

## CALIFORNIA GARLIC

This scenario was updated in December 2012. California is the largest producer of garlic in the United States measured both in acres and number of producing farms (USDA, 2004). 29,240 acres were dedicated to garlic production in 2001, with 96.5% of production occurring in Fresno (86% of the acres) and Kern Counties located within the San Joaquin Valley.

Garlic is propagated vegetatively through the planting of cloves. Root depth is usually 18-24". Both garlic and onions are grown in elevated light soil beds planted in double rows at a density of approximately 18 plants per foot. Growers typically plant garlic from mid September through November (USDA, 2004). Fields are treated with herbicide immediately after planting and will usually receive one or two further applications before harvest. Garlic intended for fresh markets will often go without any insecticide treatments, while garlic grown for dehydration will receive insecticide treatments near maturity. The majority of garlic crops, intended for dehydration, will be mowed up to 2 months before harvest by mechanical diggers. Garlic grown for fresh markets is harvested earlier by mechanical "undercut" techniques that loosen the bulbs within the soil (USDA, 2004)

The Met station chosen was the Fresno station (W93193.dvf) located at 36° 47' N, 119° 43' W and at an elevation of approximately 102 meters above sea level. The station is located within Fresno County where the majority of garlic is grown and is the closest station containing the necessary data for PRZM. This station receives an average of approximately 27 cm of rainfall annually, with the majority of rainfall occurring between November and March.

The Cerini series is the second most common soil found in garlic producing areas of Fresno, Kern, and Kings Counties, accounting for nearly 20% of garlic bearing soils acreage (USDA, 2006). Garlic in California is predominantly grown on clay loam to sandy loam soils (USDA 2004). Cerini soils are found in Fresno and Kings Counties and are fine-loamy, mixed, superactive, thermic Fluventic Haplocambids soil found on slopes of 0 to 5% (USDA, 2003). Cerini soils are identified as garlic bearing soils (USDA 2003, USDA 2006) and are among the top soils for expected irrigated yields (Table 5). Cerini soils are not expected to yield garlic without irrigation (USDA, 2006; Table 5). Location and meteorology data selections are often the most important developments affecting scenario vulnerability and protectiveness. Because over 80% of garlic in California is grown in Fresno County (USDA, 2002; USDA, 2004) the meteorology file closest to the center of Fresno County was chosen. In fact, approximately 95% of garlic grown in Fresno county is grown in the area bounded by Interstate 5 on the west, the city of Huron on the south, and US 269 on the east (R. Ehn, California Garlic and Onion Research Advisory Board, personal communication). This detailed information allowed for soil selection within that boundary.

Cerini is a Hydrologic Group C soil, which includes the 90<sup>th</sup> percentile of these soils in drainage. Cerini soils have a USLE K factor of 0.37, which is common to 58% of garlic-bearing soils and includes the 90<sup>th</sup> percentile of these soils in erodibility. Approximately 10% of garlic bearing soils have a pH lower than Cerini soils (7.7). However, soil pH is not currently a PRZM input parameter. Cerini soils have an A horizon from 0 to 5 inches (0-13 cm) deep and a B horizon from 5 to 52 inches (13-132 cm) deep. No benchmark soils of California were selected for this scenario, since no hydrologic group C or D benchmark soils bear garlic production (USDA, 2006). Cerini clay loam 0-2 percent slopes was used to parameterize this scenario (USDA 2006).

The meteorology data used in the original garlic scenario, W23188.dvf, was for San Diego and not Fresno CA as cited in the scenario documentation. The current scenario was modified to use the correct met file, W93193.dvf.

The emergence data in the scenario file, October 1 did not match the data justified in the scenario metadata- of October 30. The scenario file was changed to match the metadata. These two changes were made in response to an audit by the Quality Assurance Officer for the pesticide program, Denise Rice (2012). The dates for USLE C Factors, curve numbers, Manning N values in lines 9a-e were adjusted to be consistent with the new emergence date by adding 20 days to each date on line 9a. Finally, the curve numbers in the original scenario were selected from GLEAMS Table H-4 (Davis, Leonard, and Knisel, 1990). However, this resource is obsolete and has been revised several times subsequently. The curve numbers were selected to be consistent with current U. S. Department of Agriculture guidance (USDA, 2004). The new curve numbers are 91, 83 and 90 for residue, cropped and fallow fields respectively. The previous values were 91, 87, 88.

