Cucurbita Viruses; Preventative Strategy

Zeraim Gdera’s Carnival of New Tomatoes in Brazil
Dear family of customers

This newsletter focuses on cucurbits. Our company is very well known worldwide for its excellent tomato and pepper varieties and less for its watermelon, melon, squash and cucumber varieties. The reason for this is that we sell our pepper and tomato varieties in many markets, while we focus our cucurbit portfolio on a narrower market. Our seedless watermelon varieties are very well known in North America and our cucumbers in the Middle East. Our melon and squash programs are now maturing and we plan to introduce the new varieties into the relevant markets this year.

In order to speed-up the expansion of our cucurbit portfolio, we have decided to increase our investment in breeding and product development. One of our long-term strategic targets is to offer you a much wider range of innovative varieties.

I hope you enjoy this newsletter. Please do not hesitate to ask our agronomists for any additional information.

Yours,

Ohad Zuckerman
President & CEO

From the editor’s desk

The topic of global warming is contrapositing. But if we put aside any doubts and consider the doomsday prophets correct, we will have to stop all actions and start thinking about our future. Assume that temperatures are heating up; fossil fuels are mainly to blame and that, if not corrected quickly, terrible results will follow.

More importantly, consider global warming’s impact on agriculture. How, with highly unpredictable weather, will farmers grow crops? How will insects and diseases react?

With the beginning of a planting season for many farmers around the globe, this seventh issue of Seasons & Tastes will give you a glance of Zeraim Gedera’s TYLCV tomatoes in Brazil and Egypt and introduce you to the grafted Cucurbits to modern agriculture. Moreover, this issue will give you the state of the art methods to deal with viruses attacking Cucurbit’s crops.

Seasons & Taste editorial board would like to take this opportunity and wish you a successful growing season.

Yours Sincerely,

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www.zeraimgedera.com
Dominator - one of our new range of tomato varieties, a result of collaboration between Agristar and Zeraim Gedera, has led to solutions for some of the problems faced by tomato growers in Brazil.

According to Ceagesp (Government Institute for the distribution of fresh vegetables), Brazilian per capita tomato consumption is 6.3 kilos per year and is expected to rise. Jim Udsen, CEO of Agristar, claims that the most commonly used vegetables in Brazil are the tomato and the onion. Brazil, which is located in the heart of a tropical region, has two seasons per year, a dry and a wet one. All tomatoes are grown in open fields using indeterminate varieties trellised on bamboo stakes. Under such conditions of high temperature and humidity, disease causing bacteria thrive causing extensive damage and loss of yield. The main disease factor (Xanthomonas Campestris) causes the bacterial spot, but the position of other pathogens such as viruses and fungi is not controlled. The whitefly-transmitted geminivirus is becoming the primary cause of damage to crops and yields. The Brazilian geminivirus are related but distinct from TYLCV, which was not yet reported in the country. Zeraim Gedera and Agristar professional staff, attentive to farmers around Brazil, collaborate to offer Brazilian farmers suitable solutions to the problems they are facing: the need for bacterial and geminivirus tolerance, and resistance to other pathogens, nematodes, Fusarium and others, as well as the need for fruit that meet with the transportation conditions and market requirements. The first ray of hope came with the Giovanna variety which reached the shelves in 2005 and provides an answer for the quality, color and firmness of the fruit, as well as bacterial tolerance. The Giovanna has taken over a growing sector of the market, but does not provide an appropriate solution for the geminivirus. This is a complex of virus that is found in over 50% of the tomato growing areas. In order to give the Brazilian farmers a fitting solution without harming yields, Agristar and Zeraim Gedera’s breeders, together with tomato breeders from the Faculty of Agriculture in Rehovot, studied several large tomato varieties in Brazil under local climatic conditions, exposed to a range of pathogens. During this study, several varieties stood out, the first being Dominador. Its tolerance to Brazilian geminivirus, high yield, firm fruit, excellent color and long shelf life are a breakthrough in the Brazilian tomato market. The local farmers understood the advantages and benefits that they gained from these varieties, especially their ability for coping better with the problems in the field and reducing the need for pesticides and increasing their crop yield. Furthermore, the variety was sent for testing by researchers at the Brazilian government research institute, Embrapa (the results of these test are included at the end of this article) and it was found to be more tolerant to Brazilian geminivirus than the other varieties tested. Similar to the Dominador, farmers successfully tried two other varieties which are tolerant to bacteria and TYLCV and produce high yields and good quality, firm, bright red fruit.

**FACING THE FUTURE IN BRAZIL**

With the focus on tomato growers and consumers in the food chain stores, Zeraim Gedera and Agristar continue collaborating to find further solutions which will give the grower, the chain supplying the product and the consumer additional benefits against the problems that they face, while constantly improving. Both Companies will continue to place emphasis on the quality of the fruit and its taste.

Good Luck.

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**EVALUATION OF THE HYBRIDS OF AGRISTAR / 2007**

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Collaboration between Zeraim Gedera and Technogreen has led to a solution for Tomato Yellow Leaf Curl Virus (TYLCV) for tomato growers in Egypt

Ayham Azaiza
Tomato Product Manager / ayhama@zeraim.com

ABOUT THE TYLCV DISEASE
The TYLCV disease which is caused by a virus transmitted by whitefly is considered one of the most severe tomato crop diseases worldwide. Yield losses of the disease can be extensive and may reach 100% in some areas. In Egypt, the average loss often ranges between 60-100%.

