

CALIFORNIA STRAWBERRIES – WITHOUT PLASTIC

The Santa Maria Valley region, which includes the coastal regions of Monterey, Santa Cruz, Santa Clara, San Luis Obispo, and northern Santa Barbara Counties characterizes the strawberry production region of California (USDA, 1999). California produces more than 80% of the fresh market and processed strawberries grown in the United States (USDA 1999). Two-thirds of the California’s strawberry production occurs in the Santa Maria region, which includes the coastal regions of Santa Cruz, Santa Clara, San Luis Obispo, Northern Santa Barbara, and Monterey County (USDA 1999). Over a dozen varieties of strawberries are grown in California. 96% of the strawberries in the coastal regions are of the Camarosa variety. MLRA 15 covers most of the areas of California where strawberries are grown (USDA, 1999).

California strawberries are supplied by state nurseries, and planted in November, with first leaf emergence in December. Fields are graded and planted in beds designed to allow for proper drainage on fallow conditions. Clean tillage, raised beds, plastic mulches and water management are included in the systems approach for growing strawberries (USDA 1999). Strawberries fields are sometimes rotated with cover crops such as rye or barley (USDA 1999). Drip irrigation is used as weather and plant conditions permit (Monterey County cooperative extension agent). The maximum root depth for strawberries is 4 feet (Monterey County Cooperative extension agent; USDA 1999). Strawberries are harvested by hand (USDA 1999).

Plastic mulch, typically made from clear polyethylene is applied to warm the soil to increase early plant growth, and to keep the berries off the ground (USDA 1999). This scenario does not consider the impacts to runoff due to the use of plastic. Runoff from strawberry fields utilizing plastic may underestimate pesticide runoff.

Metfile W23234 (Santa Maria) is the meteorological data set used to represent Santa Maria Valley strawberry 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).

The majority (roughly 83%) of soils with expected irrigated yields for strawberries occur on hydrologic group A and B soils (Table 5). Approximately 50% of strawberry soils in the AOI are in hydrologic group A. The Oceano series is a hydrologic group A soil that is used for growing truck crops and fruit with irrigation (USDA, 1997). The soil accounts for approximately 23% of total bearing acres in the AOI (USDA, 2006). The Oceano series consists of deep, excessively drained soils that formed in material weathered from sandy eolian deposits and are located on slopes of 0 to 50 percent. It is a Mixed, thermic Lamellic Xeropsamments (USDA, 2001), which includes the maximum slope on which strawberry plants are grown. The Oceano series was selected for this scenario because it is a common soil that supports strawberry production (Table 5), is located within the area of peak strawberry production (Monterey County within the Santa Maria Valley Region) (USDA, 2006).

Oceano is a Hydrologic Group A soil, which includes approximately 50% of these soils in drainage. Oceano soils have a USLE K factor of 0.1. Approximately 20% of strawberry bearing soils have a pH lower than Oceano soils. However, soil pH is not currently a PRZM input parameter and is not expected to often affect chemical fate in the acidic range. Oceano soils have an A horizon from 0 to 20 inches (0-51 cm) deep and a C from 20 to 90 inches (51-229 cm) deep (USDA, 2001).

Table 1. PRZM 3.12 Climate and Time Parameters for Monterey, California – Strawberry.

Parameter	Value	Source/Comments
Starting Date	Jan. 1, 1961	Meteorological File from Santa Maria, CA (W 23273).
Ending Date	Dec. 31, 1990	Meteorological File from Santa Maria, CA (W 23273).

Pan Evaporation Factor (PFAC)	0.75	PRZM Manual Figure 5.1. Value represents Santa Maria Valley 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 – Strawberry.

