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Utilization of *Aspergillus niger* fungus as an efficient use of inorganic phosphate (P) fertilizer in Edamame (*Glycine max* (L.) Merrill)

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Abstract:
Optimizing the use of inorganic P fertilizer through phosphate dissolution by the fungus *Aspergillus niger*, thus providing phosphate elements for edamame plants. This study aims to examine the growth and yield response of edamame plants (*Glycine max* (L.) Merril) to the application of phosphate solubilizing fungus (*Aspergillus niger*) in the efficiency of reducing the use of P fertilizer. This research was conducted in the field of Kebonsari Village, Sumbersari District, Jember Regency from July to November 2024. This study used a non-factorial Randomized Group Design (RAK) consisting of 5 levels, namely: 0 ml *Aspergillus niger* fungus/plant + 100% TSP, 10 ml *Aspergillus niger* fungus/plant + 75% TSP, 20 ml *Aspergillus niger* fungus/plant + 75% TSP, 30 ml *Aspergillus niger* fungus/plant + 75% TSP, 40 ml *Aspergillus niger* fungus/plant + 75% TSP. The results showed that the application of *Aspergillus niger* fungus was able to optimize the use of inorganic P fertilizer. The dose of *Aspergillus niger* fungus did not show a significant effect on the parameters of plant height, number of productive branches, number of pods per sample, weight of pods per sample, root length, and fresh weight of plants.

Keywords:
Aspergillus niger, Edamame, phosphate solubilizing fungi

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INTRODUCTION

Edamame plants are a type of soybean plant originating from Japan. Edamame production in Indonesia is approximately 3.5 tons/ha (Setiawan et al., 2022). The low production is due to the damaged environment and wrong fertilization techniques, as well as the need for organic matter in planting to increase edamame productivity (Saetri et al., 2023).

Increased productivity and growth of edamame plants fulfill the supply of essential nutrients, one of which is phosphate (P) (Kantikowati, 2024). However, phosphorus content in the soil is very low and available to plants because it is bound by soil colloids (Firdausi, 2016). The use of phosphate solubilizing microorganisms (MPF), such as the *Aspergillus niger* fungus, can increase the efficiency of phosphate fertilizer use. This fungus has the ability to dissolve insoluble phosphate compounds through the secretion of organic acids such as citric acid and oxalic acid, which increase the availability of phosphorus to plants (Wang, et al, 2022) thus offering a more environmentally friendly solution and efficient use of phosphate (P) fertilizer in edamame cultivation.

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METHOD

This research was conducted from July to October 2024 in Kebonsari Village, Sumbersari Subdistrict, Jember Regency. East Java Province, at an altitude of 160 meters above sea level, has an average temperature of 23°C and an air humidity of around 95%. The research location is at coordinates -8.189495 ° South latitude and 113.714758° East longitude.

The tools used include sickle, koret, hoe, tugal, knapsack, kenco, scissors, nameplate, camera, stationery, raffia, plastic, filter, gallon, bottle, glaaswool, aerator, clear hose, knife, scale, bucket, water content measuring instrument, scale, and meter. The materials include edamame seeds of Biomax 1 variety, Aspergillus niger fungus, potatoes, sugar, potassium pemanganat/PK, glaaswool, manure, Urea fertilizer, TSP fertilizer, KCL fertilizer, insecticide active methomyl 40%, insecticide active abamectin 18 g/l, roundup herbicide active isopropylamine glyphosate and gramoxone herbicide active paracuat dichloride.

The research design used was a Non-Factorial Randomized Group Design (RAK), factor: the dose of *Aspergillus niger* fungus (A) consisted of 5 treatments, as follows: Control (0 ml *Aspergillus niger* fungus/plant) + 100% TSP, 10 ml *Aspergillus niger* fungus/plant + 75% TSP, 20 ml *Aspergillus niger* fungus/plant + 75% TSP, 30 ml *Aspergillus niger* fungus/plant + 75% TSP, 40 ml *Aspergillus niger* fungus/plant + 75% TSP, 30 ml *Aspergillus niger* fungus/plant + 75% TSP, 40 ml *Aspergillus niger* fungus/plant + 75% TSP.

Research activities were carried out in stages, starting from land processing, planting, applying straw mulch, replanting, weeding, hilling, watering, and fertilizing, for the application of treatments at 7 hst, 21 hst, and 35 hst.

Observations of plant height variables (14 hst, 21 hst, 35 hst), pod weight per sample, plant fresh biomass, and number of productive branches. Analysis of variance using Analysis of Variance (ANOVA), if it gets very real results, then further tests are done with the BNT (Least Real Difference) at 1% level.

RESULT

The results of this study are presented in Table 1.

