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INFLUENCE OF PLANT DENSITY, COMPOST AND BIOFERTILIZER ON TRUE SHALLOT SEED GROWTH IN ALLUVIAL SOIL

Pengaruh Kerapatan Tanaman, Kompos, dan Pupuk Hayati Terhadap Pertumbuhan Benih Botani Bawang Merah di Tanah Aluvial

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ABSTRACT

True shallot seed (*Allium cepa var Aggregatum group*) is an alternative way of growing shallot. Different environments and cultivars need a specific study. The aim of this research was to find out the best technology to grow Trisula true shallot seed by managing plant densities and applying compost and biofertilizer in alluvial soils. The study was performed from May to October 2015, using a split-plot design with four replications. The main plot was plant density: 100 plants m^{-2} and 70 plants m^{-2}. Subplots were five fertilizer application combinations, they were 100% recommended dose of NPK (R-NPK), 100% R-NPK + compost, 100% R-NPK + compost + biofertilizer, 50% R-NPK + compost and 50% R-NPK + compost + biofertilizer. Results showed that biomass and bulb yield were significantly affected by plant density and fertilizer application. The reduced 50% R-NPK by substituting with compost and biofertilizer was unable to maintain shallot bulb yield equal to 100% R-NPK, suggesting insufficient nutrients derived from compost to satisfy the shallot requirement. The best technology to grow true shallot seed of Trisula variety was 100 plants m^{-2} plant density and 100% NPK (consisting of 180 kg N ha^{-1}, 52 kg P ha^{-1} and 50 kg K ha^{-1}) with 2.5 t ha^{-1} compost that achieved the highest bulb yield of 9.83 t ha^{-1} and increased the revenue.

[**Keywords:** shallot seed, planting density, NPK fertilizer, organic fertilizer]

ABSTRAK

*Benih botani bawang merah (*Allium cepa var Aggregatum group*) merupakan salah satu alternatif dalam penanaman bawang merah. Lingkungan tumbuh dan penggunaan kultivar yang berbeda membutuhkan penelitian khusus. Penelitian ini bertujuan untuk mengetahui teknologi terbaik untuk membudidayakan benih bawang merah varietas Trisula dengan cara mengatur kerapatan tanaman serta aplikasi kompos dan pupuk hayati di tanah aluvial. Penelitian dilakukan pada bulan Mei sampai Oktober 2015 menggunakan rancangan petak terpisah dengan empat ulangan. Petak utama yaitu kerapatan tanaman: 100 tanaman m^{-2} dan 70 tanaman m^{-2}. Anak petak terdiri atas lima kombinasi pemupukan, yaitu 100% dosis anjuran NPK (R-NPK), 100% R-NPK + kompos, 100% R-NPK + kompos + pupuk hayati, 50% R-NPK + kompos, dan 50% R -NPK + kompos + pupuk hayati. Hasil penelitian menunjukkan bahwa biomassa dan hasil umbi dipengaruhi secara nyata oleh kerapatan tanaman dan pemupukan. Pengurangan 50% R-NPK serta kompos dan pupuk hayati tidak dapat mempertahankan hasil umbi bawang merah setara dengan 100% R-NPK. Hal ini menunjukkan kurangnya nutrisi yang berasal dari kompos untuk memenuhi kebutuhan bawang merah. Teknologi terbaik budi daya benih botani bawang merah Trisula yaitu kerapatan tanaman 100 tanaman m^{-2} dan pemupukan 100% NPK (terdiri atas 180 kg N ha^{-1}, 52 kg P ha^{-1} dan 50 kg K ha^{-1}) serta 2,5 ton ha^{-1} kompos yang memberikan hasil umbi tertinggi 9,83 t ha^{-1} dan meningkatkan pendapatan.*

[**Kata kunci:** benih bawang merah, kepadatan tanam, pupuk NPK, pupuk organik]

INTRODUCTION

Shallot (*Allium cepa* var Aggregatum group) is one of Indonesia's essential vegetables (Badan Penelitian dan Pengembangan Pertanian 2016), planted by many farmers in many areas, including Cirebon, West Java. Cirebon has an alluvial soil type characterized by neutral pH and high P availability (Sumarni et al. 2012). Most Cirebon's farmers are classified as small-scale farmers, tenants and less using organic fertilizer (Muliana et al. 2018). On the other hand, farmers prefer to use disproportionate quantities of chemical fertilizers to sustain crops. This practice is inefficient, causing environmental pollution, especially water pollution (Sudirman and Husrin 2019; Sudirman et al. 2013). Organic fertilizer is applied to reduce chemical fertilizer in agricultural practice. This practice, however, does not always produce comparable results in a short time. Yield decline, especially in the first period of organic practice, occurs for several reasons (Singh et al. 2019; Priyadharsini et al. 2012). To address this issue, the combined use of organic and chemical fertilizers is needed to sustain yield and reduce negative impact on environment in shallot farming.

