EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION
ORGANISATION EUROPEENNE ET MEDITERRANEENNE
POUR LA PROTECTION DES PLANTES

Report of a Pest Risk Analysis for *Raoiella indica*

This summary presents the main features of a pest risk analysis which has been conducted on the pest, according to EPPO Decision support scheme for quarantine pests.

Pest:	*Raoiella indica* Hirst
PRA area:	EPPO member countries
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Date:	2008-05-06/09 Core Member consultation 2008-10 Panel on Phytosanitary Measures 2009-02

STAGE 1: INITIATION

Reason for doing PRA:	In 2004, Dr Etienne (INRA, Guadeloupe) reported to the EPPO Secretariat the introduction of *Raoiella indica* in Martinique. Since then, the mite has spread to most Caribbean islands, Florida and Venezuala, causing foliar damage to coconut and banana plants. It is also found on various ornamental palms and other plants. Therefore, it may represent a threat to the ornamental palms industry and to date palm and banana crops in the EPPO region. *R. indica* was added to the EPPO Alert list in 2004. The Panel on Phytosanitary Measures considered that a PRA should be performed.
Taxonomic position of pest:	Acari, Tenuipalpidae

STAGE 2: PEST RISK ASSESSMENT

Probability of introduction

Entry

<u>Geographical distribution:</u>	The origin of *R. indica* is unclear. It was first found and described in India in 1924, then in several Asian and African countries (see below). In 2004, it was detected in Martinique and was subsequently found in many of the Caribbean islands, USA (Florida) and Venezuela. Present known distribution (EPPO, 2008)

EPPO region: Israel (a single record from Russia in 1979 is considered as highly doubtful).
Africa: Egypt, Mauritius, Réunion, Sudan.
Asia: India (Gao, Karnataka, Kerala, Madhya Pradesh, Tamil Nadu, West Bengal) Iran, Israel, Oman, Pakistan, Philippines, Sri Lanka, United Arab Emirates.
Caribbean: Dominica, Dominican Republic, Guadeloupe, Martinique, Puerto Rico, Saint Lucia, Saint Martin, Trinidad and Tobago, US Virgin Islands (St Thomas)
North America: USA (Florida)
South America: Venezuela

Major host plants or habitats:

R. indica is oligophagous. It has been reported on at least six families. However, its true host range is still poorly known. In particular it is likely that not all host genus have been identified in the family Arecaceae. Some host records appear erroneous because it is not clear if the organism can complete its life cycle on these plants. *Coco* sp and to a lesser extent *Musa* sp are the most damaged host plants.

The following records are found in the literature (see *Peña et al*. 2006; Borchert & Margosian 2007, for review) and are considered as true hosts. **Species in bold are those present in the PRA area.**

Arecaceae :
Acoelorraphe wrightii (Everglades palm), *Adonidia merrilli* Becc. (Manila palm, Christmas palm), *Aiphanes* spp. (multiple crown palm, ruffle palm), *Areca catechu* L. (Betel nut palm), ***Areca* sp**., *Bactris plumeriana* Mart (Coco macaco, Prickly pole), ***Caryota mitis* Lour** (Fishtail palm), *Chamaedorea* spp. (Chamaedorea palm), *Chrysalidocarpus lutescens* (Golden cane palm), *Cocos nucifera* (Coconut palm), *Dictyosperma album* (Princess palm, Hurricane palm), ***Dypsis decaryi*** (Triangle palm), ***Dypsis lutescens*** (Areca palm, Golden cane palm, Butterfly palm), *Licuala grandis* (Licuala palm, Ruffled fan palm), *Livistonia chinensis* (Chinese fan palm), ***Phoenix canariensis*** (Canary island date palm), ***Phoenix dactylifera*** L. (Date palm), ***Phoenix reclinata*** Jacq. (Senegal date palm), *Pritchardia pacifica* (Fuji fan palm), *Pseudophoenix sargentii* (Buccaneer palm/Sargent's cherry palm), *Pseudophoenix vinifera* (Buccaneer/Wine palm, Cacheo, Katié), *Ptychosperma elegans* (Queensland palm, Solitaire palm, Alexander palm), *Ptychosperma macarthurii* (Macarthur palm), ***Rhaphis excelsa*** (Lady palm, Bamboo palm), *Roystonea borinqueña* (Puerto Rican royal palm, Royal palm), ***Syagrus romanzoffianum*** (Queen palm), *Syagrus schizophylla* (Arikury palm), *Veitchia merrillii* (Christmas palm), ***Washingtonia robusta*** (Washington palm/Mexican fan palm), *Roystonea regia* (in Venezuela, Vasquez, personal communication)
Host list is expanding as new detections occur and all Arecaceae should be considered as potential hosts.

Heliconiaceae :
Heliconia bihai (Yellow dancer, Macaw flower), ***Heliconia caribaea*** (Caribbean heliconia, Wild plantain, Balisier), ***Heliconia psittacorum*** (Parrot's beak, Parrot flower), ***Heliconia rostrata*** (Lobster claw)

Musaceae :
***Musa* spp.** (Banana, Plantain), *Musa acuminata* (Dwarf banana, Edible banana, Plantain), *Musa balbisiana* (Wild banana), *Musa corniculata* (Red banana, Plantain), *Musa x paradisiaca* (Common banana, Edible banana, Plantain), *Musa sapientum* (Edible banana, Plantain), *Musa uranoscopus*

(red flowering Thai banana),

Pandanaceae :
Pandanus utilis (Screw pine)

Strelitziaceae :
Strelitzia reginae (Crane/bird of paradise flower), Ravenala madagascariensis (Traveller's tree).

Zingiberaceae :
Alpinia purpurata (red ginger, Jungle King/Queen), *Etlingera elatior* (red torch ginger), *Nicolaia elatior* (red torch ginger; torch lily)

The citations of *Ocimum basilicum* (basil) (Lamiaceae) and *Phaseolus vulgaris* and *Acer* sp. as true host appear erroneous.

Which pathway(s) is the pest likely to be introduced on:

Within the literature concerning *R. indica* the following pathways are mentioned: plants for planting, commercial consignments of cut branches and cut flowers, cut branches and cut flowers with travellers, handicrafts, wind.

