

Effect of Chemical and Organic Fertilizers on Growth and Corm Yield of Indonesian Konjac (*Amorphophallus muelleri* Blume) Grown on Alfisol soil at Medium Altitude

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Abstract: Indonesian konjac (*Amorphophallus muelleri* Blume) growing naturally obtains nutrients from the release of mineralization from leaves of the trees. Application of chemical fertilizer is common to increase growth and yield of konjac. The research work was carried in the net house (60% shading) from October 2021 to March 2022 in order to study the effect of chemical and organic material addition on growth and yield of konjac grown on Alfisol soil at medium altitude. Organic material (molasses and Chinese albizia leaves) was factorially combined with chemical fertilizers (0, 200 kg NPK/ha, 200 kg NPK/ha+200 kg ammonium sulfate (AS)/ha, 200 kg NPK/ha+400 kg AS/ha and 200 kg NPK/ha+600 kg AS/ha). Each factorially combined treatment was laid out in a randomised block design and was replicated three times. The effect of treatments was evaluated by measuring plant height at 90 days after sowing (DAS), plant diameter at 90 DAS, shoot dry weight, corm diameter, corm thickness and fresh weight of corm. All data observed were analysed by employing the standard deviation (SD) from three replicates. Plant height and plant diameter measured at 90 days after sowing (DAS) was significantly increased when Alfisol soil treated with albizia leaves or molasses was fertilized with 200 NPK. Further increase of plant height and plant diameter was noticed when 200 kg NPK/ha addition was accompanied with 200 kg AS/ha. However, an increase of AS up to 400 kg and 600 kg reduced the plant height and plant diameter. Similar effect of chemical fertilizer was also observed on plant dry weight, corm diameter, corm thickness and fresh weight of corm. Chinese albizia leaves was found to be better source of organic material, because it resulted better plant growth and corm yield of Indonesian konjac.

Keywords: Indonesian konjac, organic material, chemical fertilizer and Alfisol.

1. INTRODUCTION

The presence of secondary metabolites in the corms of konjac, such as glucomannan contributes to functional effect to human health. Therefore, konjac provides an alternative source of functional food (1, 2). As a result, the price of corms is relatively much higher than the price of tuber from other tuberous crops (3). The corms of konjac were commercialized as one of important agribusiness commodity in Indonesia and have been exported to some countries (4, 5, 6).

Konjac in Indonesia grows naturally within the trees in forest from lower to high altitude. Naturally, mineralization of organic materials obtained from the falling of leaves of trees in the forest releases nutrients to support growth and yield of konjac. As a commercial crops, like other commercial crops, farmers in Indonesia cultivate konjac by practicing an improved plant and soil management to ensure maximum growth and yield. One of the important management practices is fertilizer utilization. The fertility of variety of Indonesian soils were reported to be inadequate to support optimum growth and yields of some food and horticultural crops, fertilization was revealed to increase plant growth and yield (7, 8, 9, 10, 11, 12, 13, 14).

Organic material applied to the soil was found to improve soil physical properties, like soil structure (15). Improvement of soil structure will cause better root and tubers development (10, 16, 17). Chemical fertilizer application increased soil nutrient availability and plant nutrient absorption. Consequently, addition of organic and chemical fertilizers was found to result in better plant growth and yield (7, 8, 9, 10, 11, 12, 13, 14, 17). Nitrogen, phosphorus and potassium applied in form of NPK and ammonium

sulfate fertilizers was reported to increase plant growth and corm yield of Indonesian konjac grown on Alfisol soil (18).

The present research work was undertaken to examine the effect of organic and chemical fertilizers to plant growth and corm yield of Indonesian konjac on Alfisol soil at medium altitude.

2. MATERIAL AND METHOD

2.1. Soil Preparation

Alfisol soil was obtained from Probolinggo regency, East Java, Indonesia. The soil was dug diagonally at a depth of approximately 20-25 cm. After air drying for about a week, the soil crushed and sieved with 0.5 mm sieve. The previous research results revealed that Alfisol soil was considered to be fertile and did not show nutrient deficiency symptoms on plant growth of konjac (19, 20).

