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Chapter 7

INCIDENCE OF THE PAPAYA RINGSPOT VIRUS (PRSV-p) AND MANAGEMENT IN THE STATE OF GUERRERO, MEXICO

Elías Hernández Castro*[1], Agustín Damián Nava[2], J. Antonio Mora Aguilera[3], Juan A. Villanueva Jiménez[4], Dolores Vargas Álvarez[2] and Francisco Palemón Alberto[2]

[1]Maestría en Sistemas de Producción Agropecuaria de la Universidad Autónoma de Guerrero, Tuxpan, Iguala, Guerrero, México
[2]Facultad de Ciencias Agropecuarias y Ambientales, UAG. Iguala, Gro. México.
[3]Colegio de Postgraduados. Campus Montecillos – Fitosanidad, Texcoco, Edo. de México
[4]Colegio de Postgraduados Campus Veracruz- Agroecosistemas Tropicales, Veracruz, Ver., México

ABSTRACT

The papaya cv. 'red Maradol' is one of the most popular tropical fruits, nationally and internationally. In Mexico approximately 21,000 ha^{-1} of land is used in cultivating this fruit but despite its popularity in the producing areas, the crop has been limited by the papaya ringspot virus (PRSV-p), which is transmitted by several aphid species. In response, the Interdisciplinary Papaya Group (GIP), evaluated technology of Integrated Management PRSV-p (MIPRSV-p), the objective of this technology is to delay and reduce the damage of the disease and increase crop productivity. As in 2004, 2005 and 2007 parcels of papaya cv 'red Maradol', to assess MIPRSV-p in the state of Guerrero this management design consisting in the protection of the seedlings with a polypropylene mesh was established, the density of plants was increased (2,700 plants / ha^{-1}), plants with initial symptoms of PRSV-p removed physical barriers of *Hibiscus sabdariffa* and three rows of papaya created around the plantation and a row of corn

* Author to whom correspondence should be addressed: Elías Hernández Castro, Maestría en Sistemas de Producción Agropecuaria de la Universidad Autónoma de Guerrero, Km. 2.5 Carr. Iguala – Tuxpan, Iguala, Guerrero, México. Tel. 01 (733)1101536. ehernandezcastro@yahoo.com.mx

inserted. Incidence of PRSV-p, and population dynamics of winged aphids was recorded on a weekly basis throughout the cycle, in addition fruit harvest number and yield in kg / ha was recorded.

The results were a five month delay of PRSV-p damage with an incidence of 30 % unlike the Regional Management (MR), which in the same period came to 100 % infection, the best health allows the greatest number of fruits per plant (MIPRSV-p = 15.3, MR = 10.2), which was reflected in the yield of 78 ton/ha, unlike MR yields of 48 ton / ha^{-1}. From a total of 621 types of aphids identified, was 74.4 % of the species *Aphis gossypii*.

The greatest catch in Coastal Area occurred during the months October, November, December and January, while for the Iguala Valley the greatest were in the months of January, February and March.

Keywords: Integrated Management of the Papaya Ringspot Virus (PRSV-p), red Maradol, aphids

INTRODUCTION

Papaya (*Carica papaya* L.) is a widely distributed crop in tropical regions. World production of papaya fruit during 2008 was 9732, 158 t (SIAP, 2010). Its use is mainly as fresh fruit because it contains vitamins A and C; it is also preserved or used for extraction of pectins and papain (Agustí, 2004). In the last decade, Mexico has been one of the leading producers of papaya (*Carica papaya* L.) in the world along with Indonesia, India and Brazil; Mexico is the first exporter, by more than 10 years (FAO, 2011).

14 000 hectares of this fruit is planted in the nation under irrigation and in the rainy season, an increasing trend in states such as Michoacán, Chiapas, Oaxaca, Guerrero and Nayarit, which together with Veracruz, represent the major producing states (SAGARPA, 2010).

