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Efficiency of using nitrogen fertilizer in mustard by intercropping edamame soybeans to increase land productivity

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Abstract: This research was conducted at Experimental Farm, State Polytechnic of Jember, from June to August 2018. The purpose of this study was to determine the proper dose of N fertilizer on mustard plants with planting patterns of intercropping. The design used was a randomized block non factorial design of 5 treatments Urea fertilizer (100,75,50,25 and 0 kg / ha) and 4 replications. The size of the treatment plot is 2m x 10m. the spacing used is 20 x 20 cm. in the monoculture cropping pattern, the planting population density is 250 plants, while in intercropping plants is 200 plants. The results of the study showed that the highest yield results in 100 and 75 Urea kg/ha fertilization treatment, the ratio of land equality ratio (LER) was more than 1, so that land productivity increased by using intercropping patterns.

Keywords : edamame, intercropping, LER, mustard,

1. Introduction

Edamame is a soybean plant originally from Japan which has been successfully developed in Indonesia. This plant is a superior commodity consumed in the form of fresh edamame or frozen edamame [1,4]. Soybean plants can bind Nitrogen in the atmosphere through the activity of the *Rhizobium sp. japonicum*. Root nodules of soybean plants generally can bind Nitrogen from the air at 10-12 days after planting, depending on soil environmental conditions and temperature [5].

Vegetables are one of the constituent components of nutritious foods. Vegetables contain protein, vitamins, carbohydrates, minerals and fiber that the body needs. An increase in the population of Indonesia has triggered growing demand for vegetables. One of the most popular vegetables is mustard.

The land under Edamame plant has the potential to be used in cultivating other crops. This is one of the efficient use of agricultural land, because at this time of agricultural land by farmers increasingly limited. Intercropping system is a solution that can be used by farmers in managing their agricultural land. Mustard packcoy is one of the plants that can be used in the intercropping system. The short harvest period of mustard can be planted twice during the period Edamame and mustard packcoy plants can grow in the shade.

Intercropping is planting pattern shapes produce more than one crop in a certain time unit. Intercropping is an effort from an agricultural intensification program with the aim of obtaining optimal production, and maintaining soil fertility [12,13]. Marliah *et al*., [9] stated that the purpose of intercropping systems is to optimize the use of nutrients, water and sunlight as efficiently as possible to obtain maximum production.

Intercropping systems will increase competition in using growth factors, therefore to reduce competition it is necessary to set the planting model of intercropped plants. Marliah *et al.,* [9] showed a highly significant interaction between the spacing of sweet corn in intercropping system with varieties used to produce.

Reducing the use of fertilizer doses in plants is beneficial to improve the sustainability of land resources, reducing fertilizer costs [1,14]. With the presence of Nitrogen (N) produced by legume (edamame) root nodules at optimal N fertilizer dosages, it is expected to reduce the use of intercropping N fertilizer system with mustard. Based on the background and the problems above, this study aims to find out the most efficient intercropping model for the results of beans and mustard packcoy with a reduction in fertilizer dosage and determine the value of the land equality ratio (LER).

2. Methods

This research was conducted at the experimental farm, State Polytechnic Of Jember, from June to August 2018. The design used was a randomized block design non factorial (RBD) consisted of 5 treatments and 4 replications. The size of the treatment plot is 2m x 10m. Treatment M01 = Edamame Monoculture (control 1), M02 = Monoculture mustard (control 2), P1 = Edamame intercropping with mustard fertilizer 100 kg/ha Urea, M2 = Edamame intercropping with mustard fertilizer 75 kg/ha Urea, M3 = Edamame intercropping with mustard fertilizer 50 kg/ha Urea, M4 = intercropping Edamame with mustard fertilized 25% kg/ha Urea, M5 = intercropping Edamame with mustard without Urea fertilizer.

The planting distance used in mustard is 20 x 20 cm, while the edamame plant is 40 x 15 cm. In the monoculture cropping pattern the population density of edamame and mustard are 250 plants, while in intercropping plants are 200 plants. Planting of mustard is done at the same time with the planting of edamame

Observations made on Edamame plants include: plant height: number of leaves, fresh weight per sample and per plot, Land Equity Ratio (LER). The data obtained were analyzed using ANOVA, if there is a real effect of treatment then continued by Least Significant Difference (LSD) at 5% level.

3. Result and Discussion

1. Plant Height

Treatment of N fertilization doses on mustard plants showed a different response in each treatment but non significan different. Plant height at 2 and 4 Day after planting (DAP) in M2 and M3 treatments showed the lowest plant height, while plant height at M1 treatment showed the highest plant height (Table 1). In the monoculture pattern, plant height is lower than the intercropping pattern. It is caused by the shade that occurs in the intercropping pattern so that the plants get light not full. This is consistent with Buhaira [3] which states that the soybean plant height was higher in intercropping pattern compared to monoculture. Plants that grow under the shade will experience a higher leaf and stem area. Mustard planted in monoculture gets optimal sunlight and growing space that has no competition.

