DOI: http://dx.doi.org/10.25181/jppt.v24i2.3278
Jurnal Penelitian Pertanian Terapan Vol. 24 (2): 268-275
Website: http://www.jurnal.polinela.ac.id/JPPT

pISSN 1410-5020
eISSN 2407-1781

Habitat Improvement In Effort To Conservation Insect Diversity And Natural Enemies On Potato Cultivation

Lamria Sidauruk[1*], Ernitha Panjaitan[2], Lince R. Panataria[3] dan Patricius Sipayung[4]

[1]Universitas Methodist Indonesia, Medan
[2]Universitas Methodist Indonesia, Medan
[3]Universitas Methodist Indonesia, Medan
[4]Universitas Katolik Santo Thomas, Sumatera Utara
[*]E-mail : lamriasidauruk@yahoo.com

ABSTRACT

This study aimed to determine the habitat approach on potato cultivation to increase diversity of insects. Habitat improvement design by agricultural system and planting system on different season. This study consisted of two experiments. The first done at planting season from March to July (dry season) and the second done at planting season from October to January (rainy season). Research designed by Split plot design with main plot are farming systems (inorganic farming and organic farming) and the subplot are the design of cropping system (sole potato; potato and cabbage; potato and mustard; potato and onion). The data was analyzed by ANOVA and Tukey test. The result showed that planting season from March to July (dry season) as well as the planting season from October to January (rainy season) showed that insect diversity index, predator population and parasitoid population were higher in organic farming compared to inorganic farming systems. The design of cropping system significantly affect insect diversity index,natural enemies population such as predator Coccinelids and parasitoid Braconid wasp and M. persicae population. In organic farming, intercropping potato with cabbage found the highest insect diversity index and the highest population of parasitoid Braconid wasp and the lowest population of M. persicae. The highest population of predator Coccinelids found at interropping potato with mustard. Combined analysis of the planting on dry season and rainy season showed that insect diversity index and population of parasitoid Baraconid wasp not significantly difference between planting on dry planting and planting on rainy season. On the other hand, population of predator Coccinellids and M. persicae significantly more higher at planting on dry season than planting on rainy season.

Keywords: *conservation, habitat_improvement, potato*

Disubmit : 29 September 2023, **Diterima:** 14 Maret 2024, **Disetujui :** 28 Mei 2024;

INTRODUCTION

Biodiversity characterizes the dynamic state of an ecosystem's health, on which human survival depends. Biodiversity refers to all species of plants, animals, and microorganisms existing and interacting within an ecosystem (McNeely et al., 1990). (Altieri, 1999) stated that restore functional biodiversity of the agricultural landscape is a key strategy in sustainable agriculture. At its simplest, biodiversity measures the number and variety of species in an ecosystem. At a deeper level, it denotes genetic diversity that contributes to the population dynamics of species and provides a measure of their richness and interdependence. Two distinct components of biodiversity can be recognized in agroecosystems. The first component, planned biodiversity, is the biodiversity associated with the crops and livestock purposely included in the agroecosystem by the farmer, and which will vary depending on the management inputs and crop spatial/temporal arrangements. The second component, associated biodiversity, includes all soil flora and fauna, herbivores, carnivores, decomposers, etc. that colonize the agroecosystem from surrounding environments and that will thrive in the agroecosystem depending on its management and structure (Vandermeer & Perfecto, 2013).

Arthropods can be used to show the developed changes of ecosystem because they are very sensitive to ecosystem change. Some react very fast to environmental changes and are ideally suited to act as bioindicators. Therefor arthropods act as bioindicators of habitat disturbance such as pollution and climate change (Vandermeer & Perfecto, 2013). Arthropods are abundant and easy to sample, and so, they give more information per unit sample time. Similarly, arthropod biodiversity often grows when crop monocultures are replaced by polycultures and when landscapes encompass a variety of habitats rather than being dominated by large cropping fields (Tscharntke et al., 2012).

