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# Allelopathic Effect of *Mango* Leaf Residue against *Portulaca oleracea* or *Chorchorus olitorius* Associated *Phaseolus vulgaris* Growth

**Kowthar G. El-Rokiek*, E. R. El–Desoki, I. M. El-Metwally, and Mona G. Dawood**

Botany Department, Agriculture and Biological Division, National Research Centre, Dokki, Giza, Egypt, 33 El Bohouth st P.O. 12622.

**ABSTRACT**

The allelopathic effect of dry leaves of mango (*Mangifera indica*) at 20, 40, 60, 80 and 100g / kg surface soil were studied on the growth of *Portulaca oleracea* or *Chorchorus olitorius* associated beans (*Phaseolus vulgaris*) cv. Giza 4 in a greenhouse experiment in National Research Centre, Egypt. The results showed significant inhibition in dry weight of *P. oleracea* or *C. olitorius* in comparison to their corresponding untreated control. The phytotoxic effect on both weed dry weight reached maximum by mango leaf residue at 100g / kg surface soil. The inhibition in dry weight of *P. oleracea* attained about 78% of unweeded control (contained *P. oleracea* and beans), while the inhibition in *C. olitorius* exceeded 90% in comparison to untreated control (*C. olitorius* and beans). However, the increase in mango leaf residue up to 100g / kg soil increased significantly both growth and yield of beans represented by number and weight of pods as well as weight of seeds / plant (yield / plant) and weight of 100 seeds over unweeded plants. The contents of carbohydrates and protein in the yielded seeds increased as well. The results suggest possibility of using mango leaf residue as a bioherbicide.

**Keywords:** *Portulaca oleracea, Chorchorus olitorius*, common bean, allelochemicals, mango leaves.

***Corresponding author**

## INTRODUCTION

*Phaseolus vulgaris* is one of the major grain legumes mostly grown in the world as a source of proteins for human. Like many other grain legumes and crop plants, weeds grown associated these crop plants causing high percentage of yield loss (El-Rokiek *et al.*, 2010 and 2013 and Ahmed *et al*., 2014). Due to competition on nutrients, water, light, etc. different herbicides were used for weed control to decrease weed competition and consequently increase the crop yield (Metwally, 2002; Abdelhamid and El-Metwally, 2008; El-Metwally and Abdelhamid, 2008; Soltani *et al*., 2008 and El-Rokiek *et al*., 2013).

However, the continuous use of herbicides caused problems because of environmental, toxicological or economical purposes associated with their use ((Duke *et al*., 1999). So, the need for alternative natural herbicides becomes important to reduce the continuous use of synthetic herbicides and for the development of safer, alternative crop protectants (Marambe and Sangakkara, 1996; Mahmood and Cheema, 2004). Many crop, trees and weed species have been reported to possess allelopathic activity on the growth of other plant species (El-Rokiek and Eid, 2009; Jabran *et al*., 2010; El-Rokiek *et al*., 2011). Allelopathic substances (secondary plant metabolites) are present in many plant tissues, e.g. leaves, stems, flowers, fruits, seeds and roots (Einhellig, 2004; Singh *et al*., 2003 and 2005; Mahmood *et al*., 2010 and Ahmed *et al*., 2014). Allelochemicals are released to the environment from plants through degradation, volatilization, leaching from plant leaves, and from root exudation (Petersen *et al*., 2001; Price *et al*., 2005). Trees are considered as rich source of allelochemicals (Nandal *et al*., 1994; Jalal *et al*., 2010; Yamagushi *et al*., 2011 and El-Rokiek and El-Nagdy, 2011). Krishna *et al*. (2005) reported that mango leaf leachate caused maximum toxic effect to root and shoot of honey plant. Mango leaves have different allelopathic effects; *Cyperus rotundus* and *Cynodon dactylon* were effectively controlled by mango leaf mulches (Challa and Ravindra, 1999). Dried mango leaf powder completely inhibited sprouting of perennial weed purple nutsedge tubers (James and Bala, 2003). El-Rokiek *et al.* (2010) reported that mango leaf powder and its aqueous extract severely reduced the growth of purple nutsedge. The growth of different crops e.g. soybean and maize was reduced by mango leaf extract (Sahoo *et al*., 2010).

The objective of the present study is an attempt to control the two weeds associated *Phaseolus vulgaris* plants by leaf residue of *Mangefera indica*.