Table 1. Average plant height on mustard

Treatment	Day after planting (DAP)	
	2 DAP	4 DAP
P1(urea 100 kg/ha)	15.41 b	17.85 b
P2 (urea 75 kg/ha)	13.85 ab	17.53 ab
P3 (urea 50 kg/ha)	13.79 ab	16.75 ab
P4 (urea 25 kg/ha)	14.51 b	18.85 b
P5 (without urea)	14.88 b	17.95 b
Monoculture	11.57 a	15.98 a

The numbers followed by the same letters and the same column shows the real no different at LSD test level α = 5%.

2. Number of leaves

Based on the results of observations during at harvest, it was found that N fertilization treatment had no significant differentt on the amount of mustard pakcoy leaves (Table 2). In monoculture number leaves more than the intercropping. This is caused by the growing space on monoculture there is no competition. his is different from the intercropping pattern. in a plot there are two plants so there is a competition which results in the growth of the number of leaves decreases but the plants grow taller.

Table 2. Average the number of leaves on mustard

Treatment	Jumlah Daun
P1(urea 100 kg/ha)	9.34 a
P2 (urea 75 kg/ha)	9,50 a
P3 (urea 50 kg/ha)	10.37 a
P4 (urea 25 kg/ha)	9.13 a
P5 (without urea)	8.68 a
Monoculture	13.33 b

The numbers followed by the same letters and the same column shows the real no different at LSD test level α = 5%.

Simultaneous planting between edamame and mustard pakcoy conditions so that leaf formation on mustard is not inhibited. This is because the initial growth of edamame is slower than that of pakcoy mustard which is very fast growing. But in the end, the number of leaves on the monoculture cropping pattern is more. The formation of the number of leaves is determined by the number and size of the cell and the availability of nutrients, especially the element N [6,8].

3. Wet weight per sample and per plot

The dose of urea fertilizer significantly affected the wet weight per sample and production per plot. he treatment of urea 75 kg / ha showed the highest results of wet weight 144.52 g / sample and 21.67 kg / plot, while the lowest results are in treatment control (without fertilizer) which is 100.58 grams / sample and 15:08 kg / plot (Table 3). Urea fertilizer application 75 kg / ha is more optimal than 100 kg /ha. This is due to the high use of urea to make the root nodules of edamame soybean plants inactive to fix N and provide N, so that at a dose of 75kg /ha, it can be able to growth and development of mustard.

Table 3. Average wet weight per sample dan per plot on mustard

Treatmen	Wet weight per sample (g)	Wet weight per plot (kg)
P1(urea 100 kg/ha)	133.80 ab	20.07 b
P2 (urea 75 kg/ha)	144.52 b	21.67 b
P3 (urea 50 kg/ha)	118.92 ab	17.83 ab
P4 (urea 25 kg/ha)	110.50 a	16.57 a
P5 (without urea)	100.58 a	15.08 a
Monoculture	198.35 c	29.75 c

The numbers followed by the same letters and the same column shows the real no different at LSD test level α = 5%.

In the cropping pattern, intercropping wet weight per sample and per plot is lower when compared to monoculture plants. This is because the population and density are different. Sunlight, water, growing space and availability of nutrients are limiting factors in both cropping patterns [2.7].

4. Land equivalent ratio (LER)

LER determines land productivity and efficiency value from intercropping compared to monoculture. In table 4 shows that all treatments in intercropping cropping pattern have a LER value of more than 1.00. This indicates that the cropping systems are considered able to increase productivity so that more efficient than monocultures. The treatment of 75 kg / ha urea fertilization gave the highest LER value of 1.22.

Table 4. Land equivalent ratio on the pattern of intercropping edamame and mustard

Treatmen	Value of LER
P1(urea 100 kg/ha)	1.17
P2 (urea 75 kg/ha)	1.22
P3 (urea 50 kg/ha)	1.09
P4 (urea 25 kg/ha)	1.05
P5 (without urea)	1.00

Increased land productivity through intercropping is influenced by many things. The right choice of planting and planting time between commodities and the symbiosis of mutualism between the two is very important to consider. Legume (edamame) plants capable of fixing N from the air can be used to reduce the use of N fertilizer (10,15). on the contrary, the selected insertion plant (mustard) has a high enough adaptation to shade and relatively fast harvest time. The combination of plants between legume and vegetable plants can optimize N fertilization in both plants. This combination is the best combination because competition between parts of plants to obtain sunlight and nutrients can be minimized (11,15).

5. Conclusion

The conclusion that can be obtained from this study is the treatment of N fertilization on intercropping has no significant effect on the growth and yield of mustard greens. Leguminose plant utilization (edamame) as a shade plants (core / principal) is able to provide elements N for plant growth edamame and mustard. Intercropping pattern can increase land productivity. This is evidenced by the LER value of more than 1. The highest LER value is found in N fertilizer treatment of 75 kg / ha, which is 1.22 indicating that intercropping system is considered capable of improving the productivity of land, it is more efficient than monoculture.

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