‘Mountain Bebe’: Hybrid Grape Tomato and Its Parents NC 7 Grape and NC 8 Grape

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‘Mountain Bebe’ is the F₁ hybrid of NC 7 Grape × NC 8 Grape. It is resistant to late blight (*Ph-2* and *Ph-3* genes), tomato spotted wilt virus (*Sw-5* gene), and fusarium wilt races 2 and 3 (*I-2* and *I-3* genes). The hybrid has a compact, indeterminate growth habit with short internodes (*br* gene). It has total soluble solids equal to ‘Mountain Honey’ with dark red fruits of ≈11.7 g per fruit.

Origin

‘Mountain Bebe’ (tested as NC10259) is the F₁ hybrid of NC 07310(x)-14-1-20 (released as NC 7 Grape breeding line) × NC08135(x)-8W-15-15 (released as NC 8 Grape breeding line, Fig. 1). It was developed to incorporate the *Ph-3* gene for late blight resistance into a hybrid similar to ‘Mountain Honey’. ‘Mountain Bebe’ has the *I-2*, *I-3*, *Ph-2*, *Ph-3*, and *Sw-5* genes for resistance to fusarium wilt, late blight, and tomato spotted wilt virus, respectively. The female parent, NC 7 Grape, contributes the *I-3* and *Sw-5* genes whereas the male parent, NC 8 Grape, contributes late blight (*Ph-2* and *Ph-3* genes) resistance. It has a compact, indeterminate growth habit and short internodes conferred by brachytic (*br*) gene. It has uniform green fruits conferred by the *u* gene, weighing ≈11.7 g per fruit. The fruits are dark red (*og^c* gene heterozygous), long ovate, and sweet, with a crisp texture. In replicated trials in 2012 through 2017, it was one of the best-performing entries for marketable yield and one of the most preferred tomatoes by tomato growers and seed company representatives.

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compared with NC 4 Grape, and NC 8 Grape was selected to combine the *Ph-2* and *Ph-3* genes, which were segregating in the 08135-selfed progeny leading to its development.

Description

‘Mountain Bebe’ was compared in replicated field trials with ‘Mountain Honey’, ‘Mountain Vineyard’, and ‘Smarty’, which are superior grape tomato hybrids released from our program and grown commercially in different parts of the country. When averaged over six trials with three replications each at Mountain Horticultural Crops Research and Extension Center (MHCRC) in field trials in the summer seasons of 2012 to 2017, ‘Mountain Bebe’ had significantly higher total and marketable yields than ‘Mountain Vineyard’. However, it did not differ from ‘Mountain Honey’ and ‘Smarty’ in total and marketable yields. Percent marketable yield, average fruit size, and total soluble solids (TSS) did not differ among the four hybrids (Table 1).

‘Mountain Bebe’ has a vigorous vine with compact, indeterminate growth habit resulting from the recessive brachytic (*br*) gene present in both parents, and plants are shorter in height than ‘Smarty’. Foliage provides adequate coverage for fruit protection. Plant screening for late blight resistance under field conditions with heavy natural inoculum pressure verified that ‘Mountain Bebe’ has a high level of resistance to late blight (Fig. 2).

Fruits of ‘Mountain Bebe’ develop a deep red color and are firm in the fully ripened stage. Immature fruits have a glossy, uniform green color (*u* gene). Fruit pedicels are jointed. The fruits are long ovate and have good resistance to fruit cracking and bursting despite high TSS levels. ‘Mountain Bebe’ has performed extremely well in numerous observational trials in research stations and grower fields. The flavor of ‘Mountain Bebe’ has been rated excellent in subjective taste evaluations in research station plots and grower trial plots.

