

# Control Effect on Root-knot Nematodes by Hot Water Dipping Treatment in Kiwifruit

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## Abstract

*When kiwifruit root system infected with nematodes was treated by hot water dipping treatment, the maximum temperature for this treatment was suggested as 50°C. The lowest killing temperature of internal root-knot in the root tissue was 48°C. Consequently, root-knot nematodes could be killed without damaging root tissues by the hot water dipping treatment at 48°C for 10 minutes. This could be useful for organic production and distribution of kiwifruit seedlings by avoiding the synthetic nematicides which are not easily decomposed in soil once applied.*

## Introduction

There are 78 root-knot nematodes globally (Jepson 1987) and 6 species in Korea(Cho *et al.* 2000). Among them, northern root-knot nematode (*Meloidogyne hapla*, rkn) is one of the problematic rkns and kiwifruit is a favoured host plant of 51 host plants in Korea (Choi 2001). This rkn is easily found in major kiwifruit cultivation area in Korea (Ma 2008). One of the reasons for the wide spread of nematodes is attributed to the nursery infection where kiwifruit seedlings are raised in the nematode infected soil and distributed to individual farmers. Nevertheless, it is not easy to find nematode-free soil to raise seedlings. When kiwifruit root system was infected with nematodes the vigour of kiwifruit vine decrease (Ma *et al.* 2007) and the maturity and fruit size of kiwifruit were also influenced (Rodriguez 1987). Although some control methods are practiced in farming such as soil sterilization by solar heat and chemical nematicides (Dale and Mespel 1972, Sharma and Nene 1990), those can not be applied for organic farming system in open fields. Meanwhile, the seasonal occurrence of rkns in soil showed that rkn population started to increase at early spring and decrease during hot summer season (Ma 2008). Generally the optimum temperature for rkn reproduction is 15°C to 20°C and the maximum temperature for survival is 35°C (Wallace 1964). The hot

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temperature sensitivity of rkns can present new strategy to control nematodes (Sharma and Nene 1990).

## Materials and methods

Young kiwifruit seedlings (*Actinidia deliciosa* cv 'Hayward') were raised in the soil infected with rkns for 1 year. 1 year later, the root system of all kiwifruit seedlings (approximately 50 to 80cm tall in plant height, 1cm thick in shoot diameter at bottom) got infected with rkns. Each root systems developed about 200 to 1,000 root galls (avg. size 2mm in diameter). 30 kiwifruit seedlings were used for each treatment. Root systems were dipped in a big circulating hot water bath at each temperature for 5 or 10mins. After treatment, all the seedlings were replanted into a plastic pot with sterilized soil (sand media) because rkns are prosperous in more porous soil than clay (Wallace 1964). All pots were placed under shade net for 3 months to allow nematodes in the root galls to revive. 3 months later, the separation of nematodes from pot soil was performed by 'Sieve & Baermann funnel technique' (Southey 1986). The counting of nematodes was done under stereomicroscope (50 to 75X) after boiling nematodes-extracts in water bath at 80°C.

## Results and Discussion

Young kiwifruit seedlings did not survive of which root systems had been treated with over 52°C for 5 mins (Tab. 1). Partial root damage occurred at 50 to 51°C treatment. As a consequent, the critical condition for dipping treatment was 5mins' dipping at 50°C or below.

**Tab. 1: Growth characteristics of kiwifruit seedlings followed by hot water dipping treatment**

Temperature (°C)	Dipping time (mins)	Shoot length (cm)	Leaf size (cm)		Damage symptom of lateral roots
			Length	Width	
45	5	6.0 ab <sup>2</sup>	7.4	5.6	None
	10	9.8 a	7.5	6.3	None
50	5	4.6 ab	7.4	7.0	None
	10	3.7 ab	6.8	5.8	Partial browning
51	5	2.8 ab	5.2	5.0	Partial browning
	10	1.3 b	3.0	2.5	Partial browning
52	5	2.3 ab	7.3	4.8	Completely dead
	10	0.0 c	0.0	0.0	Completely dead
Control	-	8.1 a	7.9	5.8	None

<sup>2</sup>Duncan's multiple range test at 5% level. \*Growth at 90 days after water dipping treatment.

Although the gall number of root system and rkns were significantly were reduced by hot water dipping between 45°C and 47°C, there were escapes. At lower temperature,

rkn could not produce eggs so rkn might not reproduce in next generation (Westphal *et al.* 2002). Nonetheless, if it is considered that rkn has very short life cycle as about 40 days and the number of egg laid during 1 adult reaches up to 1,000 at a time (Taylor and Sasser 1978), small number of rkns' survival should not be allowed in nursery field. However, 10 mins at 48°C and over temperature did not show any galls in root system. The number of juvenile nematode of 2<sup>nd</sup> developmental stage was observed at 48°C for 5 mins but no nematodes was found at 48°C for 10mins dipping and over temperature as well (Tab. 2). From above, the hot water dipping temperature and time duration for complete killing of rkns within kiwifruit root tissue could be suggested as 48°C, 10mins at least and 50°C, 5mins at maximum considering root system damage by hot water dipping. This temperature range was slightly lower than that for grape root treatment (52°C, 5 mins) (Lear and Lider 1959). As known from the previous study (Wallace 1964), rkn is not easy to survive over 35°C, so, the critical factor can be the time duration following the temperature. In this study the set of time duration was only 5 and 10mins for each temperature set. Further study could be focused at the precise time duration at certain temperature at over 35°C because the lower the temperature, the less root tissue damage would occur.

**Tab. 2: Nematodes control effect of kiwifruit root tissue by hot water dipping treatment**

Temp. (°C)	Dipping time (mins)	Gall number per 1g root weight	Juveniles <i>Meloidogyne</i> number at 2 <sup>nd</sup> stage per 100 cm <sup>3</sup> soil
45	5	62.2 d <sup>z</sup>	168.9 f
	10	62.6 d	128.9 f
46	5	27.8 c	105.6 e
	10	22.5 c	14.4 d
47	5	8.6 b	7.8 c
	10	8.1 b	3.3 b
48	5	0.3 a	1.0 a
	10	0.0 a	0.0 a
49-60	5-10	0.0 a	0.0 a
Control	-	91.6 e	287.8 g

<sup>z</sup>Duncan's multiple range test at 5% level.

## Conclusions

In order to prevent the wide spread of rkns from kiwifruit nursery at the opening stage of kiwifruit orchard, hot water dipping of root system can be useful and effective. The optimal condition for this is recommended as 48°C for 10 mins. This may also reduce the use of chemical nematocides. Some synthetic nematocides are very long lasting in soil and toxic for human health such as fosthiazate, fenamiphos, oxamyl and cadusafos (Ma 2008). This dipping could help organic growers or newly starting their orchard organically with rkn-free health seedlings. For example, many nurseries use

nematocides of kiwifruit root system before selling seedlings so the seedling will be free of rkns. Some trading companies are using fumicides or similar nematocides for quarantine. For these purposes, hot water dipping can be useful tool as well as good for soil environment against chemicals.

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