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Incidence and Severity of Chili Leaf Curl Complex in Southeast Minahasa District

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Abstract : Assessment of the incidence and severity of plant pests and diseases is one of the important factors in implementing integrated pest control. This study aims to determine the pests of chili plants involved in the Chili Leaf Curly Complex (CLCC) to calculate the incidence and severity of CLCC in Southeast Minahasa District. Incidence and severity monitoring surveys were carried out in the Sub-districts of South Touluaan, Ratatotok, East Ratahan and the combination of East Tombatu and Pasan. Three areas (villages) were selected from each sub-district, and two chili gardens were selected per area by purposive sampling. Incidence surveys were carried out on all sample gardens, and for severity only one sample garden per area. Sampling in each garden was carried out on five plots (each near the corners of the garden and one plot in the middle of the garden). The number of sample units is 20% of the number of plants per garden. Plant pests involved in CLCC are *Myzuz persicae* and *Aleurodicus dispersus* as vectors of viruses and viruses. The mean range of incidence and severity of CLCC in Southeast Minahasa District were 64.68 - 95.99 % and 51.64 - 96.62 %, respectively. The varieties of white, green and purple chili cultivated in this district are susceptible to curly mosaic virus attack.
Key-words : Chili leaf curl complex, incidence, severity, *Myzus persicae*, *Aleurodicus dispersus*, curly mosaic virus.

1. Introduction

Chili production in Minahasa in recent years has decreased due to several reasons, especially pests and diseases which are the main constraints on chili production. According to[1], CLCC is a major problem in Sri Lanka because it can result in yield losses of more than 50%. This disease complex is associated with four pests, namely thrips, whiteflies, aphids and mites, and several viruses. The author's observations between 2011 and early 2012 prove that CLCC can also cause yield losses of more than 50% in most chili plantations in Minahasa. The incidence and severity of CLCC in some chili plantations can reach 100%.

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Key steps to implement integrated pest management (IPM): (1) correct pest identification, (2) understanding pest and plant dynamics, (3) planning preventive strategies, (4) monitoring, (5) decision making, (6) selection of optimal pest control tactics, (7) implementation, and (8) evaluation. The scope of monitoring includes periodic assessment of pests and pathogens, natural control factors, plant characteristics, and environmental factors for control purposes and the effectiveness of several management actions[2,3].

The most common disease assessment method is by measuring the intensity of the disease. This measurement refers to the incidence and severity of disease in a plant. Incidence of disease is usually used to assess systemic type of infection, eg wilt or viral disease, or when diseased plant or plant parts result in total loss. Disease incidence can be measured as the proportion of diseased plant communities, while disease severity is the proportion of affected plant areas[4]. The calculation of the incidence and severity of pests is carried out in the same way as in calculating the incidence of disease severity. According to[5] that the incidence of each pest or disease is expressed as a proportion of the total sample plants that have been infested by pests and pathogens, and the severity of each pest and pathogen is visually scored on each plant sample: (1) no present, (2) low, (3) moderate, and (4) severe.

Exceptions were made to thrips and whiteflies that cause damage to chili leaves known as CLCC where these 2 pests act as virus vectors, and the damage caused by viruses is more significant than the number of individual insects. CLCC damage was estimated based on the number of leaves showing leaf curl symptoms, but excluding leaves on new flush[1]. This study aims to assess the recent incidence and severity of CLCC in Southeast Minahasa District.

2. Experimental

The CLCC incidence and severity survey was conducted in the administrative area of Southeast Minahasa District. Photos of pests included in the CLCC were taken at the Entomology and Plant Pests Lab, Faculty of Agriculture, Unsrat. This survey was conducted for one month.

The disease incidence survey was conducted in the Sub-districts of South Touluaan, East Tombatu combined with Pasan, Ratahan Timur, and Ratatotok (Figure 1). Three areas (villages) were selected from each of these areas, then two chili gardens were selected per area. The selection of sampling gardens in each area was carried out by purposive sampling.

