ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 7, Issue 7 , July 2020

Minerals Contents of Some Legumes and Cereals as Affected by Water and Methanolic Extracts of *T. rotundifolia*

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ABSTRACT: Allelopathy is a phenomenon of plant releasing allelochemicals into the environment that can inhibit or stimulate the growth of other plants.*Tithonia rotundifolia*is thought to possess allelochemicals released from the shoots and roots that have inhibitory or stimulatory effects on other plant species. This study aimed to evaluate the effects of water and methanolic extracts of *T. rotundifolia* on the accumulation of mineral in *Vigna unguiculata* L. *Glycine max* L., *Zea mays* L. and *Sorghum bicolor* L. The seedlings of the test plants were treated with water and methanolic extracts of *T. rotundifolia*. Mineral contents were determined according to standard methods. The data were analyzed by Analysis of Variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT). Both water and methanolic extract treatments reduced the mineral contents of the test plants. In some cases, there was a stimulation of mineral contents. It is suggested that one mechanism of growth inhibition by plant extracts may be an effect on thenutrient uptake by recipient plant.

KEYWORDS: Allelopathy, Tithonia rotundifolia, allelochemicals, mineral content methanolic extracts

I. INTRODUCTION

Allelopathic interactions are mediated by secondary metabolites, released through leaching, root exudation, volatilization and residue decomposition into the environment and affect growth and development in natural environments and agro-ecosystems (Cheema *et al*., 2013). The allelopathic potential of some plants through the release of allelochemicals has either deleterious or beneficial effects on other plants associated in same locality (Yu *et al*.,2003). Allelopathy is mediated by many types of compounds with different sites and modes of biochemical action which are involved in the inhibition and modification of plant growth and development (Knox *et al*., 2010). These authors stated that these compounds exhibit a wide range of mechanisms of action, from effects of alkaloids on DNA, quinoneson photosynthetic and mitochondrial function, phenolics on phytohormone activity, ion uptake, and water balance.According to Rice (1984), allelochemicals are known to affect numerous physical and biochemical processes in plants. It has been shown that allelochemicals reduced contents of P, K and Mg in *Sorghum bicolor* L. and *Vigna sinensis*(Al Saadawi *et al.*, 1986; Kobza and Einhellig, 1987). Allelochemicals have beenreported toinhibit mineral contents in corn and pea (Bergmark *et al*. 1992; Abenavoli *et al*., 2010; Ghadah and Mohamed, 2018). Allelochemicals can inhibit the activities of Na+/ K+ ATPase involved in absorption and transport of ions at plasma membrane, which suppress the cellular absorptionof K+, Na+, or other ions (Mohammadkhani and Servati (2018)

Tithonia rotundifolia (Miller) S.F. Blake is a members of the family Asteraceae. The plant associates with common crops like vegetables, cassava, yam, rice, sorghum, soyabean e.t.c. and becomes a dominant plant where it is present (Tongma *et al.*, 1998). Ayeni *et al.* (1997) stated that *Tithonia* species are aggressive weeds with high invasive capacity and the ability to compete successfully with agricultural crops.Cowpea (*Vigna unguiculata* (L.) Walpers) and Soybean (*Glycine max* (L.) Merr.) which belong to the family**Fabaceae are**economically significant legumes. Maize (*Zea mays* L.) and Sorghum (*Sorghum bicolor* (L.) Moench) are annual grasses belonging to the family Poacea. *Z. mays* L. is one of the most important cereal crops. *S. bicolor* (L.) Moench is a drought resistant cereal important for grain, forage and bioethanol production (Aishah *et al*., 2011). Although most studies have investigated the effects of allelopathy on germination and growth parameters, the effects of allelopathy on nutrient in plants are poorly studied. Therefore, the objective of this study was to determine the effects of fresh shoots of *T. rotundifolia* on nutrient accumulation of *Vigna unguiculata* L. *Glycine max* L., *Zea mays* L. and *Sorghum bicolor* L.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 7, Issue 7 , July 2020

II. MATERIALS AND METHODS

A. Preparation of Extracts for the Different Treatments.

Extraction procedures were carried out according to the modified method of Qasem and Abu – Irmaileh (1985).

Preparation of Water Extracts of Fresh Shoots of *T. rotundifolia*

Fresh plants of *T.rotundifolia* were harvested and separated into shoots and roots. 250 g of the fresh shoots were cut into small chips of about four centimeter lengths and finely ground with a mortar and pestle. The ground plant material was soaked in two litres of water for twelve hours. The solution was filtered through cheese cloth to remove debris and then filtered through Whatman No 1 filter paper. Water served as control

Preparation of Methanolic Extracts of Fresh Shoots of *T. rotundifolia*

The same procedure described above for the preparation of water extract was carried out except that the ground plant part was extracted in two litres of 80% methanol for twelve hours. The solution was filtered through cheese cloth to remove debris and then through Whatman No.1 filter paper. The filtrate was concentrated using a water bath.