The EWG considered the following pathways as relevant pathways:
Plants for planting of host plants
There is trade of plants for planting of ornamental hosts of *R. indica* from infested areas to the EPPO region such as Arecaceae from Egypt, *Areca* spp from the Caribbean.
Musa acuminata and *M. balbisiana* (Banana and Plantain) are mainly traded as plants in vitro. This was not considered a likely pathway.
Coconut plants for planting are imported in the EPPO region for ornamental purposes.
The risk is considered low to medium

Cut flowers and cut branches of host plants (commercial consignments)
Heliconia sp. and *Strelitzia* sp are imported from the Carribean.
the risk is considered low.

Cut flowers, cut branches and handicrafts transported by passengers (e.g. hats, bowls made of palm leaves)
Passengers coming back from the Caribbean regularly bring back tropical "souvenirs" including cut flowers and handicrafts (Mendonça *et al.*2005).
The risk is considered as very low.

The EWG did not consider the following commodities as relevant pathways:

- Banana coconut and date fruit

R. indica is a foliage pest and so far has not been found on fruit during surveys (Elwan, 2000). This was confirmed by Ms Navia and Mr Palevski (acarologists) present at the meeting and by Mr Etienne who commented that he had only collected the mite on leaves (Etienne, pers.comm. 2007). There is one reference mentioning the presence of *R indica* on date fruits, but again Ms Navia and Mr Palevski considered the source of this reference unreliable.

- Seeds

There are no records of *R. indica* on seeds. The EWG considered that seeds are not pathways.

- Wind current (Welbourn, 2007)

The wind may disseminate the pest once introduced, but is not considered as a pathway of introduction from the infected countries into the PRA area.

Establishment

Plants or habitats at risk in the PRA area:

Within EPPO region, the following families reported to be host of *R. indica* are known to occur:

- palm trees: *Areca* sp., *Caryota mitis* (Fishtail palm), *Dypsis decaryi* (Triangle palm), *Dypsis lutescens* (Butterfly palm), *Phoenix canariensis* (Canary island date palm), *Phoenix dactylifera* (Date palm), *Phoenix reclinata* (Senegal date palm), *Rhaphis excelsa* (Lady palm), *Syagrus romanzoffianum* (Queen palm), *Washingtonia robusta.*
- banana trees: Musaceae (*Musa* sp.). In the EPPO region, Banana is produced in Spain (Canary Islands), Israel, Jordan, Morocco, Cyprus, Portugal (Madeira), Turkey.
- Streliziaceae: *Strelitzia reginae* (Crane/bird of paradise flower). There is a limited production of *S. reginae* in the EPPO region (e.g. Canary Islands, the Netherlands), which may have the potential to expand. It is very common in Israel in gardens.
- Heliconiaceae: *Heliconia bihai* (Yellow dancer), *Heliconia caribaea* (Caribbean heliconia/wild plantain), *Heliconia psittacorum* (Parrot's beak), *Heliconia rostrata* (Lobster claw). There is a limited production of *Heliconia* spp. In the EPPO region (e.g. Canary Islands, the Netherlands), which may have the potential to expand.
- There is no report of coconut production within the EPPO region but coconut trees are planted along beaches in the Canary Islands.

Climatic similarity of present distribution with PRA area (or parts thereof):

Based on the results of two climatic analyses (see Appendix 1), within the PRA area, the climate of the Canary Islands is most similar to that in the Caribbean where *R. indica* has recently caused significant damage to hosts. No other locations within EPPO have climates very similar to the Caribbean.

As *R. indica* is also present in Israel, but not an economic pest there, the NAPPFAST analysis used Israeli climate factors to determine similar climate areas. This analysis highlighted that only parts of the Mediterranean coast are found to be similar to Israeli conditions namely Algeria, Italy, Morocco, Spain, Tunisia and Turkey (see Appendix 1).
This area is estimated to allow for a low survival of the pest, as is the case in Israel. A CLIMEX analysis highlighted the same area.

There is moderate uncertainty for Madeira and the Azores.

In protected conditions (e.g. nurseries, glasshouses) that produce palms or other ornamental hosts, it is assumed that the conditions will be favourable for the establishment of the mite.
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Characteristics (other than climatic) of the PRA area that would favour establishment:

The main host plants (*Coco* sp and *Musa* sp) are not widely grown in the EPPO region. This does not favour the establishment.

Which part of the PRA area is the endangered area:	There is only a limited area of the EPPO region where hosts and suitable climatic conditions occur outdoors (see above). However, there are suitable protected environments and host plants throughout the EPPO region.

POTENTIAL ECONOMIC CONSEQUENCES

How much economic impact does the pest have in its present distribution:

- Coconut

Information on damage and related yield losses varies. Information from coconut growers in Trinidad indicate that the production was reduced by 75% percent, two years after introduction of the mite (Duncan *et al.*, 2006) although a causal relationship has not been demonstrated. There are reports of severe foliage damage on coconut plantations, young palms and seedlings in India, but no indication of its effect on yield (Sathiamma 1996; Jeppson *et al.*, 1975). *Raoiella indica* may cause yield loss in nuts of *Areca catechu* L. (Betel nut palm) when infestations are lingering and severe (Puttarudriah & Channa Basavanna, 1958).

- Date palm

In date palms it is not considered as an economically important pest in the Near-East (Elwan, 2000, Zaid & E.J. Arias-Jimenez 2002, Gerson *et al.* 1983).
The EWG considered that the lack of published information on damage on date palms and ornamental palms from Israel, Egypt, Oman and Iran is an indication of the minor importance of the pest in these areas.

- Banana

There is severe yellowing on bananas, but no quantitative data on crop yield reduction with damage recorded on leaves in Puerto Rico, Trinidad and Tobago and Venezuela. Damage on leaves due to other pests may be confused with *R. indica* (Kane *et al.*, 2006; Welbourn, 2007). There are no reports on damage on Banana in Israel.

- Ornamental plants

There is no evidence of loss of quality in ornamentals (gingers, heliconias and strelitzias) used for planting or as cut flowers.

Describe damage to potential hosts in PRA area:

R. indica is usually found on the under side of the leaves. Affected palm plants can show from scattered yellow spots on both surfaces of the leaflets to a strong yellowish discoloration of the entire leaflet. For example, severely attacked coconut trees show entirely yellow leaves, particularly on the lower third part of the plant. On banana and plantain, lower leaves turn yellow with small patchy-green yellow areas.

