Effect Of Intercropping System On Green Peach Aphid Dinamics On Organic Farming Of Potato In Karo Highland

Lamria Sidauruk, Darma Bakti, Retna Astuti Kuswardani, Chairani Hanum

Abstract: Green peach aphid (Myzus persicae Sulzer) represents one of the major pest affecting decreased production which found in different potato fields in Karo Highland. This study was conducted to determine the population dynamics of Myzus persicae (Sulzer) on potato cropping system. The experiment was laid out in split plot design with main plot are farming system such as: conventional farming, semi organic farming and organic farming. The sub plot are intercropping system consist of: potato monoculture, potato with cabbage, potato with mustard, potato with celery, potato with cabbage and mustard, potato with cabbage and celery, potato with mustard and celery, potato with cabbage, mustard and celery. Research carried out for two planting season. The first at May-August and the second at September-December. The results showed that M. persicae was consistently at different densities in different intercropping system on potato. The aphid was first recorded at three week until planting. The kind of intercroppingculture plants significantly reduced the number of aphid at two planting season. Intercropping system decrease population of M. persicae at potato. At 9 weeks after planting, the decreased are respectively at intercropping potato with mustard (3.97 aphid/leaf), potato with cabbage and mustard (4.43 aphid/leaf) and potato with celery (4.45 aphid/leaf). At 11 weeks after planting, the decreased are respectively at intercropping potato with mustard (2.99 aphid per leaf), potato with cabbage (3.10 aphid/leaf) and potato with cabbage and mustard (3.60 aphid/leaf). At 7 weeks after planting, the highest population of natural enemies Braconid wasp was found on intercropping potato with cabbage(2.62 braconid wasp/plant) and at 9 weeks was found on intercropping potato with cabbage, mustard and celery (2.38 braconid wasp/plant). The highest population of Coccinellidae found on intercropping potato with cabbage, mustard and celery (1.80/plant) at 11 weeks after planting.

Index Terms: Green peach aphid, intercropping, potato

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- *Many studies have been reported on the use of growth regulators or mycorrhizal fungi in decreasing harmful effects of environmental stress. Mycorrhiza fungi increase growth, photosynthetic pigments and photosynthesis of host plants by better mineral nutrition. They cause chlorophyll organs of plant to grow by absorbing required carbon, giving nutriments to plant and increasing efficiency of photosynthesis (Enteshari,and Hajbagheri, 2011any studies have been reported on the use of growth regulators or mycorrhizal fungi in decreasing harmful effects of environmental stress. Mycorrhiza fungi increase growth, photosynthetic pigments and photosynthesis of host plants by better mineral nutrition. They cause chlorophyll organs of plant to grow by absorbing required carbon, giving nutriments to plant and increasing efficiency of photosynthesis (Enteshari,and Hajbagheri, 2011) [6].*

1 INTRODUCTION

The green peach-potato aphid Myzus persicae (Sulzer) is found throughout the word as an economically important pest of peach, tobacco, vegetables, and flowers (Adachi-Hamigori, 2011; Capinera, 2011)[1,2]. The pest multiplies rapidly and become a limiting factor in obtaining high yield of the crop (Kurl, et al, 2010)[3]. One of the important pests of potato crop in Indonesia is M. persicae (Taulu dan Krisen, 2003)[4] including in Karo Highland. This insects from the order of Hemiptera and family Aphididae, found scattered throughout the world as a pest on a variety of horticultural plant and as a plant viral vector (Kalshoven, 1981; Lai, et al. 2011; Capinera, 2011)[5,6,2]. Among the pests infesting potato crops, green peach aphid represents one of the most virulent insects (Musa,et al,2004)[7] can caused considerable damage to the potato crop by dwarfing and curling the leaves, and by dwarfing and spindling the tops (Saljoqi, et al., 2009; Capinera,2011) [8,2]. This aphid also a vector of viruses, and yield loses caused by these viruses can be as high as 90% depending on cultivar, infestation and environmental conditions (Margaritopoulos, et al. 2002; Saljoqi,et al., 2009)[9,8]. Cropping system refers to the crops and crop sequences and the management techniques used on a particular field over a period of years (Gliessman, 1988; Nafziger, 1990; Prabhu, et al, 2009)[10,11,12]. Mixed cropping systems in organic farming offer a yield buffer capacity by diverse growing demands and different periods of root, leave and seed development of the plant varieties (Paulsen, et al, 2006)[13]. Organic farming system offers many opportunities for enhancing biological control factor on field (Fouche, et. Al., 2000)[14]. Studies have shown that mixed cropping has been advantageous in reducing insect pests and disease damage in some areas through diversifying the cropping system by introducing plant species that are nonhosts for certain insects and diseases (Jones, 2007; Jaboour, et.al.,2011)[15,16]. Various studies showed that intercropping patterns effectively reduce pests in agro-ecosystems. De Sousa (2007)[17]

