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DIVERSITY OF PEST AND NATURAL ENEMIES IN SWEET MAIZE PLANT (Zea Mays Saccharata [Sturt.] BAILEY

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ABSTRACT

There are seven pests found in the corn plantations in Sanur, among others: house fly (Musa domestica) Diptera, grasshopper (Dissosteiracarolina) Caelifera, kumbang (Orystes rhinoceros) Celeoptera, caterpillar (Spodoptera litura) Coleoptera, caterpillar (Helicoverpaarmigera) Lepidoptera, walangsangit (Leptocorisaaratorius) Hemiptera, and white tick (Trialeurodesvapårariorum) Homoptera. Natural enemies found during the research were: army beetles (Chauliognathuslugubris) Coleoptera, army dragonflies (Dunia odonatan) Odonata, wasps (Apisdorsata) Hymenoptera, and red dragonflies (Oryhetrumsabina) Odonata. The highest pest prevalence was obtained from house flies with a value of 21.08%, while there was a natural enemy obtained from red dragonflies with a value of 31.75%. The diversity index of pests was obtained 3.2099 with a dominance index of 0.8479, while the index of diversity of natural enemies was obtained 2.2956 with a dominance index of 0.7417. The linear regression relationship between house flies and cobworms with temperature had a significant effect, while the regression relationship between stinky bugs, and temperature had a very significant effect. The regression relationship between house fly and humidity had a significant effect, the beetle with humidity was very real, and the stink bugs with humidity had a very significant effect, while the multiple regression relationship between stink bugs with temperature and humidity had a very significant effect. The regression relationship between natural enemies (army dragonflies) and temperature shows a very real effect.

Keywords: Pests, natural enemies, diversity, dominance and prevalence.

1. INTRODUCTION

Sweet corn plants are widely cultivated in urban areas such as the Sanur Village of Bali, because they are vegetables or roasted as sweet corn. Efforts to plant sweet corn have encountered obstacles in the form of pests of corn crop pests. According to Surtikanti (2011), stated that in maize cultivation there are several types of pests, including important status, namely fly flies (*Atherigona* sp.), Caterpillars (*Agrothis*sp.), Grubs / urets (*Phylophagahellen*), corn stem borer (*Ostriniafurnacalis*), armyworm (*Spodoptera litura*, *Mythimna*sp.), cob borer (*Helicoverpaarmigera*), and corn hopper (*Peregrinus maydis*).

The existence of corn pests in the population is regulated by natural enemies who are predators of pests in the field. According to (1) there are several types of natural enemies found in Saree Village, Lembah Seulawah District, Aceh Besar Regency, including: dome beetles

(*Harmonia octomaculata*, *Micraspis* sp., Monochilus), Black Ants (*Delishoderusthoracius*), koksi beetles (*Harmonia octomaculatamicraspis* sp.), Tanchinid flies (*Dydercuscingulatus*), Green Grasshopper (*Oxyachinensis*), Wooden Grasshopper (*Valangahirricornis*) and Spiders (*Lycosa* sp.).

The use of natural enemies is one way to control these pests, but farmers are often dissatisfied with the performance of natural enemies. One of the factors of the unsuccessful use of biological control agents in agricultural areas is the unwise management of natural enemies. If this factor can be handled properly, then the damage to plants can be reduced and ultimately production can be increased and environmentally friendly. The management of natural enemies is intended to increase the effectiveness of biological control agents in controlling pest insects and reduce the use of synthetic pesticides that have a negative influence on the environment (2).

2. MATERIALS AND METHODE

Place and time of research

The study was conducted in two places: 1) sample collection of pests and natural enemies carried out in the field in Sanur Village, East Denpasar District, and 2) the Plant Pest laboratory, Faculty of Agriculture, Udayana University. The study was conducted in Januari until March 2020.

