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Occurrence of aphids (*Aphis gossypii* Glover) on sweet pepper (*Capsicum annuum* Linn.) applied with vermicompost

Agnes S. Riñon*

Department of Entomology, College of Agriculture, Central Mindanao University, Musuan, Bukidnon, Philippines

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Abstract

The extensive use of inorganic fertilizers in agriculture brought negative impacts not only on the environment but also on the consuming public. Vermicompost as an organic fertilizer has been emerging with promising effects in the soil, plants, and environment. The paper examines the effects of varying varieties (emperor, smooth cayenne) and levels of vermicompost (100, 150, and 200 bags/ha) on the prevalence of aphids, growth, and yield performance of sweet pepper in the field. The different varieties of sweet pepper have no effect on the population of aphids and its yield. However, with the application of vermicompost, sweet peppers grown in plots applied with vermicompost at 200 bags/ha showed the most number of aphids at the vegetative stage, however, it turned out to have the least population during the fruiting stage. At flowering until the fruiting stages, the aphids permanently existed in plots applied with inorganic fertilizers. Significant results in plants' height increase, early flowering/harvesting period, and yield was observed in plots applied with vermicompost at 200 bags/ha. The higher amount (200 bags/ha) of vermicompost have contributed to the significant impact on aphid and sweet pepper response.

***Corresponding Author:** Agnes S. Riñon ✉ nmrvillar@cmu.edu.ph

Introduction

In recent years, the never-ending issues on the unfavorable outcomes of inorganic farming awakened the consuming public on the right choice of food and food products. As a consequence, some shifted into the consumption of organically yielded agricultural products that are irregularly produced and demands high market prices. With the changing food consumption, growing population, and skyrocketing prices of inorganic farm inputs, organic farming is now gaining popularity in local, national, and even international agricultural milieu. The organic product that promised potential prices in the local markets can be planted and reaped in several ways. This method ranges from the planting of common varieties adaptable to the locality to the application of botanical insecticides, herbicides, and the fertilization of varied organic fertilizers like chicken dung, cattle manure, and even vermicompost.

The vermicompost is an organic product produced from the feeding activities of the vermi or earthworm (*Eudrilus eugeniae*) in partially decomposed miscellaneous organic residues such as cereal straw, animal manure, grasses, ipil ipil leaves, madre de cacao, sawdust, and even rotten vegetable wastes. It is an enriched organic fertilizer which is known to have several positive impacts on the growth and development of several major crops, including rice, corn and even different vegetable species.

Capsicum annuum Linn. is one of the popularly grown vegetable in the Philippines. Although it can be planted anywhere in the country, its production is usually constraint by diseases and insect pests' infestation. As a consequence, the majority of the vegetable farmers prefer for the application of inorganic chemicals to quickly address the problems on disease-carrying pathogens and insect pests. However, the method brought high pesticide residues that harm not only the consumers, but also with the whole agroecosystem, including the soil. Because of the perennial problems brought about by the unending use of these inorganic chemicals, organic farming came into the scenario.

Generally, the purpose of the research study is to evaluate the performance of aphids on vermicompost applied sweet pepper. Specifically, it aimed to:

a. Assess which of the vermicompost applied sweet pepper will display the most/least number of aphids
b. Determine the prevalence of natural enemies associated with sweet pepper and their relationship with the insect pests
c. Verify which variety produces more yields

Materials and methods

Experimental Design and Treatments

The investigation was carried out in the Agricultural Experiment Station, Central, Mindanao University, Musuan, Bukidnon. It was laid in split-plot experiment arranged in a Randomized Complete Block Design, replicated three times. Factor A was the two varieties of sweet pepper and Factor B was the different rates of vermicompost. The treatments were as follows:

