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The Use of Insecticides Viewed from a Technical View of Applications in Corn Crops: Case Study of Corn Farmer Behavior

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Abstract: Synthetic insecticides are still used as the main solution in suppressing herbivorous insect attacks on maize at the farm level. The purpose of this research is to determine and find new ways farmers use insecticides wisely through a multi-aspect approach. The method used to determine the sample was purposive sampling with 50 corn farmers spread across five villages in the Tambulava sub-district. Primary data collection was obtained by observation through direct interviews with corn farmers using a prepared semi-structured questionnaire, and secondary data were obtained through a literature study and various sources related to research issues. Quantitative data were analyzed by simple tabulation (cross-tabulation analysis), while qualitative data were analyzed using an interpretation of existing phenomena. The results showed that four herbivorous insect species attacked corn plants in the Tanambulava District: *Spodoptera frugiperda*, *Helicoverva armigera*, *Ostrinia furnacalis*, and *Locusta* sp. Insecticide application time by local farmers is generally done in the morning by 90%, with application frequency varying 1-3 times a week. There are 13 active insecticide ingredients used by corn farmers in Tambulava District, Sigi Regency.

Keywords: Application; Corn farmers; Herbivore insect; Insecticides; *Zea mays*

Introduction

Corn *(Zea mayz L.)* is a commodity that has a vital role in improving the community's economy; the plant is the most adaptable and easy to grow in various agro-climatic environments (López-Arredondo et al., 2015; Debaeke et al., 2021; Seleiman et al., 2021). The ability of corn to grow in various seasons makes corn very good for cultivation in meeting the increasing demand for food (Suminah & Anantanyu, 2023; Erenstein et al., 2022). Based on data FAOSTAT 2020 Corn planting is carried out in 170 countries with an average production of 114.7 million tons, a planting area of 193.7 million ha, and an average productivity of 5.75 tons/ha. Corn is the second most important crop after rice, to fulfill needs such as food for humans, animal and poultry feed, processed food in starch extraction, corn syrup, and corn oil (Zhang et al., 2021; Jiao et al., 2022; Nowosad et al., 2023). Corn plants generally contain 72% starch, 10% protein, and 4% fat, with 365 Kcal/100g energy density (Mulyati et al., 2021; Rawal et al., 2023; Chang et al., 2023; Okwunodulu et al., 2023).

Tambulava is one of the districts in Sigi Regency, Central Sulawesi Province, with most people doing corn farming (BPS, 2020). Corn planting is inseparable from attacks by nematodes, birds, mites, rodents, and herbivorous insects (Hade et al., 2020; Hervani & Sari, 2022; Ndiaye et al., 2022). Herbivorous insects are one of the leading causes of crop yield loss (Raderschall et al., 2021; Orta et al., 2022) . According to ((Meilin & Rubiana, 2018; Majeed et al., 2022), intensive pesticide application can affect the diversity of herbivorous insects that live in an environment. In general, the actions taken by farmers in anticipation of losses due to damage caused by

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herbivorous insect attacks are the application of insecticides. One of the contributing factors, namely the behavior and actions of farmers who were still low in managing insecticides and understanding of the impacts arising from the application of these insecticides (Sternberg & Thomas, 2018; Istriningsih et al., 2022; Kaur et al., 2022; Urio et al., 2022).

This research was conducted to reveal several ways of using insecticides on corn plants in the Tambulava Region, and whether the use of insecticides is in accordance with prudent and environmentally friendly principles (Fenibo et al., 2022; Wisnujati et al., 2020). High insecticide dependence makes it difficult for farmers to avoid these pest poisons in managing their agricultural land (Damalas & Koutroubas, 2016; Nicolopoulou-Stamati et al., 2016; Hardiansyah et al., 2022; Lisdayani et al., 2022). Information regarding the use of insecticides in controlling herbivorous insect pests on corn plants from the results of this study is expected to support local government policy-making with farmers and pest observers in particular. Based on some of the descriptions above, it is important to understand the use of insecticides and how to manage them from a technical point of view of application to corn plants. The results of this study aim to find out and find new ways to use insecticides wisely by farmers with an approach to health, environment, and sustainability aspects.

