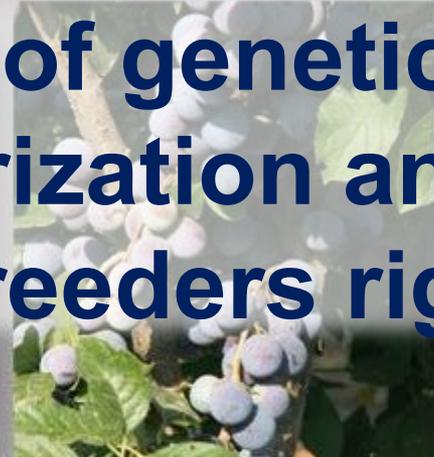




Improvement of new fruit tree cultivars and usage of genetic markers for characterization and maintenance of plant breeders rights



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New improved deciduous fruit cultivars raise the difficulty of rights protection

- ❖ Our unit at Neve Ya'ar Research Center, ARO improves new deciduous cultivars such as pomegranate, almond and apricot
- ❖ 5 new pomegranate, 6 new apricot and 5 new almond cultivars were released. Five of these are now the main cultivars grown in Israel
- ❖ All are registered for Plant Breeder's Rights in Israel and some in other countries such as USA and Europe

How can we protect these rights by molecular methods?



A glimpse at this subject complexity

Two examples are given in this lecture to demonstrate portion of the complexity of molecular usage in cultivar protection

- ❖ SNP and SSR markers for pomegranate
- ❖ Genetic mapping in almond



Molecular technology is used for both: -
Improvement (is now a routine)

Protection - in progress and there are achievements



Pomegranate cv Emek

- ❖ In order to improve pomegranates while using local varieties, a selection was made in seedlings of the Israeli variety Akko. Male parent was unknown
- ❖ Emek cv is very early, sweet, dark red to pink, red arils, soft seeds, big, productive

