Organism Pest Risk Assessment of
Pea Leafminer, *Liriomyza huidobrensis*

Executive Summary

This organism risk assessment was conducted on Pea leafminer (PLM), *Liriomyza huidobrensis*, to review current PPQ policy, determine areas of potential establishment in the United States and confirm the likelihood of introduction through the import of vegetables and cut flowers. Under current PPQ policy, PLM requires quarantine action only when infested cargo enters Florida; action is taken in Florida because Florida has a domestic control program. Based on biological information, climate modeling/mapping and interception data, PLM appears unlikely to establish permanent populations in Florida, but may be able to establish in other areas of the United States. The import of infested vegetables and cut flowers provide a good pathway for the introduction of Pea leafminer because the insect develops within the leaf and fruit material of commodities such as green onions, pea pods, and cut chrysanthemums. Pea leafminer has been intercepted numerous times on these commodities.

Introduction

This organism risk assessment was initiated at the request of USDA/APHIS/Plant Health Programs, for Pea leafminer (PLM), *Liriomyza huidobrensis* (Blanchard) (Diptera: Agromyzidae). The objectives of this risk assessment are to (1) review current PPQ policy, (2) determine areas of potential establishment in the United States and (3) confirm the likelihood of introduction through the import of infested fruits and vegetables.

Background

Liriomyza huidobrensis is a leafmining fly of increasing significance to agriculture that has spread into many new countries in recent years (Scheffer *et al*., 2001). *Liriomyza langei* (Frick) was first reported as a pest in California by Lange *et al*. (1957). It was found to be morphologically identical to *L. huidobrensis* and made a synonym by Spencer (1973). Subsequently, *L. huidobrensis* was thought to be present in California and Hawaii, but recent advances in molecular systematics revealed that the leafminer found in California and Hawaii is a separate, cryptic species of *L. huidobrensis* (Scheffer, 2000; Scheffer and Lewis, 2001; Scheffer *et al*., 2001). The name *Liriomyza huidobrensis* has thus been restricted to leafmining species from Central and South America, and the name *Liriomyza langei* was resurrected for the leafminer present in California and Hawaii (Scheffer and Lewis, 2001). *Liriomyza huidobrensis* appears to be more invasive than *L. langei* (Scheffer *et al*., 2001).

Biology

Adult female *L. huidobrensis* can mature and deposit about 117 eggs during their 18 day life span. Eggs are deposited within leaf tissue, where larval development can be completed in 16-43 days at 25 and 15 ºC, respectively (Lanzoni et al., 2002; CABI, 2004; Weintraub and Horowitz, 1995). *Liriomyza huidobrensis* exits the leaf to pupate in crop

debris and soil (Weintraub and Horowitz, 1995). While *L. huidobrensis* is endemic to warm climates, it has demonstrated the ability to survive cold temperatures and extend its range through supercooling (Chen and Kang, 2004).

Host Range

Primary hosts: *Allium cepa* (onion), *Allium sativum* (garlic), *Apium graveolens* (celery), *Chrysanthemum* x *morifolium* (florist's chrysanthemum), *Cucurbita pepo* (ornamental gourd), *Galinsoga*, *Lactuca sativa* (lettuce), *Phaseolus vulgaris* (common bean), *Pisum sativum* var. *arvense* (Austrian winter pea) (CABI, 2004)

Secondary hosts: *Amaranthus* (grain amaranth), *Amaranthus retroflexus* (carlessweed), *Aster*, *Beta vulgaris* (beetroot), *Calendula* (marigolds), *Chenopodium quinoa* (quinoa), *Capsicum annuum* (bell pepper), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Datura*, *Gerbera* (Barbeton daisy), *Gypsophila paniculata* (babysbreath), *Linum*, *Lathyrus* (Vetchling), *Solanum lycopersicum* (tomato), *Medicago sativa* (Lucerne), *Melilotus* (melilots), *Petunia*, *Solanum melongena* (aubergine), *Solanum tuberosum* (potato), *Spinacia oleracea* (spinach), *Tagetes*, *Tropaeolum*, *Verbena*, *Vicia faba* (broad bean), *Valerianella locusta* (common cornsalad), *Zinnia elegans* (Zinnia) (CABI, 2004)

Wild hosts: *Oxalis* (wood sorrels), *Bidens pilosa* (blackjack), *Emilia sonchifolia* (red tasselflower), *Galinsoga parviflora* (gallant soldier), *Portulaca oleracea* (purslane), *Sonchus* (Milkthistle) (CABI, 2004)

PPQ Policy:

The current PPQ policy for *Liriomyza huidobrensis*, established in 1997, states that quarantine action will be taken for interceptions of the Pea leafminer from imported cargo only when destined to Florida. Florida has an established domestic control program for PLM (Cavey, 1997).