Limited sources of smallholder's compel farmers to reduce production cost. Seed cost is one production input that could be reduced. This cost is related to the number of seeds planted associated with planting density and spacing distance. Investigating true shallot seed as an alternative planting material has considered cost efficiency in production and growing healthier crops. The true shallot seed has some benefits over bulb seed. It has higher yield and net income, longer shelf life, cheaper transport and storage cost (Basuki 2009). In recent years, the study of true shallot seed production in Indonesia has received more attention. They include selection of area production, nutrient management and plant density (Rosliani et al. 2016a; Rosliani et al. 2016b; Rosliani et al. 2012; Hilman et al. 2016; Palupi et al. 2016). The successful and efficient technology of planting true shallot seed at different locations and cultivars remain, however, a major challenge.

Several studies have shown that plant spacing plays a vital role in plant competition and affects shallot bulb yield. Optimal crop yield can be achieved by ideal plant density (Maboko and Du Plooy 2018). Different species and cultivars required different plant densities. Van den Brink and Basuki (2011) and Basuki (2009) reported that the optimum plant density of true shallot seed was 150−175 plants m^{-2} for Tuk-Tuk cultivar, 75−100 plants m^{-2} for Sanren cultivar and 200 plants m^{-2} for Bima cultivar. Reducing plant density would improve seed cost efficiency and maintain bulb yield. Lower plant density can increase bulb size and bulb yield. To test the hypothesis, 70 and 100 plants m^{-2} would be chosen.

Shallot 'Trisula' is a newly released variety by the Indonesian Vegetable Research Institute (IVEGRI). Several assessments recorded excellent adaptation of the valued variety comparable yield when planting using bulb planting material (Rosliani et al. 2015). However, the information of Trisula bulb yield using true seed planting material is still limited.

Organic materials like compost and biofertilizer are benefitable for plant growth. Compost improves soil biological, chemical and physical properties, including microbial soil activity, soil pH and water holding capacity, respectively (Lloyd et al. 2016; Petrovic et al. 2019). Compost was reported to increase the *Allium cepa* growth and yield in different soil conditions. Baldantoni et al. (2018) reported that in Mediterranean soils with poor soil organic materials (SOM), long-term biowaste compost fertilization experiment increases the quality of bulb yield. Similarly, other studies reported that application of 30 t ha^{-1} of beef manure compost increased onion bulb yield, Mg and K contents in loam and silty loam soils in southeastern Korea (Lee et al. 2018a; Lee et al. 2018b).

In addition, biofertilizer such as *Trichoderma harzianum* has been identified to protect plants from fungal onion pathogens such as *Alternaria porii,* the causative agent of purple blotch disease (Mythili et al. 2018; Bayoumi et al. 2019) and Fusarium basal rot diseases (Bunbury-Blanchette and Walker 2019). Improving shallot resistance against diseases should improve plant growth and bulb yield (Fauzan 2014). However, compost and biofertilizer application can provide different responses depending on varieties, compost materials and soil properties. Therefore, research on the possibility of reducing chemical fertilizer using compost and biofertilizer in shallot production is required. The research aimed to find out the best technology to grow Trisula true shallot seed by managing plant densities and applying compost and biofertilizer in alluvial soils.

MATERIALS AND METHODS

The experiment was carried out during a dry season from May to October of 2015 at the farmer's field of Babakan, Cirebon, West Java, Indonesia (6.88°S, 108.72°E, with the altitude of 5 m asl). Experimental site's soil type was identified as alluvial. The soil texture consisted of 4% sand, 25.5% silt and 70.5% loam. The soil chemical properties were pH (7.0), N-total (0.02%), P-Olsen (28.0 mg P kg^{-1}) and K-Morgan (69 ppm). The experimental field was under maize cultivation for the one-crop season. The average monthly rainfall during the growing period was 105.5 mm.

