

CALIFORNIA COLE CROP

This scenario is intended to represent general cole crop production in the Central California Coast/Coastal Valleys Range, primarily MLRAs 14 & 15, hereafter referred to as area of interest (AOI). Cole crops include crops such as broccoli, cauliflower, and cabbage. Based on 2002 USDA Census of Agriculture data, approximately 170,763 acres of these crops was grown in California (USDA, 2002). Among these crops, broccoli is the most common cole crop, representing roughly 70% of the total acreage. Within the AOI, approximately 78% of the cole crop acreage and nearly 60% of total pesticides pounds product applied to cole crops (broccoli, cabbage, and cauliflower) occurs in the counties of Monterey, Santa Barbara, and San Luis Obispo. Monterey is the top producing cole crop county in the state representing approximately 50% of the total acreage (USDA, 2002). It is also the top pesticide usage county (based on total pounds product applied) in the state (CalPIP, 2006) for application to cole crops.

This scenario is generally parameterized based on broccoli crops. Monterey County is the major broccoli production area, constituting nearly half the total acreage in California (VRIC, undated; Production areas and seasons). California broccoli production consists of 91% of all commercially grown broccoli grown in the United States (USDA 1999). Monterey County broccoli acreage was approximately 121,000 acres in 1998. (USDA 1999). The majority of broccoli grown in coastal valleys includes hybrids of the Italian green type, also known as sprouting green broccoli or calabrese. (VRIC, undated; Broccoli Varieties). Broccoli is mostly direct seeded; however, recently, there has been an increase in using transplants (VRIC 1996; USDA 1999).

Typical cropping practices includes flail mowing the previous crop, disking, ripping, plowing, multiple disking, land planning, listing, bed shaping and sprinkler irrigation practices (VRIC, 1996; UC Cooperative Extension Farm Advisor; USDA 1999). Sprinkler and furrow irrigation is typically used throughout the growing season. Both direct seeded and transplanted broccoli are established by sprinkler irrigation, which allows incorporation of herbicides and fertilizer application with the water. Once the plants are established, furrow, sprinkler or drip irrigation can be used (USDA, 1999; UC Cooperative Extension Farm Advisor; VRIC 1996). Broccoli plants have a maximum root depth of 18 inches and prefer well-drained soil, but can be grown on a variety of soil textures (VRIC 1996). In the coastal regions, two or more broccoli crops are common, in rotation with lettuce or celery (USDA 1999). Whether grown by direct seeding or with transplants, broccoli is typically grown in double rows on raised beds 38 to 42 inches. It is occasionally planted in single rows on 30 inch beds with plant spacing at 5 to 6 inches (VRIC 1996). In coastal districts, the use of high density broccoli plantings, which consists of six plant lines per bed with 80 inch centers, is a more recent trend (USDA 1999).

Metfile W23234 (Santa Maria) is the meteorological data set used to representative Central California Coast/Coastal Valleys Cole crop production. The station is located along the coast in Santa Barbara County within MLRA 15. It is roughly 106 miles to the south of Monterey County which contains the field used to represent this scenario. The Fresno station is approximately 20 miles closer to the geographic center of Monterey County, however the Santa Maria station was deemed more representative for several reasons. First, this scenario is generally a coastal scenario. Fresno is an inland station whereas the coastal Santa Maria station is more representative of the Coastal Climate of this scenario. In addition, the Santa Maria station receives approximately three inches more annual rainfall than the Fresno station, increasing the conservative nature of the scenario (NOAA, 2006).

Location and metfile selections are often the most important developments affecting scenario vulnerability and protectiveness. Metfile selection has been discussed above. Soil selection is also an important protectiveness factor. Because over 70% of the cole crops acreage consist of broccoli, soils were selected based on the ability to support broccoli production. The Marimel series was chosen for this scenario because it is found in Central California Coast/Coastal Valleys Range, is a hydrologic group C soil and accounts for 13% of cole crop bearing soils acreage (USDA, 2002; Table 5). It is a Fine-loamy, mixed, superactive, thermic Cumulic Haploxerolls soil found on slopes of 0 to 2% (USDA, 2003), which includes

the maximum slope on which cole crops are grown (R. Smith, Personal Communication). The soils are primarily use for growing truck crops, barley and orchards (USDA, 2003). Based on USDA data, the majority (78%) of cole crop bearing soils in the region are hydrologic group A and B soils. A hydrologic group C soil was chosen because over 70% of cole crop acreage consists of broccoli production and the A and B soils do not support broccoli (Table 5). This scenario has been parameterized based on Marimel Silty Clay Loam Soil.