reported that there is reduction in the incidence of pest attacks are very significant in the cropping pattern of intercropping maize with cotton compared to the monoculture cropping of corn and cotton. Intercropping pattern in horticultural crops will be increase diversifitas and stability of agricultural ecosystems, increase farmers income, reduce soil erosion and reduce investment pests and plant diseases (Ouma and Jeruto, 2010; Hinds and Hooks, 2013)[18,19]. Sutrisna, et al (2010)[20] reported that intercropping potato and celery can lower leaf pests Trips by 44 percent and pest aphids M. persicae by 55.6 percent in the potato crop. Koestoni and Sastrosiswojo (1985) [21] also found that a declining in attacks potato aphids M. persicae on potato crop intercropping with maize and sunflower. Straub et al (2014)[22]. indicate that intercropping with nonhost plants promotes leafhopper movement and vulnerability to predation, and reveal a novel mechanism by which plant diversity can reduce herbivory. This study was carried out to determine the population dynamics of Myzus persicae (Sulzer) on organic farming of potato as affected by intercropping system.

2 MATERIALS AND METHODS

This study was conducted at Balai Benih Induk Kentang, Berastagi begin at May 2013 until December 2013. Study carried out for two planting seasons which arranged by Split Plot Design with three replicates. Main plot are farming system such as: conventional farming, semi organic farming and organic farming and sub plot are cropping system such as: monoculture potato (P1); potato intercrop with cabbage (P2); Potato with mustard (P3); potato wit celery (P4); potato with cabbage and mustard (P5); potato with cabbage and celery (P6); potato with mustard and celery (P7); potato with cabbage, mustard and celery (P8). Other agronomic practices i.e. irrigation, hoeing, weeding and earthing-up were done as necessary. The data of population density of *M. persicae* and its associated natural enemies was recorded from the date of start of initial aphid infestation at 3 weeks after planting up to 11 weeks after planting. *Myzus persicae* were counted on three tagged leaves on each plant, one each in the top, middle and lower regions of three randomly selected plants, avoiding the border rows, from each plot. Mean aphid population per leaf was calculated. The data was recorded on the same leaves every couple of week. Natural enemies population i.e. predator *Coccinellidae* and parasitoid *braconid wasp* was collected per potato plant, by selecting three plants from each replicate. All data were subjected to Analysis of Variance (ANOVA) using SAS statistical software. Also, means were separated by Tukey Range Test at 5% level of significance.

