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Research Article

Response of Some Grapevine Cultivars to the Infestation by *Meloidogyne javanica* under Greenhouse Conditions in Minia Governorate, Egypt

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Abstract

A controlled greenhouse experiment was conducted in the Plant Protection Department, Faculty of Agriculture, Minia University, Egypt, to evaluate the susceptibility of ten grapevine cultivars to infection by the root-knot nematode (RKN) *Meloidogyne javanica*. The materials tested included three rootstocks (Harmony, Richter, and Freedom) grafted with the cultivar Superior, as well as seven own-rooted seedlings (Thompson Seedless, Ruby, Superior, Flame Seedless, H4, Crimson, and Balady). The results indicated significant differences among grapevine cultivars in response to infection by *Meloidogyne javanica*. Consistent with scale by Hadisoganda and Sasser, and response ratings by Southy (1970), rootstocks Harmony, Freedom, and Richter expressed strong resistance, which could be attributed to a strong genetic background as well as pre-existing documented tolerance against root-knot nematodes. Likewise, cultivars Thompson Seedless, Superior, Ruby, and Balady expressed very strong resistance, which indicates that such cultivars could serve as valuable sources of resistance in breeding programs or safe choices in viticultural settings infested with nematodes. On the contrary, cultivars Flame Seedless, H4, and Crimson expressed slight resistance, which indicates a degree of susceptibility that might suppress vine vigor and productivity under heavy nematode pressure. The diversities noticed highlight deliberate cultivar and rootstock selection as critical in integrated nematode management strategies. Resistance genotypes not only reduce nematode population numbers, but also suppress damage, hence establishing sustainable vineyard production.

Keywords: Grapevine cultivars; Root knot nematodes; Root gall index; resistance.

1. Introduction

Root Knot Nematodes (RKN) nematodes (Meloidogyne spp.) are among the most destructive of the soil-borne pathogens that affect grapevines worldwide. The organisms infest roots, disrupting uptake of nutrients and water, hence reduced vine vigor, suboptimal performance, and significant yield declines [1-3].

In Egypt, particularly in the Minia governorate, and other regions involved in viticulture, root-knot nematodes are widespread and pose a key challenge in sustainable production of grapes [4, 5].

Chemical nematicides and fumigants of the soil represented, in the past, the principal means of controlling nematodes. But, because of concerns about environmental, sanitary, and regulatory issues [6-8], their application has been placed under more and more restrictions. The above has necessitated environmentally friendly alternatives that will be of use and sustainability [5, 9]. Of such alternatives, rootstock resistance of grapes is among the best measures. Tolerant rootstocks, also known as resistant rootstocks, block nematode penetrate, in addition to nematode reproduction, thereby lowering numbers of nematodes in soils, as well as decreasing loss of yield [10, 11]. New advances in breeding programs and in molecular studies continually show grapevine genotypes that possess enhanced root-knot nematode resistance [3, 12]. The resistant rootstocks not only offer a safe, environmentally safe, non-chemical alternative to chemical nematicides, but also play a pivotal role in integrated pest management (IPM) practices developed for long-term nematode control. This study was conducted to evaluate the susceptibility of several grapevine cultivars to M*eloidogyne javanica* under controlled greenhouse conditions. Furthermore, it aimed to compare nematode penetration and reproduction in resistant and susceptible grapevine rootstocks, with the overall goal of developing an alternative strategy for managing nematode infestations in vineyards.

2. Materials and Methods

Experiment to test the susceptibility of different grape vine rootstocks and seedlings to the infection by root knot nematode *Meloidogyne javanica* was conducted under the greenhouse conditions of Plant Protection Department, Faculty of Agriculture Minia University, Minia, Egypt. Three rootstocks were planted in pots arranged randomly i.e. Harmony, Reichter and Freedom grafted with superior as well as four seedlings i.e. Thompson seedless, Ruby, Superior, Flame seedless. Each cultivar planted in four replicates in pots 20 cm in diameter filled with sterilized loamy and sandy soils (1:1) after two weeks from planting each pot was inoculated by 1500 J2 of *Meloidogyne javanica* in 10 mL of sterile water were pipetted into four small impressions (approximately 1 × 1 × 1 cm), and 2.5mL of nematode solution was added per impression. After inoculation, the impressions were covered with soil. Six weeks after inoculation, the Vitis cultivars and accessions were scored for egg mass development. To visualize the egg masses, the soil was first gently rinsed away and the roots then soaked in eosin Y (0.25 g/L deionized water) for 1 h to stain the egg masses of reproductive females. Subsequently, the stained egg masses were scored using Binocular Microscope with led lighting (40X magnification) to determine the number of egg masses per root. The root systems of all vines were dried at 60°C overnight and weighed to calculate the number of egg masses per dry gram of roots. The rates of nematode reproduction were calculated by dividing the nematode final population by the nematode initial population.

