Effect of NH_4OH on nematode, fusarium and verticillium wilt infections in tomato

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Abstract
Plant parasitic nematodes are among the most important pests that adversely influence tomato production in Lebanon and its neighboring countries. Fusarium and verticillium wilts also cause severe constraints on agricultural production in the Near East. Two experiments were conducted: A greenhouse pot experiment to estimate toxicity levels of ammonium hydroxide on tomato plants (more than 400 mg NH_4OH/Kg of soil was toxic). A second experiment in a plastic tunnel was conducted to study the effects of Ammonium hydroxide on yield and root galling in tomato plants. Results showed that NH_4OH at a rate of 400 mg NH_4OH/Kg of soil was effective in reducing root galling, fusarium and verticillium wilts and in improving yield.

Key Words
Ammonium hydroxide, root knot nematodes, verticillium wilt, fusarium wilt.

Introduction

Plant parasitic nematodes and soil borne diseases such as those caused by *Fusarium* and *Verticillium* pathogens occur worldwide and attack a wide range of crops. In addition, plant parasitic nematodes predispose host plants to be attacked by other soil pathogens leading to disease complexes with other pests. Root knot nematodes (*Meloidogyne spp.*) are considered the most economically important nematode pests attacking tomatoes. *Meloidogyne spp.* are also serious pathogens of many economic crops, including oil plants, vegetables, fruit trees, tea, tobacco, and medicinal plants. Such problems are widely spread in controlled agricultural systems (greenhouse and plastic tunnels) in Lebanon and neighboring countries which necessitate the search for appropriate measures. Chemical control of soil borne diseases, especially root knot nematodes (RKN), is mainly done by methyl bromide fumigation, which is considered the most reliable soil fumigant for the control of soil borne pathogens. However, it has been banned in many countries in the Middle East and will be banned in Lebanon effective 2015, because it is an atmospheric ozone depleting agent (Watson *et al.* 1992). Other products such as: Metam sodium (Vapam), Dazomet (Basamid), Telone and Chloropicrin differ in their effectiveness, weed infestations and toxicity to the environment in general.

The objectives of this study were to investigate the effect of NH_4OH on the occurrence and control of *Meloidogyne*, *Verticillium* and *Fusarium* species in tomato, and to evaluate the yield response for soil applications of NH_4OH treatments in a plastic tunnel.

Materials and methods

Two experiments were conducted. A pot experiment to determine the toxicity levels of ammonium hydroxide on tomatoes and a plastic tunnel experiment to study the effect of ammonium hydroxide on the suppression of soil borne diseases in tomato plants.

Pot Experiment
Plastic pots (15 cm diameter and 1 kg of soil/pot) were used. The different treatments of ammonium hydroxide were placed at a depth of 5 cm from soil surface through a hole as shown in Table 1.

Table 1. Rates of ammonium hydroxide of the pot experiment.

Treatment No.	NH_4OH pre-planting mg/kg	NH_4OH post-planting mg/kg
1	200	-
2	400	-
3	600	-
4	200	100
5	200	200
6	200	400

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The pots were left for one week before transplanting and toxicity symptoms were recorded for a period of two months.

Plastic Tunnel Experiment
The experiment was conducted in a plastic tunnel which was previously planted with vegetables (tomato, cucumber, parsley…) for several years without receiving any treatments to control soil born diseases. The design of the experiment was a completely randomized design (CRD) with five treatments and three replicates. The rates of NH_4OH are shown in Table 2.

Table 2. Rates of NH_4OH of the plastic tunnel experiment.

Treatment No.	Treatment mg/kg	Rate of NH_4OH per Plot mL/m^2
1	400	100
2	200	50
*3	(200+200)	(50+50)
*4	(200+100)	(50+25)
5	CONTROL	CONTROL

*Numbers in brackets: first number is applied pre-planting and second number is applied post-planting.