Ouma and Jeruto (2010) stated that intercropping pattern in horticultural crops will be increase diversivity and stability of agricultural ecosystems, increase farmers income, reduce soil erosion and reduce investment pests and plant diseases. (Sidauruk & Sipayung, 2018) 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. Other research also reported that there are declining in attacks potato aphids M. persicae on potato crop intercropping with maize and sunflower (Sutrisna et al., 2005). There are 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 (Hinds & Hooks, 2013). However, predator diversity studies in biological control systems have manipulated predator species richness only, and not prey diversity, such that reciprocal effects of predator and prey diversity on herbivore suppression have not been examined explicitly (Straub et al., 2014).

Insect pests are regarded as one of the significant factors limiting vegetable yield. Although several control measures are available, the most convenient method employed by farmers is the use of pesticides. Pesticides kill and injure a variety of organisms including insect pests and nontarget organisms such as wildlife, pollinators, natural enemies, and decomposer organisms. They significantly affect the highly diverse community of soil microorganisms and invertebrates that regulate nutrient cycling in ecosystems. Through drift and runoffs their impact can extend beyond the farms, affecting biodiversity of life in freshwater and marine ecosystems (Warman & Kristiana, 2018). It is therefore necessary to improve our knowledge on the processes in the agro-ecosystem and, particularly, the effects of cropping systems. Cropping system could be increasing insect diversity in agroecosystems such as populations of predators and parasitoids that play a role in pest control. Thus the use of pesticides in pest control can be reduced.

A cropping system was initially defined as the combination of a crop succession and the cultivation strategies used to manage each crop, and applied to a field. Many pests though rarely stay inside a given field but disperse via seeds, spores, insect flights, etc. It is therefore necessary to extend the temporal concept of cropping system to integrate spatial components, i.e. the location of cropping systems in a landscape and the uncultivated landscape elements such as hedges, riverbeds, roads, etc. that interfere with the life-cycle and dispersal (Donatelli et al., 2017).

RESEARCH METHODOLOGY

The research was conducted at Balai Benih Induk Kentang, Berastagi begin at Februari 2022 until January 2023. Study carried out for two planting seasons such as dry season (March to July) and rainy season (October to January) which arranged by Split Plot Design with three replicates. Main plot are farming systems such as: inorganic farming and organic farming and sub plot are cropping system such as: sole potato (T1); potato with cabbage (T2); Potato with mustard (T3); potato with onion (T4). Other agronomic practices i.e. irrigation, hoeing, weeding and earthing-up were done as necessary. The data of insect diversity index, population of predator Coccinellids and parasitoid braconid wasp was collected per plot at 4, 6, 8, 10 weeks after planting. 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.

RESULT AND DISCUSSION

Insect diversity index. Analysis of variance showed that farming system and cropping system significantly affect diversity index on dry season and rainy season at 8 weeks (Figure 1) and 10 weeks after potato planting (Figure 2).

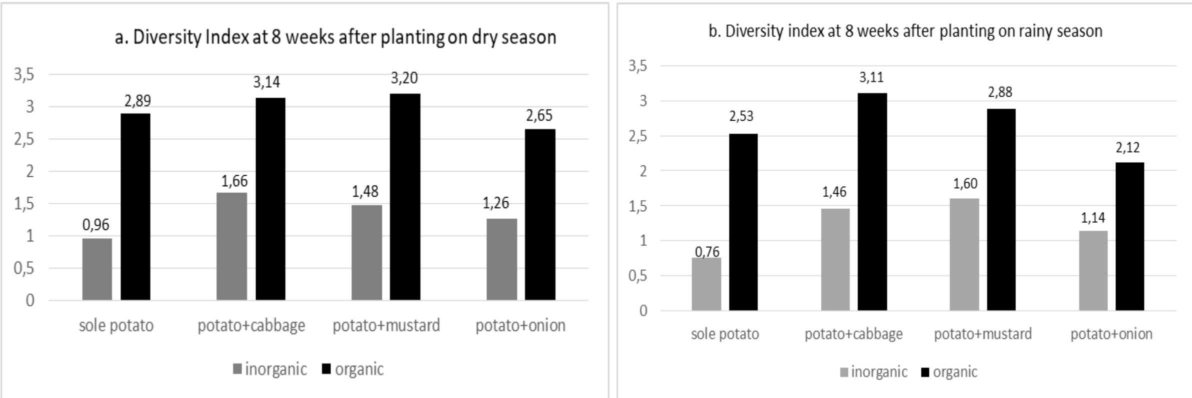

Figure 1. Insect diversity index at 8 weeks after planting on dry season (a) and rainy season (b)

