# MICRO-CLIMATIC CHARACTERISTICS OF THE NATURAL ENVIRONMENT SUPPORTING AND NOT SUPPORTING CORN LILY (*VERATRUM CALIFORNICUM*)

*Clinton C. Shock, Malheur Experiment Station, Oregon State University, Ontario, OR*

## Introduction

Corn lily (*Veratrum californicum*) is of interest because it has the potential to produce pharmaceutical precursors used in the treatment of cancer. Although corn lily grows over a wide range of locations in the mountains from northern Mexico to British Columbia in Canada, the plant seems to occupy a very narrow ecological niche where the soil stays moist for long periods without remaining saturated. The hypothesis is that the montane sites supporting corn lily are characterized by 1) very moist soil with little variation in soil water potential (SWP) during the season, and 2) soil that does not remain totally saturated nor become extremely dry during active plant growth.

## Materials and Methods

The natural environment of corn lily was monitored by tracking the soil temperature, air temperature, and SWP in each of four natural plant stands (Fig. 1). The stands were located in central Utah, southeastern Idaho, southwestern Idaho, and eastern Oregon (Table 1). At each corn lily site the soil temperature and SWP at 8-inch (20 cm) depth and the air temperature at 19 inches (50 cm) above the ground were recorded hourly. Beyond the soil dominated by corn lily, other vegetation types are encountered. Within 6 to 16 ft ( 2 to 5 m) of the corn lily, the SWP at 8-inch depth was monitored below other vegetation (Figs. 2 and 3).

Two locations were chosen because they are sources of plant materials used in other trials. The other two locations were chosen because each site has a gradation of vegetation types present where corn lily appears to occur between vegetation adapted to wetter and drier soil. The one site graded from marsh to corn lily and associate plants to grassland and coniferous forest (Figs. 2 and 3). The other site graded from marsh to corn lily and associate plants to sagebrush (*Artemesia tridentada*) and grassland.

Two Watermark Monitor dataloggers (Irrometer Co. Inc., Riverside, CA) were installed at each of the four corn lily locations (Table 1). The dataloggers were installed in May (2010) or as early as was practical and remained in the field until the end of the growing season. Dataloggers were programed to read the instruments every hour and data were downloaded several times during the season when instruments were serviced. Data from 2009 were reported previously.

Three 2010 locations had two dataloggers and each datalogger had the following instruments:

1 soil temperature probe at 8-inch (20 cm) depth in the soil below the corn lily.

1 air temperature probe at 19-inch (50 cm) height above the soil surface in the corn lily.

2 Watermark soil moisture sensors (Irrometer Co. Inc.) at 8-inch depth to determine the SWP in the soil below the corn lily.

2 Watermark soil sensors at 8-inch depth in the soil to determine the SWP in the area adjacent to the corn lily that appeared to be just a bit too dry to be dominated by corn lily.

2 Tensiometers model E (Irrometer Co. Inc.) at at 8-inch depth to determine the SWP in the area adjacent to the corn lily that appeared to be just a bit too wet to be dominated by corn lily.

Tensiometers are more accurate than Watermarks in continuously saturated soil, but require frequent maintenance in drier soils. Therefore, tensiometers were installed only in what appeared to be the wettest sites where little maintenance would be required.

The fourth site had two data loggers with the following instruments:

1 soil temperature probe at 8-inch (20 cm) depth in the soil below the corn lily.

1 air temperature probe at 19-inch (50 cm) height above the soil surface in the corn lily.

2 Watermark soil moisture sensors at 8-inch depth to determine the SWP in the soil below the corn lily.

2 Watermark soil sensors at 8-inch depth in the soil to determine the SWP in the area adjacent to the corn lily that appeared to be just a bit too dry to be dominated by corn lily.

1 Watermark soil moisture sensor at 19-inch depth to determine the SWP in the subsoil below the corn lily.

1 Watermark soil sensor at 19-inch depth in the subsoil to determine the SWP in the area adjacent to the corn lily that appeared to be just a bit too dry to be dominated by corn lily.

