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The Impact of Eco Enzymes on Generative and Vegetative Development in Various Mutant Lines of Kipas Merah Soybean (Glycine max (L) Merr.)

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Abstract.
Background. A native Acehnese soybean variety that is suited to the Aceh agroecosystem is the Kipas Merah variety. By creating drainage ditches to prevent flooding during rainy seasons, Var. Kipas Merah can be planted in rice fields either after the rice harvest or at the end of the rainy season, utilizing a no-till planting technique.
Aims. The research aims to find the effect of eco enzyme application on several 7^{th}-generation Kipas Merah soybean mutant lines on vegetative and generative growth.
Methods. From April to October 2023, the study will be conducted in the experimental garden of Syiah Kuala University's Faculty of Agriculture. A randomized full block design with three replications and a 3 x 4 factorial pattern was employed in the investigation. The three levels of eco enzyme (K) concentration (K0, K1, and K2) as well as the genotype of Kipas Merah mutant soybeans (Kipas Merah, A1, A7, and A11) were the factors under investigation.
Result. The findings demonstrated that the Kipas Merah soybean variety significantly impacted plant height and that the concentration of 10 ml L-1 was superior to other treatments. However, the A11 mutant produced superior outcomes.
Conclusion. The combination of eco enzyme concentration and mutant lines with better values was found in 10 ml L^{-1} and A_{11}.

Keywords: eco enzymes, kipas merah soybean, mutant lines

INTRODUCTION

The Kipas Merah variety is a local Acehnese soybean variety that is adaptive to the Aceh agroecosystem. Var. Kipas Merah can be planted in rice fields after the rice harvest or at the end of the rainy season, using a no-till planting method by making drainage ditches so that they are not easily flooded when it rains. This variety of soybean also has a very specific advantage, namely that the pods do not break easily even when the harvest is old enough, even when the leaves have fallen off, so that yield losses in the field can be reduced to a minimum (BPSBTPH, 2022).

To preserve the positive characteristics of local varieties and add economic value, it is necessary to carry out plant breeding to fix weaknesses without changing other characteristics that are already preferred (Sobrizal, 2016). The use of radiation techniques for plant breeding activities has been widely carried out, especially at the National Nuclear Energy Agency, to produce new superior varieties (Harsanti and Yulidar, 2016). Zuyasna et al., (2022) The first generation of Kipas Merah soybeans produced positive changes in mutant plants resulting from various levels of irradiation, namely the presence of plants that had a greater number of leaves and an increase in the number of productive branches that were strong and sturdy. Increasing the number of leaves will result in a higher photosynthesis process. Of course, this character is very profitable besides being able to improve plant characteristics, if it continues to be maintained until the final generation of selection it will have the potential to produce higher soybean production.

Maulina (2022) said The 7th generation of Kipas Merah soybean mutant lines A_1 and A_{11} exhibited improved metrics, including a greater number of productive branches, pods, seeds, seed weight, and yield potential. The A_{11} mutant line also demonstrated the highest plant height. Harsanti and Yulidar (2016), Various superior varieties developed through mutation techniques have played a significant role in boosting the production of agricultural commodities in Indonesia. Kementerian Pertanian (2016) Additionally, utilizing high-quality superior varieties, ensuring water availability, proper fertilization, pest management, and effective drainage are key factors in enhancing soybean production.

In order for optimal plant growth and production, fertilization needs to be given in plant maintenance efforts.. Fertilization can be provided using organic fertilizer and inorganic fertilizer (Amir et al., 2021). Organic fertilizer is derived from plant residues, animal waste or parts, and other organic materials that have undergone processing. It can be found in solid or liquid forms and may be enhanced with minerals and microbes. This type of fertilizer is beneficial for boosting the nutrient content and organic matter in the soil, as well as improving its physical, chemical, and biological properties (Peraturan Menteri Pertanian, 2011).

Eco enzymes are one of the materials categorized as liquid organic fertilizer (Dondo et al., 2023). Eco Enzyme is the result of the fermentation of organic materials (such as fruit and vegetable waste), sugar and water in a ratio of 3:1:10 (Widyastuti et al., 2022). Illahi et al.,

(2023) Eco enzymes have NPK content based on each test of the fruit peel used. Eco enzymes in papaya fruit skin contain 0.15% N, while dragon skin and pineapple contain 0.06%. The test results for the P content in the ecoenzyme made from dragon fruit peel were 11.45 mg P2O5/100g, in papaya peel it was 2.29 mg P2O5/100g and pineapple peel was 5.73 mg P2O5/100g. Then, in testing the K nutrient, the results showed that pineapple skin was 26.26 mg K2O/100g, dragon fruit skin was 25.53 mg K2O/100g and papaya papaya skin was 10.83 mg K2O/100g.