Molasses of 40 ml was dissolved in 750 ml water and applied to 5 kg soil in polyethylene bag. Indonesian farmers used molasses for growing rice and maize to reduce the use of chemical fertilizer. Approximately 10,000 liter/ha of molasses was sprayed to the field before growing maize and rice. Dried leaves of Chinese albizia of as much as 100 g was applied by mixing thoroughly with 5 kg soil in polyethylene bag. Indonesian konjac is commonly planted within the trees, including Chinese albizia tree. Thus, the soil obtains continuously the falling of the leaves as a source of organic material. Application of molasses and leaves of Chinese albizia was done one month before transplanting of konjac seedling.

2.2. Planting Material

Bulbil of approximately 20 g + 0.32 g was used in the present research work. Bulbil was harvested from local variety of konjac at farmers' field in Probolinggo regency, East Java, Indonesia. Healthy bulbils were selected as planting material. Bulbils were germinated according to the method previously described (19). Three weeks after germination of bulbils, the uniform and healthy seedlings of konjac were selected for transplanting.

2.3. Transplanting and Plants Caring

Alfisol soils previously treated with molasses or Chinese albizia leaves were watered to a field water holding capacity (19). One seedling was transplanted to planting hole (as deep as 5 cm) for each polyethylene bag and was watered immediately. Afterwards, watering was done to maintain the soil at field water holding capacity in order to ensure optimum growth of konjac. Weeding was done to prevent konjac plants from competing to use water and nutrients from soil. Pest management was taken whenever necessary to prevent konjac plants from suffering due to pest infestation. The rates of chemical fertilizer were applied according to the treatments. NPK fertilizer was applied at 20 DAS (50 % of the rate) and at 50 DAS (50% of the rates). Ammonium sulfate (AS) was applied at 20 DAS (25% of the rate), at 50 DAS (45% of the rate) and 70 DAS (30% of the rate). NPK and AS fertilizer was applied to the hole made 5 cm from the konjac plant and was covered by the soil. Immediately after fertilizer application, the soil was watered to make the fertilizers available to the konjac plants.

2.4. Experimental Design

The research work was undertaken in the net house (60% shading) of Indonesian Legumes and Tuber Crops Research Institute, Malang, East Java, Indonesia from October 2021 to March 2022. During the period of experimentation was rainy season. The research site was located at the altitude of about 500 m above sea level (medium altitude).

The present research work used molasses (A) and Chinese albizia leaves (B) as a main factor. Each main factor was combined with chemical fertilizers, e.g., 0 kg (1), 200 kg NPK/ha (2), 200 kg NPK/ha + 200 kg ammonium sulfate (AS)/ha (3), 200 kg NPK/ha + 400 kg AS/ha (4) and 200 kg NPK/ha + 600 kg AS/ha (5). Each combination treatment was laid out in randomized block design with three (3) replicates.

The response of konjac to the treatments was measured in plant height at 90 days after sowing (DAS), plant diameter at 90 DAS, diameter of corm, thickness of corm and fresh weight of corm. The

measurements follow the method previously employed (19, 20). Standard deviation from three replicates was used to analyze the effect of organic materials and chemical fertilizers on all variables measured.

3. RESULTS AND DISCUSSION

3.1. Plant Height at 90 Days After Sowing

Effect of chemical fertilizer and organic material on plant height of Indonesian konjac (*Amorphophallus muelleri* Blume) at 90 days after sowing (DAS) grown on Alfisol soil was depicted on figure 1 (left and right). Addition of chemical fertilizer significantly increased the plant height of konjac grown Alfisol soil previously amended with either molasses or Chinese albizia leaves. The highest plant height of konjac on soil amended with molasses (72 cm) or with Chinese albizia leaves (80 cm) was attained by application of 200 kg NPK/ha + 200 kg AS/ha. Further increased of AS, as a source of N, up to 400 kg/ha and 600 kg/ha at 200 kg NPK/ha reduced the plant height of konjac planted on Alfisol soil amended with either molasses or Chinese albizia leaves. Thus, a negative effect of higher AS application rate was noticed in this present research work. Amendment of Chinese albizia leaves on Alfisol soil caused significantly higher plant height compared to amendment of molasses on Alfisol soil at application of 200 kg NPK/ha + 200 kg AS/ha. The plant height of konjac was higher when the Alfisol soil was amended with Chinese albizia leaves (66.8 cm) instead of amendment with molasses (62.2 cm) as an organic material (Fig. 1 right).