The data were compiled and interpreted. Data from instruments in similar positions within a location were averaged to represent the conditions at the site. Data from instruments that failed or were dislodged from the soil by livestock and wildlife were not used in the averages.

Table 1. Natural environments of corn lily (*Veratrum californicum*) monitored in 2010.

| *Veratrum californicum* location | Datalogger number (starting date) | Elevation |
|---|---|---|
| Blue Mountains, Oregon | 1 (27 June 2010) | 1,761 m (5,777 ft) |
| | 2 (27 June 2010) | 1,746 m (5,728 ft) |
| Central Mountains, Idaho | 3 (8 June 2010) | 1,486 m (4,876 ft) |
| | 4 (8 June 2010) | 1,488 m (4,883 ft) |
| Sawtooth Mountains, Idaho | 5 (21 May 2010) | 1,660 m (5,447 ft) |
| | 6 (21 May 2010) | 1,661 m (5,449 ft) |
| Manti-La Sal N.F., Utah | 7 (8 July 2010) | 2,766 m (9,074 ft) |
| | 8 (8 July 2010) | 2,753 m (9,033 ft) |

# Results and Discussion

## Sawtooth Mountains, Idaho

Although the site in the Sawtooth Mountains, Idaho at 5,450 ft elevation is higher than the Central Mountains site at 4880 ft elevation, the snow at Sawtooth Mountains melted first in 2010. The corn lily emerged around May 1. Monitoring instruments were installed May 21 and maintained until September 14. The corn lily started to bloom in mid-July and seeds were fully mature on September 14. Air temperature at 19 inches (50 cm) in the corn lily canopy during the growing season ranged from below freezing to 86°F (30°C) (Fig. 4).

The soil water tensions were distinctly different between sites with corn lily and immediately adjacent sites with range grass or sedges and rushes (Fig. 5). The sites with range grass dried to beyond 50 kPa by the beginning of July. The sites with corn lily were generally between 0 and 30 kPa until August. The adjoining sites dominated by sedges and rushes ranged from 0 to 6 kPa during the corn lily growing season and dried to a maximum of 9 kPa after the corn lily matured.

## Central Mountains, Idaho

The corn lily was monitored 8 miles south of Central Mountains, Idaho, at 4,880 ft elevation. The plants were emerging on May 2, but had suffered a hard freeze in April. Monitoring instruments were installed June 8 and were maintained until September 17. The corn lily suffered hail damage in May and June. The corn lily went to bud July 8 and flowered starting July 10, with some prolonged flowering to August 10 when the non-flowering stalks were already mature. Very few corn lily plants bloomed in the Central Mountains near the monitored site in 2010. Seeds were fully mature on September 11. Air temperature at 19 inches (50 cm) in

the corn lily canopy ranged from below freezing to 95°F (35°C) during the growing season (Fig. 6).

The soil water tensions were distinctly different between sites with corn lily and immediately adjacent sites with sagebrush and range grass or willow, sedges, and rushes (Fig. 7). The sites with sage and range grass dried to beyond 100 kPa by late July. The sites with corn lily were generally between 0 and 30 kPa until the instruments were removed September 17. The adjoining sites dominated by willows, sedges, and rushes ranged from 0 to 6 kPa during the corn lily growing season and dried to a maximum of 9 kPa after the corn lily matured.

### Blue Mountains, Oregon

The corn lily was monitored in a small meadow at the headwaters of a creek in the Blue Mountains, Oregon at 5,750 ft elevation. The plants were emerging on approximately May 20. Monitoring instruments were installed June 27 and were maintained until September 16. The corn lily suffered hail damage in May, early enough to damage the vegetative stems but leaving the later emerging flowering stalks unharmed (Fig. 1). The corn lily went to bud in early July and flowered from July 15 through August 15. The corn lily had prolonged full bloom on August 8 with seed pods also already formed, when the non-flowering stalks that had suffered hail damage were already mature. Seeds were fully mature on more than 90 percent of the stalks on September 16. Air temperature at 19 inches (50 cm) in the corn lily canopy ranged from below freezing to 92°F (33.5°C) during the growing season (Fig. 8).

