

Effect of mycorrhizae and kirinyu (*chromolaena odorata* L.) compost on the production of red onion in ultisol soil

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Abstract. One of the factors causing the low productivity of red onion is the low soil fertility. Some efforts are needed to improve Ultisol fertility through improved cultivation technology. Increasing the fertility of Ultisol soils can be carried out by adding kirinyu compost and mycorrhizal inoculation so that plants can absorb nutrients maximally. Research on the application of kirinyu compost and mycorrhizal inoculation was carried out in 2018. This study used a randomized block design (RBD) consisting of two factors; which were: kirinyu compost dosage (0, 200, 400, and 600 g/plant) and mycorrhizae dosage (3, 6, and 9 g/plant). The results showed that the treatment of compost to 600 g/plant increased plant height, number of leaves, number of tillers and tuber weight for of plant. Mycorrhizal inoculation up to 9 g/plant was not able to increase plant height, number of leaves, number of tillers and tuber weight of plant. There were no interactions between the dosage of compost and mycorrhizal on all observed parameters. There was an increase in Ultisol soil fertility through the addition of kirinyu compost and mycorrhizae.

Keyword: compost, kirinyu, mycorrhizae, ultisol soil, red onion

1. Introduction

Onion is one of the horticultural commodities that has the opportunity to be traded and contributes quite high to the development of the regional economy. Therefore, the interest of farmers in the cultivation of onions is increasing, despite the fact that there are many problems both technically and economically in the cultivation of onions. The operation of onions has spread in almost all provinces in Indonesia. The onion production centers in Indonesia are: Solok, Bandung, Majalengka, Cirebon, Brebes, Tegal, Kendal, Demak, Bima, Pati, Nganjuk, Probolinggo, and Enrekang. The demand for onions tends to be evenly distributed all the time, while the production of red onions is seasonal. This condition causes turmoil due to the gap between supply and demand so that it can cause price fluctuations between times. The demand for onions continues to increase in line with the increase in the population and the need for consumption of onions. BPS data [1] shows the consumption of North Sumatra's onions per capita is 2.81 kg/person/year. The total population of North Sumatra Province in 2016 was 17,702,000 people, so the need for onions per year reached 49,742,620 tons. The availability of onions in 2016 was only 14,158 tons or there was a shortage of supply of around 35,584,620 tons.

The low productivity of onions in North Sumatra Province is caused by several factors, namely: a reduction in the area of onions, an attack of pests and diseases, the careless use of seeds, i.e. variety of size and age of seeds. In addition, cultivation techniques such as fertilization, maintenance, and pest

and disease control are also not optimal yet. Increased productivity and production of onions can be done through improved cultivation technology. This can be done through improvements in technology components, namely the use of suitable high yielding varieties, high quality seeds, fertilizing, pest and disease control, and post-harvest technology improvement. Various varieties of onions have been released with potential promising results such as Maja, Bima and Mentas varieties [2]. Pest and disease control on onions can be done with biopesticides or antagonistic microbes. Site specific red onion cultivation technology assessment activities have been carried out in several regions such as Cirebon [3] and in South Sulawesi [4]. The study was carried out after a survey to improve the existing farming conditions in local farmers [5]. However, the results of the study are not necessarily suitable to be applied to site-specific conditions in North Sumatra Province. Therefore, it is necessary to study the Good Agriculture Practices (GAP) technology package as an effort to increase the production of onions. The technology that is needed must be environmentally sound and sustainable. Therefore, increasing the potential of ultisol soil in North Sumatra Province for cultivating onions through the use of compost and mycorrhizae is necessary to be carried out immediately.

Ultisol soil is a type of mineral soil in temperate to tropical regions, dominating agricultural land in Indonesia reaching 45.80 million hectares and classified as marginal land [6]. The thin top layer of organic matter (8-12 cm) is generally low to medium. The content of N, P₂O₅, K₂O, Ca, and Mg nutrients was low, low pH (less than 5.5), low saturation <24 me / 100g, C / N ratio is low (5-10). Beside the nutrient deficiencies, the upland soil ultisols contain low organic matter, high soil bulk density (BD), low total pores space and soil permeability, and low available water [6-10]. Ultisol soil also has high contents of Al oxide, which binds nutrients into ingredients [11], and that deficiency in acid upland soil is a factor limiting crops production, but can be used for potential agricultural land if carried out by management that takes into account existing constraints. Increasing the productivity of Ultisol soil needs to be added to organic matter. The provision of organic material can reduce soil bulk density because it forms better soil aggregates and stabilizes the aggregates that have been formed so that aeration, permeability and infiltration are better [8]. Organic fertilizers given to ultisol soils can improve soil fertility, soil physical properties, and soil biology. FAO [12] stated that the active soil organic components, together with micro-organisms (especially fungi), were involved in binding soil particles into larger aggregates. Aggregation is important for good soil structure, aeration, water infiltration and resistance to erosion and crusting. The results of research by Raupp, 2001 in Soelaeman and Umi, 2012 Haryati [10,13] showed that higher contents of soil organic matter had positive impact on soil bulk density, pore volume and maximum water capacity as well as on yield and yield components of cereals.

