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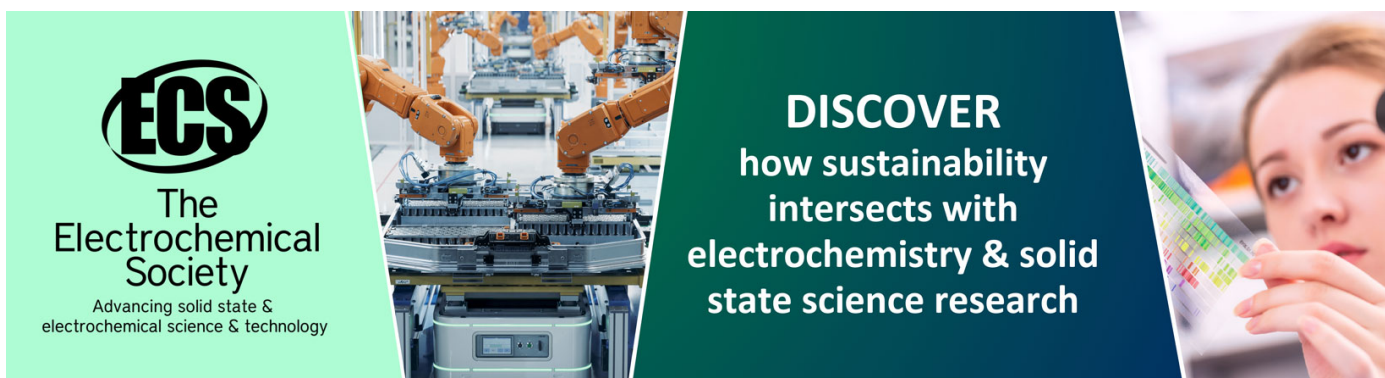
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The application of different mulches and its effect on soybean yield

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Abstract. Mulching is known as a great suppressant, a modern agricultural practise. It modifies the soil microenvironment and maintains crop yield. This study was conducted in January to April 2019 to investigate the effectiveness of several plants for mulch in various doses on soybean crop and to evaluate their effect to soybean yield. This study employed Randomized Completely Block Design (RCBD) Factorial with two factors. The first factor was 3 different plants applied for soil mulching: mexican sunflower (*Tithonia diversifolia*), siam weed (*Chromolaena odorata*) and neem (*Azadirachta indica*). The second factor was 4 different doses of mulch: 0, 8, 16 and 24 tons ha⁻¹. Variables observed were number of pods per plant, number of seeds per plant, seed weight per plant, and yield of dry seeds. The results indicated that the application of different mulches did not have effect on all variables observed. However, the application of 16 - 24 tons mulch ha⁻¹ has improved the number of pods per plant and yield of dry seeds. There was no interaction between plant types for mulching and dose of mulch in all variables observed.

1. Introduction

The presence of weeds in soybean crops can cause competition between the plant and the weeds. Not only for the nutrient, but they also compete with the crop for sunlight and water, resulting in abnormal growth of crops which contributed to a failure to reveal their potential. Allelopathy in weeds are also thought to be one obstacle for crops by delaying or preventing seed germination and reducing seedling growth [1], [2]. Therefore, weed management is essential. Mulching is known as an environmentally friendly method of weed management. This technique is expected to be able to increase soybean yield by suppressing the growth of weeds [3]. The application of organic mulch brings several advantages to crops, including reducing weed growth, improving fertility, enhancing soil water and conservation of soil moisture and structure [4].

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The effect caused by these mulches depends on types of mulch and the thickness of mulch applied. [5] stated that the application of different types of mulch contributed to different result. Some organic mulch have been used and have been proven to be effective. Mexican sunflower (*Tithonia diversifolia*), siam weed (*Chromolaena odorata*) and neem (*Azadirachta indica*) have been assessed in previous researches for its potential to increase crop yield.