The soil water tensions were distinctly different between sites with corn lily and immediately adjacent sites with range grass and forest or sedges and rushes (Fig. 9). The Blue Mountain range grass dried to beyond 100 kPa by late July as was observed at Sawtooth Mountains. The sites with corn lily were generally between 0 and 52 kPa, but exceeded 55 kPa twice in August. The adjoining sites dominated by sedges and rushes ranged from 0 to 5 kPa during the corn lily growing season until late in August and ranged from 0 to 12 kPa from late August through September 16.

### Manti la Sal National Forest, Utah

The corn lily was monitored in a mixed corn lily-aspen area of Manti la Sal National Forest just below an area of high mountain range with scattered fir and spruce at 9,050 ft elevation. The snow pack melted and the corn lily emerged in mid-June. Moisture limited access by dirt road. Monitoring instruments were installed July 8 when a few of the flowering stalks were starting to show buds. The seed stalks and seed were partially mature on September 11. Air temperature at 19 inches (50 cm) in the corn lily canopy ranged from below freezing to 81°F (27°C) during the growing season (Fig. 10).

The soil with corn lily dried considerably in late July (Fig. 11). The soil water tensions were faily similar between sites with corn lily and immediately adjacent sites with conifers and range grass until August. During August the soil at 19-inch depth with conifers and range grass dried much more quickly than the soil with corn lily. By late August the soil at 8-inch depth covered with conifers and range grass was also drying more quickly than the corresponding soil with corn lily.

## Synthesis over the Four Sites

Soils that were continuously nearly saturated (between 0 to 6 kPa) during the corn lily growing season were those dominated by rushes, sedges, and occasionally willow (Figs. 5, 7, and 9). Soils with tendencies to dry to 100 kPa and beyond were dominated by range, sage, or conifers, depending on the location (Figs. 5, 7, 9, and 11). Corn lily generally grew in sites where the soil water tension remained below 30 kPa until the beginning of August (Fig. 12). The Manti la Sal National Forest site is an exception where the soil dried moderately in July. Perhaps the lower temperature regime at Manti la Sal National Forest (Fig. 10) allows the corn lily to cope with drier soil conditions. The less pronounced temperature fluctuations at Manti la Sal National Forest compared to the other sites suggest that the relative humidity is higher and that corn lily evapotranspiration rates would be lower at Manti la Sal National Forest.

The data presented here demonstrate that corn lily occupies a narrow, natural ecological niche. The characteristics of these locations provide information about the growing conditions that may need to be met to cultivate corn lily.

*Figure 1. The soil temperature, soil water potential, and air temperature were monitored within corn lily (Veratrum californicum) stands at four locations, 2010. This corn lily stand has hail damage on the early growth, 5,750 ft elevation, Blue Mountains, Oregon.*

*Figure 2. The soil water potential was monitored in soil adjacent to corn lily (Veratrum californicum) stands at four locations in 2010. The foreground area pictured here was thought to be drier than where corn lily was competitive in the background (5,750 ft elevation, Blue Mountains, Oregon).*

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*Figure 3. The soil water potential was monitored in soil adjacent to corn lily (Veratrum californicum) stands at four locations, 2010. The foreground area pictured here was thought to be wetter than where corn lily was competitive in the middle of the picture (5,750 ft elevation, Blue Mountains, Oregon).*