3 RESULTS AND DISCUSSION

Analysis of variance showed that farming system and intercropping system significanly affect population density of *M. persicae* and the natural enemies. *M. persicae* remained a consistent pest with different densities throughout the different farming system (figure 1 and figure 2).The population of Braconid wasp and Coccinellidae at organic farming more higher than conventional farming at two planting season (figure 3, figure 4, figure 5 and figure 6). Decreasing population of pest and natural enemies on conventional farming because of continuous application pesticide to control the pest. Pesticide also killed beneficial insect at the field. It can be seen from the natural enemy populations such as: braconid wasp and coccinellidae are higher in organic farming systems than conventional system at first planting season and second planting season (Tabel 1 and 2). For other pests and pathogens, organic practices promote suitable conditions for population growth, resulting in particular challenges for growers with limited agrochemical options. Organic farming system affects not only above-ground biodiversity, but also soil biodiversity. If higher biodiversity in agroecosystems reduces invasibility, then we can expect a reduced spread of pests and diseases in organic compared to conventional farms (Letourneau and Ariana,2006)[23]. The strength of aphid suppression always increased with greater predator biodiversity, but this effect was independent of prey species diversity or identity, and no niche differentiation by aphid species was apparent among the predator species (Snyder, et al.,2008)[24]. The population of natural enemies more higher at intercropping system than monoculture system. Therefore, intercropping could be recommended as a protection method to reducing pest population on the field (Sharaby, et al. 2015)[25].

***Tabel 1**. Population of Braconid wasp at 9 and 11 weeks*

Plant age	Farming/Intercropping system	Planting Season		Average
		May-Aug	Sep-Oct	
9 Week	*Farming system*			
	Conventional	1.13	1.71	1.30 a
	Semi organic	1.47	4.09	2.79 b
	Organic	1.45	3.96	2.78 b
	Average	1.35	3.25	2.30
	Intercropping system			
	Potato Monoculture	1.21	2.47	1.77 a
	Potato+Cabbage	1.49	3.72	2.62 ab
	Potato+Mustard	1.40	3.36	2.36 ab
	Potato+Celery	1.29	2.47	1.83 a
	Potato+Cabbage+Mustard	1.28	3.61	2.40 ab
	Potato+Cabbage+Celery	1.23	2.14	1.72 a
	Potato+Mustard+Celery	1.32	3.72	2.44 ab
	Pot+Cabge+Mustard+Celry	1.59	4.53	3.15 b
	Average	1.35	3.25	2.29
11 Week	*Farming system*			
	Conventional	1.21	1.48	1.23 a
	Semi organic	1.50	1.50	2.02 b
	Organic	1.46	1.46	1.94 b
	Average	1.39	1.48	1.73
	Intercropping system			
	Potato Monoculture	1.22	1.61	1.35 a
	Potato+Cabbage	1.47	2.17	1.88 c
	Potato+Mustard	1.45	2.22	1.83 bc
	Potato+Celery	1.34	1.69	1.51 ab
	Potato+Cabbage+Mustard	1.31	2.14	1.71 bc
	Potato+Cabbage+Celery	1.33	1.86	1.61

				abc
	Potato+Mustard+Celery	1.39	1.97	1.59 abc
	Pot+Cabge+Mustrd+Celr y	1.58	2.81	2.38 d
	Average	1.39	2.06	1.74

Note : Mean values by the same letter do not significantly differ based Tukey Range Test (F = 0.05)

Table 2. *Population of Coccinellidae at 11 weeks*

Farming/Intercropping system	Planting Season		Ave rage
	May-Aug	Sept-Oct	
Farming system			
Conventional	1.18	1.04	1.11a
Semi organic	1.78	1.51	1.65b
Organic	1.86	1.65	1.75b
Average	1.61	1.40	
Intercropping system			
Potato Monoculture	1.49	1.50	1.32ab
Potato+Cabbage	1.35	1.34	1.35ab
Potato+Mustard	1.88	1.57	1.73cd
Potato+Celery	1.40	1.02	1.21a
Potato+Cabbage+Mustard	1.78	1.39	1.59bc d
Potato+Cabbage+Celery	1.45	1.45	1.45ab c
Potato+Mustard+Celery	1.54	1.54	1.54bc
Pot+Cabbage+Mustard+Celer y	1.96	1.75	1.80d
Average	1.61b	1.45a	1.50

Note: Mean values by the same letter do not significantly differ based Tukey Range Test (F = 0.05)

Intercropping system decrease population of *M. persicae* on potato at two planting season (figure 7 and figure 8). The mean of population at 9 weeks after planting, the decreased are respectively at intercropping potato with mustard (3.97 aphid/leaf), potato with cabbage and mustard (4.43 aphid/leaf) and potato with celery (4.45 aphid/leaf). At 11 weeks after planting, the decreased are respectively at intercropping potato with mustard (2.99 aphid per leaf), potato with cabbage (3.10 aphid/leaf) and potato with cabbage and mustard (3.60 aphid/leaf) (Table 3).

