The Interaction Effect of Biographical Fertilizer, Organic Fertilizer and Inorganic Fertilizer on the Growth and Results of Red Onion (*Allium ascalonicum* L.) in Dry Land

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Abstract. Shallot cultivation in dry land must integrate measures to improve the soil's physical, chemical and biological properties and not rely on using inorganic fertilisers with high enough doses. This study aimed to determine the interaction effect between natural fertilisers with organic fertiliser doses and inorganic fertiliser doses on growth and yielded onion (*Allium ascalonicum*L.) on dry land. This research was conducted on dry land in Labuhan Lombok Village, Pringgabaya District, East Lombok Regency, NTB, from June to September 2022. The design used is Factorial Randomized Block Design (RBD) 3 factors: doses of organic fertilisers, doses of biological fertilisers, and doses of inorganic fertilisers. The quantity of organic fertiliser (O) consists of 2 levels, namely 5 tons/ha (O1) and 10 tons/ha (O2). The biological fertiliser treatment consists of 2 groups: without natural fertiliser (H1) and with biological fertiliser 1 kg/ha biological fertiliser (H2). In comparison, the dose of inorganic fertiliser consists of 3 levels, namely 100% dose (D1), 75% dose (D2) and, 50% dose (D3), 25% dose (D4). Each treatment was combined and added with one control to obtain 17 treatments. Parameters observed included a) Shallot plant growth, including plant height, number of leaves per clump (strand) and number of tillers per clump (saplings); b) Shallot plant yields included wet tuber weight and dry tuber weight. The data obtained were analysed using analysis of variance (ANOVA). For natural treatment factors, a further test would be carried out with Duncan's Double Distance Mean Difference Test with a level of 5%. The interaction of biological fertilisers with doses of organic and inorganic fertilisers increased the growth and yield of shallots in dry land. Organic fertiliser doses of 5 t/ha can reduce the dosage of inorganic fertilisers by 50% and, if accompanied by biological fertilisers, can reduce the use of inorganic fertilisers by up to 75% of the recommended dosage.

Keywords: shallots; biological fertilisers; organic fertilisers; inorganic fertilisers.

INTRODUCTION

Shallot production in Indonesia reached 1.58 million tons in 2019, then increased by 14.88% in 2020 to 1.82 million tons from a harvested area of 191,201 hectares, with productivity coming to 9.49 t/ha [1]. West Nusa Tenggara (NTB) is the third shallot producer in Indonesia, or around 10.4% of Indonesia's production after Central Java (33.86%) and East Java (25.04%).

Most shallots in NTB are cultivated on dry land, so their productivity is still low, namely 8,315 t/ha. According to [2], dry matter generally has a relatively low ability to absorb and hold moisture and has a low chemical content needed by plants. This is partly due to dry land's low plant nutrient deposits and the soft soil organic matter content. This condition makes the fertility level of dry land lower than rainfed and paddy fields. These conditions require Shallot cultivation in dry land to integrate cultivation measures to improve the soil's physical, chemical and biological properties.

In contrast, until now, Shallot cultivation still relies on using inorganic fertilisers with high enough doses. The results of research [3] showed that the fertiliser for shallot plants in the first planting season was Urea 205.83 kg/ha, KCL 28 kg/ha, ZA 62.5 kg/ha and NPK 60 kg/ha, while the second planting season with Urea 150 kg/ha, KCL 53.57 kg/ha, ZA 25 kg/ha and NPK 58 kg/ha. The dosage of fertilisation by these farmers is not by the recommendations for fertilising shallots on non-andisol soil with a single fertiliser issued for Urea fertiliser (130–165 kg/ha), ZA (100–185 kg/ha), SP36 (50–125 kg/ha) and KCl (75–150 kg/ha), the dose of Urea fertiliser is so high while other fertilisers are very low.

Fertiliser use of inorganic substances continuously for a long time can reduce soil fertility, harden the soil and reduce the stability of soil aggregates [4], especially on dry land with low soil fertility. This study aims to determine the interaction effect of biological fertilisers with organic fertilisers on the growth and yield of shallots (*Allium ascalonicum*L.) in dry land.

METHOD

This research was conducted from June 2022 to September 2022 at the Agricultural Technology Research and Study Installation (IP2TP) of BPTP NTB in Pererenang Hamlet, Labuhan Lombok Village, Pringgabaya District, East Lombok, West Nusa Tenggara. That plan used factorial Randomized Block Design (RBD): biological fertilisers and inorganic fertiliser doses. The biological fertiliser treatment consisted of 2 levels, namely without natural fertiliser (H1) and with biological fertiliser 1 kg/ha biological fertiliser (H2), the dose of organic fertiliser (O) consisted of 2 levels, namely 5 tons/ha (O1) and 10 tons /ha (O2). In comparison, the dosage of inorganic fertilisers consists of 4 levels, namely 100% dose (D1), 75% dose (D2), 50% dose (D3) and 25% dose (D4). Each treatment was combined and added one control with three replications.

