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# COMPARATIVE PHYTOTOXICITY OF AQUEOUS EXTRACTS OF *CENTAUREA MACULOSA* AND *MELILOTUS OFFICINALIS* ON GERMINABILITY AND GROWTH OF WHEAT

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**ABSTRACT.** Weed incursion in cultivated fields is a serious biological problem, which causes considerable yield losses of economically important field crops through allelopathy and competitive interactions. Spotted knapweed (*Centaurea maculosa*) and yellow melilot (*Melilotus officinalis*) are among the most prevalent weeds in cultivated fields of Pakistan, particularly in wheat fields. Like many other weeds, they may pose allelopathic and competitive challenges to field crops. The objective of this study was to evaluate allelopathic potentials of the two weeds on germination and seedling growth of wheat under laboratory conditions. Amounts of 15, 20, 25 and 30% concentrated leaf aqueous extracts of *C. maculosa* and *M. officinalis* were prepared and tested for their effects on germination percentage, radicle and coleoptile lengths of wheat. Germination, radicle and coleoptile lengths of test crop declined significantly at higher concentration (25-30%) of the extracts of two weeds. However, concentration of *M. officinalis* up to 20% had either no effect or stimulatory effects on the studied growth characteristics of wheat. Highest germination inhibition and decreased seedling growth were caused by leaf extracts of *C. maculosa* at 30% extract concentration. Growth inhibition was generally dependent on the extract concentration. The study indicated that both plant exhibited allelopathic activity and growth inhibitory effects on wheat at higher concentration; however, extracts of *C. maculosa* were more phytoinhibitory

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than *M. officinalis*. The weeds could serve as potent allelopathic plants for management of other weeds.

**Keywords:** allelopathy; allelochemicals; early growth; invasive plants; weeds.

## INTRODUCTION

Wheat (*Triticum aestivum*) is one of the most important cereals, second to rice in terms of cultivation and consumption with influential role in addressing human food needs, animal feeds and global trade (Trnka *et al*., 2014; Majeed *et al*., 2017a). In the context of changing climatic conditions and human population growth, which seem to negatively influence crop production (Ludwig and Asseng, 2006; Battisti and Naylor, 2009), greater efforts are needed to multiply production of wheat and other crops for food stability. Currently, global wheat production is 72.9 million tonnes harvested from an area of 22 million hectares (FAOSTAT, 2017); however, productivity is potentially threatened by many biological and environmental constraints. Weeds infestations in wheat fields are among several other biological and environmental factors, which correspond to great reduction in crop yields (Oerke, 2006).

Effects of weeds on yield and production of wheat is, generally, negative, which cause almost 17-25% reduction year$^{-1}$ through competition for resources and allelopathic activities (Jabeen *et al*., 2013). Earlier studies have shown that aqueous extracts of different weeds, such as *Chenopodium album, Chenopodium murale, Fumaria indica, Euphorbia hirta, Cynodon dactylon, Sorghum halepense* and *Rumex crispus* (Majeed *et al*., 2012; Jabeen *et al*., 2013; Islam *et al*., 2014; Petrova *et al*., 2015) applied at different concentration had inhibitory effects on germination and growth of wheat. Although allelopathic potentials of spotted knapweed (*Centaurea maculosa*) and yellow melilot (*Melilotus officinalis*) against different weeds and other plants species have been documented (He *et al*., 2009; Wang and Qi, 2014); however, little information is available on their allelopathic effects on common bread wheat. The objective of this experiment was, therefore, to study germination and growth response of wheat to *C. maculosa* and *M. officinalis*.

## MATERIALS AND METHODS

Leaves of two weeds (*C. maculosa* and *M. officinalis*), at flowering stage, were collected from wheat fields during April 2017 and were shade dried and ground to powder; 300 g of powder of each weed were separately soaked in 1L distilled water for 48 h at room temperature; 15, 20, 25 and 30% aqueous extracts were prepared and stored at 4°C in refrigerator for further germination and seedling test.

Seeds of wheat (cv. Shahkar-2013) were placed on double layer of filter paper in Petri dishes. These were kept in incubator at 22°C (photoperiod: 12 h) at the Department of Botany, Qurtuba University of Science and Technology, during April 2017. A quantity of 8 ml of different extracts, at concentrations 0, 15, 20, 25 and 30%, were applied to Petri dishes. Allelopathic effects of test weeds were recorded on germination (%) radicle and coleoptile length of wheat.

The experiment was established in completely randomized design with each Petri dish replicated four times. Data were statistically analyzed through analysis of variance (ANOVA) using SPSS software, while significant differences in data were determined by least significant difference (LSD) at $p \leq 0.05$.

