AGRO ECOLOGICAL ZONATION OF FUSARIUM MANGIFERAE FOR ANDHRA PRADESH AND UTTAR PRADESH STATES OF INDIA

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ABSTRACT:

The study of Agro ecological zonation of *Fusarium mangiferae* in two states namely Andhra Pradesh (AP) and Uttar Pradesh (UP) of India were taken, in which randomly selected locations numbering 42 and 112 were identified respectively. For these locations climatic data pertaining to maximum and minimum temperature, RH, wind speed and evapotranspiration were collected for a period of 30 years (1972 - 2002).The data was used to generate weather surface on the vector map of AP and UP. The vector maps were prepared using the GIS. The Fusarium favourable areas are mapped by using 'threshold values' of weather parameters and geostatistical techniques. The result so obtained after layering, the favourable conditions for occurrence of mango malformation were found only in certain pockets of north western AP and entire state of UP. GIS tool was found to be very useful for prediction of spatial distribution of MM at regional scale.

1. INTRODUCTION

Geographic information systems (GIS) and modeling are becoming powerful tools in horticultural research and natural resource management. Spatially distributed estimates of environmental variables are increasingly required for use in GIS and models (Collins and Bolstad 1996). Mango is grown in the tropical and subtropical parts of the world between 35°N and 35°S and occupies most important place amongst the fruits grown in India. Malformation of mango (*Mangifera indica* L.) induced by *Fusarium mangiferae* (*Fusarium moniliformae var. subglutinans*) is considered as plant disease of international importance. Mango malformation malady is one of the most destructive disease in nature and the economic losses faced each year vary between 5 to 60 per cent, which not only causes losses to fruits but also for export of mango saplings from India. An overview of the agro ecological localization of malformation reveals its incidence prominently in the northern belt while the southern regions of India are practically free from malformation. No research work has been done for developing the agro ecological disease zonation of *Fusarium* (Mango malformation) in relation to weather parameters.

The aim of this study is to present an approach to developing the agro ecological disease zonation of *Fusarium* (Mango malformation) for AP and UP states of India based on weather parameters by using GIS techniques in conjunction with other Arc View extension tools to areas favorable for mango malformation. This study also aimed to evaluate practical use of related techniques and software.

2. MATERIAL AND METHOD

Regarding software, the Arc View spatial analyst (ESRI 1998) was used for inverse distance weighting interpolation. Inputs to the module are a point data file and a covariate grid. The program yields several output files.

2.1 Weather data

Climatic data from 112 stations in UP and 42 stations in AP of 30 years (1972-2002) observed average monthly values of minimum temperature, maximum temperature, relative humidity, wind speed, evapotranspiration were used to identify the areas favourable for Fusarium. These data will be obtained from a variety of sources.

2.2 Vectors

Every pest zonation programme will require a set of vector layers including district boundaries. Furthermore, the pest zonation programme will want to supplement the above standard vector layers with data directly relevant to the programme. Here AP and UP vector layers containing district boundaries are used.

2.3 Study Area

AP and UP are one of the major mango growing states of India. The study was conducted for all districts of AP and UP which account for 20 and 12.6 per cents and 28 and 22.2 per cents mango area and production of the India (NHB Database 2004) respectively.

2.4 Procedure

Average monthly values of weather variables of 30 years (1972 to 2002) climatic data was collected for 42 locations of AP and 112 locations of UP. The distinction between the malformation prone areas and malformation free areas were demarcated based on the AP and UP of weather variables of mango growing regions, which were arranged them in ID wise in Microsoft Excel sheet. The climatic data in Microsoft excel was converted into Dbf (Data base file) and it was added to Arc View 3.2. Then A.P district and weather data shape (shp.) files were prepared separately. Similarly U.P district and weather data shape files also prepared.

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2.5 Interpolate surface

Interpolate a continuous surface from point climatic data using inverse distance weighting surface. For this, the weather dbf in Arc View 3.2 was selected, with in that surface option was clicked for generating the following information among which out put grid specifications are changed like

For A.P:

- ➢ Out put grid extent - Same as A.P district SHP

- ➢ Out put grid cell size - 0.031715

- ➢ Number of rows - 227

- ➢ Number of columns - 254

- ➢ Inter surface method – IDW (Procedure explained in later step)

- ➢ Z value field: weather parameter

- ➢ Number of neighbours: 12

For U.P:

- ➢ Out put grid extent - Same as U.P district SHP

- ➢ Out put grid cell size - 0.031715

- ➢ Number of rows - 227

- ➢ Number of columns - 267

- ➢ Inter surface method – IDW (Procedure explained in 3.6.1.1)

- ➢ Z value field: weather parameter

- ➢ Number of neighbours: 12

ArcView Spatial Analyst did that integrated raster–vector theme analysis such as aggregating properties of a raster data theme based on an overlaid vector data theme. By the above procedure the surface of A.P and U.P from weather dbf can be obtained. The boundary vectors of AP and UP were overlaid. The interpolated surfaces were clipped to the area of AP and UP to avoid side effects. Interpolated climate surfaces are used to create grid-cell-size climate files for further use.

