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Rapid communication

First record of *Trialeurodes vaporariorum* Westwood (Hemiptera: Aleyrodidae) severely damaging field grown potato crops in South Sulawesi, Indonesia

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Abstract: Greenhouse whitefly, *Trialeurodes vaporariorum* Westwood was reported for the first time in the South Sulawesi Province of Indonesia, and is causing significant damage to field grown potato crops. In an insecticide trial, the tuber yield in infested, untreated plants was reduced by 39%, and the plants had an average number of 68 adult whiteflies per leaflet.

Key words: greenhouse whitefly population, yield loss, virus vector

Introduction

Several species of whitefly cause economic loss to major crops under field conditions in Indonesia, such as *Bemisia tabaci* Gennadius on pepper (Setiawati *et al*. 2007) and soybean (Wartono 2011), *Aleurodicus dispersus* Russell on pepper (Nasruddin and Stocks 2014), and *Aleurodicus dugesii* Cockerell on horticultural crops (Maryana 2012). In contrast, *Trialeurodes vaporariorum* Westwood has been considered a minor pest, with low populations on potato and cabbage (DAFWA 2014).

Whiteflies damage plants by removing photosynthates and excreting honeydew onto the leaf surface. The honeydew stimulates the growth of sooty mold fungi that can cover the leaf surface, reducing photosynthesis and contaminating crop products (Johnson *et al*. 1992; Liu *et al*. 1993). Whitefly can also indirectly damage a plant by transmitting plant viruses. *Bemisia tabaci* vectors more than 500 plant viruses, including *Pepper yellow leaf curl Indonesia virus* (PepYLCIV) (Tsai *et al*. 2009). *Aleurodicus dispersus* transmits *Cassava brown streak virus* (CBSV) in Kenya (Mware 2010). *Trialeurodes vaporariorum* spreads several criniviruses such as *Tomato infectious chlorosis virus* (TICV) (Duffus 1996; Wisler *et al*. 1997), and *Potato yellow vein virus* (PYVV) on potato in Colombia (Franco-Lara 2013).

On June 2, 2015, potato growers in Malino, District of Gowa, South Sulawesi Province reported to us that their crops were heavily infested by whitefly. In our visit to the potato fields on June 5, 2015, we found that more than 80% of the plants were dead. To the best of our knowledge, this is the first record of potato plants being killed by whitefly in South Sulawesi. Thus, it was imperative to identify the whitefly and assess the damage it was causing to potato crops. This information is important as the basis for further studies on the management of the pest.

Materials and Methods

Insect identification

Potato leaves heavily colonized by whitefly were collected from farmers' fields in Malino (5°14'S, 119°56'E; 1,700 m a.s.l.), District of Gowa, South Sulawesi Province, Indonesia on November 22, 2015. The leaves were placed in ziplock plastic bags before they were placed in a freezer for 48 h to assure that the insects were dead. Dried leaves with dead whitefly were sent to Canberra, Australia for identification. Pupal cases were removed from the leaves, mounted onto microscope slides in Hoyer's Mountant and examined through a Leica DM2500 microscope. Specimens were compared with reference specimens in the Australian National Insect Collection, where voucher specimens have been deposited, and relevant literature (Martin 1999) was consulted.

Whitefly population and yield loss

Whole potato tubers cv. Granola were planted in two plots 20 m wide and 30 m long in Malino on October 2, 2015. Two weeks after leaf emergence, whiteflies were present in the field. One plot was weekly treated with insecticide; while the other plot remained untreated for the whole season. The insecticide used was spinetoram, a mixture of spinosyn L and J (trade name Endure 120SC, DOW Chemical Company), at the rate of 96 g a.i. · ha^{-1}.

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Adult insects were counted in both plots one day before each weekly insecticide application. The number of adults per leaflet was determined by slowly turning the leaf and counting the insects on the lower surface of the leaf (Palumbo *et al*. 1995). In each plot, 15 plants were randomly chosen by following a W pattern and on each plant four middle leaflets from different trifoliates were observed. At the end of the season, 15 potato plants from each plot were randomly selected for harvest. Sample plants were selected following a W pattern to make sure that the samples represented the whole plot (Pedigo 1996). All tubers in each sample plant were collected and weighed. Whitefly abundance and tuber weight in sprayed and unsprayed plots were compared by t-test at 5% level and the average yield loss was calculated. Using methods of the local farmers, fungicide was applied weekly to control late blight disease in both insecticide treated and untreated plots. Another insect pest that usually causes economic damage to potato in the research site is *Liriomyza huidobrensis* (Blanchard); however, the pest population was very low during the trial. Therefore, insecticide applications were solely for suppressing the greenhouse whitefly population.