Potential Area of PLM establishment in the US

The area of the US where *L. huidobrensis* could potentially establish was determined using biological information from literature, climate modeling/mapping, comparison with the US distribution of *L. langei*, and port interception records.

1. Literature

In developmental studies on *L. huidobrensis*, 100% mortality occurred when reared at 30ºC, lowest mortality (39%) occurred when reared at 15 ºC (Lanzoni *et al*., 2002). *Liriomyza huidobrensis* reportedly favors cool temperatures for feeding and oviposition. Its recent establishment in the highlands of Indonesian demonstrates this type of behavior (Shepard *et al*., 1998). *Liriomyza huidobrensis* was positively identified by Scheffer *et al*. (2001) using molecular techniques in Guatemala, Ecuador, Sri Lanka, Indonesia and Israel. The majority of the sites where Scheffer *et al*. (2001) collected *L. huidobrensis* have cool, moderate, mountainous climates. In Israel, PLM is a pest during the autumn and spring season, but absent during the summer (Weintraub, 2001). In Peru, PLM

populations are reported to be high during the winter months and low during the warm months (Mujica and Cisneros, 1996). A cold hardiness study found 50% mortality in a *L. huidobrensis* population exposed to -5 ºC for five days, and the study determined that PLM would be unable overwinter in regions where the average monthly temperature was -5 ºC or less for January, the coldest month of the year (Chen and Kang, 2004).

2. Climate modeling and mapping

Using the North Carolina State University/APHIS Plant Pest Forecast system (NAPPFAST) (Borchert and Magarey, 2005), a model was created to determine when the daily maximum temperature was greater than 30 ºC. The model was combined with a 10-year climate database (1994-2004) for North America. A series of geo-referenced probability maps were generated to display the range of days from 10-150, where the maximum temperature over 30 ºC occurred. The probability maps were incorporated into ArcGIS 9.0, and each map was reclassified to display only areas where the minimum number of days examined occurred 8 or more years out of 10 (80-100%) (Figure 1). A cold temperature exclusion model was created to determine when the average monthly temperature was -5 ºC or lower during the month of January. The model was combined with a 10 year IPCC database for the years 1992-2002 and a probability map was generated to determine areas where the average monthly temperature was -5 C or less in January. The maps were transferred to ArcGIS and classified as previously mentioned (Figure 2).

The distribution of *L. langei* has remained limited to regions along the Pacific coast since it was first reported in the United States by Lange *et al*. (1957). Research and extension personnel in California confirmed that *L. langei* occurs in the following counties: San Diego, Ventura, San Luis Obispo, Santa Cruz, Santa Clara, San Benito, Santa Barbara, and Monterey (Chaney, 2005; Robb, 2005; Philips, 2005; Trumble, 2005). Additionally, from the NAPPFAST generated map, *L. langei* was not known to have established populations where there were greater than 50 days with a maximum temperature above 30 ºC (Trumble, 2005).

3. Port Interception Data

Examination of the PIN 309 database for all interceptions of *Liriomyza* spp. since 1984 revealed that there were 9,550 interceptions recorded, of which 9,336 were identified as *L. huidobrensis* (PIN 309 5/8/2006). The largest number of interceptions of *Liriomyza* spp. came from Colombia and Guatemala with 7,511 (78.6%) and 1,724 (18.1%), respectively, for 9,235 (96.7%) total interceptions. The majority of all interceptions were imported as cut flowers, fruit or leaves, with 7,306 (76.5%), 1,069 (11.2%), and 962 (10.1%), respectively.

The host plants with the greatest number of *Liriomyza* spp. interceptions were *Chrysanthemum* spp., *Pisum sativum*, *Allium cepa*, and *Allium* spp., with 7309 (76.5%), 1004 (10.5%), 598 (6.2%) and 210 (2.3%), respectively, with these host plants representing 9121 (95.5%) of the reported interceptions. The port of Miami, Florida had the greatest number of interceptions at 7917 (82.9%), the port of San Juan, Puerto Rico

had 1086 (11.4 %) and the port of Fort Lauderdale, Florida had 351 (3.7%) for a combined 97.9% of the interceptions. *Liriomyza langei* is frequently intercepted in Florida on commodities from California (Coile and Dixon, 1998, 1999).