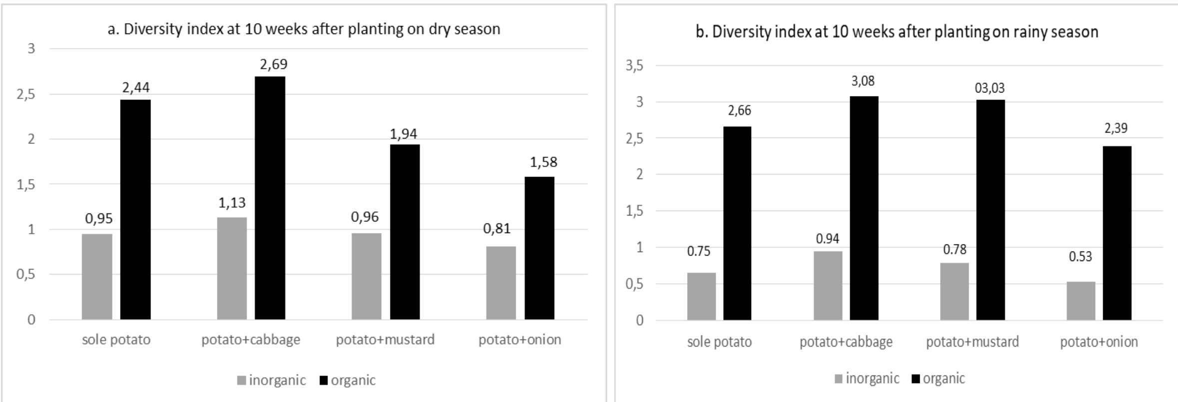

Figure 2. Insect diversity index at 10 weeks after planting on dry season (a) and rainy season (b)

Figure 1 and Figure 2 shown that in each observation, the diversity index is highest in organic farming systems, both in the dry season and in the rainy season. The diversity index (H) value in conventional farming systems is in category low to medium, while in organic farming systems it is in the medium to high category. 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 & Bothwell, 2008). One of the advantages of organic farming systems is increasing biodiversity on field compared to inorganic farming. On organic farming found a large number of species over 30 percent compared to inorganic farming, it depends on the altitude (Rahman, 2011).

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). (Botham et al., 2015) 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. Other research shown 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 (Sousa, 2007).

Population of Coccinellid. The results showed that natural enemies predominantly found in the field was predator Coccinellids. Analysis of variance showed that farming system and cropping system significanly affect population density of predator Coccinelid. The population of Coccinellid on organic farming more higher than inorganic farming at two planting season at 8 weeks after planting (figure 3) and 10 weeks after planting (figure 4).

