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# Effect of Guava Leaf Residue on Broad and Narrow Leaved Weeds Associated Wheat Plants

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## ABSTRACT

Two pot experiments were conducted in the greenhouse of National Research Centre, Egypt during the two winter seasons 2010/2011 and 2011/2012 to study the effect of guava leaves residue on the growth and yield of wheat cv. Gemaza 10 and two associated weeds, *Anagalis arvensis* L. (broad leaved weed, related to order: Ericales, family: Myrsinaceae and *Avena fatua* L. (grassy weed, related to order: Poales, family: Poaceae)). Guava leaves residue was applied in the soil surface at the concentrations 0 (Plants+*A. fatua*+ *A. arvensis* without addition of guava leaf residues) 40, 60, 80 and 100 g kg$^{-1}$ of soil per pot. Results revealed reduction in the growth of both the weeds and the reduction in *A. arvensis* was higher than in *A. fatua*. On the other hand, a significant increase in growth and yield of wheat expressed in 1000 grain weight and grain yield (g per plant) were obtained with the reduction in weed growth. The increase in growth and yield was accompanied with increase in protein and carbohydrate contents in the resultant grains. Results opened up avenues for exploring guava leaf residue as allelopathic material for weed suppression.

**Key words:** *Triticum aestivum*, guava leaves residue, allelopathy, *Anagalis arvensis* L., broad leaved weed, *Avena fatua* L., grassy weed

## INTRODUCTION

Wheat is one of the most important crops in the world. It is considered the main source of foods in Egypt. The total area under the crop is about 2-3 million Fed. (Fed. = 2400 m$^2$) in Egypt and reached to 3.049 Fed. in 2011 according to Statistics of the Central Agency for Public Mobilization and Statistics in Egypt. The production of wheat in the country has increased significantly from 6 million MT in 2002 to 8.3 MT in 2011. According to the International Grains Council (IGC), Egyptian wheat production in 2013-14 will be 9.4 MT, up from 8.5 million (http://www.world-grain.com/Departments/Country%20Focus/Country%20Focus%20Home/Focus%20on%20Egypt.aspx?cck=1).

In general, weeds are considered to be a serious problem because they compete for water, nutrients, light and space and consequently caused great reduction in crop yield. The reduction of wheat yield due to weed infestation amounted 31% (Chopra *et al.*, 1999) to 61% (Hucl, 1998) as compared to weed free control. So, controlling weeds is one option to increase wheat yield.

In recent years, because of the use of large quantities of herbicides and their potential hazards, such as residual effects, contamination of food chains and groundwater and other consequences, scientists have been looking for alternative ways to manage weeds and enhance crop production (Marambe and Sangakkara, 1996). Many plant products are found to inhibit germination and growth of plants which have some herbicides properties (El-Rokiek and Eid, 2009; El-Rokiek *et al.*, 2010a, b).

The main principle in allelopathy arises from the fact that plants produce thousands of chemicals and many of these chemicals are released by leaching, exudation or decomposition processes. Some of these compounds at certain concentrations are phytotoxic to receiving organisms and some other are stimulating. Subsequently, some of these compounds which are known as allelochemicals alter the growth or physiological functions of receiving species. The most commonly found allelochemicals are cinnamic and benzoic acids, flavonoids and various terpenes (Singh *et al.*, 2003, 2005) and these compounds are known to be phytotoxic (Einhellig, 2002, 2004). Consequently, the allelopathic extracts could be used to control the growth of weeds (Chon and Kim, 2002, 2004; Chon *et al.*, 2003; Singh *et al.*, 2003; El-Rokiek *et al.*, 2006). Guava leaves have been identified to contain chemical products belonging to the groups with allelopathic properties (Monteiro and Vieira, 2002). Begum *et al.* (2002) reported that guava leaves contain terpenoids, flavonoids, coumarins, cyanogenic acids. Gutierrez *et al.* (2008) also identified chemical products belonging to the groups with allelopathic properties such as terpenoids, flavonoids, coumarins, cyanogenic acids. Some of these compounds such as the terpenoids can be leached from the leaves by rain (Monteiro and Vieira, 2002). Some other studies have shown that guava fruit extracts affect cucumber germination (Bovey and Diaz-Colon, 1969). Root exudates inhibited lettuce and *Setaria verticillata* radical growth (Brown *et al.*, 1983).