4. Establishment Summary

Based on the information available, it appears that PLM is not likely to establish **permanent** populations in Florida, however a study by Milla and Reitz (2005) found that there was potential for **seasonal** populations of PLM to develop in South Florida. Florida has 100-150 days per year where the maximum temperature is greater than 30 ºC (Figure 3). This long period of unfavorable conditions would be detrimental to PLM establishment. In Israel, there are similar numbers of days with the maximum daily temperature above 30 ºC as observed in Florida (Gilat Weather Data, 2006) and PLM is reported to be absent in the summer (Weintraub, 2001). It is not known if PLM has the ability to survive through hot periods by aestivation, as reported in other Agromyzidae species (Frey, 1991). Alternatively, PLM may be surviving in cooler microclimates such as higher elevations, which are present in relative close proximity in Israel (Figure 6). *Liriomyza huidobrensis* has been intercepted in Florida over 8,000 times, but there is only one record of a field infestation in Florida (PIN309, 2004; Steck, 1999). A few PLM flies were collected on *Gypsophila* spp. in Lee County, Florida between February and May of 1981, but weekly sampling from September of 1981 to May of 1982 failed to detect PLM (Steck, 1999). NAPPFAST established that there were more than 180 days with a maximum temperature greater than 30 ºC in Lee Co, FL in 1981.

Liriomyza langei has been identified as a pest in California for almost 50 years, but its distribution has remained limited to areas where moderate climates prevail (Figure 4). *Liriomyza huidobrensis* has been permitted to enter all regions of the US, except Florida, since September of 1997, but it does not appear to have established a permanent field population. A leafminer was collected from *Polemonium caeruleum* (Jacob's ladder) in Boulder Creek, California in 2002 and positively identified as *L. huidobrensis* (Scheffer, 2003), but the establishment of a permanent population has not been confirmed. A map displaying the potential areas suitable for PLM establishment in the US, is bounded by areas where the maximum daily temperature is at or above 30 ºC for more than 50 days per year and the average monthly temperature in January $\leq$ -5 ºC (Figure 5). Boulder Creek, Santa Cruz County, California is an area where *L. huidobrensis* could potentially establish. *Liriomyza huidobrensis* also occurs in Ontario, Canada (CABI, 2004; Scheffer *et al*., 2001), an area suitable for PLM establishment in the southern portion as shown in Figure 5. The establishment map shows a suitable band for potential establishment of PLM in the northern United States, from the east to west coast and down along the coast of California.

It is important to emphasize that *Liriomyza huidobrensis* is an important pest of agriculture, with the ability to complete a generation in a little as 16 days at 25 ºC (Lanzoni et al., 2002). It is therefore possible for *Liriomyza huidobrensis* to occur in most regions of the US and pass through multiple generations but not establish a permanent population. *Liriomyza huidobrensis* could also move to sheltered

microclimates, such as greenhouses or shadehouses to avoid detrimental environmental conditions.

Likelihood of Introduction through the Vegetable and Cut Flower Pathway

Liriomyza huidobrensis is frequently present in the leaves of green onions and young pods of peas, at the time of harvest (CABI, 2004). The insect completes development within the host plant, it can survive cold shipping, and it has been intercepted frequently on vegetables and cut flowers (PIN 309, 2004).

There are areas of the United States outside of Florida which have susceptible hosts and favorable environmental conditions for its establishment. The likelihood that *Liriomyza huidobrensis* could be introduced to these areas via the import of host vegetables and cut flowers from infested areas will depend mainly on the volume and timing of infested imports.