Kirinyu can improve soil physical, chemical and biological properties. The resulting decomposition results can increase soil organic matter, improve aggregate and soil structure, increase Cation Exchange Capacity (CEC) and provide nutrients Nitrogen, Phosphorus, Potassium, Calcium and Magnesium [14]. Several studies have been conducted, it turns out that weeds (*Chromolaena odorata* L) can be used as a source of organic material and sources of nutrients, especially nitrogen (N) and potassium (K). Low weeds can increase the growth of banana and kapok plants on critical land in Tanjung Alai and can even replace the source of N from artificial fertilizers for corn plants [15]. Application of mycorrhizal fungi in various levels is expected to interact positively with various levels of continuous compost administration in increasing plant growth and yield in onions [16-17]. This research is interesting to study because it relates to increasing the fertility of ultisol soils by using organic fertilizers that are environmentally friendly and sustainable.

2. Materials and methods

This research was carried out in the experimental field of the Faculty of Agriculture, Methodist University of Indonesia, starting from January to March 2018. The materials used in this study were Bima Brebes variety onion seeds, solid compost, ultisol soil, mycorrhizae, fungicides, insecticides, NPK fertilizers, and dolomite lime. While the tools used in the study are as follows: hoe, machete, meter, loose, analytical scales, handsprayer, long shovel caliper, and polybag 5 kg. This study used a

Randomized Block Design (RBD) with 2 factors, namely compost kirinyu (K) with four levels, namely: (K0) without composting, (K1) 200 g/plant, (K2) 400 g/plant, (K3) 600 g/plant; and mycorrhiza (P) with three levels: (P1) 3 g/plant, (P2) 6 g/plant, (P3) 9 g/plant, where each treatment was repeated three times so there were 36 experimental plots. The solid compost was applied at 1 week before planting mixed with Ultisol soil, while mycorrhizal inoculation was carried out simultaneously when the onion plant was removed from the nursery to the polybag. Basic fertilizer is carried out one day before planting with a dose of 95g dolomite/plant. Seeds are planted perpendicular to each polybag that has already been filled with ultisol soil. To determine the effect of treatment, observations of growing components included: plant height and number of leaves when the plants were 2 to 7 weeks after planting (MST) at 1 week intervals, and number of tillers at harvest. The yield components include: tuber weight after wind drying for one week (g) per plant and per plot.

3. Results and Discussion

3.1. Initial Soil Analysis

Soil analysis was used as the basis for this study to ensure that the soil used was acidic dry land. Based on the results of soil analysis showed that the soil used in this study had acidic H₂O pH (4.1), including in the type of Ultisol soil, clay soil structure. The soil used in this study belongs to both nutrient-poor and organic soils and it has a low fertility rate. It was shown from organic C content 0.91%, N total 0.17%, P total 0.03% and K 0.03%. Mg-dd, K-dd and KTK were very low. Cation exchange capacity depends on the content of organic matter and the clay fraction contained in the soil, therefore increasing productivity of Ultisol soils can be done by using soil enhancers, increasing the amount of organic matter and fertilizing. Constraints in using Ultisol soil for agricultural development are high Al acidity and saturation, low nutrient content and organic matter, and soil sensitive to erosion. These obstacles can be overcome by applying technology such as liming, fertilizing, and managing organic matter. Prasetyo and Suriadikarta [18] stated that the nutrient content of ultisol soils is generally low because alkaline washing is intensive, while the organic matter content is low because the decomposition process is fast and some erosion is carried out.

3.2. Characteristics of onion plant growth

Plant height and number of leaves are plant growth parameters that are heavily influenced by nutrient availability in the soil [19]. Nutrients contained in the ultisol soil is quite low, the addition of compost and mycorrhizae can increase the N content in the soil and free the bound P. Average onion plant height and average number of leaves, can be seen at Table 1.

