Morphological Performance of Edamame Applied by Livestock Manure in Acid Dry Land

by Jumar .

Morphological Performance of Edamame Applied by Livestock Manure in Acid Dry Land

Untung Santoso[1], Agung Nugroho[2], Jumar[1], Riza Adrianoor Saputra[1], and Muhammad Imam Nugraha[1](✉)

[1] Department of Agroecotechnology, Faculty of Agriculture, Lambung Mangkurat University, Banjarbaru, Indonesia
imam.nugraha@ulm.ac.id

[2] Department of Agroindustrial Technology, Faculty of Agriculture, Lambung Mangkurat University, Banjarbaru, Indonesia

Abstract. The deficiency of productive agricultural land was an obstacle in the development of edamame cultivation. The utilization of suboptimal land, especially acid dry land, is a solution for the development of edamame cultivation. South Kalimantan has acid dry land covering an area of 87.61% of the total dry land. Edamame plant morphology is the basis for studying plant growth and productivity whom determined by the availability of nutrients in the soil. The object of this study was to evaluate the morphological performance of edamame grown in acid dry land with the addition of different types of animal manure. The selected treatments in this study were 3 types of organic fertilizers: chicken, goat, and cow manure with a dose of 10 t ha^{-1}. Each treatment possessed 3 replications thereby this study obtained 9 units of experiment. The height of edamame plants fed with goat manure showed the highest performance compared to chicken and cow manure. Edamame leaves applied goat manure had wider leaf area and more leaves followed by chicken and cow manure; additionally, the number and size of edamame filled pods in goat manure treatment also were greater than cow and chicken manure.

Keywords: acid dry land · edamame · livestock manure · morphology · organic fertilizers

1 Introduction

Indonesia is a vital agricultural country that has enormous food products. It is also facing a serious constraint in maintaining sustainability of food production. Arable land availability for agricultural extensification to sufficient the food products faces negative impact from land use changes issues. [1] conveyed the agricultural land encountered depreciation issue about 60,000 ha $year^{-1}$. This depreciation is due to the practice of changing the function of agricultural land to non-agricultural uses. The agricultural land extensification strategy, targeted sub optimal land, is the appropriate solution for sustaining the food production. [2] stated that the suboptimal land which has potentially

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arable suited the following criteria: idle or bare land, and agronomically appropriate for agriculture. Therefore, land resources information takes a critical role in the development of the agricultural sector to increase food productivity.

Dry land is one of the sub-optimal land that suited following criteria for agricultural land extensification. Dry land is the expanse land that never get on flooded condition most of the time in annu[21] South Kalimantan has vast dry land which covered 2,560,733 ha and 87,61% of the total dry land classified as acid dry land because their acidic condition (pH $<$ 5.5) [3]. This condition is unfavourable for agricultural land use thus the land management need to be taken to ameliorate the planting environment. Amelioration is the reputable technology to increase the soil fertility with addition of chemical or natural (organic) substances. [4] claimed that organic ameliorations have to input before application of main fertilizers. Organic ameliorations could increase pH and improved the acid dry soil physical property so the fertilizers did not experienced difficulty of unavailable and easily absorbed by plants.

The area of acid dry land in South Kalimantan that had the potential for cultivation of staple food crops reached 764,481 ha [3]. Soybean is one of the staple food that has high demand in South Kalimantan for various main food ingredients. [5] claimed that soybean production in 2015 was 10,537 t of dry seeds or undergo an increase in production of 1,591 t of dry seeds or around 17.78% compared to 2014 (8,946 t of dry seeds). The increase in production was due to an increase in harvested area, where the soybean harvested area in 2014 amounted to 6,848 ha, increasing to 7,722 ha in 2015 or an increase of 12.76%. And an increase in productivity of 4.52%, namely in 2014 by 13.06 q ha^{-1}, increasing to 13.65 q ha^{-1} in 2015. [6] stated that application of c[3]mbination of animal manure as ameliorant and fertilizer in acid dry soil could boost the number of pods per plan[3]nd weight of 100 seeds of grain for Anjasmoro variety of soybean. The increase in the number pods per plant and the weight of 100 seeds of grain was influenced by the increase in the nutrient content of P.

One important variety of soybean that highly marketable in recent years is Edamame (*Glycine max* (L.) Merrill). Edamame is a good prospect crop that needs to be developed because it has a higher ave[23]e production of 3.5 t ha^{-1} than the production of regular soybean plants which have an average production of 1.7–3.2 t ha^{-1} [7, 8]. This soybean commodity is very promising to be developed b[13]previous studies have not carried out the development of edamame in acid dry land in South Kalimantan. Therefore, the aim of this stud[12]as to evaluate the morphology of edamame in acid dry land. The performance of plant growth and development is the result of the interaction between the genetic potential of the plant and the growth environmental condition. Evaluation of the response of the genotype to the environment is necessary by using growing different varieties of crops in the development area [9].