The aim of this study was to analyze the effect of guava leaf residues on two selected weeds; *Avena fatua* L. (narrow weed) and *Anagalis arvensis* L. (broad weed) associated with wheat plants per crop.

## MATERIALS AND METHODS

Two pot experiments were conducted during two successive winter seasons (2010/2011 and 2011/2012) at greenhouse of National Research Centre, Dokki, Egypt. Wheat seeds cv. Gemaza 10 were obtained from the Agricultural Research Center, Ministry of Agriculture, Giza, Egypt.

**Preparation of material residues:** Healthy *Psidium guajava* L., leaves were collected from Egyptian gardens and washed thoroughly with running tap water to remove dust and other undesired materials and air dried in shadow then grinded to fine powder.

Ground, dried guava leaves materials were mixed thoroughly with the surface of the potted soil mixture at a rate of 40, 60, 80 and 100 g $kg^{-1}$ clay loam soil in pots which had a 30 cm diameter and 17 cm height. They were frequently irrigated with tap water for one week to allow natural decay of the guava leaves residues. Then, the pots were sown with wheat seeds (8 seeds per pot) on 3rd and 1st December for the first and the second season, respectively. The pots were infested with *Anagalis arvemsis* (broad-leaved weed) and *Avena fatua* (grassy weed) at a consistent seed (0.5 g per pot). All pots were infested with the same weight of the weed seeds. Weed seeds were sown simultaneously with wheat grain and mixed thoroughly at 2 cm depth in the soil. Two weeks later, thinning of wheat seedlings was done so that three homogenous wheat seedlings were left per pot. Routine phosphorus and potassium fertilizers were added before sowing as super phosphate (15.5%, $P_2O_5$) and potassium sulphate (48% $K_2O$) at the rate of 3 g and 1 g per pot while ammonium nitrate (33.5% N) representing sources of N at rate of 2 g per pot was added 30 days after sowing. The experiment consisted of 8 treatments including four control treatments without the addition of guava leaf residue. The control treatments were wheat with *A. arvensis*, wheat with *A. fatua*, wheat with the two weeds and weed free wheat plants. The other four treatments were guava leaves residue at 40, 60, 80 and 100 g kg$^{-1}$ of the surface of the potted soil. Six pots were used in each treatment. The pots were arranged in a completely randomized design.

Samples of weeds as well as wheat plants were taken from three pots at 90 days after sowing and at harvest.

**Weed samples:** The infested weeds were collected from each pot (all weed samples in each pot were pulled up). The data on fresh and dry weight of grown weeds were recorded.

**Wheat:** Data on wheat growth were recorded as the two plants in each pot were pulled up (three pots after 90 days from sowing and three pots at harvest). Some morphological and growth characteristics of wheat plants were recorded for each individual plant. The recorded characteristics included plant height (cm), number of tillers per plant, fresh and dry weight per plants (g). At the end of the season, wheat yield and its components including, spike length, number of spikes per plant, number of spikelets per spike, weight of 1000 grains and grains weight per plant were calculated for each treatment.

### Determination of some chemical changes in wheat grain

**Determination of total carbohydrate contents:** Total carbohydrate contents were extracted from dry finely ground wheat grain (powdered). Total carbohydrates were extracted according to Herbert *et al.* (1971) and estimated colourimetrically by the phenol-sulphuric acid method as described by Montogomery (1961).

**Determination of protein contents:** Protein contents were determined in dried wheat grain according to the method described by Lowry *et al.* (1951).