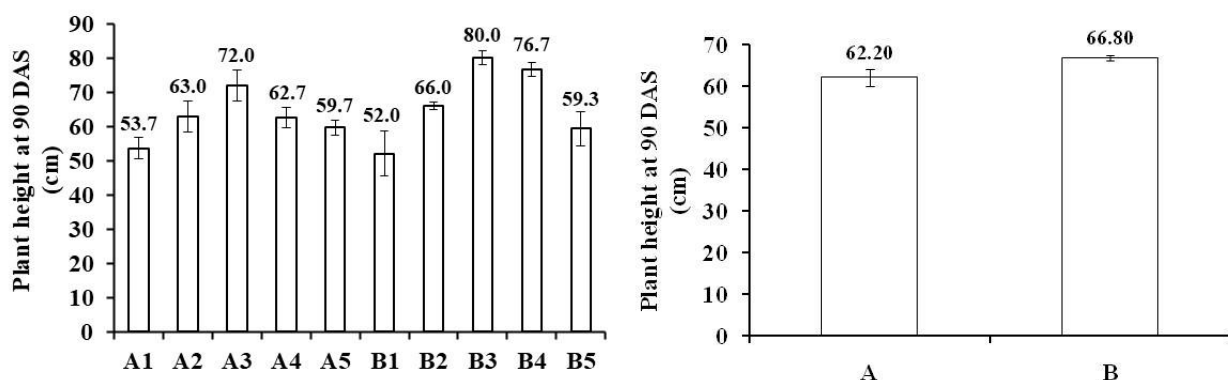


Figure 1. Effect of chemical fertilizer (left) and organic fertilizer (right) on plant height of Indonesian konjac (*Amorphophallus muelleri* Blume) at 90 DAS grown on Alfisol soil. Letters A and B are amendment with molasses and leaves of Chinese albizia (*Albizia chinensis*). Numbers 1, 2, 3 and 4 follow letters A and B are chemical fertilizers, described in MATERIAL AND METHOD.

3.2. Plant Diameter at 90 Days After Sowing

Figure 2 shows the influence of chemical and organic fertilizers on plant diameter of konjac at 90 DAS. The biggest plant diameter was attained at addition of 200 kg NPK/ha + 200 kg AS/ha on Alfisol soil amended with either molasses or Chinese albizia leaves. However, the use of Chinese albizia leaves was found to be better organic source because it resulted in bigger plant diameter than the use of molasses at the rate of 200 kg NPK/ha + 200 kg AS/ha (Fig. 2 left). As in plant height, further increase of fertilizer AS to 400-600 kg/ha at the rate of 200 kg NPK/ha significantly reduced the size of konjac plant diameter. Thus, the negative effect of higher AS is also imposed on plant diameter. Besides, Chinese albizia leaves also resulted in significantly bigger plant diameter than molasses as a source of organic material (Fig. 2 right). Thus, the result suggests better leaves of Chinese albizia than molasses as a source organic material.

Even though Alfisol is considered to be good soil as indicated by normal growth without nutrient deficiency symptoms of konjac plant, as shown in the present experiment, an improvement of soil fertility through fertilizer addition is required for konjac to grow better, measured in terms of plant

height and plant diameter. Fertilization with chemical fertilizer of konjac on Alfisol soil was also shown to produce better plant height and plant diameter of konjac in the previous studies (18).