Figure 1. Location of the Incidence and Severity Survey of Chili Pests and Diseases in Southeast Minahasa District ( )

Sampling in each chili garden was carried out on five plots (one plot near the corner of the garden and one plot in the middle of the garden). The number of sample units (individual plants) per plot depends on the number of plants in the sample garden, the standard sample size is 20% of the number of plants[6,3].

The formula for measuring the incidence of CLCC was as follows:

$$IP/D = \frac{n}{N} \times 100\%$$

I = Incidence of CLCC
n = Number of infected plants
N = Total number of plants in the garden

The CLCC severity survey uses a strategy similar to the incidence of disease, except for the number of gardens per area, which is only one garden. The category of damage used is according to the formula proposed by[1]. This formula is specifically used for combined damage by *M. persicae, Aleurodicus dispersus* and viruses.

The measurement formula is:

$$S = \frac{\sum (v \times n)}{N \times Z} \times 100\%$$

S = Severity of CLCC
v = Numerical value of each damage category (Table 1)
n = Number of individual chilies in a category of damage
N = Total number of individual chilies observed
Z = The highest number of scales or categories of damage

Table 1. Categories and descriptions of damage by *M. persicae, A. dispersus* and CMV (CLCC)

Category of Damage	Description of Damage
0	Healthy
1	10% of the canopy shows symptoms of infection
2	11 – 40 % of the canopy shows symptoms of infection
3	41 – 70 % % of the canopy shows symptoms of infection
4	> 75 % of the canopy shows symptoms of infection

Damage categories and descriptions of damage are presented in Figure 2

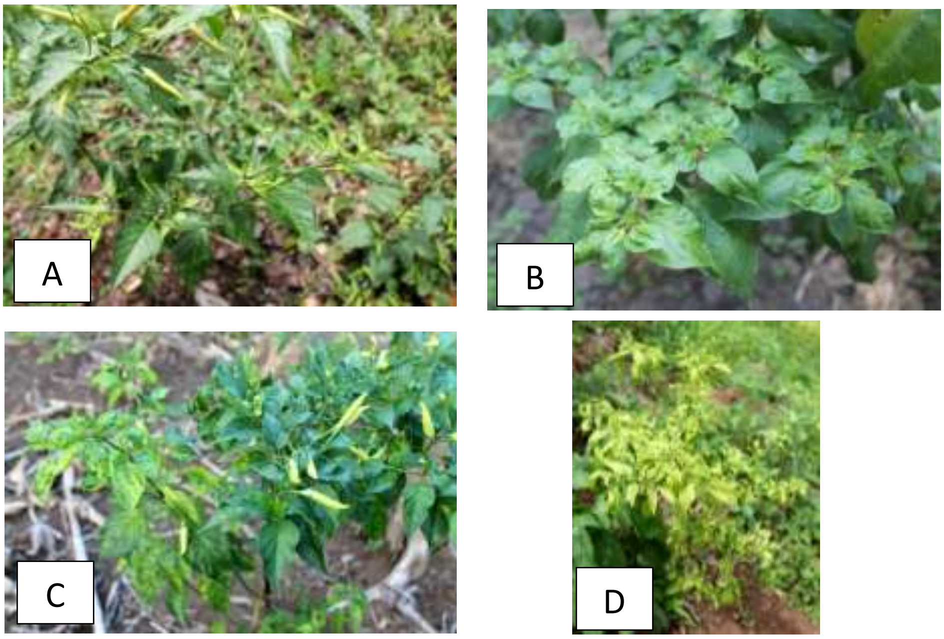

Figure 2. Category of damage. A. 1: 10% of the canopy shows symptoms of infection, B. 2:11 - 40% of the canopy shows symptoms of infection, C. 3: 41 - 70% of the canopy shows symptoms of infection, and D. 4: > 75% of the canopy shows symptoms of infection

Data on the incidence and severity of disease per region (sub-district) were described based on quantitative analysis.

3. Results and Discussion

a. Incidence of Chilli Leaf Curly Complex

The results of the CLCC incidence survey in several areas in Minahasa Regency can be seen in Table 2. The data in Table 2 shows that CLCC has spread throughout the Southeast Minahasa District (Figure 3A, B, C, D) with an average incidence ranging from 64.68% - 95.99%. Almost all chili plantations in Southeast Minahasa District contained *M. persicae* (Figure 4A) and *A. dispersus* (Figure 4B), while *B. tabaci* was not found.

