



[Environmental Horticulture Program Research Summaries](#)

IR-4 Environmental Horticulture Program F6123 Crop Safety

**Authors: Allison Ballantyne, Ely Vea and Cristi L. Palmer
Date: April 4, 2022**

Acknowledgements Susan Bierbrunner

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award numbers 2015-34383-23710, 2017-34383-27100, 2019-34383-29973, 2020-34383-32455 and 2021-343830-34848 with substantial cooperation and support from the State Agricultural Experiment Stations and USDA-ARS.

Table of Contents

Table of Contents	2
Table of Tables	2
Abstract	3
Introduction.....	4
Materials and Methods.....	4
Results and Summary	4
Phytotoxicity	4
Label Suggestions	10
Appendix 1: Contributing Researchers	11

Table of Tables

Table 1.	List of F6123 treated crops (foliar) with no or minimal transitory injury.	5
Table 2.	List of F6123 treated crops (foliar) with no injury at 1X but significant injury at 2X or 4X.....	5
Table 3.	List of F6123 treated crops (foliar) with significant injury at 1X.....	5
Table 4.	List of F6123 treated crops (foliar) where more information is needed.	5
Table 5.	List of F6123 treated crops (drench) with no or minimal transitory injury.	5
Table 6.	List of F6123 treated crops (drench) with no injury at 1X but significant injury at 2X or 4X.....	5
Table 7.	List of F6123 treated crops (drench) with significant injury at 1X.	5
Table 8.	List of F6123 treated crops (drench) where more information is needed.	5
Table 9	Detailed Summary of Crop Safety Testing with F6123.....	6

Abstract

F6123 is a fungicide being developed by FMC for the control of diseases on environmental horticulture crops such as anthracnose (*Colletotrichum* spp.), powdery mildew (*Erysiphe* spp.), black spot (*Diplocarpon rosae*), rusts (*Coleosporium*, *Phragmidium*, *Puccinia*, *Uromyces* spp.), leaf spots (*Alternaria*, *Cercospora*, *Cylindrocladium*, *Sclerotinia* *Septoria* spp.) and other foliar diseases. Although not yet available in the marketplace, F6123 was registered for use with EPA since November 20, 2019. The IR-4 Project completed 52 crop safety trials on 17 environmental horticulture plant species or genera from 2019 to 2021. In these trials, F6123 was applied either as a foliar spray or as a soil drench. Four genera or species (two foliar, two drench) exhibited minimal or no injury after foliar and drench applications in a minimum of three trials for each crop; these can be added to a list of tolerant plants in the new label for this active ingredient.

The fifteen remaining species or genera treated with foliar sprays exhibited minimal or no injury in the limited number of trials (one or two) for each crop.

Out of the thirteen remaining species or genera treated with a drench application, eight exhibited moderate to severe negative impacts. The other five exhibited minimal or no injury in the limited number of trials (one or two) for each crop.

Introduction

F6123 is a fungicide being developed by FMC for the control of diseases on environmental horticulture crops such as anthracnose (*Colletotrichum* spp.), powdery mildew (*Erysiphe* spp.), black spot (*Diplocarpon rosae*), rusts (*Coleosporium*, *Phragmidium*, *Puccinia*, *Uromyces* spp.), leaf spots (*Alternaria*, *Cercospora*, *Cylindrocladium*, *Sclerotinia* *Septoria* spp.) and other foliar diseases. Although not yet available in the marketplace, F6123 was registered for use with EPA since November 20, 2019. The IR-4 Project completed 52 crop safety trials on 17 environmental horticulture plant species or genera during 2019 to 2021.

Materials and Methods

Two trials were typically conducted for each crop species or genera, with F6123 was applied as drench applied twice at 28-day intervals in one trial or as foliar treatment applied 4 times at approximately 7-day intervals in the other. The application rates were 7, 14 and 28 fl oz per 100 gal, plus a water treated control. A minimum of ten plants (replicate treatments) were required. Phytotoxicity was planned to be recorded on a scale of 0 to 10 (0 = no phytotoxicity; 10 = complete kill). Phytotoxicity was rated weekly up to 6 weeks after initial application. For IR-4 testing, the following protocols were used: 19-006, 19-007, 20-011, 20-012, 21-011 and 20-012. For more detailed materials and methods, including application rates for various products, please visit <https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-researcher-resources/#Protocols> to view and download these protocols.

