INDIAN CITRUS RING SPOT DISEASE: EFFECT ON THE QUALITY OF PRODUCTION IN FRUITS OF RESISTANT AND SUSCEPTIBLE VARIETIES OF KINNOW (CITRUS RETICULATA) AND ITS CONTROL MEASURES.

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Abstract : Viral diseases are considered as the most dangerous of all diseases in the modern fruit production industry which have been highly developed in last few decades. Kinnow (Citrus reticulata) which is a variety of citrus fruits grown in Pakistan, India, Indonesia, China, Spain, Japan and Brazil etc. and there are so many varieties of Kinnow to be relished for their distinctive and sweet flavor, easy peeling, wide range of adaptability and high nutritious values. But the production of fruits is profusely affected by the different pests and diseases, in which viral diseases cost a lot of damage amongst all. Virus infected fruit trees are subjected to permanent damage of fruit quality and yield, a general decline of tree growth and even death. The damage by viral infections can only be checked by delivering adequate and precise information about viral diseases to the fruit growers, because if they are not managed in time, they can even wipeout the whole citrus industry.

Keywords : Citrus, Ring spot diseases Kinnow

INTRODUCTION

Citrus reticulata gets infected with a number of viruses like tristeza, ring spot, mosaic, greening, viroid and phytoplasma, where the ring spot virus has become now the matter of great concern as it causes a drastic reduction in fruits quality and production. Citrus ring spot disease was first observed by Wallace and Drake (1968) in California which was considered as a severe form of another viral disease, Psorosis (Roistacher, 1992; Derrik, et.al., 1991; de Graca, 1991) but later it was found distinct from Psorosis by Pant and Ahlawat (1998). In India it was reported in the citrus growing belt of Abohar by Thind, et.al. (1995). The disease exhibits symptoms like leaf lamina epinasty, necrotic flecks, leaf mottling, irregular chlorotic patterns, raised ring spots (yellowish ring with green tissues in the center) on leaves. Citrus ring spot disease in India is caused by a virus which was found to be distinct from the citrus ring spot viruses reported from the other places of the world in its morphology and serology as well (Ahlawat, 1997 and Byadgi and Ahlawat, 1995). So it was named as Indian Citrus Ring Spot Virus (ICRSV). ICRSV is a flexuous particle with a modal length of 640x15 nm with clearly visible cross banding (Byadgi and Ahlawat, 1995; Milne, et.al., 1997). The genome comprised of ssRNA of 7.5 Kb and the coat protein is present at the 3' end of the genome, which is found to be of 35 KDa size (Rustici, et.al. 2000). ICRSV is considered as a papillo virus causing disease incidence highest in north by 84.5%, followed by central, 67% and then sub mountainous zone by 44.5% (Lore and Cheema, 2000). The ICRSV is found to be transmitted effectively through the bud inoculation of the infected plant to the healthy ones (Byadgi and Ahlawat, 1995; Thind, et.al., 1997). The symptoms of the virus could be appeared in Kinnow plants around 65-100 days after inoculation, but the possibility of the viral transmission through the pollens also could not be ruled out as the virion were trapped in Immuno Electron Microscopy (IEM) from the pollens of Ring Spot affected trees by Ahlawat (1997).

The detrimental effect of ICRSV on Kinnow fruit's yield and production is easily seen which came as a huge loss to the economy of the country and the world at large. To figure out the loss of quality of fruits due to the ICRSV disease, the present research work was conducted with taking two different varieties of Kinnow, one that is resistant to the ICRSV, Nasnaran and the other one which is susceptible to the ICRSV i.e. Hazara. Results are discussed herein.

The two varieties of Kinnow, Nasnaran and Hazara with 9 year old plants were grown on the jattikhatti rootstock in the main farm land. Half of the plants of each variety were bud inoculated with ICRSV and rest halves were kept inoculation free to serve as control during the experimentations to determine the decline in quality and production of the fruits. The related data was collected during the cropping season 2005-2008. The fruits were harvested from infected and healthy trees of both varieties and were analyzed by the standard methods of AOAC (1970) for their quality in terms of fruit lengths, fruit breadths, peel thicknesses of fruits, fruit juice volume, rag in fruits and the fruit weights. The data obtained from the analysis is presented in table-1 and the related graph is shown as the figure-1.
Table-1: Effect of Indian citrus ring spot virus on the quality of the fruits with respect to growth and development in the fruits of resistant and susceptible varieties of Kinnow.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Resistant</th>
<th>Susceptible</th>
<th>% change in inoculated over healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Healthy</td>
<td>Inoculated</td>
<td>Healthy</td>
</tr>
<tr>
<td>Fruit-length (cm)</td>
<td>6.28</td>
<td>5.27</td>
<td>6.08</td>
</tr>
<tr>
<td>Fruit-breadth (cm)</td>
<td>7.02</td>
<td>5.66</td>
<td>6.81</td>
</tr>
<tr>
<td>Peel thickness (cm)</td>
<td>0.32</td>
<td>0.48</td>
<td>0.34</td>
</tr>
<tr>
<td>Fruit-juice Vol. (%)</td>
<td>61.58</td>
<td>52.04</td>
<td>59.52</td>
</tr>
<tr>
<td>Rag (%)</td>
<td>18.56</td>
<td>26.1</td>
<td>18.29</td>
</tr>
<tr>
<td>Fruit-weight (gm)</td>
<td>150.25</td>
<td>91.75</td>
<td>147.41</td>
</tr>
</tbody>
</table>

