International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-5, January 2020

The Role of Planting Patterns to Control Thrips from Red Chili Pepper Plants

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Abstract*: Chili plants are commodities that are vulnerable to various types of pests, one of the main pests is thrips. This study aims to determine the role of cropping patterns to control thrips from red chili plants, which was carried out in the Maros Regency, South Sulawesi. Planting patterns applied were: 1) chili using plastic mulch without the combination of other plants and the use of pesticides, 2) chili using plastic mulch combined with corn plants, 3) chili without plastic mulch combined with watermelon plants, 4) chili without plastic mulch combined with watermelon and corn plants, 5) chili without plastic mulch combined with corn plants and 6) chili using plastic mulch and pesticides (according to farmers' treatment). The results showed that the highest population of thrips was found in the chili cropping pattern without plastic mulch combined with watermelon and corn plants with as many as 15 T. parvispinus and 32 T. palmi thrips. Meanwhile, the chili planting pattern using plastic mulch without the combination of other plants and with the use of pesticides had the lowest average amount of thrips population weighing at 5.1 T. parvispinus and 9.5 T. palmi. T. parvispinuspopulation was lower at the beginning of the observation (during the vegetative period) and tends to increase during the generative period of chili plants. T. palmi shows the opposite trend, its population tends to be high at the beginning of plant growth (vegetative phase) and decreases its population when the plant enters the generative period. Based on the data and facts found during the study, it is concluded that: 1). The chili cropping pattern without plastic mulch combined with watermelon and corn plants showed the highest average number of thrips population compared to the other cropping patterns. 2). The abundance of populations of the two thrips species showed different fluctuations, where T. parvispinus populations tended to increase in line with plant development and T. palmi decreased according to plant development. 3). In general, the application of intercropping cropping patterns has not yet appeared to play a role in reducing the abundance of thrips population but there is an opportunity to apply cropping patterns as a method to control thrips by selecting plants that are more suitable to be combined with chili plants.

***Keywords*: chili planting patterns; thrips control; average population: fluctuation**

I. INTRODUCTION

Chili is a commodity that is vulnerable to various types of pests, especially from insects. Every part of the chili plant is not immune from pests, starting from the roots to the shoots and fruit of the plant. Some of these pests damage certain parts of the chili plant that can cause permanent yield loss. Besides, damage often becomes more severe because some pests also act as transmitters of various types of viral diseases or as a result of their attack chili plants become potent to certain pathogens.

According to the journal article in [2], the most common cause of pest insect problems is the expansion of monoculture plants at the expense of natural vegetation, thereby reducing the diversity of local habitats. Affecting the number of and efficiency of natural enemies, which depend on the complexity of habitats for finding prey, alternative hosts, pollen/nectar and shelter/nesting in extreme environments.

The book in [5] says that monoculture farming with high-yielding plant varieties has provided a uniform and endless supply of food for herbivorous insects. The monoculture system has also created environmental conditions that are very supportive of increasing the rate of reproduction and survival rate of herbivorous insects. Both of them triggered the explosion of insect pests on farmland.

One of the pests that attack chili plants is thrips that are detrimental to crop yields. Thrips are also important virus vectors including the Tomato Spotted Wilt Virus (TSWV), a virus that has spread among various parts of the world [8].

Some species of thrips are important pests in various plants in Indonesia. These pests attack young leaves, buds, flowers, young stems, and young fruit. An example is Thrips tabaci in onion plants, *T. palmi* in potato plants, Chaetanaphothripssignipennis Bagnall in chili and tobacco plants, *T. parvispinus* in chilies and cucumbers, and Frankliniella sp. and Megalurothripsusitatus in legume crops [8].

Damage from thrips can cause discoloration and defects in flowers, leaves, and fruits. The group of viruses carried by thrips is from the Tospovirus group. Viruses are considered the most damaging among other plant pathogens [10]. Thrips can cause the leaves to wilt leading to crop failures for chili plants [23].