2.6 Inverse distance weighted averaging (IDWA)

IDWA is a deterministic estimation method whereby values at unsampled points are determined by a linear combination of values at known sampled points. Weighting of nearby points is strictly a function of distance. This approach combines ideas of proximity, such as Thiessen polygons, with a gradual change of the trend surface. The assumption is that values closer to the unsampled location are more representative of the value to be estimated than values from samples further away. Weights change according to the linear distance of the samples from the unsampled point; in other words, nearby observations have a heavier weight. The spatial arrangement of the samples does not affect the weights.

Distance-based weighting methods have been used to interpolate climatic data (Legates and Willmont 1990; Stallings et al. 1992). The choice of power parameter (exponential degree) in IDWA can significantly affect the interpolation results. At higher powers, IDWA approaches the nearest neighbor interpolation method, in which the interpolated value simply takes on the value of the closest sample point. IDWA interpolators are of the form:

$$\hat{y}(x) = i\, y(xi)$$

Where

i = the weights for the individual locations.

y(xi) = the variables evaluated in the observation locations

The sum of the weights is equal to 1. Weights are assigned proportional to the inverse of the distance between the sampled and prediction point. So the larger the distance between sampled point and prediction point, the smaller the weight given to the value at the sampled point.

2.7 Reclass of Surface from Weather DBF

In Arc View 3.2. analysis was clicked and selecting reclassifications, in which values were reclassified. There after Fusarium moniliformae var. subglutinans favourable and unfavorable weather conditions were added with which the Reclass of surface from weather dbf was obtained.

2.7 Convert SHP Files

Reclass of surface from the above weather dbf was selected with in that click the theme option and subsequently apply convert SHP was selected. In this SHP file the legend was edited and the legend type was changed from single symbol to unique value and with in that value field was changed from none to grid code.

2.7 Geoprocessing

In this step SHP of respective was selectedted with in that pointer was directed to view and geoprocessing subsequently. Later in the activated field intersect was clicked for combining the two themes in which one is A.P district SHP and other is weather.

- ➢ Input theme to intersect - A.P district.shp.

- ➢ Overlay theme - A.P Weather.shp.

- ➢ Similarly for U.P also

- ➢ Input theme to intersect - U.P district.shp.

- ➢ Overlay theme - U.P Weather.shp.

By the above procedure a single A.P and U.P district maps of two intersects was obtained with in which legend was edited by giving labels of Favourable and Unfavourable.

2.7 Layout

With the selection of intersect theme the pointer was directed to view for layout generation and enlarged the map copied the same in Microsoft Power point slide. By the above procedure we will get

AP and UP Fusarium favourable and unfavorable mango growing zones with individual weather parameters for flowering season.

2.7 Composite map generation (Layering)

By using ArcView Spatial Analyst we will get integrated raster–vector theme analysis such as aggregating properties of a raster data theme based on an overlaid vector data theme. Layering of all individual AP and UP Fusarium favourable and unfavorable mango growing zones with individual weather parameters for flowering season are done by using the Arc View – map calculator. By this we will get individual map of AP and UP Fusarium favourable and unfavorable mango growing zones with all weather parameters (Fig 1 and 2).

3. RESULTS AND DISCUSSION

The favorable weather conditions (*i.e*., minimum temperature, maximum temperature, relative humidity, wind speed and evaporation) for the growth and development of *Fusarium mangiferae* are presented in Table 1. These are the threshold values obtained from the graphical analysis and comparison of malformation prone and free areas weather variables. Also these threshold values are in concurrence with the results obtained from laboratory studies (Mitra 1979) for maximum temperature and minimum temperature.