Mexican sunflower (*T. diversifolia*) can be used as an organic mulch and nutrient resources for soybean crop [6]. It controls weeds by suppressing the weed's growth or preventing the weeds to grow. The results of [2] revealed that the application of mulch with 5 cm thickness has increased the weight of 100 grains (seeds) and weight of dry seed yield. Siam weed (*C. odorata*) possesses low C/N and high organic P and total N matters. These matters contribute nutrients and improve soil aggregation. The mulch made from this plant has also successfully controlled weeds in soybean plants due to its allelopathic compounds. [7] has similar finding that siam weed potentially controlled weeds. Neem (*A. indica*) contains active compounds called *azadirachtin*, *meliantriol*, *salanin*, *nimbin*, *nimbidin* and other compounds. Azadirachtin contains about 17 components and it is found in all parts of the plant, especially seeds. According to [8], neem organic mulch can optimize the value of CGR (crop growth rate) compared to mulch made from siam weed. It is due to neem leaves demonstrated slow decay, which enables them to cover the surface of the soil longer and suppress weed growth better.

2. Materials and methods

2.1 Place and duration

This research was carried out in Rumpeet Village, Krueng Barona Jaya District, Aceh Besar Regency with coordinates 5032'51.27 "LU, 95022'11.25" East BT at 6 meters above sea level (masl), and at Weed Management Laboratory, Faculty of Agriculture, Universitas Syiah Kuala, Banda Aceh, from January to April 2018.

2.2 Tools and materials

Tools used in this research were handtractor, hoes, mechanical weighing scale (10kg) analytical balance (max 1000g). Materials used in this research were soybean seeds variety Dega 1 obtained from Balai Penelitian Tanaman Aneka Kacang dan Umbi (Balitkabi) in Malang, East Java, mexican flower obtained from Lot Tawar, Central Aceh Regency, siam weed and neem leaves obtained from Ie Seu Eem village, Aceh Besar Regency, urea, SP-36 and KCl fertilizers, insecticides carbofuran and deltamethrin.

2.3 Data analysis

This research used Randomized Complete Block Design (RCBD) Factorial with 2 (two) factors: 3 (three) different mulches such as M_1 = mexican flower leaf, M_2 = siam weed leaf and M_3 = neem leaf, with 4 (four) different doses such as D_0 = 0 ton ha⁻¹, D_1 = 8 tons ha⁻¹, D_2 = 16 tons ha⁻¹ and D_3 = 24 tons ha⁻¹. These experiments had 3 replications. Data collected were statistically analyzed using Analysis of Variance (ANOVA) where significant differences in existed means were compared using Duncan's New Multiple Range Test (DNMRT) at 0.05 probability level.

2.4 Research methods

The land was tilled twice using hand tractor and hoe. Independent 24 plots with size 3 m x 2.5 m have been made with space 25 cm for each experimental unit and 50 cm for each replication. The soybean seeds used in this research must be good physiologically and morphologically. Independent 4 selected seeds were infested into each planting hole along with carbofuran application. The space for planting the seeds was 30 cm x 30 cm. The practice of thinning plants (2 plants only for each hole) were done 10 days after planting to allow them plenty of growing room in order to receive all the proper growth requirements (moisture, nutrients, light, etc.) without having to compete with other seedlings.

Fertilizers used were SP36, Urea, KCl with fertilizer doses of urea 50 kg ha⁻¹, SP36 60 kg ha⁻¹ and KCl 70 kg ha⁻¹. Fertilization was carried out in stages. Urea fertilizer has been given twice, half was given during planting, by mixing the three fertilizers, while the next half is given 30 days after planting (DAP). The fertilizers were placed using ring method. The neem mulch was applied by cutting the leafy branches or twigs. The mexican flower and siam weed mulches were applied by cutting the stems 20 cm from the leaf shoots and then they were applied directly to soybean crop during planting. Crop have been harvested at 75 days after planting, when pods become dry and leaves changes their color to yellow and fall off.

2.5 Variables observed

2.5.1 Number of pods per plant. Number of pods were calculated after harvest.

2.5.2 Number of seeds per plant. This activity was done also after harvest, by calculating the seeds resulted from sampled plant in the sampled plot.