Parameter	Value	Source/Comments
Starting Date	Jan. 1, 1961	Meteorological File from Fresno, CA (W93193)
Ending Date	Dec. 31, 1990	Meteorological File from Fresno, CA (W93193)
Pan Evaporation Factor (PFAC)	0.68	PRZM Manual Figure 5.1. Value represents Southern San Joaquin Valley region.
Snowmelt Factor (SFAC)	0	The Weather Channel Interactive, Inc. (TWCII, 2006)
Minimum Depth of Evaporation (ANETD)	17.5 cm	PRZM Guidance

Parameter	Value	Source/Comments
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.37 tons EI <sup>-1</sup> *	USDA NRCS Soil Data Mart ( <a href="http://soildatamart.nrcs.usda.gov/">http://soildatamart.nrcs.usda.gov/</a> ) Value listed for the soil series Cerini.
USLE LS Factor (USLELS)	0.15	PRZM Manual (EPA, 1998) LS value for 0.5% slope and 400' slope length; LS equation (Haan and Barfield, 1978)
USLE P Factor (USLEP)	1.0	R. Ehn, California Garlic and Onion Research Advisory Board Default for crops with no contour practices
Field Area (AFIELD)	172 ha (IR) 10 ha (pond)	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	1	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	0.5%	R. Ehn, California Garlic and Onion Research Advisory Board
Hydraulic Length (HL)	600 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	2	Irrigation is applied during growing season only. Irrigation of garlic fields is stopped a few weeks prior to harvest to allow the plants to dry. "Water cutoff" normally occurs in early June for fresh market fields, and mid June for the fields growing garlic for dehydration (USDA, 2004). 1= growing season only as per PRZM Irrigation Guidance (EPA, 2005)
Irrigation Type (IRTYP)	3 (sprinkler)	Primarily sprinkler with some drip (~15%). Shannon Mueller Farm Advisor, University of California Cooperative Extension; and Irrigation Guidance for developing PRZM Scenarios, Table 3; (EPA 2005).
Leaching Factor (FLEACH)	0.1	Information unavailable, set to default = 0.1. Irrigation Guidance for developing PRZM Scenarios, Table 3; (June 15, 2005).
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	0.66	Garlic is generally irrigated at 66% AWC. Shannon Mueller, Farm Advisor, University of California Cooperative Extension; and Irrigation Guidance for developing PRZM Scenarios, Table 3; (EPA 2005).
Maximum Rate at which Irrigation is Applied (RATEAP)	0.068 cm hr <sup>-1</sup>	Irrigation Guidance for developing PRZM Scenarios, Table 1; (June 15, 2005). For CN = 87 and f = 0.1

\* EI = 100 ft-tons \* in/ acre\*hr

**Table 2. PRZM 3.12 Erosion and Landscape Parameters for Fresno, California – Garlic.**

Parameter	Value	Source/Comments
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**Table 3. PRZM 3.12 Crop Parameters for Fresno, California – Garlic.**

Parameter	Value	Source/Comments
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2004).
Initial Surface Condition (ISCOND)	1	R. Ehn, California Garlic and Onion Research Advisory Board. Garlic requires a well prepared soil surface.
Number of Different Crops (NDC)	1	Set to number of crops in simulation.
Number of Cropping Periods (NCPDS)	30	Set to weather data in meteorological file: Fresno, CA (W93193).
Maximum rainfall interception storage of crop (CINTCP)	0.1	Recommended value for light density crops (EPA, 2004).
Maximum Active Root Depth (AMXDR)	46 cm	R. Ehn, California Garlic and Onion Research Advisory Board.
Maximum Canopy Coverage (COVMAX)	80	R. Ehn, California Garlic and Onion Research Advisory Board. Gaps in coverage between rows.
Soil Surface Condition After Harvest (ICNAH)	2	R. Ehn, California Garlic and Onion Research Advisory Board. Leaf material left in soil after bulb removal.
Date of Crop Emergence (EMD, EMM, IYREM)	30/10/60	R. Ehn, California Garlic and Onion Research Advisory Board. Planting proceeds early September. Emergence set to previous year to ensure mature plant during the initial year of simulation.
Date of Crop Maturity (MAD, MAM, IYRMAT)	15/05/61	R. Ehn, California Garlic and Onion Research Advisory Board.
Date of Crop Harvest (HAD, HAM, IYRHAR)	30/07/61	R. Ehn, California Garlic and Onion Research Advisory Board. Harvest begins late July and can proceed into October.
Maximum Dry Weight (WFMAX)	0.0	Not used in scenario
Maximum Height (HFMAX)	18"	R. Ehn, California Garlic and Onion Research Advisory Board.
SCS Curve Number (CN)	91, 83, 90	USDA Hydrology National Engineering Handbook (USDA, 2004)
Manning's N Value (MNGN)	0.011	RUSLE Project; C23ONONC for Fresno onion crops which share most field conditions with garlic (USDA, 2000).
USLE C Factor (USLEC)	0.521-0.732	RUSLE Project; C23ONONC for Fresno onion crops which share most field conditions with garlic (USDA, 2000).

