



Refugia as an Environmentally Friendly Plant for Increasing Production and Income of Corn Farmers

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Abstract

The research was conducted at the Suka Maju Farmer Group, Molamahu Village, Pulubala District in March 2020. The research objective was to determine the types of Refugia plants, production yields and farmers' income. This research was traced using descriptive methods for the use of refugia plants and t test to analyze farmers' income. The results of the research on refugia plants were beneficial for farmers as natural enemies of pests and there was an increase in the income of the Suka Maju Farmer Group after using refugia as a natural enemy of pests. The yield of maize by farmers who apply refugia plants is higher (10.51 tonnes / ha) than those using conventional methods (6.67 tonnes / ha) and there is a difference in income between farmers using conventional methods and those applying refugia plants. The income yield of farmers using refugia plants was higher (Rp. 33,523,200) than those using conventional methods (Rp. 21,169,920).

Introduction

Sustainability Agricultural intensification and biodiversity conservation are the main challenges the agricultural sector is currently facing. Diversification of cropping systems has the potential to contribute to sustainable intensification that can conserve biodiversity (Meynard et al., 2018); Rosa-Schleich et al., 2019). One of the activities that can support biodiversity is the use of refugia plants as plants that can help the growth of maize plants. The refugia plant itself is a type of plant that is a natural enemy of pests that commonly attack corn plants. The availability of refugia plants planted around corn plants provides great benefits to maize plants as well as for biodiversity where the presence of refugia plants can support conservation activities as an option in maintaining agroecosystems on agricultural land, (Calzadilla et al., 2013) and (ALIFFAH et al., 2020)

Types of pests that often attack corn plants are seed flies (*Atherigona* sp.) Stem borer (*Ostrinia furnacalis*) Cob borer (*Helicoverpa armigera*) Grayak caterpillar (*Spodoptera litura*) Locusta migratoria) Aphids (*Aphis maidis*), of all These types of maize pests have their respective functions to eat away at the maize plant, which in turn does not meet expectations. So far, farmers to eradicate pests that attack corn plants have always used chemical pesticides. The use of chemical pesticides for farmers is considered faster and instant in handling and eradicating pests. However, with this practical understanding by the farmers it makes a big loss for farmers and environmental sustainability. The big loss for farmers from an economic perspective is the increase in production facilities for purchasing pesticides which are quite expensive and on the other hand, the use of fertilizers which is overused because the soil is degraded in fertility due to frequent spraying with pesticides along with fertilization which makes the soil saturated.

Another negative impact of pesticide use is a plant to be damaged, the plants do not grow normally, nutritional food contaminated with pesticides, less predatory natural enemies, emerging pest species is new, the high cost of treatment plants, and environmental conditions deteriorate as a result of application of synthetic chemicals that are not controlled, (Pearse and Rosenheim, 2020) (Singh et al., 2020) (Rani et al., 2020). Apart from having an impact on plant growth and an unfavorable environment for farmers, the use of pesticides on plants has high risk to human health (Sharma & Singhvi, 2017) (Kim et al., 2017), (Rosic et al., 2020), (Sankoh et al., 2016). The effects of pesticides on human health can be in the form of multiple myeloma, sarcoma, prostate and pancreatic cancer, uterine cancer, pancreas and Hodgkin's according to (Rusiecki et al., 2004), (Merhi et al., 2007).

Seeing the many negative effects of pesticide use on plants, the environment and human health, it is recommended that farmers use refugia as a natural enemy of predators and pests to suppress the population of plant pests (Rowen et al., 2020) (Altieri and Letourneau, 1982) (Towles, 2020). Refugia is a type of flowering plants such as sunflowers, kenikir, and paper flowers that are deliberately planted in rice fields or around plants to be cultivated. Refugia plants have striking colors, generally predominantly red, yellow and are easily cultivated plants as microhabitats and certain organisms. According to (Fauzia et al., no date) the striking color is able to attract pests and other types of animals to come perch and eat the juice of flowers and honey. In agricultural land ecosystems, the existence of good artificial microhabitat is on the edges or embankments in agricultural areas (Septiani and Aminah, 2021) (Yuantari et al., 2015) (Sam et al., 2008) The presence of microhabitat and various types of pests has an impact on the number of Arthropods in the maize ecosystem (Lu'ailey et al., 2013; Lailiyah & Haryadi, 2021). Apart from being a container of protection for natural enemies and predators that are beneficial to plants, refugia plants can also support conservation in maintaining agroecosystems on agricultural land. (Tadesse et al., 2014; Boinot et al., 2019; Karenina et al., 2020)