Table 3. *Population of M. persicae at two planting season*

Plant age	Intercropping system	Planting Season		Ave rage
		May-Aug	Sep-Oct	
9 Week	Potato monoculture	8.14	6.11	7.13d
	Potato+Cabbage	4.25	5.00	4.62ab
	Potato+Mustard	3.89	4.06	3.97a
	Potato+Celery	4.56	4.33	4.45ab
	Potato+Cabbage+Mustar d	4.28	4.58	4.43ab
	Potato+Cabbage+Celery	6.00	4.94	5.47bc
	Potato+Mustard+Celery	6.86	5.50	6.18c
	Pot+Cabge+Mustard+Cel ery	6.31	5.35	5.83bc d
	Average	5.54b	4.98a	5.26
11 Week	Monoculture Potato	5.64	2.86	4.25c
	Potato+Cabbage	3.39	2.81	3.10ab
	Potato+Mustard	3.44	2.53	2.99a
	Potato+Celery	4.50	3.22	3.86ab c
	Potato+Cabbage+Mustar d	4.44	2.81	3.62ab c
	Potato+Cabbage+Celery	5.00	3.28	4.14c
	Potato+Mustard+Celery	5.19	2.75	3.97ab c
	Pot+Cabge+Mustard+Cel ery	4.83	3.25	4.04bc
	Average	4.55b	3.30a	3.92

Note: Mean values by the same letter do not significantly differ based Tukey Range Test (F = 0.05)

Increasing biodiversity by intercropping system had positive effects for species richness commonly observed among predator species may extend to pathogen communities as well, such that conserving pathogen biodiversity may carry additional benefits for biological control. In biological control communities, greater predator species richness often strengthens pest suppression (Jabbour, et al.2011)[16]. Botham, et al. (2015)[26] reported that the composition of the Lepidoptera fauna changes with habitat size depending on the diversity of habitats in the landscape, particularly at the larger spatial scale. De Sousa (2007)[17] reported that there is reduction in the incidence of pest attacks are very significant in the cropping pattern of intercropping maize with cotton compared to the monoculture cropping of corn and cotton. Intercropping pattern in horticultural crops will be increase diversifitas and stability of agricultural ecosystems, increase farmers income, reduce soil erosion and reduce investment pests and plant diseases (Ouma and Jeruto, 2010; Hinds and Hooks, 2013)[18,19]. Sutrisna, et al (2010)[20] reported that intercropping potato and celery can lower leaf pests Trips by 44 percent and pest aphids *M. persicae* by 55.6 percent in the potato crop. Intercropping system on potato reduced pest infestation of whitefly 51.3% and aphid 62.69% (Sharaby, et al. 2015)[25].

4 CONCLUSION

Farming system significantly affected the population of *M. persicae* and the natural enemies Braconid wasp and Coccinellidae. Intercropping system significantly reduced the population of *M. persicae* . At the two planting season, the lowest number of *M. persicae* population found respectively in intercropping potatoes withd mustard, potatoes with cabbage and potatoes with celery. The number of Braconid wasp significantly increased at intercropping potato with cabbage, mustard and celery, potato with cabbage and potato with mustard and celery respectively. The number of Coccinellidae significantly increased at intercropping potato with cabbage, mustard and celery, potato with mustard and potato with cannage and mustard respectively.

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REFERENCES

[1] Adachi-Hagimori, T., M.Shibao, H. Tanaka, T. Seko and K. Miura,"Control of Myzus persicae and Lipaphis erysimi (Hemiptera: Ahididae) by Adult and Larvae of Flightless Strain of Harmonia axyridis (Coleoptera: Coccinellidae) on Non-heading Brassica Cultivars in Greenhouse",Biocontrol 56: 207-213,2011.