Sahid (2023) Eco enzymes made from banana peel have a C-Organic content of 3.03%, pH 3.3, total N 5.27% and K 0.56%. Meanwhile, eco enzymes made from a mixture of banana, papaya and pineapple waste have the best total P content with results of more than 2.29 ppm. Salsabila and Winarsih (2023) The organic material contained in eco enzymes can bind organic C in the soil so that NPK nutrients are available during the process of plant growth and productivity. In the vegetative growth phase of plants, nitrogen elements play an important role, namely forming photosynthate, the process of cell elongation and tissue thickening.

Soverda et al., (2023) The application of eco enzymes made from a mixture of fruit peels (banana, pineapple, watermelon, papaya, orange, mango), spinach, kale, lemongrass, pandan leaves, and moringa leaves at various concentrations (0 ml L^{-1}, 10 ml L^{-1}, 15 ml L^{-1}, 20 ml L^{-1}, and 25 ml L^{-1}) showed a significant effect on plant height, number of pods, number of filled pods, number of primary branches, weight of 100 seeds, and yield per hectare on Anjasmoro soybean plants. The concentration that most positively impacts growth and yield is 20 ml L^{-1}. Additionally, applying eco enzymes made from pineapple and orange peels to edamame soybeans enhances productivity, with a 1:100 dilution being the most effective treatment.

Based on this, it is necessary to test the application of eco enzymes with various concentrations (0 ml L^{-1}, 10 ml L^{-1}, and 20 ml L^{-1}) on the vegetative and generative growth of soybean plants of several 7th-generation Kipas Merah soybean mutant lines, namely A_1, A_7, and A_{11}.

METHODS

From April to October 2023, the study will be conducted in the experimental garden of Syiah Kuala University's Faculty of Agriculture. Polybags, labels, meters, scissors, knives, analytical scales, measuring cups, hand sprayers, gloves, buckets, grass cords, nameplates, hoes, stationery, soybean seeds of the Kipas Merah variety and three soybean mutant lines of the 7th generation Kipas Merah—a total of 81 seeds per line required—a mixture of soil and manure, eco enzymes (made from waste of pineapple skin, papaya, melon, watermelon, manggo, banana, and orange), 50% methomyl insecticide, 3% corbufuran insecticide, 98% Dazomet fungicide, and NPK fertilizer are the tools and materials used in this study.

Research Methods

A randomized full block design with three replications and a 3 x 4 factorial pattern was employed in the investigation. There were three plants in each experimental unit, for a total of 108 plants. Eco enzyme concentration (K0 = no eco enzyme, K1 = 10 ml L^{-1}, K2 = 20 ml L^{-1}) and soybean mutant lines (var. Kipas Merah, A1, A7, and A11) were the two variables that were examined. Anova is used to analyze data and determine whether the results of the F test indicate a significant effect. The Least Significant Difference (LSD) test is then used to further assess the differences between the treatment means at a significance threshold of 5%.

Research Implementation

Preparation of the research location was carried out by cleaning the research area from weeds. Soil and manure with a ratio of 2:1 are used as planting media in this study. The soil and manure are mixed together and then sterilized with the fungicide Dazomet 98%. For every 1 ton of soil, 100 g of Dazomet 98% fungicide was given (Halimursyadah et al., 2022). The fungicide was mixed into the planting medium and covered tightly for 2 weeks, and then put into polybags containing ± 10 kg

The seeds used in this research were seeds of good quality and healthy, yellowish in color, dense and smooth-skinned, planted in planting media containing sterilized soil and manure. Before planting, the planting medium is irrigated to moisten the planting medium. Soybean seeds are planted with a distance of 40 cm x 30 cm. Each hole is planted with 2 seeds at a depth of 2 cm.

Once a week, soybean plants were given a 10% eco enzyme solution of 200 ml per polybag, for five weeks. The eco enzyme solution was made by dissolving 10 ml of eco enzyme in 990 ml of water. Base fertilizer was given NPK (16:16:16) of 2 g per polybag at the age of 2 weeks after planting. Pest and disease control was carried out mechanically and chemically every week.