2.5.3 Seed weight per plant. The observation was made also after harvest by weighing the seeds. The seeds weighed only the seeds with moisture content 14% after being dried for 2-3 days.

2.5.4 Dry seed yield. It was calculated by weighing all seeds obtained from sampled plot 120 cm x 60 cm which have been dried for 2-3 days to reach moisture content 14%.

3. Results and discussion

The results of the research were given in Table 1. It has shown that the application of different mulch gave nonsignificant results to all variables observed, while the application different doses of mulch significantly increased number of pods per plant and dry seed yield.

Table 1. Average number of pods per plant, number of seeds per plant, seed weight per plant and dry seed yield of soybean crop treated with different mulch and different doses of mulch.

Treatments	Number of pods per plant	Number of seeds per plant	Seed weight per plant (g)	Dry seed yield (g m ⁻²)
Mulch types				
siam weed	31.33	57.33	13.17	306.53
Neem	33.33	66.83	14.70	352.88
mexican sunflower	29.58	53.50	12.69	302.09
Mulch doses (ton ha⁻¹)				
0	27.78 a	53.44	11.56	265.02 a
8	28.67 ab	56.11	12.68	301.35 ab
16	34.11 bc	58.80	14.45	346.36 ab
24	35.11 c	68.56	15.38	369.29 b

Mean values in the same columns followed by the same letters do not differ significantly as determined by Duncan's New Multiple Range Test ($\alpha = 0.05$)

3.1. Number of pods per plant

The results of analysis of variance exhibited that the application of different mulches had no difference in all variables observed. However, the application of different mulch gave significant result to number of pods per plant (Table 1). From these results, it indicated that the differences in morphology of plant leaves did not have effect on the weeds and crop, while the number of pods was increased as the dose of mulch increased. This is an evident that an improvement of mulch doses has controlled the weeds respectively. It occurred due to lower sunlight entering the ground which taken by the weeds. This phenomenon has proven that there was no competition between weeds and soybean crop, which would positively contributed to the growth and development of crop and also its yield, particularly in

an increase of pod number. This finding is in line with the results of [9] and [10]. They investigated that the application significantly improved the number of pods.

3.2. Number of seeds per plant

The results illustrated that the application of different mulches was also non significant to the number of seeds per plant (Table 1). It showed that the differences in plant morphology had no correlation with weed control and also the number of seeds. However, the number of seeds tend to increase as the dose is increasing. [6] informed that mulch helps minimizing and preventing the growth of weeds. Equal application of mulch in high dose on the ground surface would reduce the space for weeds to grow and reduce the chance of the weeds to interfere sunlight [11].

3.3. Seed weight per plant

The results also illustrated that the types and doses of mulch had no effect to seed weight. It showed that there was correlation between the other components of yield crop, especially number of pods and number of seeds with seed weight. Several previous researches exhibited that there was correlation between components observed [12].

3.4. Dry seed yield

The application of mulch types did not affect the dry seed yield, but neem mulch showed an increase in the yield. This may due to neem has slow decomposition of leaves biomass. Consequently, it has covered entire ground surface and has retained the soil moisture. Higher doses resulted in higher yield. This higher yield attributed by higher result of a variable observed, such as number of pods per plant. [13] and [14] explained that the number of pods per plant described in photosynthate partitioning between photosynthate apparatus and photosynthate allocation during plant growth and development, which linked to dry seed yield. [7], [15] and [4] also added that the application of high dose of mulch has disrupted weed growth, shown by an increase of dry seed yield.

4. Conclusions

Mulch type did not affect the number of pods per plant, number of seeds per plant, seed weight per plant, and dry seed yield. However, mulch doses gave significant results to the number of pods per plant and dry seed yield. The application of mulch with doses 16-24 tons ha⁻¹ can increase the number of pods per plant and dry seed yield. Further research needs to be carried out on the application of several types and doses of other organic mulch to the growth of weeds, growth and yield of soybean plants.

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