RKVL-318, a Root-knot Nematode-resistant Watermelon Line as Rootstock for Grafted Watermelon

Judy A. Thies¹, Amnon Levi, and Jennifer J. Ariss

U.S. Department of Agriculture, Agricultural Research Service, U.S. Vegetable Laboratory, 2700 Savannah Highway, Charleston, SC 29414-5334

Richard L. Hassell

Coastal Research and Education Center, Clemson University, 2700 Savannah Highway, Charleston, SC 29414-5334

Additional index words. *Citrullus lanatus* var. *citroides*, *Meloidogyne incognita*, watermelon breeding

The Agriculture Research Service, U.S. Department of Agriculture, announces the release of ‘RKVL-318’, a novel germplasm line useful as a rootstock and as a genetic resource for enhancing resistance to root-knot nematodes (RKNs) in watermelon cultivars. ‘RKVL-318’ is derived from the wild-type watermelon *Citrullus lanatus* (Thunb.) Matsum. et Nakai subsp. *lanatus* var. *citroides* (Bailey) Mansf. ex Greb. (*CLC*) that is indigenous to southern Africa. The ‘RKVL-318’ plants are resistant to the southern RKN (*Meloidogyne incognita*), peanut RKN (*Meloidogyne arenaria*), and Javanese RKN (*Meloidogyne javanica*). The watermelon plants grafted on ‘RKVL-318’ rootstock had considerable yield advantage over non-grafted watermelon plants in fields infested with RKN. ‘RKVL-318’ should be useful in breeding programs aiming to develop RKN-resistant rootstocks for grafted watermelon or to enhance RKN resistance in watermelon cultivars. ‘RKVL-318’ was developed at the USDA, ARS, U.S. Vegetable Laboratory, Charleston, SC, by Dr. Judy A. Thies, Research Plant Pathologist, and Dr. Amnon Levi, Research Plant Geneticist.

Origin

Development of ‘RKVL-318’ began in 1999 with greenhouse and field evaluations of the U.S. PI collection of *Citrullus* spp. for resistance to RKN. In the greenhouse study, 20 *CLC* PIs showed significantly higher RKN resistance compared with all other 400 *Citrullus* spp. PIs evaluated, including PIs representing cultivated [*C. lanatus* var. *lanatus* (*CLL*)] or desert-type watermelon [*C. colocynthis* (*CC*)] (Thies and Levi, 2003, 2007). These RKN-resistant *CLC* PIs

had 3% to 19% of the root system galled. In contrast, all of the *CC* and *CLL* PIs were highly susceptible to RKN with 73% to 100% and 32% to 100% galling, respectively. After these greenhouse observations, we selected the most resistant *CLC* PIs with 3% to 13% galling and performed additional greenhouse and field evaluations of these PIs during 2000 through 2011 (Thies et al., 2010). A single plant of PI482324 that exhibited high RKN resistance (6% galling) was self-pollinated. The most RKN-resistant plant was self-pollinated in the greenhouse in three successive generations to produce S4 seeds.

Table 1. Percentages of roots galled by *Meloidogyne incognita*, numbers of *M. incognita* eggs per gram fresh root, percentages of roots with fibrous roots, and watermelon fruit yields and numbers for ‘Tri-X 313’ seedless watermelon grafted on rootstocks of RKVL-318 wild watermelon rootstock, selected commercial rootstocks, and self-grafted and non-grafted ‘Tri-X 313’ watermelon, Charleston, SC, 2009 and 2010.

Rootstock accession	Response to root-knot nematodes			Yield	
	Percentages of roots galled ^a	Eggs per gram fresh root ^b	Percentages of roots with fibrous roots ^c	Total wt (kg/plot) ^w	No. of fruit/plot ^w
2009 field trial					
RKVL 318 (<i>Citrullus lanatus</i> var. <i>citroides</i>)	13 a ^v	16 a	87 c	29.5 e	12.0 d
Emphasis (<i>Lagenaria siceraria</i>)	86 d	835 c	33 b	17.2 d	7.0 bc
Strong Tosa (<i>Cucurbita moschata</i> × <i>Cucurbita maxima</i>)	99 e	3137 d	35 a	11.6 a	3.0 a
Tri-X 313 non-grafted (<i>C. lanatus</i> var. <i>lanatus</i>)	41 c	140 b	54 b	15.7 c	6.0 b
Tri-X 313 self-grafted	31 b	91 b	51 b	21.5 de	8.0 bc
2010 field trial					
RKVL 318	40 a	148 a	55 cd	19.9 a–e	3.0 bc
Emphasis	97 c	3950 c	66 d	7.2 ab	1.4 ab
Strong Tosa	96 c	2462 b	5 b	3.0 a	0.6 a
Tri-X 313 non-grafted	96 c	119 b	1 a	15.3 bc	2.8 b
Tri-X 313 self-grafted	76 b	188 c	30 c	20.0 cd	3.9 c

^aData were arcsine transformed before analysis; non-transformed data are shown.

^bData were log₁₀(x + 1) transformed before analysis; non-transformed data are shown.