2 Material and Methods[17]

The research was carried out in September to November 2021 and located in District of Halong, Regency of Balangan, South Kalimantan Province, Indonesia (2° 15′ 33.012” S; 115° 38′ 34.692” E). The selected treatments in this study were 3 types of organic fertilizers: chicken, goat, and cow manure with a dose of 10 t ha^{-1}. Each treatment

possessed 3 replications thereby this study obtained 9 units of experiment. Total of samples was 3 plants that was selected by purposive sampling on each unit of experiment. The materials used in this study were chicken, goat and cow manure, edamame of Ryokkoh varieties, liquid organic pesticide.

The soils for planting media firstly were cleared from crop residues by using hoe and cutlasses. After it was cleared from residues, the soils were ploughed to turn over the soils and harrowed to loosen the soils in order to germinate properly. And the last for land preparation was to make ridges to avoid getting waterlogged and built 9 plots for planting edamame. Before the planting, the main fertiliz on each plot were applied in 7 days before planting as the treatment setting (chicken, cow, and goat manure at dose 10 t ha^{-1}). The growth parameters observed at 9 weeks after planting (WAP) in this study included: plant height, number of leaves, leaf length, leaf width, leaf a, number of main branches. Meanwhile, the yield parameters observed at included: number of pods, number of filling pods, and fresh weight of pods. Every plot was applied with the same dosage by liquid organic fertilizer of biourine plus natural pesticide to remove the pests from the edamame plants.

3 Data Analysis

The method used in this research was descriptive and the data was presented by quantitative interpretation. Analyses of descriptive was presented in the form of average and standard error values. These analyses gave benefit to get a complete picture of the data in numerical form.

4 Discussion

4.1 Growth and Yields of Edamame

The results affirmed that all the composted manures allowed the leaves to grow (Fig. 1). Its role as organic amelioration by promoting useful microorganisms to promote photosynthetic rate and generate the leaves growth. [10] claimed soil that ameliorated with organic material increased Acidobacteria quantities whose had positive correlation with soil pH. Acidobacteria has competency to metabolize recalcitrant organic substrates in soils so that nutrients were easily uptake by plants. Plant growth promoting bacteria (such as Acidobacteria) alter the leaves structure and photosynthesis that lead to an improvement of plant leaf area by 29.9% [11]. Furthermore, the results confirm that the bacteria may confer benefits in photosynthetic traits of edamame plants.

The leaf area in this study described that cow manure treatment on edamame had the greater leaf area by 76.40 cm^2 compared to other manures. Cow manures decompose faster than poultry and goat manures under certain conditions. This faster decomposition rate made reaction of plant to uptake the essential nutrients immediately. [12] informed that the decomposition rates of cattle manure was faster than goat manure in spite of the lower initial concentration of N and higher C/N ratios. They claimed that total N might be a poor predictor for decomposition rates because total N in ruminant manures were form lignin that recalcitrant to digest and the organic C were from cellulose that might

Table 1. Growth and yield characteristics of edamame on acid dry land

Research treatment	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Number of leaves (leaves)	Plant height (cm)	Number of primary branches (branches)	Number of pods (pods)	Number of filling pods (seeds)	Fresh weight of pods (g $plant^{-1}$)
Chicken manure*	7.58	5.85	23.76	34.25	45.25	3.5	12.5	2.19	26.25
Chicken manure**	11.81	8.69	68.08	48	61	6	24	2.38	59
Chicken manure***	12.35	8.77	71.2	58.5	58.3	5.75	17.5	2.38	38.5
Average ± std error	**10.58 ± 1.31**	**7.77 ± 0.83**	**54.35 ± 13.27**	**46.92 ± 6.08**	**54.85 ± 4.21**	**5.08 ± 0.69**	**18.00 ± 2.88**	**2.31 ± 0.05**	**41.25 ± 8.27**
Cow manure*	11.68	8.35	64.57	60.5	58.25	5.5	22.75	2.44	57.5
Cow manure**	11.34	12.36	92.64	53.25	60.93	6.5	24	2.38	52.25
Cow manure***	12.44	8.81	71.97	63	65.48	6	20.5	2.13	43
Average ± std error	**11.82 ± 0.28**	**9.84 ± 1.10**	**76.40 ± 7.28**	**58.92 ± 2.53**	**61.55 ± 1.83**	**6.00 ± 0.25**	**22.42 ± 0.89**	**2.31 ± 0.08**	**50.92 ± 3.67**
Goat manure*	10.68	7.6	53.5	46.25	61.75	5.25	27	2.25	67.25
Goat manure**	12.16	8.55	68.41	63.25	65.1	5.75	21.75	2.25	60.5
Goat manure***	12.46	9.07	75.06	69.5	63.73	6	21.5	2.06	48
Average ± std error	**11.77 ± 0.48**	**8.41 ± 0.37**	**65.66 ± 5.52**	**59.67 ± 6.02**	**63.53 ± 0.84**	**5.67 ± 0.19**	**23.42 ± 1.55**	**2.19 ± 0.05**	**58.58 ± 4.88**