Although the use of this cultivar has spread in papaya producing areas, it has been limited by plant health problems, the most problematic disease of viral type is "Papaya Ringspot Virus" (PRSV-p) (Mora et al., 1992, Hernandez-Castro et al., 2007). The PRSV-p, is one of the most destructive diseases that occur in cultivation worldwide. This disease can cause yield losses of between 5% to 100% depending on the age at which the plant is infected (Hernández-Castro, et al., 2004).

This virus (PRSV-p), belongs to the potyvirus, is not transmitted by seed but from infected papaya plants to healthy plants by sucking insects of the aphid group, being the most common: *Myzus persicae, Aphis gossypii, A. neeri, A. citricola* and *A. spiraecola* (Nieto et al., 1990, Villanueva-Jiménez and Peña, 1991).

In Mexico 205 species of aphids, 25.85% of agricultural importance are known; given the great diversity of climates and vegetation in the country it is estimated that there are approximately 500 species (Peña-Martínez, 1999).

Faced with this problem the Interdisciplinary Papaya Group (GIP), is working in the dissemination and transfer of technology for integrated management of the disease in the state of Guerrero, México, the technology aims to delay and reduce damages by PRSV-p and thereby increase crop productivity.

MATERIALS AND METHODS

The work took place in the grounds of cooperating producers, the selected localities had a" climate or Aw (w) (i ') g, the driest of the warm subhumid with summer rains and annual average temperature of 27.9^{0}C and annual rainfall of 797 to 1313.5 mm (García, 1973 and Gob. Edo. Guerrero, 1990). The validation plots with the papaya plants were established from December 2003 to December 2005 in the Coastal Region of Guerrero and the last plot in December 2006 to January 2007, in the Northern region of the state, as shown in Table 1, with a total of eight plots of 1 ha-1 surface. Four were set up with the technology of the Integrated PRSV-p Management and four with traditional management of producers of the region (MR).

Table 1. Distribution of plots *Carica papaya* L., and the assessment the PRSV-p, in the State of Guerrero, Mexico

Locality	Evaluation period	Region of the State of Guerrero
El Papayo (Loc. 1)	2003 - 2004	Coastal region
Coyuca de Benítez (Loc. 2)	2004 – 2005	Coastal region
San Marcos (Loc. 3)	2004 – 2005	Coastal region
Iguala (Loc. 4)	2006 - 2007	Northern region

The MIPRSV-p technology consisted in application of the following measures: protection of seedlings with polypropylene mesh, which prevents them from being infected by aphids to ensure plant health at the time of cultivation; high plant density (2,700 pl/ha^{-1}); the practice of eradication of diseased plants with initial symptoms of the disease of PRSV-p was performed (visual symptoms of PRSV-p began to appear in the first plants approximately four months after the transplant until fruit set), a corn barrier was planted on the same date around of cultivation of papaya and also intercropped every three rows, the VS -525 maize variety was used. A distance of 1.5 m was established between individual papaya plants and 2.10 m between rows.

On the other hand in the MR which served as controls, the following practices were performed: a density was established of 2,000 plants ha^{-1}, removal of weeds, intensive application of insecticides and application of chemicals to soil and foliar fertilizer.

The plots were established with furrow irrigation, four applications of chemical fertilizer with the formula 120-30-120 gr/plant, divided into four applications; the first 20 days after transplantation and the remainder (3) every 30 days after each, weed control was performed manually.

Variables

To meet the objective the following variables were considered:

- Incidence of PRSV-p disease. To assess the incidence of virus, records were made every five days throughout the cycle. On each date both healthy plants and plants that

had any of the following symptoms caused by the virus were detected: Chlorosis, mosaic, distortion, stunting and oily spots on flowers, petioles and fruit. In addition the incidence of disease was determined by the following formula

$$\%I = \frac{ni * 100}{Ni}$$

where:

I = Disease incidence percentage.
ni = number of diseased plants at the time i.
Ni = total number of plants evaluated.