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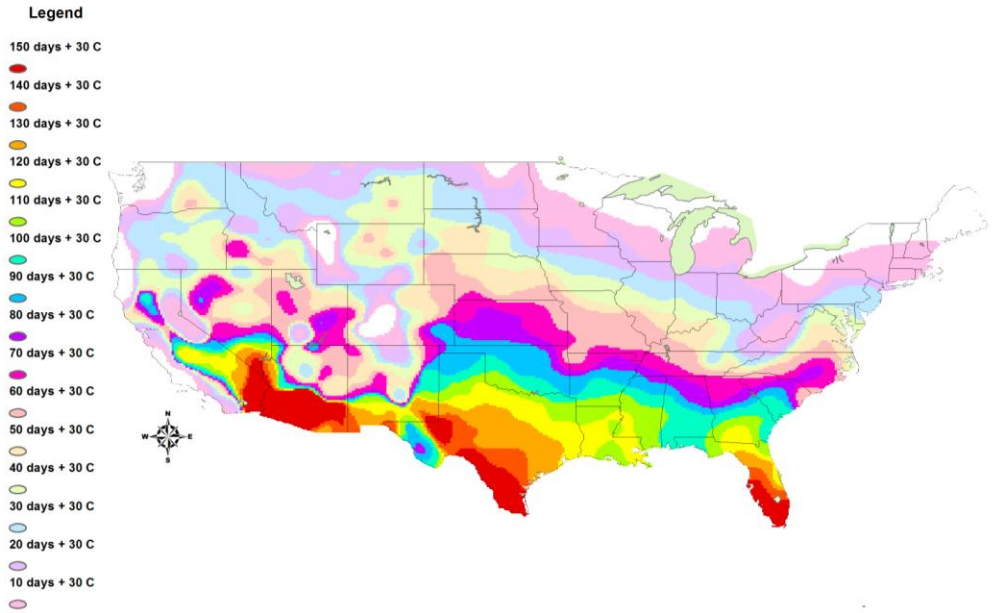

Figure 1. Map displaying the area of the United States where the maximum daily temperature was 30 ºC or greater for 10-150 days during a year. (10 year climate database in NAPPFAST)

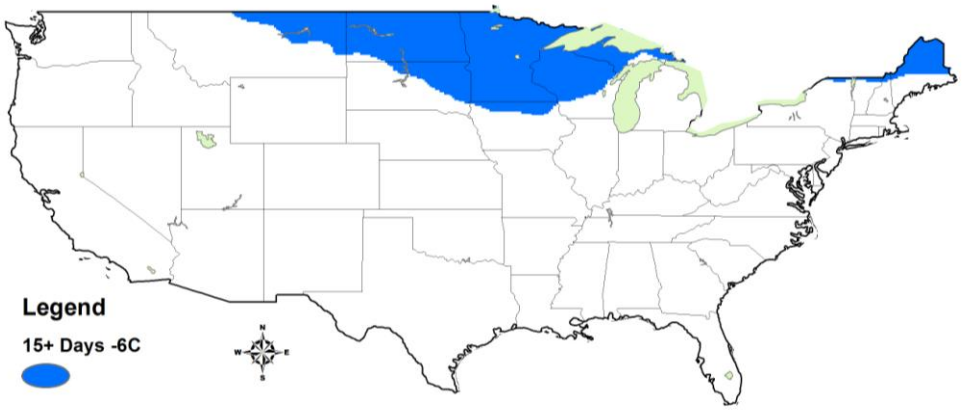

Figure 2. Map displaying the area of the United States where the average monthly temperature was -5 ºC or lower during the month of January. (10 year climate database in NAPPFAST)