Parameter	Value	Source/Comments
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.1 tons EI ⁻¹ *	USDA NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) Value listed for the soil series Oceano.
USLE LS Factor (USLELS)	0.25	PRZM Manual (EPA, 1998) LS value for 1.5% slope and 400' slope length. Calculated based on Haan and Barfield (1978)
USLE P Factor (USLEP)	0.5	Mark Bolda, Monterey County Extension Agent Default for row crops with contour practices with a slope of 1.5%
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)	1.5%	Mark Bolda, Monterey County Extension Agent Midpoint of slope used to plant Strawberries (1-2%)
Hydraulic Length (HL)	600 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	1	All of California's strawberry acreage is irrigated and most of the crop is grown on an annual basis. USDA Crop Profile for Strawberries in California (USDA, 1999)
Irrigation Type (IRTYP)	4 (drip)	Always drip irrigation. Mark Bolda, Monterey County Extension Agent
Leaching Factor (FLEACH)	0	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)	0.026 cm hr ⁻¹	Set to default as per Irrigation Guidance for developing PRZM Scenario, Table 3; (EPA 2005). F=0, CN = 89

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

Table 3. PRZM 3.12 Crop Parameters for Monterey, California – Strawberry.

Parameter	Value	Source/Comments
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2004).
Initial Surface Condition (ISCOND)	1	1= fallow. Fallow initial soil surface condition. Mark Bolda, Monterey County Extension Agent
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, CA (W 23273).

Table 3. PRZM 3.12 Crop Parameters for Monterey, California – Strawberry.		
Parameter	Value	Source/Comments
Maximum rainfall interception storage of crop (CINTCP)	0.1	Set to midpoint of the range for light density crops. Similar to other strawberry scenarios. (EPA, 2004).
Maximum Active Root Depth (AMXDR)	48 in	Mark Bolda, Monterey County Extension Agent
Maximum Canopy Coverage (COVMAX)	80	Mark Bolda, Monterey County Extension Agent
Soil Surface Condition After Harvest (ICNAH)	2	2= cover crop. A cover crop is planted after harvest. Mark Bolda, Monterey County Extension Agent
Date of Crop Emergence (EMD, EMM, IYREM)	01/01/61	Mark Bolda, Monterey County Extension Agent California strawberries are supplied by state nurseries, and planted in November, with first leaf emergence in December. First crop set to the first month/year in PRZM to ensure crop is present during initial year. California Strawberry Profile, USDA http://www.ipmcenters.org/CropProfiles/docs/castrawberries .
Date of Crop Maturity (MAD, MAM, IYRMAT)	01/06/61	Strawberries are harvested in one or more of the growing areas every month of the year, with peak production occurring in late spring. First crop. California Strawberry Profile, USDA - http://www.ipmcenters.org/CropProfiles/docs/castrawberries .
Date of Crop Harvest (HAD, HAM, IYRHAR)	01/07/61	Strawberry plants produce fruit for six months or longer in California. First crop. California Strawberry Profile, USDA - http://www.ipmcenters.org/CropProfiles/docs/castrawberries .
Maximum Dry Weight (WFMAX)	0.0	Not used in scenario
Maximum Crop Height (HTMAX)	46 cm	Plants may be as high as 18 inches (46 cm). Mark Bolda, Monterey County Extension Agent
SCS Curve Number (CN)	92, 89, 90	GLEAMS Manual Table H-4; Fallow = SR Conservation Tillage/poor, Cropping and Residue = Row Crop SR Conservation tillage/poor; Curve numbers do not compensate for plastic mulch.(USDA, 1990)
Manning's N Value (MNGN)	0.070	RUSLE EPA Pesticide Project: D26STSTN Strawberry, Bakersfield, CA. No-till. Cover Code 3: 70-100% residue cover, residues over soil surface during critical period
USLE C Factor (USLEC)	0.005 - 0.010	RUSLE EPA Pesticide Project: D26STSTN Strawberry, Bakersfield, CA. No-till. Cover Code 3: 70-100% residue cover, residues over soil surface during critical period

Table 4. PRZM 3.12 Oceano Loam Soil Parameters for Santa Cruz County, California – Strawberry.		
Parameter	Value	Source/Comments
Total Soil Depth (CORED)	203 cm	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov)
Number of Horizons (NHORIZ)	2	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov).

Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 193 cm (HORIZN = 2)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov). The top horizon was split into two horizons as per PRZM Scenario Guidance (EPA, 2004).
Bulk Density (BD)	1.65 g/cm ³ (HORIZN = 1) 1.65 g/cm ³ (HORIZN = 2)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov). Midpoint of the reported range. PRZM Scenario Guidance (EPA, 2004).
Initial Water Content (THETO)	0.12 cm ³ /cm ³ (HORIZN =1) 0.12 cm ³ /cm ³ (HORIZN =2)	NRCS Soil Data Mart (SDM); Calculated using the Rawls and Brakensiek method with data from Soil Data Mart. PRZM Manual (EPA 1998)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1.0 cm (HORIZN = 2)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov). PRZM Scenario Guidance (EPA, 2004).
Field Capacity (THEFC)	0.12 cm ³ /cm ³ (HORIZN =1) 0.12 cm ³ /cm ³ (HORIZN =2)	NRCS Soil Data Mart (SDM); Calculated using the Rawls and Brakensiek method with data from Soil Data Mart. PRZM Manual (EPA 1998)
Wilting Point (THEWP)	0.039 cm ³ /cm ³ (HORIZN =1) 0.039 cm ³ /cm ³ (HORIZN =2)	NRCS Soil Data Mart (SDM); values are mean 15-bar water contents of Oceano loam soils.
Organic Carbon Content (OC)	0.58% (HORIZN = 1) 0.58% (HORIZN = 2)	NRCS SDM; values for horizons 1 to 3 = mean %OM / 1.724. PRZM Scenario Guidance (EPA, 2004).



**Figure 1. 2002 harvested acres for strawberries based on USDA Census of Agriculture for California and conterminous US (inset)
Estimates do not include data for individual farms which NASS has excluded to protect the identify of individual farms.**

Table 5. Strawberry Bearing Soils of Monterey, San Luis Obispo, Santa Barbara, Santa Clara, and Santa Cruz Counties (California) Ranked by Area.

Soil	Total Acreage	% Area	Drainage	Erodibility	Slopes (%)	pH	OM (%)	% Sand	% Silt	% Clay	Strawberries (crates)	
											Irrigated	Non-Irr.
OCEANO	44,106	22.67%	A	0.1-0.2	0-30	5.6-6.3	0.75-1	79.7-95	1.5-16.8	3.5	850	-
METZ	28,750	14.78%	A	0.15-0.32	0-9	7.5	0.75	63.5-79.2	15.8-26.5	5-10	1250	-
BAYWOOD	24,180	12.43%	A	0.15-0.2	0-30	6.2-6.5	2.5	81.1-96.8	0.7-16.4	2.5	1500-1600	-
ARROYO SECO	22,040	11.33%	B	0.37	0-9	7.3	2	45.4-67.4	19.6-41.6	13	1100-1200	-
PLACENTIA	18,070	9.29%	D	0.37	0-15	6.7	1.25	65.1	18.9	16	1110-1275	-
ARNOLD	14,297	7.35%	B/A	0.15-0.28	5-15	5.6-6.2	0.75	78.5-96	1.5-16.5	2.5-5	1100	-
PICO	13,745	7.06%	B	0.32	0-2	8.2	2.5	64.5	19.5	16	1250	-
BETTERAVIA	6,415	3.30%	C	0.37	0-9	5.3	0.75	83.5	9	7.5	750-800	-
SOQUEL	6,145	3.16%	B	0.24-0.28	0-15	6.1	1.5	41.6	37.4	21	1350-1700	-
WATSONVILLE	6,080	3.12%	D	0.37	0-15	6.5	0.75	43	38.5	18.5	600-650	-
CONEJO	4,425	2.27%	B	0.2-0.28	0-9	7-7.2	2.5	35.4-39.2	33.6-37.3	23.5-31	1350	-
ELKHORN	3,620	1.86%	C	0.32	5-30	6.3	2	67.3	20.2	12.5	1200	-
SANDY ALLUVIAL LAND	855	0.44%	C	0.15	0-5	7.6	0.75	96	1.5	2.5	1500	-
FLUVAQUENTIC HAPLOXEROLLS	770	0.40%	B	-	0-15	7	1.3	-	-	13	3000	-
BAYWOOD VARIANT	590	0.30%	B/D	0.24	0-2	6.5	2.5	81.1	16.4	2.5	1600	-
SAN EMIGDIO VARIANT	490	0.25%	B	0.28	0-2	7.9	0.75	67.4	19.6	13	1350	-

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