Regardless of the fact that there are several chemical pesticides available which are intended to reduce the whitefly population in tomato fields, there are three major negative aspects to the pest control using chemicals: in open field crops, the plants are exposed to a new wave of whitefly every day requiring frequent and costly treatments. Another minus is, the pesticide residue that remains on the produce arriving at the markets and, in many cases, the chemical pesticides are not sufficiently effective. Genetic tolerance to disease is the best and easiest solution for the farmers and safer and healthier for the consumers.

TYLCV resistant development program with the Faculty of Agriculture in Israel, led to successful new varieties
The tomato development team at the Faculty of Agriculture in Rehovot headed by Prof. Nachum Keidar and Prof. Haim Rabinowitz began, at Zeraim Gedera’s request, a breeding program for TYLCV tolerant tomatoes. Part of this broad scale program deals with the development of determinate varieties suitable for growing in open fields without trellising.

This program which at the beginning was headed by Shai Leviatov the current Zeraim Gedera tomato development manager and is today headed by Raviv Ozeri, focuses on the development of new high yielding varieties that include properties such as high TYLCV tolerance, high fruit setting capacity in hot temperatures and superior quality fruit.

The key target market chosen for the program is Egypt. Egypt, with a population of over 70 million, is one of the largest potential markets for open field tomatoes in the world. The produce is primarily for supplying the local market with a small amount for export mainly to the Arabian Peninsula and Gulf countries.

With the introduction of the Soave variety to the Egyptian farmers, which achieved very positive responses and widespread distribution because of its high tolerance to the TYLCV virus, robust growth and excellent quality fruit, Zeraim Gedera set new standards for the tomato market in Egypt and today we are considered one of the leading Companies in this field. However the breeding program does not rest on its laurels and we are witness to significant expansion over the past two years in the number of new varieties selected by Technogreen* and Zeraim Gedera professionals and by the leading farmers in various regions in Egypt.

In addition to the successes of the tomato market in Egypt, the significant outcome of the program has gained much success in many other Middle East countries and in Turkey (for example, tomato Dante in Turkey). As a result of its successes in these countries, Zeraim Gedera plans to expand its activities within these countries in this basic but extremely important market.
By a lucky coincidence, as I flew to León, Mexico, for the International Tomato Congress in July, I sat right by a friend I had met at the 2006 Tomato Congress. His Company produces cherry tomatoes on-the-vine in 400 hectares of greenhouses in Jalisco, Mexico for export to the U.S. The entire 2-1/2 hours in the air we spent talking about only one subject - tomatoes - seemed like only a few minutes.

There has never been a more interesting, dynamic, or exciting time for the fresh tomato industry, and about one thousand people gathered with us for three days of discussion about the King of the Vegetables.

This group gathered from near and far, from every state in Mexico, from Canada, from Argentina, and from almost everywhere in between. It was a fine place to gather - in Mexico, where the tomato was first domesticated more than a thousand years ago, and in León, the geographic belly-button of the Western Hemisphere.

For the consumer who loves tomatoes, these are great times, and they’re getting better. More and more consumers in North America are being converted into tomato lovers every day, as the quality and variety of fresh tomatoes grows.

The current work of seed Companies and geneticists deserves a lot of the credit for that. Rather than focusing their breeding efforts overwhelmingly on high yield, as they once did, they are now also paying great attention to developing tasty tomatoes that consumers will love. Now, consumers have incredible choices in color, flavor, size and shape for healthful, delicious tomatoes.

Consumers also know that eating tomatoes has great health benefits, because of the tomato's high levels of vitamin-C, potassium, and lycopene. "Lycopene" is now a common word that’s apt to pop up in casual conversation, and most people know that tomatoes are the richest source of lycopene and that it promotes a healthy heart and a healthy prostate and can prevent certain kinds of cancer.

One of the fascinating chapters in the colorful history of the tomato happened in 1893, when the tomato was the subject of a Supreme Court case in the United States. At that time, the U.S. charged a duty on all imported vegetables, and one importer challenged the tariff’s application to tomatoes, arguing that the tomato is a fruit, not a vegetable. The venerable Supreme Court justices decided that, although the tomato may be a fruit botanically, its common culinary use made it a vegetable. Today, the flavor and sweetness of newer varieties of tomatoes are irresistible. Some varieties can now even reach 9 brix of sweetness, which almost qualifies the tomato as a dessert.

Today’s demands for food safety are uncompromising. So are the demands for high quality and constant availability.

It's no wonder consumption and trade in tomatoes in the world is growing so rapidly. Consumers are grabbing tomatoes named for fruits: cherry, grape, and strawberry - they’re grabbing red, orange, and yellow ones... even the "Ugly" tomato! Last year, the value of the trade in fresh tomatoes between Mexico, the U.S. and Canada reached a new record value of more than $1.5 billion. The U.S., which now imports 1/3 of the fresh tomatoes it consumes, is the world’s biggest...
hectares of “protected” tomato production (including greenhouses and shade structures), is accounting for most of the growth in supply.

