

***THRIPS PALMI* KARNY (THYSANOPTERA: THIRIPIDAE): COULD IT SURVIVE IN NEW ZEALAND?**

P.R. DENTENER, D.C. WHITING and P.G. CONNOLLY

HortResearch, Private Bag 92169, Auckland, New Zealand

Corresponding author: pdentener@hortresearch.co.nz

ABSTRACT

Melon thrips (*Thrips palmi* Karny) is one of several Risk Group 2 pests on New Zealand MAF Biosecurity Authority's list of unwanted pests. Its wide host plant range, and its presence world-wide, including several countries in the Pacific region, underpin its biosecurity status. In this case study we used CLIMEX, a climate matching software program, to determine likely locations in New Zealand where melon thrips could establish once introduced. Possible establishment was based on climate match with overseas locations where melon thrips is present, and on a range of biological parameters specific to the response of melon thrips to climatic conditions. The upper North Island is predicted to be most suited to melon thrips establishment. This also matches the known New Zealand distribution of *Hercinothrips bicinctus*, banana thrips, a species found worldwide in locations similar to that of melon thrips.

Keywords: Melon thrips, *Thrips palmi*, CLIMEX, climate match, *Hercinothrips bicinctus*.

INTRODUCTION

Melon thrips (*Thrips palmi* Karny) is one of 22 insects on the New Zealand MAF Plants Biosecurity Register of Quarantine Risk Group 2 pests (MAF 2001a). Interception of a Risk Group 2 pest at New Zealand's border results in the consignment being treated, reshipped or destroyed.

Melon thrips has been recorded in several countries in Asia, Central America, the Caribbean, Oceania, Africa, and South America (CABI/EPPO 1998). Outdoor populations of melon thrips appear restricted to tropical or semi-tropical regions. However, there have been outbreaks on suitable host plants grown in protected cultivation in Japan and Western Europe. While present within the Oceania region, melon thrips has not been found in New Zealand, Cook Islands, Fiji, Kiribati, Marquesas, Niue, Solomon Islands, Tokelau, Tonga, Tuvalu or Vanuatu (Waterhouse 1987).

Melon thrips is a polyphagous pest, feeding on more than 50 plant species representing over 20 taxonomic families (Wang & Chu 1986). It especially attacks members of the Cucurbitaceae, Solanaceae, Leguminaceae and Orchidaceae. Its introduction into New Zealand would have serious repercussions for the horticulture and agriculture industries.

Adult melon thrips are strong flyers but their small size makes their dispersal susceptible to weather and wind. Their activity peaks during hot weather when updrafts may carry them great distances (Waterhouse 1987). While melon thrips has moderate dispersal potential by itself, it is also liable to be carried on fruits or plants of host species, or in packing material.

Expert systems such as CLIMEX, BIOCLIM/BIOMAP, BIOSIM or process-oriented models can be used to forecast pest and disease population dynamics in terms of climate based risk forecasting (Dobesberger 2000). In this paper we evaluate the potential for melon thrips to establish in New Zealand, using CLIMEX (CSIRO 1999) and information available in the literature. A comparison is also made with the CLIMEX predicted establishment potential of banana thrips (*Hercinothrips bicinctus* (Bagnall)) and its already known distribution in New Zealand. Banana thrips was chosen to test the accuracy

New Zealand Plant Protection 55:18-24 (2002)

of the prediction for potential establishment of melon thrips in New Zealand because of similarities in the world-wide distribution of the two species.

MATERIALS AND METHODS

Sutherst (1991) states that "...One of the first constraints on an immigrant insect pest is the climate at the time of its arrival The pest could establish at the point of entry or it could be transported immediately to other areas on the same continent with more favourable climates. We need to know the area at risk of colonization and whether the climate will enable the species to build up into economically damaging populations...". CLIMEX uses the climatic responses of an organism and meteorological data to assist the prediction of potential relative abundance and distribution of a poikilothermic organism (Sutherst & Maywald 1985). It is particularly useful for summarising current knowledge and to provide insight when detailed biological or climatological information is scarce (Worner 1988).