Table 2. Average incidence of CLCC in several sub-districts in Southeast Minahasa District

Sub-districts	Average Disease Incidence (%)
Touluaan Selatan	64,68
Ratatotok	73,09
Tombatu Timur dan Pasan	90,59
Ratahan Timur	95,99

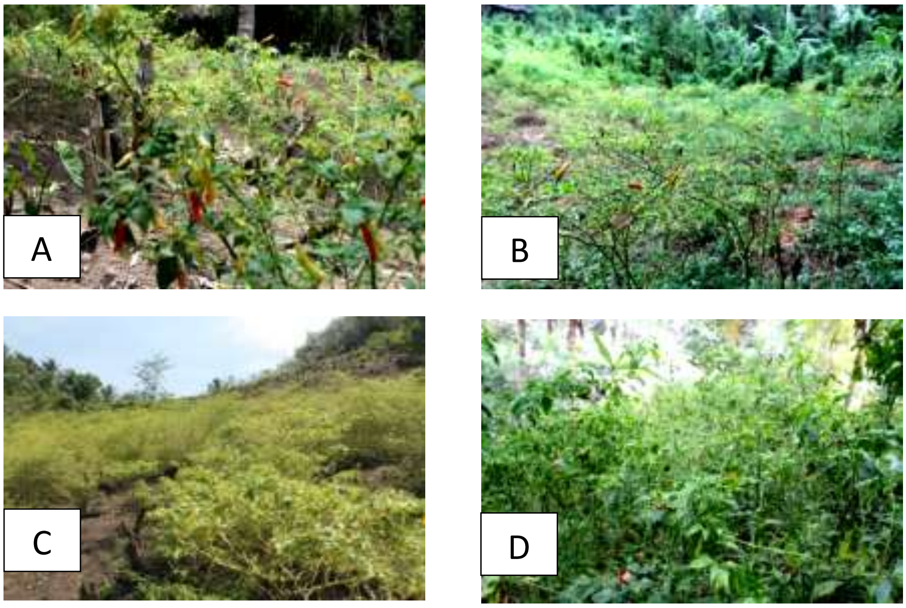

Figure 3. Existence of CLCC in Southeast Minahasa Districts. A. In South Touluaan Sub-district, B. In the Sub-districts of East Tombatu and Pasan, C. In Ratatotok Sub-district t, and D. In Ratahan Timur Sub-district

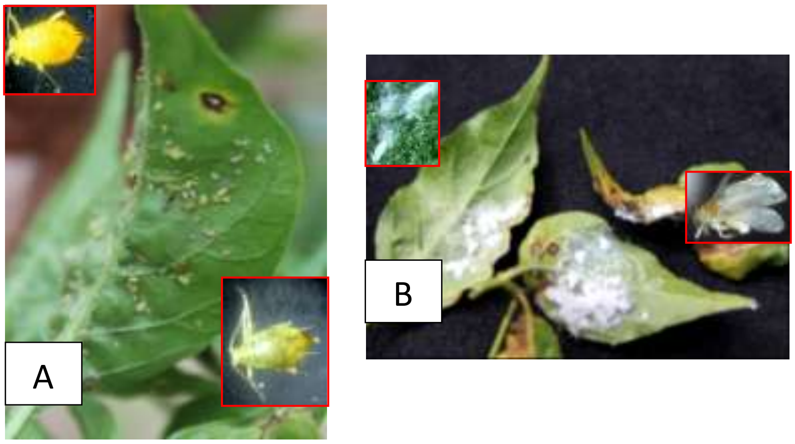

Figure 4. Causes of CLCC establish. *Myzus persicae* (A) and *Aleurodicus dispersus* (B) as Chili Virus Vectors

These viral vectors can be easily spread over long distances by wind, storms and plant propagation materials[7]. *M. persicae* easily transfers from one plant to another because of its many hosts such as cabbage, eggplant, green beans, lettuce, papaya, chili, sweet potato, tomato, and several species of shrubs and trees. This aphid also attacks several ornamental plants including carnations, chrysanthemums and roses[8]. The spiraling white fly is reported to host 38 plant genera, including 27 plant families and more than 100 species. Usually this pest attacks several species of vegetables, ornamental plants, fruit and shade trees. Specific crops attacked include soursop, avocado, banana, breadfruit, citrus, coconut, eggplant, mango, palm, papaya, chili and rose[9].