As could be predicted, the increasing supply of greenhouse-grown tomatoes is placing downward pressure on prices, and that may continue as greenhouse tomato production expands. So, only the best, most efficient greenhouse producers should be expected to thrive. Those with ideal conditions – good light, ideal day and night temperatures, good water, low pest pressures, and close proximity to their market – have a big advantage.

Per capita tomato consumption in the U.S. has grown from 15 to 20 pounds in only the last fifteen years. With the new sweet, tasty, colorful varieties now being developed, tomato consumption should continue to grow in North America. So will the opportunities – and the challenges – for tomato producers.

To take best advantage of the great opportunities that are continuing to grow in the business of fresh tomatoes, it’s now more important than ever to be well informed about the current developments and improvements in the production and marketing of tomatoes.

For that reason, it was a great pleasure for our Latin American team at Meister Media Worldwide to welcome all of the people who attended the Second International Tomato Congress.

For all of us at the Tomato Congress, the conferences, the panels, the exhibition, and the great conversations and new friendships expanded our knowledge and our ideas about the King of the Vegetables.

(Next year’s International Tomato Congress will take place July 23-25, 2008, in León, Guanajuato, Mexico. For information go to www.thetomatocongress.com)
Zeraim Gedera Aims to Create A MARKET PULL on its Products Through the Fresh Produce Industry

Interview with Gerry Kelman / Former Global VIM Manager
Gerry@zeraim.com

America's Changing Appetite: Food Consumption and Spending to 2020

Written by: Noel Blisard, Biing-Han Lin, John Cromartie and Nicole Ballenger. With permission of Biing-Han Lin, one of the authors.

America’s appetite, like its population, is always changing. Foods once favored are now rarely eaten. Foods once only dreamed about are a reality.

Increased food spending driven by population growth is just one way consumers will shape the future of the US food system. The research was also designed to understand how shift in the demographic profile of the projected US population in 2020 will effect what people will eat and how much they will spend, where people will eat, and what product characteristics will command the consumer’s food dollar.

Shift in Age Distribution Dominate Demographic Effects
Interestingly, the expenditure model results suggest that regional population distribution changes will have virtually no effect on per capita food expenditures over the next 20 years.

By 2020, away-from-home food expenditures are expected to increase almost 10% on a per capita basis due to income growth alone.

By 2020, per capita expenditures for at-home food influenced by income growth will likely shift somewhat in favor of fruit (up 4.2%) miscellaneous prepared foods (up 3.8%) and vegetables (up 3.3%).

Educational Attainment Enhances Dietary Knowledge
Increases in education level reinforce the shift in consumption expected to occur with income growth. More years of schooling enhances consumer awareness and knowledge of diet and health issues, which favors consumption of some foods over others. The effect of increased education levels is projected to increase consumption of fruit and vegetables.
After a number of years, what does Zeraim Gedera have to show for all this effort?

We need to understand that much patience is required. Working relationships and business partnerships with fresh produce Companies are built-up over a long period of time and mutual trust (the key element in such relationships) doesn’t materialize overnight. This is particularly true when we refer to relationships that do not have the basic buying/selling element as their cementing factor.

We must never forget that, although it is “Genetics” that creates the value to the industry, the cost of the seeds themselves is but a very small proportion of the total cost in producing the resulting fresh produce. Zeraim Gedera’s VIM approach is aimed at creating a market pull on its products through the Fresh Produce industry. Zeraim Gedera is aiming to find an appropriate formula by which it can participate in the revenues of its Produce Business Partners as a return on the added value that the Company contributes. There are encouraging signs that the Fresh Produce industry is willing to pay for such added value, understanding that only a strong and continuous R&D effort will bring innovative products to the marketplace. Having said that, we can quantify areas where our VIM efforts have brought about an increase in the quantities of seed purchased, and the introduction of new varieties has resulted from “market pull” from the Fresh Produce industry.

What is the main message that you are passing-on to your successor, Roy Avnery?

There are, I believe, two ideas/motivations in Zeraim Gedera behind the development of VIM, one major, the other minor...

The major motivation is to find a way in which Zeraim Gedera, as a vegetable variety breeding Company which has invested literally millions of US$ in developing varieties, can be adequately rewarded for the time and money expended. Even the very highest seed prices to the grower in no way represent the true value of the seed in the context of its contribution to the final product. At the same time, it will be counterproductive for very high seed prices to “squeeze” the grower while our aim is for other links in the supply chain to pay their contribution to our breeding investment.

The minor, but nevertheless important, idea behind VIM is to develop an additional and parallel channel for seed market development, directly leading both to added seed sales, through ‘market pull’ from the consumer end of the fresh produce chain and also to shortening “time-to-market”. This is “additional and parallel” to a Seed Company’s traditional “market push” to the growers.

* Our next Seasons & Tastes will give you a wider glance at our VIM activities around the globe.
Zeraim Gedera’s Cucurbit Breeding Team

FACING THE FUTURE

Gadi Leibovitch
Cucurbit Team Manager / Gadi@zeraim.com

As part of our strategic outlook, which perceives R&D investment as an important tool for providing our customers with reliable professional solutions, Zeraim Gedera has expanded its research and development in the Cucurbits sector.