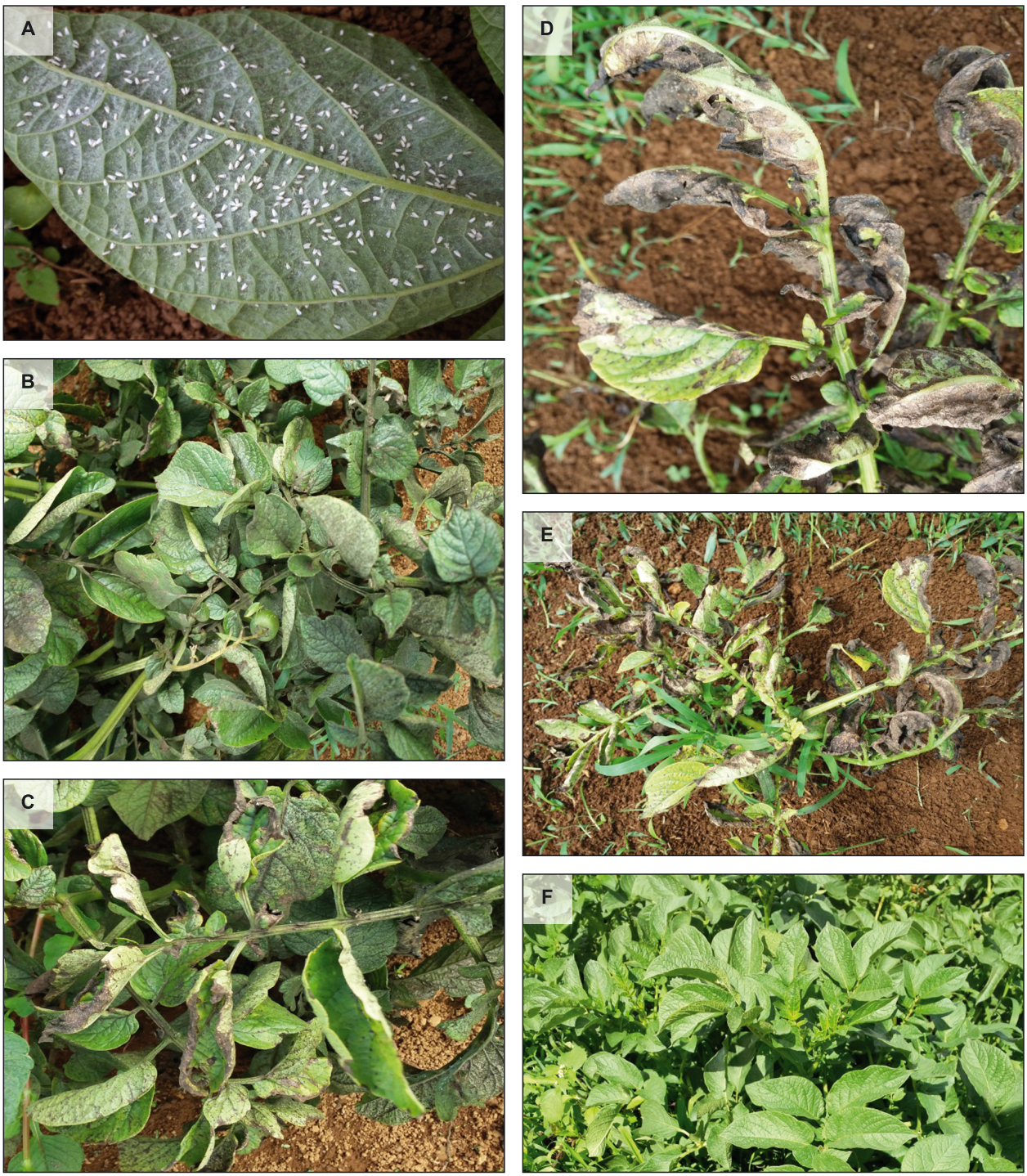

Fig. 1. Potato plants infested with *Trialeurodes vaporariorum*. Newly infested leaves (A), sooty mold forming on the leaf surface (B), necrosis on the leaf margins and leaf cupping (C), dead leaf (D), heavily infested plant starting two weeks after plant emergence (E), and weekly insecticide sprayed plants (F)