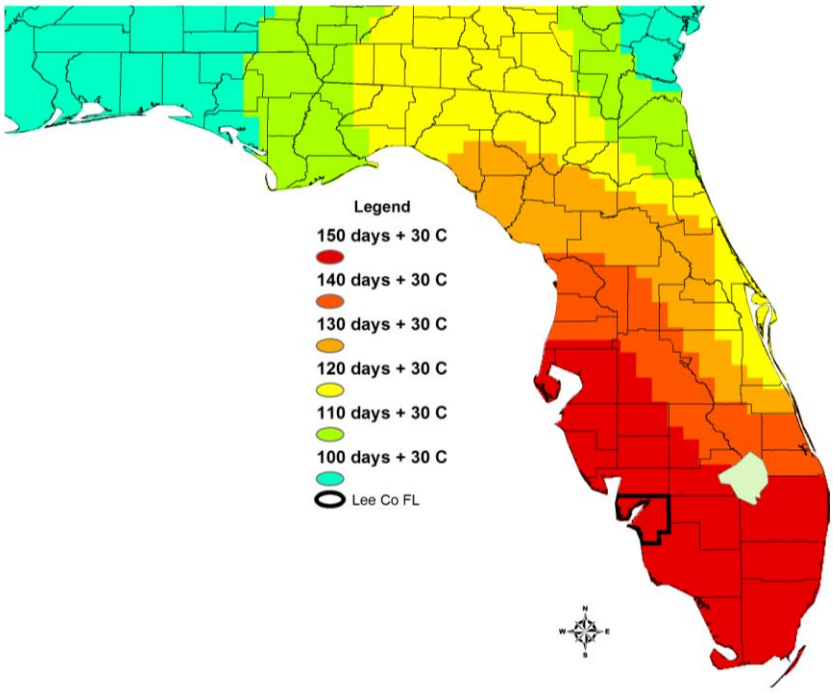

Figure 3. Map displaying the area of Florida where the maximum daily temperature was 30 ºC or greater for 100-150 days during a year. (10 year climate database in NAPPFAST)

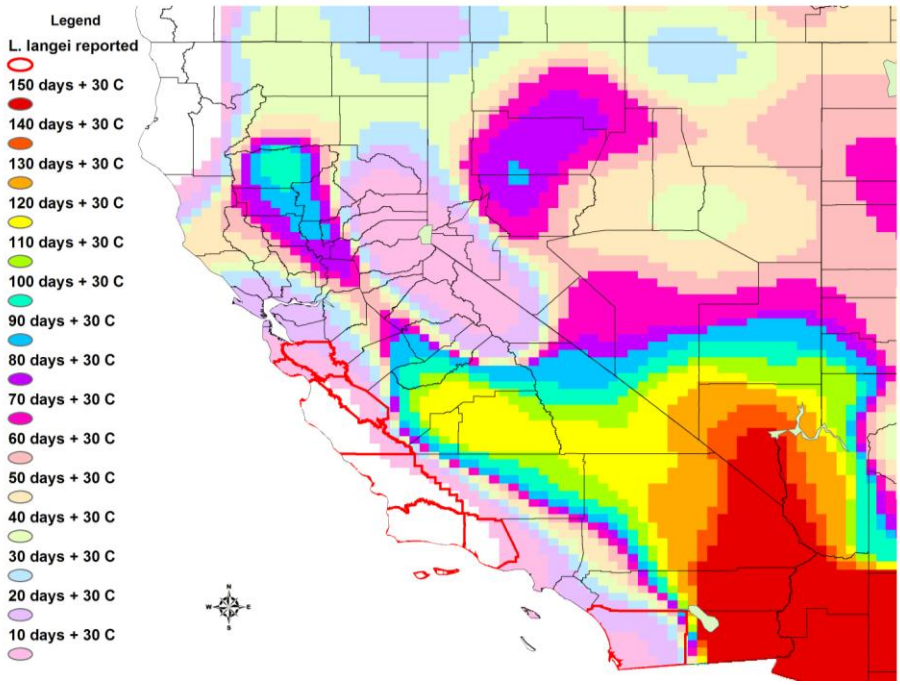

Figure 4. Map displaying the area of California where the maximum daily temperature was 30 ºC or greater for 10-150 days during a year and the counties reported to have established populations of *L. langei*. (10 year climate database in NAPPFAST)