T_1 – Variety 1 + Inorganic Fertilizer
T_2 – Variety 1 + Vermicompost @ 100 bags/ha
T_3 – Variety 1 + Vermicompost @ 150 bags/ha
T_4 – Variety 1 + Vermicompost @ 200 bags/ha
T_5 – Variety 2 + Inorganic Fertilizer
T_6 – Variety 2 + Vermicompost @ 100 bags/ha
T_7 – Variety 2 + Vermicompost @ 150 bags/ha
T_8 – Variety 2 + Vermicompost @ 200 bags/ha

Nursery Preparation and Sowing

To develop vigorous seedlings and to avoid insect pests' and diseases infestation, the nursery was set in an area away from those that were previously planted with vegetable crops of the nightshade family. The sweet pepper seeds were sown in the germination box containing a mixture of 3 parts vermicompost and 1-part carbonized rice hull for faster growth and effortless pulling. At two leaf-stage, the seedlings were pricked in the rolled banana leaves and were placed in areas with partial shade.

Land Preparation and Transplanting

Strict sanitation within the vicinity of the experimental area was conducted prior to land preparation to eliminate weeds and breeding sites of

some insect pests and disease-causing pathogens that might cause harm to the developing sweet pepper. Thorough plowing and harrowing were done to fully remove unwanted vegetation and pulverize soil clods.

The seedlings were transplanted when they were 4 weeks old or about 4-6 inches in height. The method was done late in the afternoon to minimize transplanting shock. The seedlings were planted at .5 x .75m apart. On the following day, they were covered with cut banana bracts to prevent from over-exposure to direct sunlight.

Fertilization

A vermicompost at the rate of 100 bags/ha (treatments 2 and 6), 150 bags/ha (treatments 3 and 7), and 200 bags/ha (treatments 4 and 8) were applied basally prior to transplanting to supplement soil fertility. Inorganic fertilization was done following the split method. Treatments 1 and 5 were basally applied and side dressed during the flowering stage.

Sampling of arthropods

The sampling of insect pests and natural enemies was done one week after transplanting until the harvesting period on a 15-day interval. The method was carried out by visual counting and netting. Visual counting was performed by a thorough examination from the base until the tip of 10 sample sweet pepper plants per plot. Sweep netting was performed in a diagonal manner at 10 sweeps per plot. All insect pests and natural enemies collected were brought to the laboratory for sorting and identification.

Growth and growth parameters

The collection of the data on the growth and other growth parameters of sweet pepper were done together with insect sampling under the following methods:

a. Plants' height. This was done by simply measuring the sweet pepper from the base until its tip. Only 10 sample plants were measured per plot.
b. Number of days to flower/first harvest. The data on these were taken when 50% of the sweet pepper plants bear flowers and fruits.

Harvesting

The harvesting of matured sweet pepper was conducted at 80-100 days after transplanting. The shiny and soft fruits were harvested first and were immediately brought to the laboratory for sorting. Also, deformed and damaged fruits were collected to avoid the spread of insect pests and diseases.

Statistical analysis

The data were analyzed using the analysis of variance (ANOVA) for split-plot experiment arranged in RCBD. Treatment means were compared using Duncan's Multiple Range Test (DMRT).

Results and discussions

Population density of aphids, aphis gossypii glover

Several species of insect pests had occurred in the experimental area during the whole duration of the research period. However, the majority were just seen occasionally that preferred to feed on other vegetables species nearby. The only insect pest species observed was the aphids, *Aphis gossypii* Glover, Hemiptera: Aphididae (Fig. 1). They were found abundantly and produced several generations from the vegetative until the fruiting stages of the sweet pepper hence, considered being the only major insect pest at that time.

Fig. 1. Aphids, Aphis gossypii Glover present in sweet pepper (*Capsicum annuum* Linn.).

The population density of aphids (*Aphis gossypii* Glover) at different growth stages of sweet pepper is presented in Fig. 2. Aphid population increased remarkably in all growth stages.