Determining the Diversity Index and the Domination Index

The diversity and dominance of pests and natural enemies can be determined by calculating the Shannon-Wiener diversity index (3) and the dominance of pests and natural enemies is calculated by calculating the Simpson index (4).

(1) Index of diversity of pests and natural enemies

The diversity index of pests and natural enemies is determined by the Shannon-Wiener diversity index by formula (3):

$$H' = - \sum_{i=1}^{s} Pi \ ln \ Pi.$$

Where:
H '= Shannon-Wiener diversity index
S = number of genus
Pi = ni / N as the proportion of type i (ni = total number of individuals pest type total i, N = total number of individuals in total n)

The criteria used to interpret s low diversity, H'value of 1 - 3 m neans diversity is classified high.

Table 1. Criteria for assessing environmental quality weighting (6)

Diversity index	The condition of the community structure	Category	Scale
>2,41	Very stable	Very good	5
-2,4	More stable	Well	4
1,21 – 1,8	Pretty stable	Is	3
0,61 – 1,2	Not stable enough	Bad	2
<0,6	Unstable	Very bad	1

(2) Domination index

The dominance index of pests and natural enemies is calculated by calculating the Simpson index (4), with the formula as follows:

$$C = \sum_{i=1}^{s} Pi^2$$

Where:
C = Simpson index
S = number of genus
Pi = ni / N, namely the proportion of individuals of type iand all individuals (ni = total number of individuals of type i, N = total number of individuals in total n)

Furthermore, the species dominance index (D) can be calculated by formulation 1- C (7)

Criteria used to interpret the dominance of pest types and natural enemies of the soil are: close to 0 = lower index or lower dominance by one species of pest and natural enemies or there are no species that extreme dominate other species, close to 1 = large index or tends to be dominated by several species of pests and natural enemies (4).

Population Dynamics

The pests that appear in each plot of the experiment are counted for their population and species and quantitatively recorded in number from week to week during the growing period of the plant. The exponential growth dynamics of each pest population are then calculated using the (8):

$Nt = Noe^{r}ordN/dt = rN$

Where:
No = Total initial population, at time t = 0
Nt = total population at time t

e = Basic natural logarithm = 2.71828
r = reasonable intrinsic speed of growth
dN = Speed changes population/time at a certain time
dt = Time interval.

Relationship Between Pest Populations with Temperature and Humidity

Analysis to determine the relationship between pest populations with temperature and humidity is used a regression analysis approach, and the interrelationships of the two variables are calculated by correlation analysis (9).

3. RESULTS AND DISCUSSION

Corn Plant Pest Population

Observation of pest population on corn plants found house flies (*Musca domestica*) Diptera, as many as 35 tails, Grasshopper (*Dissosteiracarolina*) Caelifera as many as 27 tails, beetle (*Oryctes rhinoceros*) Coleoptera as many as 24 tails, Grayworm (*Spodoptera litura*) Coleoptera as many as 27 tails, beetles (*Oryctes rhinoceros*) Coleoptera as many as 24 tails, caterpilar(*Helicoverpaarmigera*) Lipedoptera 20 tails, stink bug (*Leptocorisaoratorius*) Hemiptera 18 tails, and white lice (*Trialeurodesvaporariorum*) 19 tails Homoptera (Table 2; Figure 1).

Elongated egg fly flies are placed on the youngest leaf (hypocotyl). After 48 hours the eggs hatch at night, coming out of the eggs in the form of larvae move quickly toward the point where the main food is available. This pest attacks plants ranging from growing to about onemonth old plants. Flies live on the seed shoots and enter the stalk. Flies are like seeds of young plants between the ages of 6 to 9 days after planting which hatch from their eggs. At the time the new plants have 2-3 leaves and generally the fly eggs hatch on the first leaf (10).Grasshopper pests that attack corn plants by eating young plants. Grasshopper attacks the corn plant until it consumes all parts of the leaf, even the bone leaves. These yellows are commonly found in the lowlands, rice fields, and cultivation of corn plants adjacent to the grass (11).