Table 1. Average Onion Plant Height

Treatment	Plant Height (cm)					
	2WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
Kirinyu compost						
0 (K ₀)	14,06a	12,88a	14,57a	13,72a	15,87a	17,90a
200g/plant (K ₁)	17,82b	18,34b	20,09b	16,92ab	23,54b	31,59b
400g/plant (K ₂)	19,71bc	21,00c	21,88bc	19,65bc	31,82c	38,35c
600g/plant (K ₃)	21,03c	21,67c	23,42c	22,72c	33,05c	39,07c
BNJ _{0,05}	1,91	1,71	2,13	4,66	3,05	4,43
Mycorrhizae						
3g/plant (P ₁)	18,01	18,69	20,35	17,62	26,68	32,43
6g/ plant (P ₂)	18,07	18,40	19,40	19,27	26,84	32,35
9g/ plant (P ₃)	18,40	18,32	20,23	17,87	24,69	30,41
BNJ _{0,05}	-	-	-	-	-	-

Note: The number followed by the same letter in the same column means that it has no significant difference with 5% BNJ tes*WAP : week after planting

Table 2. Average Number of Leaves

Treatment	Number of Leaves(sheet)					
	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
Kirinyu compost						
0 (K ₀)	3,01	3,16a	3,49a	3,89a	4,06a	4,26a
200g/ plant (K ₁)	3,23	3,20ab	3,59ab	4,81b	6,41b	6,63b
400g/ plant (K ₂)	3,27	3,43ab	3,68ab	5,79c	7,80c	7,18b
600g/ plant (K ₃)	3,40	3,51b	3,88b	5,93c	7,43bc	8,07c
BNJ _{0,05}	-	0,31	0,29	0,74	1,07	0,73
Mycorrhizae						
3g/tnm (P ₁)	3,34	3,33	3,63	5,18	6,49	6,67
6g/tnm (P ₂)	3,18	3,30	3,69	5,23	6,40	6,50
9g/tnm (P ₃)	3,17	3,35	3,65	4,91	6,38	6,44
BNJ _{0,05}	-	-	-	-	-	-

Note: The number followed by the same letter in the same column means that it has no significant difference with 5% BNJ test

3.3. Parameters of Tiller Number and Tuber Weight

The results of the analysis of variance showed that the compost treatment significantly affected the number of tillers for each clump and weight of tubers for each clump, while the inoculation of mycorrhizae and the interaction of the two treatments had no significant effect on the number of tillers and tuber weight per clump. Application of 600g / plant of kirinyu compost produced the highest number of tillers and was significantly different from without giving of kirinyu compost, and by giving 200g / plant of kirinyu compost, but not significantly different from the 400g / plant dose. Whereas the giving of compost in the amount of 600g/plant gave the most weight of tubers for each plant which was the most significant different from that without kirinyu compost application, giving 200g / plant and 400g / plant of kirinyu compost.

Table 3. Average Number of Tillers

Mychorrizae Kirinyu compost	Mychorrizae 3g/plant (P ₁)	Mychorrizae 6g/plant (P ₁)	Mychorrizae 9g/plant (P ₁)	Average
0 (K ₀)	7,78	5,78	5,45	6,33a
200g/plant (K ₁)	7,67	8,67	6,67	7,67ab
400g/plant (K ₂)	9,00	9,33	8,22	8,85b
600g/plant (K ₃)	9,33	8,44	9,22	9,00b
Average	8,44	8,06	7,39	
BNJ (K) _{0,05} = 1,73				

Note: The number followed by the same letter in the same column means that it has no significant difference with 5% BNJ test

Table 4. Average Tuber Weight

Mychorrizae Kirinyu compost	Mychorrizae 3g/plant (P ₁)	Mychorrizae 6g/plant (P ₂)	Mychorrizae 9g/plant (P ₃)	Average
0 (K ₀)	9,95	8,36	4,67	7,66a
200g/plant (K ₁)	35,28	31,15	27,43	31,29b
400g/plant (K ₂)	48,25	50,42	43,40	47,36c
600g/plant (K ₃)	57,53	52,68	52,29	54,17c
Average	37,75	35,65	31,95	
BNJ (K) _{0,05} = 8,20				

Note: The number followed by the same letter in the same column means that it has no significant difference with 5% BNJ test