Reinforcing professional know-how
In recent years the Company’s research and development department has focused on learning new issues relating to genetic tolerance to diseases in the Cucurbit genus. Furthermore, we have found numerous ways to improve the selection and development processes, which are aimed at cutting the time involved in product development. We hope that the know-how and experience we are accumulating in these processes will enable us to improve the quality of our products as well as the quality of the support we offer to all our customers in the fresh vegetable supply chain.

R&D expansion worldwide
The Cucurbits programs are currently being expanded with development activities worldwide. Hence for the Beit Alpha cucumber variety we focus mainly on the activities of the Turkish market while strengthening our cooperation and improving cucumber development collaboration with Toros Company (Zeraim Gedera’s sole distributor in Turkey). This matter is professionally managed by Omri Sever, Zeraim Gedera’s cucumber breeder who has made much progress. The Company is expanding its Slicer cucumber and Zucchini development program in Mexico.

Zeraim Gedera’s Summary of Cucurbits for 2007 Spring-Summer Season

WATERMELON
Our key market is NAFTA. Our main market segment large watermelon (8-10 kg). Following our trials all through the seasons, we are about to launch several new products for the early season, both in Mexico and the United States. In addition, for the main season, we will be launching the Super Crisp 32 variety which is also suitable for the early season. The second market segment is the Personal Watermelon. Along with Petit Treat, we have another two new products that focus on fruit size (1-2 kg), with more than 8 fruit per plant. Our new products have excellent qualities such as taste, sugar content, texture and deep red flesh. Both market segments have three pattern types: Crimson, Tiger strip and Dark rind.

Gad Avisar
Cucurbit Product Manager gad@zeraim.com

Petit Crisp
Zeraim Gedera’s Zucchini breeder, Erika Debreczeni, has been given the task of leading the program opposite the Mexican team and we anticipate significant progress during 2008. We are continuing our diverse watermelon activities in North America. We have expanded our know-how and understanding of product profiles and market trends. The contact between our team in the United States, Meir Peretz, Tomi Beth Shappington and Woody Speir, has created an excellent atmosphere for promoting development activities and customer relations. Emanuel Cohen’s determination as the leader and promoter of the watermelon breeding activities should also be mentioned.

In the melon project, which is one of four Cucurbits crops being promoted by Zeraim Gedera, the focus is on the operations in Spain, Brazil and Costa Rica. While learning about the movement of produce in the export markets we came to the conclusion that the greatest efforts in export melon production takes place in these countries. From the fruitful cooperation with the Company’s product department, we learned much about the product profiles for these countries, from the aspect of production and their consumer requirements along the entire supply chain. We expanded the scope of trials of varieties in these markets with strong and fruitful professional cooperation between the local teams and partners. Our melon breeder, Amir Lerer, has developed a good relationship with our local partners and is continuing with the creative momentum.

New employees were recruited during 2007
Roi Cohen, who holds a BA degree in Biotechnology and Environmental Sciences from Tel Hai College in Israel, serves as assistant watermelon developer and Motti Soloman, who holds a BA degree in Plant Protection from the Faculty of Agricultural in Rehovot, has joined the technical team of the Company’s Cucurbits department.

In addition, at the beginning of 2007 Liora Lipschitz joined the staff as backup for the melon development project. Liora’s previous experience as a fundamental pepper and cucumber person contributes greatly to improving and reinforcing the development activities.

Strengthening the relationships between the breeders and the local teams in the target countries, as well as the fruitful and deep contact between the team of breeders and the product management staff at Zeraim Gedera enables faster and more precise progress in the process of breeding new products.

**SQUASH**

Our main target in the dark green Zucchini market is to introduce our new products which will include a range of virus tolerances including powdery mildew. Our new products will offer early ripening with high concentrated yield.

**CUCUMBER**

Our cucumber products are spread in a few markets: Turkey - We have launched the Kafka. Mexico - we are expanding our portfolio of the Beit Alfa variety to all seasons with higher yield and better fruit quality. The Slicer market - we are about to introduce new products which can challenge the commercial varieties grown today. Our new products have strong plants combined with short internodes, very dark fruit, high yield and high fruit firmness and crispness.
CUCURBITA VIRUSES; Preventative Strategy

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The roots of the squash family go as far back as the beginning of human civilization. Melon and watermelon seeds found in the tombs of ancient Egyptian Pharaohs indicate that this family of fruits was part of the diet of the blue-blooded royals who ruled Egypt 5000 years ago. Melons and cucumbers were found in many parts of Africa and were an important source of nourishment for the African farmers. The Cucurbita (squash) sector is financially significant and it constitutes one third of the vegetable production in Israel.

Viruses are extremely sophisticated pathogens which infect plants, in much the same way as they do humans and animals, with incurable illnesses. The high frequency of viral diseases in squash can be explained by various factors:

1. The domestication process that squash varieties have endured for thousands of years has exposed them to an evolutionary line with multiple viral pathogens. The development process focuses on the removal of bitter, highly toxic substances which act as strong repellents for insects and other plant eaters. These processes cause many plants of this genus to become excellent hosts for insects such as the tobacco whitely and aphids.