**Table 4. PRZM 3.12 Cerini Clay loam Soil Parameters Fresno, California – Garlic.**

Parameter	Value	Source/Comments
Total Soil Depth (CORED)	157 cm	NRCS Soil Data Mart (SDM) ( <a href="http://soildatamart.nrcs.usda.gov">http://soildatamart.nrcs.usda.gov</a> )
Number of Horizons (NHORIZ)	5	NRCS Soil Data Mart (SDM) ( <a href="http://soildatamart.nrcs.usda.gov">http://soildatamart.nrcs.usda.gov</a> ).
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 3 cm (HORIZN = 2) 51 cm (HORIZN = 3) 25 cm (HORIZN = 4) 68 cm (HORIZN = 5)	NRCS Soil Data Mart (SDM) ( <a href="http://soildatamart.nrcs.usda.gov">http://soildatamart.nrcs.usda.gov</a> ). The top horizon was split into two horizons as per PRZM Scenario Guidance (EPA, 2004).

Bulk Density (BD)	1.45 g/cm <sup>3</sup> (HORIZN = 1) 1.45 g/cm <sup>3</sup> (HORIZN = 2) 1.5 g/cm <sup>3</sup> (HORIZN = 3) 1.45 g/cm <sup>3</sup> (HORIZN = 4) 1.45 g/cm <sup>3</sup> (HORIZN = 5)	NRCS Soil Data Mart (SDM) ( <a href="http://soildatamart.nrcs.usda.gov">http://soildatamart.nrcs.usda.gov</a> ). Midpoint of the reported range. PRZM Scenario Guidance (EPA, 2004).
Initial Water Content (THETO)	0.313 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =1) 0.313 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =2) 0.326 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN = 3) 0.236 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN = 4) 0.198 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN = 5)	NRCS Soil Data Mart (SDM); values are mean 1/3-bar water contents of Cerini clay loam soils.
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 3 cm (HORIZN = 2) 3 cm (HORIZN = 3) 5 cm (HORIZN = 4) 4 cm (HORIZN = 5)	NRCS Soil Data Mart (SDM) ( <a href="http://soildatamart.nrcs.usda.gov">http://soildatamart.nrcs.usda.gov</a> ). PRZM Scenario Guidance (EPA, 2004).
Field Capacity (THEFC)	0.313 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =1) 0.313 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =2) 0.326 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN = 3) 0.236 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN = 4) 0.198 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN = 5)	NRCS Soil Data Mart (SDM); values are mean 1/3-bar water contents of Cerini clay loam soils.
Wilting Point (THEWP)	0.173 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =1) 0.173 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =2) 0.195 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN = 3) 0.150 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN = 4) 0.115 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN = 5)	NRCS Soil Data Mart (SDM); values are mean 15-bar water contents of Cerini clay loam soils.
Organic Carbon Content (OC)	0.46% (HORIZN = 1) 0.46% (HORIZN = 2) 0.41% (HORIZN = 3) 0.23% (HORIZN = 4) 0.17% (HORIZN = 5)	NRCS SDM; values for horizons 1 to 3 = mean %OM / 1.724. PRZM Scenario Guidance (EPA, 2004).

### *Sensitive Parameter Uncertainties*

#### USLEC

Selected onion crops as closest match to garlic parameters for USLEC values. Garlic and onions are both grown in rows on raised soil beds with mechanical harvesting.