350 SNP markers were established for the Newe Ya'ar pomegranate collection





Marker
Variety
Rosh Hapered
Akko
Emek

C14142_724	XX	XX	XX	XX	XX
C12440_1530	XX	XX	XX	XX	XX
C6041_1303	XX	XX	XX	XX	XX
C11619_335	XX	XX	XX	XX	XX
C1726_1378	XY	XY	XY	XY	XY
C7865_2329	XX	XX	XX	XX	XX
C10369_2411	YY	YY	YY	YY	YY
C4224_1348	XX	XX	XX	XX	XX
C6910_924	XX	XX	XX	XX	XX
C1256_273	XX	XX	XX	XX	XX
C11577_177	XX	XX	XX	XX	XX
C11387_159	YY	YY	YY	YY	YY
C8153_128	XX	XX	XX	XX	XX
C11701_918	XY	XY	XY	XY	XY
C7632_502	XX	XX	XX	XX	XX
C714_1341	YY	YY	YY	YY	YY
C1374_478	XX	XX	XX	XX	XX
C6289_1362	XX	XX	XX	XX	XX
C7290_615	XX	XX	XX	XX	XX
C15128_598	XX	XX	XX	XX	XX
C7133_526	YY	YY	YY	YY	YY
C7443_1488	YY	YY	YY	YY	YY
C8035_1576	YY	YY	YY	YY	YY
C4817_294	XX	XX	XX	XX	XX
C1126_1142	XY	XY	XY	XY	XY
C6587_1777	YY	YY	YY	YY	YY
C10907_695	XX	XX	XX	XX	XX
C8325_1133	YY	YY	YY	YY	YY
C1480_1142	XY	XY	XY	XY	XY
C1486_614	XX	XX	XX	XX	XX
C1058_338	XX	XX	XX	XX	XX
C1352_532	XX	XX	XX	XX	XX
C4477_976	YY	YY	YY	YY	YY
C6892_319	XX	XX	XX	XX	XX
C1726_1001	YY	YY	YY	YY	YY
C10355_1043	YY	YY	YY	YY	YY
C2233_226	XX	XX	XX	XX	XX
C240_714	XY	XY	XY	XY	XY
C614_1380	YY	YY	YY	YY	YY
C1102_216	YY	YY	YY	YY	YY
C1465_630	XX	XX	XX	XX	XX
C10200_337	XX	XX	XX	XX	XX
C7634_62	XY	XY	XY	XY	XY
C521_173	XX	XX	XX	XX	XX
C15733_979	XX	XX	XX	XX	XX
C436_764	YY	YY	YY	YY	YY
C11295_543	XX	XX	XX	XX	XX
C692_286	YY	YY	YY	YY	YY
C1053_610	YY	YY	YY	YY	YY
C3720_828	XX	XX	XX	XX	XX
C1465_1571	XX	XX	XX	XX	XX
C1170_807	XX	XX	XX	XX	XX
C1817_815	XY	XY	XY	XY	XY
C3780_779	YY	YY	YY	YY	YY
C377_813	XY	XY	XY	XY	XY
C9527_466	YY	YY	YY	YY	YY
C204_515	XX	XX	XX	XX	XX
C1804_237	XX	XX	XX	XX	XX
C1313_484	XX	XX	XX	XX	XX
C6047_146	XX	XX	XX	XX	XX
C1123_1676	YY	YY	YY	YY	YY
C4569_780	XX	XX	XX	XX	XX
C720_1460	XX	XX	XX	XX	XX
C7888_929	XX	XX	XX	XX	XX
C12392_658	XY	XY	XY	XY	XY
C6956_2314	XX	XX	XX	XX	XX
C469_846	YY	YY	YY	YY	YY
C1070_930	XX	XX	XX	XX	XX
C4610_1191	XX	XX	XX	XX	XX
C1106_1411	YY	YY	YY	YY	YY
C8650_1025	YY	YY	YY	YY	YY
C9544_1132	XX	XX	XX	XX	XX
C7928_442	XX	XX	XX	XX	XX
C7507_1510	XY	XY	XY	XY	XY
C5985_624	XX	XX	XX	XX	XX
C10334_815	XY	XY	XY	XY	XY
C1915_2110	XX	XX	XX	XX	XX
C1518_1280	YY	YY	YY	YY	YY
C1074_731	YY	YY	YY	YY	YY
C762_566	XX	XX	XX	XX	XX
C6059_322	YY	YY	YY	YY	YY
C9902_550	XX	XX	XX	XX	XX
C4267_402	YY	YY	YY	YY	YY
C8054_507	XX	XX	XX	XX	XX
C5980_2216	YY	YY	YY	YY	YY
C8005_661	YY	YY	YY	YY	YY
C6943_338	XY	XY	XY	XY	XY
C1023_419	XX	XX	XX	XX	XX
C11971_187	XX	XX	XX	XX	XX
C7604_1208	YY	YY	YY	YY	YY
C9320_2238	XY	XY	XY	XY	XY
C8915_2218	XX	XX	XX	XX	XX
C4838_1448	YY	YY	YY	YY	YY
C12799_423	XY	XY	XY	XY	XY
C4472_579	YY	YY	YY	YY	YY
C9528_492	YY	YY	YY	YY	YY
C7494_879	YY	YY	YY	YY	YY
C10132_271	XY	XY	XY	XY	XY
C6486_247	XX	XX	XX	XX	XX
C6684_1047	XX	XX	XX	XX	XX
C4974_573	YY	YY	YY	YY	YY
C19923_1166	XY	XY	XY	XY	XY

The SNPs revealed that Rosh Hapered is the pollen donor

Today there are 5000 SNP markers that contribute to the accuracy of the identification of a cultivar



SSR for pomegranate identification

Variety	SC28915	SC7483	sc106926	16196
Akko	236/230	268/270	252/252	133/133
Shani-Yonay	236/236	268/270		133/133
Emek	236/236	270/270	248/252	133/139
Rosh Hapered 1	236	270	248	
Rosh Hapered 2	236	270	248	

- ❖ This varieties have many common characteristics
- ❖ Just 4 SSRs can differentiate them

more SNP markers will allow better identification

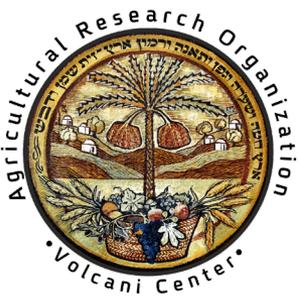


Almond cv Matan

- ❖ Using the local variety Um ElFahem and a self fertile cultivar we selected cv Matan
- ❖ Almond improvement objectives are: self fertile, large attractive kernel, good taste, high yields, balanced tree structure, suitable for hot climate
- ❖ Matan cv holds all these traits!