NC 7 Grape combines the single dominant genes *I-2* and *I-3* for resistance to fusarium wilt races 2 and 3 and the *Sw-5* gene for tomato spotted wilt virus resistance. It has a compact, indeterminate

This is the first known F₁ hybrid grape tomato cultivar to combine several important disease resistances, including enhanced late blight, fusarium wilt races 2 and 3, and tomato spotted wilt virus. The combined disease resistances allow even organic growers, who have limited approved chemical pesticides, to control important diseases, especially late blight. ‘Mountain Bebe’, which is very similar to ‘Mountain Honey’, is an improvement for late blight resistance by combining *Ph-2* and *Ph-3* genes (Panthee and Gardner, 2013a). ‘Mountain Honey’ has the *Ph-2* gene for late blight resistance but lacks the *Ph-3* gene, which gives superior late blight resistance over cultivars with *Ph-2* only.

NC 7 Grape is a sister line of NC 4 Grape, which was released earlier and used as the parent of ‘Mountain Honey’ and ‘Mountain Vineyard’. A detailed pedigree of NC 4 Grape has been published (Panthee and Gardner, 2013a; Panthee and Gardner, 2013b).

NC 8 Grape is a sister line of the NC 6 Grape, which was released as a parent of ‘Mountain Honey’. The pedigree of NC 6 Grape has been published (Panthee and Gardner, 2013a). Single plant selections for NC 7 Grape and NC 8 Grape were made during the F₄ generation with earlier generations of the two lines that are the same as those for NC 4 Grape and NC 6 Grape, which are the parents of ‘Mountain Honey’. NC 7 Grape was selected for superior horticultural traits

Fig. 1. Pedigree of ‘Mountain Bebe’ (NC10259) hybrid and its parent NC 7 Grape and NC 8 Grape tomato breeding lines. This pedigree is the abbreviated form of ‘Mountain Honey’, which was previously published (Panthee and Gardner, 2013a).

Table 1. Overall performance (average of combined data) of grape hybrid ‘Mountain Bebe’ (NC10259) using NC 7 Grape and NC 8 Grape as parents in replicated trials at Mountain Horticultural Crops Research and Extension Center at Mills River, NC, from 2012 to 2017.

Genotype	Total yield (t/ha)	Marketable yield (t/ha)	Marketable (%)	Fruit wt (g/fruit)	TSS (%)	Disease resistance
Mountain Vineyard	52.9	46.6	88.2	11.3	6.8	F1, F2, F3, S, V
Mountain Honey	55.7	50.7	91.0	10.9	6.8	F1, F2, F3, S, LB (Ph2), V
Mountain Bebe	62.3	57.5	92.3	11.6	6.6	F1, F2, F3, S, LB (Ph2, Ph3), V
Smarty	58.2	53.9	92.6	10.9	6.8	F1, F2, rin, V
LSD (0.05)	9.5	7.6	NS	NS	NS	

F1, F2, F3 = fusarium wilt races 1, 2, and 3; LB = late blight; *rin* = ripening inhibitor gene; S = tomato spotted wilt virus (Sw-5 gene); V = verticillium wilt race 1; LSD = least significant difference.

growth habit resulting from the brachytic (*br*) gene. Compared with NC 4 Grape, NC 7 Grape is more compact in growth habit. This allows for developing compact growth-habit cultivars, which are easier and more economical to grow with shorter stakes than tall-growing cultivars.

NC 7 Grape has the crimson (*og^c*) gene for increased red fruit color and high lycopene content (Table 2). Because the *og^c* gene is recessive, the other parent in F₁ hybrids must have the *og^c* gene for the trait to be expressed in the hybrid. NC 7 Grape has an average fruit weight of 11 g, with 6% TSS,

equivalent to the NC 4 Grape. As a result of the NC 7 Grape tomato line being heterozygous for the *ms-10* gene linked to the anthocyanin absent (*aa*) gene, 25% of plants grown from seed of NC 7 Grape have green stems instead of the normal purple stem. Saving only the green stem plants at transplanting of the seedlings results in 90% of the plants at flowering being homozygous for the recessive *ms-10* male sterility trait and not requiring emasculation when used as the female parent in crosses to make F₁ hybrid seed. The sterile plants can be easily identified at the flowering stage by

the reduced anther size, extended style, and absence of pollen grains.