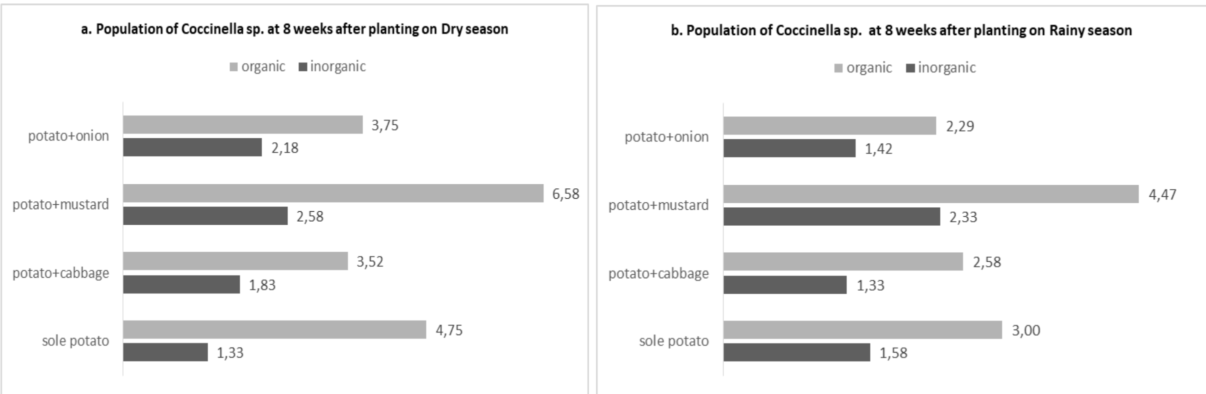

Figure 3. Population of Coccinellid at 8 weeks after planting on dry season (a) and rainy season (b)

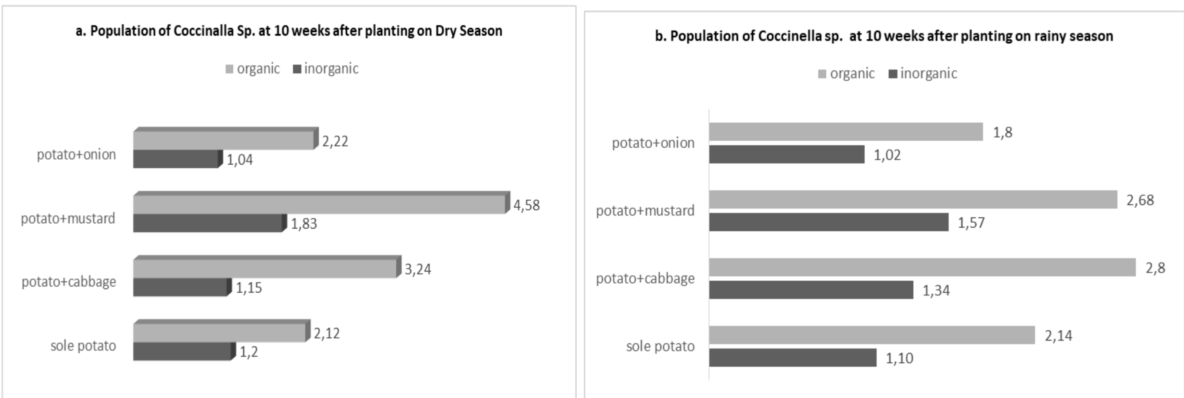

Figure 4. Population of Coccinellid at 10 weeks after planting on dry season (a) and rainy season (b)

Decreasing population of natural enemies on inorganic farming because of continuous application pesticide to control the pest. Pesticide also killed beneficial insect at the field. It can be seen from populations of predator Coccinellid are higher in organic farming systems than inorganic system at planting on dry season and planting on rainy season.

Combined analysis of the planting on dry season and rainy season showed that population of predator Coccinellids significantly more higher at planting on dry season than planting on rainy season. This is presumably because of the highest population of aphids which prey to predator Coccinellid found in highest population the dry season. The high predator population is closely related to the prey population. A high prey population will attract predators to come and stay in that place, followed by an increase in the predator's ability to prey to an optimal extent. The temperatures on dry season benefited the presence and abundances of M. persicae as a prey to predator Coccinellid. The optimum temperature for M. persicae is 250C – 30 0C (Sampaio et al., 2017).

Population of Braconid wasp. Analysis of variance showed that farming system and cropping system significanly affect population density of parasitoid Braconid wasp. The population of Braconid wasp on organic farming more higher than inorganic farming at two planting season at 8 weeks after planting (figure 5) and 10 weeks after planting (figure 6). Combined analysis of the planting on dry season and rainy season showed that population of parasitoid Braconid wasp not significantly difference between planting on dry season than planting on rainy season.

