# MANAGEMENT OF TOMATO RINGSPOT VIRUS IN RED RASPBERRY WITH CROP ROTATION.

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Tomato ringspot virus (ToRSV) is a problem in red raspberry production in southern Washington State and in the Willamette Valley of Oregon. Vigor declines after plants become infected with ToRSV. Infected plants often die in 4-5 years, while healthy plantings may remain productive for 20 years or more. Infected plants also have crumbly fruit, which greatly reduces the value of the crop. ToRSV first appears as isolated patches in the field which slowly expand as the nematode vector, *Xiphinema americanum,* is moved through the field. *X. americanum* rarely reaches population densities that cause direct damage. Growers usually fumigate the soil before planting raspberry in fields with histories of ToRSV, but the virus often reoccurs within 3-4 years in the new planting. A few viruliferous nematodes surviving below the depth of effective fumigation can migrate into the rhizoshpere and reinfect new raspberry plantings. An alternative approach to soil fumigation is to plant crops that are not hosts for the virus. This is a means to purge nematodes of ToRSV prior to planting raspberries. Nematodes feeding on roots of virus-free rotational crops lose the virus when they molt and the virus is not transmitted to eggs. The objective of this research was to evaluate rotational crops for the management of ToRSV as an alternative to soil fumigation.

In fall 1998, plots were established in 0.5 acres area of a raspberry field in Vancouver, WA that had plants symptomatic of ToRSV infection. The effects of five treatments on nematode population densities and ToRSV were evaluated during 18 months while treatments were made and for 36 months after replanting raspberries in the field. Treatments were the rotational crops *Brassica napus* ("Humus" rapeseed) and *Festuca arundinacea* (tall fescues) (both non-hosts for ToRSV), clean fallow, fumigation with methyl bromide, and controls that remained in raspberry. Experimental design was a randomized block with 5 replicates. Plots were 3 x 8 m and separated by 3 m alleyways planted with tall fescue. Raspberry plants in fallow and rotational crop plots were killed with glysophate in September and the plot area was plowed and tilled in October. Rotation crops were seeded on 22 October 1998. In the spring and fall of 1999, the *B. napus* plots were tilled and reseeded. For fumigation and control plots, raspberry plants were removed on 19 October 1999, and plots were plowed and tilled. On 15 November, methyl bromide 99.5% was injected into the soil at 15 cm at 100 g $m^2$ under a polyethylene film. Fallow plots were maintained weed-free with applications of glyphosate and hand cultivation. Crops were incorporated and all plots were tilled in May 2000. On 6 June 2000, ten "Meeker" raspberry plants were planted on 60 cm spacing in the plots. Weeds were controlled in raspberry rows and alleyways with application of herbicides and hand weeding during the study. Raspberry leaf samples were collected in each plot from October 2000 through July 2003. Soil was processed by a combination of a wet sieving and Baermann funnel method to collect and quantify population densities of *X. americanum.* Leaves were assayed for ToRSV with ELISA in the spring and fall during the last 36 months.

After 7 months of establishing rotational crops, population densities of *X. americanum* were greatest in grass plots and lowest in *B. napus* plots (Fig. 1), but differences were not significant ($P > 0.05$). After one year population densities were greater ($P > 0.05$) in grass and plots maintained in raspberries (control and fumigation plots) than in fallow or canola plots. Prior to planting raspberries in May 2000, densities remained high in grass and control plots, while densities were lowest in the plots fumigated with methyl bromide (< 1 nematode 250 g $^{-1}$ soil). After tilling the plots and planting raspberries in May 2000, population densities of *X. americanum* dropped dramatically and remained low through July 2003. As of July 2003, ToRSV was not detected in raspberry leaves collected in fumigated, fallowed, or plots planted with rotational crops, while 4 to 16% of the leaves collected in the control plots tested positive for ToRSV.

In summary, plots fumigated with methyl bromide had the lowest population densities of *X. americanum* at the time of replanting raspberries. *X. americanum* population declined to low densities after planting in all treatments and remained low through May 2003. ToRSV was not detected in raspberry leaves until three years after replanting raspberries and then only in the control treatments. The long period required for ToRSV to be detected may be a function of the very low population densities of viruliferous nematodes in the soil after planting and the time required for the virus to become systemic in the plant. Rotations with non-host of ToRSV and an extended period of weed-free fallow were as effective as fumigation with methyl bromide in preventing reinfection of raspberry plants with ToRSV for up to three years.

Fig. 1. Effect of rotational crops, fallow and fumigation with methyl bromide on population densities of *X. americanum*. Methyl bromide was applied in November 1999? . Population means at each date with the same letter do not differ significantly according to LSD tests ($P > 0.05$).