How much economic impact would the pest have in the PRA area:

The main host where damage and yield losses are recorded (coconut) is present in very low quantities in the EPPO region (beach landscape in Canary Islands). There is banana production in the EPPO region, but the crop yield reduction due to *R. indica* on banana is unknown.
In the vast majority of the EPPO region, there are three factors that will influence economic damage: a) lack of suitable climatic conditions, b) the most suitable host, i.e., coconuts, are rarely present in the EPPO region, and c) on the EPPO region, relevant hosts (bananas, date palms) have effective control practices that can be used against this pest.

No judgement can be made for ornamental plants as there is no information. *Phoenix canariensis* is recorded as a host but there is no specific evidence of damage.

CONCLUSIONS OF PEST RISK ASSESSMENT

Summarize the major factors that influence the acceptability of the risk from this pest:

Estimate the probability of entry:

Plants for planting the risk is considered low to medium
Cut flowers are considered to present a low risk.
Cut branches and cut flowers with tourists presents a very low risk

Globally the risk of entry is considered low
Volume of trade is considered low and concentration low

Estimate the probability of establishment and spread:

The most favourable host (coconut) is rarely present.
Based on climate matching, the EPPO climatic conditions seem favourable only in a limited part of the region (Canary Islands) there is uncertainty for Madeira and the Azores .
Climatic conditions in Algeria, Italy, Morocco, Spain, Tunisia and Turkey are estimated to allow for a low survival of the pest, as is the case in Israel.

Estimate the potential economic impact:

On the host plants recorded in the EPPO region, only banana is reported as having foliar damage (no information on yield reduction is available).

There is uncertainty regarding the effect of *R. indica* on native palm trees.

Degree of uncertainty

Knowledge gap and uncertainties have been identified:

Host range of *R. indica*
True hosts for *R. indica* were considered to be those with all live stages of the mite. Conditional hosts will allow pest subsistence but not reproduction and development. Accordingly, the current host lists (Welbourn, 2007; Mendoca *et al.*, 2005; *Peña et al.*, 2006) should be re-evaluated and new hosts should be tested according to these criteria.

Molecular characterization of populations of *R. indica* from different climatic regions around the world is needed to identify different bioptypes or even sibling species

Although some data is available specific information on the trade volume of ornamental host plants from infested *R. indica* areas to the EPPO region is lacking.

Foliar pest damage (chlorosis, necrosis) has been reported for coconut and bananas, but not for other hosts. For bananas studies are needed to correlate leaf damage levels to yield loss.

Environmental response of the organism
More information is needed on thermal and humidity requirements for the pest to establish and cause damage. Additionally, there is need to learn about the climatic factors limiting the distribution of the mite in the EPPO Region.

Biological control Agents
Effective biological control agents for *R. indica* are not known. For instance, the effect of alternate food sources (pollen, other arthropods) to conserve and augment populations of these enemies needs to be determined. Secondly, reproductive potential of the natural enemy on *R. indica*, needs to be elucidated. Third, the phenologies of *R. indica* and its natural enemies need to be determined on different plant hosts and climatic regions.

Factors that have influenced the current temporal and spatial distribution of the mite in the Middle East are not known. In Israel, *R. indica* was only detected when a survey was conducted on the spatial distribution of the old world date mite (Gerson *et al.*, 1983). From 1999 to 2008, in southern date production area of Israel it has barely detected during an intensive monitoring programme for the old world date mite.

OVERALL CONCLUSIONS

This pest presents a low risk for the EPPO region. There is uncertainty about the potential risk for the Canary Islands and possibly Madeira and the Azores.
Although it is likely to become established in some areas around the Mediterranean basin it is not likely to cause damage there (based on its behaviour in Israel, Egypt, Iran, and Oman).

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APPENDIX 1

NAPPFAST Polygon Climate Factor Comparison Analysis for *Raoiella indica*

1 Introduction

Since *Raoiella indica* (Tenuipalpidae) was detected in Martinique in 2004 (Flechtmann & Etienne, 2004), it has spread rapidly through the Caribbean region causing extensive foliar damage, primarily on young coconuts, other palms and bananas (Welborne, 2007). In contrast, *R. indica* has been present in Israel for over 25 years (Gerson et al. 1983) without causing any significant damage (Zaid and Arias-Jimenez, 2002) and it has been present in Egypt since 1942 . The aim of this study was to investigate the climatic factors that might limit the abundance of *R. indica* in Israel to explain the differences in the reported pest status of the organism between the Caribbean and Israeli infested areas.

2 Methods

1. The North Carolina State University-Animal Plant Health Inspection Service Plant Pest Forecasting (NAPPFAST) system was used to determine whether there were areas in the EPPO region where climatic conditions might be suitable for the mite to reach economically damaging status by comparing climatic factors from Israel with Caribbean regions using global layers.
2. We generated a polygon along the border of Israel to represent an area where the mite is present, but does not occur at sufficient densities to reach economically damaging status.
3. We generated polygons along the borders of the Dominican Republic and Puerto Rico to represent areas where the mite is a newly infesting pest causing more extensive damage.
4. For Israel and the combined Caribbean polygons we used the polygon climate match function in NAPPFAST to generate areas of similar conditions for three factors:
   (i) Growing Season Moisture % ((sum of precipitation/sum of evaporation-transpiration) *100) evaporation transpiration rate is standardized for grass surface and growing season is determined by week of last 0 C to week of first 0 C.
   (ii) Monthly minimum temperature, and
   (iii) Monthly maximum temperature (30 year averages 1976- 2005) for all 12 months.
5. For both polygons, three climate match layers were generated and exported to ESRI Arc Map 9.2. The three climate match layers for Israel were added using raster calculator, with the resultant layer (Israel 3 Combined) modified to display areas only where 2 or 3 climate match factors were present concurrently. The same process was performed on the Caribbean climate match layers (Caribbean 3 Combined). The climate match parameters for the two representative polygon areas are given in Figure 6(a-f).

3 Results

See Figures 1 to 5. For the three climate factors utilized in the analysis, the Caribbean factors are present in regions of India, the Philippines, Florida, Venezuela and several other areas where *R. indica* is reported as a pest (Figure 1). Within the EPPO region, only the Canary Islands share the Caribbean factors (Figure 4).

The Israeli factors are present primarily around the Mediterranean Sea with regions of Spain, Italy, Morocco, Algeria, Tunisia and Turkey having two or more factors in common (Figure 4).

4 Conclusion

As with many other organisms that cannot regulate their body temperature, the distribution of *R. indica* is assumed to be largely influenced by climatic factors. The similarity of climatic factors in regions around southern Europe and North Africa with Israel indicate *R. indica* may establish in these areas, but should not attain pest status.