The lowest incidence of LLCC (64.68%) was in the South Touluaan Sub-district. This condition is related to the size, location and farming system. The sample gardens were only smaller than 0.3 ha, each garden was separated by fallow land and forest, and the agricultural system was polyculture (Figure 5A, B, C).

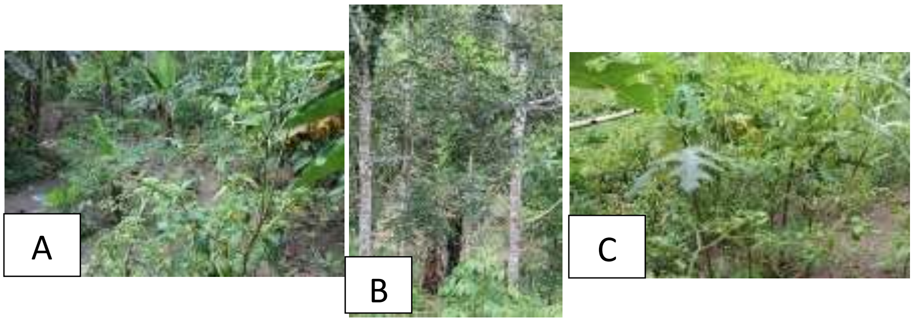

Figure 5. Condition of gardens in South Touluaan Sub-district. A. Chili gardens are smaller than 0.3 ha; B. Fallow Land; C. Land with polyculture farming system

Factors inhibiting the spread of aphids and spiraling whiteflies were spacing, intercropping with non-host plants, and fallow areas. These factors make it difficult for apterous pests to move from one plant to another. Both of these pests can also be carried by the wind, but can get caught in fallow areas overgrown with shrubs and tall trees[10,11,12].

The results of the study by[13] regarding the effect of intercropping patterns of chili, corn and sweet potato during 2005 - 2007 in China showed that the intercropping system could reduce the incidence of viral diseases by 43%, 36% and 40% in 2005, 2006 and 2007 respectively compared to with chilies cultivated in monoculture. Chili, corn and sweet potato intercropping, and chili and corn intercropping can significantly reduce the incidence of potyvirus and aphid infestations[14].

Olfactory and visual signals from non-host plants in the vicinity of the plant can reduce the attraction of herbivores to the host plant. The diversity of stimuli originating from intercropping patterns can hide the olfactory cues used by monophage herbivores to find their host plants or otherwise repel these herbivores. The volatile compounds emitted by *Desmondium uncinatum* can significantly reduce the damage to maize by *Chilo partellus* up to 99.2%. This study also confirmed that chemical compounds released by non-host plants around plants act as insect repellents[15,16,17].

Many studies suggest that the diversity of plant species supports the diversity, abundance and activities of natural enemies. Intercropping provides additional resources such as food, shelter and increases the abundance and effectiveness of natural enemies. The reduced incidence of pests in intercropping systems could be related to an increased population of natural enemies[18,17]. In a review of 42 different studies comparing parasitoid densities and levels of parasitism, accordant with[19] that 2/3 of studies concluded that natural enemies were more prevalent in intercropping systems than monocultures.

b. Severity of Chili Leaf Curly Complex

CLCC Severity data in several areas in Southeast Minahasa Sub-district can be seen in Table 3. The highest mean CLCC disease severity in Southeast Minahasa is found in Ratahan Timur Sub-district, which is 96.62%, followed by East Tombatu and Pasan, Ratatotok and South Toluaan Sub-districts, respectively 78.69%, 62.10%, and 51.64%. All varieties of chili cultivated in Southeast Minahasa are susceptible to CMV attack (Figure 6).