Each treatment was $6m^2$. Application of NH_4OH was done one week prior to transplanting .A soluble fertilizer N-P-K (20-20-20+T.E.) was applied via irrigation system to all plots at the same rates.
Soils samples from beside the roots were collected twice a week to perform nematode counts and to identify the infestation severeness of *Verticillium* and *Fusarium* wilts. Furthermore, in mid-season, a plant was pulled from each plot and Root Galling RGI was performed along with *Verticillium* and *Fusarium* Assessments. RGI was assessed on a scale of 1 to 5 as indicated in Table 3:

Table 3. Assessment of RGI in plastic tunnel experiment.

Galling Index	№ of Galls on Root canopy	Diameter of Galls (mm)
1	0-Sparse	≤1
2	Sparse Galls	1-2
3	Non- Coalescent Galls	2-3
4	Numerous Galls	3-4
5	Extremely Abundant Galls	>4

The Baermann Funnel technique was used as a nematode extraction and larvae separation technique. Mounts for nematode identification were prepared.

Results and discussion

The soil was clayey loam, slightly alkaline (pH of 7.3), non saline, calcareous ($CaCO_3$) with sufficient levels of micro and macronutrients. During the season, results and severity of infections were estimated from isolations as shown in Table 4.

Table 4. Degree of infection in different treatments.

Treatment No.	Root Galling Index	Nematode	Fusarium	Verticillium
1	0.5	+	-	+
2	1.5	++	+	+
3	2	+++	++	++
4	1.2	++	++	++
5	4.5	+++++	++++	++++

\+ : Low Concentration
++ : Medium Concentration
+++ : High Concentration
++++ : Very High Concentration
+++++ : Extremely High Concentration

Plants amended with NH_4OH showed an abundant growth as compared to the control treatment; this could be due to the higher N supply. NH_4OH also led to the reduction of root knot galling of tomato plants and *Fusarium* and *Verticillium* infections (Table 4, and Figures 1 and 2).

Results show that ammonium hydroxide at a rate of 100 ml NH_4OH/m^2 almost doubled the yield of tomato (Figure 1) and reduced RGI from a rate of 4.5 to 0.5 (Figure 2).

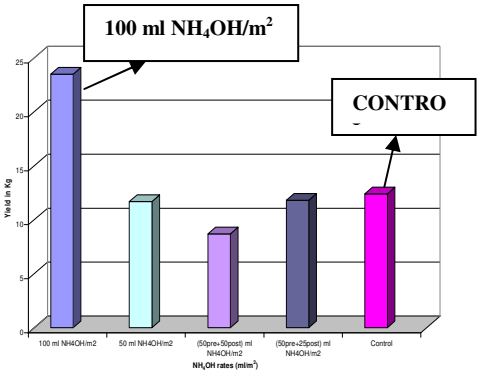

Figure 1. Effect of NH_4OH concentrations on yield of tomato

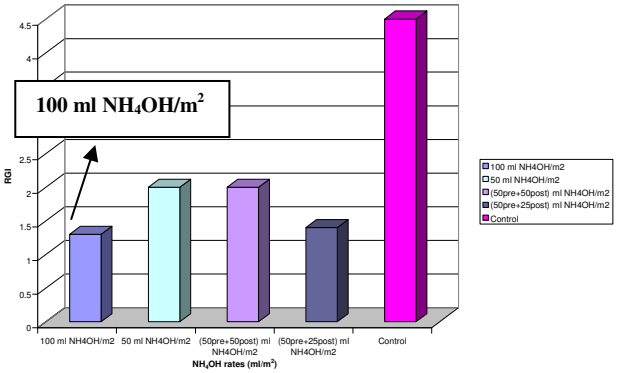

Figure 2. Effect of NH_4OH concentrations on RGI of tomato

The pre-planting application of NH_4OH was found to be more effective than the post-planting application of NH_4OH. Actually, it is recommended to only apply NH_4OH Pre-planting because of its toxicity effects on the plant if applied during the growing season. The results were obtained when NH_4OH was applied pre-planting at a rate of 100 ml/m^2

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