[2] Capinera, J.L., "Green Peach Aphid, Myzus persicae (Sulzer) (Insecta: Hemiptera: Aphididae)", The Institute of Food and Agricultural Sciences (IFAS). University of Florida, Gainesville.2011.

[3] Kurl, S.P., N. Parihar and K. Malik., 2010," Population Estimation of Myzus persicae (Sulzer) on Cauliflower", J. Exp.Zool. India 13(1): 243-245, 2010.

[4] Taulu,L.A. dan J.Krisen, "Hama dan Penyakit Penting Tanaman Kentang di Kecamatan Modoinding dan Modayak", Eugenia 9 (4):45-51, 2003.

[5] Kalshoven, L.G.E., "Pests of Crops In Indonesia", PT. Ichtiar Baru- Van Hoeve. Jakarta. Pp. 398- 410. 1981.

[6] Lai, R., M.You, L.A.P. Lotz and L. Vasseur, "Response of Green Peach Aphids and Other Arthropods to Garlic Intercropped with Tobacco", Agronomy Journal 103 (3): 856-863, 2011.

[7] Musa, F.M. C. Carli, L.R. Susuri dan Ismail M. Pireva, "Monitoring of Myzus persicae (Sulzer) in potato fields in Kosovo", Acta agriculturae slovenica, 83 (2): 379-385, 2004.

[8] Saljoqi, A.U.R., K. Khan and S. Rehman," Integrated management of potato-peach aphid, Myzus persicae (sulzer)", Sarhad J. Agric. 25(4): 573-580, 2009.

[9] Margaritopoulos, J.T., J.A. Tsitsipis, S. Goudoudaki and R.L. Blackman,"Life cycle variation of Myzus persicae (Hemiptera: Aphididae) in Greece", Bulletin of Entomological Research 92: 309–319, 2002.

[10] Gliessman, S.R,"Multiple Cropping System: A Basic for Developing an Alternative Agriculture. University of California St. Cruz.p. 69-83.

[11] Nafziger, E., "Cropping System" , Department of Crop Sciences, 49-63.

[12] Prabhu, M., A.R.Kumar, V. Balasubramanian and R. Jagadeesan,"Cropping system in Tropical Vegetables", The Asian Journal of Horticulture 4(1):245-250, 2009.

[13] Paulsen, H.M., M. Schochow, B. Ulber, S. Kuhne and G. Rahmann,"Mixed Cropping Systems for Biological Control of Weed and Pests in Organic Oilseed Crops", Aspects of Applied Biology 79, 215-220. 2006.

[14] [Fouche, C., M.Gaskell, S.T. Koike, J. Mitchell and R. Smith, "Insect Pest Management for Organic Crops", Vegetable Research and Information Center. Vris.ucdavis.edu.p.1-5, 2000.

[15] Jones, V.L., 2007 Multiple Cropping as a Sustainable Agriculture Practice. Agricultural Research, Langston University, Langston .

[16] Jabbour, R., D.W. Crowder, E.A. Aultman and W.E.Snyder "Entomophatogen biodiversity increases host mortality",Biological Control 59, 277-283, 2011.

[17] De Sousa, H.F.A.,"Effect of strip intercropping of cotton and maize on pests incidence and yield in Morumbala District, Mozambique" African Crop Science Conference Proceedings Vol. 8:1053-1055, 2007.

[18] Ouma, G. & Jeruto, P., "Sustainable horticultural crop production through intercropping: The case of fruits and vegetable crops: A review", Agricultural and Biology Journal of North America 1(5): 1098-1105, 2010.

[19] Hinds, J. and C.R.R., Hooks, "Population Dinamics of Arthropods in Sunn-hemp Zucchini Interplanting System",Crop Protection 53:6-12, 2013.

[20] Sutrisna, N, Suwalan Sastraatmadja, dan Iskandar Ishaq, "Kajian Sistem Penanaman Tumpang Sari Kentang (Solanum tuberosum L.) di Lahan Dataran Tinggi Rancabali", bbp2tp.litbang.deptan.go.id. 2010.