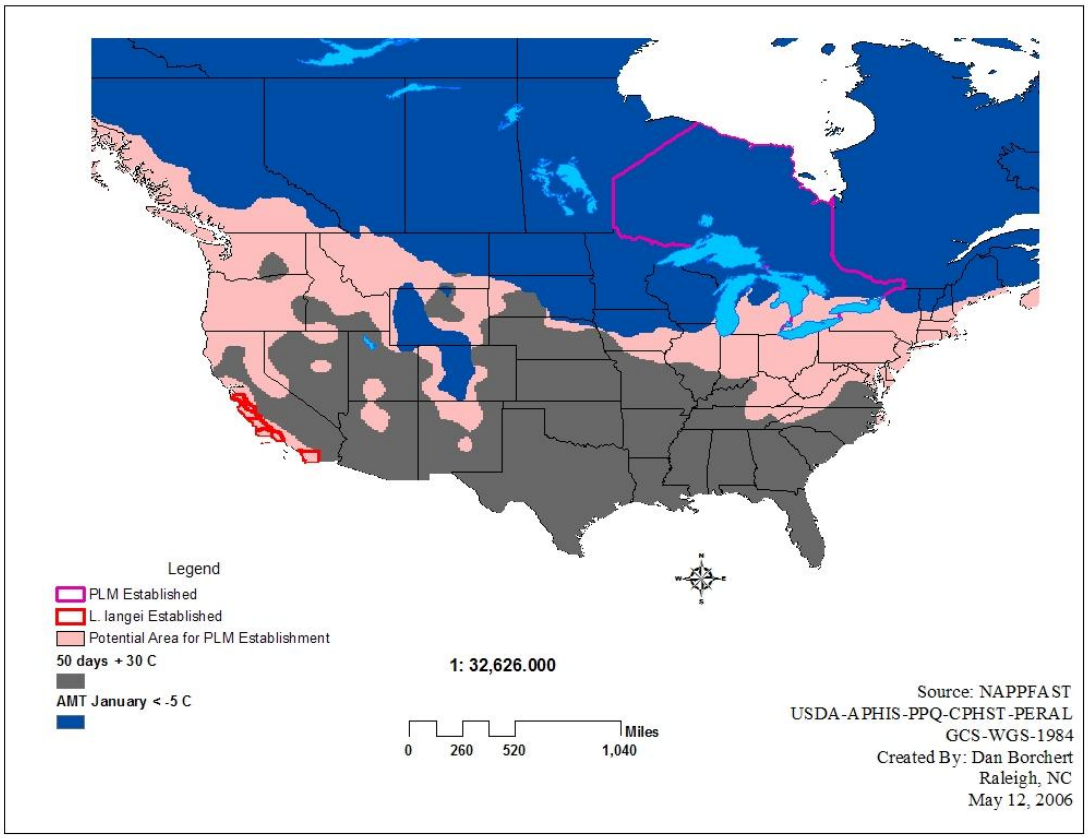

Figure 5. Map displaying the potential area in the United States and Canada suitable for establishment of *Liriomyza huidobrensis* (PLM), the climate factors affecting the potential establishment of PLM (50 or more days with maximum temperature above 30 ºC and the average monthly temperature ≤ -5 ºC in January), the areas where PLM is established in Canada and the area where *L. langei* is established in the United States. (10 year climate database in NAPPFAST).

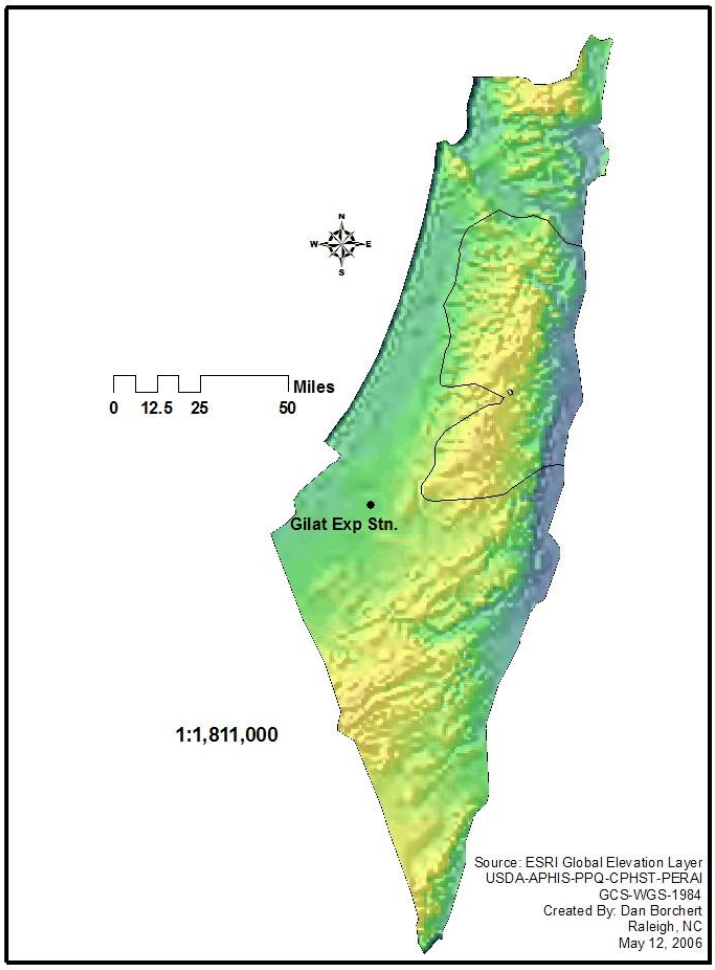

Figure 6. Elevation map of Israel and West Bank with the location of the Gilat Experiment Station indicated for reference.