5 References

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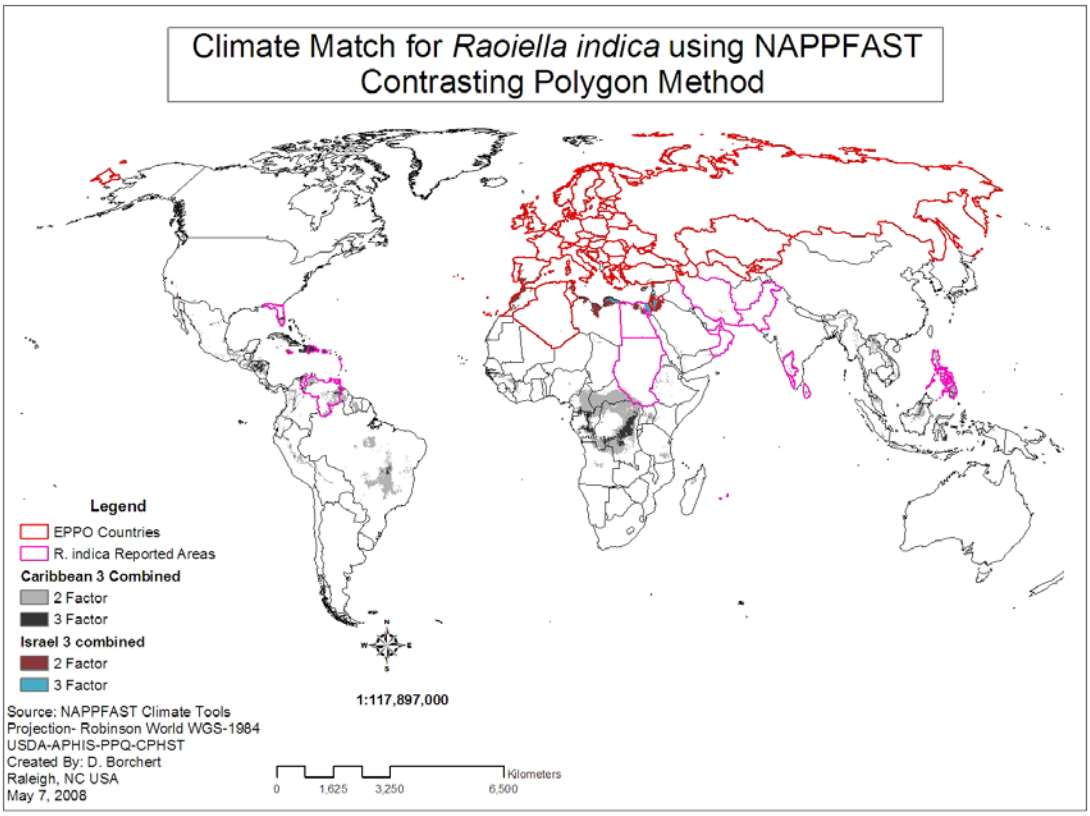


Figure 1: World map of climate match for Caribbean and Israel regions related to reported pest status.

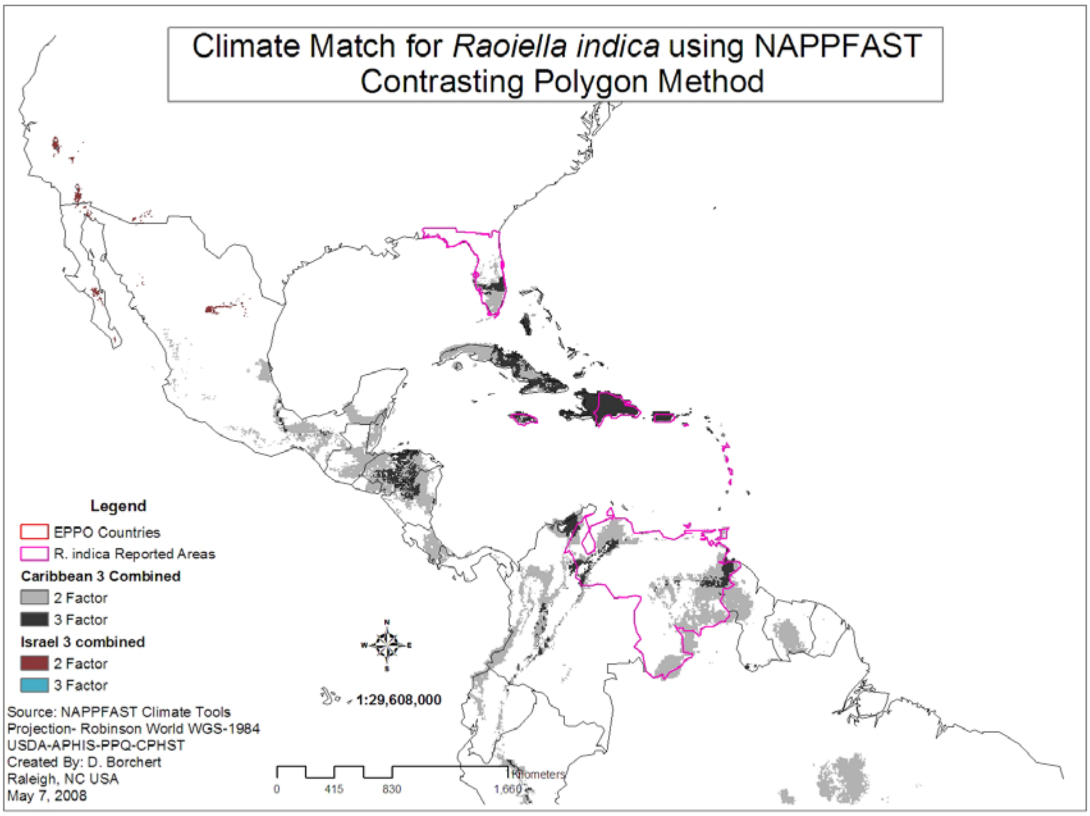


Figure 2. Gulf of Mexico detailed map of climate match for Caribbean and Israel regions related to reported pest status.