Marimel is a Hydrologic Group C soil, which represents 13% of these soils in drainage based on soil survey data (USDA, 2006). Because exposure scenarios are intended to represent the “high end” of what might occur in an actual agricultural setting, local expert knowledge and soil survey data led to the selection of Marimel soils. Marimel soils have a USLE K factor of 0.28; approximately 42% of cole crop bearing soils have an erodibility higher than 0.28 (Table 5). Approximately 44% of cole crop bearing soils have a pH lower than marimel soils (7.5). However, soil pH is not currently a PRZM input parameter and is not expected to often affect chemical fate in the acidic range. Based on the official soil series description Marimel soils have an A horizon from 0 to 35 inches (0-89 cm) deep and a C horizon from 35 to 60 inches (89-152 cm) deep (USDA, 2003).

Table 1. PRZM 3.12 Climate and Time Parameters for Monterey, California – Cole Crop.		
Parameter	Value	Source/Comments
Starting Date	Jan. 1, 1961	Meteorological File from Santa Maria (W23234)
Ending Date	Dec. 1, 1991	Meteorological File from Santa Maria (W23234)
Pan Evaporation Factor (PFAC)	0.75	PRZM Manual Figure 5.1. Value represents the central coastal region.
Snowmelt Factor (SFAC)	0	The Weather Channel Interactive, Inc. (TWCII, 2006)
Minimum Depth of Evaporation (ANETD)	17.5 cm	PRZM Manual (EPA 1998).

Table 2. PRZM 3.12 Erosion and Landscape Parameters for Monterey, California – Cole Crop.		
Parameter	Value	Source/Comments
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.28	USDA NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) Value listed for the soil series Marimel silty clay loam.
USLE LS Factor (USLELS)	0.2	LS value for 1% slope and 400' slope length PRZM Manual (EPA, 1998)
USLE P Factor (USLEP)	1.0	Richard Smith, Monterey County Extension Agent Default for cole crop with no contour practices
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	1	PRZM Manual Figure 5.12 (EPA, 1998) Type I, IREG=1
Slope (SLP)	1%	Richard Smith, Monterey County Extension Agent Midpoint of the range for Marimel silty clay loam.
Hydraulic Length (HL)	600 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	2	Once established, broccoli may either be furrow, sprinkler or drip irrigated. (USDA< 1999)
Irrigation Type (IRTYPE)	3 (sprinkler)	Transplants are initially sprinkler irrigated. Once established, broccoli may either be furrow, sprinkler or drip irrigated. (USDA, 1999)

Table 2. PRZM 3.12 Erosion and Landscape Parameters for Monterey, California – Cole Crop.		
Parameter	Value	Source/Comments
Leaching Factor (FLEACH)	0.1	Irrigation Guidance for developing PRZM Scenario, Table 3; (June 15, 2005).
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	0.5	Set to default as per Irrigation Guidance for developing PRZM Scenario, Table 3; (EPA 2005).
Maximum Rate at which Irrigation is Applied (RATEAP)	0.1 cm hr ⁻¹	Set to default as per Irrigation Guidance for developing PRZM Scenario, Table 3; (EPA 2005).

