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Production and quality of some edamame varietiesas affected by residual effect of worm compost application

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Abstract. Edamame is a kind of soybean which is consumed as green vegetable. It is harvested when its pod is still fresh green colour at 58-65 days after cropping. This research aimed to evaluate production and quality of some edamame varieties as affected by residual effect of worm compost application. The research carried out at Mangli Village, Kaliwates, Jember, East Java on an irrigated field that has been used previously for research concerning utilizing of worm compost (Treatment-I). The research was designed factorial in complete randomized block consisted of two factors of treatment with three replications. The first factor was variety of edamame (V), includes: R75 (V1), R75/F2 (V2) and R76 (V3). The second factor was combination between worm compost and inorganic fertilizer, includes 100% N inorganic (C0), 50% N inorganic + 50% N worm compost (C1), 25% N inorganic +75 N worm compost (C2), and 100% N worm compost. (C3). The observed variables were crops growth components (crops height, number of productive branch and internodes), yield components (the weight of raw matter and export matter grades, pod size, fibre content, vitamin C and sugar content). The result indicated that there was interaction effect between varieties and worms compost on to weight of raw matter yield. Variety of R75 fertilized with doses of 75% worm compost and variety of R76 fertilized with 100% worm compost gave the best result for raw matter grade weight.

1. Introduction

Edamame is a special type of soybean (*Glycine max L. Merrill*). Taxonomically,edamame is not different to the common soybeans [1]. Edamame is consumed as a fresh green bean with a unique flavor, high nutritional value for source of protein, vitamins, minerals and fiber. Edamame is harvested at the young stage of pods i.e. between 58 up to 65 days after cropping. Therefore, edamame requires an intensive and good practice of cultivation. The edamame quality indicators are skin color, aroma, taste, number of seeds per pod and seed size. Good quality has the criteria of 2–4 seeds per pod and free from pest and disease. The weight of 500 gram contains less than 175 pods and weigh of 100 seeds more than 30 grams. In addition, the quality of the seeds in the form of vitamin C, fiber and sugar total [2].

Edamame was developed in Jember Regency of East Java by PT Mitra Tani 27 since 1994, on regosol wetland soils. This crop is an export commodity because its economic value is much higher than ordinary soybeans. Edamame requires a high degree fertility of land. While most of the land cropped with edamame in Jember has a less supporting level of fertility [3]. Based on the research data, the land is traditionally cropped with tobacco that has been cultivated more than 100 years. The intensive soil used has decreased the soil organic matter as lower as 1.5 percent [4]. The lands are now used for edamame cropping programmed intensively. Thus, the use of organic matters on edamame cultivation is carried out as an effort to increase soil organic matter. Worm compost is one kind of organic matters that easy to apply on edamame crop. This organic matter is processed from the earthworm excretion on compost from edamame crops waste. This organic matter becomes a fertilizer that contains macro and micro nutrients as well as some important hormones for crops growth, i.e. N, P, K, S, Ca, Mg, Fe, Mn, Zn, Cu, Bo, Mo, auxin, cytokine and gibberellins [5]. Earthworms are able to decompose organic waste faster compared to decaying microorganisms. Organic waste can experience volume reduction of 40–60% as compost [6]. Moreover, worm compost is rich in nutrients and its quality is better than other organic matters. The use of compost can reduce N doses used up to 50% thereby reducing production costs [7].

The above cultivation practice can also be prepared for the development of eco-farming system as a requirement of eco-labelling in the free market. Compost as a source of organic matters can provide long-term effects to the chemical properties and activities of soil microorganisms. The study showed that there is still high compost content in the soils after six years of sunflower cultivation without the addition of mineral or organic fertilizers [8]. The use of organic matters in green tea plantation showed a decrease in yields in second and third year but experiencing the quality improvement from year to year [9]. Nutrients in the soil will experience changes due to time and seasons. Such changes are through the process of washing, erosion, evaporation, immobilization and transporting nutrients through harvesting. Thus, these factors will affect the effectiveness of compost in its role as organic fertilizer to the production and quality of edamame soybean on second and subsequent rotation of crops. This research is intended to explore the effect of worm compost in the second crop compared to the first crop.