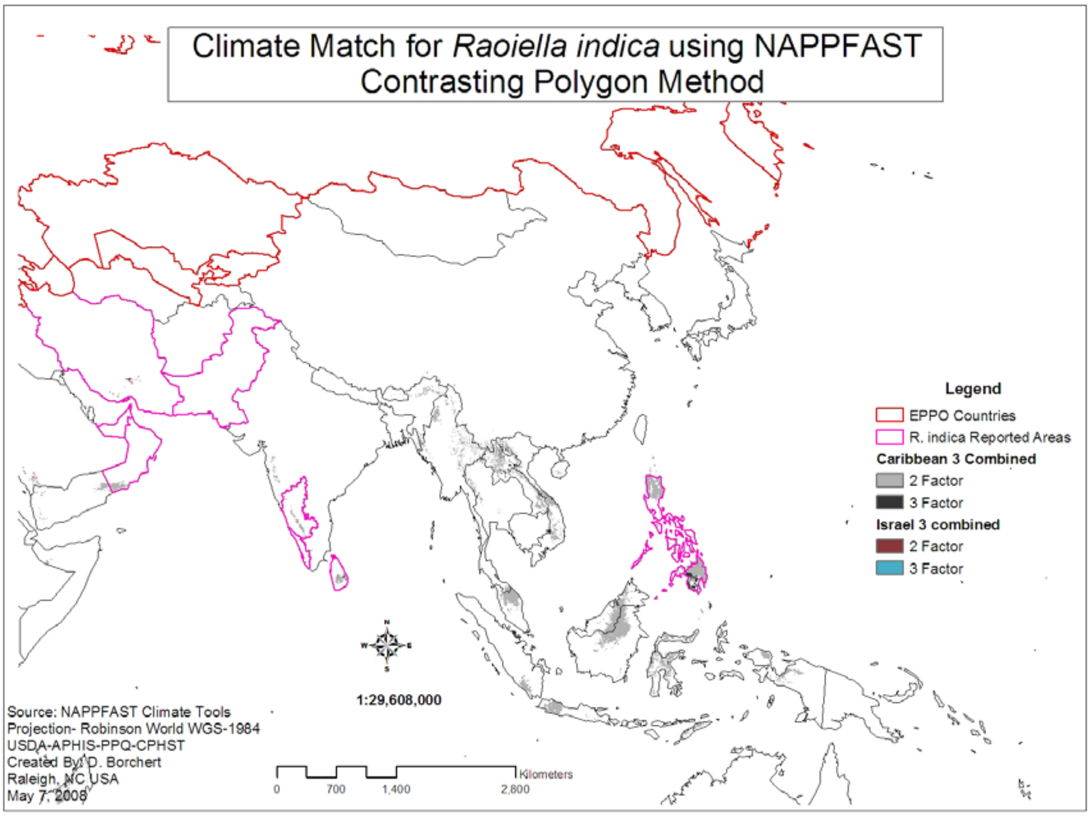


Figure 3. Indian Ocean detailed map of climate match for Caribbean and Israel regions related to reported pest status.

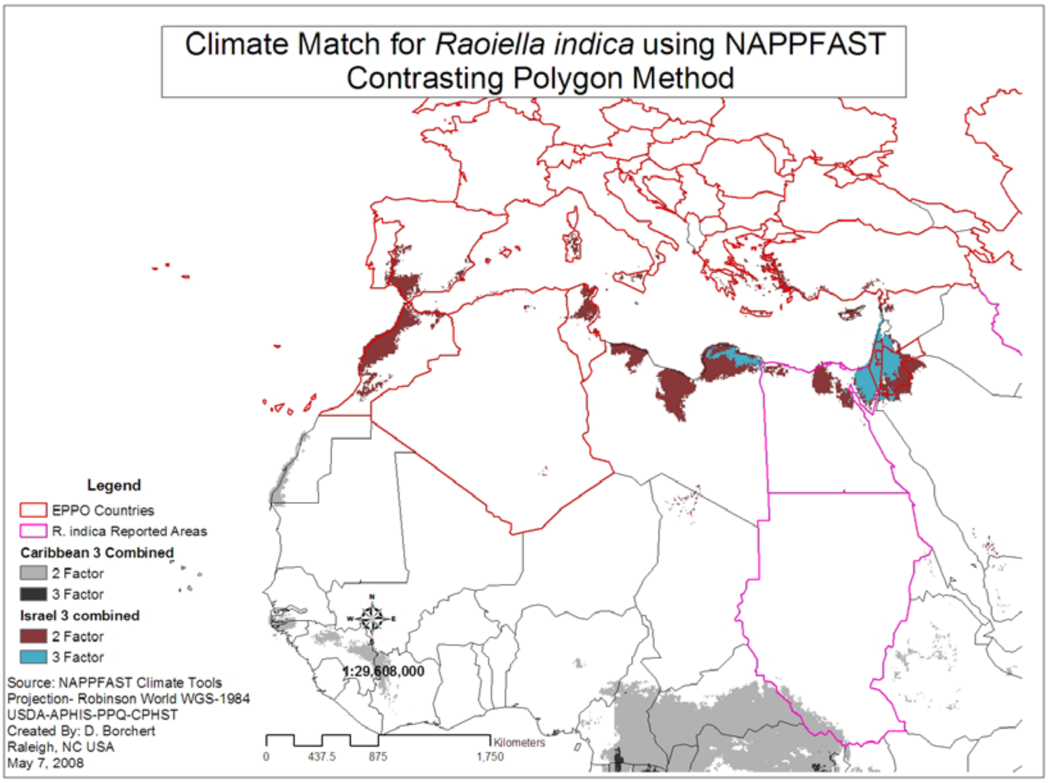


Figure 4. Mediterranean Sea detailed map of climate match for Caribbean and Israel regions related to reported pest status.