Table 3. Average CLCC severity in several Sub-districts in Southeast Minahasa District

Sub-districts	Average Disease Severity (%)
Touluaan Selatan	51,64
Ratatotok	62,10
Tombatu Timur dan Pasan	78,69
Ratahan Timur	96,62

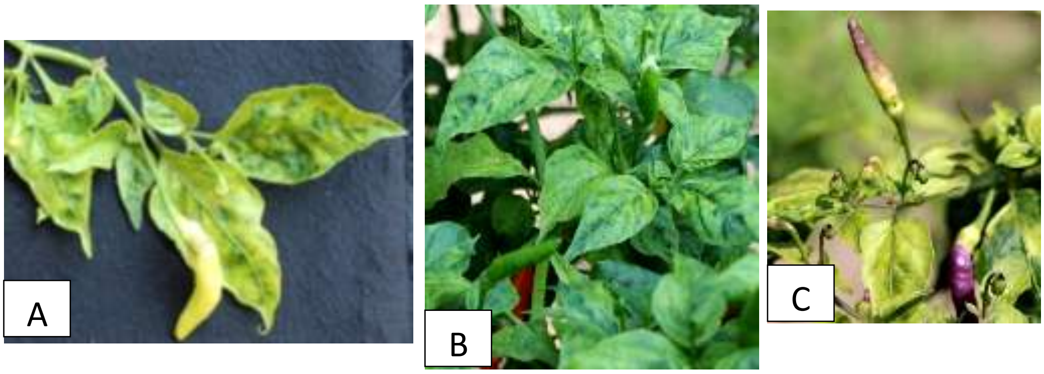

Figure 6. Chili varieties in Southeast Minahasa District were vulnerable to curly mosaic virus attack. A. white variety chili, B. green variety chili, and C. purple variety chili

The level of damage is different because these CLCC pathogens generally occur may be related to the individual traits of the plant, the pathogen and the environment. The development of disease in a plant community depends on the presence of susceptible hosts, the shape and stage of growth, the structure and density of the plant population, and the health of the plant before infection, the pathogenicity of the pathogen (including virulence, aggressiveness, reproduction, spread and survival), adaptability, favorable environmental conditions that make the host susceptible, and pathogen activity[4].

According to[20], chili varieties cultivated by farmers in Minahasa were susceptible to curly mosaic virus attack. As stated by[21] that control of this virus is directed at the vector because resistant varieties are not yet available.

The chili varietal factor was not a factor in the low CLCC severity in the South Touluaan Sub-district, but the difference in the severity level was probably due to the age of the virus inoculation by the vector. The incubation period for CMV varies from 26 to 39 days[22]. Based on this fact, the prevalence of curly mosaic disease in South Touluaan Sub-district, Mosaic is low, perhaps because at the time the mosaic was carried out, green peach aphid inoculation of this virus had not been too long compared to other areas.

Another factor that can reduce the severity of CMV disease is the presence of RNA satellites in the virus that causes CMV (Cucumovirus). RNA satellites depend on CMV for replication, encapsulation and mosaicism, but are not required for the CMV life cycle. The presence of RNA satellites in CMV may result in a decrease in the accumulation of CMV in infected plant tissue and alter the symptoms of CMV-induced disease. A number of satellite RNA variants can attenuate symptoms of CMV-induced disease in a host plant[23].

As reported by[24] that CMV containing satellite RNA-5 when pre-infected in red chili (*Capsicum annuum* L.) was quite effective in suppressing the development of CMV. Effective cross-protection expression occurred at least 20 days after pre-infection.

On the report of[25], 43 double-stranded RNA samples from chili plants that showed very mild symptoms of CMV disease. Four samples contained approximately 400 bps of satellite RNA. Two of these four samples had a significant protective effect against oceanic CMV which naturally induces severe mosaic disease.

4. Conclusions

1. The range of incidence and severity of CLCC in Southeast Minahasa District were 64.68 - 95.99 % and 51.64 - 96.62 %, respectively.

2. Plant-disturbing organisms involved in the chili leaf curl complex in Southeast Minahasa District, namely *M. persicae, A. dispersus*, and CMV

3. Varieties of white, green and purple chilies are susceptible to curly mosaic virus attack.

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