Note: * = block I, ** = block II, *** = block III, std error = standard error

decomposed very fast because it was already have abundance of cellulolytic bacteria. [13] also informed that ruminant manures could decomposed faster than poultry manures because the ruminant contain more *O*-alkyl C and di-*O*-alkyl C that represent cellulose (labile C compounds) in Spectra of 13C nuclear magnetic resonance (NMR) method.

Cow manure had capability not only providing essential nutrients for plant growth but also had capacity to inhibit fungus growth on plants whom severing the nutrients uptake. [14] informed the compost of cattle manure gave better growth performance on maize than composted poultry manure application because the composted cattle manure has higher disease reducing effects. They claimed that composted cow manure gave higher concentration of NH_4-N and inhibited the growth of pathogen in leaf tissues. Adequate nutrients uptake by plants instigated resistances in plants through arrangement of thicker

cell walls or synthesis of mutual compounds such as phytoalexins, antioxidants, and flavonoids presenting opposition against pathogens [15].

Goat manure had leaves more than cow and chicken manures. The local soybean that was applied with goat manures 42 days after planting (DAP) had number of leaves (81 sheets) more than cow and chicken manures [16]. These results were affected by K elements in goat manure that are higher than cow manure. These results were in line with [17] which also stated that goat manure had number of leaves than cow manures by referring to higher K elements. Potassium (K) was participated in the process of metabolism and raising the resilience of some parts of the plants such as leaves, fruits, and flowers.

The plant height on the Table 1 indicated that cow and goat manures had better results on edamame in acid dry soils. This results in line with the [18] claimed that amendment with cow manure appropriated to ameliorate the acid soils with applied dose around 5 t ha^{-1}. [19] informed that 20 t ha^{-1} of goat manures was comparable to chicken manures with the same dose, even goat manures might be applied in the absence of chicken manures to give better plant growth parameters. [20] also corroborated previous studies which claimed that ruminant manures (cattle and goat) had a constant raising effect on the plant height growth of baby spinach but also had slow performance on early stage because of the large C/N ratio. [21] even stated that poultry manure had susceptibility giving the least plant height than goat and cow manure in gully eroded soil. [22] found that the okra that cultured during rainfall in high intensity with poultry manures reduced the yield qualities. Therefore, they suggested planting of okra with amendment of poultry manures was suitable under moderate intensity rainfall to avoid the reduction nutrients of nutrient and proximate content of vegetables. Goat manure had the liming effects providing highest values of soil K, Ca and Mg and supported the application of urea fertilizer which gave the highest plant height with combination dose 8 t ha^{-1} goat manures + 200 kg ha^{-1} [23].

The results in this research described that the amendment of manures ameliorated soil organic matter and contributed to soil fertility. The more soil fertility increased, the more resilience nutrients dynamic in soils for the purpose of improving crop productivity. [24] in their research stated that goat manure compost and biourine combination showed an increasing yield up to 46% on red chilies in Deli Serdang district, North Sumatera with the dose of organic and inorganic fertilizers according to farmers habitus. Organic and inorganic fertilizers combination (semi-organic farming) also the alternative application chosen by farmers to increase crop qualities and productivity. [25] informed in the research that the ultisol (low of P elements) demanded the addition of 5 t ha^{-1} of cow manures, 1.5–2.5 t ha^{-1} of Santap NM2 fertilizer, and 0.15 t ha^{-1} of Phonska to increase soybean yield by 21–27% (0.42–0.55 t ha^{-1}). [26] declared that composted cow manure with dose of 8 t ha^{-1} remarkably increased the number of pods and weights of grains in soybean that was compared to the control without manures application. Goat manure combined with inorganic fertilizers also had positive remarkable results on yield and productivity of soybean. [27] informed that their results revealed that number of pods and fresh weight of pods were greater with 1.5 kg m^{-2} of goat manure and 45 g m^{-2} of ExpertTM fertilizer treatment and followed decreasing results were found on 1.0 kg m^{-2}

of goat manure and 40 g m^{-2} of ExpertTM fertilizer treatment where 30 g m^{-2} expert fertilizer was applied as top dressing and the remaining dose was applied in basal.