True shallot seeds of Trisula variety were sown and transplanted into the planting bed after six weeks. The plants were maintained, and the bulbs were harvested at 90 days after transplantation. Trisula true shallot seed was produced by IVEGRI. Compost was purchased from the nearby agricultural shop. Biofertilizer used was Biotricho (*Trichoderma* spp.) and was supplied by IVEGRI. Granule compost contains organic C 15%, C/N ratio 15–25, pH 4–9, water content 8–20%, and dark brown color as listed by the company.

The study used a split-plot experimental design with four replications. The treatments consisted of two planting densities as the main plot and five fertilizer combinations as the sub-plot. Planting densities were 100 plants m^{-2} and 70 plants m^{-2}. Fertilizer combinations (subplots) consisted of (1) 100% recommended dose of NPK (R-NPK) fertilizer; (2) 100% R-NPK + compost; (3) R-NPK + compost + biofertilizer, (4) 50% R-NPK + compost; and (5) 50% R-NPK + compost + biofertilizer. The plot size was 1 m x 9 m, and the planting spaces was

10 cm x 10 cm for 100 plants m^{-2} and 10 cm x 15 cm for 70 plants m^{-2}. The number of plants for each plot was 630 for 10 cm x 15 cm spacing and 900 plants for 10 cm x 10 cm spacing. Compost and biofertilizer were applied in broadcasting on raised bed.

A recommended dose of NPK consisted of 180 kg N ha^{-1}, 52 kg P ha-1 and 50 kg K ha^{-1} (Sumarni et al. 2012). The compost used was Petroganik with a rate of 2.5 t ha^{-1}, and biofertilizer was 50 kg ha^{-1}. Nitrogen sources were a mixture of urea and ammonium sulfate (ZA) applied at 10, 20 and 30 days after planting (DAP) each 1/3 rate. The P source was superphosphate or SP-36 and was applied three days before planting. In addition, potassium fertilizer was applied as potassium chloride (KCl) at 10 and 30 DAP, each ½ rate. All fertilizers were applied in a broadcast method.

Intensive agricultural management practices, including irrigation, weeding and pest control were conducted during the growing season. Watering was applied twice a day in the morning and noon until 80 DAP. Weeding was performed every month until the plants aged 60 DAP. To control pests and diseases, the crops were sprayed with pesticides (beta silfutrin 25 g l^{-1}, doses 21 ml per 16 l water and chlorfenaphyr 200 g l^{-1}, doses 41 ml per16 l water) and fungicides (propineb 70%, doses 24 g per 16 l water and mancozeb 80% doses 22 g per 16 l water). The first spray was given at 12–85 DAP. The spray interval was 4–7 days, depending on the severity of pest and disease attack and field weather.

Plant height, leaf number and tiller number were recorded weekly from 28 to 49 DAP. Nitrogen, P and K uptakes were sampled at 42 DAP. The leaf N content was determined by the macro-Kjeldahl method using 40% NaOH extraction. Phosphorus and potassium contents were extracted using HNO_3 65% and $HClO_4$ 60%, and their concentration was measured using Spectrophotometer UV-VIS and Spectrophotometer SSA. The biomass (g per plant) was observed at six weeks after planting. The plant materials were dried in an oven at 65°C for three days (Memmert type UN 450) and weighed on an electrical balance (Precisa type XB 620C). All data were analyzed using ANOVA, and the mean comparisons were tested using DMRT (α = 5%).

RESULTS AND DISCUSSION

All observed parameters showed no interaction between plant density and fertilization treatments. There was no significant difference between plant densities on the plant height and leaf number. The fertilizer treatments significantly affected the plant height and leaf number (Table 1). The 50% NPK had a significantly lower leaf number than 100% NPK treatments, particularly at the last growing stage, 49 days after planting.

VEGETATIVE GROWTH

Plant density and fertilization did not affect plant height and leaf number (Table 1). Meanwhile, fertilizer levels significantly increased leaf number at 42 and 49 DAP. The treatments of 100% NPK and 100% NPK + compost gave the largest number of leaves. The unexpected response was observed that application of compost and biofertilizer with 100% NPK decreased leaf number. This could be related to the decrease in compost decomposition and soil pH around plant root due to ammonium sulphate (ZA) fertilizer (Havlin et al. 2014). This condition could reduce root and shoot growth and leaf number. Application of 100% NPK + compost + biofertilizer gave less leaves than 100% NPK, but was not significantly different from 100% NPK fertilizer + compost.