[21] Koestoni, T. and S. Sastrosiswojo,"Pengaruh pola tanam kentang-jagung, kentang-bunga matahari dan kentang-gandum terhadap tingkat populasi kutu daun persik (Myzus persicae Sulz.) pada tanaman kentang di lapangan", Balai Penelitian Hortikultura, Lembang, Indonesia, pp: 54-59,1985.

[22] Straub, C.S., N.P. Simasek, R. Dohm, M.R. Gapinski, E.O. Aikens and C. Nagy, "Plant Diversity Increases Herbivora movement and Vulnerability to Predation", Basic and Applied Ecology, 15: 50-58, (2014).

[23] Leteourneau, D. and Ariana van Bruggen,"Crop protection in organic agriculture: a global perspective"Chapter 4. Pp. 93 -21,2005.

[24] Snyder, G.B., D.L. Finke and W. E. Snyder," Predator biodiversity strengthens aphid suppression across single- and multiple-species prey communities", Biological Control 44: 52-60, 2008.

[25] Sharaby, a., H. Abdel-Rahman and S.S. Moawad, "Intercropping System for Protection the Potato Plant from Insect Infestation", Ecologia Balkanica 7(1): 87-92, 2015.

[26] Botham, M.S., E.C. Fernandez-Ploquin, T. Brereton, C.A. Harrower, D.B. Roy and M.S. Heard, "Lepidoptera Communities Across an Agricultural Gradient: How Important are Habitat Area and Habitat Diversity in Supporting High Density?"Journal Insect Conservation. Pub. Online 19 Frbruary 2015. 17 p. 2015.