The NC 8 Grape tomato breeding line has a vigorous plant with a desirable, compact, indeterminate growth habit conditioned by the brachytic (*br*) gene for short internodes. Fruit of NC 8 Grape tomato have an average weight of ≈15 g. They develop a deep red color, are crisp in texture, and are firm during the fully ripened stage. Immature fruits have a glossy, uniform, light green color (*u* gene). Fruit pedicels are jointed. The fruits are ovate and have good resistance to fruit cracking and bursting despite high TSS levels. The flavor of NC 8 Grape has been rated excellent in subjective taste evaluations because of its high sugar (8.3%) level. NC 8 Grape has resistance to late blight (*Ph-2* and *Ph-3*), as verified by molecular markers closely linked to the resistance gene and based on greenhouse experiments and field evaluations in 2009, when late blight was severe. NC 8 Grape is the first known breeding line of grape tomato with the *Ph-2* and *Ph-3* genes combined for late blight resistance and verticillium wilt race 1, and possibly *I* and *I-2* genes for resistance to races 1 and 2 of fusarium wilt. This is the main improvement over NC 6 Grape.

Uses

The presence of the *I-2*, *I-3*, *Ph-2*, *Ph-3*, and *Sw-5* genes for resistance to fusarium wilt race 3, late blight, and tomato spotted wilt virus, respectively, were verified by molecular markers tightly linked to the resistance genes (data not shown). These combi-

Fig. 2. Screening of tomato hybrids for late blight resistance under field conditions at Mountain Research Station, Waynesville, NC, in Summer 2017. Late blight disease was scored on a scale of 0 to 5, where 0 = no disease, 1 = 1% to 20% plants covered with the disease, 2 = 21% to 40% plants covered with the disease, 3 = 41% to 60% plants covered with the disease, 4 = 61% to 80% plants covered with the disease, and 5 = 81% to 100% plants covered with the disease or plant completely dead.

Table 2. Summary of fruit quality of grape breeding lines based on Spring 2018. Observations were made based on the IPGRI Tomato Descriptor (IPGRI, 1996). There were no variations in the fruit pedicel joint loss (present), plant growth type (intermediate), internode length (short), and fruit color (red) among all the breeding lines.

Genotype	Crimson	Foliage color	Foliage density	Ribbing at calyx end	Fruit shape	Fruit size	Days to maturity	TSS (%)	Fruit wt (g)	Lycopene
NC 4 Grape	Present	Dark green	Intermediate/sparse	Weak	Heart-shaped/high-rounded	Very small	119/115	5.4	10.0	484
NC 6 Grape	Absent	Light green	Intermediate	Very weak	Heart-shaped	Very small	119	8.3	16.0	—
NC 7 Grape	Present	Dark green	Intermediate/sparse	Weak	Rounded/high-rounded	Small	110/119	5.7	11.0	456
NC 8 Grape	Absent	Light green	Dense	Weak	Heart-shaped	Very small	108	8.1	15.0	—

nations, along with yield, desirable plant growth habit, and good fruit quality make 'Mountain Bebe' unique.

NC 7 Grape and NC 8 Grape have desirable combinations of plant, fruit, and disease resistances, which make them useful as parents for developing F₁ hybrids and for further breeding to develop new grape tomato breeding lines.

Availability

We plan to license 'Mountain Bebe' to a private seed company on an exclusive basis

for seed production and sales. The date of first commercial seed sales is unknown. Distribution of seed of NC 7 Grape and NC 8 Grape to other breeders requires a signed material transfer agreement (MTA), which can be downloaded at the following website address: <http://www.mountainhort.ncsu.edu/programs/tomato/releases/tomato-seed-transfer-agreement.pdf>. Small trial samples of 'Mountain Bebe' are available from D.R. Panthee (dilip_panthee@ncsu.edu), MHCREC, 455 Research Drive, Mills River, NC 28759.

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