Climate Match

Climatic information was used from or near 38 locations in 20 countries where melon thrips has been found (Anon. 1991a, b; Australian Academy of Science 1996; Bhatti 1980; Bournier 1999; CABI/EPPO 1997, 1998; Castineiras et al. 1997; Cooper 1991; Hong et al. 1998; Houston et al. 1991; Walker 1994). Using CLIMEX software with local climatic information it is possible to identify locations in New Zealand with similar climatic conditions, and hence the possibility of establishment of melon thrips. This can only be an approximation since meteorological data, even when collected close to established melon thrips populations, may not truly reflect the local climatic conditions experienced by melon thrips. For example, meteorological stations are commonly situated at airports, in urban areas or on sea coasts, and may not provide an accurate guide to climatic conditions experienced by the targeted organism (Baker 1996).

CLIMEX was loaded with meteorological data compiled from 286 New Zealand locations (Anon. 1983) by Dr Susan Worner (Lincoln University). A "Match Climates" function then compared the overseas and New Zealand databases, using the following five parameters: minimum temperature, maximum temperature, rainfall amount, rainfall pattern and relative humidity (9 am, 3 pm). Each of these parameters has its own match index (e.g. Maximum Temperature Match Index). The level of similarity between locations is given by the overall "Match Index" (MI) which is the result of a mathematical formula using the five component match indices described above, and ranges from 0-100, with 100 as best match (Sutherst et al. 1999).

A similar climate match was carried out for banana thrips. Less detailed information on the worldwide distribution of banana thrips is available than for melon thrips. Only four locations in Australia (2), Brazil and Peru (CAB 1983) were used for the climate match.

Ecoclimatic Index

CLIMEX uses long-term averages from meteorological sites to derive a weekly and annual population Growth Index (GI) describing the potential for growth of a given species' population during the favourable season. Four Stress Indices (cold, hot, wet and dry), and their interactions, describe the probability of the population surviving through an unfavourable season. These Growth and Stress Indices are combined into an Ecoclimatic Index (EI) which gives an overall measure of the suitability of a location for permanent occupation by a particular insect species (Sutherst et al. 1999).

Melon thrips parameter values for CLIMEX were first estimated for its spread in Australia, and modified in July 2000 (R. Sutherst, pers. comm.) to account for the thrips' new record in Cuba (Piñón et al. 1999) (Table 1). All available literature on the impact of temperature on melon thrips development is laboratory based. Kawai (1985), Yawei et al. (1996) and McDonald et al. (1999) described slightly lower temperatures for both "lower temperature threshold" and "lower optimum temperature" for population growth. However, Sutherst's slightly higher values have

been used because (1) *T. palmi* is essentially a tropical species and (2) using these values CLIMEX best matches the known worldwide geographical distribution of melon thrips. To date no research describing the minimum EI value needed to maintain melon thrips populations has been published.

For both melon and banana thrips predictions, maps (Fig. 1) were drawn using the map package with the statistical software “R” (Ihaka & Gentleman 1996). New Zealand locations in the CLIMEX database were then projected onto the map using longitude and latitude information.

TABLE 1: CLIMEX Growth and Stress Indices parameter values (R. Sutherst, pers. comm.) used as thresholds for melon thrips population growth. Data is only provided for those indices where there is sufficient information.