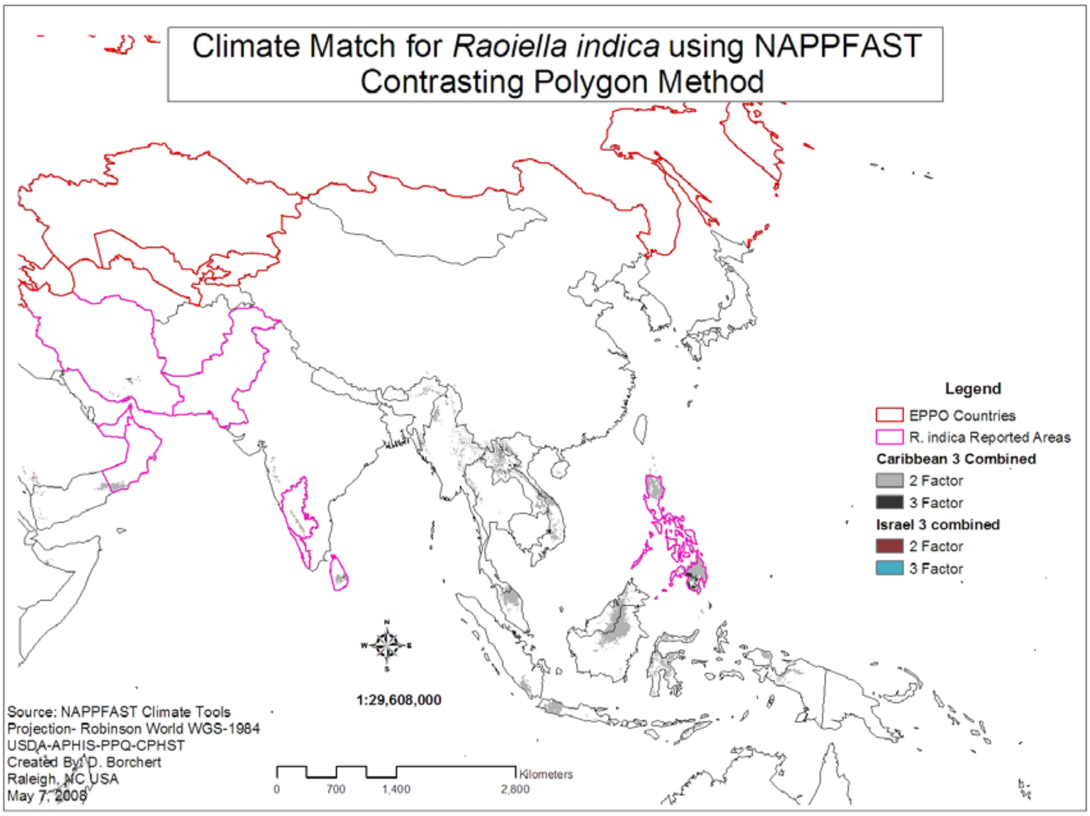
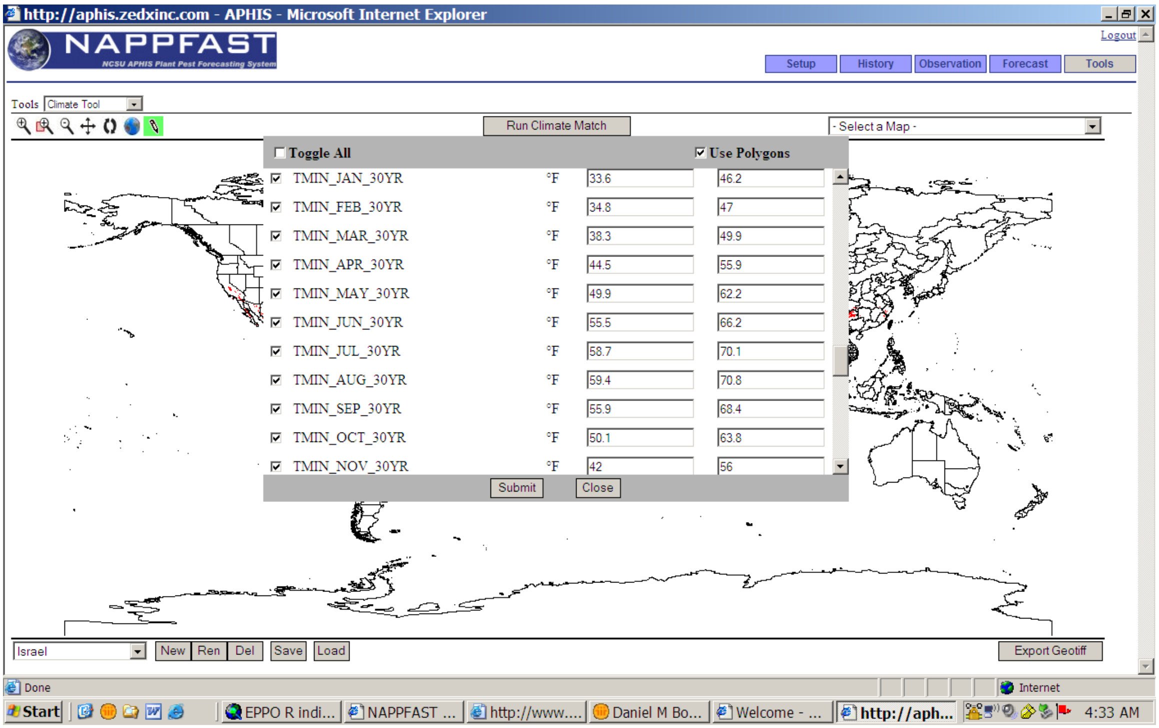
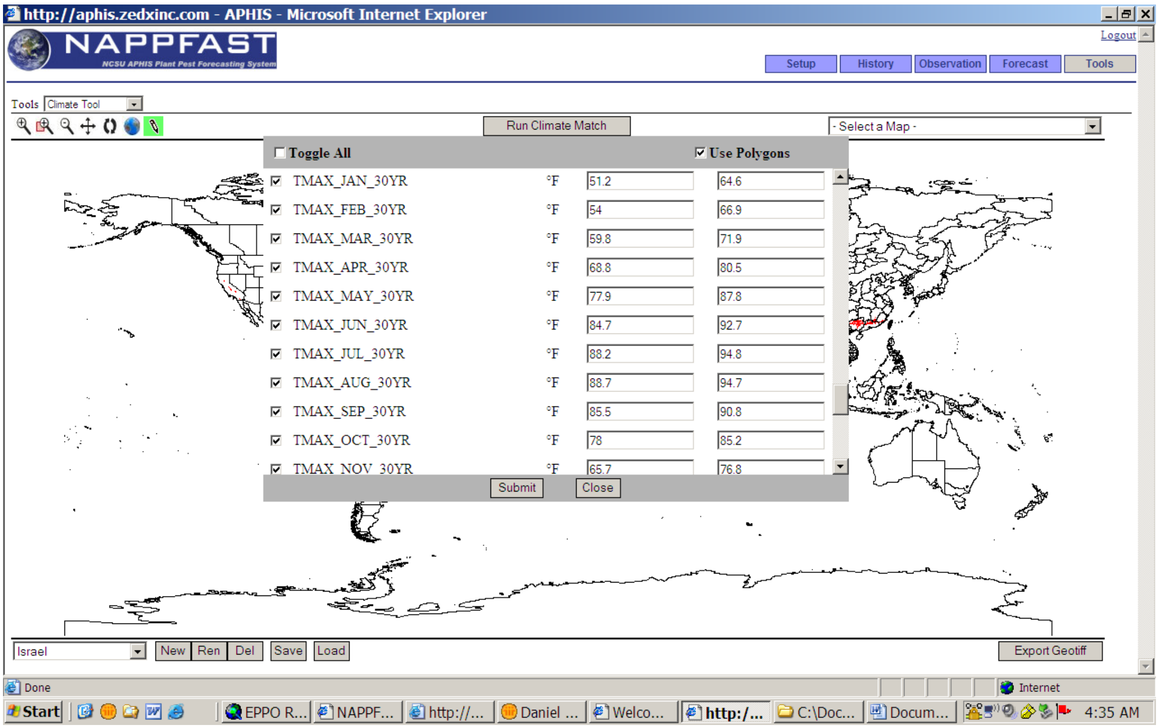


