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# PHYTOTOXIC POTENTIAL OF *CELTIS AUSTRALIS* L. (FAMILY ULMACEAE) AGAINST FOUR CROP SPECIES

**IMTIAZ AHMAD[1*], FARRUKH HUSSAIN[2,4], BARKATULLAH[2] AND BASHIR AHMAD[3]**

[1]*Department of Botany, Bacha Khan University, Charsadda, Pakistan*
[2]*Department of Botany, University of Peshawar, Pakistan*
[3]*Centre of Biotechnology and Microbiology, University of Peshawar, Pakistan*
[4]*Department of Biotechnology and Microbiology, Sarhad University of Science and Information Technology, Peshawar, Pakistan*
[*]*Corresponding author e-mail: imtiazahmad9310@yahoo.com*

**Abstract**

Bioassays were conducted to test the phytotoxic potential of *Celtis australis* against *Trifolium alexandrinum, Brassica campestris, Triticum aestivum* and *Lactuca sativa* under laboratory condition. Aqueous extracts from twigs and leaves were obtained by soaking 5 and 10g plant material in 100 ml distilled water for 24 and 48hr durations. Aqueous extracts significantly delayed/retarded the germination and reduced the plumule and radicle growth of all the four test species. Generally, extracts soaked for 48h especially 10 gm/100ml were inhibitory than 24h extracts of 5 or 10gm material. Extracts from twigs were inhibitory to germination of wheat while same extracts inhibited the plumule growth of *B. campestris.* Radicle growth of *T. alexandrinum* was inhibited more by twig extracts. Hot water extracts from twigs were less inhibitory than leaf extracts. Litter and mulch also significantly delayed the seed germination and retarded the overall growth of seedlings of all test species. The number and length of seminal roots of *T. aestivum* was suppressed by all aqueous extracts, added litter and mulch. The inhibitory response depended upon the test species, concentration, soaking duration and physiological parameters. The results suggested that *Celtis australis* has strong phytotoxic potential.

**Key words:** Phytotoxic potential, *Celtis,* Aqueous extract, *Brassica campestris*, *Triticum aestivum*.

## Introduction

Allelopathy is a complex natural process that operates along with competition to suppress and finally exclude susceptible associated species from the common habitat (Hussain *et al.,* 2010, 2011). Allelopathy can also be a useful biological control agent (Tabaglio *et al.*, 2008, Uremis *et al.,* 2009). Studies on allelopathic effects of trees including *Azadirachta indica* (Zoheir *et al.,* 2008), *Ficus subincisa*, *Bauhinia purpurea* and *Toona hexandra* (Singh *et al*., 2009), *Esenbeckia leiocarpa* (Souza *et al.,* 2010), and *Eucalyptus* spp. (Fang *et al.,* 2009; Espinosa-Garcia *et al.,* 2008; Bagavathy & Anthony, 2007; Khan *et al.,* 2008) have been conducted. Similarly, the allelopathy of *Tetrapleura tetraptera* (Amoo *et al.,* 2008), *Pinus halepensis* (Fernandez *et al.,* 2006), *Alnus nepalensis*, *Artocarpus heterophyllus* and *Emblica officinalis* (Kumar *et al.,* 2006) has also been worked out. It is also reported that *Broussonatia papyrifera* (Hussain *et al.,* 2004) exhibits strong allelopathic effect. Although references on the allelopathic potential of *Celtis laevigata* (Lodhi & Nickell, 1973; Lodhi, 1976) are available but no work on the phytotoxic potential of *Celtis australis* is available. *Celtis australis* L. (Family Ulmaceae), a deciduous up to 15 m tall tree, grows as wasteland species. It is also cultivated along the crop fields as fuel wood species. It is observed that *Triticum aestivum*, *Trifolium alexandrinum* and *Brassica campestris* show poor growth in its vicinity. The present study was, therefore, undertaken to assess the phytotoxic potential of *C. australis* against *Trifolium alexandrinum* L., *Brassica campestris* L. and *Triticum aestivum* L., which grow in its vicinity. *Lactuca sativa* L. was used as an additional test species. The findings will help agronomists and social forestry specialists while planting these trees on farm lands. The results will also be a contribution to the field of allelopathy.

## Materials and Methods

Healthy leaves and twigs of *Celtis australis* L., collected from trees growing in Swat, were shade dried at room temperature (20°C-25°C). They were powdered and stored for experimental use. Washed glassware was sterilized at 170°C for about 4h. The results were subjected to one way ANOVA.