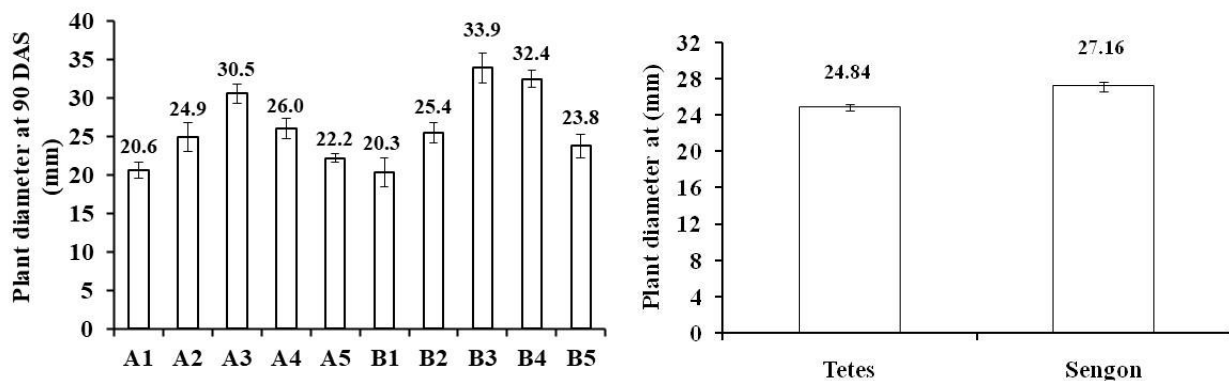


Figure 2. Effect of chemical fertilizer (left) and organic fertilizer (right) on plant diameter at 90 DAS of Indonesian konjac (*Amorphophallus muelleri* Blume) grown on Alfisol soil. Letters A and B are amendment with molasses and leaves of Chinese albizia (*Albizia chinensis*). Numbers 1, 2, 3 and 4 follow letters A and B are chemical fertilizers, described in MATERIAL AND METHOD.

3.3. Diameter of Corm

Diameter of konjac corm as affected by application of chemical fertilizer on Alfisol soil is depicted on figure 3 (left). Application of chemical fertilizer caused significant increase of diameter of konjac corm. The highest diameter of konjac corm was achieved at addition of 200 kg NPK/ha + 200 kg AS/ha on Alfisol soil amended with molasses (10.9 cm) or amended with Chinese albizia leaves (11.7 cm). An increase of AS fertilizer to 400-600 kg/ha at application of 200 kg NPK resulted in significant reduction of konjac corm diameter on Alfisol soil amended with either molasses or amended with Chinese albizia leaves. Such a reduction effect also observed on plant height and plant diameter of konjac. Figure 3 (right) revealed that konjac plant produced 10.2 cm diameter of corm on Alfisol soil amended with Chinese albizia leaves as an organic source, whilst the corm diameter of konjac was 9.3 cm when molasses was applied. The result indicates better leaves of Chinese albizia than molasses. The result also indicates that improvement of plant height and plant diameter due to application of 200 kg NPK/ha + 200 kg AS/ha is followed by an increase of corm diameter. Previous studies also revealed that better plant growth was accompanied by bigger diameter of corm (18, 20).

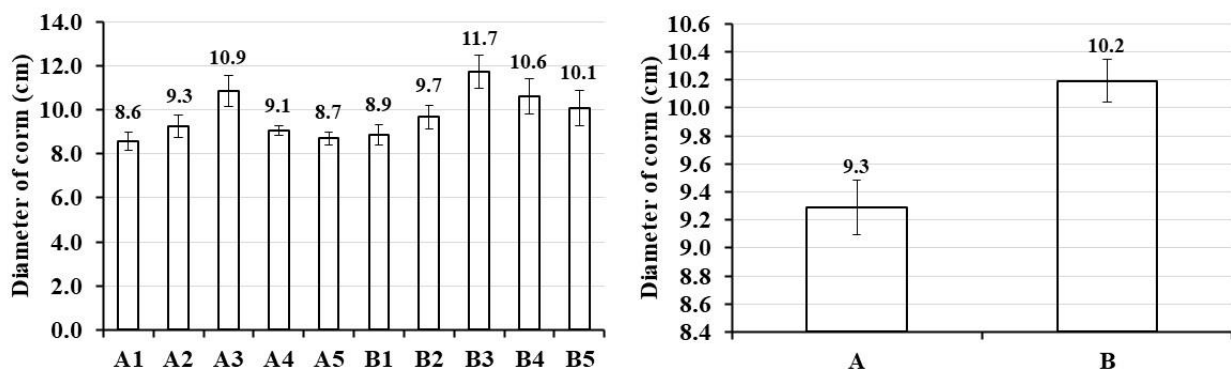


Figure 3. Effect of fertilizer (left) and organic fertilizer (right) on corm diameter of Indonesian konjac (*Amorphophallus muelleri* Blume) grown on Alfisol soil. A and B are molasses and Chinese albizia (*Albizia chinensis*). Numbers 1, 2, 3 and 4 follow letters A and B are chemical fertilizers, described in MATERIAL AND METHOD.