Growth Indices (GI)		Stress Indices	
<i>Temperature Index</i>		<i>Cold stress</i>	
Lower threshold temperature	12	Temperature threshold	2
Lower optimum temperature	22	Temperature rate	0.1
Upper optimum temperature	30	Day-degree threshold	10
Upper threshold temperature	35	Degree-day rate	0.0004
Minimum day-degrees	622	<i>Heat stress</i>	
<i>Moisture Index</i>		Temperature threshold	39
Lower soil moisture threshold	0.3	Temperature rate	0.0005
Lower optimal soil moisture	0.6	Day-degree threshold	100
Upper optimal soil moisture	0.7	Degree-day rate	0
Upper soil moisture threshold	2	<i>Dry stress</i>	
		Threshold	0.1
		Rate	0.001
		<i>Wet stress</i>	
		Threshold	2.5
		Rate	0
		<i>Cold-dry stress</i>	
		Degree-day threshold	10
		Moisture threshold	0.2
		Rate	0
		<i>Cold-wet stress</i>	
		Temperature threshold	10
		Moisture threshold	1.5
		Rate	0

RESULTS

A Climate Match between selected overseas locations where melon thrips is present, and all New Zealand locations, is shown in Fig. 1a. In order for a New Zealand location to be matched in our research, it had to be similar in overall climate conditions to at least 75% of the overseas locations where melon thrips is present. With an MI of 35 (Fig. 1a) 36 overseas locations match New Zealand sites in areas (Crosby et al. 1976) such as Northland, Auckland, Coromandel, Waikato, and coastal parts of the Bay of Plenty, Gisborne, Hawke’s Bay, Taranaki, Wanganui, Wellington and Wairarapa (all North Island), and Farewell Spit in Nelson (South Island).

CLIMEX was used to calculate an EI to describe how favourable the climate of a location in New Zealand is for melon thrips (Fig. 1c). The EI never exceeded 33 (out of 100), and only Kaitaia and Mechanics Bay had an EI ≥ 30 . Locations with EI values

greater than 15 were only found in the upper North Island (Northland, Auckland, Coromandel, Waikato, Bay of Plenty and Gisborne areas). The remainder of New Zealand is unsuitable for melon thrips due to cold stress in winter. Similarity in New Zealand locations selected using an EI >15 (Fig. 1c) and those selected with a Climate Match