Figure-1: Effect of Indian citrus ring spot virus on the quality of fruits with respect to growth and development in the fruits of resistant and susceptible varieties of Kinnow.

The data in table-1 revealed that after the infection of ICRSV, the Kinnow fruits were found with increased peel thicknesses and the percent rag present in the fruit while the fruit lengths, fruit breadths, fruit juice volume and fruit weights decrease in the infected fruits as compared to the healthy ones in both the varieties. Maximum decrease in fruit lengths and fruit breadths by 20.23% and 20.8% were observed in case of the infected or inoculated fruits of susceptible variety in comparison to the resistant one. But the peel thickness and rag present in the fruits were found to get increased, where 50% increase in peel thickness and 51.99% increase in the rag present were observed in the case of susceptible variety which is more than in the resistant one where this increase was only by 40.62%.

The alterations in the growth and development or quality parameters what we have studied here, clearly indicate that the infection of ICRSV caused the alterations in metabolism of the plant which directly affect the growth and development of the fruits. Susceptible variety was always shown up with the greater alterations as compared to the resistant one, owing to the fact that resistant variety has quite lesser impact of ICRSV infection in comparison to the susceptible variety. The poor growth and quality of virus infected fruits may be due to the hindered normal transports and alterations in membrane.
permeability of the cytoplasm so the fruits may not receive proper nourishment which is essential for their proper growth and development. Virus utilizes host proteins for its replication and makes the plant undernourished, causing poor growth of fruits. Growth and development of fruits may also be affected by growth hormones which become sub-optimal in the diseased plants. So this could be the possible explanations about the degraded quality of Kinnow fruits due to ICRSV infection.

Control measures

Virus control is one of the main prerequisite for the improvement of fruit production, yields and fruit quality. Prevention is the very important measure regarding virus control as no methods are known for the treatment of infected trees under regular production conditions. Such curative measures may include meristem culture, micrografting, production and use of healthy initial planting material, prevention of virus spread by early detection of pathogen or in fact multiple pathogens by reducing time, labor and costs, use of resistant and tolerant fruit tree cultivars and biological controls.

Healthy planting material implies the highest quality and is produced for the fruit tree cultivars and rootstocks. The production of such material passes through certain rigorous tests like serological analyses and indicator plants. Serological analyses are used specifically to diagnose virus infected plants. Antisera are usually prepared for the virus and analysis is done through techniques like agar-gel diffusion test, ISEM (immunosorbent electron microscopy) and ELISA (enzyme linked immunosorbent assay) techniques. Indicator plants are used because of their unique and quick characteristic reactions to the particular virus for the diagnosis of causative virus present in the mother plant. For the early detection of viruses, initially, primers and taqMan probes for the viruses by singleplex realtime (q) reverse transcription (RT)-PCR. Further optimization of this method included the development of a multiplex (m) RT-qPCR assay to detect simultaneously more than one virus in a single reaction. These RT-qPCR assays proved to be 100 and 1000 times more sensitive than conventional RT-PCR. Thus, providing a valuable alternative tool for detection for the viruses (Giuliana Loconsole, et. al., 2010).

Prevention of the spread of the virus in orchard may be achieved by establishing new plantation spatially isolated from infected ones. Then, all new plantations should be monitored regularly and infected trees should be destroyed immediately.

Use of tolerant and resistant cultivars also plays a vital role in producing virus free fruit trees. Besides these, there are some other biological controls like cross protection, vegetative protection and creation of genetic resistance, where genetic resistance can be created by introducing the viral coat protein gene and potentially other viral genes into the genome of the host plants by genetic engineering techniques to obtain transgenic plants.

REFERENCES