3.4. Thickness of Corm

Figure 4 (left) depicts the effect of chemical fertilizer on konjac planted on Alfisol soil previously amended with molasses or leaves of Chinese albizia. Thickness of corm was found to be highest when

200 kg NPK/ha + 200 kg AS/ha was applied on Alfisol soil previously treated with molasses (7.18 cm) or amended with Chinese albizia leaves (7.83 cm). Further increase of AS fertilizer to 400-600 kg/ha at application rate of 200 kg NPK/ha resulted in reduction on corm thickness of konjac grown on Alfisol soil amended with either molasses or Chinese albizia leaves. The reducing effect of AS fertilizer applied at higher rates (400-600 kg AS/ha) was also observed on plant height (Fig. 1), plant diameter (Fig. 2) and corm diameter (Fig. 3). Figure 4 (right) shows thickness of corm was 7.1 cm and 6.3 cm when Alfisol soil treated with Chinese albizia leaves and molasses, respectively, suggesting better use of Chinese albizia leaves than molasses.

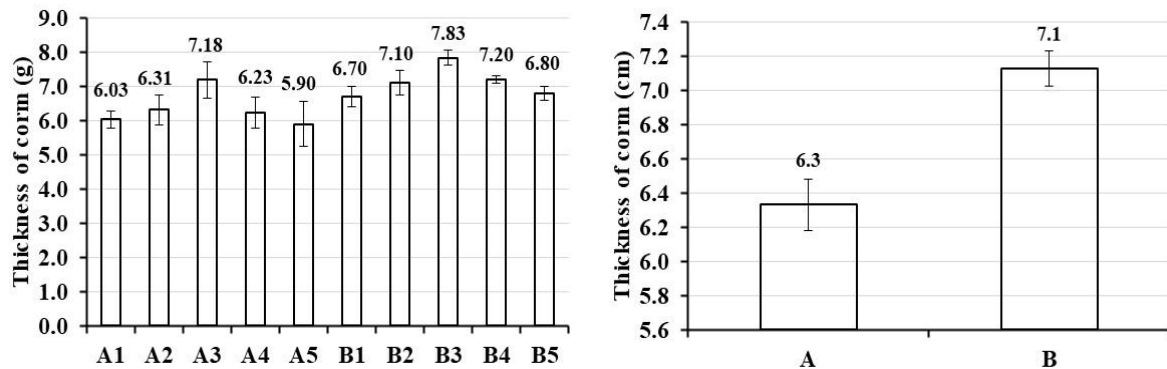


Figure 4. Effect of chemical fertilizer (A) and organic fertilizer (right) on corm thickness of Indonesian konjac (*Amorphophallus muelleri* Blume) grown on Alfisol soil. A and B are molasses and leaves of Chinese albizia (*Albizia chinensis*). Numbers 1, 2, 3 and 4 follows letters A and B is chemical fertilizer, described in MATERIAL AND METHOD.

3.5. Fresh Weight of Corm

The performances of corm due to chemical fertilizer treatments on Alfisol soil previously amended with molasses or Chinese albizia leaves were shown on figure 5. An increase of corm size was observed due to chemical fertilizer application of 200 kg NPK/ha + 200 kg AS/ha on Alfisol soil amended with either molasses or Chinese albizia leaves. The performances of corm sizes of konjac grown on Alfisol soil, amended with either molasses or Chinese albizia leaves, look decreasing at increasing rate of AS fertilizer (400 kg/ha to 600 kg/ha). This figure indicates the negative effect of AS fertilizer at high rate on corm yield.

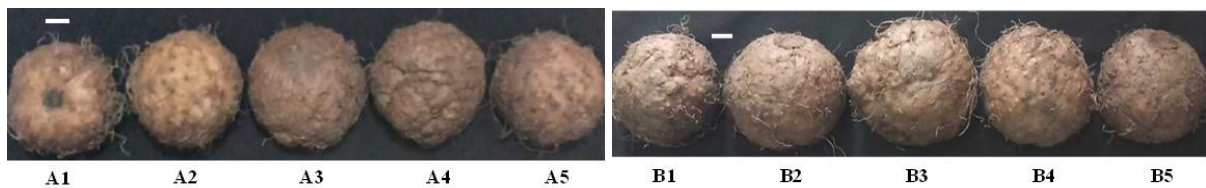


Figure 5. Effect of chemical fertilizer on corm performances of Indonesian konjac (*Amorphophallus muelleri* Blume) grown on Alfisol soil amended with molasses (A) or leaves of Chinese albizia (*Albizia chinensis*) (B). Numbers 1, 2, 3 and 4 follow letters A and B are chemical fertilizer treatment, described in MATERIAL AND METHOD. Bar represents 1 cm scale.