## MATERIAL AND METHODS

Pot experiments were conducted in greenhouse of the National Research Centre, during two successive summer seasons on August of 2013 and 2014. Mango leaves were collected from Egyptian gardens, washed well with tap water to remove dust and were dried in an electric oven at 40 $^0$C. The dried leaves were ground to a fine powder. The dried mango powder was mixed with the soil surface at the rate of 20, 40, 60, 80 and 100g/kg soil. The experiments were carried out in plastic pots (30 cm diameter and 17 cm height) filled with equal amounts of sieved soil (clay and sand; 2:1 v/v). Seeds of *Phaseolus vulgaris* cv. Giza 4 were sown 2 cm deep, and germinated under the average maximum and minimum temperature of 37.5±1 and 20 ±1°C. The pots were infested with a constant weight of seeds *Portulaca oleracea* L. or *Chorchorus olitorius*. Weed seeds were sown simultaneously and mixed thoroughly at a depth of 2 cm in the soil. Thinning of *P. vulgaris* was done after 2 weeks so that 3 homogeneous seedlings were left per pot. Ammonium nitrate and super phosphate (2: 1 w/w) were added for each pot 15 days after sowing. The experiment consisted of 15 treatments including five control treatments. The five control treatments were; pots containing free weed plant (*P. vulgaris* only), pots containing *P. oleracea* or *C. olitorius,* pots containing *P. vulgaris* and *P. oleracea* or *C. olitorius.* Each treatment was represented by 9 pots. All pots were distributed in a complete randomized design.

### Weed samples

Weed samples were taken from three pots at the flowering stage and at harvest. All weed samples in each pot were pulled up and dried at an electric oven at 70$^0$c for determining dry weight.

### *Phaseolus vulgaris* Data

The following data were taken for each individual plant:

Plant height, number of leaves as well as dry weight (g/plant) at flowering stage. At harvest, number and weight of green pods per plant were taken from three pots of each treatment and the other three pots were left for dry yield. The data on dry yield weight of seeds / plant and weight of 100 seeds.

**Determination of carbohydrate content in *P. vulgaris* seeds**

Total carbohydrates were extracted from dry finely ground yielded seeds of *P. vulgaris* according to Herbert *et al*. (1971) and estimated colourimetrically by the phenol-sulphoric acid method (Montogomery 1961).

**Determination of protein content in *P. vulgaris* seeds**

Total protein contents were extracted from dried grinded seeds according to Bradford (1976).

**Statistical analysis**

The data were statistically analyzed according to Snedecor and chochran (1980). The least significant differences (LSD) were calculated at $P \leq 0.05$.

## RESULTS

**Weed growth**

The results in Table 1 indicate significant reduction in dry weight of either *Portulaca oleracea* or *Chorchorus olitorius* with using mango leaf residue (MLR) at different concentrations. The reduction in dry weight of either of the two weeds was correlated with the rate of MLR as compared to the corresponding control. MLR had maximum allelopathic effect at 100g / kg soil surface which represent the highest level of activity against *P. oleracea* or *C. olitorius*. The reduction in dry weight of *P. oleracea* at harvest reached about 78%, while the reduction *in C. olitorius* reached about 90.6% of the corresponding control.

***Phaseolus vulgaris* growth**

MLR at all concentrations increased significantly plant height of *P. vulgaris* at flowering in comparison to untreated control (Table 2). The highest concentration of MLR (100g/ kg soil surface) caused observable significant increase in plant height. Mostly, the number of leaves elevated significantly over untreated control especially with 100g / kg soil surface of MLR. The results in Table 2 also show great significant increase in dry weight of *P. vulgaris* plants over untreated control. The increase in dry weight of *P. vulgaris* was more pronouncing when treated with MLR at 100g / kg soil surface especially that associated with *C. olitorius* as compared to untreated control.

***Phaseolus vulgaris* green and dry yield**

*Phaseolus vulgaris* plant treated with MLR at different concentrations resulted in great significant increase in green yield represented by number of pods / plant and weight of pods / plant (Table 3). The results were obtained for the crop associated with *P. oleracea* or *C. olitorius*. Similarly dry yield represented by weight of seeds/pod, weight seeds/plant and weight of 100 seeds were found to be increased significantly due to treatments with different concentrations of MLR. The treatments of pots containing *P. vulgaris* and *P. oleracea* or *Paseolus vulgaris* and *C. olitorius* with MLR at 80 or 100g / kg soil surface clearly exhibited the best results in all dry yield parameters over corresponding control, sometimes with nonsignificant difference between the two concentrations.