**i. Aqueous extract bioassay:** Five and 10 g powdered leaves or twigs were soaked separately in 100 ml distilled water for 24 and 48 hours at room temperature (20°C-25°C) and filtered. The pH of extracts was adjusted to 6.5. The aqueous extracts along with distilled water control were used against *Trifolium alexandrinum* L., *Brassica campestris* L., *Triticum aestivum* L. and *Lactuca sativa* L. Ten seeds of each species were kept in Petri dishes on two folds of filter papers and moistened with respective aqueous extracts. Distilled water was used as control. For each treatment 5 replicates, each with 10 seeds were taken. Germination, length of plumule and radicle fresh and dry weight and moisture contents were recorded after 72 h. Twenty seedlings from each treatment were randomly selected for determination of fresh and dry weight.

**ii. Hot water extract bioassay:** Five and 10 g dried leaves or twigs were separately boiled in 100 ml water for 5 minutes and filtered. The room cooled extracts were applied against the same test species.

**iii. Effect of litter:** Five g powdered litter from leaves or twigs were placed in a Petri dish and topped with single sheet of filter paper and moistened with 5 ml water. In control treatment fine pieces of filter papers were used. For each treatment, five replicates, each with 10 seeds were made. The Petri dishes were incubated as before and same parameters were determined as mentioned above.

**iv. Effect of mulching:** Five gm powdered leaves or twigs were mixed with sterilized moist sand in small plastic pots. For each treatment five replicates, each with 10 seeds *were made*. Control consisted of fine pieces of filter papers. Seeds of same four test species were sown and incubated at 25°C. After 7 days, germination, growth of plumule and radicle were measured. Twenty seedlings were randomly taken out for the measurement fresh and dry weights and moisture contents.

**Results and Discussion**

**Effect of aqueous extracts:** Aqueous extracts obtained through boiling or soaking at room temperature affected the germination and various growth parameters. The germination, radicle and plumule lengths of *Brassica campestris* were significantly reduced by all the extracts at all concentrations and soaking durations (Table 1). Similarly, hot water extracts also proved significantly inhibitory. The results are in agreement with those of Todaria *et al.,* (2005) and Hussain *et al.,* (2004, 2010, 2011) in this aspect. The germination and overall growth of *Brassica campestris* was also inhibited by aqueous extracts from *Parthenium hysterophorus* (Singh *et al.,* 2005; Maharjan *et al*., 2007) and *Solidago canadensis* (Sun *et al.,* 2006), *Prosopis juliflora* and *Acacia nilotica* (Khan *et al.,* 2005; Maharjan *et al.,* 2007) and *Hemistepta lyrata* (Gao *et al.,* 2009). Extracts from twigs significantly inhibited the germination of *T. aestivum* at both the concentrations, while leaf extracts were inhibitory to germination at higher concentration only (Table 1). However, the plumule and radicle growth of *T. aestivum* was significantly reduced by both twigs and leaf extracts. Extracts from twigs were slightly inhibitory than leaves (Table 2). Hot water extracts from twigs and leaves also significantly arrested not only germination but also reduced the overall growth of the seedlings. Our results agree with those of Sher *et al.,* (2011), who also reported similar allelopathic behavior of *Populus euphratica*. Aqueous extracts of *Eucalyptus camaldulensis* (Khan *et al*., 2008), *Parthenium hysterophorus* (Maharjan *et al*., 2007), *Dodonaea viscosa* (Barkatullah *et al*., 2010), *Prosopis juliflora* and *Accacia nilotica* (Khan *et al*., 2005) and *Prosposis juliflora* (Siddiqui *et al*., 2009) were significantly inhibitory to seed germination and growth of wheat; the present findings agree with them. Our findings are also supported by Lodhi (1976), Lodhi & Nickel (1973) who reported that extracts from *Celtis laevigata* obtained by boiling or soaking at room temperature or boiled were inhibitory to germination and seedling growth of test species.