Table 3. PRZM 3.12 Crop Parameters for Monterey, California – Cole Crop.		
Parameter	Value	Source/Comments
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2004).
Initial Surface Condition (ISCOND)	3	Richard Smith, Monterey County Extension Agent Residue initial soil surface condition
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: Santa Maria (W23234).
Maximum rainfall interception storage of crop (CINTCP)	0.25	PRZM manual Table 5-4 (EPA, 1998). Default value recommended value for surrogate crop (soybeans) (EPA, 2004).
Maximum Active Root Depth (AMXDR)	46 cm	Roots can extend to 18 inches. Richard Smith, Monterey County Extension Agent
Maximum Canopy Coverage (COVMAX)	100	Richard Smith, Monterey County Extension Agent
Soil Surface Condition After Harvest (ICNAH)	3	Richard Smith, Monterey County Extension Agent Residue after harvest soil surface condition
Date of Crop Emergence (EMD, EMM, IYREM)	01/01/61	Emergence occurs from January thru November. Set to the first crop during wet season. (R. Smith, Vegetable Crop and Weed Science Farm Advisor)
Date of Crop Maturity (MAD, MAM, IYRMAT)	22/02/61	Crops are harvested at maturity. Set to one week prior to harvest. (R. Smith, Vegetable Crop and Weed Science Farm Advisor)
Date of Crop Harvest (HAD, HAM, IYRHAR)	01/03/61	Harvest occurs from mid-February thru December. Set to the first crop. (R. Smith, Vegetable Crop and Weed Science Farm Advisor)
Maximum Dry Weight (WFMAX)	0.0	Not used in scenario
Maximum Crop Height (HTMAX)	30 cm	Richard Smith, Monterey County Extension Agent
SCS Curve Number (CN)	92, 88, 89	Gleams Manual Table H-4 (USDA, 1990); Fallow = SR+CT poor condition; Cropping and Residue = Row Crops, SR+CT poor Hydrologic Group C. CT is used for cole row crops.
Manning's N Value (MNGN)	0.011	RUSLE Project; C24BGBGC for California Green Beans with conventional till (USDA, 2000). Data are from San Francisco, which is the closest RUSLE file with similar crop practices and coastal CA climate.

Table 3. PRZM 3.12 Crop Parameters for Monterey, California – Cole Crop.		
Parameter	Value	Source/Comments
USLE C Factor (USLEC)	0.083 - 0.795	RUSLE Project; C24BGBGC for California Green Beans with conventional till (USDA, 2000). Data are from San Francisco, which is the closest RUSLE file with similar crop practices and coastal CA climate.

Table 4. PRZM 3.12 Marimel Silty Clay Loam Soil Parameters for Monterey, California – Cole Crop.		
Parameter	Value	Source/Comments
Total Soil Depth (CORED)	152 cm	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov)
Number of Horizons (NHORIZ)	3	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov). Horizon A spans scenario horizons 1 and 2 in order to conform to PRZM input requirements.
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 31 cm (HORIZN = 2) 111 cm (HORIZN = 3)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov)
Bulk Density (BD)	1.5 g/cm ³ (HORIZN = 1) 1.5 g/cm ³ (HORIZN = 2) 1.5 g/cm ³ (HORIZN = 3)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov); values are mean 1/3-bar moist bulk densities of a soil sampled as a Marimel silty clay loam soil.
Initial Water Content (THETO)	0.334 cm ³ /cm ³ (HORIZN =1) 0.334 cm ³ /cm ³ (HORIZN =2) 0.308 cm ³ /cm ³ (HORIZN =3)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov); values are mean 1/3-bar water contents of a soil sampled as a Marimel silty clay loam soil.
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1.0 cm (HORIZN = 2) 3.0 cm (HORIZN = 3)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov);
Field Capacity (THEFC)	0.334 cm ³ /cm ³ (HORIZN =1) 0.334 cm ³ /cm ³ (HORIZN =2) 0.308 cm ³ /cm ³ (HORIZN =3)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov); values are mean 1/3-bar water contents of a soil sampled as a Marimel silty clay loam soil.
Wilting Point (THEWP)	0.219 cm ³ /cm ³ (HORIZN =1) 0.219 cm ³ /cm ³ (HORIZN =2) 0.174 cm ³ /cm ³ (HORIZN =3)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov); values are mean 15-bar water contents of a soil sampled as a Marimel silty clay loam soil.
Organic Carbon Content (OC)	1.74% (HORIZN = 1) 1.74% (HORIZN = 2) 0.87% (HORIZN = 3)	NRCS SDM; values = mean %OM / 1.724.

