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Set of elite New Israeli Mango Cultivars

The Israeli mango breeding project has been in progress for almost 40 years • This article does not describe all of the project's products, but rather focuses on the main mango cultivars developed under the project's auspices that have been registered at the Breeders' Rights Council and become commercial varieties in Israel and are now tested in several countries all over the world

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>> Introduction

The mango (*Mangifera indica L.*) is one of the most common tropical fruit trees in the world, with a worldwide yield of close to 40 million tonnes (Source: FAOSTAT, 2013). It is a dicotyledonous tree of the Anacardiaceae family, which includes some 35 species.

Israel is one of the northernmost countries to grow mangos on a commercial basis. The relatively low winter temperatures and the unstable weather typical of the spring, when flowering and fruit set occur, are not ideal for mango cultivation, and sometimes tree fertility is impaired. On the other hand, the hot, dry summer, during which the fruit matures, allows the cultivation of a high-quality fruit that is free from the diseases and blemishes that plague the fruit in tropical regions.

Mango was introduced to Israel during the early

20th century (mainly by the late prof. Hanan Oppenheimer), but turned into a crop only during the last 50 years. The industry was based mainly on three Floridian varieties, 'Tommy Atkins', which ripens early in the season and is colorful but its flesh is somewhat fibrous and sometimes of poor quality; 'Keitt', a green, overly large fruit, which ripens late and lacks flesh color; 'Kent', whose color and sometimes quality are problematical; and on 'Maya', a well-established Israeli cultivar, which is very tasty but has a particularly short shelf life, which necessitates daily harvesting of the ripe fruit and the use of air freight for exports.

In Israel, there are some 20,000 dunams (5,000 acres) of mangos. In the past, mango orchards were scattered around the Western Negev, the Arava and the Sharon, but nowadays most are concentrated in the Kinnerot Valley and the Beit



Shean Valley. The economic success of recent years has led to the planting of thousands of dunams of mangos in these areas and renewed interest in mangos in other areas of Israel. The annual yield is approximately 40,000 tones, 40% of which is for export, chiefly to Europe.

>> Breeding Project

Israel's unique conditions and the wish to become a lead player in the export of high-quality fruit to Europe led to the creation of the breeding project, in order to improve the Israeli mango and produce elite cultivars.

The goal of the Israeli breeding project is to produce a range of exclusive mango cultivars, with high quality fruit, an attractive appearance, a high level of fertility and a long shelf life. The cultivars must also be suited to the Israeli climate, meet market requirements and cater to the taste of the – primarily European – consumer. To achieve this goal, the project has focused on colorful fruits that have a delicate, sweet and sour taste and a pleasing aroma, are non-fibrous and of high interior and exterior quality. The project concentrates on developing exceptionally fine cultivars that are unique in shape, taste or color, and on a range of early- and late-ripening cultivars that will extend the marketing season. As a commercial breeding project, we also encourage the commercialization of the

cultivars abroad, while protecting the interests of Israeli growers.

The Israeli mango breeding project has been in progress for about 40 years. For most of this period, the project has been headed by Dr. **Eli Tomer** and Prof. **Uri Lavi**, both senior researchers at the Agricultural Research Organization.

In the past, most of the breeding plots were located in the Western Negev, but today, the trees are tested in plots at the Volcani Institute and in the central growing area in the Kinnerot Valley.

>> Outline of the Breeding Process

The program makes use of a broad genetic diversity and creates new combinations (usually via open pollination), in a process that involves selection of trees with appealing and tasty fruits that are worth testing as individual trees, their selection following grafting on commercial rootstocks and their further selection under semi-commercial and commercial conditions, in order to determine which of them should then be developed as new cultivars. The breeding process is a long task taking at least 15-20 years and several selection stages.

The project concentrates on the selection of attractive, colorful fruit with a delicate, sweet and sour taste, a pleasing aroma, non-fibrous texture and good quality, inside and out. These cultivars are also selected for a high level of fertility and a long shelf life. They are suited to the Israeli climate, meet market requirements and cater to the taste of western consumers. In addition, the project is developing a range of cultivars that mature throughout the summer and fall months, so as to extend the season during which Israel can market and export high quality fruit.

Over the years, the breeding project has produced almost ten high-quality cultivars, although not all of them have become



"The goal of the Israeli breeding project, launched more than 40 years ago, is to produce a range of exclusive mango cultivars, with high quality fruit and an attractive appearance, a high level of fertility and a long shelf life, which are suited to the Israeli climate, meet market requirements and cater to the taste of the – primarily European consumer"

popular in Israel. For instance, the 'Naomi' cultivar, which at one time was planted extensively, is no longer a commercial cultivar in Israel, although it is very common in Egypt, and 'Tango', which is a top-quality variety, with a distinctive shape and flavor, but rather small in size has not yet been planted on a commercial scale in Israel.