Parameters observed include; shallot plant growth (plant height, number of leaves and number of tillers per hill) measured every week at 4–8 weeks, and shallot yield parameters (wet bulb weight and dry bulb weight) measured at harvest and two weeks after harvest. The data obtained were analysed using analysis of variance (ANOVA) and different actual treatments. Further tests were conducted with the Duncan Mean Difference Test Double Distance at 5%.

RESULTS AND DISCUSSION

State of the Research Location. The research location is at an altitude of ± 52.4 above sea level or about 1 km from the coast. The land in the area is dry land with a flat topography with water sources for irrigation using deep wells. Rainfall at the start of planting in July 2022 ranges from 21–50 mm, and in August 2022 reaches 51–100 mm. The results of soil analysis at the research location are in Table 1.

Table 1 – Chemical properties of the soil at the experimental site

Parameter	Score	Criteria
H_2O pH	7.86	Slightly alkaline
C-organic (%)	0.27	Very low
N total (%)	0.08	Very low
C/N	15.86	Tall
P Total (%)	0.29	Very low
K Total (%)	0.72	Very low

Notes: Results of soil analysis from BPTP NTB Laboratory

State of Soil Biology. Microbial population measurements were carried out using the Standards Plate Counts (SPC) method to obtain microbial counts in the range of 30–300 CFU (Colony Forming Unit)/ml in the Microbiology Laboratory, Faculty of Agriculture, Unram. The CFU test results showed that the bacteria density at the study site was 5.10 x 10^7 (CPU g-sample). The thickness of bacteria in the shallot root area for each treatment can be seen in Table 2.

Table 2 – Bacterial Density of Each Treatment

Treatment Combination	Bacterial Density (CPU g-Sample)
$H_0O_0D_1$ (Control)	5.10 x 10^7
$H_1O_1D_1$	6.17 x 10^7
$H_1O_1D_2$	6.40 x 10^7
$H_1O_1D_3$	6.13 x 10^7
$H_1O_1D_4$	6.40 x 10^7
$H_1O_2D_1$	1.53 x 10^8
$H_1O_2D_2$	1.31 x 10^8
$H_1O_2D_3$	2.03 x 10^8
$H_1O_2D_4$	1.12 x 10^8
$H_2O_1D_1$	1.08 x 10^8
$H_2O_1D_2$	5.90 x 10^7
$H_2O_1D_3$	7.30 x 10^7
$H_2O_1D_4$	7.80 x 10^7
$H_2O_2D_1$	9.70 x 10^7
$H_2O_2D_2$	6.73 x 10^7
$H_2O_2D_3$	7.57 x 10^7
$H_2O_2D_4$	7.00 x 10^7

Treatment of organic fertilisers and biological fertilisers can increase the density of bacteria, reaching 6.13 x 10^7 to 2.03 x 10^8 (CPU g-sample).

The higher the dose of organic fertiliser, the higher the density of bacteria. The treatment of biological fertilisers on dry land did not significantly increase the density of bacteria, but the role of organic fertilisers significantly increased the density of bacteria. Based on the research results [5] that the use of organic fertilisers can increase the population of soil bacteria from 10^2 to 10^7 and is also supported by the results of research [6] that the use of manure can increase the population of Azotobacter bacteria (0.02 %) and Azospirillum (0.46%).

Interaction of Biological Fertilizers with Organic Fertilizers. Based on the analysis of the variance of the interaction of biological fertilisers with organic fertilisers, it significantly affected plant height, number of leaves, fresh weight and dry weight of shallot bulbs.