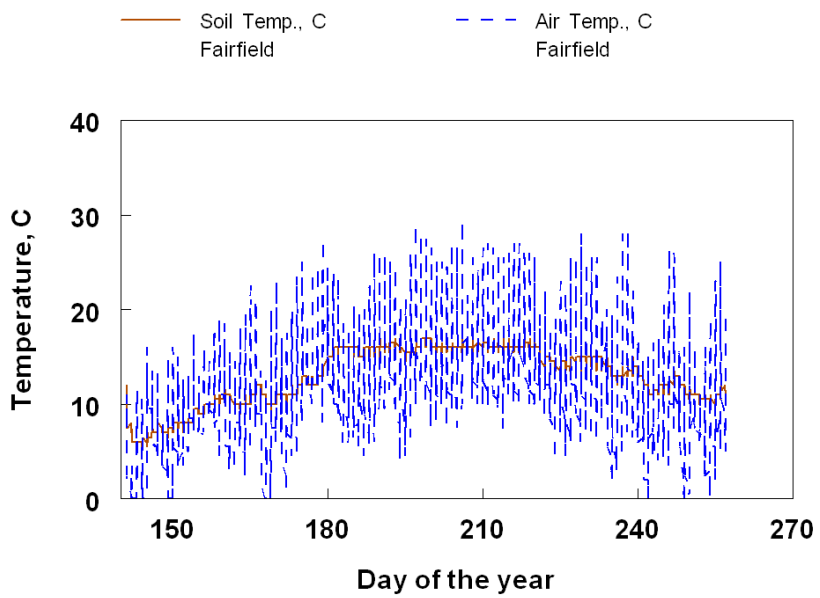


*Figure 4. Soil temperature at 8-inch depth and air temperature at 50 cm in the canopy from locations dominated by corn lily (Veratrum californicum) at 5,450 ft elevation, Sawtooth Mountains, Idaho, 2010.*

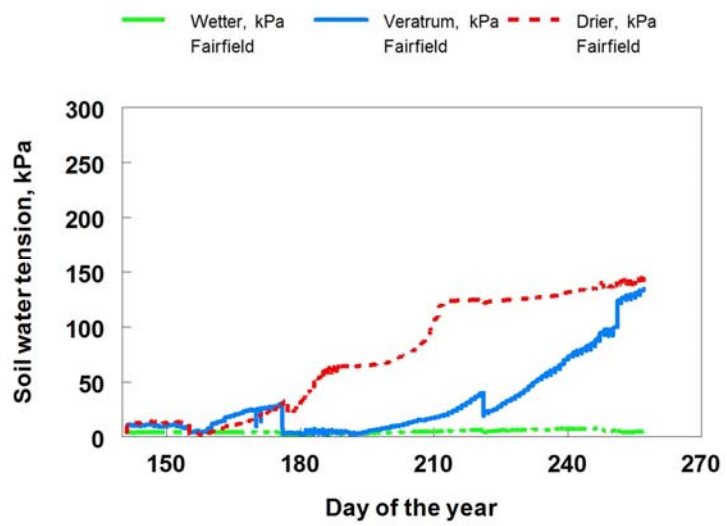


*Figure 5. Soil water potential at 8-inch depth in areas dominated by corn lily (Veratrum californicum) and areas wetter and drier than those dominated by corn lily at 5,450 ft elevation, Sawtooth Mountains, Idaho, 2010.*