Efforts to use refugia plants in certain types of plants can help the economy of the farmers themselves because currently the types of plants that are managed without pesticides can be categorized as Organic crops and the selling price in the market is different from those that use pesticides. Modern society also understands and wants the fulfillment of food needs through natural processes without using pesticides with their main goal is to avoid various diseases caused by consuming food plants that use pesticides.

Molamahu Village, Pulubala Subdistrict, is aware of the market demand related to maize plants, namely plants cultivated with an organic system and what is equally important is maintenance that does not require money, only takes time and effort to control the plants every day. The main obstacle for the people of Molamahu village is limited funds in buying production facilities that support their crop production, so that with the existence of pest control technology using refugia plants, they are trying to make various solutions in producing their agricultural products without reducing the production of corn plants that are temporarily cultivated. (Sakir & Desinta, 2018). Choices Molamahu village farmers choose the cost of maize crops because of corn crops or (*Zea mays*) is an excellent commodity and food typical of the Gorontalo people themselves. According to the Agricultural Research and Development Agency (2016), apart from being a food source, corn also plays an important role in agribusiness-based industries because corn is a staple ingredient used in the food industry and for animal feed, besides that according to (Suarni et al., 2015; Suarni & Yasin, 2019) corn is

also a raw material for flour for making cakes, a raw material for cosmetics, which is used as a mask mixed with olive oil and honey (Nisa, 2017; Dardouk et al., 2019; Diaz et al., 2013).

Methods

Research was carried out in Molamahu Village, Pulubala District, Gorontalo District, Gorontalo Province in September 2020. Researchers took this location because in this village there is a group of corn farmer farmers who apply pest management technology with an environmentally friendly concept, namely using the Refugia plant. Sampling using purposive sampling method of 25 people from 27 farmer groups. The technique of collecting interview data (questionnaire), observation, and documentation and data analysis tools in this study used descriptive methods to present the research objectives. For the first purpose, the use of refugia plants is in the form of documentation and describes the refugia planting model in maize, while for the second purpose, testing the income and production of maize farmers using the paired t test. This test according to Sugiyono (2011) is used to test the comparative hypothesis of the average of two samples if the data is in the form of intervals or ratios. The t-test formula is used to test the comparative hypothesis of two correlated samples, namely.

$$\frac{X_1 - X_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2} - 2r \left(\frac{S_1}{\sqrt{n_1}} \right) \left(\frac{S_2}{\sqrt{n_2}} \right)}}$$

Results and Discussion

Types of Refugia Plants planted by Farmers

Molamahu Village is one of the villages in Pulubala District where the community cultivates corn plants. Previously, the cultivation of maize in this village used conventional methods where there were still many uses of chemicals, which then switched to the planting method using Refugia plants as environmentally friendly plants that can eradicate pests without using pesticides. The area of maize land in Molamahu Village is 938 hectares. Look picture A in the attachman.

The cultivation of maize by Molamahu village farmers has long been carried out using Refugia plants for pest control. Based on the research results, there are three types of Refugia plants cultivated by the Molamahu village community, namely 1). Types of sunflowers (*Helianthus Annuus* L) 2). Chicken droppings (*Tagetes Erecta* L) 3). Flower kenikir (*Cosmos caudatus*). The following is a picture of refugia plants used by farmers on the edge of corn plants.