Table 3 – The effect of the interaction between biological fertiliser treatment and organic fertiliser treatment on the average plant height at various plant ages

Organic fertiliser	Plant Height, cm									
	28 Days		35 Days		42 Days		49 Days		56 Days	
	Organic Dosage									
	O1	O2	O1	O2	O1	O2	O1	O2	O1	O2
H_1	27.59 ^{ab}	25,67 ^{b}	33,39 ^{a}	30,25 ^{b}	39.76 ^{a}	35,66 ^{b}	42.80 ^{a}	39,83 ^{a}	44.72 ^{a}	43,21 ^{a}
H_2	27.47 ^{ab}	28.90 ^{a}	33,66 ^{a}	33.74 ^{a}	38.07 ^{ab}	38.19 ^{ab}	41.55 ^{a}	43.02 ^{a}	43,46 ^{a}	44.99 ^{a}
BNJ	3.60		6,64		7,64		8,83		11.94	

Notes: The numbers followed by different letters mean the values are significantly different

Shallot plants have two growth phases: the vegetative and the generative phases. Shallot plants enter the vegetative stage after 11–35 HST, and the fertile phase occurs when the plants are 36 HST. The generative phase consists of the tuber formation phase (36–50 DAP) and the tuber maturation phase (51–56 DAP) [7]. In the growth phase of shallot plants at the age of 28 to 35 days (Table 3), the interaction of biological fertiliser treatment with an organic fertiliser at a dose of 10 t/ha significantly increased plant height (28.90 & 33.74 cm) compared to without using natural fertiliser (25.67 & 30.25 cm). Entering the generative phase to the high ripening stage of shallots was not significantly different between treatments because most photosynthate results were translocated for the filling and maturation of the bulbs.

The optimum number of leaves allows light distribution as photosynthetic formation between leaves is more evenly distributed. It is deposited on the stems and roots, which affects the weight of shallot bulbs. The interaction of biological fertiliser treatment with organic fertiliser treatment significantly affected the number of shallot leaf leaves at the end of the growth phase to the tuber maturation phase, namely at 35 to 56 days. The amount of red onion with the treatment of biological fertiliser (H2) with a dose of 10 t/ha (O2) organic fertiliser was not significantly different compared to that without using natural fertiliser (H_1) with the same amount of organic fertiliser, but substantially different from the non-biological treatment (H_1) with a dose of 5 t/ ha (Table 4).

Table 4 – The effect of the interaction between biological fertiliser treatment and organic fertiliser treatment on the average number of leaves at various plant ages

Organic fertiliser	Plant Height, cm									
	28 Days		35 Days		42 Days		49 Days		56 Days	
	Organic Dosage									
	O1	O2	O1	O2	O1	O2	O1	O2	O1	O2
H_1	15,6 ^{a}	13.88 ^{a}	24,22 ^{a}	17.89 ^{b}	30.71 ^{a}	22.11 ^{b}	35.55 ^{a}	26.64 ^{b}	38.66 ^{ab}	28.12 ^{c}
H_2	14.80 ^{a}	15.50 ^{a}	21.46 ^{ab}	22,28 ^{b}	27.38 ^{ab}	31.02 ^{a}	32.42 ^{ab}	35,45 ^{a}	33.08 ^{bc}	39.33 ^{a}
BNJ	8.58		9.37		14.56		16.0		15,21	

Notes: Numbers followed by different letters indicate significantly different values

At the age of 42 to 56 days, the biological fertiliser treatment with an amount of 10 t/ha organic fertiliser was significantly different from the treatment without natural fertiliser with the same dose of organic fertiliser but not substantially different from the treatment without biological fertiliser with 5 t/ha organic fertiliser. Organic fertiliser doses of 5 t/ha can increase the number of shallot leaves. Still, adding organic fertiliser doses to 10 t/ha, not combined with biological fertilisers, can reduce the number of shallot leaf leaves.

The interaction of biological fertiliser treatment with organic fertiliser treatment significantly affected shallots' wet and dry weight (Table 5).

Table 5 – The effect of the interaction between biological treatments and organic fertiliser treatment on the average wet weight and dry weight of plants

Treatment	Wet weight (t/ha)		Dry weight (t/ha)	
	Organic Dosage			
Organic fertiliser	O1	O2	O1	O2
H1	46.2 [a]	40.4 [b]	15.8 [ab]	12,3 [b]
H2	47.6 [a]	47.1 [a]	14.7 [ab]	16,6 [a]
BNJ	6,31		10.60	

Notes: Numbers followed by different letters indicate significantly different values

The highest fresh shallot bulb weight was in the biological fertiliser treatment with a dose of 10 t/ha of organic fertiliser, which was 47.1 t/ha, significantly different from that without natural fertiliser with the same amount of organic fertiliser, namely 40.4 t/ha, but not substantially different from without biological fertilisers or using biological fertilisers with a dose of 5 t/ha organic fertiliser. Organic fertiliser treatment of 10 t/ha, which was not combined with natural fertilisers, did not increase the wet bulb weight of shallots and even tended to reduce shallot productivity in dry land.