- Population dynamics and identification of species of captured aphids was evaluated for which yellow plastic trays of 30x23x13 cm containing water and detergent to break the surface tension were used as traps. The traps were placed at the height of the papaya canopy and moved according to the growth of the plants. Four traps, one at each cardinal point at the edge of the area evaluated of the established plot. Review of trays and collection of aphids was performed twice a week. Aphids were separated from other insects, counted and placed in a glass jar containing 70% ethyl alcohol, properly labeled with the date of data collection, the cardinal point and corresponding number of aphids. Collected aphids were taken to the laboratory for identification.
- At first cut the number and weight of fruit and the plant height was taken, taking an average of 100 plants at random from each of the plots established

Data Analysis

With the data obtained from the incidence and aphid population dynamics, graphics were made, to explain the development process of the disease, the period of greatest amount of aphids per month per species. And finally a comparison of the data including plant height, number and weight of fruit, and the final yield of each of the evaluated plots was performed.

RESULTS AND DISCUSSION

Incidence of the Papaya Ringspot Virus, was detected from 45 days after transplanting (about a month and a half) in the MR plots, whereas plots with MIPRSV-p, the incidence was recorded starting 135 days after planting (four and half months), as seen in Figure 1, in the case of MIPRSV-p infected plants of plots presenting the early symptoms, were eliminated.

The progress of the disease coincides with that reported in the paper entitled Incidence of the Papaya Ringspot Virus and capture of winged aphids in Tabasco, Mexico (Cortez-Madrigal and Mora-Aguilera, 2008), which at 150 days after transplantation (approximately five months) the incidence reached a 32.2% infection while in the area evaluated by this time has less than 20% incidence when the plants is bearing fruit.

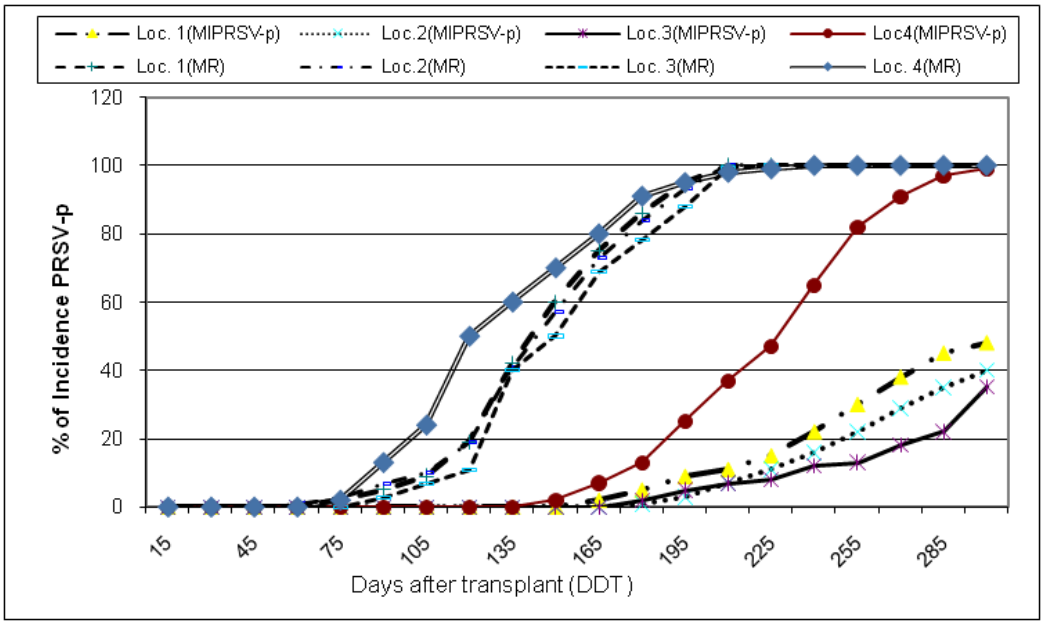

Figure 1. The progress of disease PRSV-p, in test plots in the state of Guerrero, Mexico.

Moreover plots with MR, in the same time reached 80% incidence of PRSV-p, these results have been encouraging, as it has managed to delay the damage caused by the disease for up to six months on average in all plots, having an incidence of less than 10%, while in the same period the witness (MR), came to 85% infection (Figure1); time the flowering and fruit set is given.