Fresh weight of corm was shown to be highest when 200 kg NPK/ha + 200 kg AS/ha was applied to konjac grown on Alfisol soil after amendment of molasses (457 g/plant) or Chinese albizia leaves (581 g/plant) (Fig. 6 left). When AS fertilizer was increase to 400 kg/ha - 600 kg/ha at application of 200 kg NPK/ha, the fresh weight of corm decreased at amendment with either molasses or Chinese albizia leaves. Our present research work indicates that higher application of AS fertilizer negatively affected the corm yield of konjac. The negative effect of higher AS fertilizer application was also shown on plant height (Fig. 1), plant diameter (Fig.2), shoot dry weight (Fig. 3), corm diameter (Fig. 4) and corm thickness (Fig. 5). Figure 6 (right) revealed that the use of molasses yielded lower fresh weight of corm

(403 g/plant) than the use of Chinese albizia leaves (488 g/plant). Lower plant growth, as measured in plant height, plant diameter and shoot dry weight, due to the use of molasses was also shown in this research work (Figs, 1, 2 and 3). Our present research indicates that the decreasing plant growth of konjac, measured as plant height, plant diameter and shoot dry weight, is followed by the decreasing corm yield, measured as corm diameter, corm thickness and fresh weight of corm. Thus, this research result is in accordance to the research results reported previously which revealed that the lower growth of konjac resulted in lower corm yield (20, 21).

Alfisol soil was reported to be good soil since konjac plant could grow normally without the appearance of nutrient deficiency symptoms (19, 20, 21). However, our present research work revealed that plant growth improvement and corm yield increase of konjac was attained when chemical fertilizer was added on Alfisol soil. An improvement of plant growth and corm yield of konjac due to addition of fertilizer was reported elsewhere (7, 18). In addition to chemical fertilizer addition, the results of present research work reported that the use of Chinese albizia leaves was better than the use of molasses as an organic material.

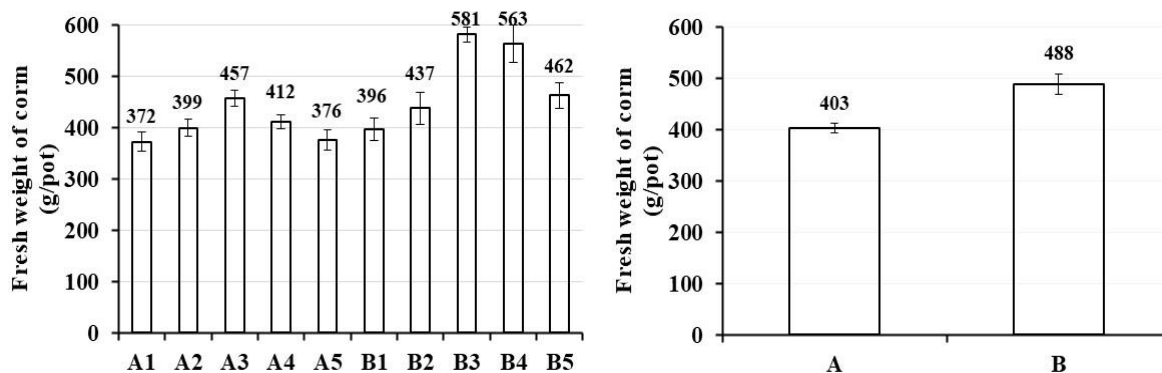


Figure 6. Effect of chemical fertilizer (left) and organic fertilizer (right) on fresh weight of corm of Indonesian konjac (*Amorphophallus muelleri* Blume) grown on Alfisol soil. A and B are molasses and leaves of Chinese albizia (*Albizia chinensis*). Numbers 1, 2, 3 and 4 follow letters A and B are chemical fertilizers, described in MATERIAL AND METHOD.

4. CONCLUSION

The fertility of Alfisol soil obtained from Probolinggo regency, East Java is inadequate to support optimum growth and corm yield of konjac. Addition of 200 kg NPK/ha + 200 kg AS/ha is required for optimum plant growth and corm yield of Indonesian konjac. Further increase of AS fertilizer (400 kg/ha- 600 kg/ha) at 200 kg NPK/ha applied to Alfisol soil significantly reduced plant growth and corm yield of konjac. Leaves of Chinese albizia produced better plant growth and corm yield compared to molasses as a source of organic material.

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