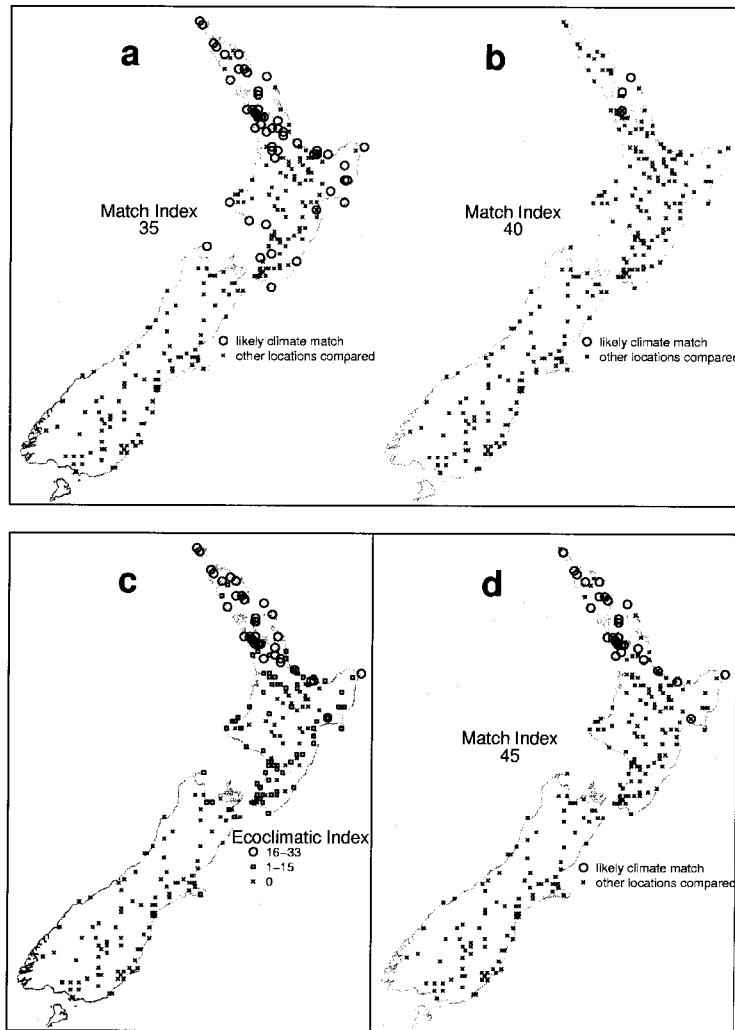


FIGURE 1: Likely New Zealand distribution of melon thrips and banana thrips. (a & b) Climate match of New Zealand locations with overseas locations where melon thrips are present. (c) Predicted distribution of melon thrips based on Ecoclimatic Index. (d) Climate match of New Zealand locations with overseas locations where banana thrips are present.

(Fig. 1a) indicates that a Match Index of 35 is appropriate. A more stringent MI of 40 would only show a good match with overseas locations for Mechanics Bay and Leigh (Auckland area), and Mokohinau Island (Northland) (Fig. 1b).

A Climate Match for banana thrips (Fig. 1d; MI of 45) shows that locations in Northland, Auckland, Coromandel, North Waikato, and coastal Bay of Plenty and Gisborne completely match all 4 overseas locations used.

DISCUSSION

The areas where melon thrips could potentially establish in New Zealand as estimated by the Climate Match function (climate only) were similar to the prediction of locations based on growth and stress indices, which include biological data, used by CLIMEX. Implementing the slightly lower temperature indices thresholds published in the literature (Kawai 1985; Yawei et al. 1996; McDonald et al. 1999) would show that melon thrips might establish in some parts of the South Island (data not provided), but these values were based on laboratory data. R. Sutherst (pers. comm.) argues against this and suggests "...concentrate on using geographical distribution to infer the parameter values rather than lab data which is not too reliable in the field due to microclimatic effects...". In addition, he states that "...the CLIMEX threshold is that for population growth, not for development per se...".

Banana thrips has been collected in New Zealand from the Three Kings Islands, Northland, Auckland, Coromandel and Taranaki areas (Spiller 1956; Mound & Walker 1982; Holt 1989; Martin 1999; MAF 2001b). Melon thrips' potential establishment in New Zealand matches that of the established banana thrips, which is found worldwide in locations similar to melon thrips. This similarity supports our predictions for likely establishment of melon thrips in the upper half of the North Island.

CLIMEX has provided a reasonable initial assessment of the climatic favourability of given locations to estimate the risk of exotic pest species establishing in New Zealand (Frampton 1990). Baker (1996) discusses the possible development of a pest risk mapping system using CLIMEX to construct European risk maps for *Leptinotarsa decemlineata*, *Ceratitidis capitata* and *Bactrocera tryoni*. He concludes that "...The development of most insect species is predominantly influenced by temperature, so establishment can reliably be predicted by the parameters interpolated in gridded climatologies and used in CLIMEX...".

It is important to realise that the indices provided by CLIMEX are not absolute and should be interpreted in a comparative or relative manner (Worner 1988). In addition, a decision to accept the final value of each parameter is made by process of iteration (Stewart et al. 1995; Worner 1988). Although ecoclimatic and growth indices provide only coarse measures of an organism's response to climate, they give valuable information in the absence of more detailed data (Worner et al. 1989). Based on the results of this study, it is likely that melon thrips could establish in the upper half of the North Island of New Zealand.

ACKNOWLEDGEMENTS

We thank Sue Worner for the extended New Zealand meteorological data base; Rob Sutherst for the growth and stress indices parameters; Stephen Goldson, John Charles, Philippa Stevens and Chris Hale for comments on the manuscript. This research was funded by the New Zealand Foundation for Research, Science and Technology (C06X0004).