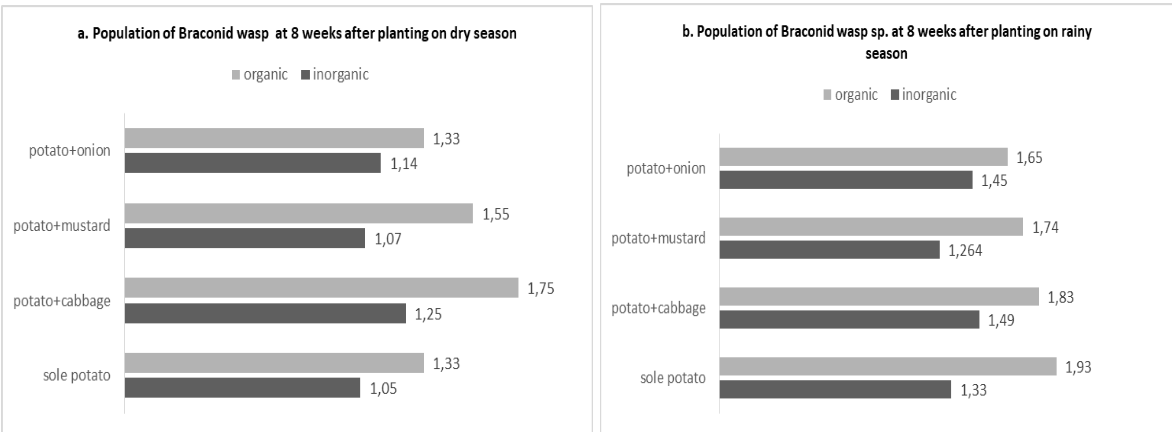

Figure 5. Population of Braconid wasp at 8 weeks after planting on dry season (a) and rainy season (b)

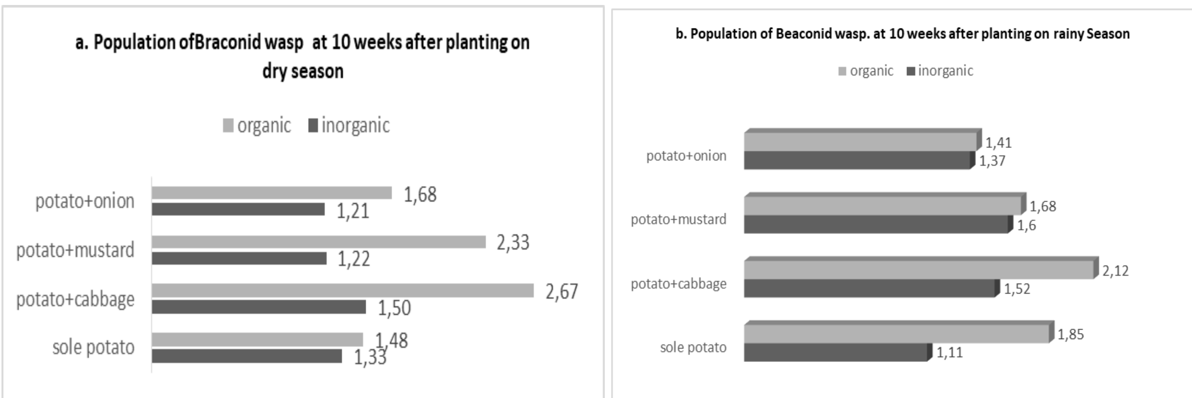

Figure 6. Population of Braconid wasp at 10 weeks after planting on dry season (a) and rainy season (b)

Population of Braconid wasp affected by cropping system showed that The number of parasitoid Braconid wasp significantly increased at intercropping potato with cabbage, potato with mustard and potato with onion respectively. The population of natural enemies more higher at intercropping system than monoculture system. Therefore, intercropping could be recommended as a biological protection method to reducing pest population on the field (Sharaby, et al. 2015).

Population of *Myzus persicae* Sulzer. Analysis of variance showed that farming system and cropping system significanly affect population of *M. persicae* on dry season and rainy season. Effect of farming system significant for population of *M. persicae* at 8 weeks after planting but not significantly affect at 10 weeks after planting. Population of *M. persicae* significantly different at dry season and rainy season at 8 and 10 weeks after planting (Table 1).