The dry weight of shallot bulbs was highest in the biological fertiliser treatment with a dose of 10 t/ha of organic fertiliser, which was 16.6 t/ha, significantly different from the treatment without using natural fertilisers with the same dose, namely 12.3 t/ha and was the lowest dry weight of the onion. Lower compared to other treatments. Treatment of biological fertilisers with an amount of 10 t/ha organic fertiliser did not significantly affect the dry weight of shallot bulbs compared to treatment without biological fertilisers or using natural fertilisers with a dose of organic fertiliser of 5 t/ha. The use of organic fertiliser doses of 5 t/ha is sufficient to meet the needs of shallots, and the use of organic fertilisers of 10 t/ha must be accompanied by the use of biological fertilisers to obtain higher wet bulb weight and dry bulb weight of shallots in a parched land.

Based on the research results [8], the interaction of biological fertilisers with organic fertilisers increases the absorption of N, P and K nutrients, affecting onion plant height, number of leaves and shallot bulb weight. This interaction causes the tuber weight to be higher than without using biological fertilisers.

Interaction of Biological Fertilizers, Organic Fertilizers and Inorganic Fertilizers. Based on the analysis of variance of the interaction of biological fertilisers, organic fertilisers, and inorganic fertilisers, they significantly affected plant height, number of leaves and wet weight of shallots. The impact on plant height was seen at 35 to 42 days (Table 6), namely in the growth phase until the beginning of tuber maturation. While the effect on the number of leaves appears at the age of 42 to 56 days or enters the tuber maturation phase until ahead of harvest, it significantly affects the wet weight of shallots at harvest.

Plant height (Table 6) and number of leaves (Table 7) in the treatment of biological fertilisers with inorganic fertiliser doses of 100% recommendation (D_1), doses of 75% (D_2) and doses of 50% (D_3) at doses of organic fertiliser 10 t/ha not significantly different from the amount of 5 t/ha. This shows that using biological fertilisers and reducing inorganic fertiliser doses up to 50% of the recommended dosage does not reduce plant height. Reducing the use of organic fertiliser doses of 5 t/ha did not reduce the growth of shallot plants. The use of biological fertilisers is not significantly different from the use of natural fertilisers on plant height. Still, applying organic fertilisers on dry land is necessary to improve soil structure so that air aeration and water movement become smooth.

Table 6 – The effect of the interaction between biological fertilisers, organic fertilisers and inorganic fertilisers on the average plant height at the age of 35 days

Organic fertiliser	Plant height at 35 days (cm)							
	Organic O1				Organic 02			
	D1	D2	D3	D4	D1	D2	D3	D4
H_1	38.1 ^{a}	36.7 ^{ab}	33.2 abc	25.5 ^{d}	34.2 ^{abc}	30.3 ^{bcd}	31.2 ^{bcd}	25.3 ^{d}
H_2	36.1 ^{ab}	34.2 ^{abc}	33.5 abc	30.9 ^{bcd}	37.9 ^{a}	36.1 ^{ab}	32.2 ^{abc}	28.8 ^{cds}
BNJ	6,64							
	42 days old plant height (cm)							
H_1	45.4 ^{a}	43.7 ^{ab}	39.9 ^{abcd}	30.0 ^{e}	40.6 ^{abcd}	34.6 ^{cdes}	37.3 ^{bcde}	30.2 ^{e}
H_2	41.9 ^{abc}	39.7 ^{abcd}	37.2 ^{bcde}	33.5 ^{de}	40.9 ^{abcd}	42.2 ^{abc}	38.9 ^{abcd}	30.8 ^{e}
BNJ	7,64							

Notes: Numbers followed by different letters indicate significantly different values

Table 7 – Effect of interaction between biological fertilisers, organic fertilisers and inorganic fertilisers on the average number of plant leaves at 42 to 56 days

Fertiliser Biological	Number of Plant Leaves Age 42 Days (cm)							
	Organic O1				Organic 02			
	D1	D2	D3	D4	D1	D2	D3	D4
H1	33.1 ^{a}	28.1 ^{ab}	30.6 ^{ab}	31.1 ^{ab}	17.8 ^{b}	19.1 ^{ab}	21.62 ^{ab}	29.9 ^{ab}
H2	24.1 ^{ab}	26.9 ^{ab}	29.3 ^{ab}	29.3 ^{ab}	33.1 ^{a}	29.6 ^{ab}	33.2 ^{a}	28.2 ^{ab}
BNJ	14.56							
	Total Leaves of Plants Age 49 Days (cm)							
H1	39.0 ^{bc}	33.7 ^{abc}	34.0 ^{abc}	35.5 ^{abc}	21.5 ^{c}	24.1 ^{bc}	26.7 ^{abc}	34.2 ^{abc}
H2	27.8 ^{abc}	33.4 ^{abc}	35.7 ^{abc}	32.8 ^{abc}	37.4 ^{abc}	34.9 ^{abc}	42.2 ^{a}	27.3 ^{abc}
BNJ	16.0							
	Number of Leaves of Plants Age 56 Days (cm)							
H1	41.3 ^{ab}	38.3 ^{abc}	35.5 ^{abc}	37.3 ^{abc}	23.4 ^{c}	26.4 ^{bc}	29.2 ^{abc}	33.5 ^{abc}
H2	30.1 ^{abc}	34.9 ^{abc}	34.2 ^{abc}	33.1 ^{abc}	43.3 ^{a}	43.3 ^{a}	43.4 ^{a}	27.3 ^{bc}
BNJ	41.3 ab							