Table 1. Recapitulation of Fingerprint Results of Various Observation Parameters

No	Observation Parameters	Treatment
		Aspergillus niger fungus
1	Plant height 14 HST (cm)	Ns
2	Plant height 21 HST (cm)	Ns
3	Plant height 35 HST (cm)	Ns
4	Sample pod weight 65 HST (grams)	Ns
5	Fresh biomass of plants 65 HST (grams)	Ns
6	Number of productive branches 65 HST	Ns

Based on the results of data analysis in Table 1. above, it can be seen that the application of *Aspergillus niger* fungus to edamame plants (*Glycine max* (L.) Merril) shows different unreal effects (ns) on plant height parameters, sample pod weight, fresh plant biomass, root length, number of productive branches in edamame plants.

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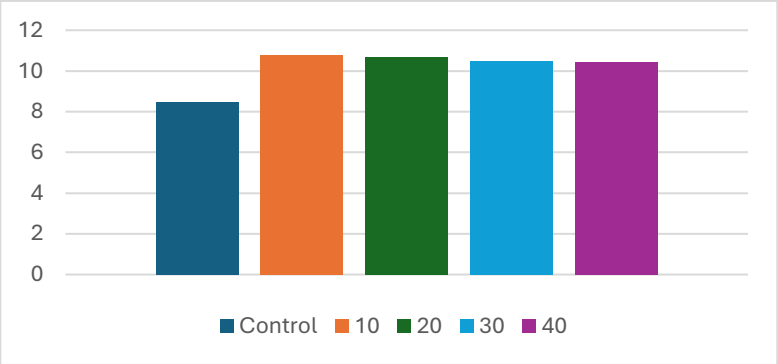
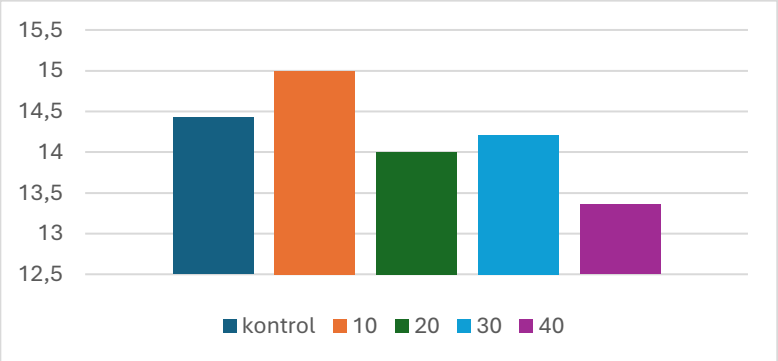
Plant height

Observation of plant height was carried out 3 times, at 14 hst observation showed a real difference from control with the application of *Aspergillus niger* fungus, the highest at the 10 ml treatment, which was: 10.77 cm. This showed that the exposure had no real effect.



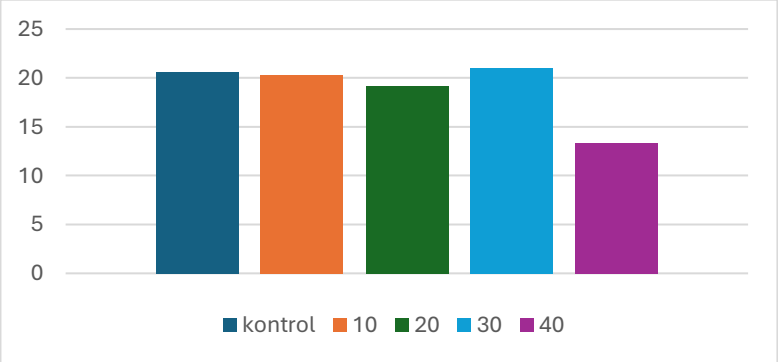
Graph 1. Plant height 14 hst

Observation of plant height at 21 hst, showed the highest results in the administration of 10 ml, namely: 15 cm, from the observation of 14 hst and 21 hst it was assumed that the administration of 10 ml was sufficient to support the height of the edamame plant, rather than giving more doses to the plant and less use of P fertilizer.



Graph 2. Plant height 21 hst

Observation of plant height at 35 hst showed the highest result at 30 ml administration, which is 20.9 cm, while in the control, it was 20 cm.



Graph 3. Plant height 35 hst

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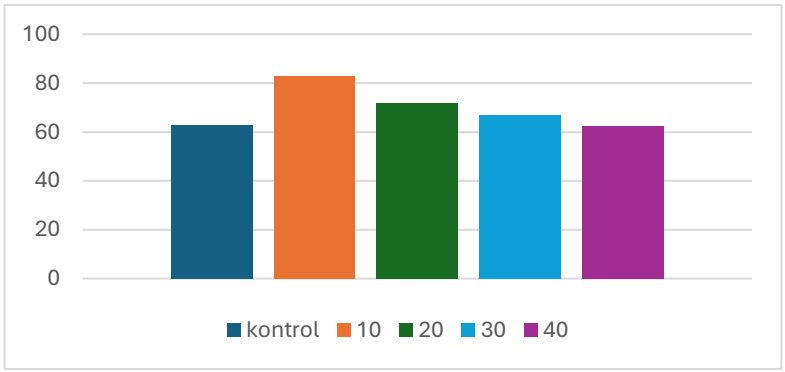
Weight of Sampling Pods

Observation of Pod Weight Sampling was carried out at 65 hst, the results showed the highest at 10 ml, namely: 83 g. The administration of 10 ml was able to increase the yield of pods from the control and other treatments.