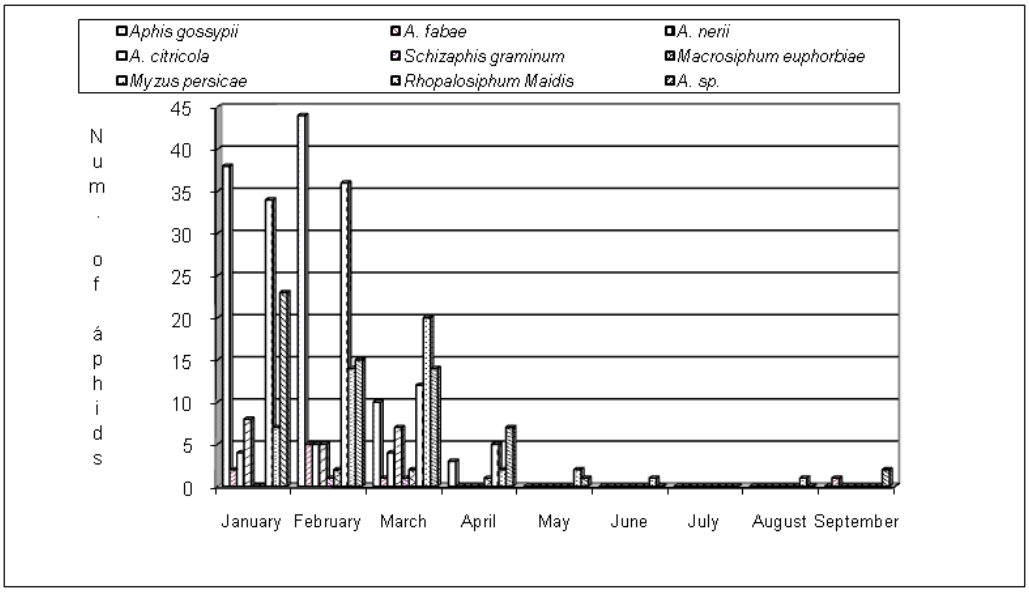

Figure 2. Population dynamics and diversity of aphid species, in plantings of papaya in the Coastal Zone of state Guerrero, Mexico.

The presence of aphids in the papaya plots was detected 30 days after transplantation, with an average of five individuals in each tray, populations increased during the next two months and fell from the fourth month after transplantation (Figure 2 and 3) this is because it is the start of the hottest months of the year. These results agree with those reported by Villanueva (1990), which work in papaya cultivation on College of Postgraduates, Veracruz, Mexico, by reporting high incidence peaks of winged aphids in the months of September to February. Similar results were found by Nieto et al., (1990) and Téliz et al., (1991).

These increases in aphid population are influenced by favorable climatic conditions for development, such as low temperatures, similar results are reported by Holmes & Hassan (1948) where since 1948 in Hawaii it is mentioned that the dispersion of PRSV-p in a population of papayas, was faster during the winter and spring months, and this was associated with high aphid vector populations.

The species most prolific in papaya plantations was *Aphis gossypii* (Figure 2 and 3) and along with *Myzus persicae*, were found in the work done in Coastal of Guerrero (Hernandez-Castro et al., 2007), while in Veracruz and Michoacan *A. gossypii* and *A. spiraecola* were found to have greater species abundance (Hernández 1998. Rivas-Valencia et al., 2008), and Tabasco to *A. spiraecola* (Cortez-Madrigal and Mora- Aguilera 2008), all these species are reported as the most efficient transmitters of virus in papaya cultivation (Villanueva and Peña 1991, Hernández 1994).

The months with the highest number of aphids were February and March (Figure 2 and 3), which coincides with that reported in research in Tabasco (Cortez-Madrigal and Mora-Aguilera 2008), where these researchers reported two distinct peaks: February-March and March-April.