2. Materials and Method

The Treatment was conducted in Mangli Village, Kaliwates, Jember Regency, East Java, Indonesia on the altitude ± 84 m. The location of the Treatment is an irrigated field that formerly used for Treatment-I. Varieties used were edamame varieties of R-75, R75 (F2 Bondowoso) and R76. The Treatment used factorial method in randomized complete block design which consists of 2 factors treatment with 3 replications, i.e:

Treatment: I

Variety Factor (V), i.e. V1 (R75), V2 (R75 F2), V3 (R76)

Fertilizer Factor (F), i.e.:

F0: 100% inorganic fertilizers
F1: 50% worm compost + 50% inorganic fertilizers
F2: 75% worm compost + 25% inorganic fertilizers
F3: 100% worm compost

Treatment: II

Factor variety (V) was the same as Treatment I

Fertilizer Factor (F), i.e.:

F0: 100% inorganic fertilizers
F1: 50% inorganic fertilizers
F2: 25% inorganic fertilizers
F3: 0% inorganic fertilizers

Nutrition content from organic matters worm compost used is 5.85% N, 0.81% P2O5, 1.33% K2O and 37.53% organic matter with C/N ratio 25. Inorganic fertilizers as source of N and N worm compost given in the previous Treatment was calculated based on the recommendation doses of N.

Table 1. The total amount of N from inorganic fertilizers and N from worm compost equivalent to amount of N recommendation (kg·ha^{-1}) in Treatment-I.

Doses of Worm	Organic Fertilizer		Inorganic Fertilizers					Total N (kg)
	Worm	N	Urea	N (kg)	ZA (kg)	N (kg)	Total N	

Compost (%)	Compost (kg)	(kg)	(kg) (45% N)		(22.5% N)		inorganic (kg)	
0	0	0	250.00	112.50	150.00	33.75	146.25	146.25
50	1250	73.13	125.00	56.25	75.00	16.88	73.13	146.25
75	1875	109.69	62.50	28.13	37.50	8.44	36.56	146.25
100	2500	146.25	0	0	0	0	0	146.25

Table 2. The combination of N inorganic fertilizer (kg·ha^{-1}) in Treatment-II.

Doses of Worm Compost (%)	Inorganic Fertilizers				
	Urea (kg) (45% N)	N (kg)	ZA (kg) (22.5% N)	N (kg)	Total N inorganic (kg)
0	250.00	112.50	150.00	33.75	146.25
50	125.00	56.25	75.00	16.88	73.13
75	62.50	28.13	37.50	8.44	36.56
100	0	0	0	0	0

2.1. Treatment implementation
Treatment-II was carried out on the field which formerly used for Treatment-I. Idle period given was 2 weeks to reduce pest disease from Treatment-I. A crop beds were made with 10 m length, 1 m width and 25 cm height each bed. Distance between bed 50 cm and distance between block 1 m. The number of bed in Treatment-II was 36 beds. Cropping space 12x25 cm so that there were 332 crops each bed. The depth of seed planting was 2 cm. Then the seed was covered with worm compost.

3. Results and Discussion
Crops height growth over the doses of compost showed inconsistency, except in R76 varieties. The highest crops height on R76 varieties was 49.70 cm with 100% compost doses. There was a trend of decreasing crops height when relying on residual compost. Table 4 shows the T-test results that the height of the Treatment-II crop is significantly different with Treatment-I at doses compost 0%, 50% and 75%. Treatment-II crops height is lower compared to Treatment-I with negative value. Meanwhile, 100% compost dose is insignificant different. This means the organic matter content is still sufficient for crop growth. Number of leaves and number of branches in Treatment-II were lower than Treatment-I. However, the number of nodes in Treatment-II was higher than in Treatment-I.

Table 3. Effect of organic fertilizer dose on crops height (A), number of leaves (B),Number of branches C) and number of node (D) in three edamame varieties.

Doses of Compost (%)	Var R75				Var R75 (F2)				Var R76			
	A	B	C	D	A	B	C	D	A	B	C	D
0	47.83	11.07	2.07	9.30	48.83	10.83	2.20	9.07	46.37	10.93	1.83	9.17
50	47.60	11.20	1.90	9.30	48.40	10.17	1.87	8.87	48.60	10.33	2.20	9.23
75	47.77	10.97	1.93	9.27	47.60	10.73	2.03	9.23	48.90	10.70	1.73	9.37
100	47.40	11.07	1.80	9.23	47.70	9.87	1.63	9.00	49.70	10.70	1.97	9.33

Table 4. T-test difference in crops growth at age 45 days after planting between Treatment-II and Treatment-I in all compost doses.