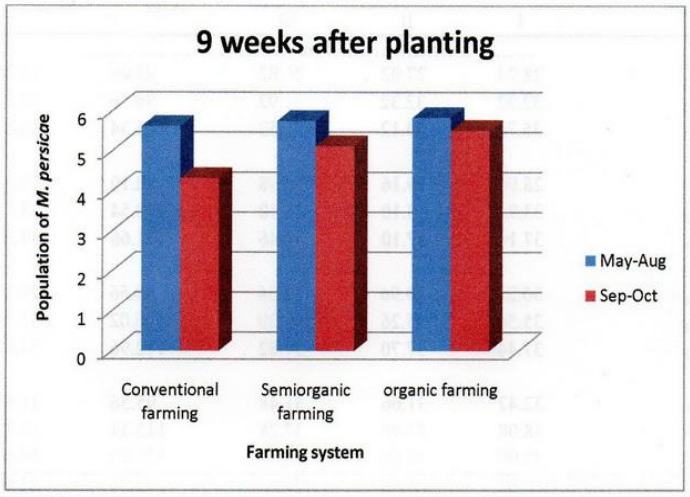


***Figure 1**. Effect of farming system on M. persicae population at 9 weeks after planting*

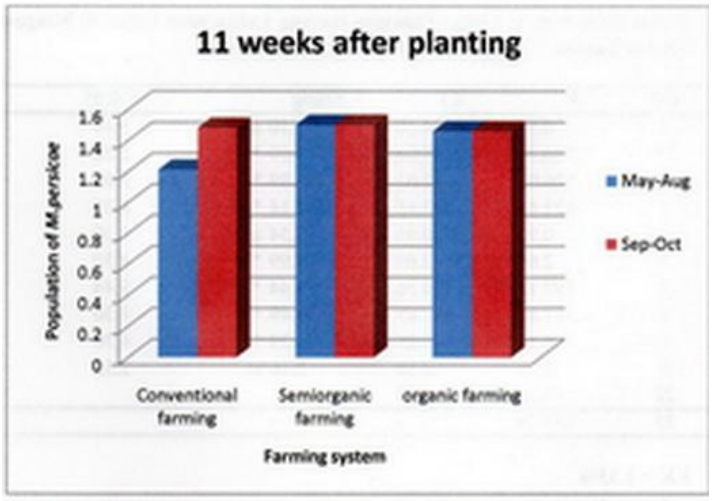


***Figure 2.** Effect of farming system on M. persicae population at 11 weeks after planting*

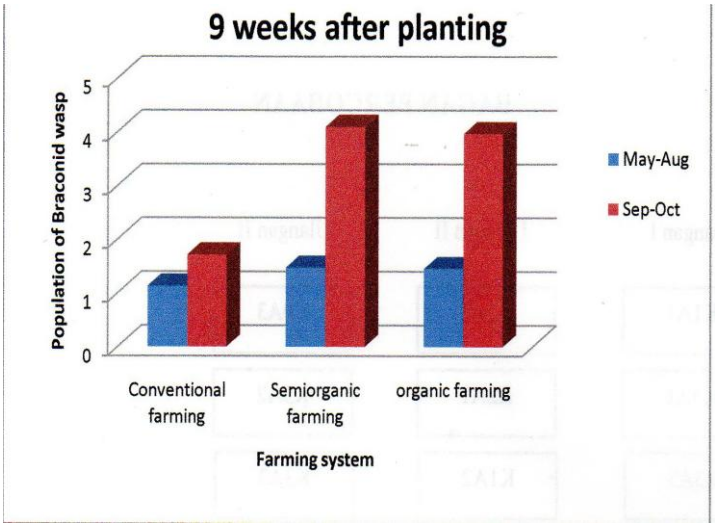
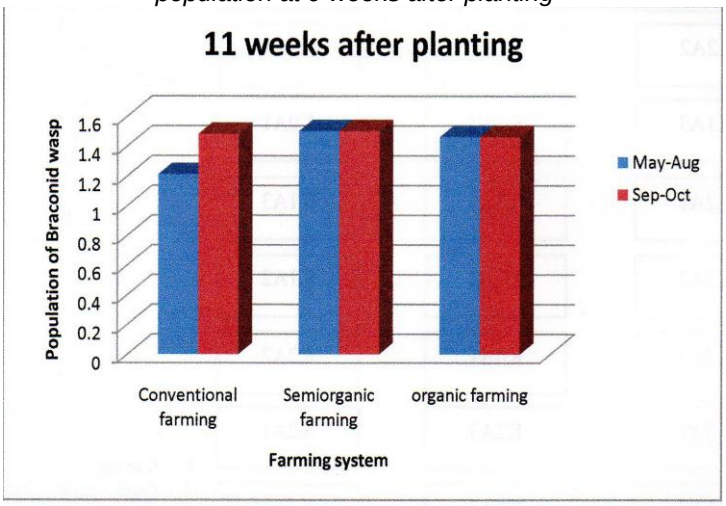


***Figure 3.** Effect of farming system on Braconid wasp population at 9 weeks after planting*



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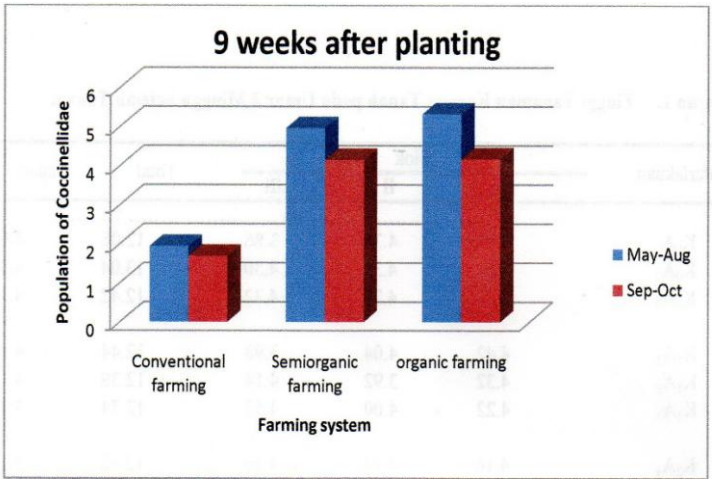