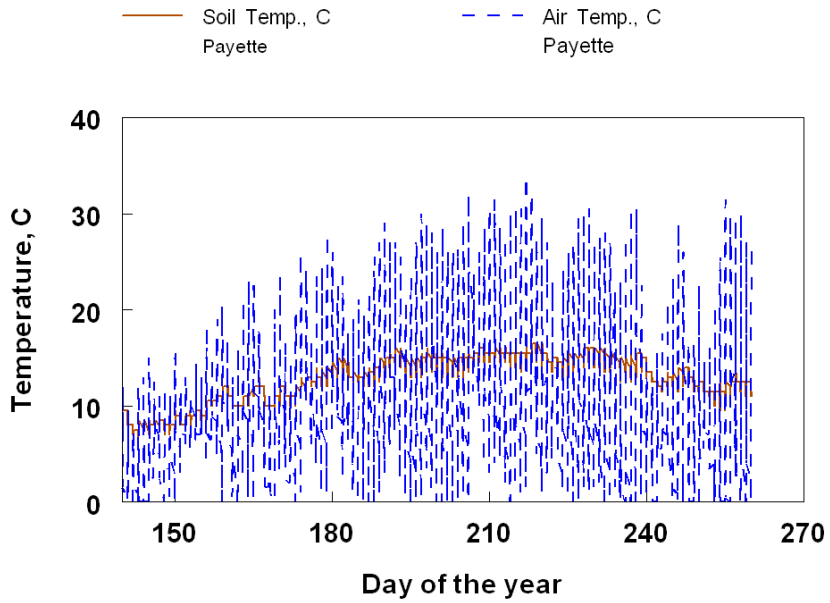


*Figure 6. Soil temperature at 8-inch depth and air temperature at 50 cm in the canopy from locations dominated by corn lily (Veratrum californicum) at 4,880 ft elevation, Central Mountains, Idaho, 2010.*

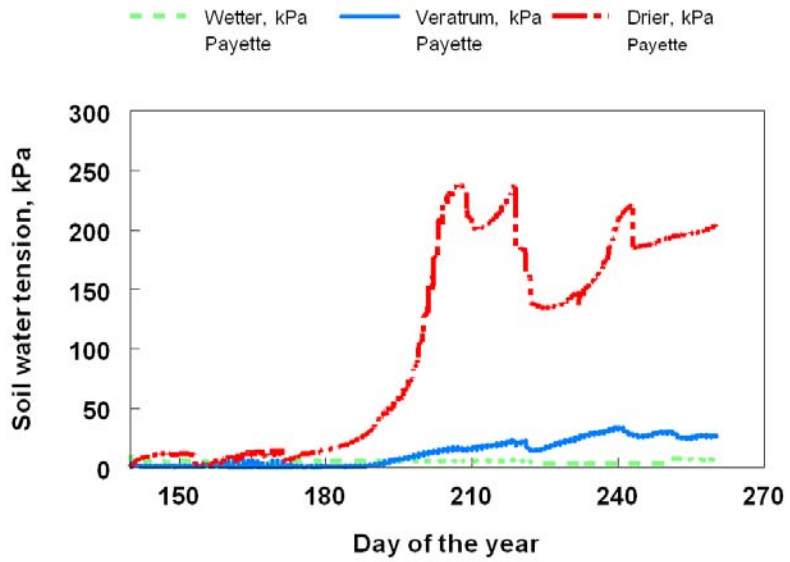


*Figure 7. Soil water potential at 8-inch depth in areas dominated by corn lily (Veratrum californicum) and areas wetter and drier than those dominated by corn lily at 4,880 ft elevation, Central Mountains, Idaho, 2010.*