Weather Parameters	Flowering
T Max	< 29 ℃
T Min	< 17 ℃
RH	< 66 %
Wind speed	< 3.6 km/hr
Evaporation	< 4.2 mm/day

Table. 1: The Favourable Weather Conditions (Threshold Values) for the Development of *Fusarium Mangiferae* and Occurrence of Mango Malformation

Agro ecological zonation of favorable climatic conditions for the *Fusarium mangiferae* growth and development over Andhra Pradesh and Uttar Pradesh are presented in Fig.1 and 2. For the development of *Fusarium mangiferae* during flowering period in the month of November (initial month of flowering), favourable maximum temperatures were observed at Srikakulam, Rangareddy, Hyderabad districts and partly districts of Chittor, Anantapur, Cuddapah, Prakasam, Vizianagaram, Mahabubnagar, Medak and Nalgonda. The favorable minimum temperatures were observed over parts of Adilabad, Karimnagar, and Nizamabad. The relative humidity was favorable over Adilabad, Nizamabad, Karimnagar, Medak and Rangareddy districts and parts of Warangal, Nalgonda, Mahabubnagar, Kurnoor and Anantapur districts. Wind speed was favorable in Krishna district only, whereas evaporation was favourable in the parts of Srikakulam, Vizianagaram, Krishna, Nellore, Chittor, Cuddapah and Anantapur districts. The composite map developed for the month of November by layering the above all weather variables showed that the conditions for the development of *Fusarium* were found to be favourable only in certain pockets of North Western AP particularly districts of Medak, Rangareddy, Hyderabad and part of Adilabad. The remaining districts of AP are relatively free from the disease.
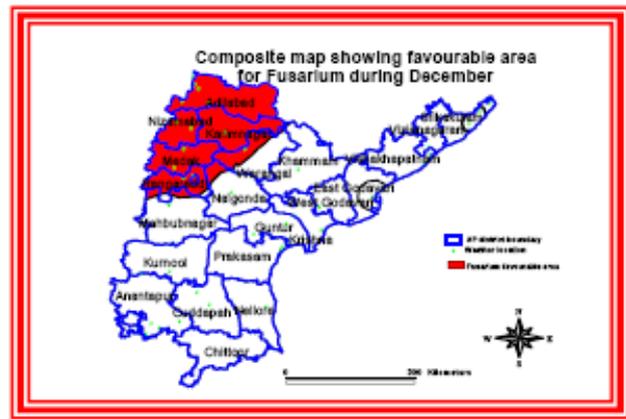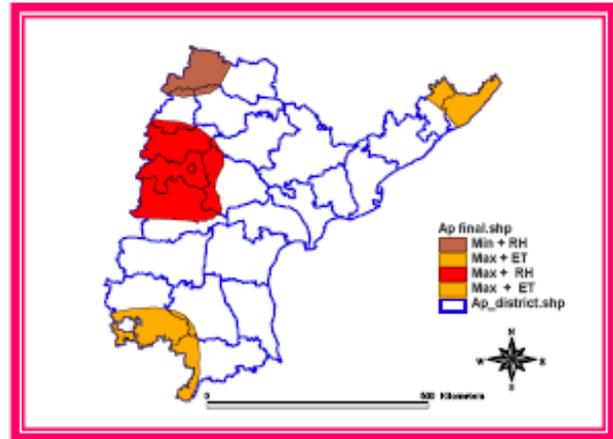

Figure 1. Composite AP Map Showing Favourable Area for Fusarium During November and December

The weather variables behavior during the month of December (2nd month of flowering) in Andhra Pradesh, for the favoring the *Fusarium mangiferae* are presented in Fig. 1 The maximum temperature was favorable for entire Andhra Pradesh, whereas minimum temperatures prevailed over Adilabad, Karimnagar, Nizamabad, Medak and Hyderabad districts and parts of Rangareddy, Warangal, Nalgonda and Mahabubnagar districts. The evaporation was favorable over Adilabad, Karimnagar, Nizamabad, Khammam, East Godavari, Srikakulam and Krishna districts and parts of Nalgonda, Medak, Hyderabad, Rangareddy, Prakasam, Guntur, West Godavari, Visakapatnam and Vizianagaram. Relative humidity was favorable Adilabad, Karimnagar, Nizamabad, Rangareddy and Hyderabad districts and Mahabubnagar, Kurnool, Anantapur, Cuddapah, Nalgonda, Karimnagar, Khammam and Srikakulam districts. Wind speed was favorable in all the districts of AP except in West Godavari district. The composite map developed by layering the above all weather variables showed that the conditions for the development of *Fusarium* were found to be favourable only in certain pockets of North Western AP particularly districts of Medak, Rangareddy, Hyderabad and part of Adilabad and Srikakulam. The remaining districts of AP are relatively free from the disease during the December month.