***Figure 5.** Effect of farming system on Coccinellidae population at 9 weeks after planting*

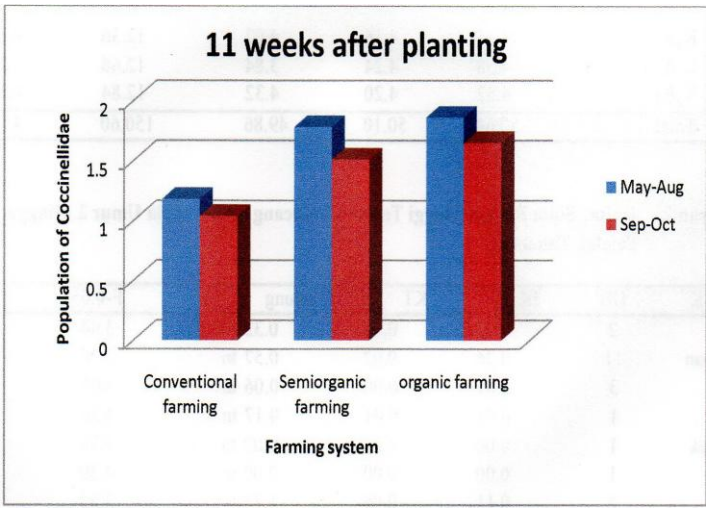

Figure 6. *Effect of farming system on Coccinellidae population at 11 weeks after planting*

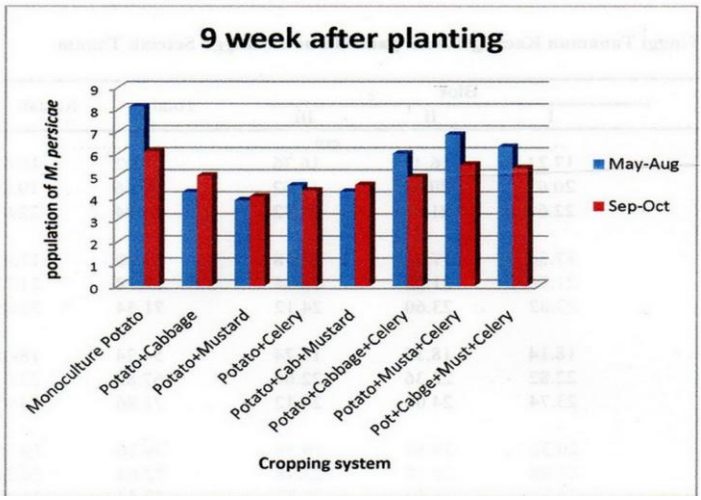

Figure 7. *Effect of cropping system on M.persicae population at 9 weeks after planting*

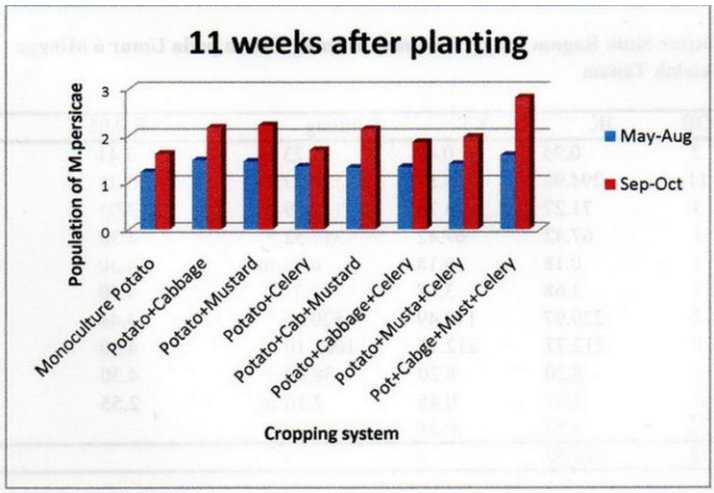

Figure 8. *Effect of cropping system on M.persicae population at 11 weeks after planting*