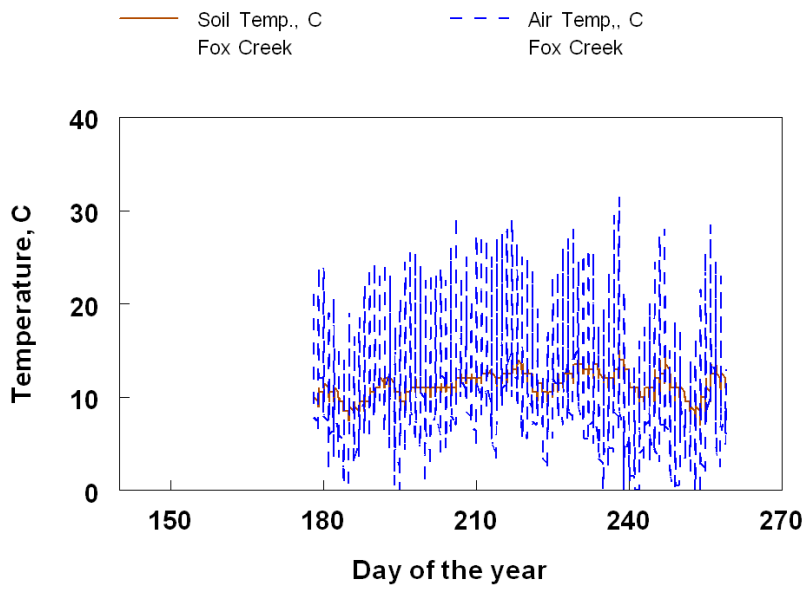


Figure 8. Soil temperature at 8-inch depth and air temperature at 50 cm in the canopy from locations dominated by corn lily (*Veratrum californicum*) at 5,750 ft elevation, Blue Mountains, Oregon, 2010.

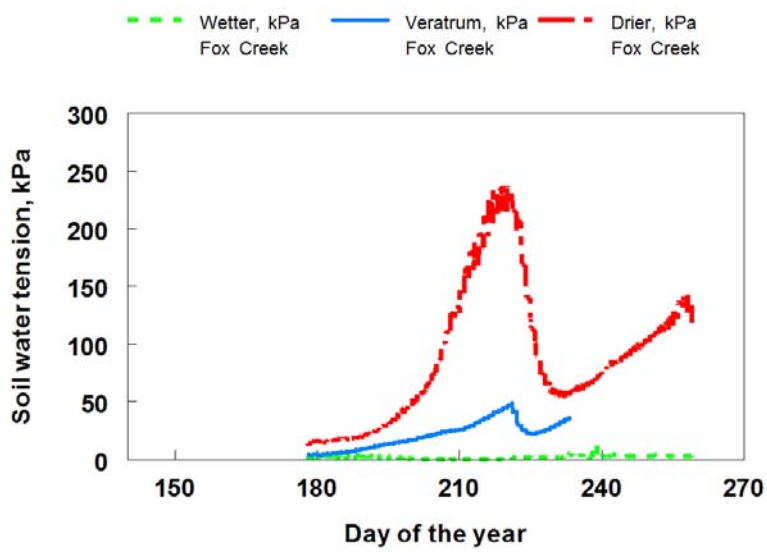


*Figure 9. Soil water potential at 8-inch depth in areas dominated by corn lily (Veratrum californicum) and areas wetter and drier than those dominated by corn lily at 5,750 ft elevation, Blue Mountains, Oregon, 2010.*

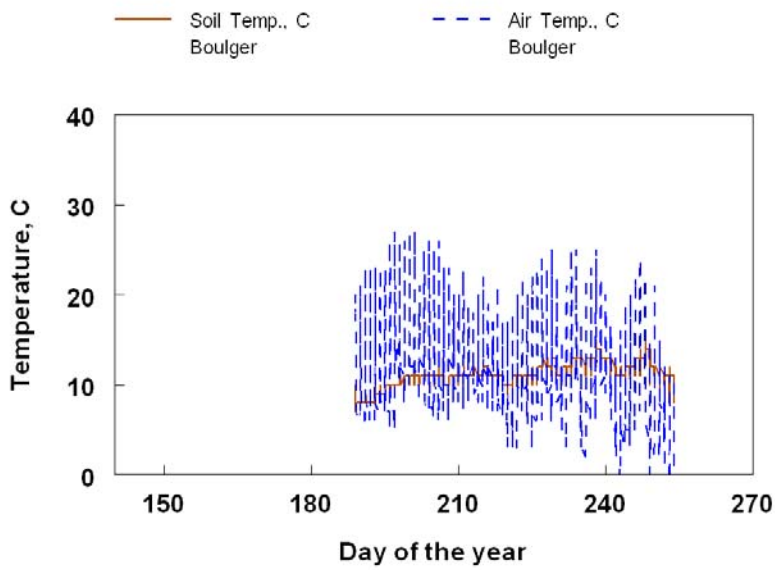


*Figure 10. Soil temperature at 8-inch depth and air temperature at 50 cm in the canopy from locations dominated by corn lily (Veratrum californicum) at 9,050 ft elevation, Manti la Sal National Forest, Utah, 2010.*