## RESULTS AND DISCUSSION

Results demonstrated that maximum germination (100%) occurred in control and 15-20% aqueous treatment of *C. maculosa* and 20% concentration of *M. officinalis* (*Fig. 1*). Exceeding concentration of both weeds resulted in lowering germination of seeds; 30% extract concentration resulted in 84.7 and 94.7% germination for *C. maculosa* and *M. officinalis*, respectively.

Radicle growth was found maximum (14.9 cm) in 15% extract concentration of *M. officinalis*, followed by control (14.6 cm) with no effect by 20% concentration of this weed (*Fig. 2*). Concentration of extracts exceeding 15% for *C. maculosa*, while 20% for *M. officinalis* had drastic effects on radicle growth. Lowest radicle length (9.2 cm) was observed in 30% treatment of *C. maculosa*, while at this concentration of *M. officinalis* radicle length was found to be 12.4 cm.

Contrary to radicle length, coleoptile length was not significantly influenced by extract of the two weeds at concentration ≤ 20%; however, higher concentration (25 and 30%) resulted in significantly reduced coleoptile lengths (*Fig. 3*). The most inhibitory effects were visible in 30% treatment of *C. maculosa*, where coleoptile grew to a length of 7 cm, when compared to control, where coleoptile length was 10.2 cm. Extracts of *M. officinalis*, at 25 and 30% concentration, were also inhibitory however less severe than *C. maculosa*.