The low temperature (maximum and minimum), moderate relative humidity, evaporation and feeble wind favoured the growth of

Fusarium mangiferae over the Indian sub continent. In Andhra Pradesh the favorable minimum temperature and relative humidity both are observed over parts of Medak, Adilabad, Karimnagar, Nizamabad and Rangareddy. This might be due to the moderate weather conditions, which were influencing by the Bay of Bengal.

In Uttar Pradesh the favorable weather conditions prevail in all districts except Lalitpur. The weather variables behavior for the entire state during the February month (initial month of flowering) was presented in Fig. 2. The maximum and minimum temperatures, relative humidity and wind speed were favorable for the *Fusarium mangiferae* in the entire state, whereas that the evaporation was favorable for entire state, except Lalitpur district. The composite map developed for the month of February by layering the above all weather variables showed that the conditions for the development of *Fusarium* were found to be favourable entire state except Lalitpur. These results are in conformity with Chakrabarti and Kumar, (2002).
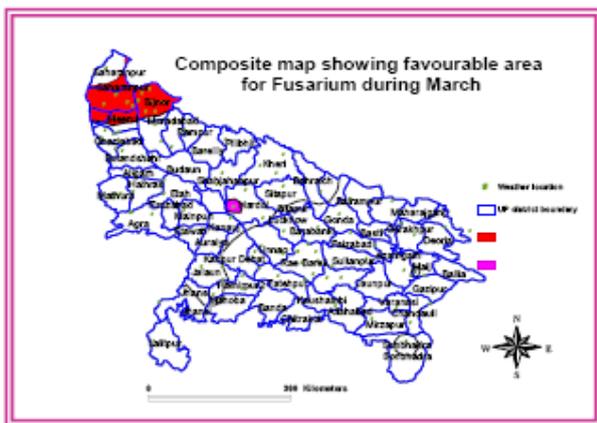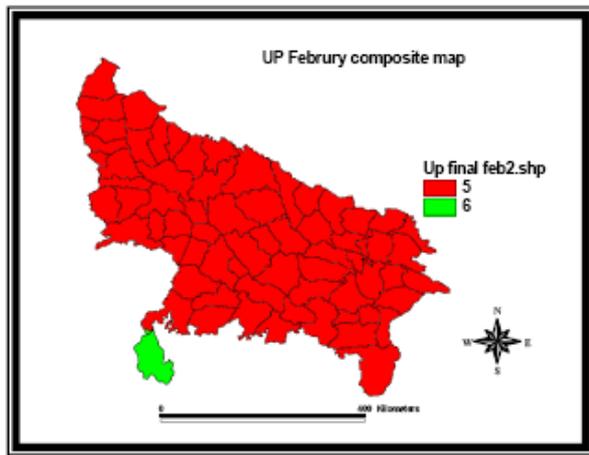

Figure 2. Composite UP Map Showing Favourable Area for Fusarium During February and March

The weather variables behavior for the entire state during the March month (2nd month of flowering) is presented in Fig. 2. The maximum temperatures were favorable in parts of Bijnor and Meerut, whereas the minimum temperatures were favorable in the Saharnapur, Bijnor, Meerut, Ghaziabad, Bulandshahr, Moradabad, Rampur, Barelly, Pilibht, Buduan, Aligarh, Hathras, Mathura, Firozabad, Etah, Shahjahanpur, Firozabad, Agra, Mainpur, Kanauj, Auraiya, Hardoi districts and parts of Bahraich, Unnao, Lucknow, Jhansi, Mahoba, Hamirpur, Julan, Kanpur, Sonbhadra, Maij and Balarampur districts. The relative humidity and wind speed favorable for the entire state, while evaporation for the *Fusarium mangiferae* growth and development was unfavorable in the entire UP state except parts of Hardoi district. The composite map developed by layering the above all weather variables showed that the conditions for the development of *Fusarium* were found to be favourable only in entire districts of Muzaffarnagar, Bijnor and part of Saharnapur, Meerut and Hardoi districts. The remaining districts of UP are relatively free from the disease during the March month.

In Utter Pradesh during the flowering periods (February-March) the weather variables were highly favorable for the entire state. Also along with the weather variables (*i.e*., minimum and maximum temperature, relative humidity, wind speed and evaporation) number of the cloudy days, and daily duration of wetness over flower surface favoured the growth and development of *Fusarium mangiferae*. GIS tool was found to be very useful for prediction of spatial distribution of *Fusarium mangiferae* at regional scale which otherwise could have been impossible.

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