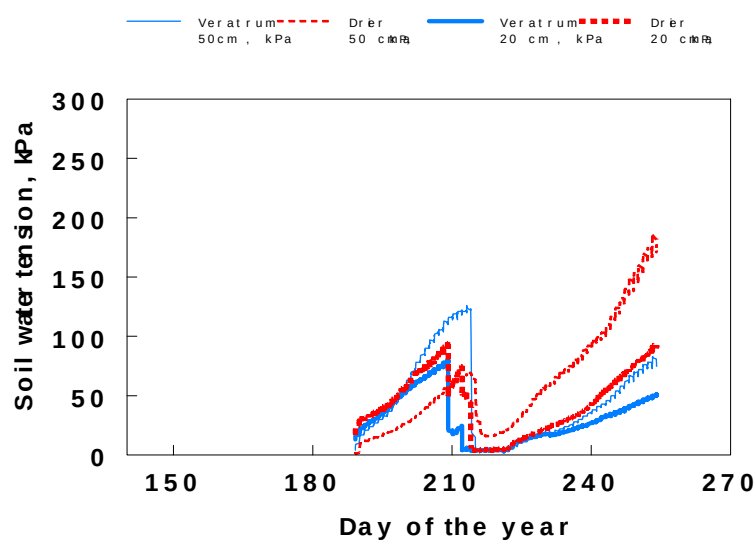


*Figure 11. Soil water potential at 8-inch depth in areas dominated by corn lily (Veratrum californicum) and areas wetter and drier than those dominated by corn lily at 9,050 ft elevation, Manti la Sal National Forest, Utah, 2010.*

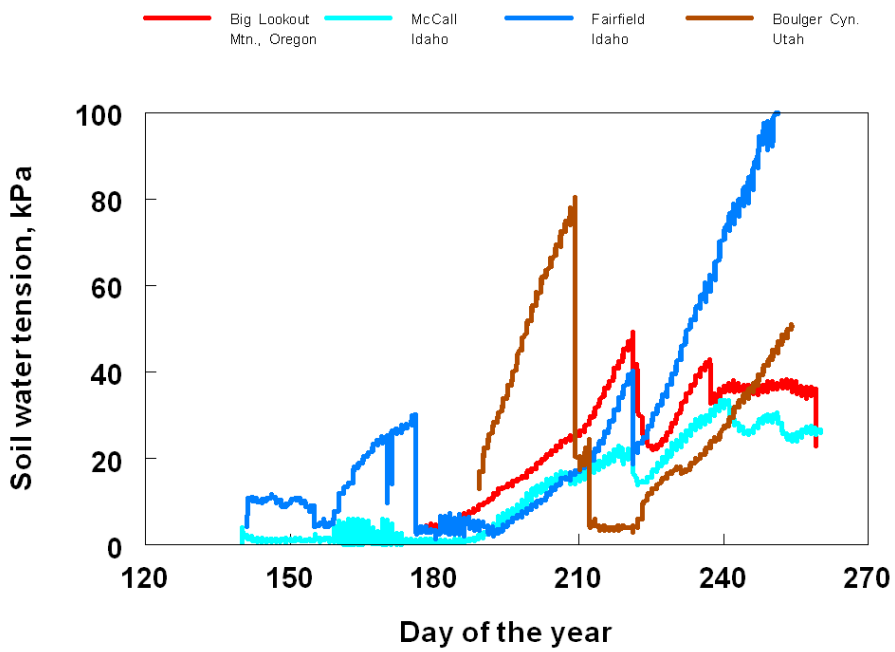


*Figure 12. Soil water potential at 8-inch depth in areas dominated by corn lily (Veratrum californicum) at four different locations in the Intermountain West, 2010: Blue Mountains, Oregon; Central Mountains, Idaho; Sawtooth Mountains, Idaho; and Manti la Sal National Forest, Utah.*