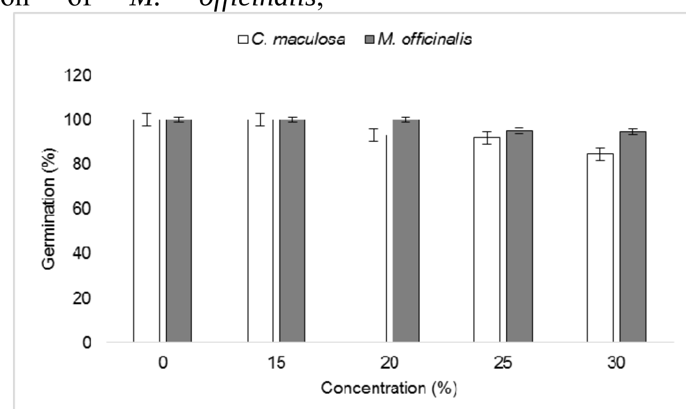


**Figure 1 - Effect of leaf extracts of *C. maculosa* and *M. officinalis* on the germination of wheat**

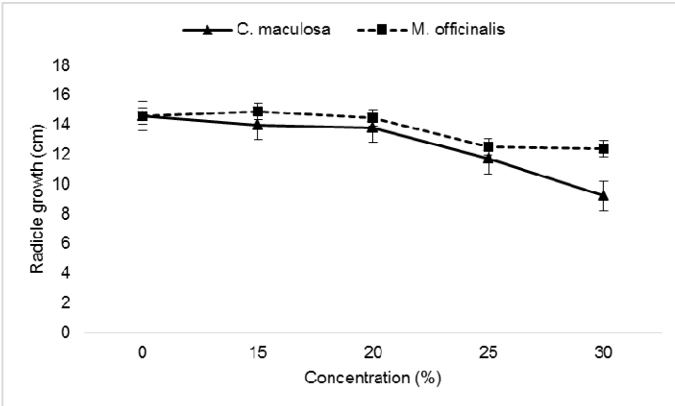


**Figure 2 - Effect of leaf extracts of *C. maculosa* and *M. officinalis* on radicle growth of wheat**

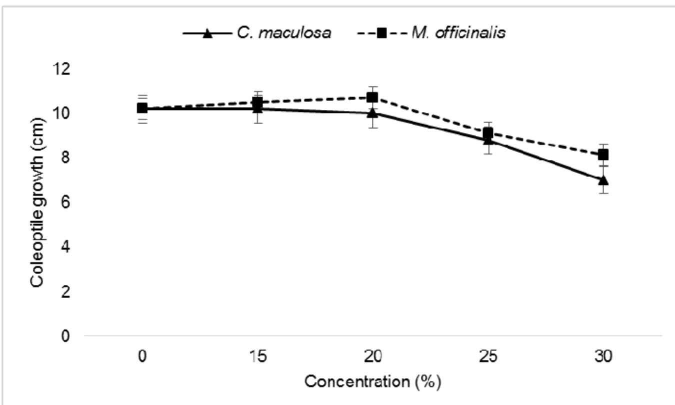


**Figure 3 - Effect of leaf extracts of *C. maculosa* and *M. officinalis* on coleoptile growth of wheat**

Data presented in *Table 1* shows percent increase or decrease in germination, radicle and coleoptile length in response to different concentration of aqueous extracts of two weeds. Germination and growth test indicated that leaf extracts of *C. maculosa* were more detrimental than *M. officinalis*. Germination of seeds was lowered by 7.06, 8.6 and 18.06% by *C. maculosa* extracts at 20, 25 and 30% concentration, respectively, while 15% concentration had no effect (*Table 1*). Extracts of *M. officinalis* had no effect on germination at 15 and 20%, but inhibitory responses were observed at 25 and 30% concentration. All the tested extract concentration of *C. maculosa* was phytotoxic to radicle elongation; however, highest concentration reduced radicle length by 58.7%, compared to *M. officinalis*, which had relatively less sever effects. Moreover, lower extracts (15 and 20%) of *M. officinalis* had stimulatory effects, which increased radicle length by 2 and 0.7%, respectively. For coleoptile length, only 15% concentration of *C. maculosa* was not phytotoxic, while higher concentration significantly reduced this parameter reaching to 45.7% reduction at 30% concentration. Extracts of *M. officinalis* at 15 and 20% extract concentration promoted coleoptile growth accounting for 2.8 and 4.7% increase over control, but 25 and 30% concentration caused gradual reduction in coleoptile elongation by 11.9 and 25.4%, respectively.

**Table 1 - Percent increase (+) and decrease (-) in germination, radicle and coleoptile growth of wheat under allelopathic influence of two weeds**

| Concentration (%) | Germination | | Radicle growth | | Coleoptile growth | |
|---|---|---|---|---|---|---|
| | *C. maculosa* | *M. officinalis* | *C. maculosa* | *M. officinalis* | *C. maculosa* | *M. officinalis* |
| 15 | 0 | 0 | -4.3 | +2 | 0 | +2.8 |
| 20 | -7.06 | 0 | -5.8 | +0.7 | -2 | +4.7 |
| 25 | -8.6 | -4.93 | -24.7 | -16.8 | -15.9 | -11.9 |
| 30 | -18.06 | -5.6 | -58.7 | -17.7 | -45.7 | -25.4 |

In general, our data indicated that wheat responded more negatively to extracts of *C. maculosa* than to *M. officinalis*, which had both stimulatory (at concentration 15 and 20%), as well as inhibitory effects at higher doses of extracts. In previous work, phytotoxic effect of *C. maculosa* on *Poa sanbergii* and some members of Asteraceae, Ranunculaceae and Liliaceae have been documented with decreased plant height and leaf numbers of target plants, due to its active allelochemical (±) catechin (Thorpe *et al.*, 2009). Our results partially agree with Siyar *et al.* (2017), who documented both stimulatory and inhibitory effects of *M. alba* on germination of wheat. Similarly, aqueous extracts have been shown to inhibit germination and growth of *Portulaca oleracea*, *Herba taraxaci* and *Rumex patientia* at higher concentration (Wang and Qi, 2014); however, studies of the allelopathic activities of these two weeds on wheat have not been reported. Our study seems to be the first report of *in vitro* allelopathic assay of *C. maculosa* and *M. officinalis*. Although, Thorpe *et al.* (2009) asserted that *C. maculosa* produce a potent allelochemical (catechin), which have phytotoxic effects on other plants; nevertheless, Duke *et al.* (2009) suggested that the invasive weed has strong antioxidant potentials and could not show phytotoxicity. Thus our study, based on the phytotoxic effect on germination and growth of wheat, does not agree with Duke *et al*. (2009) and proposes it as an allelopathic plant. Moreover, to a lesser extent, *M. officinalis* has also allelopathic activity. Lower germination and seedling growth of wheat in response to different concentrations could be explained as potential allelochemicals present in leaf extracts of the two weeds might have altered water absorption, due to changes in enzyme activity and metabolic processes in seeds and seedling with consequent retardation in the studied parameters (Muhammad & Majeed, 2014; Majeed *et al*., 2017b).

## CONCLUSION

Aqueous leaf extracts of *Centaurea maculosa* and *Melilotus officinalis*, at concentration 25-30%, inhibited germination, radicle and coleoptile growth of wheat. Lower concentration ($\leq$ 20%) of *M. officinalis* had either no influence or promoted the studied parameters. *C. maculosa* was found more phytotoxic than *M. officinalis*, which explains it invasive nature. Phytoinhibitory effects of the two weeds at higher concentration suggest their allelopathic nature and they may potentially be employed as allelopathic source for management of other weeds.

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