Below is a description of six Israeli cultivars developed by the breeding project, which have been registered over the last 15 years at the Breeders' Rights Council and are planted in orchards that extend over hundreds, if not thousands of dunams throughout Israel. Their success has attracted growing interest among mango growers in Israel and abroad. Some of the cultivars ripen early in the season while others ripen late they are all colorful, non-fibrous and very high in quality.

'Shelly'

'Shelly' is a seedling of the 'Tommy Atkins' cultivar. In the past, the male parent was identified as 'Keitt', but recent molecular analysis points to the possibility that the male parent is the 'Kent' cultivar (Sherman, Ofir, and Cohen, unpublished results). 'Shelly' is the oldest of the cultivars described here and has been planted extensively in Israel since the early 2000s. The rounded fruit is apple-shaped, medium-sized and on average, weighs about 500 g (between 350-700 g and sometimes even more). The fruit is fleshy and not fibrous. The peel is fairly delicate, which means that some aspects of the packing house treatment need to be adapted to prevent damage to the fruit. One of this cultivar's exceptional characteristics is its long shelf life: Tests have shown that mature fruit can survive a storage and shelf life period of up to 30 days at room temperature. Similarly, the mature fruit can remain on the tree

unharmed for several weeks, which means that high-quality ripe fruit can be picked selectively over a long period.

The 'Shelly' cultivar ripens fairly late in the season. In the Kinnerot Valley, it ripens in the second half of August and in September, and in Beit Dagan and the Western Negev, even later, in September and even October. 'Shelly's color develops early and the fruit can be ripened artificially after picking – both desirable characteristics. However, due to these properties, some growers are tempted to pick the fruit too early in the season, before it is really ready for harvesting, then ripen it artificially and market it, despite the low to mediocre quality obtained.

Orchards of 'Shelly' mangos stretch over approximately 2000 dunams in the Kinnerot Valley and Beit Shean Valley, and despite a reduction in other regions of Israel, it is one of the two main cultivars grown in the Central Arava. The tree's growth is restrained and its yield is high. A mature plot can produce a very high yield with an average annual yield of 4-4.5 tones/dunam.

'Omer'

The 'Omer' cultivar has been identified as a hybrid





'Tali' - fertile tree, with an impressive-looking fruit, very high in quality on the inside, juicy sweet-sour taste and pleasing aroma



seedling of the 'Zillate' cultivar, which was produced from open pollination. 'Omer' is a mid-season variety (in the Kinnerot Valley it ripens at the end of July-August) and has an oval shape, a delicate, sweet taste and a fleshy, fairly juicy texture. Some tasters report that its taste is reminiscent of pineapple. The fruit weighs around 450 g and has an attractive, very colorful skin of purple and bright red that usually covers most of its surface. The tree is fertile and yields on average approximately 3 tones/dunam.

'Omer' has several significant characteristics that make it particularly attractive to growers: The fruit tends to be uniform in size and durable on the packing-house conveyor belt and during shipping, which ensures a minimum level of losses during packing, export and marketing. These characteristics have made 'Omer' extremely attractive and sought after by European dealers and international companies, who hope to grow it in different countries all over the world. The goal is to make 'Omer' one of the leading varieties in Europe and to generate a continuous presence in chain stores for most of the year.

At present, this cultivar is grown on a commercial scale over an area of approximately 2000 dunams in the north of Israel. It has not yet been tested commercially in the dry, southern region of Israel.

'Noa'

'Noa' is the product of open pollination of the cultivar 'Shelly'. In its early years, it was defined as a late-ripening variety, but it seems that in most areas where it is grown it ripens shortly after mid-season. In the Kinnerot Valley it ripens mid-August.



'Shelly' – storage and shelf life of up to 30 days at room temperature

The fruit is relatively large, weighing around 650 g on average (between 480 and 810 g). It is a firm, impressive-looking fruit, with a long, oval shape, slightly curved, and with a blend of red, orange, yellow and green colors on its skin. It is similar in shape and size to the high-quality, late-ripening, green cultivar 'Keitt' and is sometimes referred to as 'Red Keitt'. One of 'Noa's advantages is the fact that it changes color as it ripens, which allows the consumer to easily ascertain whether the fruit is ripe and ready to be eaten. The fruit's interior and exterior quality is excellent and non-fibrous.