Root gall index values were estimated according to the following scales: (0 = 0 galls; 1 = 1-2 galls; 2 = 3-10 galls; 3 = 11-30 galls; 4 = 31-100 galls and 5 =>100 galls [13]. Response of the tested cultivars to root knot nematode, *Meloidogyne javanica*, based on root gall index ranges was determined according to [14] as follow: 0- 1.0 = highly resistant (HR); 1.1-3.0 = very resistant (VR); 3.1-3.5 = moderately resistant (MR); 3.6-4.0 = slightly resistant (SR) and 4.1-5.0 = susceptible (S).

Other rating scale levels for evaluate the response of different cultivars to root knot nematode infestation by gall indices was mentioned by [15] based on root gall indices as follow: 0= immune; 1= highly resistant ; 2 = resistant ; 3= moderately resistant, 4 = moderately susceptible, 5= susceptible, 6= highly susceptible.

The third scale was depending on the rate of build-up (Pf/Pi): ≥ 3= highly susceptible (HS), 2-3 = S, 1-2= MS, 0.5-1.0= MR, 0.3-0.5= resistant (R) and ≤0.3= HR [16].

Statistical analysis: The experiment was conducted in a completely randomized design with four replicates. Differences among treatment means were evaluated using Duncan's Multiple Range Test (DMRT) at the 5% probability level, employing SPSS statistical software [14].

3. Results and Discussion

cultivars and rootstocks against the infection by root-knot nematode *Meloidogyne javanica* infection on the base of gall indices by different rating mentioned by [14, 15]. The first rating designates, Harmony, Freedom and Richter cultivars as highly resistance. Other cultivars differed in their resistance whereas Thompson seedlesd, Superior, Ruby and Balady were very resistance. Flame seedless, H4 and Crimson were slightly resistance. As for the response rating mentioned by [15] grape vine cultivars, Harmony, Freedom and Richter were designated as immune for the infection with the tested nematode (*M. javanica*). Ruby show resistance response, while the moderately resistance cultivars were Thompson seedless, Superior and Balady. While moderately susceptible cultivars were Flame seedless, H4 and Crimson.

Resistance of table grape cultivars to infestation by nematodes may be due to content of phenolic components in varying cultivars. Dixon 2001 stated that among the possible mechanisms, there is the expression of a group of phenolic compounds known as stilbenoids, that are primarily linked to plant resistance against pests [17].

Development and reproduction of *M. javanica* infection differed from cultivar to another and that is an indicator of the extent of cultivars response. Data explained in Table (2) point to another scale that who is the reproduction factor (Pf/Pi) that consider a clear indicator for susceptibility and resistance of cultivars. The three rootstocks i.e. Harmony, Freedom and Richter showed high resistance. Ruby and Balady were moderate resistant. Thompson seedless, Superior and Flame seedless gave susceptible response for *M. javanica* infestation. H4 and Crimson cultivars classified by Pf/Pi scale to be high susceptible. The designations of [18] based on the relationship between root gall index as indicator of plant damage and rate of nematode increase (R factor) as indicator of nematode reproduction or host efficiency were used to determine tolerant, resistant or susceptible cultivars.

This work found wide variation in the resistance of table grapes against *Meloidogyne javanica*. Harmony, Freedom, and Richter rootstock grafted with Flame Seedless were highly resistant, while Thompson Seedless, Superior, Ruby, and Balady were very highly resistant. Flame Seedless, H4, and Crimson, however, proved to be slightly resistant.

