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IPPC Global Workshop on Systems Approaches

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In partnership with:



Assessment of the efficacy of a systems approach for fruit fly pest management in citrus in South Africa

Aruna Manrakhan, Sean Moore and Vaughan Hattingh

Citrus Research International, South Africa





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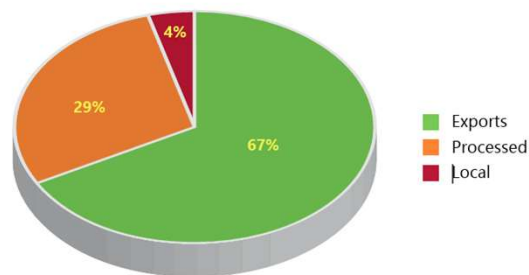
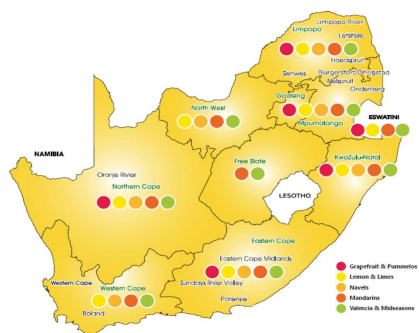
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Citrus industry in South Africa

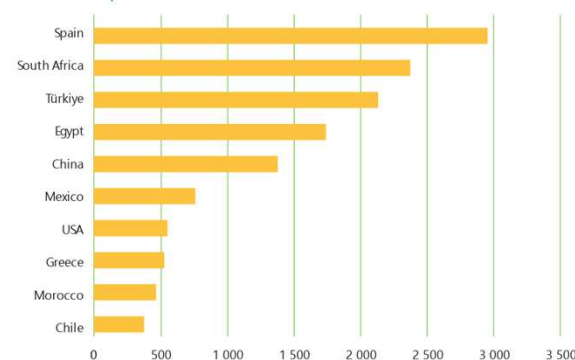
- 2nd in the world in citrus exports
- 101 624 ha under citrus production
- Citrus produced mostly for export
- ~3 million tons exported in 2025



Source: USDA, FAO

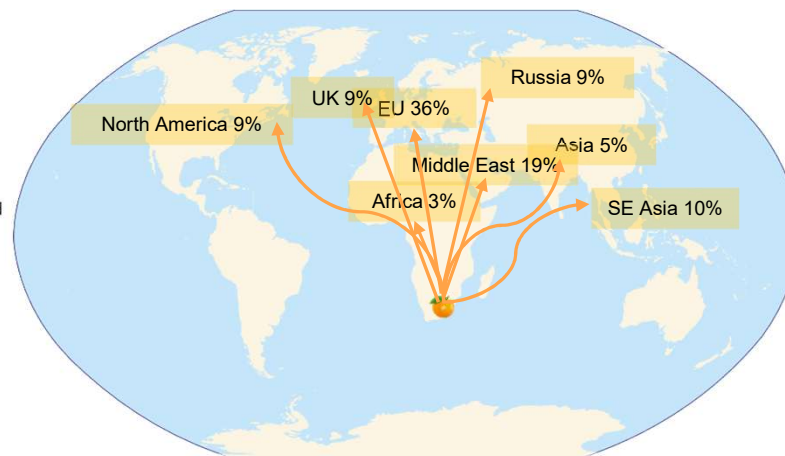
Tons x 1000

World Citrus Exports



Source: Trademap, USDA

Tons x 1000



Source: Citrus Growers' Association of Southern Africa: <https://www.cga.co.za/>



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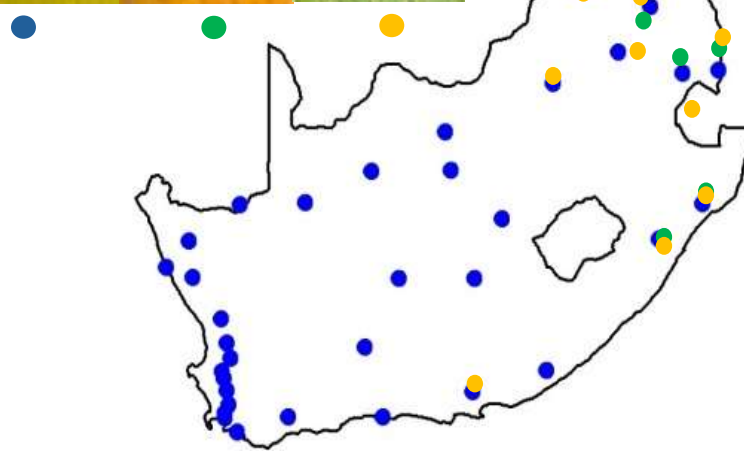