The author's search results on various sources, generally pest control techniques including thrips carried out by farmers, is the use of synthetic pesticide effectiveness in dealing with pest disorders. However, its use turns out to cause losses such as pest resistance, pest resurgence, the killing of natural enemies, and environmental pollution problems and are very dangerous to humans.

Therefore we need the application of environmentally friendly pest management techniques. An agroecosystem design, through habitat management, is a technique for pest control. The journal article in [16] revealed that pest control by agroecosystem management is a biological control technique by optimizing

Revised Manuscript Received on January 24, 2020.

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the role of natural enemies as a limiting factor for the development of herbivorous populations in an ecosystem. Optimizing the role of natural enemies is done through increasing biodiversity by increasing vegetation diversity. Increasing vegetation diversity is done through the application of polyculture planting patterns with optimal agronomic arrangements so that optimal and sustainable land productivity is obtained.

The potential of natural enemies as biological control of plant pests in an agroecosystem can be increased by manipulating habitats [11]. One of the efforts made is the creation of ecosystem diversity through the application of polyculture.

The book [23] describes that with diversity in an agroecosystem, it causes interactions between phytophagous insects and entomophagous insects to maintain ecosystem balance. The creation of diversity in an ecosystem is one integrated pest control concept where the basic concept is based on an ecological and environmental approach with the hope of a balanced population between insect pests and their natural counterparts.

The research conducted tries to manipulate land vegetation by applying some chili cropping patterns, hoping to put pressure on the survival of thrips pests by increasing their natural enemies to control thrips populations.

II. MATERIAL AND METHODS

The study was conducted in June 2018 until November 2018 in the Cenrana District which is one of the regions producing red chili in the Maros district. Field experiments were carried out on farmers' land by planting chili, corn, and watermelon on land measuring 14.4 m x 5 m which was made into 12 beds with a size of 1.2 m x 5 m (for 1 treatment). As the main crop, chili plants were planted in each bed using a spacing of 50 cm x 70 cm with 20 plants per beds adding up to 240 chili plants for each treatment.

The planting patterns applied were: 1) chili using plastic mulch without a combination of other plants and pesticides, 2) chili using plastic mulch combined with corn plants, 3) chili without plastic mulch combined with watermelon plants, 4) chili without plastic mulch combined with watermelon and corn plants, 5) chili without plastic mulch combined with maize plants and 6) chili using plastic mulch and using pesticides (according to farmers' treatment).

Corn is planted one row in the middle of the bed (between the rows of chili plants) with a distance of 0.5 m accumulating 10 plants/bed (120 plants per treatment). While 2 watermelon plants were planted at each end of the bed so that there were 4 plants/beds (population of 24 plants/treatment).

Between treatments, one was given a distance of ± 5 meters. While the treatment using pesticides (treatment of farmers), given a distance of 30-40 meters. Around the study area, the land was cleared to make a distance between the study plot and surrounding farmers' land and was periodically cleared.

Before planting, chilies were seeded for thirty days, watermelon plants were seeded for ten days, and corn plants were planted directly on the beds. Chili seedlings are planted two weeks early in the beds because of consideration of the productive age of chili is longer than watermelon and corn plants. While corn seeds were planted directly on the beds together with watermelon plants in the hope that the plant growth can be uniform.

Furthermore, plants are maintained following crop cultivation standards such as fertilization (macro and micro fertilizers), provision of stakes, irrigation, and other activities but pesticide spraying is not carried out so that infestation of pests/diseases, predation, parasitation, and competition on the experimental land can run naturally. Control of pests and diseases using pesticides is only used in the treatment of farmers.

The research method used is the descriptive method by direct observation of the experimental plants. Observation of thrips pests was done once a week starting from when the chili plants were three weeks old after transplanting. There were 12 sample plants per cropping pattern that were chosen systematically so that there are 72 samples obtained from each observation.

Thrips were captured using a clear plastic bag measuring 20 cm x 30 cm, by covering the shoots of the plant and then pat the plant until the thrips fall into a plastic bag (figure 1).