B. Raising of the Seedlings of the Test Crops in Pots.

Top humus soil was put into plastic pots (28 cm diameter x 15 cm height). Seeds of the test plants were sown in each of the pots and watered with 400 ml of tap water every morning. At two weeks, seedlings in each pot were thinned down to 10 seedlings per pot. The pots in the control regime were supplied with water while the pots belonging to the different treatments were supplied with either the appropriate water extracts (FWE) or methanolic extracts (FME) in same quantity. The pots were laid out in a completely randomized design.

C. Determination of mineral contents

Determination of magnesium (Mg), iron (Fe), manganese (Mn) and zinc (Zn) was done by using an Atomic absorption spectrophotometer (AAS) (AOAC, 1995) as described by Kasangi *et al.* (2010). Phosphorus was determined according to the method of Yoshida *et al.* (1972) as described by Jaleel *et al.* (2009).Potassium was determined according to the methods of Williams and Twine (1960) as described by Jaleel *et al.* (2009)

D. Statistical Analysis

The data obtained were analysed by factorial Analysis of Variance (ANOVA) to determine significant ($P< 0.05$) effects. The data were also analysed by correlation analysis and the significant differences between means were determined using Duncan's Multiple Range Test DMRT.

III. RESULTS AND DISCUSSION

The mineral composition of the test crops treated with methanolic and water extract of *T. rotundifolia* are shown in tables 1 and 2. The contents of phosphorus, potassium and magnesium in the control *V. unguiculata,G. max, Z. mays* and *S. bicolor* plants were higher than those of the FWE and FME plants. ANOVA showed that there were significant differences between the control plants and extract treated plants for these mineral elements at $P < 0.05$. The iron contents in the control *V. unguiculata* and *G. max* plants were significantly ($P < 0.05$) higher than those of the FWE and FME plants. Mineral elements are known to be essential for various physiological processes (Bendre and Pande, 2005). For example, phosphorus is a constituent of nucleic acids, phospholipids, phosphoproteins, dinucleotides, and adenosine triphosphate and hence, it is required for processes including the storage and transfer of energy, photosynthesis, the regulation of some enzymes, and the transport of carbohydrates. Potassium is an essential factor in protein synthesis, glycolytic enzymes, and photosynthesis. Magnesium is a constituent of chlorophyll molecule where it occupies a central position and it also acts as cofactor of enzymes which acts on phosphorylated substrate. The micro elements studied include iron, manganese and zinc which are naturally activators of metabolic enzymes. That chlorophyll and carotenoid synthesis are partly dependent upon these mineral elements have been well established in literature. For example, Biljana and Jovanka (2006) stated that phosphorus had influence on the stability of chlorophyll molecule in plants, especially with the advent of unfavorable weather conditions. They reported that mineral nutrition significantly affects the dynamics of leaf surface formation and extent of leaf area, which is reflected in the sum total of

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

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the leaf surface, the photosynthetic potential and net photosynthesis of the plants. According to these authors, the greatest influence on development of plants by macro metabolic elements is exerted by nitrogen, which is enhanced by phosphorus and to lesser extent by potassium. In this study, the phosphorus, potassium and magnesium contents in the test crops were significantly reduced by treatment with the extracts. This finding was in agreement with the work Harper and Balke (1981) who reported that potassium accumulation in oat was reduced by exposure to phenolic acids. Bhowmik and Doll (1984) observed a reduction in phosphorus content in *Zea mays* exposed to weed residue. Kobza and Einhellig (1987) found that ferulic acid reduced phosphorus content of the roots and shoots and iron content in the shoots of sorghum. Baziramakenga, *et al.* (1994) also, reported that allelochemicals reduced the mineral contents of soybean. Geng *et al.* (2009) showed that allelochemicals reduced the absorption of minerals in tomato. Mohammadkhani and Servati (2018) stated that treatment by 0 to 5% dry powders of *Cardariaalba* and *Alhagi maurorum* plants reduced absorption of macronutrients (NO3 −, K+, Ca2+ and P) and micronutrients (Fe^{2+} and Cu^{2+}) in roots and leaves of wheat plants. According to Einhellig, (1987), the interference with nutrient uptake and the subsequent reduction in nutrient accumulation is one of the most effective mechanisms of phenolic compound action.