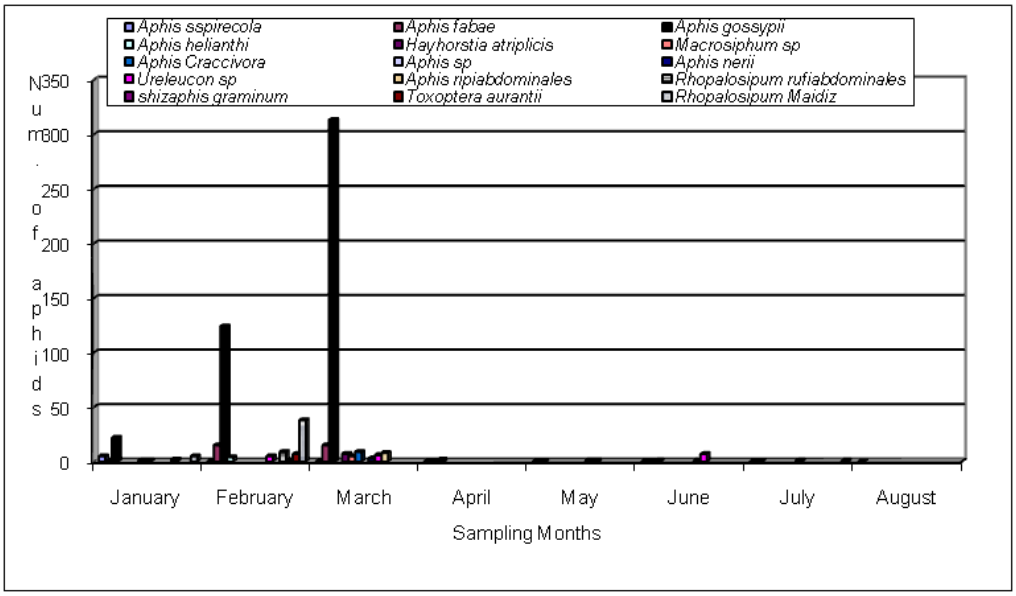

Figure 3. Population dynamics and species diversity of aphids in papaya plantation in the Northern Zone (Iguala) from state Guerrero, Mexico.

Other research indicates that the greatest catches of aphids in the tropics are recorded in winter and lowest in summer (Mora and Teliz 1987 Teliz et al., 1991), about Hernandez-

Castro et al., (2007) notes that the Coastal Guerrero defined two peaks from October to November and December to February are reported and also can see, that the greatest catches coincided with the period of lowest rainfall.

This lower incidence of plants viruses helped to obtain a yield in MIPRSV-p managed plots of up to 50 ton / ha, unlike the average yields of the plots with the regional management (MR) of approximately 22 ton / ha (Table 2.), these results are similar to those obtained in an experiment in the state of Veracruz, Hernandez et al., (2000) where they obtained yields of 30 ton / ha, various practices integrating PRSV-p management with cv. 'red Maradol', making it clear that such strategies offer better results than regional management.

Table 2. Effect MIPRSV-p in the production of cv. 'red Maradol' in plots established in the North and Coastal of Guerrero, Mexico

Technology	Average plant height (m)	Average No. of fruits / plant	Average fruit weight (Kg)	Final Yield (ton / ha)
Loc. 1 (MIPRSV-p)	1.48	8.0	3.2	52.3
Loc. 2 (MIPRSV-p)	1.47	7.6	3.5	49.2
Loc. 3 (MIPRSV-p)	1.53	6.9	3.8	49.7
Loc. 4 (MIPRSV-p)	1.50	7.5	3.3	50.3
Loc. 1 (MR)	1.40	4.1	3.0	22.2
Loc. 2 (MR)	1.41	4.0	2.9	19.8
Loc. 3 (MR)	1.52	4.8	3.2	21.8
Loc. 4 (MR)	1.49	5.3	3.1	22.7

CONCLUSION

The application of PRSV-p integrated management technology retards infection and lessens the severity, allowing greater production of fruit and therefore increased yield.

It is important to monitor aphids in papaya plantations for times of migration of these insects, that aphids do not colonize papaya plants, however many of these species are transmitting the Papaya Ringspot Virus and short flights migrations within the crop can occur.

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