Until the plants reach the generative phase, weeds are strictly controlled. When plants exhibit signs of disease, chemical pest management is used. In the event of an insect or caterpillar attack, plants are treated with Lannate 25 WP, which contains 25% methomyl, at a concentration of 2 g per liter of water. Plant height at 2, 4, 6, 8, and 10 weeks after planting (WAP), the total number of pods, the number of filled pods, the seed weight per plant, and the percentage of full pods are among the observation metrics.

DISCUSSION

Weeds are kept under rigorous control until the plants enter the generative phase. Chemical pest control is employed when plants show symptoms of disease. Plants are treated with Lannate 25 WP, which contains 25% methomyl, at a dosage of 2 g per liter of water in case they are attacked by insects or caterpillars. Observation measures include plant height at 2, 4, 6, 8, and 10 weeks after planting (WAP), number of pods, number of filled pods, seed weight per plant, and percentage of full pods.

Wasito and Lubis (2023) The N nutrient element increased, as seen by the results of soil nutrient tests conducted using the spectrophotometer method. Prior to the eco enzyme's administration, the N nutrient content was 0.14%, but following its application, it was 0.18%. In 2019, Fathin et al. For plant vegetative growth, including plant height, nitrogen is a useful ingredient. Lubis and associates (2022) When eco enzymes were applied to edamame soybeans, the plant height achieved better results of 31–32 cm as opposed to 26.7 cm, which was the plant height from the commercial description. The reason for this is that, although eco enzymes do not actually affect plant height statistically, their performance can raise plant height. This is believed to be the result of eco enzymes' yet comparatively low nutritional content. Sulistyowati and associates (2015) Different plant heights are one of the vegetative development results that can be obtained by using different genotypes or varieties that grow in the same environment. It is believed that these variations in results from each genotype are caused by genetic variances.

The average number of branches aged 10 WAP tends to be higher in the Kipas Merah parent (9.11) when eco enzyme concentration (K0) is not applied, as Table 2 demonstrates. This is considerably different from the A7 (G2) mutant line, but not statistically different from the mutant A1 and A11. The average number of branches aged 10 WAP in the A11 (G3) mutant line is substantially different from that of the A7 (G2) and the parent (G0) when the eco enzyme concentration is 10 ml L-1 (K1). The average number of branches aged 10 WAP in the Kipas Merah (G0) soybean parent differs significantly from the A7 (G2) mutant line when an eco enzyme concentration of 20 ml L-1 (K2) is applied. The A11 (G3) mutant line, which produced an average of 10.11 branches at an eco enzyme concentration of 10 ml L-1 (K1), was the finest example of the relationship between eco enzyme concentration and the Kipas Merah soybean mutant line (Fig. 1).

Table 1. Average height of soybeans at 6, 8 and 10 WAP due to the aplication of eco enzyme concentration in several mutant lines of Kipas Merah soybeans

Treatment	Plant Height (cm)		
	6 WAP	**8 WAP**	**10 WAP**
Eco enzyme Concentration			
K_0 (0 eco enzyme)	63.01	73.11	77.01
K_1 (10 ml L^{-1})	66.68	77.08	80.99
K_2 (20 ml L^{-1})	65,86	76.14	80.21
Soybean Mutant Lines			
G_0 (parent)	60.67a	71.74a	75.71a
G_1 (A_1)	60.20a	69.89a	74.20a
G_2 (A_7)	76.54b	87.418b	90.05b
G_3 (A_{11})	63.33a	72.74a	77.65a
LSD 0.05	**4.16**	**4.15**	**4.40**

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% LSD level.

Table 2. The average number of soybean branches at 10 WAP due to the interaction effect of ecoenzyme concentration and the Kipas Merah soybean mutant line

Kipas Merah Soybean Mutant Line	Eco enzym Concentration		
	K_0 (0 eco enzym)	**K_1 (10 ml L^{-1})**	**K_2 (20 ml L^{-1})**
G_0 (Parent = Kipas Merah)	9.11Ba	7.78Aa	9.78Bb
G_1 (A_1)	8.33ABa	9.67Ba	8.56Ba
G_2 (A_7)	6.89Aa	6.33Aa	5.45Aa
G_3 (A_{11})	8.67Ba	10.11Ba	9.44Ba
LSD 0.05		**1.59**	

Note: Numbers followed by the same letter (uppercase letters vertically and lowercase letters horizontally) do not differ significantly at the 5% level (LSD 0.05).