Results and Discussion

Insect identification

The whitefly species attacking potato crops in Malino was identified as greenhouse whitefly, *Trialeurodes vaporariorum* Westwood (Hemiptera: Aleyrodidae). To the best of our knowledge, this is the first report of the presence of the *T. vaporariorum* in South Sulawesi and accounts for economic damage to potato in Indonesia. The insect is found, but at low population levels, on potato and cabbage in Java (DAFWA 2014), cucumber in West Java (Prabowo 2009), tomato in Central and West Java (Anjarsari 2011), and pepper in West Sumatra (Jamsari *et al*. 2014).

Greenhouse whitefly is a cosmopolitan species found in both tropical and sub-tropical regions (Mound and Halsey 1978). It is a polyphagous pest attacking numerous food, vegetable, and fruit crops (CABI 2005). Greenhouse whitefly, as its name indicates, was an important pest of horticultural crops in greenhouses, such as tomato, Begonia, Poinsettia (White 2014), and *Rosmarinus* sp. (Lubiarz *et al*. 2013). However, recently it has become increasingly important in inflicting serious damage to numerous field grown plants (Wintermantel 2004; Lourencao *et al*. 2008); though, no direct economic damage to potato in the field has been reported. In our study however, heavy infestations of hundreds of adult greenhouse whitefly were found on the lower surfaces of plant leaflets (Fig. 1A). Early symptoms evident in infested potato plants are whitish spots that subsequently turned dark. As the population increased, sooty mold accumulated on the leaf surface (Fig. 1B), necrosis developed on the leaf margins, and some leaves cupped upward (Fig. 1C). Necrotic areas on the leaves expanded and coalesced, which caused the whole leaf to dry-out (Fig. 1D).

Whitefly population and yield loss

According to the local potato growers we interviewed, they first noticed the whitefly in their fields three years ago and the problem has worsened each year. In this study, whitefly infestation was evident two weeks after plant emergence. The average numbers of adult whiteflies per leaflet for the whole season were 11.2 and 68.4 on treated and untreated plants, respectively. Application of the insecticide spinetoram maintained the whitefly population at a level significantly lower than the population in the untreated control throughout the season (Fig. 2). Untreated plants were smaller and less vigorous than treated plants (Figs. 1E and 1F, respectively) and over 90% of the untreated plants were dead by the ninth week after plant emergence (seven weeks post infestation).

The study site (Malino) is located 1,700 m a.s.l. with annual temperatures ranging from 10–26°C. In the tropics, *T. vaporariorum* population outbreaks occur primarily in the highland areas, whereas in sub-tropical regions the insects thrive in lowland areas with temperatures ranging from 19.9–20.3°C (Caballero 1994; Fitriasari 2010).

Insecticide treatment significantly affected plant yields. Average yield of the sprayed plants was 18 t · ha^{-1}, compared with that of unsprayed plants (11 t · ha^{-1}) (t-test, 0.05; Fig. 2). Thus, in the absence of insecticide applications, potato yield was reduced by 7 t · ha^{-1} or about 39%. The yield loss was mainly attributable to direct damage of feeding injuries by the greenhouse whitefly because populations of other insect pests were negligible and no viral disease symptoms were noticed during the study.

Conclusions

The outbreak of the greenhouse whitefly (*T. vaporariorum*) on potato fields in Malino, Indonesia substantially inhibited plant growth and reduced yield by 39%. This is the first report of both the whitefly in this province and that it has caused significant economic damage in Indonesia. Potato growers should be educated about this threat and further studies should be conducted to develop integrated control measures for the pest. In addition, it is also important to investigate whether this insect causes indirect damage to potato in South Sulawesi by transmitting plant viruses.