F6123 was supplied to researchers (See list of researchers in Appendix 1) by FMC.

Results and Summary

Based on the type and nature of injury seen with pesticide applications, tested plant species were placed into four categories: 1) no significant phytotoxicity or growth differences from the untreated check or any injury was transitory, 2) no or minimal transitory injury seen at the 1X rate, but the 2X and/or 4X rates did cause significant phytotoxicity, 3) significant injury at the 1X rate sufficient to recommend growers not utilize F6123, and 4) more data are needed to make informed recommendations. These categories were represented separately for foliar and drench applications.

Phytotoxicity

As a foliar application, across all crops tested, F6123 exhibited no or minimal negative impact on all plant species or genera. Two of these crops had the minimum number of three tests for definitive conclusion of crop safety (Table 1). As a foliar application, no crop displayed significant injury with F6123 (Tables 2 and 3). There are fourteen species or genera where less than three trials were conducted so there is not enough information available at this time (Table 4). As a foliar application, all trials for each of these crops showed no or minimal, transitory phytotoxicity.

As a drench application, F6123 exhibited moderate to severe negative impacts on eight plant species or genera. Two of these crops had the minimum number of three tests for definitive conclusion of crop safety (Table 5). As a drench application, eight crops displayed significant injury with F6123 (Table 6 and 7). There are five species or genera where less than three trials were conducted so there is not enough information available at this time (Table 8).

Please see Table 9 for a summary of the individual trial results.

Table 1. List of F6123 treated crops (foliar) with no or minimal transitory injury.

Phlox sp.*
Rudbeckia fulgida var. *speciosa**

Table 2. List of F6123 treated crops (foliar) with no injury at 1X but significant injury at 2X or 4X.

None

Table 3. List of F6123 treated crops (foliar) with significant injury at 1X.

None

Table 4. List of F6123 treated crops (foliar) where more information is needed.

<i>Antirrhinum majus</i> ^{1*}	<i>Petunia x hybrida</i> ¹
<i>Begonia semperflorens</i> ¹	<i>Rosa</i> sp. ^{1*}
<i>Coreopsis</i> sp. ²	<i>Tagetes erecta</i> ¹
<i>Dahlia x hortensis</i> ^{1*}	<i>Tagetes patula</i> ²
<i>Delphinium grandiflorum</i> ¹	<i>Viola x wittrockiana</i> ¹
<i>Gerbera jamesonii</i> ¹	<i>Zinnia elegans</i> ²
<i>Magnolia grandiflora</i> ²	
<i>Pelargonium x hortorum</i> ¹	

Table 5. List of F6123 treated crops (drench) with no or minimal transitory injury.

Coreopsis sp.
Zinnia elegans

Table 6. List of F6123 treated crops (drench) with no injury at 1X but significant injury at 2X or 4X.

<i>Begonia semperflorens</i>	<i>Tagetes erecta</i>
<i>Petunia x hybrid</i>	<i>Viola x wittrockiana</i>
<i>Rudbeckia fulgida</i> var. <i>speciosa</i>	

Table 7. List of F6123 treated crops (drench) with significant injury at 1X.

*Antirrhinum majus*³
Pelargonium x hortorum
Phlox sp.

Table 8. List of F6123 treated crops (drench) where more information is needed.

<i>Dahlia x hortensis</i> ¹	<i>Tagetes patula</i> ²
<i>Delphinium grandiflorum</i> ¹	
<i>Magnolia grandiflora</i> ²	

¹ No or minor injury in 1 trial

² No or minor injury in 2 trials

³ Injury found only on 'Montego Yellow' cultivar

*Already registered for F6123 foliar treatment

Table 9 Detailed Summary of Crop Safety Testing with F6123.