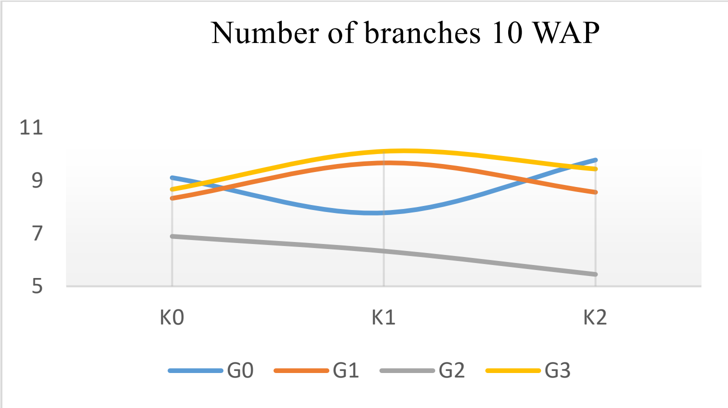

Fig.1. Graph of interaction between eco enzyme concentration treatment and Kipas Merah soybean mutant line on the number of branches at 10 WAP

In 2023, Soverda et al. When different concentrations of eco enzymes are administered to the soil and plants, the primary and productive branches of soybean plants are affected in comparison to when eco enzymes are not applied. The nitrogen nutrients present are thought to be able to enhance the number of shoots, stems, and leaves. The more branches there are, the more leaves there will be, improving the activity of the photosynthesis process. Photosynthate will proliferate in these circumstances and be carried to the branch to fill the pods.

Table 3. Average number of pods per plant, number of pithy pods per plant and percentage of pithy pods per plant due to eco enzyme concentration in several mutant lines of Kipas Merah soybeans

Treatment	Number of Pods per Plant	Number of Pithy Pods	Percentage of Pithy Pods (%)
Eco enzym concentraion			
K_0 (0 ecoenzyme)	232.45a	39.31	16.91
K_1 (10 ml L^{-1})	258.96b	40.86	15.77
K_2 (20 ml L^{-1})	219.28a	35.96	16.40
LSD $_{0,05}$	**29.86**	-	-
Soybean Mutant lines			
G_0 (Parent = Kipas Merah)	241.26	34.86	14.45
G_1 (A_1)	246.41	44.50	18.06
G_2 (A_7)	220.00	34.93	15.88
G_3 (A_{11})	239.91	40.56	16.91

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% LSD level.

In contrast to the 20 ml L^{-1} concentration (K2) and the control without eco enzyme (K0), Table 3 demonstrates that the eco enzyme concentration of 10 ml L^{-1} (K1) produced the highest average number of pods (258.96 pods). Compared to the other mutant lines, the A1 (G1) mutant line produced a comparatively greater number of pods (246.41 pods), although this difference was not statistically significant. An eco enzyme concentration of 1:100 produced an average of 34.74 edamame soybean pods per sample, as opposed to 30.08 pods per sample without eco enzyme, according to a prior study by Lubis et al. (2022).

Table 3 demonstrates that, while not statistically significantly different from other concentrations, the average number of filled pods was higher for the eco enzyme concentration of 10 ml L^{-1} (K1). Similar to the other mutant lines, the A1 (G1) mutant line had a greater average number of full pods (44.50 pods), however this difference was likewise not statistically significant.

Although it was not statistically different from other concentrations, the average result for the percentage of pithy pods in the treatment without eco enzyme (K0) tended to be greater (16.91%). Statistically significantly different from other mutant lines, the average pithy pod percentage of the A1 (G1) mutant line tends to be greater (18.06%). While the number of pithy pods is correlated with the number of flowers that are fertilized and turn into seeds, the number of pods generated is directly correlated with the number of flowers formed. (Tambunan and others, 2022). One of the factors used to assess a soybean plant's capacity for production is the quantity of pithy pods it produces. Although not all pods produce pithy seeds, the number of pods that successfully form provides an estimate of the number of seeds generated by a single plant. Variations in plant genetics may be the true source of the variance in the number of pithy pods (Pandiangan et al., 2017). In addition, Waluyo (2018) asserts that environmental elements surrounding the plant growth environment have a significant impact on variations in the percentage of pithy pods. In 2014, Sarjan and Sab'I Since it will ultimately determine the plant's output, the seed filling phase of soybean plants is the most crucial stage. The pod sucker attack is one of the inhibiting elements in this period. Al Hadi and associates (2018) The pod ladybug (Ritorus linearis), which attacks during the seed development and pod formation phase, attacked during the pod filling process, resulting in deflated, dry, and empty pods and seeds. By sticking their stylets into the pod skin and directly into the seeds, ladybugs suck the pod juice, which results in poor pod growth and subpar harvest yields.