The results showed that the compost treatment gave a significant effect on plant height, number of leaves, number of tillers and tuber weight. This result is in line with the study conducted by Tambing (2000) in Burhanuddin (2006) [20,21]. The results of the mid-value test showed that the addition of 600g / plant (K3) of compost on average showed better results for all components of growth and the results observed were then followed by K2, K1 and K0. This is allegedly caused by the amount of nutrients contained in which the higher the dose of compost is given the more amount of nutrients contained and available for plants for growth and development. The continuous compost can improve plant growth because it can increase the level of humus and nutrients in the soil. Continuous compost has the ability to change all soil fertility factors such as nutrients, increase humus content, and soil structure. From the physical aspect the compost will continuously encourage the process of soil blending, so that it can support the growth and development of onions. The results of the decomposition of complex compounds such as polysaccharides from manure can bind soil particles into porous aggregate units so as to facilitate infiltration and percolation. This condition increases oxygen supply for respiration and root growth because gas exchange is better [2,13]. This is evidenced by the increasing soil nutrient content after the study, namely as follows: pH (5.1), organic C content (1.550%), N total (0.30%), P total (0.18%) and K (0.14%) than before the study where the pH (4.1), organic C content (0.910%), N total (0.17%), low P total (0.03%) and K (0 , 03%).

The formation of the number of leaves is determined by the number and size of cells, also influenced by nutrients absorbed by the roots to serve as food ingredients. In addition, the ratio of C / N ratio in plants will affect plant growth. At high C / N ratio (high C, low N) inhibited plants grow due to protoplasmic deficient cells, while thick cell walls with high carbohydrate content. on the contrary if C / N is low, vegetative growth will be fertile, but growth will be hampered, cell walls become thin and susceptible to disease and food reserves are small. The C / N ratio of the compost will be 14.16%, which means that this compost has met the quality of compost. With the availability of nutrients in sufficient quantities, the physiological processes in plant plants will run well, especially nutrients that play a dominant role in plant growth and development. Photosynthesis results in the form of carbohydrates besides being supplied to leaves, stems, and roots are also supplied for generative development of plants, and stored as food reserves [21]. Increasing plant height and number of leaves showed that more doses of organic matter were given to increase the growth of red onion plants, besides that it was a source of organic matter containing nutrients that could increase plant growth and production, including the amount of N, P and K content. also increased. In the growth of vegetative parts, plants require relatively large amounts of N elements [3]. In addition P and K elements also have an important role for the growth process, and help the formation of proteins and carbohydrates, play a role in strengthening the plant body.

Kirinyu is potential enough to be used as a source of organic material because of its high biomass production. From the results of the continuous compost analysis, the organic C-nutrient content was 7.65%, N 4.10%; P 0.21%; and K 0.99%, pH 7.02 [14,15]. Based on the results of the study, it was found that mycorrhizal inoculation and its interaction had no significant effect on all parameters. Plant growth and production are strongly influenced by plant quality and environmental conditions. In this study, the application of kirinyu compost and mycorrhizal could not give a significant effect on vegetative and genetic parameters.

Mycorrhizae have the ability to associate with almost 90% of plant species (agriculture, forestry, plantations and feed crops) and help in increasing the efficiency of nutrient uptake (especially phosphorus) on marginal land. The intensity of mikoriza vesikular arbuskular (MVA) infection is influenced by various factors, including fertilizer and plant nutrition, pesticides, pH, density of inoculum and the level of susceptibility of plants and the availability of nutrient minerals, especially phosphorus [22-25] . Phosphorus affects the MVA colonies because of the concentration of root carbohydrates or the number of root exudates. The P element is needed by plants for carbohydrate formation. Carbohydrate supplies from host plants are the basis for the development of mycorrhizal fungi. Other macro nutrients and micro nutrients are also needed. In this study the soil pH after the

study was still acidic, which caused no significant. The highest weight of onion tubers obtained in the treatment of 3 g / plant mycorrhizae.

4. Conclusion

From the results of the study, it can be drawn, such as: Kirinyu compost treatment at each age of observation can improve all components of the observed results. The continuous composting of 600g/plant gives better results with a productivity of 2.62 tons/ha. Treatment of mycorrhizal inoculation on ultisol soil and interaction between kirinyu and mycorrhizal compost had no significant effect on plant height, number of leaves, number of tillers, and tuber weight for each plant. There is an increase in ultisol soil fertility through the improvement of onion cultivation technology.

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