The growth of roots in plants was also the important parameters to interpret nutrient dynamics and adequacy. The growth of roots was presented in Fig. 2. Application of manures in many previous studies enhanced root elongation by modifying soil nutrients condition as suitable for plant growth. [28] stated that root length was influenced remarkably amended by goat manure and positively correlated with the existence of P elements.

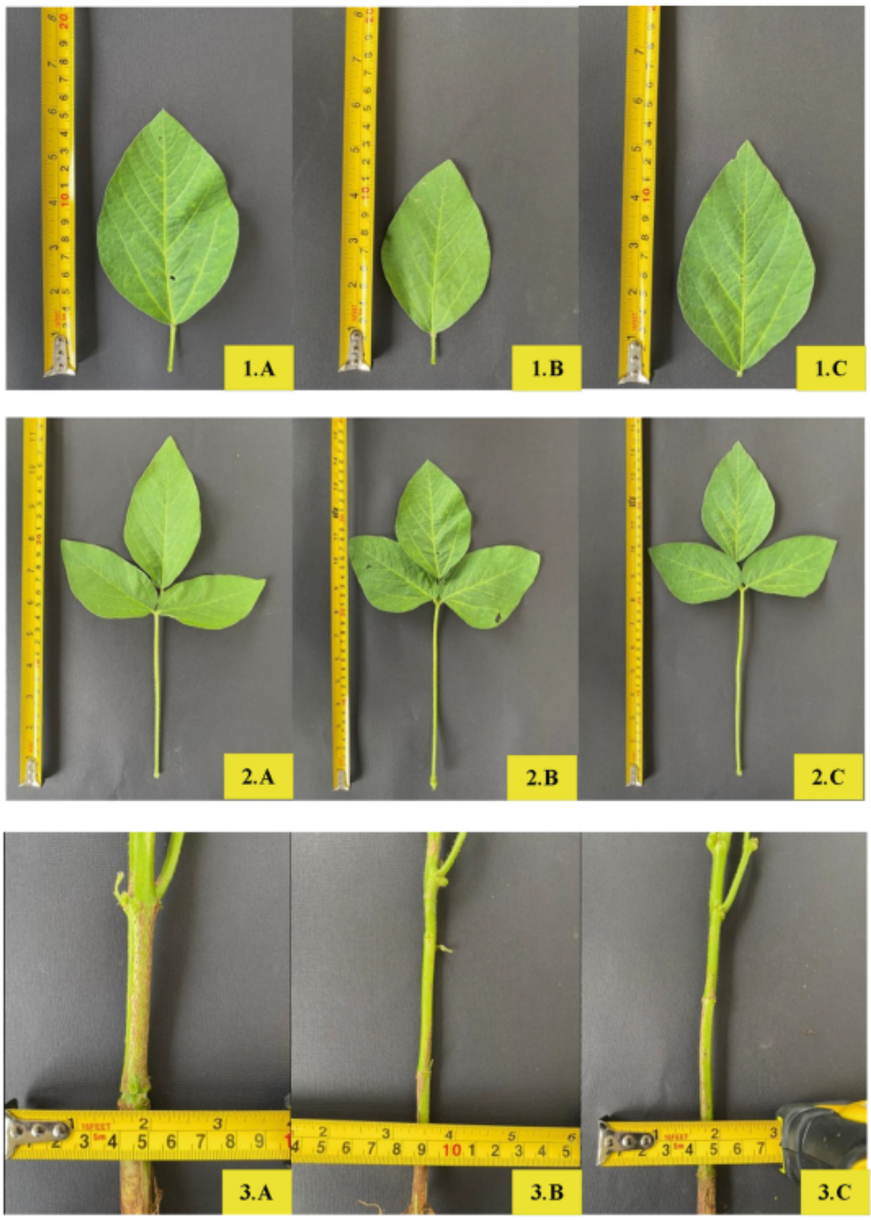

Fig. 1. Performance of leaves (1 and 2) and stem (3) of edamame. Note: treatments of goat (A), cow (B), and chicken manure (C).

Fig. 2. Performance of roots (4), plant structure (5) and pods (6) of edamame. Note: treatments of goat (A), cow (B), and chicken manure (C).

[29] reports that application of goat manures was significantly improving relative root elongation on commercial commodities such as *Chrysanthemum indicum* L., *Raphanus sativus*, *Brassica rapa, Sesamum indicum* L., and *Daucus carota*. Macronutrients such as N and P elements had magnificent and beneficial effect on both aerial and root growth.

5 Conclusion

Goat manure application showed the best growth and yield performance of edamame in acid dry land. The leaves and plant height of edamame applied with goat manure had larger leaf areas, more leaves, and higher plant height; additionally, the number and size of edamame filled pods also showed the best results. It is recommended to carry out further research on the response of edamame applied to different manures on different types of land, in order to obtain an overview of the performance on the land character.

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