Plant density significantly affected nutrient uptake per hectare. Plant density of 70 plants m^{-2} had lower shoot, root and total NPK uptake than 100 plants m^{-2} (Table 2). Decreased nutrient uptake was linear with decreased biomass per hectare. Decreased plant density reduced the number of populations and plant biomass per hectare (Table 3). The similar response has previously reported that high plant density (10 m x 10 m plant spacing) had a higher onion biomass per hectare compared to low plant density (20 cm x 20 cm plant spacing) (Hussain et al. 2017).

Fertilization significantly affected nutrient uptake and plant biomass (Table 2 and 3). These findings were similar to other studies. Abdissa et al. (2011) reported that N fertilization of 138 kg ha^{-1} increased onion biomass from 6.23 to 7.49 t ha^{-1}. On the other hand, reducing NPK fertilizer dose decreased *Allium cepa* growth (Borole et al. 2015). The decrease in NPK fertilizer rate from 180 kg N ha^{-1} + 52 kg P ha^{-1} + 50 kg K ha^{-1} to a half dose of 90 kg N + 26 kg P ha^{-1} + 25 kg K ha^{-1} decreased nutrient absorption and plant biomass (Table 2). The decreased shallot biomass was related to the insufficient NPK content as essential elements for the plants. Insufficient amount of the macronutrients would reduce the vegetative growth, including the root growth, leaf area index and bulb yield (Chagas et al. 2016).

BULB YIELD

Plant density and fertilization significantly increased bulb yield (Table 3). Plant density of 100 plant m^{-2} produced 134% more bulb yield per hectare than that

Table 1. Effect of plant density and fertilization on plant height and leaf number of shallot.

Treatments	Plant height (cm)				Leaf number			
	28 DAP	35 DAP	42 DAP	49 DAP	28 DAP	35 DAP	42 DAP	49 DAP
Plant density								
100 plants m^{-2}	26.4[ns]	28.0[ns]	28.4[ns]	30.2[ns]	3.6[ns]	4.6[ns]	4.8[ns]	5.6[ns]
70 plants m^{-2}	23.1	24.3	25.8	26.8	3.3	4.1	4.6	5.6
Fertilizer application								
100% R-NPK	24.7[ns]	25.5[ns]	26.6[ns]	28.3[ns]	4.1[a]	5.0[ns]	5.7[a]	6.4[a]
100% R-NPK + compost	24.8	26.5	26.5	28.9	4.1[a]	4.8	5.2[a]	6.0[ab]
100% R-NPK + compost + biofertilizer	24.7	26.4	27.5	28.8	3.1[b]	4.1	4.4[b]	4.8[bc]
50% R-NPK + compost	24.3	25.9	26.9	27.6	3.0[b]	3.7	4.5[b]	4.5[c]
50% R-NPK + compost + biofertilizer	25.2	26.5	27.9	28.9	3.0[b]	3.9	4.5[b]	5.2[b]
CV main plot (%)	20.2	19.9	21.4	17.6	31.0	54.5	38.2	30.6
CV subplot (%)	9.7	10.4	8.6	8.9	19.5	27.7	19.5	17.0

Mean values within a column followed by the same letters are not significantly different at $p < 0.05$ according to Duncan's Multiple Range Test. ns = not significant; R-NPK = recommended NPK fertilizer; DAP = days after planting.

Table 2. Effect of plant density and fertilization on nutrient uptake of shallot.

Treatments	Chlorophyll content ($mg\ g^{-1}$)	Shoot ($mg\ plant^{-1}$)			Root ($mg\ plant^{-1}$)		
		N	P	K	N	P	K
Plant density							
100 plants m^{-2}	0.53[ns]	12.00	1.24	8.08	10.59	1.10	7.17
70 plants m^{-2}	0.57	9.78	0.94	6.20	8.36	0.80	5.13
Fertilizer application							
100% R-NPK	0.55[ns]	11.68	1.23	6.80	11.15	1.20	6.78
100% R-NPK + compost	0.56	10.40	0.95	7.25	9.13	0.85	6.40
100% R-NPK + compost + biofertilizer	0.60	9.43	0.95	6.65	9.20	0.88	6.30
50% R-NPK + compost	0.52	10.68	1.10	7.53	8.70	0.88	6.10
50% R-NPK + compost + biofertilizer	0.53	12.28	1.23	7.48	9.20	0.95	5.65

The plant analysis, chlorophyll measurement and NPK uptake are a composite of plant samples across the replications. No statistical analysis was given in this observation. R-NPK = recommended NPK fertilizer.