Table 2. Corn pests population per 10m2

Type of pests	Observation of the week after planting (WAP)									
	I	II	III	IV	V	VI	VII	VIII	IX	Amount
Lalatrumah (*Musca domestica*) Diptera,	6	2	3	4	6	4	3	4	3	35
Grasshopper (*Dissosteiracarolina*) Caelifera	3	1	2	3	4	5	4	3	2	27

Beetle (*Oryctes rhinoceros*) Coleoptera	-	4	3	2	3	2	4	3	2	24
Grayworm (*Spodoptera litura*) Coleoptera	-	4	3	5	1	2	3	3	2	23
Caterpilar (*Helicoverpaarmigera*) Lepidoptera	-		-	-	-	4	5	6	5	20
Stink bug (*Leptocorisaoratorius*) Hemiptera	-	1	2	3	2	1	2	3	4	18
White lice (*Trialeurodesvaporariorum*) Homoptera	1	2	3	2	1	2	3	2	3	19

Caterpillars are found in plants after plants are 2 week after planting, attacks on young plants can inhibit plant growth and can even kill plants. Severe attacks on plantations can result in only leaf bones. Tuna caterpillars are found when the plant is 6 week after planting, together with the appearance of cob hair. Eggs are placed on the hair of a single cob, and hatched after ± 4 days. This caterpillar becomes a pupa in a cob or on the ground. Active moths at night and capable of laying 600-1000 eggs, Stadia pupa ranges between 12-14 days (12).

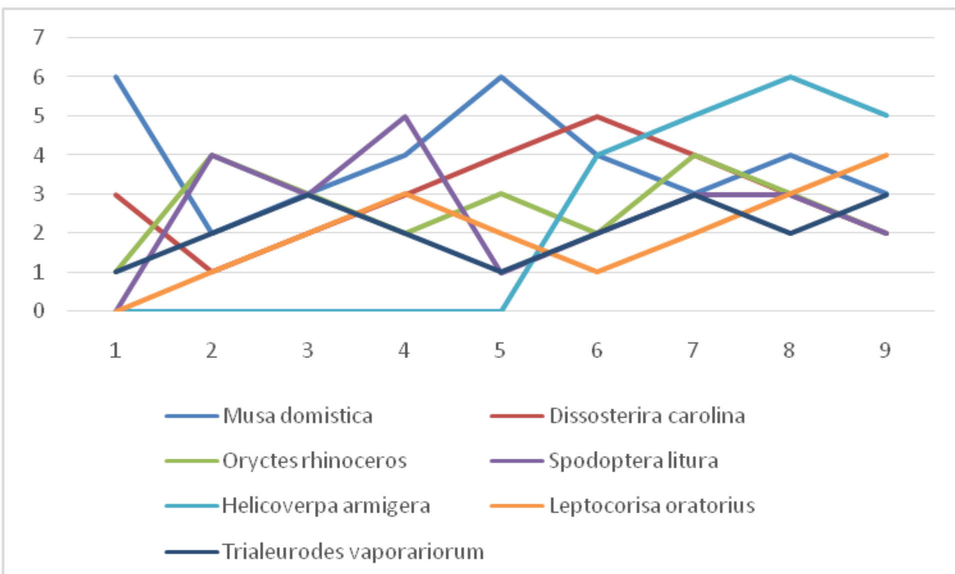

Figure 1. Development of corn pests population every week

Natural Enemy Populations

Observations during the study conducted every week in the corn plant found natural enemies as follows: Army beetle (*Chauliognathuslugubris*) Coleoptera as many as 15 tails, Dragonflies army (*Dunia odonatan*) Odonata as many as 20 tails, Wasp (*Apisdorsata*) Hymenoptera as many as 15 tails and Dragonflies red (*Oryhetrumsabina*) Odonata of 20 tails (Table 3; Figure 2).