As the pods are filled, the plant will collect the nutrients from the soil for use in metabolism. When there are enough nutrients available, the metabolic process will be stimulated, producing dry material that the plant will then transform into seeds (Waluyo, 2018). According to Tambunan et al. (2022), soybeans need a lot of nutrients, particularly N, P, and

K. In soybean plants, increasing nitrogen can have an impact on the rate of phosphorus uptake and, consequently, the rate of seed filling. According to Rezyawaty et al. (2018), nitrogen and phosphorus have an impact on the quantity of full and empty soybean pods because they are involved in the filling process of soybean pods. Ardian and associates, 2024 Low photosynthesis brought on by a shortage of water may be the reason for the decline in the number of full pods. In soybeans, dryness during the reproductive season can impede the transfer of photosynthate into the seeds, lowering the weight of the seeds and the quantity of fruiting pods.

Table 4. Average number of seeds per plant, seed weight per plant and potential yield due to eco enzyme concentration in several mutant lines of Kipas Merah soybeans

Treatment	Number of Seeds per plant	Weight of seeds per plant (g)	Yield Potensial (ton ha^{-1})
Eco enzym concentraion			
K_0 (0 eco enzym)	80.03	8.16	0.95
K_1 (10 ml L^{-1})	84.08	8.45	0.99
K_2 (20 ml L^{-1})	73.33	7.71	0.90
Soybean Mutant lines			
G_0 (Parent = Kipas Merah)	69.67	7.24	0.85
G_1 (A_1)	87.07	8.96	1.04
G_2 (A_7)	72.15	7.30	0.85
G_3 (A_{11})	87.70	8.92	1.04

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% level (LSD $_{0.05}$)

Variations in air temperature can have an impact on soybean plants' ability to grow and survive. In the dry season, when the air temperature is between 20 and 30 degrees Celsius, soybean plants will grow to their full potential and yield high-quality seeds (Taufiq and Sundari, 2012). Sundari and Taufiq (2012) The ideal temperature ranges for the flowering and ripening phases are 20–24°C and 15–22°C, respectively. Jumakir and Nugroho (2020) The temperature above 27 degrees Celsius is not ideal for the rate at which seeds fill and mature, which leads to less-than-ideal seed quality. According to BPS data, the city of Banda Aceh experienced an average temperature of 28.80°C throughout the blossoming phase to pod filling in June and July, with an air temperature of 36.20°C during this time. Temperature is therefore thought to have an impact on the pithy pods of soybean plants and to play a role in the pods filling into seeds.

While not statistically different from the other concentrations, Table 4 shows that the eco enzyme concentration of 10 ml L^{-1} (K1) produced a larger average number of seeds (84.08 seeds). When compared to the other mutant lines, the A11 (G3) mutant line tended to have a larger average seed count (87.70 seeds), but this difference was likewise not statistically significant.

The study's estimated soybean production falls between 0.85 and 1.04 tons ha-1, indicating that the prospective yield is often lower than the average yield of Kipas Merah soybeans (2.5 tons ha-1). Hariyono and Octavia (2022) The weight of seeds per plant can affect the amount of soybeans produced per hectare; the more seeds per plant, the greater the potential yield per hectare. Syaifudin and associates (2018) The amount of seeds in the soybean pods will vary depending on how full they are. The weight of the seeds increases with the number of seeds per plant. The weight of the soybean seeds during planting is correlated with the number of pods and shows the plant's capacity to use assimilate for seed filling. Susetyo and associates (2019) The interplay of environmental factors and genetic factors can impact the potential yield of soybeans in the field.

