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Short Communication

Interactions between galling insects and plant total phenolic contents in *Rosa canina* L. genotypes

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This study aimed to determine interactions between gall induction by *Diplolepis* sp. and leaf total phenolic content in *Rosa canina* genotypes. A total 20 *R. canina* genotypes with and without insect damage has been selected in different parts of Northeast Anatolia and the leaf samples collected in July 2009. Total phenolic content was estimated by the Folin–Ciocalteu colorimetric method and expressed as gallic acid equivalents (GAE) in mg/g dry weight. The results showed that seven genotypes without insect damage had significantly greater total phenol content in its leaves compared to insect damaged *R. canina* plants. These results clearly indicate that total phenolic content in *R. canina* genotypes that had no galling insect damage may have an important part of chemical defense of *R. canina* plants against *Diplolepis* sp. This may have also suggested that these resistant genotypes against galling insect are important for sustainable and organic rose hip production.

Key words: *Rosa canina*, galling insect, *Diplolepis* spp. total phenolics.

INTRODUCTION

The genus *Rosa* contains above 100 species that are widely distributed in particular Europe, Asia, the Middle East and North America (Nilsson, 1997). These deciduous shrubs are widely grown in gardens for their flowers and fruits and these shrubs shows strong resistance to hard environmental conditions (rocky, inclined places, poor soils and limiting water) and pests and diseases. However, this resistance widely belongs to genotypes used. The genotypes belonging to the same specie has different altitude against pests and diseases. Turkey is one of the most important germplasm centers for rose species. Twenty five rose species (about 25% of all rose species) have so far been reported to grow in Turkey (Ercisli, 2005).

Members of the Rosaceae family including rose hip have long been used for food products (such as jam, tea, marmalade, soup) and medicinal purposes. Rose hips are well known for their efficacy in strengthening the body's defense against infection, and particularly the common cold. The fruits, leaves and even roots are boiled in water and used as diuretics and as ingredients in common cold remedies in Turkey (Sen and Gunes, 1996). Rose hips are also well known to have the highest vitamin C content (300 - 4000 mg/100 g) among fruits and vegetables. In addition, rose hips contain other vitamins and minerals, carotenoids, tocopherol, bioflavonoids, fruit acids, tannins, pectin, sugars, organic acids, amino acids and essential oils (Chai and Ding, 1995; Ercisli, 2007).

The medicinal functions of Rosaceae fruits may be partly attributed to their abundance of phenolics. Phenolics possess a wide spectrum of biochemical activities, such as antioxidant, antimutagenic, anticargionogenic effects, as well as ability to modify gene expression (Nakamura et al., 2003).

Rose gal which is caused by *Diplolepis* sp. is an important problem in all rose hip growing areas in Turkey. The insect lays its eggs on flower buds of rose hips and induces galls on the seeds and developed galls cause with or without split open rose hip fruits. Severe gall formation causes fruit deformations. The insect reduces fruit yields and fruit quality and affected fruit are not

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Table 1. Total phenolic content of galled and ungalled *R. canina* plant leaves.

	Total phenolic content mgGAE/g dry weight	
Sampling locations	**Galled**	**Ungalled**
Erzurum	78.13b	101.04a
Erzurum	87.13^{NS}	89.33
Erzurum	93.35a	86.61b
Kars	73.10^{NS}	71.44
Kars	75.45b	86.80a
Erzincan	66.34b	73.12a
Erzincan	70.71^{NS}	71.28
Erzincan	74.45a	68.48b
Sivas	72.78b	83.89a
Sivas	67.69b	88.44a
Average	75.91b	82.04a

marketable, owing to the presence of the galls (Guclu et al., 2008).

Previous studies showed an interaction between plant–insect, suggested the potential effects of plant chemical defenses on host-selection behaviors of insects (Kolehmainen et al., 1994; Roininen et al., 1999). However, as far as literature search is concerned, studies of plant phenolics-insect interactions in *Rosa* species have not been reported. Plant secondary compounds may be altered by insect attack and the amount of total phenolics in leaves in galled and ungalled plants can be different. The resistant genotypes against galling-insect may have accumulate more plant secondary metabolites for protection against natural enemies

In this paper, the interaction between host total phenolic content and galling insect within galled and ungalled *Rosa canina* genotypes was examined. This is the first observational study that documents the interaction between galling insect and host total phenolic content in *R. canina* plants.