Fig. 1: Catching thrips on chili plants

Thrips were placed into bottles filled with ethyl acetate to later be counted and identified according to the identification key belonging to Sartiami (2008).

The parameters observed were the average population of each thrips species and the fluctuations in the abundance of thrips caught on the chili plants per observation. To calculate abundance it is formulated as follows:

$$K = \frac{ni}{A} \quad (1)$$

Formula description:
K = Species abundance for species of i
ni = Total number of individual species of i
A = Total number of individuals sampled

III. RESULTS AND DISCUSSION

A. The average number of thrips infesting red chili plants

From the experiment, it was found that Thrips that attacked the plants were *T. palmi* and *T. parvispinus*. The average number of thrips population of each species that attacked the chili plants from several chili planting systems can be seen in Table 1.

Retrieval Number: D4419118419/2020©BEIESP
DOI:10.35940/ijrte.D4419.018520

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Table I: Average Amount Of Thrips That Infested The Red Chili Plants

Species	Treatment (Crop Pattern)	Average Number of Thrips (individual)
T. parvispinus	1). Chili + corn (plastic mulch)	7,5
	2). Chili + Corn + Watermelon	15,36*
	3). Chili (plastic mulch)	5,14
	4). Chili + Watermelon	7,5
	5). Chili + Corn	11
	6). Chili treated by farmers	6,42
T. palmi	1). Chili + corn (plastic mulch)	12,14
	2). Chili + Corn + Watermelon	32,29*
	3). Chili (plastic mulch)	9,5
	4). Chili + Watermelon	7,85
	5). Chili + Corn	18,64
	6). Chili treated by farmers	14,29

*) highest population

Table 1 shows that the highest number from the two species of thrips that attacked the chili plants from each observation was found in the chili plants without plastic mulch which was planted with corn and watermelon treatment, namely *T. parvispinus*accumulating to 15.36 thrips and *T. palmi* as much as 32.29 thrips. While chili plants grown monoculturally but were given plastic mulch, the lowest average population of thrips was *T. parvispinus*with 5.14 and *T. palmi* for 9.5.

It seems that thrips are more inclined to chili plants without plastic mulch that was also planted together with corn and watermelon. The growth of each plant can be seen in Figure 2. Due to shade, this may have caused a sort of partial blockage of sunlight by the corn or watermelon leaves, thus making thrips feel at home in the plant chili. Different results when corn is intercropped with tomatoes, such as a journal article in [17] comparing four intercropping systems involving kale, onions, corn, and tomatoes, found that the thrips population was lower than other intercropping combinations only that the weight of the tomatoes produced was low.

Fig. 2: Growth of chili plants intercropped with corn and watermelon

It is also different when corn is planted to control whitefly like the journal article in [1] which conducted research on whitefly in tobacco plants using corn as a barrier around tobacco plantations, the results showed that the application of a single and double barrier system can suppress the whitefly population so that the spread of diseases in tobacco were decreased.

The diversity of vegetation created by planting chili peppers with corn and watermelon does not seem to make it a controller of thrips on chili plants. On the contrary, there are more thrips populations in chili plants that are intercropped with chili, corn, and watermelons compared to chili plants grown in monocultures. It could be due to its role as a shelter for pests. The existence of other plants, although not a host in the intercropping system, might increase the pest population due to the availability of places for pests to lay eggs [9]. The same thing stated in the journal article in [3], that crop diversity in a cropping pattern does not mean reducing pest populations because of many factors that influence it.

Fig. 3: Growth of chili plants intercropped with corn (using plastic mulch)

Planting chili with corn and watermelon seems to create a microclimate that is suitable for breeding thrips. Decreased wind speed due to restriction by the corn plants which decreased the possibility of the thrips to be carried by the wind or the presence of watermelon plants that propagate on the ground making a place for thrips to be able to maintain their survival due to having another host. The idea is reflected upon the average thrips population on plants combined with maize thrips population was high.