Table 5. Weekly climatic data during experiments at Lamahi, Dang, Nepal, 2018/19

Week	maximum temperature (°C)	minimum temperature (°C)	relative humidity (%)	solar intensity (mJ m^{-2})	wind velocity (m s^{-1})	total rainfall (mm day^{-1})
1	28.42	17.32	51.27	29.33	1.29	0.06
2	26.07	15.34	55.81	27.8	1.29	0
3	25.62	14.41	55.03	28.11	1.67	0.19
4	24.84	13.98	53.18	27.02	1.26	0
5	25	14.87	54.94	27.8	1.14	0
6	23	12.71	53.76	25.96	1.22	0
7	22.55	11.48	47.66	25.99	1.32	0.03
8	21.94	10.21	44.72	24.75	1.18	0
9	20.49	8.65	40.12	23.05	1.4	0
10	21.25	9.26	42.1	24.97	1.39	1.09
11	21.04	9.76	49.44	25.68	1.38	1.83
12	22.48	10.08	40.4	25.39	1.4	0
13	21.25	11.11	58.67	28.58	1.5	28.86
14	20.48	7.62	47.04	24.23	1.67	0.02

Clear and succinct results are desired. Instead of offering data in great detail, the results should provide a summary of (scientific) findings. Please indicate how your findings or results differ from those of other researchers' earlier publications. Instead than restating the work's findings, the conversation ought to delve into their importance. It is frequently useful to combine the Results and Discussion sections. Steer clear of lengthy discussions of published literature and citations. It is the most crucial part of your essay when it comes to debate. You have the opportunity to sell your data here. Don't restate the results; instead, make the commentary relevant to the findings. should frequently start with a succinct synopsis of the primary scientific discoveries (not experimental outcomes). It is important to discuss the following elements: What relevance do your findings have to the initial query or goals stated in the Introduction section? Do you offer a scientific explanation of each of your findings or results, and if so, why? What else has been reported by other researchers that aligns with your findings? Or do things differ in any way?

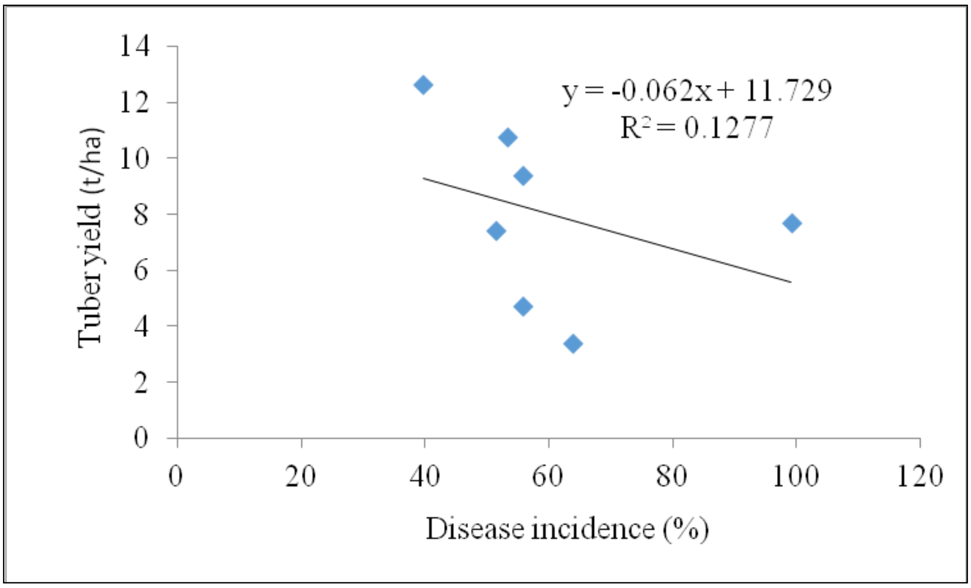

Figure 2. Estimated linear relationship between disease incidence and tuber yield (t ha^{-1}) of seven potato cultivars at Lamahi, Dang, Nepal, 2018/19

CONCLUSION

At a concentration of 10 ml L^{-1}, the eco enzyme concentration treatment had a substantial impact on the parameters pertaining to the number of productive branches and the number of pods per plant. Plant height, the number of branches at 6 and 8 MST, the number of productive branches, and the age of blooming were all considerably altered by the Kipas Merah soybean mutant line. The A11 soybean line outperformed the other mutant lines. Regarding the number of branches at 10 MST, a relationship between the eco enzyme concentration and the Kipas Merah soybean mutant line was noted. The A11 mutant line and an eco enzyme concentration of 10 ml L^{-1} produced the best results in this investigation.

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