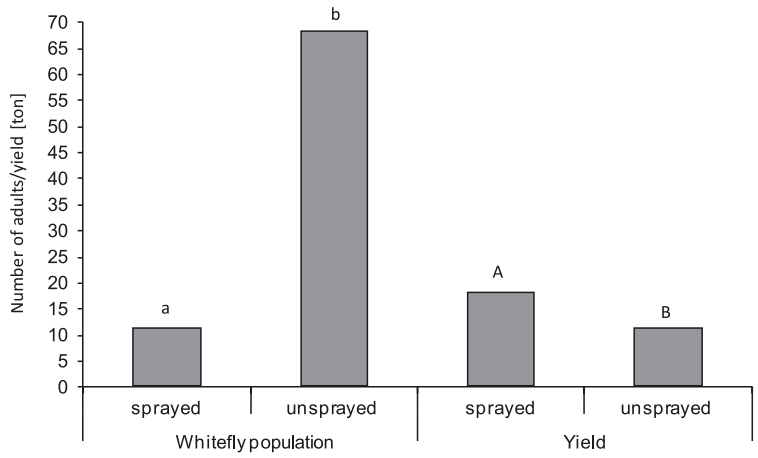

Fig. 2. Number of adult whiteflies per leaflet and plant yield (t · ha^{-1}) on insecticide-treated and non-treated potato plants. Bars with different letters are significantly different (t-test, 0.05). Lower case letters indicate a difference in whitefly number and upper case letters indicate a difference in plant yield

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References

Anjarsari R.L. 2011. [*Trialeurodes vaporariorum* Westwood (Hemiptera: Aleyrodidae) on tomato plants (*Lycopersicum esculentum* Mill.): The sizes of rostrum and wing in different altitudes and the retention period of *Tomato infectious chlorosis virus* (TICV)]. Master's thesis, University of Agriculture Bogor, Indonesia, 32 pp. (in Indonesian)

Caballero R. 1994. Clave de campo para immaduros de moscas blancas de centroamérica. [Field Key for Immature Whitefly in Central America]. Escuela Agrícola Panamericana, Zamorano, Honduras, DVP-EAP #585, 4 pp. (in Spanish)

CABI (Centre for Agriculture and Bioscience International). 2005. Crop Protection Compendium [CD-ROM], Wallingford, UK.

DAFWA (Department of Agriculture and Food, Western Australia). 2014. Whitefly: potato and cabbage pest in Indonesia and Western Australia. Available on: https://www.agric.wa.gov.au/cabbage/whitefly-potato-and-cabbage-pest-indonesia-and-western-australia [Accessed: November 2, 2015].

Duffus J.E. 1996. Whitefly-borne viruses. p. 255–263. In: "*Bemisia*: Taxonomy, Biology, Damage, Control, and Management" (D. Gerling, R. Mayer, eds.). Intercept, Andover, Hants, UK, 702 pp.

Fitriasari E.D. 2010. [Transmission efficiency of tomato yellow leaf curl virus by whitefly on tomato plants]. Master's thesis, University of Agriculture, Bogor, Indonesia, 28 pp. (in Indonesian)

Franco-Lara L., Rodríguez D., Guzmán-Barney M. 2013. Prevalence of *Potato yellow vein virus* (PYVV) in *Solanum tuberosum* Group Phureja Fields in Three States of Colombia. American Journal of Potato Research 90 (4): 324–330.

Jamsari Ferita I., Syukriani L., Lalan H., Herberg F., Nellen W. 2014. Existence of two distinct whiteflies in chili-pepper cultivation in west Sumatra-Indonesia based on mitochondria cytochrome oxidase gene I sequences. Asian Journal of Plant Pathology 8 (2): 34–44.

Johnson M.W., Caprio L.C., Coughlin J.A., Tabashnik B.E., Rosenheim J.A., Welter S.C. 1992. Effect of *Trialeurodes vaporariorum* (Homoptera: Aleyrodidae) on yield of fresh market tomatoes. Journal of Economic Entomology 85 (6): 2370–2376.

Liu T.X., Oetting R.D., Buntin G.D. 1993. Population dynamics and distribution of *Trialeurodes vaporariorum* and *Bemisia tabaci* (Homoptera: Aleyrodidae) on poinsettia following applications of three chemical insecticides. Journal of Entomological Science 28: 126–135.