The abundance of natural enemies (predators) in maize plants is (1) dome beetles (*Harmonia octomaculata*, *Micraspis* sp., (2) *Monochilus,* (3) Black Ants (*Delishoderusthoracius*), (4) koksi beetles (*Harmonia octomaculata, Micraspis*sp), (5) tanchinid flies (*Dydercuscingulatus*), (6) Green Grasshopper (*Oxyachinensis*), (7) Wood Grasshopper (ValangaHirricornis), (8) Spiders (*Lycosa*sp) in Saree Village Lembah Seulawah District Great Aceh District (13).*Helicoverpaarmigera* and stem borer are the dominant pests.The highest population of the two pests is found in 10 week after plantation. Natural enemies such as *Oreussp*, *Phaedorus*, and *Carabid verania* beetles play a role in controlling the two dominant pests (14).

Table 3. Population of natural anemies per 10 m2

Type of natural anemies	Observation week after planting									
	I	II	III	IV	V	VI	VII	VIII	IX	Amount
Army beetle (*Chauliognathuslugubris*) Coleoptera	1	2	-	2	3	-	2	3	2	15
Dragonflies army (*Dunia odonatan*) Odonata	1	2	1	1	1	2	3	2	3	16
Wasp (*Apisdorsata*) Hymenoptera	-	-	-	3	1	2	3	2	1	12
Dragonflies red (*Oryhetrumsabina*) Odonata	-	1	2	1	2	3	4	3	4	20

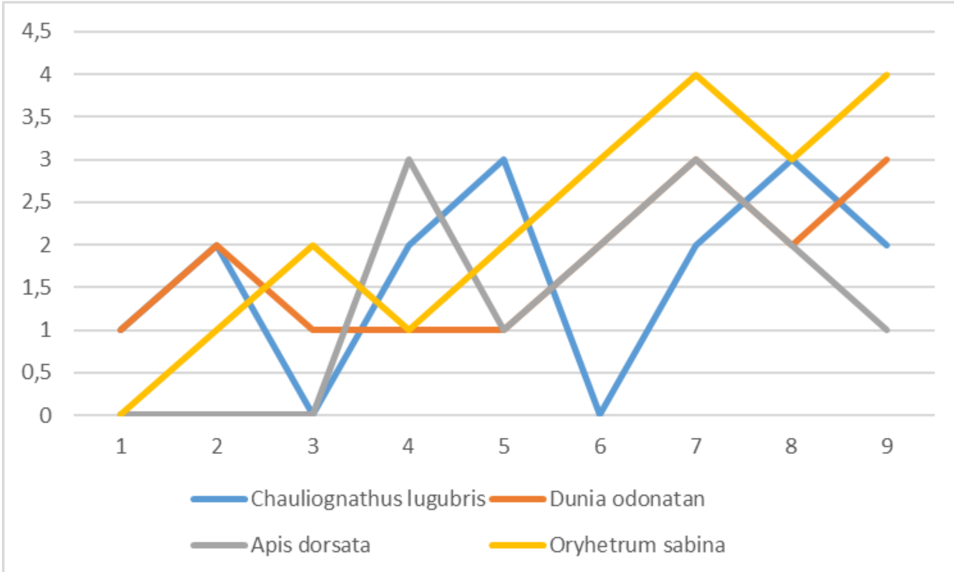

Figure 2. Development of natural enemy populations on maize

Value of Population Dynamics

Population dynamics in the highest house fly pest (*Musca domestica*) were achieved when 2 MST and 4 MST were 0.58 respectively, locust (*Dissosteiracarolina*) was highest when 2 MST was 0.78, beetle (*Oryctes rhinoceros*) was highest at 6 MST of 0.78, the highest armyworm (*Spodoptera litura*) was reached on day 3 of MST of 0.97, stink bug (*Leptocorisaoratorius*) was highest on day 2 and 6 respectively of 0.78, and lice the highest white (*Trialeurodesvaporariorum*) was achieved on days 1 and 5 respectively 0.78 (Table 4).