**Statistical analysis:** The data obtained were subjected to standard analysis of variance procedure of complete randomized design; LSD values were obtained when F values were significant at 5% level (Snedecor and Cochran, 1980).

## RESULTS

Results presented in Table 1 on the growth parameters of weeds shows that both fresh and dry weights of *A. arvensis* (broad leaved weed) and *A. fatua* (grassy weed) were significantly reduced by Guava Leaves Residue (GLR) after 90 days from sowing and at harvest. In general, the reduction caused by GLR in fresh and dry weight of *A. arvensis* was higher than that of *A. fatua* in comparison to the controls of *A. arvensis* alone with wheat or with *A. fatua* and wheat. The inhibition in weed fresh and dry weight increased with the increase in the rate of GLR (40-100 g). The reduction in dry weight reached maximum value by using GLR at 100 g kg$^{-1}$ surface soil. This reduction recorded was 61.7% in *A. arvensis* after 90 days from sowing in comparison to the untreated control. The corresponding result in *A. fatua* was 37.7% reduction. The inhibition was consistent during the experimental period, i.e., the reduction increased at harvest to reach 63.3% in *A. arvensis* and 40.3% in *A. fatua* using GLR at 100 g kg$^{-1}$ surface soil (Table 1).

Table 1: Effect of guava (*Pisidium guajava*) leaf residue on fresh and dry weight of *Anagalis arvensis* (broad leaved weed) and *Avena fatua* (grass weed) associated wheat plants (Average of the two seasons)

| Treatments | Rate of guava residue | 90 days after sowing: Fresh weight *A. fatua* | Fresh weight *A. arvensis* | Dry weight *A. fatua* | Dry weight *A. arvensis* | At the end of the season *A. fatua* | At the end of the season *A. arvensis* |
|---|---|---|---|---|---|---|---|
| Plants+*A. fatua* | 0 | 0.00 | 18.50 | 0.00 | 4.43 | 0.00 | 1.85 |
| Plants+*A. arvensis* | 0 | 4.00 | 0.00 | 0.84 | 0.00 | 26.30 | 0.00 |
| Plants+*A. fatua*+ *A. rvensis* | 0 | 3.08 | 13.50 | 0.68 | 3.10 | 22.16 | 15.50 |
| Weed free plants | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 40 | 2.51 | 13.00 | 0.62 | 3.04 | 16.83 | 13.50 |
| | 60 | 2.63 | 12.83 | 0.50 | 2.95 | 13.80 | 12.16 |
| Guava residue (g) | 80 | 2.34 | 8.30 | 0.46 | 2.07 | 9.66 | 11.20 |
| | 100 | 1.10 | 7.66 | 0.26 | 1.96 | 8.06 | 9.26 |
| LSD at 5% level | | 0.33 | 1.35 | 0.032 | 0.23 | 1.48 | 0.88 |

Table 2: Effect of guava (*Pisidium guajava*) leaf residue on plant height, number of tillers, fresh and dry weight of wheat plants after 90 days from sowing (Average of the two seasons)

| Treatments | Rate of guava residue | Plant height (cm) | No. of tillers | FW (g per plant) | DW (g per plant) |
|---|---|---|---|---|---|
| Plants+*A. fatua* | 0 | 75.66 | 2.33 | 24.50 | 7.04 |
| Plants+*A. rvensis* | 0 | 80.00 | 2.33 | 30.00 | 7.50 |
| Plants+*A. fatua*+*A. arvensis* | 0 | 72.66 | 2.00 | 26.33 | 6.44 |
| Weed free plants | 0 | 86.00 | 4.00 | 54.25 | 9.48 |
| | 40 | 80.00 | 2.66 | 36.00 | 7.08 |
| Guava residue (g) | 60 | 83.00 | 3.00 | 39.00 | 7.65 |
| | 80 | 83.66 | 3.33 | 39.83 | 7.76 |
| | 100 | 84.33 | 3.66 | 42.66 | 8.14 |
| LSD at 5% level | | 2.71 | 0.34 | 1.04 | 0.21 |

**Wheat growth:** Results on the growth parameters of wheat presented in Table 2 indicates a significant increase in plant height as well as number of tillers was obtained by GLR at different concentrations as compared to the unweeded control (Plants+ *A. fatua*+ *A. rvensis* without addition of guava leaf residues). The results also showed significant increase in fresh weight due to GLR treatments. The increase in fresh weight was accompanied by increase in dry weight which reached to 26.4% over untreated control by using GLR at 100 g kg$^{-1}$ surface soil.