Method

This research was carried out from Januari to December 2022 in the Tambulava District Area (North Sibalaya Village, West Sibalaya Village, Lambara Village, South Sibalaya Village, and Sibowi Village). Locations were determined by purposive sampling, considering that the five areas were corn planting centers in Sigi Regency. The research used a descriptive observational method, describing farmers' condition in using insecticides by controlling herbivorous insect attacks on corn plants. Respondents were determined using the Simple Random Sampling Method. The number of respondents taken was 50 farmers, considering that the sample size could represent the existing population (the condition of the population was homogeneous).

Primary data sources in this study were obtained using observation through direct interviews with corn farmers using a semi-structured questionnaire. Secondary data was obtained through literature study and various sources related to research issues, including reports of research results published as support in the preparation of research results. Quantitative data were analyzed using simple tabulation analysis (cross-tabulation analysis) to be interpreted Siregar et al., 2021. Qualitative data analysis was carried out employing an interpretation of existing phenomena (Adlini et al., 2022) . The focus of the analysis was the use of insecticides on corn plants.

Result and Discussion

Characteristics of Respondents

Table 1. Characteristics of respondents (farmers) of corn crops in Tambulava district

Characteristics	Categories	Total	%
Age (y.o)	15-25	2	4
	25-35	2	4
	>35	46	92
	Total	50	100
Farming experience (years)	< 10	6	12
	10-20	13	26
	21-30	15	30
	>30	16	32
	Total	50	100
Education level	Non-schooling	1	2
	Elementary school	7	14
	Junior high school	18	36
	Senior high school	21	42
	University	3	6
	Total	50	100
Methods of controlling plant Pest organisms	Pesticide	50	100
	Biologic	-	-
	No	-	-
	Total	50	100

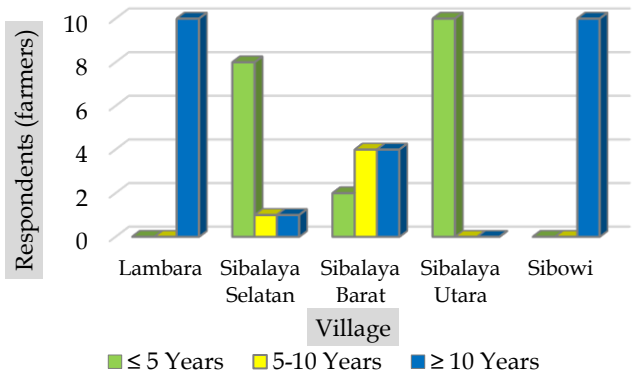

Figure 1. Farmers experiences in using insecticides

Based on Table 1, the results obtained were that of the 50 respondent farmers spread across five villages in the Tambulava District, Sigi Regency, the age of the farmers who mostly managed corn farming were in the productive age of > 35 years at 92%. Respondent farmers with the highest farming experience at the age of 30 years and over amounted to 32%, with the highest educational level of 42% graduating from high school.

Respondent farmers who carry out corn cultivation activities in controlling plant-disturbing organisms using pesticides were 100%. Herbivorous insects that attack maize plants in the Tambulava District include *Spodoptera frugiperda, Helicoverva armigera, Ostrinia furnacalis,* and *Locusta sp*.

Types of insecticides

Observations regarding the types of insecticides used by corn farmers in Tambulava District, Sigi Regency, are presented in Table 2. Based on the results of interviews, the types of insecticide active ingredients used by farmers from the five villages were not following the target pests. Each village uses various types of insecticides, with the highest number shown by corn farmers in Lambara Village, with seven types of insecticides, while in North Sibalaya Village, they only use 1 type.

Table 2. Types of Insecticides (active ingredients) used

Village	Types of insecticides (active ingredients)
North sibalaya village	Lambda cyhalothrin 25 g/l
West sibalaya village	Metomil 40%
	Propineb 70%
Lambara village	Chlorpyrifos : 200 g/l
	BPMC 480 g/l
	Diazinon 600 g/l
	Alphamethrin 15g/l
	D-allethrin : 0.26 %
	Cypermethrin: 50 g/l
	Lambda cyhalothrin 30g/l
South sibalaya village	Fipronil 50 g/l
	Cypermethrin 50%
	Chlorantraniliprole 50 g/l
	Fenvalerate : 200 g/l
Sibowi village	Metomil 40%
	Chlorpyrifos 540 g/l
	Cypermethrin: 50 g/l
	BPMC 500g/l
	Alphamethrin 15g/l