Doses (%)	Crops Height (cm)	Number of Leaf	Number of Branches	Number of nodes
0	−2.03*	−0.68**	−4.78**	0.62**
50	−5.52**	−1.26*	−0.53**	0.52**
75	−5.30**	−0.80*	−0.64**	0.70**
100	-2.19^{ns}	−0.78**	−0.71**	0.73**

Decrease or loss of organic matter in the soil caused by *splash andrunoff,* soils mobilization microorganisms, leaching and lost through harvested crops. Loss of compost in cold areas can reach 70% in the rainy season and 20% on dry season. Loss of this compost will be larger in the tropics with high rainfall[10]. Worm compost contains 2–3 times potassium content compared to original soils. It also increases soil pH, thus increase activity of microorganisms that play an important role in the mineralization process [11]. Edamame production can be measured by the weight and number of *Raw Matters* (RM) and *Standard Export Matters* (SEM) qualified pods.

Table 5. The effect of worm compost and variety on pod weight of RM (g/crops).

Doses (%)	Variety		
	R75	R75 (F2)	R76
0	53.50 abc	48.33 abcd	56.50 ab
50	50.67 abcd	43.83 bcde	34.83 e
75	57.67 a	42.17 cde	38.50 de
100	39.50 de	48.00 abcd	45.83 abcde

Note: Figures that followed by the same letter are not significantly different based on DMRT level of 5%

The combination of the worm compost 75% and R75 varieties result in the highest weight of RM pod i.e. 57.67 g per crops or 10.38 tons per hectare. However, its value is not significantly different to a 0% and 50% compost combination with all three varieties.

Table 6. The effect of worm compost doses on Standard Export Matter (SEM).

Doses (%)	SEM Weight	
	g/crops	t/ha
0	33.22 a	5.98 a
50	24.94 a	4.88 a
75	27.11 a	4.59 a
100	25.50 a	4.49 a

Note: Figures are followed by the same letter is not significantly different based on DMRT level of 5%

Table 6 indicates that the highest SEM of 33.22 g/crops or 5.98 t/ha at doses compost 0% or 100% inorganic fertilizer. The SEM weight at doses of 50%, 75%, and 100% were not different with 0% doses. However, it tends to be lower than the 0% doses.

Table 7. T-test difference in rough fibre, vitamin C and sugar content.

Compost Doses (%)	Rough Fibre (%)	Vitamin C (mg/100g)	Sugar (%)
0	-3.78*	0.11^{ns}	0.51ns
50	-0.75^{ns}	0.09^{ns}	0.55*
75	-2.45^{ns}	0.02^{ns}	0.83*
100	-3.35^{ns}	0.22^{ns}	0.88*

Edamame sweetness is an important quality that distinguishes it from common soybean. Sweet taste of edamame is measured by testing the content of sucrose and its delicacy may be affected by glutamate acid [1]. Sugar level increase at 100% compost doses as an indication that compost having micro element as a sugar precursor and contain high humic acid [12, 13]. The content of organic matter in the soil in the second crop is higher than before or the first crop. This is due to the influence of soybean properties that capable to symbioses with rhizobium. These bacteria release the organic compounds in the rhizosphere to attract useful soil microbes. The abundance of microbes indicates high soil organic matter [14]. While the content of N, P and K increase for doses of 0% compost and tend to decrease in the dosesof 50%, 75% and 100% compared to Treatment-I. This phenomenon is similar to the results of Yadav research [15]. However, compost does not have negative residual effect while inorganic fertilizer leaving heavy toxic metals. Compost has a longer time effect whereas, in short term, N mineralization is more affected by inorganic matter[16].

4. Conclusion
The highest yield of Raw Matter quality group of R75 variety is achieved with the treatment of 75 percent doses of compost. Doses of 100 percent compost gave better yield and quality rather than doses of 75 percent and 50 percent.Doses compost 0 percent (or 100 percent inorganic fertilizer) gave the best yield. Edamame production declines in the Treatment-II compared to the Treatment-I.

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