) on growth parameters of shallot plants (Allium ascalonicum L.)

Treatment	Growth parameters			
	Plant height (cm)	Number of Leaves (pieces)	Weight of fresh stover (g)	Dry Stove Weight (g)
V1	33.1458a	20.6250a	5.2333a	4.2208a
V2	32.6250a	20.3958a	5.1700a	4.1883a
V3	19.3958b	16.6250b	2.5792b	1.5308b
P0	27.333b	17.5833b	4.4556a	3.4356a
P1	29.194a	19.3611a	4.3689a	3.3689a

P2	28.556ab	20.1944a	4.2789a	3.2478a
P3	28.472ab	19.7222a	4.2067a	3.2011a
V1P0	32.000a	19.0000c	5.4533a	4.3700a
V1P1	34.417a	19.8333bc	5.1600a	4.1967a
V1P2	33.500a	22.5833a	4.9767a	3.9467a
V1P3	32.667a	21.0833c	5.3433a	4.3700a
V2P0	30.583b	17.4167c	5.3433a	4.3500a
V2P1	34.083a	21.8333a	5.2667a	4.2933a
V2P2	32.583a	20.7500b	5.1267a	4.1433a
V2P3	33.250a	21.5833ab	4.9433a	3.9667a
V3P0	19.417a	16.3333a	2.5700a	1.5867a
V3P1	19.083a	16.4167a	2.6800a	1.6167a
V3P2	19.583a	17.2500a	2.7333a	1.6533a
V3P3	19.500a	16.5000a	2.3333a	1.2667a

Explanation: In instances where treatments sharing identical alphabetical designations within a given column are subjected to scrutiny via the 5% t-test (LSD).

Utilizing the t-test (LSD) at a 5% significance level to analyze all growth parameters of shallot plants revealed no statistically significant differences across plant height, leaf count, fresh stover weight, and dry stover weight. This trend persisted for both the local rubber variety (V1) and the white local variety (V2), while the local Javanese variety (V3) exhibited significant deviations. Notably, the local rubber variety (V1) demonstrated the highest yield, contrasting with the lowest yield observed in the local Javanese variety (V3) across all growth parameters. This disparity arises from the comparatively shorter stature, reduced foliage, and smaller size of the local Javanese variety (V3) in comparison to the local rubber variety (V1) and the white local variety (V2).

In the context of various microbial consortia applications, discernible differences emerged in plant height and leaf count parameters, whereas no significant distinctions were noted in fresh and dry stover weight parameters. Specifically, the EM4 microbial consortium (P2) and decomposer beka (P3) yielded significantly different outcomes compared to the M21 microbial consortium (P1) and the control treatment (P0) concerning plant height parameters. Meanwhile, significant differences were observed between the microbial consortium M21 (P1) and the control (P0). This discrepancy stems from the presence of specific bacteria, namely Pseudomonas and Acetobacter, exclusively found in M21 (P1) but absent in EM4 (P2) and Beka Decomposer (P3). These bacteria play pivotal roles in stimulating growth and enhancing nutrient absorption within the soil.

Analysis of the t-test (LSD) data at a 5% significance level on shallot plant growth parameters, as presented in Table 1, indicates nonsignificant differences in the application of various microbial consortia to local rubber variety shallot plants (V1). Notably, no significant differences were observed in plant height, fresh stover weight, and dry stover weight. Conversely, a significant disparity was noted in leaf count parameters, with the highest value recorded at 22.58 for the V1P2 combination (local rubber onion variety and EM4 application).

This discrepancy is attributable to the presence of Rhodopseudomonas Sp. (photocytic bacteria) and yeast within EM4 (P2), facilitating nutrient absorption optimization in local rubber variety shallots. Application of diverse microbial consortia to local rubber variety (V2) yielded significant differences in plant height and leaf count parameters but no notable distinctions in fresh and dry stover weight parameters. Notably, significant variations were observed in comparison to the control treatment (P0), underscoring the influence of microbial consortia on shallot plant height.

Table 1 further illustrates average plant height discrepancies ranging from 30.58 cm to 34.08 cm, with the highest value recorded for the V2P1 combination (white variety shallots with M21 decomposer) and the lowest for the V2P0 combination (white variety shallots with control). Likewise, significant differences were observed in leaf count parameters, with the highest value of 21.83 in the V2P1 treatment and the lowest of 17.41 in the V2P0 treatment. This underscores the substantial impact of microbial consortium application on plant height and leaf count while leaving fresh and dry stover weight unaffected.