Significant increases in spike length, number of spikelets per spike and number of spikes per plant were recorded by GLR from 40-100 g kg$^{-1}$ surface soil as compared to the unweeded control (Plants+*A. fatua*+*A. arvensis*). The increase was observable by using GLR at 100 g (Table 3).

Results presented in Table 3 also reveal significant increases in weight of grains per spike, weight of 1000 grains (g) as well as grain yield (weight of grain per plant) by GLR treatments in comparison to the unweeded control (Plants+*A. fatua*+*A. arvensis*). Yield increase was remarkable with the application of GLR at 100 g which increased the grain yield to 134.6% over unweeded untreated control (Plants+*A. fatua*+*A. arvensis* without addition of guava leaf residues). It is worthy to mention that weed free pots recorded the highest growth and yield attributes (Table 2 and 3).

Table 3: Effect of guava (*Pisidium guajava*) leaf residue on yield and yield components of wheat plants (Average of the two seasons)

| Treatments | Rate of guava residue | Spike length (cm) | No. of spiklets per spike | No. of spikes per plant | Grains weight per spike (g) | Grain yield (g per plant) | 1000 grain weight (g) |
|---|---|---|---|---|---|---|---|
| Plants+*A. fatua* | 0 | 9.33 | 15.00 | 3.00 | 1.29 | 4.77 | 38.00 |
| Plants+*A. arvensis* | 0 | 9.33 | 15.66 | 3.14 | 1.36 | 5.24 | 39.33 |
| Plants+*A. fatua*+*A. arvensis* | 0 | 8.23 | 12.33 | 2.60 | 0.86 | 4.77 | 39.33 |
| Weed free plants | 0 | 11.33 | 17.66 | 6.21 | 2.12 | 13.85 | 44.26 |
| | 40 | 10.66 | 16.33 | 3.75 | 1.59 | 8.81 | 39.46 |
| | 60 | 11.00 | 16.11 | 4.00 | 1.63 | 10.11 | 39.83 |
| Guava residue (g) | 80 | 11.33 | 16.50 | 4.37 | 1.66 | 11.05 | 41.06 |
| | 100 | 11.33 | 17.08 | 4.50 | 1.72 | 11.19 | 41.53 |
| LSD at 5% level | | 0.57 | 0.66 | 0.249 | 0.06 | 0..63 | 1.13 |

Table 4: Effect of guava (*Pisidium guajava*) leaf residue on percentage of carbohydrate and protein contents in wheat grain (Average of the two seasons)

| Treatments | Rate of guava residue | Carbohydrate (%) | Protein (%) |
|---|---|---|---|
| Plants+*A. fatua* | 0 | 48.53 | 10.61 |
| Plants+*A. arvensis* | 0 | 60.30 | 11.65 |
| Plants+*A. fatua*+*A. arvensis* | 0 | 43.33 | 10.36 |
| Weed free plants | 0 | 72.36 | 13.76 |
| | 40 | 60.74 | 12.09 |
| Guava residue (g) | 60 | 60.76 | 12.67 |
| | 80 | 63.51 | 13.44 |
| | 100 | 66.58 | 13.67 |
| LSD at 5% level | | 2.04 | 0.37 |

**Carbohydrate and protein contents in wheat grains:** Accumulation of total carbohydrates as well as protein in the grains obtained was the highest in weed-free plants. Uncontrolling weeds (Plants+*A. fatua*+*A. arvensis* without addition of guava leaf residues) caused a great reduction in the total carbohydrate percent amounted by 40.1% compared to weed-free treatment (Table 4) and weed also reduced protein content to 24.7% compared to weed-free treatment. However application of different concentrations of GLR resulted in significant increase in the total carbohydrates as compared with those produced by unweeded (Plants+*A. fatua*+*A. arvensis* without addition of guava leaf residues) treatment, it recorded great significant content by the highest concentration 100 g. Increases in protein contents in the yielded grains were also observed in response to GLR treatments as compared to the unweeded untreated control (Table 4).