2. Squashes are usually grown in Israel in the spring and autumn when the insect populations are extremely high.

3. Many wild plants can serve as natural hosts for viral diseases and in Israel; for example, some plants serve as carriers of several important viruses that attack squirting cucumber (Ecbalium elaterium).

4. Transferring some of the squash crops from open fields into greenhouses has led to squash crops being grown continuously throughout the entire year, as opposed to the past when they were traditionally grown as summer crops.

The list of viruses which attack squash crops in Israel includes 14 different viruses and the methods of reducing the damage they cause depends on how they spread. Plant viruses are usually spread by groups of insects known as vectors. Aphids are an important vector for viruses which can be indiscriminately spread by various winged species of aphids. This important group of non persistent viruses includes potyviruses which attack a wide range of host plants of the squash family. These include: Zucchini yellow mosaic virus (ZYMV), Zucchini yellow fleck virus (ZYMV), Papaya ringspot virus (PRSV) and Cucumber mosaic virus (CMV), which can severely harm Cucurbita varieties. Another important vector which harms the squash family is the sweet potato whitely (Bemisia tabaci). The dramatic rise in the whitely population in Israel and worldwide has led to an outbreak of viral diseases caused by geminiviruses and other groups of viruses. This group includes several viruses such as Watermelon chlorotic stunt virus (WmCMV), Squash leaf curl virus (SLCV), Cucurbit yellowing stunt disorder virus (CYSDV) and Cucumber vein yellowing virus (CVVV).

The shift towards monoculture and intensive greenhouse farming has significantly increased the dispersion of soil borne viruses like Melon necrotic spot virus (MNSV) which severely harms melons and watermelons. MNSV and Cucumber leaf spot virus (CLSv) which attacks cucumbers are spread by fungal zoospores which cling to the roots of the plants and introduce the virus into the root tissue. Another category of soil and water born viruses are Tobamo virus species which penetrate into the plant tissue via wounds in the roots or...
leaves caused by mechanical damage during planting and ongoing treatment. This group includes the following viruses: Cucumber green mottle virus (CGMMV) and Cucumber fruit mosaic virus (CFMMV) which has spread widely in greenhouse grown cucumbers in recent years.

The harmonious assimilation of viruses into the basic molecular mechanism of the cells does not allow chemical treatment for curing the diseases and therefore the strategy is to minimize damage from these pathogens by preventative means. There are several methods for preventing viral disease in open fields, including:

1. Spraying with mineral oils intended to protect squash varieties from non persistent viruses such as ZYMV and PRSV, which could cause severe damage. The active mechanism of the oil has not been comprehensively interpreted, but the assumption is that the aphid which lands on the sprayed leaf changes its feeding behavior in a way that lowers the efficiency of virus transmission.

2. Covering the soil with reflective or colored polyethylene film. We have found that covering the soil with silver or yellow polyethylene film reduces the number of insects which land on the plants grown on the soil mulches. The reflection of light from the soil cover reduces the contrast of the plant against the ground in which it is growing and decreases the insect’s ability to recognize the plant and land on it. The use of such film delays infection and in many cases reduces the damage to the crop. For example, zucchini grown on yellow polyethylene film protects effectively them against SLCV geminivirus.

3. Using physical barriers prevents contact between the insect and the plant, thus preventing infestation. Using Agryl films as row cover for low tunnels or as floating cover can effectively protect against the spread of whitefly vectored viruses such as CYSDV and SLGV and prevent the spread of non persistent viruses, such as ZYMV and PRSV.

4. Development of tolerant varieties is the ideal solution for dealing with viral diseases, but here there is still room for much improvement due to the shortage of effective tolerant sources and the time required until a tolerant product is achieved.

Most agricultural produce has been moved from open fields into greenhouses. Dealing with diseases and viruses in greenhouses requires specialized solutions which are adapted to greenhouse technologies. The use of UV absorbing polyethylene film has been thoroughly researched and developed in our laboratory over the past decade. The protection effect provided by this method is based on the ‘double compartment effect’. A greenhouse with its roof covered with a UV-absorbing polyethylene filters the UV rays and form a UV-deficient compartment within the greenhouse, while the external environment around the greenhouse becomes a compartment rich in this radiation. Insects are attracted to the UV rich compartment, so that the flight of the insects flying towards the walls of the structure is diverted to the external environment, significantly reducing their penetration. The use of this method must be combined with covering the walls with 50 mesh netting which serves as a mechanical barrier against the penetration of pests.

We have recently developed an effective method for preventing the spread of the soil borne tobamo viruses within greenhouses. This type of protection can be achieved by planting the seedlings in holes containing virus free growing medium such as perlite, tuff or compost. Soil born viral diseases can also be prevented by using plants grafted onto disease resistant rootstock. For example, watermelon seedlings grafted on MNSV tolerant pumpkin rootstock are efficiently protected from MNSV a virus that once caused severe crop damage and which has almost disappeared since the use of grafted watermelon seedlings has become widespread.