Graph 4. Weight of Sampling Pods

Fresh Biomass of Plants

Observation of Plant Fresh Biomass was carried out at 65 hst, the results showed the highest at 10 ml administered, namely: 47.33 g. Meanwhile, at the control: 32 gr, so that the application of aspergillus niger mushrooms increases the fresh biomass of plants.

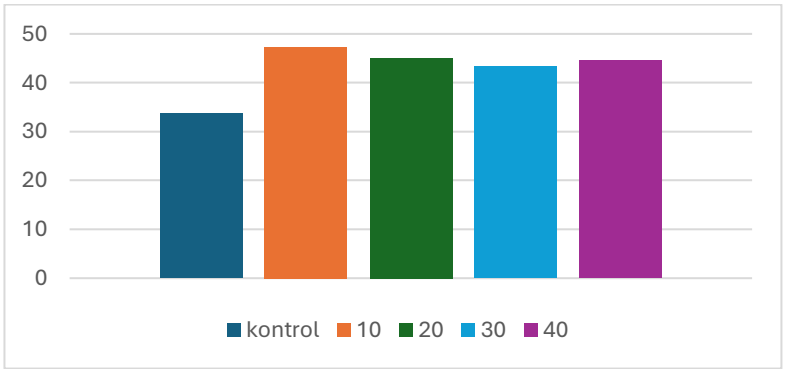
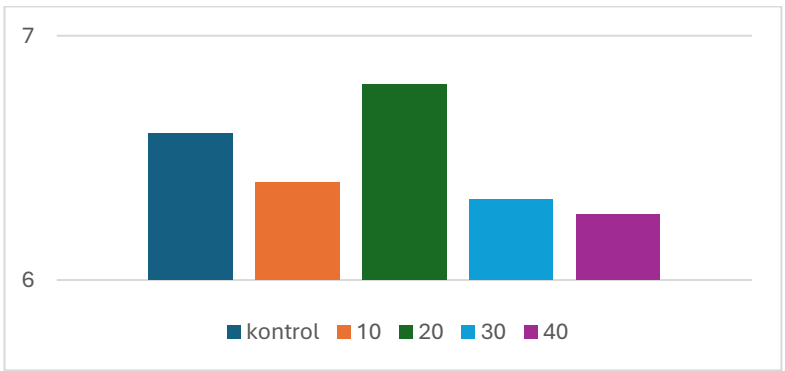


Chart 5. Fresh Biomass of Plants

Number of Productive Branches

Observation of the number of productive branches was carried out at the age of 35 hst, the highest result was given 20 ml, namely: 6.8. The number of productive branches is uniform on average.



Graph 6. Number of Productive Branches

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DISCUSSION

The results of the study showed that the application of *Aspergillus niger* fungus did not show a significant effect on the growth and productivity of edamame plants, a reduction in the dose of P fertilizer to 75% from 100% was replaced by the administration *of aspergillus niger* fungus. The environment or soil serves as a place for water and nutrient supplies, affecting the ability and place of living organisms that are able to support plant growth (Ilyasa, 2020). *Aspergillus niger* dissolves phosphate in organic matter in the soil (Hutagaul, 2017). Phosphorus in the soil, which is bound to metal compounds so that it is difficult to dissolve or takes longer (Sari et al, 2017), is too late to supply the phosphate (P) content needed by edamame plants.

Aspergillus niger, in addition to being a phosphate solvent, is often used in conjunction with PGPR or included in the formulation of a consortium of plant supporting microbes. Syed et al, 2020). However, according to Agustian (2025), in peatlands, PGPR has no effect on the growth of edamame plants. Therefore, the administration *of Aspergillus niger* fungus is not able to compensate for the application of P fertilizer with a 100% dose in supporting the growth of special edamame plants in the growth phase or vegetative phase. So that the variables show that they are different and not real.

CONCLUSION

This study concluded that the administration of *Aspergillus niger* fungus was able to optimize the use of phosphate fertilizer (P) with a dose of 75% of 100 kg/ha on edamame plants and the administration of *Aspergillus niger* fungus did not have a significant effect on the parameters of plant height, sample pod weight, number of pods, number of productive branches and fresh weight of plants.

Based on the results of this study, further research needs to be conducted regarding the reduction of the use of inorganic P fertilizers and the increase in the dose of phosphate-solvent mushrooms (*Aspergillus niger*) in order to be able to show significant different results.

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