Aqueous extracts delayed the germination of *T. alexandrinum* and *L. sativa* in the present case. The overall growth of seedling (radicle and plumule) was also significantly retarded (Table 1). Ethanolic extracts from *Hypericum myrianthum* also delayed the germination and retarded the radicle growth of *L. sativa* (Fritz *et al.,* 2007). The germination and overall growth of *T. alexandrinum* was significantly inhibited by soil infested with *Chenopodium murale* (El-khatib *et al.,* 2004). Hot water extracts had similar inhibitory effects on test species (Table 2). Leaf litter leachates of *Cymbopogon citratus, Derris scandens, Tamarindus indica* and *Gliricidia sepium* also inhibited radicle and hypocotyl length of *Lactuca sativa* (Fujii *et al.,* 2004). This agrees with our findings. Hot water extract from *Cenchrus* and *Bothriochla* were also inhibitory to test species (Hussain & Ilahi 2009; Hussain *et al.,* 2010, 2011). The fresh weight, dry weight and moisture content of all test species were significantly reduced by aqueous extracts including hot water extracts (Table 3).

**Table 1. Effect of aqueous extracts of *Celtis australis* on germination of test species.**

| Treatments/extracts | Test species | | | |
|---|---|---|---|---|
| | ***Brassica campestris*** | ***Triticum aestivum*** | ***Lactuca sativa*** | ***Trifolium alexandrinum*** |
| Control | 100 | 94 | 96 | 100 |
| 5gm/ 100 ml leaf. 24 hr | 24** | 92$^{ns}$ | 60** | 59** |
| 5gm/ 100 ml leaf. 48 hr | 14** | 86$^{ns}$ | 56** | 65** |
| 10gm/ 100 ml leaf. 24 hr | 28** | 88$^{ns}$ | 55** | 64** |
| 10gm/ 100 ml leaf. 48 hr | 18** | 80** | 55** | 66** |
| 5gm/ 100 ml twig 24 hr | 22** | 72** | 54** | 70** |
| 5gm/ 100 ml twig 48 hr | 16** | 64** | 54** | 58** |
| 10gm/ 100 ml twig 24 hr | 32** | 64** | 54** | 55** |
| 10 gm/ 100ml twig 48 hr | 14** | 64** | 55** | 54** |
| 5 gm/100ml hot water leaves extracts | 40** | 64** | 66** | 55** |
| 10 gm/100ml hot water leaves extracts | 14** | 44** | 60** | 55** |
| 5 gm/100ml hot water twig extracts | 34** | 74** | 60** | 48** |
| 10 gm/100ml hot water twig extracts | 16** | 42** | 60** | 55** |

Ns = Non-significant, ** = Highly significant

Each value is the mean of 5 replicates, each with 10 seeds

**Table 2. Effect of aqueous extracts of *Celtis australis* on plumule and radicle lengths of test species.**

| Test species | *Brassica campestris* | | *Triticum aestivum* | | *Lactuca sativa* | | *Trifolium alexandrinum* | |
|---|---|---|---|---|---|---|---|---|
| **Treatments** | **Radical** | **Plumule** | **Radical** | **Plumule** | **Radical** | **Plumule** | **Radical** | **Plumule** |
| Control | 48.86 | 28.94 | 36.92 | 30.43 | 6.40 | 10.00 | 7.74 | 8.12 |
| 5gm/ 100 ml leaf. 24 hr | 2.02** | 1.7** | 17.35** | 13.33** | 3.2** | 4.74** | 1.62** | 4.56** |
| 5gm/ 100 ml leaf. 48 hr | 0.98** | 0.7** | 13.63** | 9.14** | 2.62** | 4.16** | 1.12** | 1.94** |
| 10gm/ 100 ml leaf. 24 hr | 2.04** | 1.26** | 8.66** | 6.72** | 2.38** | 4.44** | 0.74** | 3.08** |
| 10gm/ 100 ml leaf. 48 hr | 1.54** | 0.84** | 7.06** | 3..78** | 3.60** | 2.98** | 0.86** | 1.3** |
| 5gm/ 100 ml twig 24 hr | 2.12** | 1.68** | 11.82** | 8.55** | 3.20** | 5.53** | 1.82** | 3.90** |
| 5gm/ 100 ml twig 48 hr | 1.06** | 0.72** | 8.89** | 5.08** | 2.44** | 4.55** | 1.72** | 2.92** |
| 10gm/ 100 ml twig 24 hr | 2.25** | 1.09** | 5.68** | 3.19** | 2.17** | 4.26** | 1.64** | 3.16** |
| 10 gm/ 100ml twig 48 hr. | 1.04** | 0.42** | 5.05** | 2.51** | 2.40** | 2.75** | 1.42** | 1.74** |
| 5 gm/100ml hot water leaves extracts | 2.54** | 1.51** | 4.44** | 7.91** | 3.42** | 3.62** | 2.12** | 3.36** |
| 10 gm/100ml hot water leaves extracts | 0.70** | 0.49** | 1.84** | 3.43** | 2.90** | 3.21** | 1.91** | 3.20** |
| 5 gm/100ml hot water twig extracts | 1.88** | 1.19** | 3.73** | 9.78** | 3.21** | 4.25** | 1.62** | 2.41** |
| 10 gm/100ml hot water twig extracts | 0.79** | 0.50** | 1.59** | 2.99** | 2.83** | 3.43** | 1.40** | 2.10** |