From the historic perspective of decades, we can say that there has been perceptible penetration of new viral pathogens. At the same time research has focused on the development of new solutions which improve the ability to deal with groups of viral pathogens. The future goal of virology research is to reinforce the know-how relating to the relationship between the viral pathogens and the host plant, and the vector responsible for spreading it. Based on this know-how, we will be able to improve the means for sustainable interaction directed at coping with viral diseases without harming the quality of the environment. Another goal that we should present is expanding the use of resistance to viral pathogens. Together with conventional development programs, we must continue examining and developing genetic engineering technologies which will increase shored-up resistibility and shorten development processes.
Introducing Grafted Cucurbits to Modern Agriculture – The Israeli Experience

Amnon Koren / Head of Field Service, Hishtil Ltd.

Grafted vegetables have been cultivated in eastern Asia for decades, but their adoption in the western world has only begun since the banning of the fumigant methyl bromide in 2005 by the Montreal Protocol.

The primary motive for using grafted plants is to avoid damage caused by soilborne pests and pathogens in situations in which genetic or chemical approaches for disease management are not available. Grafting a susceptible scion onto a resistant rootstock provides a resistant plant. Grafting plants allows for a more rapid response to the appearance of new races of a pathogen. In addition, grafted plants may contribute to enhanced tolerance to abiotic stresses, more efficient water and nutrient use, and improved fruit yield and quality.

Intra- and Interspecific Grafting

Suppression of soilborne pathogens can be achieved by grafting susceptible scions onto resistant rootstocks of the same species (intra specific grafting) or on a close member of the same botanical family (inter specific grafting).

In tomatoes, for example, large collection of tomato rootstocks is available. These stocks contain different genes for resistance to fungal pathogens, viruses, and nematodes; thus intra specific grafting is very common. In melons, however, resistant muskmelons or Cucurbita rootstocks are used for different purposes. Intra specific grafting is mainly used to avoid damage caused by wilt pathogens such as Fusarium oxysporum f. sp. melonis for which resistance genes exist in certain melon varieties.

The possibility of using melon rootstocks for reducing Monosporascus wilt damage was studied in order to avoid undesirable effects of the Cucurbita rootstock on fruit quality. Although there are muskmelon accessions with differing levels of quantitative resistance to the disease that may serve as rootstocks, it has not been possible to obtain grafted plants with reliable resistance under a variety of environmental conditions. In fact, for suppression of root and stem rot diseases for which dependable resistance is not available in melons, only Cucurbita rootstocks provide the required nonspecific resistance. Intra- and inter specific grafting have their own beneficial and detrimental characteristics as to phytopathological and horticultural behavior. Cucurbita rootstocks provide nonspecific but efficient protection against a wide range of soilborne pathogens and against some abiotic stresses, but such rootstocks may in certain cases affect fruit size and quality. On the other hand, susceptible muskmelons grafted onto resistant muskmelons have fewer horticultural problems related to scion-rootstock compatibility, but their resistance is often limited to one or a few pathogens, or even to a specific race of one pathogen.

RESPONSE OF GRAFTED CUCURBITS TO NEMATODES

Genetic resistance to root-knot nematodes, Meloidogyne spp., is not present in commercial cucurbits. However, cucurbit accessions that are less susceptible to these nematodes are being used as rootstocks in Korea. In a study conducted in southern California, susceptible mel-ons grafted on Cucumis and Cucurbita stocks had lower gall ratings and higher shoot weights compared with non grafted melons, but the final galls observed were similar in both grafted and non grafted plants. Grafting prevented growth reduction and lowered the buildup of nematode populations, and it was concluded that grafting made the plants tolerant but not resistant to nematodes.

The lack of rootstocks possessing dependable resistance to root-knot nematodes can endanger the use of grafted plants in heavily infested soils. The current status is not satisfactory, and progress should be made to improve the resistance of Cucurbita and other cucurbit rootstocks to nema-
todes; however, detailed knowledge is currently lacking on issues such as host range of different nematode species, levels of susceptibility among various cucurbits, relationship between root infection and damage in grafted plants, and mode of resistance. In greenhouse experiments, we evaluated the response of Cucurbita accessions to Meloidogyne javanica. Differences in susceptibility were found, and two Cucurbita breeding lines out of the 23 tested did not produce any galls (R. Cohen and Y. Oka, unpublished). Interestingly, galls on the roots of the susceptible Cucurbita lines were much smaller than those on susceptible muskmelons, watermelons, and cucumbers that were tested as additional control plants. These results indicate that it might be possible to breed Cucurbita rootstocks that will be resistant or at least less susceptible to root-knot nematodes.

**PHYSIOLOGICAL AND ABIOTIC STRESSES**

Tolerance to salinity and boron. Agricultural production in arid and semiarid regions such as Israel relies heavily on irrigation. The water resources in these regions are scarce; thus the use of marginal water sources (saline water and treated sewage effluent) for irrigation is increasing.

Fernandez-Garcia et al. showed that under saline conditions, the Cl− and Na+ uptakes of grafted tomato were significantly lower than those of non-grafted plants, indicating that the former plants had higher salinity tolerance than the latter. Likewise, Romero et al. compared the effects of salinity on two varieties of grafted muskmelon. They found that the grafted muskmelons were more tolerant to salinity than the non-grafted ones; they suggested that grafted plants developed various mechanisms to prevent the physiological damage caused by excessive accumulation of Cl− and Na+ in the leaves, including exclusion of Cl− and/or reduction of Cl− absorption by the roots. Similar results were found in experiments conducted in the Negev Heights of southern Israel: grafted watermelons were more tolerant to irrigation with saline water than non-grafted plants (Fig. 7). Grafted plants might also be more tolerant to excessive boron concentrations than non-grafted ones.