<b>Table 5. Garlic Bearing Soils of Fresno, Kern, and Kings Counties (California) Ranked by Area.</b>												
<b>Soil</b>	<b>Total Acreage</b>	<b>% Area</b>	<b>Drainage</b>	<b>Erodibility</b>	<b>Slopes (%)</b>	<b>pH</b>	<b>OM (%)</b>	<b>% Sand</b>	<b>% Silt</b>	<b>% Clay</b>	<b>Garlic (tons)</b>	
											<b>Irrigated</b>	<b>Non-Irr.</b>
CIERVO	92,670	22.78%	C/D	0.28	0-2	8.2	0.9	32	28	40	8.3-8.8	-
CERINI	76,200	18.74%	C	0.37	0-2	7.7	0.8	32	40	28	10.8	-
CALFLAX	54,140	13.31%	C	0.37	0-1	8	0.8	28	40	32	8.8	-
WESTHAVEN	50,290	12.36%	C/B	0.37	0-2	7.6-7.8	1.2	30-35	40-45	20-30	8.8-10	-
HESPERIA	27,871	6.85%	B	0.32	0-9	7.3-7.9	0.25	67.4	19.6	13	13-14	-
PANOCHE	27,870	6.85%	B	0.37	0-2	7.8	0.7	35	37	28	8	-
LETHENT	26,979	6.63%	C	0.37	0-1	8	2	35	37	28	6-9.5	-
EXCELSIOR	20,110	4.94%	B	0.28	0-2	7.8	0.8	60	28	12	9.2	-
POSOCHANET	16,430	4.04%	C	0.32	0-1	7.9	1.4	32	34	34	7.5	-
MILHAM	7,700	1.89%	B	0.32	0-2	7.4	0.5	59	22	19	7.5	-
ARVIN	3,480	0.86%	B	0.43	2-5	7	0.75	65.7	22.8	11.5	14	-
DIGIORGIO	2,982	0.73%	B	0.2	0-2	7.9	0.75	55.1	17.4	27.5	13	-



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## Works Cited

EPA. 1998. Carsel, R.F., J.C. Imhoff, P.R. Hummel, J.M. Cheplick, and A.S. Donigian, Jr. PRZM-3, A Model for Predicting Pesticide and Nitrogen Fate in the Crop Root and Unsaturated Soil Zones: Users Manual for Release 3.0. National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, GA.

EPA. 1999. Jones, R.D., J. Breithaupt, J. Carleton, L. Libelo, J. Lin, R. Matzner, and R. Parker. Guidance for Use of the Index Reservoir in Drinking Water Exposure Assessments. Environmental Fate and Effects Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington, DC.

EPA. 2004. Abel, S.A. Procedure for Conducting Quality Assurance and Quality Control of Existing and New PRZM Field and Orchard Crop Standard Scenarios. Environmental Fate and Effects Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington, DC.

EPA. 2005. Irrigation Guidance for developing PRZM Scenarios. June 15, 2005.

Haan, C.T. and B.J. Barfield. 1978. Hydrology and Sedimentology of Surface Mined Lands. Office of Continuing Education and Extension, College of Engineering, University of Kentucky, Lexington KY 40506. pp 286.

Rice, Denise. 2012. *EFED Quality System Audit*. Internal EPA Memorandum to Donald Brady dated June 5, 2012.

TWCII. 2006. Averages and Records for Fresno, CA. The Weather Channel Interactive, Inc. Online at: <http://www.weather.com/outlook/recreation/outdoors/wxclimatology/monthly/graph/USCA0406>

USDA. 1990. Davis, F.M., R.A. Leonard, W.G. Knisel. GLEAMS User Manual, Version 1.8.55. U.S. Department of Agriculture, Agricultural Research Service (ARS), Southeast Watershed Research Laboratory, Tifton, GA. SEWRL-030190FMD.

USDA. 2000. Revised Universal Soil Loss Equation (RUSLE) EPA Pesticide Project. U.S. Department of Agriculture, National Resources Conservation Service (NRCS) and Agricultural Research Service (ARS).

USDA. 2002. 2002 Census of Agriculture. U.S. Department of Agriculture, National Agricultural Statistics Service (NASS). Online at: <http://www.nass.usda.gov/census/census02/preliminary/2002censusdates.htm>.

USDA. 2003. Official Series Description –CERINI Series. U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). Dec. 2006. Online at: <http://ortho.ftw.nrcs.usda.gov/osd/dat/C/CERINI.html>

USDA. 2004. Crop Profile for Garlic in California. U.S. Department of Agriculture, Pest Management Centers. August 2004. Online at: <http://www.ipmcenters.org/CropProfiles/docs/CAgarlic.html>.

USDA. 2006. Soil Survey Areas of Fresno, Kings, and Kern Counties. U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), Soil Data Mart. March 1, 2006. Online at: <http://soildatamart.nrcs.usda.gov>.

USDA, 2004. Part 630 *Hydrology National Engineering Handbook. Chapter 9: Hydrologic Soil Cover Classes*.