Conversely, the application of various microbial consortia to local Javanese variety shallot plants (V3) yielded no significant differences in any growth parameters, including plant height, leaf count, fresh stover weight, and dry stover weight. This suggests that the utilization of microbial consortia on local Javanese variety (V3) shallot plants does not substantially impact plant growth.

Effect of Microbial Consortium Application on the Yield of Shallot Varieties The investigation into the yield parameters of shallot plants (Allium ascalonicum L.), encompassing metrics such as the quantity of bulbs per cluster, bulbs per plot, bulb diameter (measured in centimeters), fresh bulb weight per cluster (expressed in grams), dry bulb weight per cluster (also in grams), and the dry tuber weight per plot (measured in grams), underwent rigorous analysis of variance at a significance level of 5%, as delineated in Table 2.

Table 2. 5% t test (LSD) on the yield parameters of shallot plants (Allium ascalonicum L.)

	Result parameters					
Treatment	Number of Tubers per Plant (piece)	Number of Tubers per plot (piece)	Tuber Diameter (mm)	Fresh weight of tubers per hill (g)	Dry weight of tubers per hill (g)	Dry Weight of Tubers per Plot (g)
V1	7.4792a	89.750a	20.6250a	15.9708a	11.9792a	143.733a
V2	7.3333a	88.000a	20.3958a	16.1917a	12.1433a	145.726a
V3	7.5417a	90.500a	16.6250b	7.8375b	5.8775b	70.531b
P0	5.6389b	67.667a	17.5833a	13.6911a	9.6689a	116.017a
P1	8.1111a	97.333a	19.3611a	13.5744a	10.2689a	123.220a
P2	8.0000a	96.000a	20.1944a	13.1767a	9.8822a	118.582a
P3	8.0556a	96.667a	19.7222a	12.8911a	10.1800a	122.167a
V1P0	5.5833b	67.000b	19.0000c	15.5067a	11.6300a	139.543a
V1P1	8.0833a	97.000a	19.8333bc	16.2933a	12.2233a	146.647a
V1P2	8.0000a	96.000a	22.5833a	15.7333a	11.8000a	141.583a
V1P3	8.2500a	99.000a	21.0833ab	16.3500a	12.2633a	147.157a
V2P0	5.9167b	71.000b	17.4167b	15.7267a	11.7967a	141.547a
V2P1	7.8333a	94.000a	21.8333a	16.6967a	12.5200a	150.270a
V2P2	7.8333a	94.000a	20.7500a	16.0533a	12.0400a	144.493a
V2P3	7.7500a	93.000a	21.5833a	16.2900a	12.2167a	146.593a
V3P0	5.4167b	65.000b	16.3333a	7.4400a	5.5800a	72.750a
V3P1	8.4167a	101.000a	16.4167a	8.0833a	6.0633a	72.743a
V3P2	8.1667a	98.000a	17.2500a	7.7433a	5.8067a	69.670a
V3P3	8.1667a	98.000a	16.5000a	8.0833a	6.0600a	66.960a

Explanation : Treatments followed by the same letter in the same column show no significant difference in the 5% t test (LSD).

Utilizing the findings derived from the t-test (LSD) conducted at a significance level of 5% on the yield parameters of shallot varieties, discernible distinctions emerged particularly in the metrics of tuber diameter, fresh weight of tubers per cluster, dry weight of tubers per cluster, and dry weight of tubers per plot. Conversely, parameters such as the number of tubers per plant and per plot exhibited no statistically significant deviations. Examination of Table 2 revealed that the local rubber variety of red onion displayed the highest recorded tuber diameter value at 20.62 mm, while the local Javanese variety indicated the lowest value at 16.62 mm. In terms of fresh weight of tubers per cluster, dry tuber weight per cluster, and tuber weight per plot, the local white variety of shallots demonstrated the highest values, juxtaposed with the local Javanese variety reflecting the lowest values.