**Table 1: Effect of mango leaf residue on dry weight of *Portulaca oleracea* and *Chorchorus olitorius* associated *P. vulgaris*.**

| Treatments | Mango leaves (g/Kg soil) | Dry weight g/pot | |
|---|---|---|---|
| | | At flowering stage | At harvest |
| Bean only | 0 | - | - |
| *Portulaca oleracea* | 0 | 0.689 | 18.826 |
| Bean +*P. oleracea* | 0 | 0.427 | 14.930 |
| | 20 | 0.326 | 9.116 |
| | 40 | 0.258 | 8.370 |
| | 60 | 0.115 | 7.346 |
| | 80 | 0.105 | 5.166 |
| | 100 | 0.039 | 3.273 |
| *Chorchorus olitorius* | 0 | 1.501 | 18.863 |
| Bean + *C. olitorius* | 0 | 0.460 | 17.693 |
| | 20 | 0.383 | 12.946 |
| | 40 | 0.298 | 7.030 |
| | 60 | 0.172 | 2.956 |
| | 80 | 0.079 | 2.586 |
| | 100 | 0.018 | 1.666 |
| LSD at 5 % | | 0.126 | 0.467 |

## Carbohydrate and protein contents

The results in Table 4 reveal significant increase in carbohydrate content in the yielded seeds of *P. vulgaris* by applying mango leaf residue upto 100g / kg surface soil as compared to the content of unweeded untreated seeds. Maximum content was measured with using MLR at 100g / kg surface soil. The changes in protein content due to different concentrations of MLR in seeds of *P. vulgaris* are more or less similar to that of the changes in carbohydrate content.

**Table 2: Effect of mango leaf residue on some growth characters of *P. vulgaris.***

| Treatments | Mango leaves (g/Kg soil) | Plant height (cm) | No leaves/ plant | Dry weight/ plant (g) |
|---|---|---|---|---|
| Bean only | 0 | 55.33 | 7.26 | 2.266 |
| *Portulaca oleracea* | 0 | - | - | - |
| Bean +*P. oleracea* | 0 | 28.50 | 5.83 | 1.500 |
| | 20 | 31.00 | 6.20 | 1.500 |
| | 40 | 45.50 | 6.26 | 1.716 |
| | 60 | 48.00 | 7.26 | 1.733 |
| | 80 | 48.50 | 7.30 | 1.850 |
| | 100 | 49.00 | 7.50 | 2.033 |
| *Chorchorus olitorius* | 0 | - | - | - |
| Bean + *C. olitorius* | 0 | 29.33 | 4.50 | 1.770 |
| | 20 | 33.33 | 5.50 | 1.850 |
| | 40 | 36.66 | 6.00 | 2.000 |
| | 60 | 39.00 | 6.10 | 2.060 |
| | 80 | 44.33 | 6.76 | 2.266 |
| | 100 | 54.00 | 8.03 | 3.166 |
| LSD at 5 % | | 2.07 | 0.55 | 0.121 |

**Table 3: Effect of mango leaf residue on yield and yield components of *P. vulgaris.***

| Treatments | Mango leaves (g/Kg soil) | Green yield | | Dry yield | | |
|---|---|---|---|---|---|---|
| | | No.pods/plant | Wt.pods/plant (g) | Wt.seeds/pod(g) | Wt.seeds/plant(g) | Wt.100seeds (g) |
| Weed free been | 0 | 6.66 | **9.26** | **1.766** | **8.03** | **43.88** |
| *Portulaca oleracea* | 0 | - | - | - | - | - |
| Bean +*P. oleracea* | 0 | 3.00 | **4.60** | **1.266** | **3.46** | **29.21** |
| | 20 | 4.00 | **5.10** | **1.400** | **4.03** | **32.50** |
| | 40 | 4.50 | **5.63** | **1.600** | **4.46** | **37.86** |
| | 60 | 4.66 | **7.10** | **1.700** | **5.96** | **42.50** |
| | 80 | 4.66 | **7.36** | **1.766** | **6.03** | **43.05** |
| | 100 | 5.00 | **8.50** | **1.766** | **6.23** | **44.00** |
| *Chorchorus olitorius* | 0 | - | - | - | - | - |
| Bean + *C. olitorius* | 0 | 3.33 | **3.60** | **1.000** | **3.75** | **33.11** |
| | 20 | 3.50 | **3.63** | **1.333** | **4.00** | **35.83** |
| | 40 | 3.66 | **4.06** | **1.433** | **4.20** | **36.67** |
| | 60 | 4.00 | **4.93** | **1.566** | **4.43** | **37.86** |
| | 80 | 4.60 | **5.46** | **1.766** | **6.11** | **39.66** |
| | 100 | 7.00 | **10.70** | **1.833** | **8.53** | **44.44** |
| LSD at 5 % | | 0.63 | 1.07 | 0.20 | 0.39 | 3.08 |