At the vegetative stage, plots applied with vermicompost at the rate of 200 bags/ha obtained the highest aphid population of 52.17 individuals. This differed significantly with plots used with vermicompost at the rate of 150 and 100 bags/ha, and plots applied with inorganic fertilizers having 46.17, 38.00, and 33.50 individuals respectively. The high population density of aphids in plots with the highest amount of vermicompost can be attributed more to the faster growth of plants which provided them with their nutritional requirements at that time. On the contrary at flowering stage, plots applied with inorganic fertilizers now obtained the highest aphid population of 218.67 individuals that differed significantly with plots applied with vermicompost at the rate of 200 and 150 bags/ha with 206.50 and 203.67 individuals respectively. However, it failed to show significant the difference with plots applied with vermicompost at the rate of 100 bags/ha having 218.67 individuals. At the fruiting stage, the highest population was still shown in plots applied with inorganic fertilizers having 520.00 individuals. It differed significantly with plots applied with vermicompost at the rate of 200, 150, and 100 bags/ha having 464.33, 485.50 and 498.83 individuals, respectively.

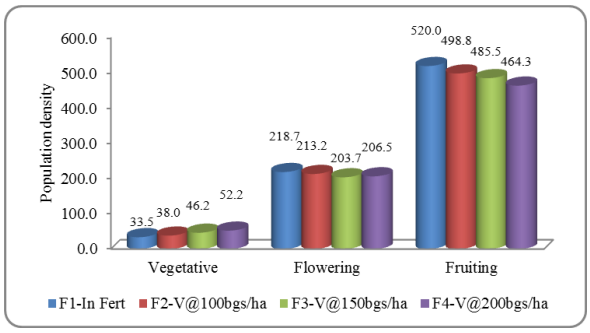

Fig. 2. Population density of aphids, *Aphis gossypii* Glover at different growth stages of sweet pepper

Natural Enemies Associated with Sweet Pepper

Prevalence of Natural Enemies

The natural enemies (Table 1) such as dragonfly, *Orthetrum* sp., lady beetles *Cheilomenes sexmaculatus, Minochilus* sp, *Micraspis discolor* and spider, *Araneus* sp were prevalent from the vegetative until the fruiting stages of sweet pepper. However, only the latter two species slightly suppressed aphid populations because of their considerable number compared to the other species. Predation by lady beetle, *Micraspis discolor* mostly happened at the vegetative stage, particularly in plants applied with inorganic fertilizer.

Table 1. Prevalence of natural enemies on sweet pepper.

Taxa	Growth Stages		
	Vegetative Stage	Flowering Stage	Fruiting Stage
Odonata			
Libellulidae			
Orthetrum sp.	✓	✓	✓
Coleoptera			
Coccinellidae			
Cheilomenes	✓	✓	✓
sexmaculatus	✓	✓	✓
Menochilus sp.	✓	✓	✓
Micraspis discolor			
Araneae			
Araneidae			
Araneus sp.	✓	✓	✓

Predator-Prey Relationship

The association among predators and prey in the field was observed as exhibited by the presence of predaceous lady beetle, *Micraspis discolor* and spider, *Araneus* sp versus the aphids, *Aphis gossypii.*

As shown in Fig. 3, there was a remarkable increase in the aphid population from vegetative until the fruiting stage. Similar flow, although in minimal number was also observed among lady beetles *Micraspis discolor* and spiders Araneus sp. This scenario clearly implied that predators' population can be triggered by the abundance of their prey. However, they failed to suppress the population of the aphids because of being outnumbered by their preys. Despite of the significant population of aphids, no control measure was implemented since the total damage failed to reach the economic injury level.

Growth Parameters and Yield

Sweet pepper varieties are not significantly different from one another in terms of their growth. The vermicompost stimulates the developmeent of a wide range of plant species, including horticultural crops like pepper (Arancon *et al.*, 2005). The sweet pepper growth as measured by the plants' height showed a significant increase from vegetative until the fruiting stages (Fig. 4).

In all three growth stages, all the plots applied with vermicompost at the rate of 200 bags/ha differed significantly with the plots applied with inorganic fertilizers. However, it failed to show significant difference from those plots applied with vermicompost at the rate of 150 and 100 bags/ha.