** = Highly significant

Each value is a mean of 5 replicates, each with 10 seeds

**Table 3. Effect of aqueous extracts of *Celtis australis* on moisture contents, fresh and dry weights of test species.**

| **Treatments** / **Test species** | **5gm/ 100 ml leaf. 24 hr** | **05gm/ 100 ml leaf. 48 hr** | **10gm/ 100 ml leaf. 24 hr** | **10gm/ 100 ml leaf. 48 hr** | **05gm/ 100 ml twig 48 hr** | **05gm/ 100 ml twig 48 hr** | **10gm/ 100 ml twig 24 hr** | **10gm/ 100 ml twig 48 hr** |
|---|---|---|---|---|---|---|---|---|
| | **Fresh weight (% of Control)** | | | | | | | |
| *Triticum aestivum* | 83.33 | 70.37 | 72.96 | 55.92 | 76.29 | 69.25 | 75.92 | 58.51 |
| *Brassica Campestris* | 75.49 | 45.59 | 70.59 | 47.55 | 79.55 | 49.51 | 59.31 | 42.65 |
| *Lactuca sativa* | 38.46 | 46.15 | 46.15 | 46.15 | 53.84 | 46.15 | 38.46 | 46.15 |
| *Trifolium alexandrium* | 66.66 | 37.50 | 50.00 | 41.66 | 70.83 | 50 | 45.83 | 45.83 |
| | **Dry weight (% of Control)** | | | | | | | |
| *Triticum aestvum* | 88.15 | 78.28 | 83.55 | 67.76 | 82.23 | 75.00 | 86.18 | 68.42 |
| *Brassica Campestris* | 86.84 | 52.63 | 82.46 | 57.89 | 88.59 | 56.14 | 68.42 | 50.87 |
| *Lactuca sativa* | 33.33 | 50 | 50 | 50 | 66.66 | 50 | 50 | 50 |
| *Trifolium alexandrinum* | 87.50 | 50.00 | 62.50 | 50.00 | 100 | 50 | 60 | 41.6 |
| | **Moisture content (% of Control)** | | | | | | | |
| *Triticum aestivum* | 87.47 | 76.85 | 71.00 | 46.60 | 64.80 | 64.04 | 56.49 | 51.92 |
| *Brassica Campestris* | 70.36 | 69.69 | 67.38 | 59.48 | 76.00 | 73.23 | 69.82 | 63.33 |
| *Lactuca sativa* | 37.50 | 25.00 | 25.00 | 25.00 | 18.75 | 25 | 16.66 | 25 |
| *Trifolium alexandrium* | 64.28 | 62.50 | 70.00 | 75.00 | 56 | 50 | 60 | 41.6 |

Aqueous extracts of both leaves and twigs in all the treatments significantly reduced the number and length of seminal roots in wheat. Hot water extracts was also inhibitory to test species. The length and number of seminal roots of wheat (Table 5) also got reduced with added litter and mulch.

It was obvious that extracts from 10gm were more inhibitory than 5 gm treatment. Moreover, 48h soaking of either 5 or 10 gm material was strongly phytotoxic than 24h soaked material. This agrees with our previous studies on other plants (Hussain *et al*., 2004, 2010, 2011).

**Effects of litter and mulching:** The effects of added litter and mulch were quite similar to each other and to results obtained in aforementioned bioassays against the test species. The germination and overall growth (radicle and plumule) was significantly delayed and arrested. The germination of *T. alexandrium* and *L. sativa* was inhibited more than other test species. The seedling growth of *B. campestris* was suppressed more than *T. alexandrinum*, *T. aestivum* and *L. sativa* (Table 4).

## Conclusion

The findings suggest that *C. australis* has strong phytotoxic potential against the crops tested in the present study. Its plantation should be carefully assessed along field borders. Further study is required to see the mechanism and phytotoxins responsible for the observed inhibition. The findings must also be tested under field conditions.