Within just a few years, more than 1000 dunams of 'Noa' have been planted in Israel. The average annual yield of this cultivar is 2.5-3 tones/dunam. However, we must take into consideration the fact that most of the trees in Israel were planted only five years ago and are relatively young and we are only just beginning to gather information about the cultivar's behavior in commercial orchards in different regions of cultivation.

'Tali'

'Tali' is the hybrid product of open pollination of the 'Maya' cultivar. It is heart-shaped, orange in color, with a broad red cheek. The tree is fertile and the fruit is very attractive. Its interior quality is very good, its taste is juicy and sweet-sour, and it has a pleasing aroma. The fruit from the Kinnerot Valley orchards weighs around 470 g. 'Tali' is an early fruit that matures in the first half of July. Like other early-ripening varieties, it is often picked and marketed too early. Several



growers promoted it particularly as an early-ripening variety, and hundreds of dunams of orchards were planted in the Kinnerot Valley.

'Orli'

'Orli' is the hybrid product of open pollination of the 'Tommy Atkins' cultivar. It ripens early in the season; in the conditions prevalent in the Kinnerot Valley it ripens at the beginning of July. It is an attractive fruit, spherical, like 'Shelly', and broad near the stipe. It is orange, yellow and bright red in color and has a sweet-sour taste and juicy, fleshy texture. The fruit weighs about 450 g (between 410-480 g). At present there are some 100 dunams of 'Orli' planted in the Kinnerot Valley region and it is recommended for commercial cultivation.

'Agam'

'Agam' is the hybrid product of open pollination of the 'Shelly' cultivar. It ripens at the beginning of the season. The fruit is very attractive and has a rounded, slightly oval shape. Its deep red and bright purple coloring usually covers the entire skin. The fruit has an exceptionally rich, sweet taste and a smooth, buttery texture. The



'Orli' – attractive fruit, orange, yellow and bright red in color, with a sweet-sour taste and a rich juicy, fleshy interior

Table:
Main characteristics of Israel mango cultivars (data relates to orchards in the Kinnerot Valley)

Cultivar	Planting area (dunams)	Shape	Color	Average weight (g)	Ripens
Shelly	2000	Round, apple-shaped	Orange with red cheeks	500	End of August, beginning of September
Omer	2000	Triangular, oval	Purple-red	450	End of July, beginning of August
Noa	1000	Long, curved	Blend of red, orange, yellow and green	650	Middle to end of August
Tali	100-150	Full, heart-shaped	Orange with red cheeks	470	Beginning to end of July
Orli	80	Round, spherical and broad near the stipe	Orange, yellow and red	450	Beginning to end of July
Agam	50	Rounded, slightly oval	Deep red-purple	350 in Betiha, 450 in Beit Dagan	Middle of July

flesh is bright orange and non-fibrous. Taste tests have defined 'Agam' as an especially tasty, high-quality fruit. Taste panels and European dealers who have tested this variety have always recommended the fruit.

'Agam' has been endorsed for many years for commercial planting, but despite its exceptional quality, the extent of planting has been limited and there are only a few dozen dunams of orchards. Two reasons for the limited number of orchards may be suggested: firstly, the tendency of growers to pick the fruit too early, before the full quality of the taste has developed, and secondly, the small size and low weight of the fruit growing in the Kinnerot Valley - a mere 350g.

It is significant that 'Agam' grows to a good size and a weight of 420-450 g in the breeding plots at Beit Dagan. It seems that the summer heat in the environs of the Kinneret stunts the fruit's growth. This phenomenon of stunted fruit growth in the Kinnerot Valley has been observed on other cultivars, such as the excellent 'Tango' variety. We believe that planting this cultivar at sea level and above at the edge of the Kinnerot Valley and in other areas of Israel, such as the Western Negev, will yield larger fruit. We hope that in the near future, this cultivar will be tested extensively in these areas and will take up its position as a top-quality Israeli variety.

Summary

The Israeli mango breeding project has brought about significant changes in the Israeli mango sector, and there's more to come. More than a third of mango orchards today are Israeli varieties developed in the Israeli mango breeding program and their fruit is highly sought after in the European markets. The range

of cultivars has expanded and the development of early-ripening cultivars allows the season to be lengthened. Plans for the future include the development of even better cultivars, and especially additional cultivars for the beginning and end of the season – top quality early-ripening fruit for the beginning of the summer, as well as late-ripening, colorful fruit that will replace the green 'Keitt' cultivar and extend the season into the fall months, in order to help growers compete on the European export market.

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