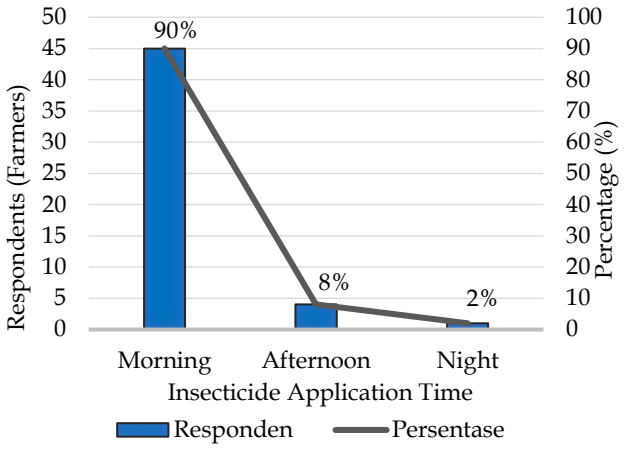

Figure 2. Time of application insecticides

Respondent farmers who applied insecticides according to the dosage listed on the packaging labels (Figure 3), are shown by corn farmers from Lambara and Sibalaya Village (100%). Meanwhile, corn farmers in South Sibalaya Village (20%), North Sibalaya Village (10%) and Sibowi Village (30%), and applied pesticides not according to the stated dosage. Based on PHT, insecticide applications must be safe for human health and the environment, so the application must comply with the instructions on the packaging label (Gunawan et al., 2023; Arsi et al., 2022; Effendi et al., 2020).

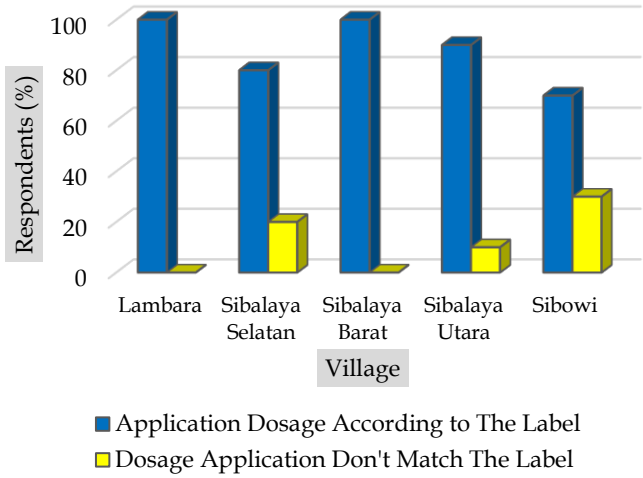

Figure 3. Percentage of Respondents who used insecticide according to the dose and not according to the packaging label

The use of insecticides by corn farmers is increasing daily, but an increase does not match this in farmers' understanding of using insecticides. From 50 respondents, 60% of corn farmers applied insecticides 1-3 times a week, 14% without rules, and 26% applied ≥ 3 times a week (Figure 4).

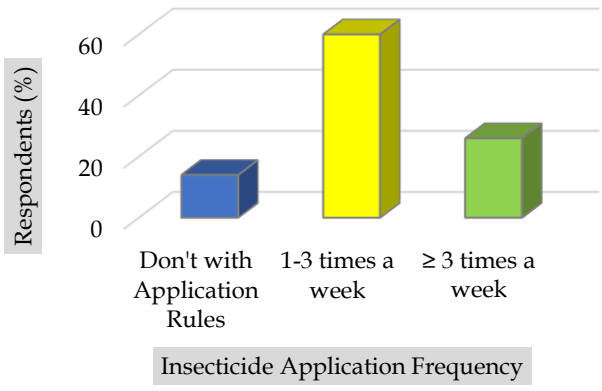

Figure 4. Frequency of insecticide application of corn crops in Tambulava district

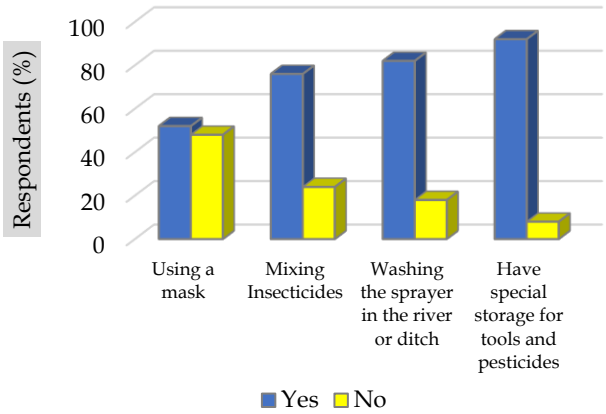

Figure 5. Farmers actions when applying insecticides in terms of environmental and health aspects.