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Quarantine fruit fly pests associated with citrus in South Africa

- Three fruit fly species:
 1. *Ceratitis capitata*
 2. *Ceratitis rosa*
 3. *Bactrocera dorsalis*
- Mitigation of risk of fruit flies
 - ❖ Cold disinfestation treatments
 - ❖ **Fruit fly systems approach (FF SA)**
for export to EU (Since 2019)

C. capitata *C. rosa* *B. dorsalis*





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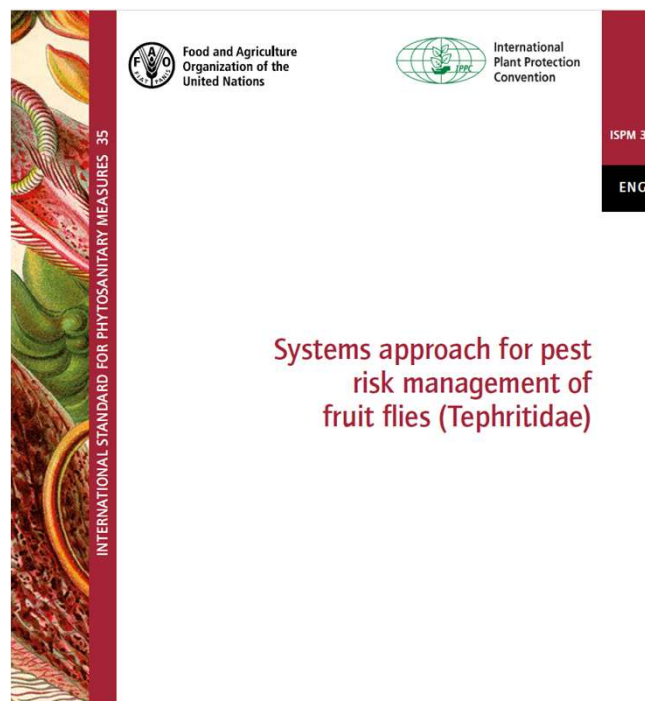


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Guidelines used for development of FF SA on citrus





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Supportive information for development of FF SA on citrus

Fruit fly biology & ecology

COMMUNITY AND ECOSYSTEM ECOLOGY

The Distribution, Relative Abundance, and Seasonal Phenology of
Ceratitis capitata, *Ceratitis rosa*, and *Ceratitis cosyra* (Diptera:
Tephritidae) in South Africa

MARELIZE DE VILLIERS,^{1,2} ARUNA MANRAKHAN,^{3,4} PIA ADDISON,⁴ and VAUGHAN HATTINGH¹

Environ. Entomol. 42(5): 831–840 (2013); DOI: <http://dx.doi.org/10.1003/EN12289>

ABSTRACT *Ceratitis capitata* (Wiedemann), *Ceratitis rosa* (Wiedemann), and *Ceratitis cosyra* (Wiedemann) are three fruit fly species (Diptera: Tephritidae) of economic direct damage to a number of commercially produced fruit species in different climatic regions of South Africa. *C. capitata* and *C. rosa* were also compared in Stellenbosch, Western Cape. Yellow bucket traps a 2-yr period in the different sampling areas. Data determined fruit fly infestation. *C. capitata* was found in all areas, while *C. rosa* was absent from or only present in a few areas.

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Research Paper

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Temporal and spatial patterns of *Bactrocera dorsalis* (Diptera: Tephritidae) populations in its southern limits of distribution: effects of climate and landscape on its range expansion

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Abstract

Bactrocera dorsalis (Hendel) (Diptera: Tephritidae) is an invasive tropical pest that is currently expanding in its geographical range into temperate regions. This study examined the temporal and spatial dynamics of *B. dorsalis* along an altitudinal gradient in Mpumalanga Province, South Africa, in its southernmost adventive limit, which experiences a temperate climate with dry winters. Populations were monitored from October 2020 to October 2022 at three sites with altitudes ranging from 425 to 1741 m above sea level. At each site, clusters of attractant-baited traps (methyl eugenol and three-component Biolure) were set up and serviced at least monthly. We analysed the effects of climate, time of the year, altitude, and landscape on *B. dorsalis* abundance. Single population peaks of *B. dorsalis* were recorded from mid-summer to autumn in all sites, with higher prevalence at the low-altitude site. In the low- and mid-altitude sites, catches were recorded year-round, while at the high-altitude site, there were no catches for four to six months after onset of winter. Higher *B. dorsalis* catches were recorded as temperatures increased and precipitation decreased. Catches were higher in commercial orchards and home gardens compared to abandoned orchards. These findings provide valuable information for improving simulation models of *B. dorsalis* distribution and population growth that can be used to inform the management of this pest.