## DISCUSSION

Under appropriate conditions, allelochemicals may suppress the developing of weed seedlings and often exhibit selectivity similar to synthetic herbicides (Weston, 1996). Hence, allelochemicals are eco-friendly and free from the problems associated with present synthetic/chemical herbicides. Results of the present investigation indicate that the growth of *A. arvensis* (broad leaved weed) as well as *A. fatua* was reduced by all concentrations of GLR. The reduction increased with the increase in GLR concentration. Moreover, the degree of inhibition in *A. arvensis* was higher than *A. fatua*. These results are in consistent with other results of different plant extracts that were found to suppress growth of different weed species (Cheema *et al*., 2003; El-Rokiek *et al*., 2006). Allelopathic activity of released compounds in *P. guajava* extracts has been well documented by Bovey and Diaz-Colon (1969), Brown *et al.* (1983), Chapla and Campos (2010) and Dawood *et al.* (2012). The alleopathic activity in guava leaves was due to terpenoids, flavonoids, coumarins, cyanogenic acids have been reported by Begum *et al.* (2002) and Gutierrez *et al.* (2008). Chon and Kim (2004) attributed the highly allelopathic herbicidal potential of some plant extracts to the presence of allelopathic substances, e.g., coumarin, o-coumaric acid, p-coumaric acid, benzoic acid, phydroxybenzoic acid and ferulic acid. This suggestion was confirmed by El-Rokiek *et al.* (2012b) who found that the extract of guava dry leaves contain some phenolic acids e.g., ferulic, coumaric and chlorogenic acids. It was observed that the reduction in dry weight of *A. arvensis* in pots of untreated unweeded (Plants+*A. fatua*+*A. arvensis* without addition of guava leaf residues) control was 15.74% in comparison to its dry weight in pots that contain *A. arvensis* only. The corresponding result in *A. fatua* was 16.21% in comparison to pots containing *A. fatua* only. It is also clear that little difference between the two weeds as compared to their corresponding control indicated that the reduction in weed growth may be attributed to the allelopathic effect of GLR and not competition between weeds.

The results also indicate that the reduction in both *A. arvensis* and *A. fatua* was accompanied by increase in different growth character of wheat plants (Table 2) and consequently this reflected on wheat grain yield and its components (Table 3). Indication of negative effect of guava leaves on weeds and not on wheat explained by that allelochemicals often exhibit selectivity similar to that in synthetic herbicides (Weston, 1996). In general, controlling weeds in wheat increased crop growth and hence increased net return on crop yield (El-Metwally and El-Rokiek, 2007; Geisel *et al.*, 2008; Raatz *et al.*, 2011; Sharara *et al.*, 2011; El-Rokiek *et al.*, 2012a). The results also show increases in some metabolic activity such as carbohydrate and protein contents in the yielded grains (Table 4). The increased metabolic activity of wheat plants was supposed to be due to increase in the contents of carbohydrate and protein as have been previously reported by Coruzzi and Last (2000). In addition, El-Rokiek *et al.* (2012b) attributed the increase in carbohydrate and protein to the increase in growth and yield of crop plants.

## CONCLUSION

The results from this study indicate the usefulness of allelopathic activity of guava leaves residue for elaborating method(s) to combat *Anagalis arvensis* (brod leaved weed) and *Avena fatua* (grassy weed) in wheat. However, detailed works under field conditions are still required.

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