In planting chili together with watermelon, the growth of each plant can be seen in Figure 4, showing that the use of watermelon as a chili companion plant seems to be quite instrumental in reducing thrips population, although not as good as plastic mulch. The emergence of watermelon flowers in almost every vine segment has a role in the preservation of natural enemies of insect pests. As is known that flowering plants are plants that are capable of attracting many insects and other plant utilization bodies, and also have many benefits for these bodies, for example as a source of food or a place to stop to lay eggs or hide from danger. The existence of flowering plants will invite various types of pests into these ecosystems that have various roles both as herbivores, as well as natural enemies, pollinators or other ecological functions. The diversity of fauna due to the presence of flowering plants will lead to the formation of a more stable ecosystem, which in turn will maintain the balance of ecosystem components [11].

The growth of watermelon which spreads over the surface of the soil under the chili, besides suppressing weeds naturally also seems to make it a strategic place for arthropods, natural enemies of pests to take shelter. A journal article in [7] that uses cover crops on maple plants, reveals that overall cover crops do not add to the damage by red maple pests. However, careful attention must be paid to selecting ground cover plants so they do not compete with the main tree for nutrients, water, and space so that the main plant growth remains optimal. A journal article in [6] states that the use of cover crops from wheat and clover on cotton plants revealed that cover crops significantly reduced thrips attacks. Also, chinch infestation decreases in plots prepared with wheat cover compared to cotton which lacks this additional habitat.

Fig. 4: Growth of pepper plants intercropped with watermelons

The monoculture chili cultivation with the use of plastic mulch plant growth is shown in figure 5. Figure 5 shows that the use of plastic mulch seems to make thrips less comfortable living in plants. Due to the use of plastic mulch, it is usually utilized to reduce the growth of weeds, which is sometimes an alternative host for insect pests. Also, the silver color of plastic mulch has been shown to reduce certain insect pests [13]. Studies conducted in the journal article in [18] show that growing vegetable crops using silver mulch is an effective method for reducing *T. palmi* populations and must be considered in integrated pest control (IPM) program for this insect species.

Fig. 5: Growth of monoculture chilli plants (using plastic mulch)

B. Fluctuations in the abundance of Thrips that Infest Red Chili

In general, each treatment showed that the average number of *T. palmi* was greater than the amount of *T. parvispinus*. However, there are different population fluctuations between the two. *T. parvispinus* has a lower population at the beginning of the observation (vegetative period) and tends to increase during the generative period of chili as shown in Figure 5. While *T. palmi* shows the opposite trend, the population tends to be high at the beginning of plant growth (vegetative phase) and decreases in population when the plant enters the generative period (figure 6). Factors that regulate pest populations in plants are the phenological stage of the host plant, weather and climate, and natural enemies [4].

Figures 6 and 7 show that *T. parvispinus* and *T. palmi*'s interest in plant age tend to be different which is probably due to the different attraction between the two species of thrips to the content of chemical compounds and the physical structure of plants that differ according to the age of the chili plant. Young plants contain primary and secondary chemical compounds that play an important role in the interaction of thrips with chili plants.

According to the book in [20] which revealed that nutrients, especially compounds containing nitrogen elements, such as proteins and sterols, very influence the breeding of insects, especially female insects. Nutrient content in plants depends on the type of plant, plant parts, plant age, and season. In general, insects will choose a host plant or plant parts that have sufficient nutritional content as a place to live and at the same time to meet their needs [14].

An increase in the population of *T. parvispinus*as the age of the chilli plants shows that the thrips favorite level tends to the chili plants as its main host, in addition to the growth of corn and watermelon in between the chili plants that are getting older making it return to the chili plants whose leaves continue to multiply. Meanwhile, the *T. palmi* whose population tends to decrease in chili plants along with the growth of other companion plants, especially watermelons, shows that watermelon is one of the main hosts of *T. palmi*.

