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INCREASED GROWTH AND PRODUCTION OF UPLAND RICE (*ORYZA SATIVA* L.) ON ANDOSOL IN POLYBAGS BY PROVISION OF ARBUSCULAR MYCORRHIZAL FUNGI

Chairani Siregar[1*], Yenni Asbur[1], Yayuk Purwaningrum[1], Rahmi Dwi Handayani Rambe[1], Murni Sari Rahayu[1], Mindalisma[1], Syamsafitri[1], Arif Anwar[1], Indra Gunawan[1], Mahyuddin[1], Dedi Kusbiantoro[2], Khairunnisyah[2], Dian Hendrawan[2], Surya Dharma[2], Mahyu Danil[3], M. Nuh[3], Miranti[3], Susan Novrini[3], Wan Bahroni Jiwar Barus[3]

[1]Department of Agrotechnology, Faculty of Agriculture, Universitas Islam Sumatera Utara, Jalan Karya Wisata Gedung Johor, Medan 20144, Indonesia.
[1]Department of Agribusiness, Faculty of Agriculture, Universitas Islam Sumatera Utara, Jalan Karya Wisata Gedung Johor, Medan 20144, Indonesia.
[3]Department of Agricultural Product Technology, Faculty of Agriculture, Universitas Islam Sumatera Utara, Jalan Karya Wisata Gedung Johor, Medan 20144, Indonesia.

Corresponding Author: Chairani Siregar
Department of Agrotechnology, Faculty of Agriculture, Universitas Islam Sumatera Utara, Jalan Karya Wisata Gedung Johor, Medan 20144, Indonesia.

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ABSTRACT

Upland rice cultivation in dry land is often constrained by the lack of availability of P nutrients due to low soil pH, especially when planted on Andosols. CMA is beneficial for plants because CMA is very useful for increasing nutrient uptake, especially P elements. The research was carried out at the gauze house of the Faculty of Agriculture, Universitas Islam Sumatera Utara, Gedung Johor, Medan, North Sumatra with an altitude of ± 25 m above sea level. The study used a completely randomized block design with three replications and a dose of CMA as a treatment. The results showed that the administration of CMA at a dose of 45 g/polybag was able to increase the growth and production of upland rice plants.

KEYWORDS: CMA, upland rice, dry land, P.

INTRODUCTION

Upland rice is a type of rice cultivation, namely rice cultivation on dry land. Upland rice is generally planted once a year at the beginning of the rainy season. The low upland rice production is also due to the large number of people planting dry land with long-lived local varieties of upland rice. This upland rice variety has several weaknesses such as easy to fall, easy to fall off, low yield and generally less tolerant of drought.[1]

National rice production in general comes from lowland rice and non-paddy rice production. Non-paddy rice production can include upland rice produced from dry land and swamp rice produced from swamp land. So far, most of the national rice production is lowland rice and only a small part is non-paddy rice. Given the large contribution of lowland rice to national rice production, efforts to increase rice production have an important role to support rice self-sufficiency. However, efforts to increase the production of lowland rice are increasingly difficult to realize lately due to several factors, namely: (a) Many irrigation networks in paddy fields are not maintained or damaged so that efforts to expand rice plants in the dry season are increasingly difficult to realize, (b) The occurrence of conversion of paddy fields to non-agricultural uses thereby reducing the area of paddy fields that can be cultivated for rice crops, (c) Increasing the area of paddy fields that can be stimulated through the printing of new paddy fields is increasingly difficult to realize due to limited land resources that can be used as paddy fields, and (d) Efforts to increase the productivity of lowland rice are increasingly difficult to realize due to the phenomenon of land fatigue which causes the response of lowland rice productivity to the use of rice production facilities to be smaller.[2]

Based on this, upland rice cultivation is one solution. However, upland rice cultivation in dry land is often constrained by the lack of availability of P nutrients due to low soil pH, especially when planted on Andosols. Andosols have distinctive properties and are closely related to the high allophane content and accumulation of organic matter and the occurrence of complexes of organic matter with Al.[3] The presence of allophane

minerals causes this soil to have a large CEC, high water retention and low bulk density. However, at the level of development of allophane to haloysite, Andosols will lose their large soil CEC properties and highwater holding capacity.[4] Besides, the presence of allophane in the soil is inversely proportional to the availability of nutrients, especially phosphorus, nitrogen, sulfur and chlorine. All of these elements are firmly fixed by allophane clay minerals even though these elements are needed by plants.[5]