Notes: Table entries are sorted by crop Latin name. Only those trials with research reports received by 3/16/2022 are listed below.

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
33769	Garden Snapdragon (<i>Antirrhinum majus</i>) 'Montego Yellow'	Greenhouse	Freiberger	NJ	2019	Drench	Moderate to severe injury increasing with rates (7, 14 and 28 fl oz per 100 gal).
33769	Garden Snapdragon (<i>Antirrhinum majus</i>) 'Montego Yellow'	Greenhouse	Freiberger	NJ	2019	Foliar	Minor injury with 7, 14 and 28 fl oz per 100 gal applied 4 times.
33769	Garden Snapdragon (<i>Antirrhinum majus</i>) 'Rocket Red'	Greenhouse	Grunwald	OR	2021	Drench	No injury, growth or flowering reduction when applied at 7, 14 and 28 fl oz per 100 gal rates
33769	Garden Snapdragon (<i>Antirrhinum majus</i>) 'Rocket Red'	Greenhouse	Grunwald	OR	2021	Foliar	No injury, growth or flowering reduction when applied at 7, 14 and 28 fl oz per 100 gal rates
33758	Clubed Begonia (<i>Begonia semperflorens</i>) 'Dragon Wing Red'	Greenhouse	Freiberger	NJ	2019	Drench	Low to severe injury increasing with rates (7, 14 and 28 fl oz per 100 gal).
33758	Clubed Begonia (<i>Begonia semperflorens</i>) 'Dragon Wing Red'	Greenhouse	Freiberger	NJ	2019	Foliar	Minor injury with 7, 14 and 28 fl oz per 100 gal applied 4 times; minor stunting at 4X.
33760	Tickseed (<i>Coreopsis</i> sp.) <i>C. auriculata</i> 'Nana'	Field Container	Fraelich	GA	2019	Drench	No injury or significant growth reduction with 7, 14 and 28 fl oz per 100 gal applied twice; treated plants marketable.
33760	Tickseed (<i>Coreopsis</i> sp.) <i>C. coreopsis</i> 'Nana'	Field Container	Fraelich	GA	2019	Foliar	No injury or significant growth reduction with 7, 14 and 28 fl oz per 100 gal applied 4 times weekly; treated plants marketable.
33760	Tickseed (<i>Coreopsis</i> sp.)	Field Container	Harvey	WA	2019	Drench	No injury with 7, 14 and 28 fl oz per 100 gal applied twice at 28-day interval.
33760	Tickseed (<i>Coreopsis</i> sp.)	Field Container	Harvey	WA	2019	Foliar	No injury with 7, 14 and 28 fl oz per 100 gal applied 4 times at 7-day intervals.
33760	Tickseed (<i>Coreopsis</i> sp.) <i>C. verticillata</i> 'Moonbeam'	Field Container	Klett	CO	2020	Drench	No injury and no effect on flower production or bloom time, with 7, 14 and 28 fl oz per 100 gal applied twice; moderate growth reduction at 4X.
33756	Dahlia Hybrids (<i>Dahlia x hortensis</i>) 'Figaro Mix'	Greenhouse	Freiberger	NJ	2019	Drench	Minor injury with 7, 14 and 28 fl oz per 100 gal.
33756	Dahlia Hybrids (<i>Dahlia x hortensis</i>) 'Figaro Mix'	Greenhouse	Freiberger	NJ	2019	Foliar	No injury or growth reduction with 7, 14 and 28 fl oz per 100 gal applied 4 times.
33757	Siberian Lackspur (<i>Delphinium grandiflorum</i>)	Field Container	Harvey	WA	2019	Drench	No injury with 7, 14 and 28 fl oz per 100 gal applied twice at 28-day interval.