Figure a shows the types of Refugia plants used by farmers to protect their crops from pests. In Figure a, the type of plant planted is the Refugia Chicken(DungTagetes Erecta L). Types of chicken dung (*Tagetes Erecta* L) were planted around (hedgerows) corn plants with a spacing of 1.5 m as well as the distance between refugia plants and 1.5 m maize plants. Furthermore, in figure b there are two types of refugia plants, namely sunflowers (*Helianthus Annuus* L) and 2). The flower of Kenikir (*Cosmos caudatus*) in Figure b, the refugia plant is planted between the waterways and about 1 m apart on the edge of the corn plant. The distance between refugia plants and corn plants is only a short distance away so that pests planning to attack corn plants will land first on refugia plants where there is already a food source for pests. If the refugia flower blooms, it produces pollen that can be consumed by insects and eventually the insects will also eat the eggs of the pests. According to (AF, Rosmawati and Jamdin, 2019), (Arsi et al., 2020) Refugia plants are a temporary shelter by pests to lay eggs in refugia flowers and

leave their eggs in refugia flowers and finally the eggs hatch and the children will eat the refugia flowers. and died from eating the poison of the refugia flower.

Production Results of corn plants using Refugia plants and those using conventional systems

Look table 1 in attachman Based on the results of the study, the production of maize using conventional methods with an average land area of 1 ha of production is 6.67 tonnes / ha. Meanwhile, maize production using the Refugia plant method with an average land area of 1 ha obtained a higher yield than conventional methods, namely 10.51 tonnes / ha. The results of the t test show that $t \text{ count } (15.87) > t \text{ table } (25; 0.05) (2.06)$ which shows a significant difference (significant at the 95% confidence level) between corn production before and after using the Refugia plant.

The high yield of maize using the refugia plant is influenced by several things ranging from seeds, natural maintenance, namely the use of refugia plants and no less important is the knowledge of farmers in cultivating land and corn plants. According to (Goulet, 2013), experience is knowledge that is formed in each farmer and continues to experience development throughout farming activities where they compare the success and failure of farming. Based on this experience, they then decided to maintain and cultivate corn or other crops to be developed. Molamahu village farmers use the method of maintaining maize plants using environmentally friendly technology, namely using Refugia plants (Barthel et al., 2013). The choice of Refugia plants by farmers because refugia plants have the advantages of being environmentally friendly, not using pesticides, less maintenance costs, available in nature. According to local farmers, according to their experience, the use of pesticides in eradicating pests is more disadvantageous because they have to spend money to buy pesticides which are of course in large capacities because they fit the land area (Affandi & Sinaga, 2014). Meanwhile, the price of pesticides is expensive and gives a lot of losses to soil fertility (Astaikyna et al., 2020). If the soil is less fertile, you have to buy more fertilizer (Rutgersson et al., 2020). The price of fertilizer for the use of 1 ha of land is costly (Sirappa & Razak, 2010). Based on this experience, they can compare planting refugia plants easier where it is available free in nature and only through cultivating Refugia plants using intensive measures that can help and protect their maize plants.

In the experience of sukamaju farmers, they also consider other experiences, namely paying attention to the planting season. The growing season is adjusted to the weather and farming experience. According to (Suharyanto, 2017) (Harta et al., 2019) the amount of production is related to farming experience. Long farming experience has enabled farmers to solve a problem in farming. Then (Herlina & Prasetyorini, 2020), (Hossain et al., 2019), (Soto et al., 2019), (Asare-Nuamah & Botchway, 2019), there are many natural problems that are difficult for farmers to avoid in farming, one of which is climate change, increase and decrease in temperature, instability of rain fall, and erratic tidal events. These problems can be avoided and minimized by farmers based on farming experience where they plant according to the growing season (Mokoginta & Indrianti, 2020) and seeing climatic conditions. These changes have an effect on the quality and quantity of yields of maize grown by farmers. So that the longer the farming experience of a farmer, the farmer is able to face a problem in farming.

Differences in Corn Revenue from Conventional Methods and the use of the Refugia plant

The difference in the average income of maize farmers using conventional methods and the use of Refugia plants was carried out using the paired t sample test. The conventional method itself is a pattern of maintenance carried out by farmers using pesticides in handling pests. From the

results of data analysis, the sig value <0.05 , the hypothesis that there is a difference in the average income received by farmers is presented in Table 2. From this table shows that there is a difference in the average income of maize farmers who apply conventional methods and the use of Refugia plants, where income using conventional methods is lower than those using Refugia plants with a land area of 1 ha.