Tabel 4. Value of population dynamics of pest

Type of pest	Obsevation week after planting							
	I	II	III	IV	V	VI	VII	VIII
Lalatrumah (*Musca domestica*) Diptera,	0,13	0,58	0,52	0,58	0,26	0,29	0,53	0,29
Grasshopper (*Dissosteiracarolina*) Caelifera	0,13	0,78	0,58	0,52	0,49	0,31	0,29	0,26
Beetle (*Oryctes rhinoceros*) Coleoptera	-	0,29	0,26	0,58	0,26	0,78	0,29	0,26
Grayworm (*Spodoptera	-	0,29	0,97	0,08	0,78	0,58	0,39	0,26

litura) Coleoptera								
Caterpilar (*Helicoverpaarmigera*) Lepidoptera	-		-	-	-	0,49	0,47	0,32
Stink bug (*Leptocorisaoratorius*) Hemiptera	-	0,78	0,58	0,26	0,19	0,78	0,58	0,52
White lice (*Trialeurodesvaporariorum*) Homoptera	0,78	0,58	0,26	0,19	0,78	0,58	0,26	0,58
Temperature (°C)	26,2	26,7	26,8	26,3	25,8	26,6	26,5	26,4
RH (%)	96	95	95	97	99	87	96	98

RH = relative humidity

The dynamics of pest populations in maize are determined by birth, death and migration of pests in a certain place. According to (15) the factors determining the level of pest population consist of interval, external and food factors. Internal factors include the life cycle, the shorter the pest life cycle the faster the development of pests. Likewise sex ratio (the ratio between males and females) the more females the faster the insect population develops. External factors include the abiotic and biotic environment. The abiotic environment includes temperature, humidity and others, while biotic factors include predators, parasitoids, pathogens, competitors and others. Food factor is another factor that greatly determines the development of pest insect populations.

The dynamics of natural enemy populations can be known as follows: army beetles (*Chauliognathuslugubris*) highest on day 1 of week after planting of 0.78, army dragonflies (World of donations) highest on day 1 and of 5 of MST of 0.78, wasp (*Apisdorsata*) the highest on the 5th day of the week after planting was 0.78 and the red dragonfly (*Oryhetrumsabina*) was the highest on the 2nd and 4th day of the week after planting respectively 0.78 (Table 5).

Table.5. Value of population dynamics of natural anemies

Type of natural anemies	Observation week after planting							
	I	II	III	IV	V	VI	VII	VIII
Army beetle (*Chauliognathuslugubris*) Coleoptera	0,78	-	-	0,58	-	-	0,58	0.26
Dragonflies army (*Dunia*	0,78	0,19	0,39	0,39	0,78	0,58	0,26	0,58

odonatan) Odonata								
Wasp (*Apisdorsata*) Hymenoptera	-	-	-	0,13	0,78	0,58	0,26	0,19
Dragonflies red (*Oryhetrumsabina*) Odonata	-	0,78	0,19	0,78	0,58	0,52	0,29	0,52
Temperature(°C)	26,2	26,7	26,8	26,3	25,8	26,6	26,5	26,4
RH (%)	96	95	95	97	99	87	96	98

RH = Relative humidity

Prevalence of Pests and Natural Enemies in Corn Plants

The highest population of house fly pests was 35 with a prevalence of 21.08%, followed by grasshoppers with 27 animals with a prevalence of 16.27%, with 24 beetles with a prevalence of 14.46%, grayworms 23 with a prevalence of 13 , 86%, 20 cobs of caterpillars with a prevalence of 12.05%, 19 head lice with a prevalence of 11.45% and 18 tails with a prevalence of 10.84% (Table 5), while the natural enemy population of corn plants highest red dragonfly 20 tails with a prevalence of 31.75%, followed by army dragonflies 16 tails with a prevalence of 25.97%, army beetles 15 tails with a prevalence of 23.81% and a wasp population of 12 tails with a prevalence of 19.08% (Table 6).