Boron is a trace element that is essential to plant growth, but it can be toxic to plants when its concentration in the soil solution exceeds a certain value. The combined effects of boron and salinity on the growth and yield of grafted and non-grafted muskmelon plants were reported recently. The grafted plants accumulated less boron than the non-grafted ones and were less damaged when exposed to similar boron concentrations (Fig. 8). It was suggested that the Cucurbita rootstock excluded some boron, consequently decreasing the boron concentration in the scion of the grafted plants. Both plant types absorbed less boron when irrigated with water containing higher salt concentrations. The fruit yield of grafted plants was less affected by boron accumulation in the leaves than that of non-grafted plants. The low boron uptake under high salinity irrigation was considered to be mainly a result of reduced transpiration of the plants. Increasing water salinity decreased the sensitivity of both plant types to increases in leaf boron concentration, which indicates that the effects of boron and salinity on muskmelon plants were not additive. The increased use of marginal water in agriculture in Israel and in other regions that suffer from water shortage may lead to the use of grafted plants for this purpose as well.

**ROOTSTOCK-SCION INTERACTION**

As grafting is a composite of two different plants, the interaction may confer other beneficial or negative effects besides those relative to soilborne pathogens. In the Arava Valley of southern Israel, growers prefer growing trellised melon plants because this procedure saves labor, increases yields, and makes pesticide applications easier and more effective. Trellised muskmelon plants are pruned to one main branch that bears three or four fruits, compared with one to two fruits per prostrate plant. In experiments conducted in disease-free soil pretreated with methyl bromide, trellised grafted muskmelons collapsed when they were loaded with fruit, in contrast to those grown prostrate which matured properly (R. Cohen, unpublished). Fruit load subjects the plants to a progressive increase of water stress, and it seems that when grown trellised the grafted plants cannot cope with this demand. Plant collapse was evident only in a hot climate, whereas in cooler weather, in which the water demand was lower, trellised grafted plants survived. In addition to their greater fruit load, trellised plants are exposed to solar radiation from all directions, whereas in prostrate plants radiation is intercepted only in their upper canopy, while the lower leaves and fruits are shaded. Preliminary results of our research indicate that besides water, the auxin balance between the scion and the rootstock is involved in this physiological collapse. Similar alterations in growth regulators were seen with cucumber plants grafted onto squash roots. The grafted cucumber plants bore no female flowers, whereas the control plants developed female flowers above the second node. Another but different effect of the rootstock on the scion was a result of reduced radiation to the carmine spider mite Tetranychus cinnabarinus that was found in a Lagenaria accession and transferred to some of the scions grafted onto it. Grafting the susceptible Cucurbita cv. Brava onto the Lagenaria rootstock increased the resistance of the scion to the same level as that of the nongrafted Lagenaria rootstock, but grafting the susceptible Cucumis melo cv. Noy Yizre’el onto the resistant Lagenaria did not affect its susceptibility to mites.

The use of grafted vegetables will likely become more common as a replacement for soil fumigation as a means for managing soilborne diseases.
Light and Radiation

Total Radiation = visible radiation + invisible radiation. Visible radiation is within the 400-700 nanometer wavelength range.

Radiation necessary for photosynthesis is within the visible radiation spectrum. This radiation is called photoactive radiation (PAR) and is measured in microeinsteins/m²/sec.

The above graph of the visible light spectrum compares the human eye's response to visible radiation, as measured in footcandles (lumens/m²), to PAR light, measured by a quantum meter in microeinsteins (microeinsteins/m²/second). As the growers need to know the amount of PAR light available for photosynthesis, quantum meters are used to provide measurements in microeinsteins.

As can be seen in the two graphs below, the light used in photosynthesis is in the blue and orange-red light ranges. The top graph (A) displays the relative absorption spectra of the carotenoids, chlorophyll a and chlorophyll b pigments.

The bottom graph (B) shows their relative effectiveness in photosynthesis.

At the Light Saturation Point (LSP) increased exposure to PAR light produces no further photosynthesis, which translates into no further positive impact on crop yield. However, each plant strain has been found to have its own specific LSP.

Zeraim Gedera cultivates varieties of peppers in the Negev and Arava regions in Israel, areas with abundant natural radiation. As a result, the pepper varieties developed by Zeraim Gedera have a higher LSP than other strains and are able to utilize high levels of PAR light, leading to a greater crop yield.
Hollow Heart

Hollow heart is a problem most likely to occur early in the season and when conditions alternate between wet and dry soil and/or hot and cold temperatures. Crown set fruit and seedless watermelons are more susceptible to hollow heart. Good pollination is important in preventing this disorder, particularly in seedless watermelon. Too much nitrogen and/or excessive water, especially during fruit set, can encourage hollow heart and bland flavor.