Table 5. Cole Crops Bearing Soils of Monterey, San Luis Obispo, and Santa Barbara Counties (California) Ranked by Area.													
Soil	Total Acreage	% Area	Drainage	Erodibility	Slopes (%)	pH	OM (%)	% Sand	% Silt	% Clay	Broccoli-IrrYield	Cabbage-IrrYield	Cauliflower-IrrYield
PICO	13,745	33.4%	B	0.32	0-2	8.2	2.5	64.5	19.5	16	--	375	--
BOTELLA	9,739	23.6%	B	0.2-0.28	0-9	6.5	3-4	34.2-41.6	33.6-37.4	21-31	--	--	400
CORRALITOS	5,531	13.4%	A	0.15-0.2	0-2	5.8-6.1	0.75	80.5-96	1.5-17	2.5	--	--	350
MARIMEL	5,300	12.9%	D/C	0.15-0.28	0-2	7.5	3	18.1-55.1	17.4-50.9	27.5-31	3-3.5	--	--
ELKHORN	3,620	8.8%	C	0.32	5-30	6.3	2	67.3	20.2	12.5	3	--	--
MOCHO VARIANT	1,845	4.5%	A	0.24	0-2	7.91	1.5	70.5	16.5	13	30	--	--
BAYSHORE	1,435	3.5%	B	0.28	0-2	8.2	2.5	18.1	50.9	31	3.5	--	--

Contacts

Richard Smith

Vegetable Crop and Weed Science Farm Advisor
University of California Cooperative Extension
Monterey, Santa Cruz and San Benito Counties
1432 Abbott Street, Salinas, CA 93901
Phone: 831-759-7357
Fax 831-758-3018

Works Cited

CalPIP. 2006. 2005 Pesticide Usage Reporting. California Pesticide Information Portal, CA Department of Pesticide Regulation. Accessed December 4, 2006. Online at:
<http://calpip.cdpr.ca.gov/cfdocs/calpip/prod/main.cfm>.

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. Online at:
<http://www.epa.gov/ceampubl/gwater/przm3/przm312b.htm>.

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. Pesticide Root Zone Model (PRZM) Field and Orchard Crop Scenarios: Guidance for Selecting Field Crop and Orchard Scenario Input Parameters. Environmental Fate and Effects Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington, DC. Online at:
www.epa.gov/oppefed1/models/water/przm_scenario_metadata.wpd.

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

NOAA. 2006. Comparative Climatic Data – Bakersfield, Ca Mean Annual Precipitation: 1971-2000. National Oceanic and Atmospheric Administration (NOAA), National Weather Service Forecast Office. Online at: <http://www.ncdc.noaa.gov/oa/climate/online/ccd/nrmcp.txt>; and
http://www1.ncdc.noaa.gov/pub/data/ccd-data/CCD_2005.pdf.

NOAA. 2006. National Climatic Data Center. Climate Data Inventories – Monterey, CA Station. Online at:
<http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwDI~StnSrch~StnID~20002236>

TWCII. 2006. Averages and Records for Fresno, CA. The Weather Channel Interactive, Inc. Online at:
<http://www.weather.com> and
<http://www.weather.com/outlook/recreation/outdoors/wxclimatology/monthly/93307>.

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 – Marimel Series. U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). Dec. 2006. Online at: <http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdname.cgi?-P>.

USDA. 2006. Soil Survey Areas of Monterey, San Luis Obispo, and Santa Barbara Counties (California). U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), Soil Data Mart. March 1, 2006. Online at: <http://soildatamart.nrcs.usda.gov>.

USDA. 1999. Crop Profile for Broccoli in California. U.S. Department of Agriculture, Pest Management Centers. Online at: <http://www.ipmcenters.org/CropProfiles/docs/cawheat.html>.

VRIC. 1996. Broccoli production in California. University of California. Division of Agriculture and Natural Resources. Vegetable Research and Information Center. Vegetable production series. Publication 7211. Online at: <http://vric.ucdavis.edu/selectnewcrop.broccoli.htm>