Phosphorus is classified as the main macro nutrient and is generally absorbed by plants in the form of orthophosphate anions ($H_2PO_4^-$ and HPO_4^{2-}). Andosols are generally deficient in phosphorus because they have a very high phosphorus fixation capacity[3], and if there is a phosphorus deficiency, it will inhibit plant growth. To overcome this, it can be done by giving arbuscula mycorrhizal fungi (CMA) on Andosols. CMA is a fungus that lives in the soil. This fungus is always associated with higher plants and both provide mutual benefits.[6] CMA is beneficial for plants because CMA is very useful for increasing nutrient uptake, especially phosphate (P) elements. Musfal[7] reported that the rate of entry of P nutrients into the CMA hyphae could be up to six times faster in the roots of plants infected with CMA compared to those without CMA. This happened because the external hyphae network of CMA was able to expand the absorption field. The results of other nutrient uptake studies were reported by[8], [9], and[10], namely CMA can increase nitrogen (N) and potassium (K) uptake. Tarafdar and Rao[11] also reported that the application of CMA to legumes could increase the uptake of micro elements Cu and Zn.

Based on this, this study aimed to determine the effect of giving CMA in increasing the growth and production of upland rice on Andosols in polybags.

MATERIALS AND METHODS

The research was carried out at the gauze house, Faculty of Agriculture, Universitas Islam Sumatera Utara, Gedung Johor, Medan, North Sumatra with an altitude of ± 25 m above sea level.

The study used a completely randomized block design with three replications and doses of CMA as treatment, namely: 0 g/polybag (C0), 15 g/polybag (C1), 30 g/polybag (C2), and 45 g/polybag (C3).

Prior to the start of the research, the research area in the screen house was first cleaned of disturbing materials during the research process. The planting medium used is Andisol soil type that has been loosened and cleaned of rocks, roots, and other materials. Then put in a 10 kg polybag and given CMA a week before planting with the appropriate dose of treatment. Furthermore, new upland rice seedlings were planted with two seeds per polybag. The variables observed were: plant height, number of tillers, number of productive tillers, age of flowering, number of panicles, weight of dry grain per plant, and weight of 100 dry grains.

Observational data that has been obtained during the study were processed according to the research method used. If there is a significant difference, it is continued with Duncan's test at the 5% level. Data processing was carried out using Minitab 19 software.

RESULTS AND DISCUSSION

The results showed that the CMA treatment had a significant effect on plant height, number of tillers, and number of productive tillers of upland rice, but had no significant effect on flowering age of upland rice (Table 1).

Table 1 shows that the administration of CMA at a dose of 45 g/polybag produced the highest upland rice plant, which was 115.60 cm. Meanwhile, the lowest upland rice was in the treatment without CMA, which was 106.24 cm. In this case, there was an increase in plant height of 8.1% by giving CMA 45 g/polybag. This is because CMA plays a very important role in the availability of P. Andosols used in this study contains high total P, but low available P. In the presence of CMA, P becomes available to plants. CMA has the ability to decompose P bound in the soil so that it can be absorbed by plant roots. Hyphae that secrete phosphatase enzymes so that P in the soil will be dissolved and available to plants and stimulate growth and fruit formation in long bean plants. Plants infected with CMA were able to absorb higher P elements than plants that were not infected.[7]

Table 1: Upland rice plant growth was influenced by the dose of CMA.

Treatments	Plant Growth of Upland Rice			
Dose of CMA (g/polybag)	Plant Height (cm)	Number of Tillers (tillers)	Number of Productive Tillers (tillers)	Flowering Age (days)
0	106.24b	7.17b	7.13c	90.21
15	106.74b	7.38b	7.33bc	90.04
30	113.12a	7.92ab	7.71b	89.29
45	115.60a	8.46a	8.29a	87.50

Note: The numbers in the same column followed by different notations show significant differences at the 5% level based on Duncan's test.