Tabel 1. Effect of farming system on population of *M. persicae* at 8 and 10 weeks after planting

Farming	8 weeks after planting			10 weeks after planting		
System	dry season	rainy season	means	dry season	rainy season	means
inorganic farming	5,62	4,32	4.97a	4,32	2,75	3,53
organic farming	7,66	5,51	6,59b	4,96	2,93	3,95
Means	6,66b	4,91a	5,78	4,64b	2,84a	3,74

Table 1 indicated that there are biotic factors that play a role in controlling pest populations naturally in organic farming systems at 10 weeks after planting. The results showed that population of *M. persicae* significantly different in organically managed plants compared to inotganic managed plants. *M. persicae* populations tend to be higher in organic farming systems. This is presumably because in organic farming systems with polyculture cropping patterns there is a significant increase in insect diversity. With increasing diversity of insects, it is suspected that natural enemies, both predators and parasitoids, will also increase. This is what helps pest control so that pest populations are reduced in organic farming systems. Organic farming can achieve ecological balance through patterning farming systems, building habitats, maintaining genetic diversity and farming. Sustainable organic farming can contribute to the restoration of biodiversity in agricultural ecosystems. Regulation of agricultural systems will naturally increase the diversity of predatory and parasitoid insects which can have a positive or negative impact on the level of prey consumption. Combined analysis of the planting on dry season and rainy season showed that population of *M. persicae* significantly more higher on dry season than planting on rainy season.

Population of *M. persicae* significantly affected by cropping system at 8 and 10 weeks after planting. Population of *M. persicae* significantly different at dry season and rainy season at 8 and 10 weeks after planting (Table 2).

Tabel 2. Effect Cropping of system on population of *M. persicae* at 8 and 10 weeks after planting

Cropping	8 weeks after planting			10 weeks after planting		
System	dry season	rainy season	means	dry season	rainy season	means
sole potato	8,14	6,11	7.13c	5,64	2,86	4.25c
potato+cabbage	4,25	5,00	4.62ab	3,39	2,81	3.10ab
potato+mustard	3,89	4,06	3.97a	3,44	2,53	2.99a
potato+onion	4,56	4,33	4.45ab	4,50	3,22	3.86bc
Means	6,66b	4,91a	5,78	4.55b	3.30a	3,92

The population of *M. persicae* significantly decreased at intercropping potato with mustard, potato with cabbage and potato with onion respectively. Election of intercropping plants that are not hosts for the pest *M. persicae* is also the first step in managing agricultural ecosystems to increase insect diversity. Different intercrops can have different roles in managing insect pests and their parasitoids. The use of intercropping plants increases the diversity of plants in the field which can suppress pest attacks and increase the performance of natural enemies. The addition of flowering plants to plantations with low diversity sources can increase the population of useful insects, both predators and parasitoids. Therefore, intercropping could be recommended as a protection method to reducing pest population on the field (Sharaby et al., 2015).

Based on the research results, it can be seen that the population of *M. persicae* in the dry season tends to be higher when compared to the rainy season, this is also followed by the population of its natural enemies, but the diversity index in the two growing seasons is not significantly different. This is due to the nature of aphids which can develop better in the dry season with relatively higher average temperatures and low rainfall. In high rainfall aphid pests experience obstacles in laying eggs and their mobility. The increase in air temperature and CO2 significantly affected the population of *M. persicae* (Bezemer et al., 1998). (Wentasari & Gusta, 2018) reported that intercropping systems can changes microclimatic characteristics on agroecosystem such as light interception, temperature and relative humidity.

CONCLUSION

Conservation insect diversity and natural enemies on potato cultivation can be carried out with an organic farming system with intercropping patterns potatoes with cabbage and potatoes with mustard. Insect diversity index more higher at organic farming system on intercrop potato with cabbage and potato with mustard than sole potato at dry season and rainy season. The population of Coccinellids more higher at organic farming system on intercrop potato with cabbage and potato with mustard than sole potato. Population at dry season more higher than rainy season. The population of Braconid wasp more higher at organic farming system on intercrop potato with cabbage and potato with mustard than sole potato. Population at dry season not significantly difference to rainy season. The lowest population of *M. persicae* found at intercropping potato with mustard at rainy season.

ACKNOWLEDGMENTS

This study supported by Balai Benih Induk Kentang Kutagadung, Berastagi and the Methodist University of Indonesia Medan.

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