The actions of farmers in using insecticides in terms of health and environmental aspects are still very far from the principles of IPM (Radityo et al., 2023; Widiarta et al., 2021; Azhari et al., 2021). The results showed from the health aspect of farmers in the application of insecticides 52% use masks, still practice mixing insecticides (76%), washing spray equipment in rivers or ditches (82%) and from a security perspective, as many as 92% of farmers have storage areas for insecticides and the tools used (Figure 5).

External factors

Table 3. External factors in the use of insecticides

External factors	Category	n	%
Agricultural extension	1-4 times per year	18	36.00
	5-8 times per year	1	2.00
	9-12 times per year	22	44.00
	Never	9	18.00
	Total	50	100.00
SLPHT	Ever (1-2 times)	28	56.00
	Never	22	44.00
	Total	50	100.00

Source: Primary data after being processed by the author, 2022

The results showed that the experience of corn farmers in using synthetic insecticides in West Sibalaya Village varied greatly from 5-10 years and ≥ 10 years, while Lambara and Sibowi Villages had experience using pesticides ≥ 10 years. North Sibalaya Village showed experience using insecticides ≤ 5 years (Figure 1). This is because, in this area, they just started cultivating corn after the earthquake and liquefaction that occurred in 2018 (Basir-Cyio et al., 2021; Nurdin et al., 2022; Rofi & Pancarini, 2023). This incident caused irrigation to be cut off, and farmers switched from planting rice to corn (Sun et al., 2022).

In general, corn farmers in 5 villages of Tanambulava District applied insecticides (Figure 2) in the morning by 90%, in the afternoon by 8%, and 2% at night. According to (Hasmari et al., 2022; Septariani et al., 2019; Mberulata et al., 2022; Naftaly et al., 2024), to obtain the effectiveness of using insecticides, it should be done in the afternoon because herbivorous insects tend to be active at that time until the evening. Insecticide application in the morning is expected to be able to control herbivorous insects effectively because it corresponds to the time of insect activity (Salsabilla et al., 2023; Pratiwi et al., 2023; Siswanti et al., 2022; Masturina et al., 2022).

The use of pesticides is carried out on a scheduled basis by farmers who generally use it 1 to 3 times a week (60%), even as many as 26% do it more than three times a week without prior monitoring. The frequency of insecticide applications can reach 3-5 times a week using more than two types of insecticides and can even reach seven types of insecticides (Matowo et al., 2020; Pisa et al., 2021; Horgan & Peñalver-Cruz, 2022). The increase in the total concentration can be up to 150 -200% higher than the recommended level by mixing two or three types of insecticides at one time of application (Meijer et al., 2021; Lu et al., 2021; Aslantas et al., 2023).

The use of insecticides that are not regulated and scheduled shows farmers' anxiety about the agricultural products they are trying to produce. Herbivorous insect attacks that often occur in corn plantations cause farmers to use pesticide applications on a scheduled basis. The actions of farmers who were not appropriate in using pesticides were not only caused by farmers' lack of knowledge but also because of the anxiety factor of crop failure if they did not use pesticides (Tang et al., 2021; Versari et al., 2021).

Conclusion

Corn farmers in the Tambulava district area use 100% synthetic insecticides to control herbivorous insect attacks. Insecticide application time by local farmers is generally done in the morning by 90%, with application frequency varying 1-3 times a week. There are 13 active insecticide ingredients used by corn farmers in Tambulava District, Sigi Regency.

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Author Contributions

Conceptualization and design of research work A; R; implementation of field/laboratory experiments and data collection A; R; S.S.; data analysis and interpretation A; S.S.; manuscript preparation S.S; M. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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