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
33757	Siberian Lackspur (<i>Delphinium grandiflorum</i>)	Field Container	Harvey	WA	2019	Foliar	No injury with 7, 14 and 28 fl oz per 100 gal applied 4 times at 7-day intervals.
33765	Barberton Daisy (<i>Gerbera jamesonii</i>) 'Revolution Yellow Light Eye'	Greenhouse	Catlin	NY	2020	Foliar	No injury with 7, 14 and 28 fl oz per 100 gal after 2nd application, moderate injury at 4X after 3rd application; minor stunting at 2 and 4X. Minimal and acceptable spray residue.
33172	Magnolia, Southern (<i>Magnolia grandiflora</i>) 'Edith Bogue'	Field Container	Grunwald	OR	2020	Drench	No injury, growth or flowering reduction when applied at 7, 14 and 28 fl oz per 100 gal rates
33172	Magnolia, Southern (<i>Magnolia grandiflora</i>) 'Edith Bogue'	Field Container	Grunwald	OR	2020	Foliar	No injury, growth or flowering reduction at 7, 17, and 28 fl oz per 100 gal rates
33172	Magnolia, Southern (<i>Magnolia grandiflora</i>)	Field Container	Wade	SC	2021	Drench	No injury at 7, 14 or 28 fl oz per 100 gal.
33172	Magnolia, Southern (<i>Magnolia grandiflora</i>)	Field Container	Wade	SC	2021	Foliar	No injury at 7, 14 or 28 fl oz per 100 gal applied 4 times at weekly intervals.
33755	Geranium, Zonal (<i>Pelargonium x hortorum</i>) 'Patriot White Imp.'	Greenhouse	Freiberger	NJ	2019	Drench	Severe injury with 7, 14 and 28 fl oz per 100 gal.
33755	Geranium, Zonal (<i>Pelargonium x hortorum</i>) 'Patriot White Imp.'	Greenhouse	Freiberger	NJ	2019	Foliar	Moderate injury with 7, 14 and 28 fl oz per 100 gal applied 4 times.
33755	Geranium, Zonal (<i>Pelargonium x hortorum</i>) 'Dynamite Dark Red'	Greenhouse	Grunwald	OR	2018	Drench	No injury, growth or flowering reduction when applied at 7, 14 and 28 fl oz per 100 gal rates
33406	Petunia (<i>Petunia x hybrida</i>)	Greenhouse	Bodine	NJ	2020	Foliar	No injury or growth reduction with 7, 14 and 28 fl oz per 100 gal applied 4 times weekly.
33406	Petunia (<i>Petunia x hybrida</i>)	Greenhouse	Saha	MI	2021	Drench	Minor injury with 7, moderate with 14 and 28 fl oz per 100 gal. No growth reduction.
33761	Phlox (<i>Phlox</i> sp.) <i>Phlox paniculata</i> 'Festival'	Field Container	Fraelich	GA	2020	Drench	No injury or significant growth reduction with 7, 14 and 28 fl oz per 100 gal; all treated plants marketable.
33761	Phlox (<i>Phlox</i> sp.) <i>Phlox paniculata</i> 'Festival'	Field Container	Fraelich	GA	2020	Foliar	No injury or significant growth reduction with 7, 14 and 28 fl oz per 100 gal applied 3 times; all treated plants marketable.
33761	Phlox (<i>Phlox</i> sp.)	Field Container	Harvey	WA	2019	Drench	Severe injury with 7, 14 and 28 fl oz per 100 gal applied twice at 28-day interval.
33761	Phlox (<i>Phlox</i> sp.)	Field Container	Harvey	WA	2019	Foliar	No injury with 7, 14 and 28 fl oz per 100 gal applied 4 times at 7-day intervals.
33761	Phlox (<i>Phlox</i> sp.) <i>P. subulata</i> 'Drummond's Pink'	Field Container	Klett	CO	2020	Drench	No injury or growth reduction, and no effect on flower production or bloom time, with 7, 14 and 28 fl oz per 100 gal applied twice.