Table 6. Population of pest and natural enemies on corn

Name of pest	Amount of population	Prevalence (%)	Name of natural enemies	Amount of population	Prevalence (%)
Lalatrumah (*Musca domestica*) Diptera,	35	21,08	Army beetle (*Chauliognathuslugubris*) Coleoptera	15	23,81
Grasshopper (*Dissosteiracarolina*) Caelifera	27	16,27	Dragonflies army (*Dunia odonatan*) Odonata	16	25,97
Beetle (*Oryctes rhinoceros*) Coleoptera	24	14,46	Wasp (*Apisdorsata*) Hymenoptera	12	19,08
Grayworm (*Spodoptera litura*) Coleoptera	23	13,86	Dragonflies red (*Oryhetrumsabina*) Odonata	20	31,75

Caterpilar (*Helicoverpaarmigera*) Lepidoptera	20	12,05		
Stink bug (*Leptocorisaoratorius*) Hemiptera	18	10,84		
White lice (*Trialeurodesvaporariorum*) Homoptera	19	11,45		
Jumlah	166			63

Diversity index and index of dominance of natural pests and enemiesThe results of the analysis of the diversity index of pests obtained 3.2099 with a dominance index of 0.8479 (Table 6), while the index of diversity of natural enemies obtained 2.2956 with a dominance index of 0.7417 (Table 7). Based on the data above, it is matched with Table 6, the community criteria for pest population are very stable with a very good category and scale of 5, while the dominance index approaches 1, meaning that there are species that dominate are house flies. The diversity index of natural enemies after matching with Table 1, obtained the condition of stable community structure with good category and scale 4, and dominance index approaching 1, dominated by red dragonfly species.

Table 7. Diveristy and dominance index of pest and natural enemies

Parameter	Pest	Enemies
H diversity index	3,2099	2,2956
D domination index	0,8479	0,0,7417

Relationship of Regression and Correlation between Pest Populations with Temperature and Humidity

Regression analysis results of the relationship between house flies (*Musca domestica*) with temperature showed a significant effect with the regression equation Y1 = -7.550 + 0.301 X1* (r = 0.55, r2 = 0.30), the relationship of Grasshopper (*Dissosteiracarolina*) with temperature showed not significantly different, the relationship between beetles (*Oryctes rhinoceros*) with temperature had no significant effect, the regression relationship between caterpillars (*Spodoptera litura*) with temperature had no effect, the relationship between cobworms (*Helicoverpaarmigera*) had significant effect with the regression equation Y5 = -22.098 + 0.85 X1* (r = 0.91; r2 = 0.84), the relationship between stinky bugs (*Leptocorisaoratorius*) with temperature has a significant effect on the regression equation Y6 = -14.839 + 0.5811 X1 ** (r =

0.83 ; r2 = 0.70) and the relationship of white lice (*Trialeurodesvaporariorum*) with temperature has no significant effect (Table 8).

The regression relationship between house flies (Musca domestica) and humidity significantly affected the regression equation Y1 = 30.81931 - 0.04621 X2 * (r = -0.53; r2 = 0.28), the relationship between grasshopper (*Dissosteiracarolina*) with humidity has no significant effect, the relationship between beetles (*Oryctes rhinoceros*) and humidity has a very significant effect with the regression equation Y3 = 4.2102 - 0.0401 X2 ** (r = -0.76; r2 = 0.58), the relationship between caterpillars (*Spodoptera litura*) with humidity has no significant effect, the relationship between the larvae of cob (*Helicoverpaarmigera*) with humidity has no significant effect, the relationship between stinky bugs (*Leptocorisaoratorius*) with the slope has a very significant effect with the regression equation Y6 = 4.4784 – 0.0415 X2 ** (r = 0.71; r2 = 0.50) and the relationship of white lice (*Trialeurodesvaporariorum*) had no significant effect (Table 7).