Lourencao A.L., Alves A.C., Fugi C.G., Matos E.S. 2008. Outbreaks of *Trialeurodes vaporariorum* (West.) (Hemiptera: Aleyrodidae) under field conditions in the State of Sao Paulo. Brazil Neotropical Entomology 37: 89–91.

Lubiarz M., Goszczyński W., Cichocka E. 2013. Invertebrates inhabiting culinary herbs grown under cover. Journal of Plant Protection Research 53 (4): 333–337.

Martin J.H. 1999. The whitefly fauna of Australia (Stenorrhyncha: Aleyrodidae). A taxonomic account and identification guide. CSIRO Entomology Technical Paper 38: 1–197.

Maryana E. 2012. [Host range and damage intensity of the giant whitefly, *Aleurodicus dugesii* Cockerell (Hemiptera: Aleyrodidae) on horticultural crops in Cisarua District (Bogor) and Cipanas District (Cianjur)]. Master's thesis, University of Agriculture, Bogor, Indonesia, 51 pp. (in Indonesian)

Mound L.A., Halsey S.H. 1978. Whitefly of the world: A systematic catalogue of the Aleyrodidae (Homoptera) with host plant and natural enemy data, British Museum (Natural History). John Wiley & Sons, Chichester, UK, 340 pp.

Mware B., Narla R., Amata R., Olubayo F., Songa J., Kyamanyua S., Ateka E.M. 2010. Efficiency of cassava brown streak virus transmission by two whitefly species in coastal Kenya. Journal of General and Molecular Virology 1: 40–45.

Nasruddin A., Stocks I.C. 2014. First report of economic injury due to the spiraling whitefly (Hemiptera: Aleyrodidae) on pepper in Indonesia. Florida Entomologist 97 (3): 1255–1259.

Palumbo J.C., Tonhasca A., Byrnei D.N. 1995. Evaluation of three sampling methods for estimating adult sweetpotato whitefly (Homoptera: Aleyrodidae) abundance on cantaloupes. Journal of Economic Entomology 88 (5): 1393–1400.

Pedigo L. 1996. Entomology and Pest Management. 2nd ed. Prentice-Hall Inc., USA, 679 pp.

Prabowo D.P. 2009. [Survey on pests and diseases of cucumber (*Cucumis sativus* Linn.) in Ceharang, Pacet, Cianjur, West Java]. Undergraduate's thesis, University of Agriculture, Bogor, Indonesia, 45 pp. (in Indonesian)

Setiawati W., Udiarto B.K., Soetiarso T.A. 2007. [Selectivity of selected insecticides against whitefly (*Bemisia tabaci* Genn.) and its predator *Menochilus sexmaculatus* Fabr.]. Journal of Horticulture 17 (2): 168–174. (in Indonesian)

Tsai W.S., Shih S.L., Green S.K., Lee L.M., Luther G.C., Ratulangi M., Sembel D.T. 2009. Identification of a new begomovirus associated with yellow leaf curl diseases of tomato and pepper in Sulawesi, Indonesia. Plant Disease 93 (3): 321.

Wartono I.W., Laba, Wawan 2011. Effectiveness of BPMC application against *Bemisia tabaci* (Gennadius) population and CMMV disease incidence on soybean. Jurnal Entomologi Indonesia 8 (2): 63–72.

White J. 2014. Whiteflies in the greenhouse. Cooperative Extension Service. College of Agriculture, University of Kentucky. Entfact-456. Available on: http://www2.ca.uky.edu/entomology/entfacts/entfactpdf/ef456.pdf [Accessed: February 2, 2016]

Wintermantel W.M. 2004. Emergence of greenhouse whitefly (*Trialeurodes vaporariorum*) transmitted criniviruses as threats to vegetable and fruit production in North America. APSNet Feature Story. Available on: http://www.apsnet.org/publications/ apsnetfeatures/Pages/GreenhouseWhitefly.aspx [Accessed: November 20, 2015]

Wisler G.C., Duffus J.E., Liu H.Y., Li R., Falk B.W. 1997. New whitefly-transmitted closterovirus identified in tomatoes. California Agriculture 51 (2): 24–26.