Figure 5. Detailed map of climate match for Caribbean and Israel regions related to reported pest status.

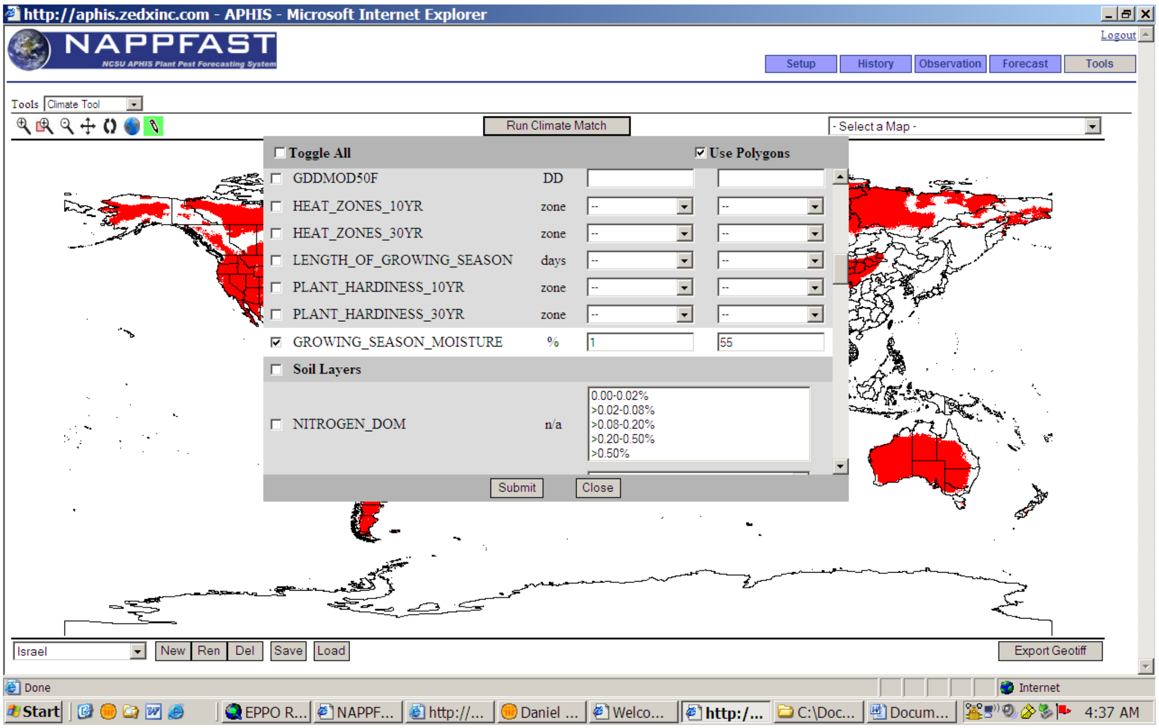
Figure 6. NAPPFAST Climate match parameter ranges for Israel and Caribbean polygons.



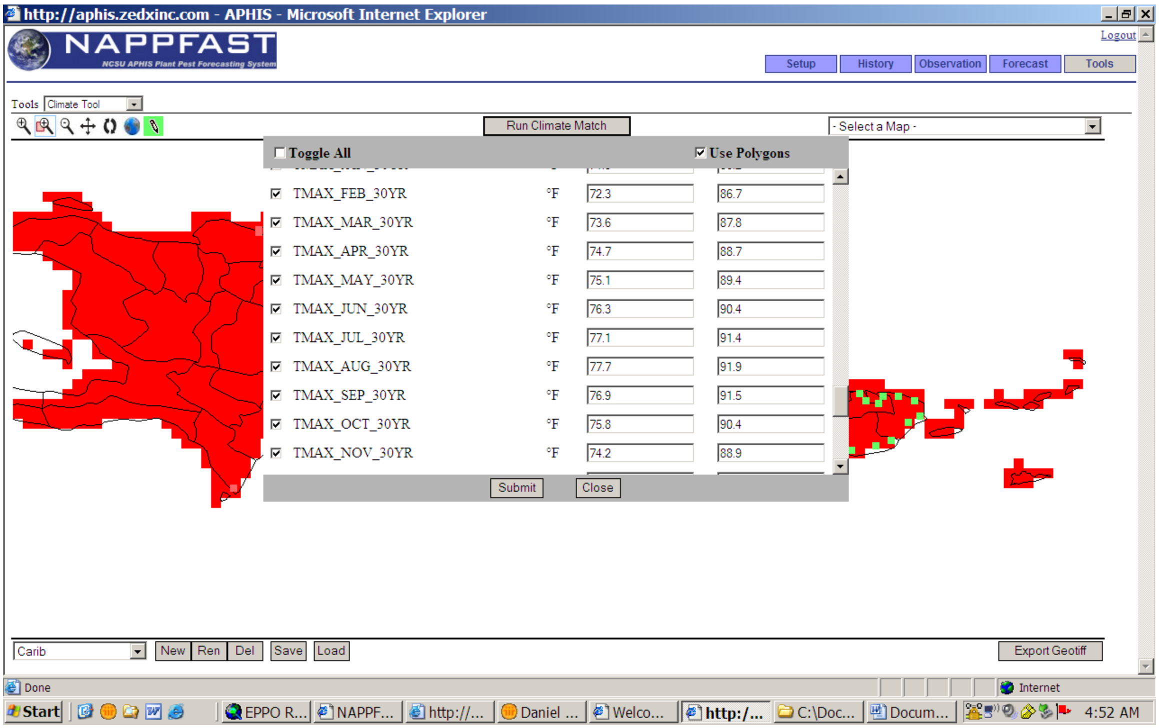
6a. Israel polygon Monthly T min ranges
Dec T min 30 yr range: 36.1-49.4 F