Self fertility *Sf* allele was used for gene assisted selection but is not enough for cultivar protection





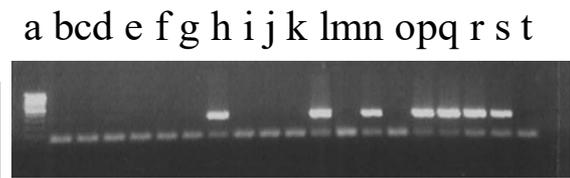
Breeding process of cv Matan

Self compatible almond cultivar (*Sf* allele)

High quality local old almond cultivar ('Um ElFahem')

Crossbreeding

PCR identification of *Sf* allele in F1



Planting only *Sf* positive seedlings

Selection for high quality cultivars

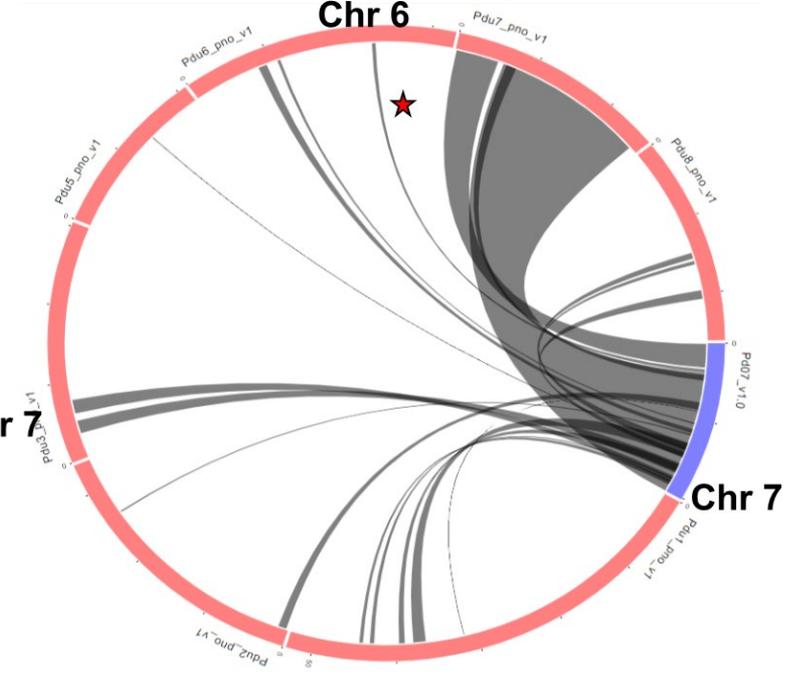
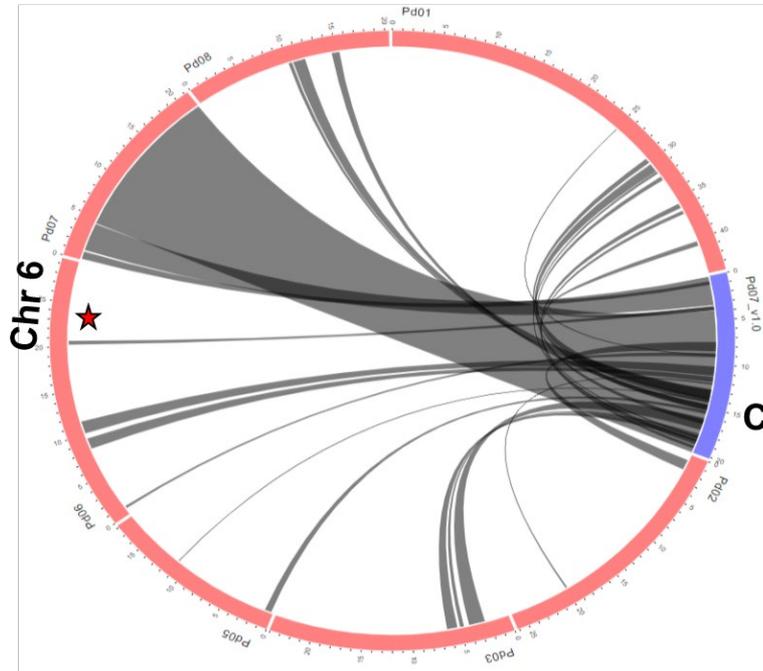
Commercial usage



Major structural genomic variation between almond cultivars

Texas

Nonpareil



Variance among cultivars is challenging the usage of genetic markers and necessitates *de novo* genomic sequencing