See table 2 in attachman There is a difference in income because based on higher production yields and better quality of the maize produced, the maize is large in size and is not damaged by pests when compared to conventional methods. The t test results show that $t_{count} (15.821) > t_{table} (25; 0.05) (2.06)$ which means that H_1 is accepted. Thus, there is a significant difference (significant at the 95% confidence level) between the income of maize farmers using the Refugia plant and conventional methods.

This difference is also seen in the analysis of the R / C ratio. There is a difference in the value of the R / C ratio between the conventional method and the value of the R / C ratio that applies the Refugia plant where the yield using refugia plants is higher than the R / C ratio value using the conventional method. The R / C ratio of these two methods is more than one, but the use of refugia plants is 61% higher than the conventional method. The t test results show that $t_{count} (18.56) > t_{table} (25; 0.05) (2.06)$ which means that H_1 is accepted. Thus, there is a significant difference (significant at the 95% confidence level) between the R / C ratio after using refuge plants. See table 3 below in the attachman.

Are not excessive to finance farm production. Based on the results of data analysis, there is a clear difference in the production costs between conventional methods and the use of refugia plants where the average production cost of conventional methods is Rp. 4,598,480 and the use of Refugia plants of Rp. 3,659,000 which indicates that the production costs Molamahu village maize production using conventional methods and refugia plants got a difference where corn plants using refugia plants had higher income and abundant production compared to conventional methods. According to (Basuki et al., 2013; Supratikno & Setiadi, 2017; Mulaa et al., 2011) The factors that influence the high income of farmers who apply Refugia plants are related to the production costs that of conventional methods are greater than planting using refugia plants and using fertilizers using manure.

The difference in income is because the conventional method uses more plant fertilizers such as urea, foliar fertilizers, fruit fertilizers and pesticides, which are quite expensive. Unlike the refugia planting method, farmers do not spend a budget for fertilizer and pesticide spending because everything is readily available in nature such as the use of fertilizers, farmers prepare homemade manure whose raw material is livestock manure or household waste that can be decomposed and then mixed with soil (Supratikno & Setiadi, 2017).

Furthermore, by (Supratikno & Setiadi, 2017) the advantages of cultivating refugia plants compared to other methods are that Refugia plants are easily obtained in nature as well as the use of manure, which is much cheaper, and free, everything is available in nature so that farmers can reduce crop production costs. On the other hand, farmers use conventional methods using chemical fertilizers which are expensive. In addition to manure, the use of drugs containing pesticides to eradicate pests of plants is quite high price when it is used on the vast land that big, so the production costs for fertilizing, pest control conventional outweighs the cost of production

results of data analysis the researcher to 50 farmers each 25 farmers using refugia plants and manure to increase their maize production and 25 farmers using conventional methods, namely using chemical pesticides and fertilizers to increase the yield of their maize crops and the results

of the comparison are differences in production costs on the same land area, namely 1 ha each that is, for conventional methods or the use of chemical fertilizers and pesticide spraying, the average cost is Rp. 5,748,685. Meanwhile, farmers who apply refugia cultivation and use of manure require an average production cost of Rp. 3,626,570. According to Surya (2020) in his research, he also added that in farming, the Refugia planting method has a lower cost efficiency level than conventional farming.

Conclusion

The conclusion of the research namely: (1) There are three types of Refugia plants developed by the community of Molamahu village, namely Chicken(DungTagetes Erecta L), Sunflower (Helianthus Annuus L) and Kenikir Flower (Cosmos caudatus; (2) There are differences in maize production between farmers who use conventional methods and those who apply the Refugia plant method. The yields of maize by farmers who apply the refugia plant method are higher than those using conventional methods; (3) There is a difference in income between farmers who use conventional methods and those who apply the Refugia plant method. The income yields of farmers who apply the refugia plant method are higher than those using conventional methods.

Suggestion

The suggestion of the research: (1) The application of the refugia plant method to farmers is further enhanced through guidance, counseling and assistance; (2) Guidance to increase farmers 'knowledge in cultivating healthy plants, the costs of farming are incurred so that they can produce maximum production that affects farmers' income; (3) A government policy is needed to develop plant maintenance, both corn and other crops, using environmentally friendly methods.

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