The highest number of tillers was also obtained in the treatment with a dose of CMA 45 g/polybag, which was 8.46 tillers, and the lowest number of tillers in the treatment without CMA, which was 7.17 tillers (Table 1). This is because in the presence of CMA, P becomes available to plants. CMA has the ability to decompose P bound in the soil so that it can be absorbed by plant roots. CMA is a form of symbiotic mutualism between fungi (myces) and roots (rhiza) of higher plants. Fungi obtain carbohydrates in the form of simple sugars (glucose) from plants. On the other hand, fungi distribute water and soil nutrients to plants.[12] Therefore, the availability of high nutrients for rice plants will increase the number of tillers in the process of growth and development of upland rice.

CMA significantly affected the number of productive tillers of upland rice, where the highest number of productive tillers was found in the 45 g/polybag treatment and the lowest was in the treatment without CMA (Table 1). This is due to root colonization by CMA can increase vegetative growth, generative and P concentration of soybean plants. In addition, it can also increase N nodulation and fixation. Improvement of nutrient uptake due to symbiosis with CMA is not only limited to phosphate, but also to various other elements so as to improve the quality of degraded land due to limestone mining and increase soybean production.[13]

Flowering age of upland rice was not affected by CMA (Table 1). This is because the flowering age of upland rice is more influenced by the genetic nature of the plant itself because in this study one type of upland rice variety was used. This is in accordance with the opinion of[14] that plants are influenced by genetics, including plant height.

The results showed that the CMA treatment had a significant effect on the number of panicles, weight of dry grain per plant, and weight of 100 dry grain of upland rice (Table 2).

Table 2: Upland rice production is affected by the dose of CMA.

Treatments	Production of Upland Rice		
Dose of CMA (g/polybag)	Number of Panicles (panicles)	Weight of Dry Grain per Plant (g)	Weight of 100 Dry Grain (g)
0	7.13c	38.15b	2.33c
15	7.33bc	40.16b	2.35c
30	7.71b	47.34a	2.41b
45	8.29a	49.43a	2.45a

Keterangan: Angka pada kolom yang sama diikuti oleh notasi yang berbeda menunjukkan berbeda nyata pada taraf 5% berdasarkan uji Duncan.

Table 2 shows that the application of CMA significantly affected the number of upland rice panicles. The highest number of panicles was obtained in the administration of CMA at a dose of 45 g/polybag, which was 8.29 panicles, and the lowest was in the treatment without CMA, which was 7.13 panicles. CMA can colonize and develop in a symbiotic mutualism with plant roots, thereby increasing plant growth and helping to suppress the development of several soil pathogens. CMA infection can increase plant growth and its ability to utilize nutrients, especially P, Ca, N, Cu, Mn, K, and Mg elements.[15] This is because mycorrhizal colonization on plant roots can expand the area of root absorption in the presence of external hyphae that grow and develop through root hairs.[16]

CMA also had a significant effect on dry grain weight per upland rice plant (Table 2). The heaviest dry grain weight per plant was obtained at a dose of 45 g/polybag CMA, which was 49.43 g, and the lowest was obtained in the treatment without CMA, which was 38.15 g. This is because CMA has the ability to decompose P bound in the soil so that it can be absorbed by plant roots. In addition, CMA can increase the ability of plants to grow and survive in dry conditions. CMA can improve and increase the water absorption capacity of host plants.[17] Light has an influence on the growth of CMA. The intensity of light affects the supply of photosynthate required by CMA. Plants with high photosynthetic rates also tend to improve the supply of photosynthesis for CMA, due to the increased concentration of carbohydrates in the roots thereby increasing production in plants.[18]

The weight of 100 dry grains was also affected by CMA (Table 2). The heaviest weight of 100 grains of dry grain was obtained in the CMA treatment with a dose of 45 g/polybag, which was 2.45 g, and the lowest in the treatment without CMA, which was 2.33 g. This is because CMA has a role for plant growth and production. The role of CMA for plants is to increase nutrient absorption, protect host plants from the damaging effects caused by drought stress, can adapt quickly to contaminated soil, protect plants from root pathogens, improve soil productivity and strengthen soil structure.[19] The results of research by Haryantini and Santoso[20] showed that inoculation of CMA in chilies could increase P uptake and increase adaptation to drought. CMA that infects the root system of the host plant will produce a network of external hyphae that can grow expansively and penetrate the subsoil layer thereby

increasing the capacity of the roots to absorb nutrients and water.

CONCLUSION

The administration of CMA at a dose of 45 g/polybag was able to increase the growth and production of upland rice plants in Andosol compared to without CMA administration.

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