Citrus susceptibility

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ORIGINAL CONTRIBUTION

WILEY [JOURNAL OF APPLIED ENTOMOLOGY](https://onlinelibrary.wiley.com/doi/10.1111/jen.12400)

Host use of the oriental fruit fly, *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae), in South Africa

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Abstract

The highly invasive oriental fruit fly, *Bactrocera dorsalis* (Hendel), has been declared

Non-host status of commercial export grade lemon fruit (*Citrus limon* (L.) Burman f. cv. Eureka) for *Ceratitis capitata*, *Ceratitis rosa*, *Ceratitis quilicii* and *Bactrocera dorsalis* (Diptera: Tephritidae) in South Africa

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Effective pre-harvest measures in orchard to suppress fruit fly populations

Fruit Fly trapping



Protein baiting



Male annihilation



Orchard sanitation



- Reduction/prevention of fruit fly infestation
- Suppression of fruit fly pest population in orchards (Female fruit fly numbers <1 per trap per week)



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FF SA for citrus from South Africa

Risk reduction measures



Lemons and limes

1. **Non-host status** of commercial export grade lemons and limes
2. **Official inspection** of samples of packed lemons and limes (ongoing verification of non-host status)



Other Citrus

1. **Fruit fly good agricultural practices** plus inspection at packhouse
2. **Packhouse grading** and official inspection of samples of packed fruit
3. **Cold shipping** (-1°C to 4°C)



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Assessment of efficacy of FF SA pre-shipping

Survey in 13 mandarin and 13 orange orchards in South Africa over 2 years

In orchards



On delivery at packhouse



After sorting and grading





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Some internationally approved cold treatments

% mortality for <i>Ceratitis capitata</i> in citrus ; Confidence Level (CL)						
Pulp Temperature (°C)	Duration of Treatment (Days)					
	16 days	18 days	20 days	22 days	24 days	26 days
6						
5						
4						
3		99.9973%; 95% CL	99.9987%; 95% CL			
2	99.9900%; 95% CL	99.9900%; 95% CL	99.9917%; 95% CL	99.9917%; 95% CL		
1	99.9900%; 95% CL	99.9900%; 95% CL	99.9917%; 95% CL	99.9917%; 95% CL		
0	99.9900%; 95% CL	99.9900%; 95% CL	99.9917%; 95% CL	99.9917%; 95% CL		
-1						

Cooling during shipping FF SA

Source: International Standards for Phytosanitary Measures No. 28 Annexes 24- 29; USDA Treatment manual



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Findings

Development of “higher temperature” cold treatments

Infestation, cold exposure, dissection



Comparison of cold tolerance between species

C. capitata



>

C. rosa



B. dorsalis



Using *C. capitata*- most cold tolerant species

Treatments	Estimated No. of treated larvae	Total No. of survivors	Lower bound Mortality Calculated (%) (95% CI)
3.5°C for 24 d	118484	0	99.998
5°C for 27 d	99332	0	99.996



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Calculated efficacy of FF SA

Citrus type	Pre-harvest control measured by Inspection at packhouse		Packhouse grading + Official inspection		Cold storage (e.g 3.5°C for 24 days)		Calculated % efficacy of systems approach at 97% CL
	Infestation	Upper bound proportion potentially infested*	Infestation	Upper bound proportion potentially infested*	Infestation	Upper bound proportion potentially infested*	
Mandarin	0,0000 (0/20800)	0,0002	0,0066 (1/21100)	0,0003	0,0000 (0/118484)	0,0000	>99.9968
Orange	0.0028 (1/40383)	0,0002	0.0000 (0/17280)	0,0003	0.0000 (0/118484)	0,0000	>99.9968

*Calculated at 99% Confidence Level (CL) following equations in Couey & Chew 1986 J. Econ. Entomol. 79: 887-890



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Conclusions

The Fruit Fly Systems Approach applied to South African citrus provides an equivalent level of phytosanitary protection to internationally recognised cold-disinfestation treatments and is effective in mitigating fruit fly risk in citrus exported from South Africa.



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Thank you