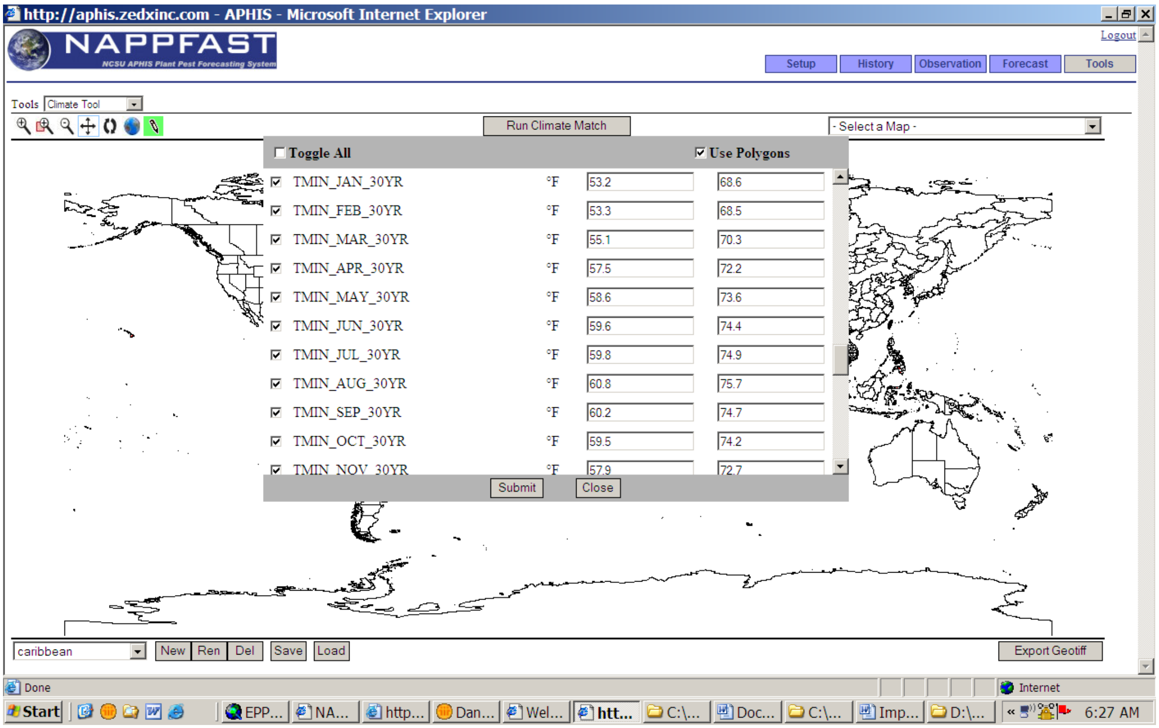
6b. Israel polygon 30 year monthly T max ranges
December T max 30 yr range: 54.1-68 F



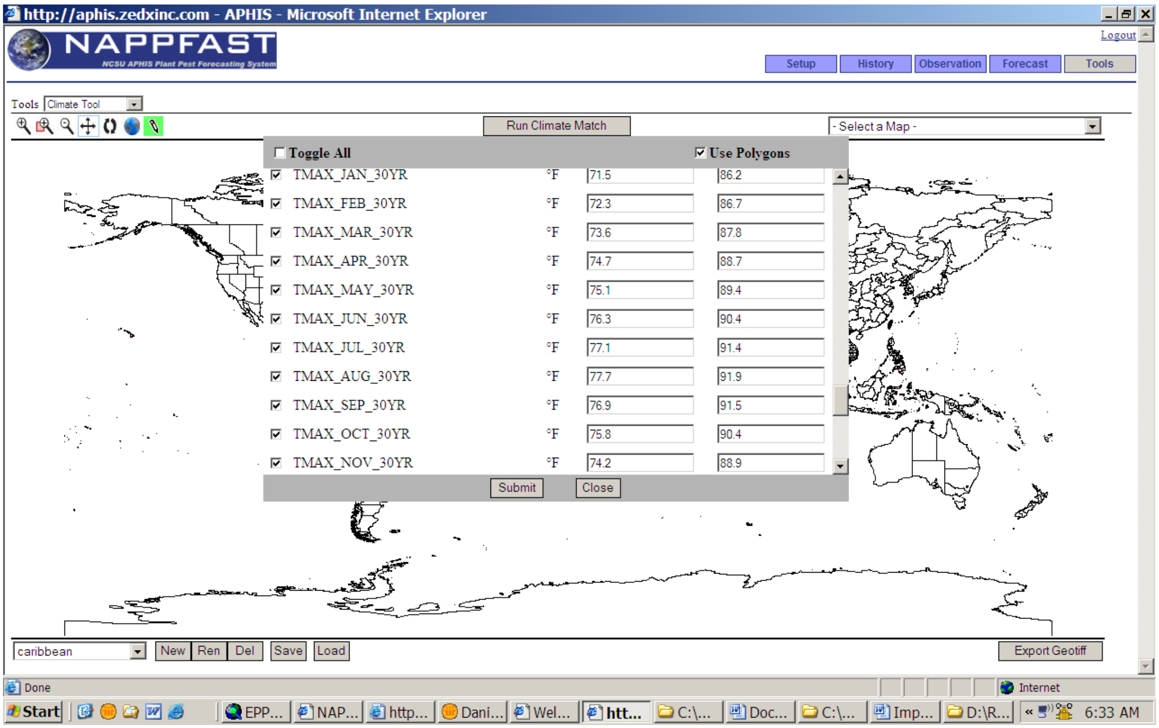
6c. Israel polygon Precipitation/Evaporation range



6d. Caribbean polygons Precipitation/Evaporation Range



6e. Caribbean polygons Monthly 30 yr T-min ranges.
December 55-70.2 F



6f. Caribbean polygons Monthly 30 yr T-max ranges.
December 72.6-87.2 F