It seems that interspecific competition is occurring which causes the rise and fall of populations of one species of thrips, for example, the 2nd and 14th observations of the plastic mulch chili planting system combined with corn show a high *T. parvispinus* population while *T. palmi* is low. Likewise, the 7th observation of the chili planting system combined with corn (without plastic mulch) shows the same thing. As stated on the webpage at [23] that competition can occur because of fighting over the same resources in limited conditions.

The chili cropping pattern carried out according to the farmers' treatment did not show a significant decrease in the thrips population at each observation, even though using pesticides. According to personal interviews with nearby farmers, the use of pesticides to treat thrips pests is very often done especially on chili and watermelon plants. Thrips are the "main enemy" of pest groups for farmers because even though they have been sprayed, the population is still large, so the road farmers take is to increase the dose of pesticides used.

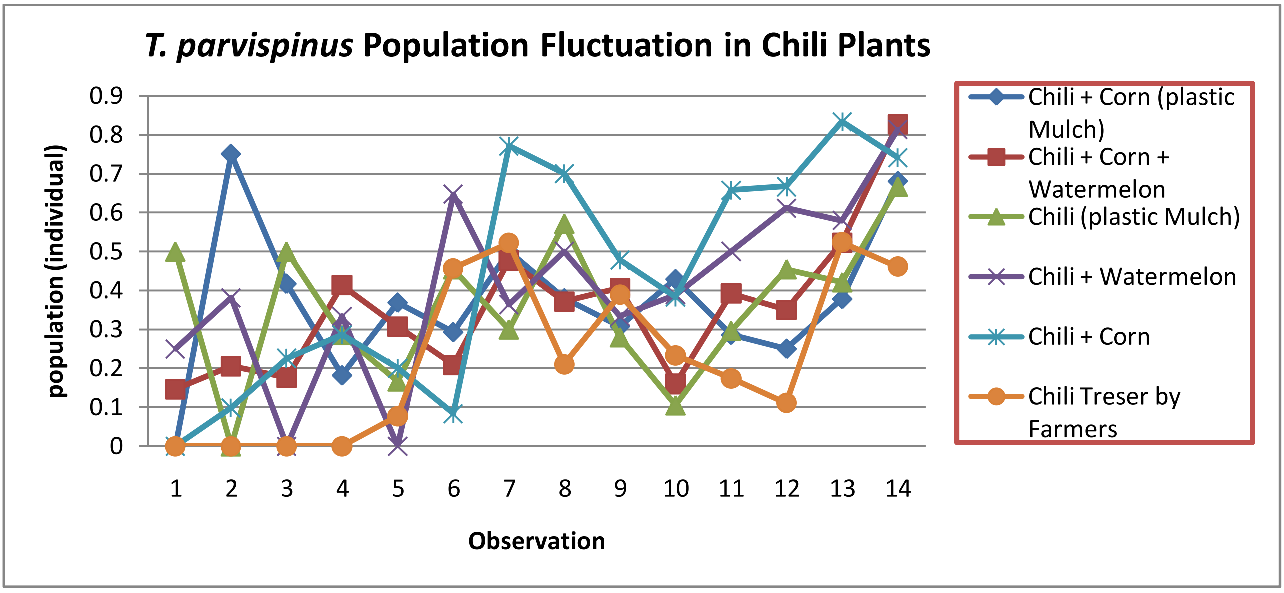

Fig.6: *T. parvispinus* population fluctuation in chili plants

Pesticides, when viewed from a positive perspective, can help humans in terms of eradicating pests that damage agriculture. But on the other hand, pesticides also harm humans and the surrounding environment if the use is excessive. So the use of pesticides must be based on the rules of use to reduce the adverse effects [21].