Table 3. Effect of plant density and fertilization on biomass and bulb yield of shallot.

Treatments	Biomass ($t\ ha^{-1}$)	Fresh bulb yield ($t\ ha^{-1}$)
Plant density		
100 plants m^{-2}	6.47[a]	10.80[a]
70 plants m^{-2}	2.77[b]	4.62[b]
Fertilization:		
100% R-NPK	5.23[a]	8.85[a]
100% R-NPK + compost	5.92[a]	9.83[a]
100% R-NPK + compost + biofertilizer	4.55[ab]	8.20[ab]
50% R-NPK + compost	3.62[b]	5.73[b]
50% R-NPK + Compost + biofertilizer	3.43[b]	5.95[b]
CV main plot (%)	13.7	13.7
CV subplot (%)	18.9	18.9

Mean values within a column followed by the same letters are not significantly different at $p < 0.05$ according to Duncan's Multiple Range Test. ns = not significant.

of 70 plant m-2. In addition, 100% NPK treatments gave higher yield than 50% NPK treatments. The highest bulb yield was achieved by 100% NPK + compost that increased the bulb yield by 11% but was not significantly different with 100% NPK fertilizer alone.

The two-fold increase of bulb yield in 100 plants m^{-2} was caused by the larger number of populations while the low bulb in 70 plants m^{-2} plots was related to a high level of pest incidence and weed number. During the plant growth it was observed that the all 70 plants m^{-2} plots had more weeds and severe attack of armyworm, Spodoptera exigua, than 100 plants m^{-2} plots. Raising the number of populations would increase crop biomass and bulb yield per plot.

Planting density has a significant effect on the leaf photosynthetic capacity, agronomic traits, and yield of plants. For example, increasing plant density improved the leaf area index of common buckwheat

(Fang et al. 2018), blessed thistle (Ghiasy-Oskoee et al. 2018) and rice (Kimura and Shimono 2019) that increased shoot biomass and led to a better crop yield. In this experiment, plant density had a significant impact on plant biomass, nitrogen and bulb yield. Several studies documented similar results. Liaqat et al. (2016), for example, stated that plant density has a major impact on plant height and onion yield, but was not on bulb diameter in Bahawalpur, Pakistan. Another result was reported by Khadrah et al. (2017), who studied the impact of plant density on onion bulb yield in Egypt, that lower plant density increased market bulb yield. Optimum plant density, however, may vary among species and varieties. Wider plant spacing increases bulb size in some varieties, but is not in other varieties. This occurs because plant genotypes are varied. A decreased bulb yield in low plant density was due to the lower populations, which in turn reduced bulb yield per hectare.

Composts may improve soil characteristics, reduce the potential of N-leaching (Triyono et al. 2013) and substitute urea application (Multazam et al. 2014). Application of composts and biofertilizer + 100% NPK dose, however, did not significantly increase bulb yield. The potential cause of the lack of response on alluvial soil was due to current soil fertility. The expected shallot bulb yield equals to yield of recommended NPK rate, by reducing 50% recommended NPK rate, which is compensated by compost and biofertilizer additions was not achieved. In fact the yield decreased significantly. This suggests the crop nutrients derived from compost were insufficient to satisfy shallot requirement. The experimental site is an alluvial soil with neutral pH, high P and K content. Likewise, Suwandi et al. (2016) reported that compost had no significant impact on Bima and Mentes shallot dry weight on alluvial soil. Furthermore, Dapaah et al. (2014) found that manure application did not increase bulb yield in neutral pH and high soil available P and K. Nonetheless, the response can vary in different soil conditions. Unlike other studies that reported composts increased shallot bulb yield (Firmansyah et al. 2016; Purba 2015; Widyaningsih 2014), the increment of shallot bulb yield in this experiment did not happen. It is obvious from this study that compost should not be applied alone, but it should be combined with chemical fertilizer and other organic materials to increase bulb yield. Mafongoya and Jiri (2016) reported that chemical fertilizer plus manure increased bulb yield from 43.2 t ha^{-1} to 85.2 t ha^{-1}. Kwaghe et al. (2017) also reported that NPK + poultry manure gave a higher bulb yield than NPK fertilizer alone. The addition of organic material increased the bulb yield due to the increasing micronutrients and soil pH.