REFERENCES

- Anon. 1991a: *Thrips palmi* and *Bemisia tabaci* also in Dominica [on muskmelon]. *FAO Plant Prot. Bull.* 39(4): 184.
- Anon. 1991b: First record of *Thrips palmi* in continental United States. *FAO Plant Prot. Bull.* 39(4): 188.
- Anon. 1983: Summaries of climatological observations to 1980. *N.Z. Met. Serv. Misc. Publ.* 177.
- Australian Academy of Science 1996: Submission to the Review of the Australian Quarantine Inspection Service, March 1996. www.science.org.au/academy/media/aqis4.htm (22/03/02).
- Baker, R.H.A. 1996: Developing a European pest risk mapping system. *OEPP/EPPO Bulletin* 26: 485-494.
- Bhatti, J.S. 1980: Species of the genus *Thrips* from India (Thysanoptera). *System. Entomol.* 5: 109-166.
- Bournier, J-P. 1999: Deux Thysanoptères, nouveaux déprédateurs du cotonnier en Côte d'Ivoire. *Ann. Soc. Entomol.* 35 (3-4): 275-281.
- CAB 1983: *Hercinothrips bicinctus*, map 457. In: Distribution maps of insect pests. Series A (Agricultural) December 1983. Commonwealth Institute of Entomology, UK.
- CABI/EPPO 1998: *Thrips palmi*, map 149. In: Smith, I.M.; Charles, L.M.F. ed. Distribution maps of quarantine pests for Europe: Distribution maps of quarantine pests for the European Union and for the European and Mediterranean Plant Protection Organization. CAB International. Wallingford, UK.
- CABI/EPPO 1997: *Thrips palmi*. In: Quarantine pests for Europe (2nd Edition): data sheets on quarantine pests for the European Union and for the European and Mediterranean Plant Protection Organization. CAB International. Wallingford, UK. Pp 538-542.
- Castineiras, A.; Baranowski, R.M.; Glenn, H. 1997: Distribution of *Neoseiukus cucumeris* (Acarina: Phytoseiidae) and its prey, *Thrips palmi* (Thysanoptera: Thripidae) within eggplants in South Florida. *Florida Entomol.* 80 (2): 211-217.
- Cooper, B. 1991: Status of *Thrips palmi* (Karny) in Trinidad. *FAO Plant Prot. Bull.* 39 (1): 45-46.
- Crosby, T.K.; Dugdale, J.S.; Watt, J.C. 1976: Recording specimen localities in New Zealand: an arbitrary system of areas and codes defined. *N.Z. J. Zool.* 3: 69.
- CSIRO 1999: CLIMEX for Windows version 1.1. CSIRO Publishing.
- Dobesberger, E. 2000: Climate based modelling of pest establishment and survival in support of pest risk assessment. *Annual Meeting North American Plant Protection Organization*. www.nappo.org/annrep9920/english/annrep99-00_3c.html (22/03/02).
- Frampton, E.R. 1990: Impact of climate change on quarantine pests. In: Prestidge, R.A.; Pottinger, R.P. ed. The impact of climate change on pests, diseases, weeds and beneficial organisms present in New Zealand agricultural and horticultural systems. Report to New Zealand Ministry for the Environment, Wellington. Pp 171-179.
- Holt, V.A. 1989: Pest status and inter-relationships between three species of thrips, (Thysanoptera: Terebrantia) *Heliothrips haemorrhoidalis*, *Megalurothrips kellyanus*, and *Thrips obscuratus*, present on citrus in the Auckland area. Unpublished MSc thesis, University of Auckland. 155 p.
- Hong, K.J.; Lee, M-L.; Han, M-J.; Ahn, S-B.; Kim, I-S.; Lee, G-H.; Ku, D-S. 1998: Distribution and host plants of recently introduced palm thrips, *Thrips palmi* Karny (Thysanoptera: Thripidae) in Korea. *RDA J. Crop Prot.* 40 (2): 89-95.
- Houston, K.J.; Mound, L.A.; Palmer, J.M. 1991: Two pest thrips (Thysanoptera) new to Australia, with notes on the distribution and structural variation of other species. *J. Aust. Entomol. Soc.* 30: 231-232.