Furthermore, results stemming from the analysis of variance underscored the consequential impact of applying a microbial consortium on the number of tubers per plant, while its influence on other parameters such as tuber diameter, fresh weight of tubers per cluster, dry weight of tubers per cluster, and dry weight of tubers per plot was deemed statistically insignificant. This phenomenon can be attributed to the facilitative role of specific bacteria strains, including Rhodopseudomonas Sp., Bacillus Sp., and Pseudomonas Sp., in enhancing nutrient absorption within the soil, thereby influencing tuber production. Notably, the number of tubers per plant exhibited a range between 5.63

and 8.11, with the highest value observed in the M21 treatment (P1) and the lowest in the control treatment (P0).

Upon closer examination, it was observed that the local rubber variety of shallot (V1) manifested statistically significant disparities in parameters such as the number of bulbs per plant, number of bulbs per plot, and bulb diameter. Contrastingly, the application of various microbial consortia, namely M21 (P1), EM4 (P2), and Beka decomposer (P3), yielded non-significant differences in the number of tubers per plant and per plot when compared to each other, albeit significantly differing from the control treatment (P0). Additionally, concerning tuber diameter parameters, while the M21 treatment (P1) did not exhibit any discernible effect, both EM4 (P2) and Beka decomposer (P3) treatments yielded noteworthy impacts.

This discrepancy is hypothesized to stem from the genetic predisposition inherent in the local rubber variety of shallots, thereby impeding the optimal functionality of the bacteria present in the M21 treatment (P1). Furthermore, variations in bacterial composition between M21 (P1) and EM4 (P2) elucidate the observed discrepancies, which significantly deviate from the control behavior (P0). Conversely, the Beka decomposer treatment (P3) yielded results comparable to M21 (P1) and EM4 (P2), attributed to the shared bacterial strains such as Bacillus Sp., Trichoderma Sp., and Streptomyces Sp.

The most favorable outcomes were discerned in the V1P3 treatment, featuring a blend of local rubber onion varieties (V1) coupled with the utilization of Beka decomposer (P3), boasting the highest recorded values of 8.25 for the number of bulbs per plant and 99.00 for the number of bulbs per plot. Conversely, parameters including fresh weight of tubers per hill, dry weight of tubers per hill, and dry weight of tubers per plot failed to exhibit significant deviations. These results imply that the application of microbial consortia solely impacts the number and diameter of bulbs within the local rubber variety of shallot (V1).

Similarly, the local white variety of shallots (V2) mirrored analogous outcomes, signifying substantial disparities in parameters such as the number of bulbs per plant, number of bulbs per plot, and bulb diameter, while other metrics remained statistically indistinguishable. This underscores the singular influence of bacteria contained within all microbial consortia (M21 (P1), EM4 (P2), and Beka decomposer (P3)) on the aforementioned parameters.

Conversely, the local Javanese variety of red onion (V3) exhibited divergent outcomes compared to both the local rubber (V1) and white (V2) varieties. Noteworthy differences were solely evident in the parameters of the number of bulbs per plant and per plot, while other metrics exhibited no significant deviations from the control treatment (P0). Additionally, all microbial consortia yielded non-significantly different results, indicative of a consistent influence exerted by the bacteria strains on shallot plants.

Ultimately, the V3P1 treatment, incorporating the local Javanese variety of shallots (V3) alongside the utilization of M21 (P1) as a microbial consortium, showcased the most favorable results, attaining a peak value of 8.41 for the number of bulbs per plant and 101 for the number of tubers per plot. Conversely, the V3P0 treatment, combining local Javanese varieties of shallots with the control treatment (P0), yielded the lowest yield.

Conclusion

Based on the findings elucidated above, it is evident that significant disparities were observed among varieties in various parameters including plant height, leaf count, fresh stover weight, dry stover weight, tuber diameter, fresh tuber weight per cluster, tuber dry weight per cluster, and tuber dry weight per plot. Conversely, no statistically significant variance was detected in the number of tubers per plant and per plot. Furthermore, the integration of a microbial consortium with diverse shallot varieties demonstrated a notable impact on leaf count and tuber diameter, while exhibiting no statistically significant influence on plant height, fresh stover weight, dry stover weight, tuber count per plant, tuber count per plot, fresh tuber weight per cluster, dry tuber weight per cluster, and dry tuber weight per plot. Notably, the most substantial yield was achieved through the utilization of a local white variety onion treatment combined with the application of the M21 (V2P1) microbial consortium, yielding an average of 150.27 grams per plot or 16,905 kilograms per hectare (equivalent to 16.9 metric tonnes per hectare).

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