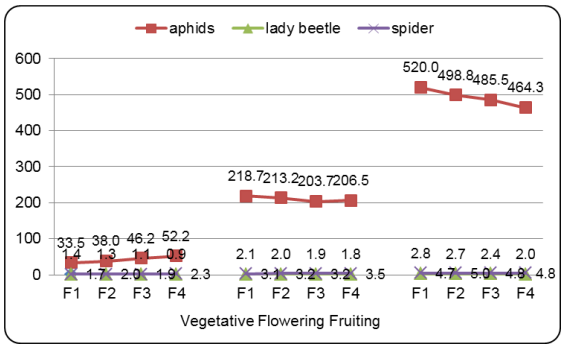

Fig. 3. Population density of aphid, lady beetle, (*Micraspis discolor*) and spider, at different growth stages of sweet pepper.

The result indicated that, the significant increase in plants' height could be more accounted to the greater amount of vermicompost applied in the field. This result is in agreement with the findings of Narkhede *et al.* (2011) who reported that significant increase in plants' height, leaf length, and fruit yield of pepper plants was observed in plots treated with vermicompost.

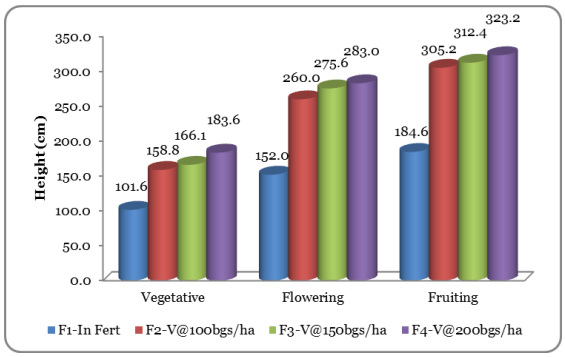

Fig. 4. Height (cm) at different growth stages of sweet pepper.

The performance of sweet pepper on the number of days to produce flowers is dependent on the kind of the variety used (Table 2). Variety 2 was the first to develop flowers at an average of 32.58 days after transplanting, this significantly differed from Variety 1 that develop flowers at an average of 33.58 days after transplanting. The plots applied with vermicompost at the rate of 200 bags/ha was the first group to develop flowers at an average of 30.33 days after transplanting. Plots applied with vermicompost at the rate of 150 and 100 bags/ha were the second and the third groups to develop flowers at an average of 32.17 and 34.00 days after transplanting, respectively. The plots applied with inorganic fertilizers were the last group to develop flowers at an average of 35.83 days after transplanting. Each treatment differed significantly with one another. Consequently, plots that produce flowers first were also the same plots harvested first, and the last plots to produce flowers were also the last plots harvested. The result indicated that early flowering and harvesting can be achieved with the application of more amounts of vermicompost.

No significant difference was noted with the non-marketable yield of the different varieties. However, the plots applied with vermicompost at the rate of 200 bags/ha reflected the highest marketable mean the yield of 250.83 g/plot that differed significantly with plots applied with inorganic fertilizers, which were found to have the lowest marketable yield of 89.17 g/plot. Plots applied with vermicompost at the rate of 150 bags/ha with a yield of 197.50 g/plot, are not significantly different from plots applied with vermicompost at the rate of 100 bags/ha with a mean yield of 180.00 g/plot but significantly different from plots applied with inorganic fertilizers with a mean yield of 89.17 g/plot.

For treatment combinations, Variety 2 applied with vermicompost at the rate of 200 bags/ha with a mean yield of 340.00 g/plot differed significantly from the rest of the treatment combinations. Also, this variety applied with vermicompost at the rate of 150 and 100 bags/ha with a mean yield of 220.00 and 215.00 g/plot significantly differed from Varieties 1 and 2 applied with inorganic fertilizer with a mean yield of 88.33 g/plot and 90.00 g/plot respectively, and Variety 1 applied with vermicompost at the rate of 100 bags/ha with a mean yield of 145.00 g/plot, however, it failed to show a significant difference

from Variety 1 applied with vermicompost at the rate of 150 and 200 bags/ha with a mean yield of 175.00 and 161.67 g/plot, respectively.