**Table 4: Effect of mango leaf residue on carbohydrate and protein contents in *P. vulgaris* seeds**

| Treatments | Mango leaves (g/Kg soil) | Carbohydrate percentage | Protein percentage |
|---|---|---|---|
| Weed free beans | 0 | 51.88 | 27.65 |
| *Portulaca oleracea* | 0 | - | - |
| Bean +*P. oleracea* | 0 | 27.43 | 19.94 |
| | 20 | 31.08 | 20.83 |
| | 40 | 33.28 | 22.32 |
| | 60 | 42.66 | 24.09 |
| | 80 | 44.78 | 24.69 |
| | 100 | 47.94 | 27.91 |
| *Chorchorus olitorius* | 0 | - | - |
| Bean + *C. olitorius* | 0 | 26.98 | 18.62 |
| | 20 | 30.92 | 21.20 |
| | 40 | 31.50 | 24.18 |
| | 60 | 37.81 | 27.55 |
| | 80 | 42.53 | 27.64 |
| | 100 | 51.21 | 28.37 |
| LSD at 5 % | | 2.61 | 0.39 |

## DISCUSSION

Many fruit trees and weed species have been reported to possess allelopathic activity on the growth of other plant species (Jalal *et al*., 2010). Allelochemicals released to the environment from plants through plant degradation, volatilization, leaching from root exudation and from plant leaves as well (Qasem, 2001and Kobayashi, 2004).

The present results indicate that the dry weight of either *Portulaca oleracea* or *Chorchorus olitorius* was significantly inhibited by using (MLR) at different concentrations. Maximum allelopathic activity was recorded at harvest by using 100 of MLR (78 and 90 %, respectively). The results coincide with the finding of different workers (James and Bala, 2003; Padmanaban and Daniel, 2003; Rudramuni *et al*., 2006 El-Rokiek *et al*., 2010; Jalal *et al*., 2010; Sahoo *et al*., 2010 and Ashafa *et al*., 2012). In general different plant leaves posses allelopathic activity causing reduction in weed growth (El-Rokiek and Eid, 2009; El-Rokiek and El-Nagdy, 2011 and El-Rokiek *et al*., 2011and Yamagushi *et al*., 2011). The reduction in either *Portulaca oleracea* or *Chorchorus olitorius* may be due to presence of some toxic compounds present in the MLR that released to the soil. In this respect, Singh *et al.,* (2003); Chon and Kim (2004) backed the highly allelopathic reducing activity of some plant extracts to the presence of allelopathic substances e.g. coumarin, o-coumaric acid, pcoumaric acid, benzoic acid, P-hydroxybenzoic acid, ferulic acid and cinnamic acid. Moreover, Kanwal *et al*. (2010) isolated five flavonoids from mango leaves. HPLC analysis of aqueous extract of dry leaves of mango resulted in the existence of ferulic, coumaric, benzoic, vanelic, chlorogenic, caffiec, gallic, hydroxybenzoic and cinnamic acids (El-Rokiek *et al*., 2010).

The reduction of either *Portulaca oleracea* or *Chorchorus olitorius* was accompanied by increasing in *P. vulgaris* growth and yield as expected. Controlling weeds increase the competition of the crop plant against weeds and consequently resulted in increased growth and yield (Metwally, 2002; El-Metwally and Abdelhamid, 2008; Soltani *et al*., 2008 and El-Rokiek *et al*., 2013). The increase in growth was concomitant with increase in carbohydrate content in the yielded seeds.

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