MATERIALS AND METHODS

Study site and sample collection

This study was conducted at the Northeast Anatolia region in Turkey year 2009. A total of 20 (10 galled and 10 ungalled) *R. canina* plants were selected from Kars, Erzurum, Erzincan and Sivas regions. The altitude of study areas ranged from 1280 - 1910 m. These areas mainly have cold temperature climate characteristics with short vegetation. Surveys and sampling were conducted in July, 2009 during the dry summer season. After a preliminary analysis of presence of galling insect species, we found *Diplolepis* sp. which always present in all sites. In each individual of the *R. canina* plant sites, we sampled 25 leaves from per galled plant and 25 leaves from per ungalled plants. The leaves was air-dried at room temperature (20 ± 2°C) and subsequently essayed for total phenols. Total phenolic content was estimated by the Folin–Ciocalteu colorimetric method, based on the procedure of Singleton and Rossi (1965), using gallic acid as a standard. A UV spectrophotometer (Nicolet 100) used and the quantitative measurements were performed, based on a standard calibration curve of six points: 20, 100, 200, 300, 400, 500 mg/L of gallic acid in methanol. The total phenolic content was expressed as gallic acid equivalents (GAE) in mg/g dry weight.

Statistical analysis

The experiment was a completely randomized design with four replications. Data were subjected to analysis of variance (ANOVA) and means were separated by Duncan multiple range test at $p < 0.05$ significant level.

RESULTS AND DISCUSSION

The total phenolic content of *R. canina* genotypes (galled and ungalled) is shown in Table 1. As seen in Table 1, general statistically significant differences ($p < 0.05$) on total phenolic content were obtained among galled and ungalled *R. canina* genotypes (Table 1). The results of the Duncan test for each plant indicate that seven plants had greater total phenolic concentrations in leaves without galls than in leaves with galls (Table 1).

Total phenolic content generally were found to be higher in ungalled leaf samples compared to galled plants which belongs to same specie, *R. canina*. In Erzurum, Kars, Erzincan and Sivas regions, total phenolic contents of ungalled plants were between 86.61 - 101.04; 71.44 - 86.80; 68.48 - 73.12 and 83.89 - 88.44 mg GAE/g dw, respectively. However, in same regions these values were between 78.13 - 93.35; 73.10 - 75.45; 66.34 - 74.45 and 67.69 - 72.78 mg GAE/g dw for galled plants indicating lower values than ungalled plants (Table 1).

Considering average values of ten *R. canina* genotypes, the average total phenolic content of ungalled plants was 82.04 mg GAE/g dw and it was 75.91 mg GAE/g dw in galled plants (Table 1). Another word, ungalled *R. canina* plants produced higher amounts of total phenolic content in leaves and may have correlated with the infestation levels and their naturally higher amount of phenolics may be responsible for a non-preference mechanism. Similar results in tissues that were not attacked by *Phytophthora capsici* in *Capsicum annuum* were reported by Gayoso et al. (2004).

In previous studies, the total phenolic contents determined in the leaves of *Rosa* species were found to range from 57 - 152 mg GAE/g dw (Nowak and Gawlik-Dziki, 2007) which is in line with the study's results. These results support the hypothesis that phenolics are involved in the defense against *Diplolepis* sp. and defense reaction varied among the genotypes.

In literature, few studies conducted on manipulation of galling insects on defensive secondary compounds of their host plants (Hartley, 1998) and controversial results of this chemical manipulation have been reported. In some cases, chemical compounds such as host phenolics are less abundant in the galls than in normal plant tissues (Abrahamson and Weis, 1986; Nyman and Julkunen-Titto, 2000), while in other cases, galls contain higher concentrations of defense chemicals than in normal tissues (Hartley and Lawton, 1992; Vereecke et al., 1997; Hartley, 1998). It was originally suggested that phenolics were produced by plants as a defense mechanism against galling insects (Tjia and Houston, 1975; Westphal et al., 1981; Zucker, 1982). However, more recent studies show that host phenolic concentrations are not associated with plant resistance against galling insects (Abrahamson et al., 1991; Hartley, 1999). This study found that the concentration of phenols was greater in ungalled than galled leaves in seven genotypes. In fact, studies also showed that galling insect species have the capacity to stimulate the production of host secondary compounds increasing phenolic concentrations in the surrounding galled areas. Therefore, it can be concluded that the increase total phenolics may have occurred, mainly, only at galling point in susceptible genotypes and the other conclusion is that resistance genotypes can also produce more phenolics in all its tissues (Hartley and Lawton, 1992; Hartley, 1998). Unfortunately, the study did only total phenolic analysis on leaves of galled and ungalled plants and did not analysed total phenolic analysis around galling point (fruit and seed) of galled plants.

Our results indicate that galling insects may directly affect host plant chemical traits, changing the concentration of foliar phenolics, and indirectly may affect the infestations. Further characterization of the types of phenolic compounds that are induced might indicate if there is phenolic-based resistances to sucking insects are underway.

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