Marketable yield revealed that plots applied with vermicompost at the rate of 200 bags/ha is 64.5% higher than plots applied with inorganic fertilizers. This conforms with the findings of Llaven *et al.* (2008) that the number of marketable pepper fruits per plant was significantly 1.5 and 1.9 times greater in the 1:2 and 1:3 vermicompost soil treatments compared to plants cultivated in unamended soil after 90 days. In the non-marketable yield, the varieties used failed to show significant difference among each other. But, it was noted that plots applied with vermicompost at the rate of 200 bags/ha with a mean yield of 66.67 g/plot is significantly different from plots applied with inorganic fertilizer with a mean yield of 37.50 g/plot, but, failed to show significant difference from those applied with vermicompost at the rate of 150 and 100 bags/ha with a mean yield of 60.00 and 43.33 g/plot, respectively.

However, the total yield is not comparable with the national average yield of sweet pepper due to the presence of *Sclerotium rolsfii* at the base of the stems that caused the plant to wilt and eventually die during the late fruiting stage

Table 2. Growth parameters and yield of sweet pepper.

	No. of days to flower	No. of days to first harvest	Yield			
			Marketable		Non-marketable	
			g/plot	kg/ha	g/plot	kg/ha
Varieties						
V_1	33.58^a	73.63	142.50	950.0	49.58	330.53
V_2	32.58^b	72.33	216.25	1,441.66	54.17	361.13
F Test	*	ns	ns		ns	
Fertilizers						
F_1 Inorganic fert	35.83^a	84.00^a	89.17^c	713.36	37.50^b	300.00
F_2 V @ 100bgs/ha	34.00^b	75.96^b	180.00^b	1,440.00	43.33^{ab}	346.64
F_3 V @ 150bgs/ha	32.17^c	67.80^c	197.50^{ab}	1,580.00	60.00^{ab}	480.00
F_4 V @ 200bgs/ha	30.33^d	64.17^d	250.83^a	2006.64	66.67^a	533.36
F Test	**	**	**		*	
Treatment combinations						
V_1F_1	36.00	36.00	88.33^d	706.64	45.00	300.00
V_1F_2	34.67	34.67	145.00^{cd}	966.67	48.33	322.20
V_1F_3	32.67	32.67	175.00^{bc}	1,166.66	43.33	288.86
V_1F_4	31.00	31.00	161.67^{bc}	1,077.80	61.67	411.13
V_2F_1	35.67	35.67	90.00^d	600.00	30.00	200.00
V_2F_2	33.33	33.33	215.00^b	1,433.33	38.33	255.53
V_2F_3	31.67	31.67	220.00^b	1,466.67	76.67	511.13
V_2F_4	29.67	29.67	340.00^a	2,266.67	71.67	477.80
F Test	ns	ns	*		ns	
cv (a)	1.07%	3.72%	48.29%		43.42%	
cv (b)	2.25%	3.78%	27.31%		34.66%	

Conclusions

Vermicompost can be described as a mixture of earthworm, *Eudrilus eugeniae* feces, decomposed organic matter from agricultural wastes and microorganisms like bacteria and fungi as decomposing agents. When applied in greater amounts (200 bgs/ha) will reduce aphid population particularly at the flowering and fruiting stages. The use of inorganic fertilizers in sweet pepper production particularly at flowering and fruiting stages will allow the continuous growth and reproduction of aphids since it provided them their nutrient requirements to produce several generations. The natural enemies when outnumbered cannot suppress the population of their preys, also they are mostly found in areas where their host is abundant. The rapid increase in plants' height, early flowering, and harvesting as well as promising yield can also be attributed to vermicomposts. The significant performance of vermicompost in the reduction of aphid population and the beneficial effects on plants growth and yield has great potential in sweet pepper production.

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