Notes: Numbers followed by different letters indicate significantly different values

Plant height and several leaves tended to be lower at doses of organic fertiliser 10 t/ha compared to amounts of 5 t/ha, probably because the application of organic fertiliser given directly to the planting hole of 25 g per hole (5 t/ha) was sufficient to meet plant needs and microbial activity in a dry land. In addition, it is also influenced by the high C/N ratio in the experimental field. The condition of a high C/N ratio (15.86) indicates that there is still organic matter in the soil that has not undergone composting, which microorganisms need as a source of carbon and nitrogen energy as a source of protein for cell formation [9]. Based on [10], manure (10 t/ha) significantly reduced shallot plant height and increased the number of leaves, tillers and tuber weight.

The interaction of biological fertilisers, organic fertilisers and inorganic fertilisers can also increase the wet bulb weight of shallots (Table 8). The highest wet bulb weight of shallot plants was in the biological fertiliser treatment with a dose of 100% recommendation (D_1) with an amount of 10 t/ha (O_2) organic fertiliser, namely 49.2 t/ha, while the lowest wet weight was in the treatment with an inorganic fertiliser dose of 25% dose recommendation (D_3) is 33.0 t/ha. The damp bulb weight of shallots was not significantly different between treatments D_1, D_2, D_3 and D_4 using biological fertilisers. This shows that reducing the dose of organic fertiliser to 25% of the recommended dose does not reduce the wet bulb weight of shallots. However, without biological fertilisers, the importance of the damp tuber treatments D_1, D_2, and D_3 was not significantly different.

Table 8 – The effect of the interaction between biological fertilisers, organic fertilisers and inorganic fertilisers on the average fresh weight of shallot plants

Organic fertiliser	Wet Weight (t/ha)							
	Organic O1				Organic O2			
	D1	D2	D3	D4	D1	D2	D3	D4
H1	49.0 a	47.7 abc	46.3 abcd	41.8 cds	45.4 abcd	42.2 bcd	41.1 d	33.0 e
H2	48.4 ab	48.0 abc	47.0 abcd	47.1 abcd	49.2 a	46.6 abcd	47.3 abcd	45.5 abcd
BNJ	6,31							

Notes: Numbers followed by different letters indicate significantly different values

This is supported by the research results by [11] that using biological fertilisers with inorganic fertilisers (NPK) can increase nutrient uptake, improve the structure and weight of shallot bulbs and reduce the use of inorganic fertiliser doses. The use of organic fertilisers and inorganic fertilisers accompanied by biological fertilisers does not reduce nutrient uptake, growth and yield of shallots. It can minimise inorganic fertiliser doses up to 50% of the recommended dosage.

The interaction of biological fertiliser treatment with inorganic fertiliser doses did not affect the number of shallot tillers. These results are the same as the research results by [9, 12] in that applying organic fertilisers and inorganic fertilisers does not affect the number of shallot tillers. The number of shallot tillers is determined more by genetic factors or the influence of varieties compared to fertilisation and environmental management. This is also supported by the research results by [13] that the treatment of types significantly affects the number of shallot tillers.

CONCLUSIONS

The interaction of biological fertilisers with organic fertiliser doses increases shallots' growth and yield in dry land. A 5 t/ha dosage of organic fertiliser meets shallots' development and yield needs. Adding organic fertiliser doses to 10 t/ha must be combined with biological fertilisers to increase shallot productivity in dry land. The interaction of natural fertilisers with amounts of organic and inorganic fertilisers increased the growth and yield of shallots in dry ground. Organic fertiliser doses of 5 t/ha can reduce the dosage of inorganic fertilisers by 50%. If accompanied by biological fertilisers, it can reduce the use of inorganic fertilisers by up to 75% of the recommended dosage.

Conflict of interest

The author declares no conflicting interest.

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