Table 1: Effect of water and methanolic extracts of *T. rotundifolia* on the macro mineral elements composition of the test crops

	Macro mineral nutrient		
Treatments	P (mg/kg)	K (mg/kg)	Mg (mg/kg)
V. unguiculata control	305.25±2.9 ^{g}	4558.32 ± 3.1 ^{j}	2623.31 ± 9.9 ^{i}
FWE	188.43±9.6 ^{d}	2131.43 ± 9.8 ^{f}	1445.70 ± 2.3 ^{f}
FME	190.53 ± 7.9 ^{d}	2140.23 ± 4.3 ^{g}	1538.54 ± 1.2 ^{g}
G. max control	380.33 ± 2.3 ^{h}	4015.53 ± 3.1 ^{i}	3200.83 ± 7.7 ^{j}
FWE	302.43 ± 1.1 ^{g}	2867.32 ±2.7 ^{h}	1118.80 ± 3.1 ^{d}
FME	284.87 ± 4.0 ^{f}	2879.43± 6.8 ^{h}	1122.76 ± 4.2 ^{d}
Z. mays control	145.75 ± 2.9 ^{b}	7113.97 ± 15.2 ^{l}	2200.43 ± 3.4 ^{h}
FWE	140.63 ± 1.2 ^{b}	1498.11 ± 2.5 ^{d}	806.95 ± 3.2 ^{a}
FME	157.94 ± 1.2 ^{b}	1456.32 ± 9.4 ^{d}	798.65 ± 4.2 ^{a}
S. bicolor control	160.12 ± 1.2 ^{c}	6330.33 ±18.4 ^{k}	2123.65 ±7.3 ^{h}
FWE	156.39 ± 3.1 ^{b}	1289.42 ± 3.1 ^{c}	1000.53 ± 2.6 ^{c}
FME	162.23 ± 3.1 ^{c}	900.23 ± 3.3 ^{a}	870.47 ± 3.2 ^{a}

Values within columns followed by same letter are not significantly different at 5% level of probability as determined by Duncan's multiple range test.

FME = Fresh shoot methanolic extract FWE = Fresh shoot water extract

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

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Table 2: Effect of the water extract (FWE) and methanolic extract (FME) of *T. rotundifolia* on the micro nutrient elements composition of the test crops

	Micro mineral nutrient content		
Treatments	Zn (mg/kg)	Mn (mg/kg)	Fe (mg/kg)
*V.unguiculata*control	32.56 ± 2.2 ^{h}	13.25 ± 1.2 ^{b}	171.32 ± 1.4 ^{g}
FEW	30.54 ± 1.5 ^{h}	15.52 ± 1.8 ^{b}	80.91 ± 1.8 ^{b}
FME	34.32 ± 1.2 ^{h}	12.65 ± 1.2 ^{b}	60.48 ± 1.3 ^{a}
G. max control	12.21 ± 0.8 ^{b}	22.98 ±1.2 ^{d}	181.11 ± 1.7 ^{h}
FEW	13.32 ± 1.5 ^{b}	20.65 ± 1.2 ^{d}	151.36 ± 3.1 ^{f}
FME	11.39 ± 0.6 ^{b}	21.42 ± 0.9 ^{d}	144.64 ± 3.4 ^{f}
Z. mays control	32.64 ± 1.4 ^{h}	20.74 ± 1.8 ^{d}	150.76 ± 2.8 ^{f}
FEW	35.21 ± 1.2 ^{h}	21.39 ± 1.7 ^{d}	154.34 ± 1.2 ^{f}
FME	33.27 ± 1.7 ^{h}	23.28 ± 1.2 ^{e}	148.72 ± 1.2 ^{f}
S. bicolor control	18.32 ± 0.6 ^{d}	29.23 ± 1.2 ^{f}	164.43 ±1.2 ^{g}
FEW	22.53 ± 1.3 ^{f}	34.16 ± 1.2 ^{g}	169.16 ± 3.2 ^{g}
FME	24.47 ± 1.3 ^{g}	27.97 ± 2.2 ^{h}	168.14 ± 3.4 ^{g}

Values within columns followed by same letter are not significantly different at 5% level of probability as determined by Duncan's multiple range test.
Key: FME = Fresh shoot methanolic extract FWE = Fresh shoot water extract

IV. CONCLUSION

It is shown that both water and methanolic extract treatments reduced the mineral contents of the test plants. Therefore, it is suggested that one mechanism of growth inhibition by plant extracts may be an effect on the nutrient uptake by recipient plant.

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