These findings confirm previous studies, which have shown that rootstocks such as Freedom and Harmony show considerable resistance to root-knot nematodes due to their genetic make-up, particularly due to the influence of *Vitis champinii* and related species [19, 20]. Furthermore, screen experiments using Vitis cultivars under controlled conditions have shown that a high proportion of genotypes show complete or partial resistance to *M. javanica*, in turn, confirming the occurrence of significant resistance traits in the genus. Its genetic foundation has been attributed to a dominant locus, known as MJR1, in chromosome 18 of *Vitis cinerea*.

The respective locus induces resistance by prompting a hypersensitive reaction at the root apical meristem, therefore preventing nematode establishment [4]. Such resistances of this kind also underscore the value of introducing resistant genotypes in breeding protocols, as not only population numbers of nematodes reduce, but damage to crops is also reduced. The findings support that there is considerable variability in resistance among cultivars. The defense mechanisms could also include stilbenoid phenolic compounds, as

evidenced by higher quantities being detected in resistant rootstock Freedom [21]. Genetic loci of resistances such as MJR1 also exhibit a likely role in defense via hypersensitive root reaction [4]. In addition, pre-treatment protocols, such as hot-water treatment (55 °C, 20 min), can severely reduce infestations of nematodes in nursery stocks [22].

Ultimately, root-knot nematode infestations could be managed sustainably by combining resistant cultivars and rootstocks in vineyard production practices, without compromising vine vitality and productivity.

Flame Seedless, H4, and Crimson, in contrast, registered a score of weak resistance, that is, there was also a level of susceptibility that could jeopardize vine productivity and vine health under heavy nematode infestations. The noticed variability also suggests that prudent cultivar and rootstock selection remain critical in effective nematode management practices.

4. Conclusions

This work shows cultivar-dependent differences in resistance to *M. javanica*. The resistant genotypes, especially Harmony, Freedom, and Richter, hold potential in breeding and vineyard establishment in infested vineyards. The selection of resistant materials is imperative in sustainable nematode management. Future studies should integrate biochemical markers, mapping loci of resistance, as well as environmentally friendly treatments, to establish firmly based strategies of integrated pest management.

Table 1: Susceptibility of grapevine cultivars seedlings and rootstocks to infection by *Meloidogyne javanica* under greenhouse condition

Cultivars	Root galls/root system	Root gall index	Response 1-According to Hadisoganda &Sasser (1982) 2- According to Southy, 1970
Harmony	0	0	1-Highly Resistance, 2-Immune
Freedom	0	0	1-Highly Resistance, 2-Immune
Richter	0	0	1-Highly Resistance, 2-Immune
Thompson seedless	25	3	1-Very Resistance, 2-Moderately Resistance
Superior	30	3	1-Very Resistance, 2-Moderately Resistance
Ruby	10	2	1-Very resistance, 2-Resistant
Flame seedless	40	4	1-Slightly resistance, 2-Moderately Susceptible
H4	60	4	1-Slightly Resistance, 2-Moderatly Susceptible
Balady	20	3	1-Very Resistance, 2-Moderately Resistance
Crimson seedless	42	4	1- Slightly Resistance, 2-Moderately Susceptible

Table 2: Development and reproduction of *Meloidogyne javanica* infection on certain grape vine cultivars under greenhouse conditions according to Reproduction factor (RF)

Cultivars	Egg masses/root	Egg masses/g.	Final soil population	RF*	Host category
Harmony	0	0	100	0.06	HR
Freedom	0	0	140	0.09	HR
Richter	0	0	200	0.13	HR
Thompson seedless	170	40	3600	2.40	S
Superior	190	42	4000	2.66	S
Ruby	106	25	1500	1.0	MR
Flame seedless	240	50	4200	2.80	S
H4	380	80	8140	5.42	HS
Balady	120	27	2180	1.45	MR
Crimson seedless	265	54	4700	3.13	HS

*RF= Reproduction factor

A reproduction factor = (final population density / initial pop.)

On the basis of potential reproduction if (Pf/Pi) = ≥ 3 HS, 2-3 = S, 1-2 = MS, 0.5-1.0 = MR, 0.3-0.5 = R and ≤0.3 = H

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