^cRoot systems were rated on a 0% to 100% scale, where 100% = 100% of root system had fibrous roots and 0% = root system had no fibrous roots.

^wSix plants per plot (12 feet × 15 feet = ≈30 square feet per plant).

^vMeans within a column followed by the same letter are not significantly different ($P < 0.05$) according to Fisher’s protected least significant difference. Means are compared within each trial.

Reprinted with permission from Thies et al. (2015).

Description

Rootstock performance of ‘RKVL-318’ was compared with commercial rootstocks and with non-grafted triploid watermelon cultigens in replicated field trials (2009 and 2010) in which soils were heavily infested with RKN (Table 1) (Thies et al., 2015). ‘RKVL-318’ roots had significantly less root galling (mean = 26% of root system galled) than standard commercial rootstocks ‘Emphasis’ (mean = 91% galled) and ‘Strong Tosa’ (mean = 97% galled) and non-grafted ‘Tri-X 313’ (mean = 69% galled) (Fig. 1A and B). ‘RKVL-318’ root systems (used as rootstocks for ‘Tri-X 313’ seedless watermelon) produced significantly more ($P < 0.05$) fibrous roots (mean = 87% of root system was fibrous) than the commonly used commercial cucurbit rootstocks, including ‘Emphasis’ bottle gourd (*Lagenaria siceraria*) (mean = 22% fibrous roots), ‘Strong Tosa’ interspecific squash hybrid (*Cucurbita maxima* × *Cucurbita moschata*) (mean = 20% fibrous roots), or non-grafted control ‘Tri-X 313’ (mean = 42% fibrous roots). We have identified root fibrosity as a trait associated with RKN resistance in watermelon rootstocks. Overall, ‘RKVL-318’ rootstocks showed high graft compatibility with the triploid seedless ‘Tri-X 313’ scions and produced higher ($P < 0.05$) watermelon fruit yields than commercial cucurbit rootstocks (Yetisir et al., 2003). In fields infested with RKN, yields of ‘Tri-X 313’ seedless watermelon grafted on ‘RKVL-318’ rootstocks were an average 73% and 53% greater than ‘Strong Tosa’ and ‘Emphasis’ rootstocks,

Received for publication 15 Oct. 2012. Accepted for publication 8 Jan. 2014.

¹To whom reprint requests should be addressed; e-mail judy.thies@comcast.net.

Fig. 1. (A) Root-knot nematode-resistant RKVL 318 wild watermelon rootstock root system with very minimal root-knot nematode galling. (B) Root-knot nematode-susceptible 'Emphasis' bottle gourd rootstock root system with severe RKN galling. Charleston, SC, 2010.

respectively, and an average 55% greater than non-grafted 'Tri-X 313'.

'RKVL-318' has a runner growth habit with an intermediate leaf blade type. The 'RKVL-318' plants are andromonoecious, having male and hermaphrodite flowers. The fruits have an oblate shape with average fruit size of 20.9 × 18.0 cm. The rind color of

mature fruits is light green with darker green stripes, which have irregular margins; average rind thickness is 2.7 cm. The flesh color is light green to yellow with a firm texture and does not exhibit a hollow heart. 'RKVL-318' produced 1.3 fruits per plant (6.8 kg per fruit). Fruits are ready for harvest at 90 d post-planting. The seeds are moderately large and red in color.

'RKVL-318' should be useful for scientists and plant breeders interested in developing RKN-resistant watermelon rootstocks and/or in developing watermelon breeding lines or cultivars with enhanced RKN resistance.

Seed Availability

Small seed samples of 'RKVL-318' are available for distribution to interested research personnel and plant breeders. Written requests for seed should be submitted to Dr. Judy Thies, U.S. Vegetable Laboratory, 2700 Savannah Highway, Charleston, SC 29414-5334. Seed of 'RKVL-318' also will be submitted to the National Plant Germplasm System where it will be available for research purposes, including the development and commercialization of new cultivars. It is requested that appropriate acknowledgment of the source be given when this germplasm contributes to research or development of a new breeding line or cultivar.

Literature Cited

- Thies, J.A., J. Ariss, R. Hassell, S. Buckner, and A. Levi. 2015. Accessions of *Citrullus lanatus* var. *citroides* are valuable rootstocks for grafted watermelon in fields infested with root-knot nematodes. *HortScience* 50:4–8.
- Thies, J.A., J.J. Ariss, R.L. Hassell, S. Olson, C.S. Kousik, and A. Levi. 2010. Grafting for management of southern root-knot nematode, *Meloidogyne incognita*, in watermelon. *Plant Dis.* 94:1195–1199.
- Thies, J.A. and A. Levi. 2003. Resistance of watermelon germplasm to the peanut root-knot nematode. *HortScience* 38:1417–1421.
- Thies, J.A. and A. Levi. 2007. Characterization of watermelon (*Citrullus lanatus* var. *citroides*) germplasm for resistance to root-knot nematodes. *HortScience* 42:1530–1533.
- Yetisir, H., N. Sari, and S. Yucel. 2003. Rootstock resistance to fusarium wilt and effect on watermelon fruit yield and quality. *Phytoparasitica* 3:163–169.