**Table 4. Effect of Mulch and Litter of *Celtis australis* on the growth of test species.**

| Treatments | Effect of mulching | | | | Effect of added litter | | | |
|---|---|---|---|---|---|---|---|---|
| **Test species** | ***Brassica campestris*** | ***Triticum aestvum*** | ***Lactuca sativa*** | ***Trifolium alexandrium*** | ***Brassica campestris*** | ***Triticum aestvum*** | ***Lactuca sativa*** | ***Trifolium alexandrium*** |
| | **Germination (%)** | | | | | | | |
| Control | 74 | 76 | 90 | 85 | 90 | 90 | 96 | 94 |
| Test | 54** | 56** | 60** | 55** | 40** | 56** | 68** | 60** |
| | **Plumule length mm** | | | | | | | |
| Control | 76.37 | 89.96 | 54.34 | 47.49 | 28.06 | 18.64 | 4.18 | 8.68 |
| Test | 41.36** | 43.71** | 21.22** | 15.36** | 2.56** | 4.41** | 1.36** | 2.34** |
| | **Radicle length mm** | | | | | | | |
| Control | 19.38 | 76.38 | 44.21 | 29.35 | 25.80 | 23.73 | 4.84 | 7.04 |
| Test | 8.85** | 9.16** | 17.32** | 12.34** | 1.63** | 4.78** | 1.74** | 1.28** |
| | **Fresh weight mg** | | | | | | | |
| Control | 1.80 | 2.01 | 1.83 | 1.67 | 2.32 | 1.92 | 0.09 | 0.16 |
| Test | 0.36 ** | 0.81 ** | 0.92** | 078** | 0.36** | 0.51** | 0.05** | 0.08** |
| % of control | 20 | 40.29 | 50.27 | 46.70 | 15.51 | 26.56 | 55.55 | 50 |
| | **Dry weight mg** | | | | | | | |
| Control | 0.9 | 1.40 | 0.80 | 0.70 | 1.10 | 0.80 | 0.03 | 0.07 |
| Test | 0.23 ** | 0.52** | 0.50** | 040 | 0.21** | 0.30** | 0.02 | 0.04 |
| % of control | 25.55 | 37.14 | 62.50 | 57.41 | 19.09 | 37.50 | 66.66 | 57.14 |
| | **Moisture content (%)** | | | | | | | |
| Control | 100 | 95.14 | 128.75 | 138.57 | 201.81 | 140 | 200 | 128.57 |
| Test | 56.52 ** | 55.77** | 84** | 95 | 71.42** | 70** | 150 | 100** |
| % of control | 56.52 | 58.61 | 65.24 | 68.56 | 35.38 | 50 | 75 | 77.77 |

** = Highly significant

**Table 5. Effect of various treatments on the number and size of seminal roots in wheat.**

| Treatments | Mean number of seminal roots | | Mean length of seminal roots | |
|---|---|---|---|---|
| | **Control** | **Test** | **Control** | **Test** |
| 5gm/ 100 ml leaf 24 hr | 2.66 | 1.28** | 31.23 | 14.40** |
| 5gm/ 100 ml leaf 48 hr | 2.66 | 1.00** | 31.23 | 10.23** |
| 10gm/ 100 ml leaf 24 hr | 2.66 | 0.76** | 31.23 | 6.45** |
| 10gm/ 100 ml leaf 48 hr | 2.66 | 0.86** | 31.23 | 6.32** |
| 5gm/ 100 ml twig 24 hr | 2.66 | 1.20** | 31.23 | 8.31** |
| 5gm/ 100 ml twig 48 hr | 2.66 | 1.18** | 31.23 | 6.23** |
| 10gm/ 100 ml twig 24 hr | 2.66 | 1.20** | 31.23 | 4.53** |
| 10 gm/ 100ml twig 48 hr. | 2.66 | 1.20** | 31.23 | 4.37** |
| 5 gm/100ml hot water leaves extracts | 2.66 | 1.56** | 31.23 | 6.51** |
| 10 gm/100ml hot water leaves extracts | 2.66 | 1.46** | 31.23 | 2.52** |
| 5 gm/100ml hot water twig extracts | 2.66 | 1.38** | 31.23 | 7.35** |
| 10 gm/100ml hot water twig extracts | 2.66 | 1.26** | 31.23 | 2.01** |
| Added litter | 2.8 | 1.40** | 21.32 | 5.44** |
| Added mulch | 3.4 | 1.70** | 35.30 | 7.28** |

** = Highly significant

Each reading is the grand mean of 5 replicates and each replicate with 10 seeds

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