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
33761	Phlox (Phlox sp.)	Field Container	Wade	SC	2021	Drench	No injury at 7, 14 or 28 fl oz per 100 gal.
33761	Phlox (Phlox sp.)	Field Container	Wade	SC	2021	Foliar	No injury at 7, 14 or 28 fl oz per 100 gal applied 4 times at weekly intervals.
33767	Rose (Rosa sp.) 'Lokelani'	Field Container	Cheng	HI	2020	Foliar	No injury or growth reduction with 7, 14 and 28 fl oz per 100 gal applied 3 times biweekly.
33768	Coneflower, Orange, var. speciosa (Rudbeckia fulgida var. speciosa)	Field Container	Beckerman	IN	2021	Drench	Minor to moderate injury increasing with rate (7, 14, or 28 fl oz per 100 gal) no impact on height, however, plant width was reduced numerically from the nontreated control.
33768	Coneflower, Orange, var. speciosa (Rudbeckia fulgida var. speciosa)	Field Container	Beckerman	IN	2021	Foliar	No injury or height differences at 7, 14, or 28 fl oz per 100 gal; however, plant width was reduced numerically from the nontreated control with 14 fl oz significantly narrower.
33768	Coneflower, Orange, var. speciosa (Rudbeckia fulgida var. speciosa) 'Goldsturm'	Field Container	Fraelich	GA	2019	Drench	No injury or significant growth reduction with 7, 14 and 28 fl oz per 100 gal applied twice; treated plants marketable.
33768	Coneflower, Orange, var. speciosa (Rudbeckia fulgida var. speciosa) 'Goldsturm'	Field Container	Fraelich	GA	2019	Foliar	No injury or significant growth reduction with 7, 14 and 28 fl oz per 100 gal applied 4 times weekly; treated plants marketable.
33768	Coneflower, Orange, var. speciosa (Rudbeckia fulgida var. speciosa)	Field Container	Harvey	WA	2019	Drench	No injury with 7, 14 and 28 fl oz per 100 gal applied twice at 28-day interval.
33768	Coneflower, Orange, var. speciosa (Rudbeckia fulgida var. speciosa)	Field Container	Harvey	WA	2019	Foliar	No injury with 7, 14 and 28 fl oz per 100 gal applied 4 times at 7-day intervals.
33762	Marigold, African (Tagetes erecta) 'Taishan Orange'	Greenhouse	Bodine	NJ	2020	Drench	Minor injury with 7, severe with 14 and 28 fl oz per 100 gal applied twice.
33762	Marigold, African (Tagetes erecta) 'Taishan Orange'	Greenhouse	Bodine	NJ	2020	Foliar	No injury or growth reduction with 7, 14 and 28 fl oz per 100 gal applied 4 times weekly.
33763	Marigold, French (Tagetes patula) 'Durango Red'	Greenhouse	Bodine	NJ	2020	Drench	No injury or growth reduction with 7, minor with 14, and severe with 28 fl oz per 100 gal applied twice.
33763	Marigold, French (Tagetes patula) 'Durango Red'	Greenhouse	Bodine	NJ	2020	Foliar	No injury or growth reduction with 7, 14 and 28 fl oz per 100 gal applied 4 times weekly.
33763	Marigold, French (Tagetes patula) 'Bonanza Yellow'	Greenhouse	Grunwald	OR	2021	Drench	No injury, growth or flowering reduction when applied at 7, 14 and 28 fl oz per 100 gal rates
33763	Marigold, French (Tagetes patula) 'Bonanza yellow'	Greenhouse	Grunwald	OR	2021	Foliar	No injury, growth or flowering reduction when applied at 7, 14 and 28 fl oz per 100 gal rates