Table 8. Regression relationship between pest and temperature and relative humidity in corn plant

Regression relationship	Regression formula	Correlation coefficient (r)	Determination coefficient (r2)
House fly with temperature	Y1 = -7.550 + 0.301 X1*	0.55	0.30
Caterpillar cob with temperature	Y5 = -22.098 + 0.85 X1*	0.91	0.84
Stink bugs with temperature	Y6= -14.839 + 0.5811 X1**	0.83	0.70
House fly with relative humidity	Y1 = 30.81931 – 0.04621 X2*	-0.53	0.28
Beetle with relative humidity	Y3 = 4.2102 – 0.0401 X2**	-0.76	0.58
Stink bugs with relative humidity	Y6 = 4.4784 – 0.0415 X2**	0.71	0.50
Stink bugs with temperature and relative humidity	Y6 = -17.978 – 0.5677 X1 + 0.7092 X2**		

The multiple regression relationship between house flies with temperature and humidity showed no significant effect, while the multiple regression relationship between stinking bugs and temperature and humidity showed a very significant effect with the regression equation Y6 = -17.978 - 0.5677 X1 + 0.7092 X2 * * (Table 7).

The regression relationship between natural enemies with temperature and humidity is as follows: army beetles with temperature show no significant effect, the relationship of army dragonflies with temperature shows a very real effect with the regression equation Y9 = 13.8118

- 0.50423 X1 ** (r = -0.72; r2 = 0.28), the relationship between wasps and temperature showed no significant effect, and the regression relationship between red dragonflies with temperature also showed no significant effect.

Climate change can affect directly or indirectly on pest insects. Climate directly affects the bioecology of insect pests such as climate change which will cause a disruption in the process of insect breeding (decrease or increase). Indirectly climate change will affect the life support environment of insects such as climate change that causes the unavailability of food (plants) as a source of nutrition from insect pests due to too hot or too cold. Thus the existence of climate change directly or indirectly will affect the lives of pest insects, so that its role in a trophic level will be different. Often due to climate change there is an explosion of populations of certain pest insects, or the occurrence of the extinction of a pest insect (16)

4. CONCLUSSION

Based on the results and discussion above, it can be concluded as follows: there are seven pests found in the corn plantations in Sanur, among others: house fly (musadomestica) Diptera, grasshopper (*Dissosteiracarolina*) Caelifera, beetle (*Orystes rhinoceros*) Celeoptera, caterpillar (*Spodoptera litura*) Coleoptera, caterpillar (*Helicoverpaarmigera*) Lepidoptera, stink bug (*Leptocorisaaratorius*) Hemiptera, and white tick (*Trialeurodesvapararriorum*) Homoptera. Natural enemies found during the study were: army beetle (*Chauliognathuslugubris*) Coleoptera, army dragonfly (*Dunia odonatan*) Odonata, wasp (*Apisdorsata*) Hymenoptera, and red dragonfly (*Oryhetrumsabina*) Odonata.The highest prevalence of pests is obtained from house flies with a value of 21.08%, while there is a natural enemy obtained from red dragonflies with a value of 31.75%.The diversity index of pests was obtained 3.2099 with a dominance index of 0.8479, while the index of diversity of natural enemies was obtained 2.2956 with a dominance index of 0.7417. The linear regression relationship between house flies and cobworms with temperature has a significant effect, while the regression relationship between stinky bugs, with temperature has a very significant effect. The regression relationship between house fly and humidity had a significant effect, the beetle with humidity was very real, and the stink bugs with humidity had a very significant effect, while the multiple regression relationship between stink bugs with temperature and humidity had a very significant effect. The regression relationship between natural enemies (army dragonflies) and temperature shows a very real effect.

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