In neutral pH, Bima cultivar requires 100 kg N ha^{-1}, 30 kg P_2O_5 ha^{-1} and 106 kg K_2O ha^{-1} to produce 15 t ha^{-1} fresh bulb yield (Sopha et al. 2015). Higher nutrient uptake will produce a higher bulb. Nevertheless, different cultivars have different capacity to generate bulb yield. For example, Bangkok cultivar has a higher bulb yield and need a higher nutrient than Bima cultivar (Sopha et al. 2015).

Biotricho containing *Trichoderma* spp. has a beneficial effect on plant growth. *Trichoderma* has a biocontrol activity, especially on fungal pathogens, such as *Stemphylium vesicarium*, *Alternaria porii* and *Botrytis* spp. Various pathways clarify the mechanism of biocontrol of *Trichoderma*, both direct and indirect pathways (Abo-Elyousr et al. 2014). However, the effect of *Trichoderma* application on fungal disease incidence did not observe in this experiment. Also, there was no significant difference in shallot growth and bulb yield in with or without *Trichoderma.* The lack response of microorganism application on *Allium* growth was also reported by Yeptho et al. (2012) where incorporation of biocontrol agent, *Azotobacter chroococum* failed to improve the *Allium* growth and yield because of the high amount of microorganisms on organic manure that they used in the experiment. However, in this experiment, there was no soil microorganism's observation, before and after the experiment. The effect of *Trichoderma* application on the biology and soil properties was not apparent. Despite the limitation of the observation in this experiment, the lack response of the biocontrol agent, *Trichoderma* on the shallot growth and yield perhaps can be explained by some theories. *First*, the toxicity of systemic fungicide. During the plant growth, an intensive disease control using systemic and contact fungicide was held. Fungicides inhibit the radial growth of *Trichoderma harzianum*, a primarily systemic fungicide that toxic to the fungus (Sarkar et al. 2010). *Second*, the effect of the *Trichoderma* did not show because of the high dose of fungicide. Despite the toxicity of systemic fungicides on *Trichoderma,* the mix application between *Trichoderma* and fungicide may result in a compatibility. However, the response may vary depending on the concentration of the fungicide and the biocontrol agents (Suseela Bhai and Thomas 2010). The high concentration and high interval of fungicide application in this experiment may cover the effect of *Trichoderma* on the shallot growth and yield. *Third*, the NPK fertilization effect was greater than biofertilizer.

Partial Economy Analysis

Application of 100% NPK fertilizer + 2.5 t ha^{-1} compost increased the bulb yield by 11% from 8.85 to 9.83 t ha^{-1}. Although statistically, the results were not significantly different, the bulb yield increased of about 0.98 t ha-1 could improve the farmer's return. The extra cost for compost was 2.5 x 1000 x IDR500 = IDR1.250.000 (compost price was IDR500 kg^{-1}, based on Minister of Agriculture regulation, Permentan No. 01/2020). The current shallot price was IDR17.000 kg^{-1}, therefore, the increase of income from bulb yield was 0.98 x 1000 x IDR17.000 = IDR14.700.000. This analysis showed the additional income of IDR14.700.000 – IDR1.250.000 = IDR13.450.000.

CONCLUSIONS

The best technology for growing shallot from TSS of Trisula variety in alluvial soil was 100 plants m^{-2} plant density and 100% NPK fertilizer application consisting of 180 kg N ha^{-1}, 52 kg P ha^{-1} and 50 kg K ha^{-1}, with 2.5 t ha^{-1} compost that increased the bulb yield by 11% and improved the farmer's revenue. The application of 100% NPK + compost and biofertilizer gave the highest chlorophyll content but is not significantly different with other treatments. The expected shallot bulb yield equals to yield of recommended NPK rate, by reducing 50% recommended NPK rate, which is compensated by compost and biofertilizer additions was not achieved. This suggests the crop nutrients derived from compost were insufficient to satisfy shallot requirement. A multiyear experiment could be suggested to assess the effect of compost and biofertilizer on the soil properties and shallot growth to reduce chemical fertilizer use in shallot production in alluvial soils.

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