In the experimental plants, no significant disturbance was found in the leaves of other pest species. Plants planted by polyculture may play a role in suppressing thrips and other pests. However, to reduce pest attacks, it takes a combination of several control techniques to run effectively and safely

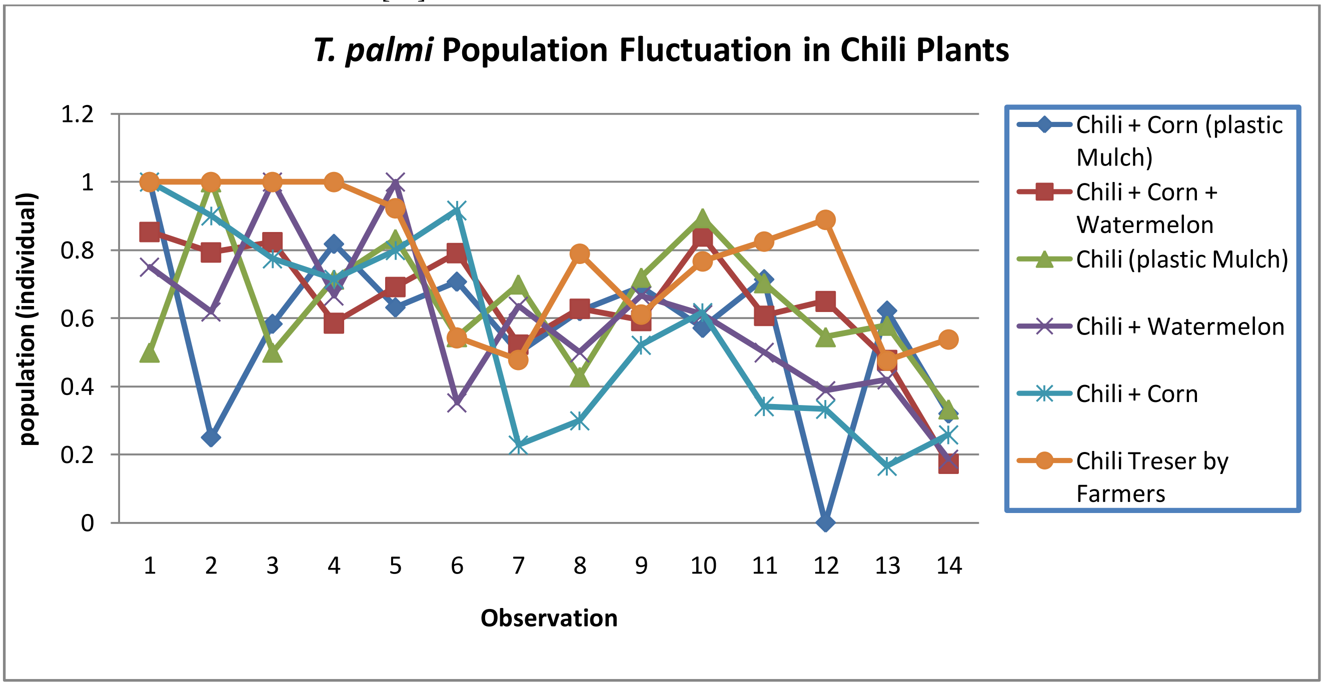

Fig.7: Fluctuation of *T. palmi* populationin chili plants

IV. CONCLUSION

Based on data and facts found during the study, it is concluded that: 1). The intercropping pattern between chili, corn, and watermelon shows the highest average number of thrips population compared to other cropping patterns. 2). The abundance of the two thrips species shows a different pattern, where *T. parvispinus* populations tend to increase in line with plant development, whereas *T. palmi* decreases according to plant development. 3). In general, the application of intercropping cropping patterns has not yet shown its role in reducing the abundance of thrips population, but there is an opportunity to apply cropping patterns as controlling thrips. However, to reduce pest attacks, it takes a combination of several control techniques to be effective and safe by choosing plants that are more suitable to be combined with chili plants

ACKNOWLEDGEMENT

We would like to express our gratitude for the Indonesian Domestic Lecturer Scholarship Program (BUDI-DN) which is a synergy between the Ministry of Research, Technology and Higher Education

(Kemristekdikti) together with the Educational Fund Management Institution (LPDP), Ministry of Finance of the Republic of Indonesia for its assistance in financing this research

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