- Ihaka, R.; Gentleman, R. 1996: R: a language for data analysis and graphics. *J. Comput. Graph. Stat.* 5: 299-314.
- Kawai, A. 1985: Studies on population ecology of *Thrips palmi* Karny. VII. Effect of temperature on population growth. *Jap. J. Appl. Entomol. Zool.* 29: 140-143.
- Martin, N.A. 1999: Arthropods and molluscs associated with poroporo (*Solanum aviculare* and *S. laciniatum*): an annotated species list. *J. Royal Soc. N.Z.* 29 (1): 65-76.
- Ministry of Agriculture and Forestry [MAF] 2001a: Plants Biosecurity and Forest Biosecurity. Register of Quarantine Risk Group 2. www.maf.govt.nz/biosecurity/pests-diseases/registers-lists/regulated-pests/index.htm (22/03/02).
- Ministry of Agriculture and Forestry [MAF] 2001b: Plant Pest Information Network (PPIN) Database. Ministry of Agriculture and Forestry, Lincoln, New Zealand.
- McDonald, J.R.; Bale, J.S.; Walters, K.F.A. 1999: Temperature, development and establishment potential of *Thrips palmi* (Thysanoptera: Thripidae) in the United Kingdom. *European J. Entomol.* 96: 169-173.
- Mound, L.A.; Walker, A.K. 1982: Terebrantia (Insecta: Thysanoptera). Fauna of New Zealand (1). Science and Information Division, DSIR, Wellington. 120 p.
- Piñón, M.; Hernández, L.; Hernández, A.; Gómez, O.; Casanova, A.; Depestre, T.; Estrada, J. 1999: Evaluation of commercial products for the control of *Thrips palmi* in aubergine. *Manejo Integrado de Plagas* 53: 84-86.
- Spiller, D. 1956: A check list of New Zealand Thysanoptera. *N.Z. Entomol.* 2 (1): 11-14.
- Stewart, C.A.; Julien, M.H.; Worner, S.P. 1995: The potential geographical distribution of alligator weed (*Alternanthera philoxeroides*) and a biological control agent *Agasicles hygrophila*, in New Zealand. *Proc. 48th N.Z. Plant Prot. Conf.*: 270-275.
- Sutherst, R.W. 1991: Predicting the survival of immigrant insect pests in new environments. *Crop Prot.* 10 (October): 331-333.
- Sutherst, R.W.; Maywald, G.F. 1985: A computerised system for matching climates in ecology. *Agric. Ecosyst. Environ.* 13: 281-299.
- Sutherst, R.W.; Maywald, G.F.; Yonow, T.; Stevens, P.M. 1999: User Guide. CLIMEX. Predicting the effects of climate on plants and animals. CD-ROM. CSIRO Publishing. 88 p.
- Walker, A.K. 1994: A review of the pest status and natural enemies of *Thrips palmi*. *Biocontrol News Info.* 15 (1): 7N-10N.
- Wang, C-L.; Chu, Y-I. 1986: Review of the southern yellow thrips, *Thrips palmi* Karny. *Chinese J. Entomol.* 6: 133-143.
- Waterhouse, D. F. 1987: *Thrips palmi* Karny. Thysanoptera: Thripidae. In: Waterhouse, D. F.; Norris, K. R. ed. Biological control: Pacific prospects. Inkata Press, Melbourne. Pp. 90-94.
- Worner, S.P. 1988: Ecoclimatic assessment of potential establishment of exotic species. *J. Econ. Entomol.* 81 (4): 973-983.
- Worner, S.P.; Goldson, S.L.; Frampton, E.R. 1989: Comparative ecoclimatic assessments of *Anaphes diana* (Hymenoptera: Mymaridae) and its intended host, *Sitona discoideus* (Coleoptera: Curculionidae), in New Zealand. *J. Econ. Entomol.* 82 (4): 1085-1090.
- Yawei, B.; Xuihui, G.; Chumxian, G.; Huaping, C. 1996: The effect of temperatures on the growth and development of *Thrips palmi* Karny. *Acta Agric. Zhejiangensis* 8 (5): 312-315.