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
33753	Pansy, Large Flowering; Wittrock's Violet (Viola X wittrockiana) 'Spring Matrix DP Orange'	Greenhouse	Freiberger	NJ	2019	Drench	Minor to severe injury increasing with rates (7, 14 and 28 fl oz per 100 gal) applied twice.
33753	Pansy, Large Flowering; Wittrock's Violet (Viola X wittrockiana) 'Spring Matrix DP Orange'	Greenhouse	Freiberger	NJ	2019	Foliar	No injury with 7 and 14 fl oz per 100 gal applied 4 times weekly; very minor with 28 fl oz.
33759	Zinna, Elegant (Zinnia elegans)	Field Container	Harvey	WA	2019	Drench	No injury with 7, 14 and 28 fl oz per 100 gal applied twice at 28-day interval.
33759	Zinna, Elegant (Zinnia elegans)	Field Container	Harvey	WA	2019	Foliar	No injury with 7, 14 and 28 fl oz per 100 gal applied 4 times at 7-day intervals.
33759	Zinna, Elegant (Zinnia elegans) 'Luminosa Pink'	Field Container	Klett	CO	2020	Drench	No injury and no effect on flower production or bloom time, with 7, 14 and 28 fl oz per 100 gal applied twice; moderate growth reduction at 4X.
33759	Zinna, Elegant (Zinnia elegans)	Field Container	Wade	SC	2021	Drench	No injury visible at 7, 14 or 28 fl oz per 100 gal; however, significant stunting occurred by 3 weeks after application at 4X.
33759	Zinna, Elegant (Zinnia elegans)	Field Container	Wade	SC	2021	Foliar	No injury at 7, 14 or 28 fl oz per 100 gal applied 4 times at weekly intervals.

Label Suggestions

In this report, two species and genera exhibited no or minimal injury after foliar treatments of F6123 at 7, 14 and 28 fl oz per 100 gal. If tested crops will be listed on the label, these can be included in a future label:

Phlox sp*
Rudbeckia fulgida var. *speciosa*

In this report, two species and genera exhibited no or minimal injury after drench treatments of F6123 at 7, 14 and 28 fl oz per 100 gal. The current F6123 label does not list drench as an approved application. If drench applications are added and tested crops will be listed on the label, these can be included in a future label:

Coreopsis sp.
Zinnia elegans

Given the lack of phytotoxicity across so many different plant species and genera, it is suggested that a general statement can be placed on the label such as ‘foliar applications have not been demonstrated to cause damage on various environmental horticulture plant species according to labeled use instructions. F 6123 may be used on a wide number of crops, but must be tested on a limited portion of the crop prior to applying to the whole crop if the grower has no previous experience applying F6123 to that crop.

In this report, eight species and genera exhibited moderate to severe injury after a single drench treatment of F6123 at 7, 14 and 28 fl oz per 100 gal. If drench applications are added to a future label, it is recommended that the following should be listed in a section of the label cautioning against use with drench applications:

Antirrhinum majus
Begonia semperflorens
Pelargonium x hortorum
Petunia x hybrid
Phlox sp.
Rudbeckia fulgida var. *speciosa*
Tagetes erecta
Viola x wittrockiana

*Already registered for F6123 foliar treatment

Appendix 1: Contributing Researchers

Dr. Janna Beckerman	Purdue University Lilly Hall Rm 1-321 West Lafayette, IN 47907
Mr. Dave Bodine Mr. Tom Freiberger (<i>past affiliate</i>)	USDA-ARS Cream Ridge Experiment Station Cream Ridge, NJ 08514
Dr. Nora J. Catlin	Cornell Cooperative Extension 423 Griffing Avenue Riverhead, NY
Dr. Zhiqiang Cheng	Univeristy of Hawaii 3050 Maile Way Cilmore Hall 609A Honolulu, HI 96822
Dr. Nik Grunwald	USDA ARS Horticultural Crops Research 3420 NW Orchard Ave Corvallis, OR 97330
Mr. John Harvey (<i>past affiliate</i>)	USDA-ARS 5230 Konnawac Pass Road Wapato, WA, 98951
Dr. James Klett	Colorado State University Dept of Horticulture and LA Fort Collins, CO 80523
Mr. Duane Larson	USDA-ARS 5230 Konnawac Pass Road Wapato, WA, 98951
Dr. Debalina Saha	Michigan State University 1066 Bogue St, Room A220 East Lansing, MI 48824
Mr. Paul Wade	USDA-ARS US Vegetable Laboratory 2700 Savannah Highway Charleston SC 29414