Misshapen Fruit

These can result from drought, poor pollination or other developmental problems. Watermelon vines need to be inspected weekly to remove diseased or misshapen fruit. ‘Bad’ fruit should be thrown in the row middles to avoid inspecting them again. In watermelons, only two ‘good’ fruit will usually mature on a single plant, even in the small (‘icebox’) cultivars.

What Causes Misshapen (crooked) Fruit in Parthenocarpic Cucumbers?

The photo on the left shows crooked cucumbers. Crooked fruit in seedless cucumbers is usually a physiological disorder. The deformation begins early when the ovary of the fruit is less than 1.5cm long and remains misshapen throughout the development of the ovary into fruit. This is caused by:

- The interference of the growing ovary by other plant parts such as a leaf or stem. Severe curvature sometimes occurs when a flower petal becomes stuck on the spines of a leaf stem or another young fruit.

- Thrips and other insects feeding on one side of the young fruit and ovary.
- Adverse temperatures.
- Excessive soil moisture.
- Poor nutrition. An example of poor nutrition is the photo on the left showing nitrogen deficiency where the basal end is swollen and the distal or flower end is narrow.

Indoor Squash and Pollination

Indoor squash has mainly pistillate flowers and only a very limited amount of male flowers. Pollination is done by spraying the crown of the plant (the flower bud is in the head) with a hormone every 5-7 days. However, there are some growers that prefer spraying the stigma on the day of anthesis (the day the flower bud expands into an open flower). Never spray open flowers.

The hormone is based on the auxin indolacetic acid (IAA) and other derivatives of this acid. Some of the commercial products are called: fruton, agriton and proton. In general, the recommendations are 0.06% - 0.10% (6-10g in 10 liters of water. It is highly recommended to check the manufacturer’s recommendations.
Soberano

Roma type tomato

- Short internodes
- Resistance to F-3
- Firm fruit with shiny red color
- Indeterminate plant
- Uniform fruit size & shape
- High yield

<table>
<thead>
<tr>
<th>Weight [gr]</th>
<th>Diameter [mm]</th>
<th>Shape &amp; Color</th>
<th>Shoulders</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-130</td>
<td>45</td>
<td>Uniform</td>
<td>Medium</td>
<td>V, F-1, F-2, F-3, ToMV</td>
</tr>
</tbody>
</table>

Cultivation: Outdoor
Trellising: -
Cycle: Medium
Maturity: Medium
Planting Season: AU, SP

Godzilla

TSWV Tolerance & TM Resistance

- Very vigorous plant
- Good setting under high temperatures
- Very thick fruit walls
- Excellent shiny fruit color
- Grower friendly, extended planting seasons

<table>
<thead>
<tr>
<th>Weight [gr]</th>
<th>Diameter [mm]</th>
<th>Shape &amp; Color</th>
<th>Cultivation</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>200-250</td>
<td>100-130</td>
<td>Nethouse, greenhouse</td>
<td>Dutch, Spanish</td>
<td></td>
</tr>
</tbody>
</table>

Planting Season: Main season
Growing Season: AU, WI
Maturity: Medium
Resistance: TM 3 (L4), TSWV*
### Aurelius

**White Bush - clarita**

- High yield
- Very easy harvest
- High tolerance to PM
- Vigorous plant

<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>Diameter (mm)</th>
<th>Shape &amp; Color</th>
<th>Skin</th>
<th>Cultivation</th>
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</thead>
<tbody>
<tr>
<td>120-140</td>
<td>30</td>
<td>Slightly ribbed</td>
<td>Bush, Outdoor</td>
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</table>

<table>
<thead>
<tr>
<th>Tolerance</th>
<th>Maturity</th>
<th>Planting Season</th>
<th>Stem</th>
<th>Internode</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMV*</td>
<td>Early</td>
<td>AU, SP</td>
<td>Erect</td>
<td>Short</td>
</tr>
</tbody>
</table>

### Neptune

**Beit Alfa Type / Indoor Varieties**

- Vigorous plant
- High yield
- Very early maturity
- Uniform fruit size
- Fruit of top quality

<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>Diameter (mm)</th>
<th>Color</th>
<th>Skin/ Rind</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>160-180</td>
<td>25-35</td>
<td>Dark</td>
<td>Ribbed</td>
<td>PM*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cultivation</th>
<th>Maturity</th>
<th>Planting Season</th>
<th>Side Branches</th>
<th>No. of fruit per node</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouses/ Tunnels</td>
<td>Very early</td>
<td>WI</td>
<td>A few</td>
<td>1 to 2</td>
</tr>
</tbody>
</table>
DID U KNOW? The cucumber has existed for nearly ten thousand years and has its roots in Asia. An archaeological excavation near the border of Thailand and Myanmar unearthed evidence of cucumber cultivation dating back to 7750 BC. (source: http://www.scribd.com/doc/47502/cucumber-history)

Our Quarterly Recipe

TZATZIKI CUCUMBER & YOGURT SALAD

Ingredients (6 diners) >
- 2 cups of yoghurt
- Unpeeled cucumber, chopped
- Clove garlic, crushed
- 1 spoon of olive oil
- Juice of 1/2 lemon
- Salt

Preparation >
- Pour the ingredients into a bowl and mix.

Bon appetit.