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Phytochemical Screening and the Phytotoxic Effects of Aqueous Extracts of *Tithonia diversifolia* (Hemsl) A. Gray

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Abstract

Investigation was carried out on the phytochemical composition of methanolic and water aqueous extracts of *Tithonia diversifolia* and their phytotoxic effect on the growth of Sorghum bicolor (L.) Moench. The phytochemical analyses indicated the presence of bioactive substances such as alkaloids, saponins, glycosides, flavonoid, tannins, terpenoid and phenols in the methanolic extract and the later five allelochemicals in the water extract. The allelochemicals were of higher concentrations in the methanolic extract than in the water extract. The methanolic extract was found to be more phytotoxic than the water extract since the reduction of the germination percentage of the test crop was in the order of 100% methanolic extract > 50% methanolic extract >100% water extract. The germination and seedling growth inhibition was then extract concentration dependent and significant at $P < 0.05$. Both methanolic and water extracts have greater inhibitory effects on the growth of the radicle than on the plumule growth at 100% extract concentrations.

Keywords: phytochemical screening, phytotoxic, *Tithonia diversifolia* methanolic, water extract

1. Introduction

Tithonia diversifolia (Hemsl) A. Gray commonly referred to as Mexican sunflower is a member of the family Asteraceae. It is a perennial broad-leaved weed which grows to about a height of five meters or more and varies from highly branched low population variety to unbranched high population variety. Imeokpara and Okusanya (1994) observed that most farmers find it difficult to manage *Tithonia diversifolia* infestation in most crop fields particularly rice and maize field. *T. diversifolia* has been reported to contain some allelochemicals and therefore suggested as being capable of posing a serious phytotoxicity threat to agricultural crops.

Rice (1984) and Putnam (1988) observed that chemicals with allelopathic potential i.e. allelochemicals are present in the root, rhizome, stem, leaves, flowers, inflorescence, pollen, fruits and seeds of plants. They further stated that leaves are the major sources of these allelochemicals. Rice (1984) stated that allelochemicals are known to affect numerous physical and biochemical processes in plants. According to Gniazdowska and Bogatek (2005), the effects of allelochemicals action are detected at molecular, structural, biochemical, physiological and ecological levels of plant organization.

Analysis of water extracts of different crops showed the presence of natural/organic chemical substances such as alkaloids, tannins, phenolics, coumarins, terpenes, cyanates, glycosides, quinines and coumarins. Goffin et al. (2002) isolated tagitinin C a known sesquiterpene lactone (Pal et al., 1977; Baruah et al., 1979) from the aerial parts of the *T. diversifolia.* According to Ayeni et al. (1997) several studies have indicated that these allelochemicals and their derivatives are toxics and may inhibit shoot/ root growth, and nutrient uptake.

Water extracts from several species of the family Asteraceae and the soil on which they were grown have been shown to inhibit germination and growth of other plant species (Inderji & Dakshini, 1994; Kil & Yun, 1992; Maccas et al., 1993), Narwal et al. (2002) stated that the aqueous extract of the root of *Helianthus annus* delayed and inhibited the germination and seedling growth of linseed (*Linum usitatissium* L.) and mustard (*Brassica juncea* L.). Aqueous extracts from the leaves of *Helianthus tuberosus* L. *Xanthium occidentale, Uctuca sativa* and *Cirsum japonica* all in the Asteraceae family inhibited the root growth of Lucerne (Chon et al., 2003). Mulatu et al. (2006) reported that aqueous extract of P*arthenium hysterophorus* leaves and flower inhibited seed germination of lettuce. Otusanya et al. (2007) reported that the growth of *Amaranthus cruentus* was inhibited by aqueous extract of *Tithonia diversifolia.* Ilori et al. (2007) similarly observed that the radical growth of *Oryza*

sativa was inhibited by aqueous extract of *Tithonia diversifolia*.

Javed and Asghari (2008) found that the leaf extract of *Helianthus annus* inhibited the rate of germination of wheat seedlings. Methanolic extract *of Xylocarpus granatum* Koen inhibited the growth of wheat rootlets by about 91.9% and shoots by 89.4%, at 250 µg/ml concentration (Shahid-Ud-Daula & Basher, 2009). Aqueous and methanol extracts of *Withania somnifera* was found to markedly suppressed the germination, root and shoot growth of *Parthenium hysterophorus* (Arshad, 2011).

2. Materials and Methods

Extraction procedure was carried out according to the modified method of Hegazy and Farrag (2007).The seeds of test plant were soaked in 5% sodium hypochlorite to prevent fungal infection after which they were rinsed for about 5 minutes in running water. The seeds were selected randomly on the basis of uniformity of size and finally washed in distilled water. Ten seeds were placed in clean oven dried Petri dishes which had been lined with a Whatman No 1 filter paper. The filter paper in each Petri dish allocated to the control was moistened with 10 ml of distilled water while the filter paper in each of the Petri dishes allocated to the methanolic and water extract treatments was moistened with 10 ml of the appropriate extracts. The Petri dishes were incubated at room temperature for 2 weeks. Thereafter, the seeds were moistened at two days interval. Emergence of I mm of the radicle was used as the criterion for germination.

Seeds were observed every day and the number of germinated seeds was recorded. Phytochemical tests were carried out according to the methods of Ghani (1998) and Ayeni and Yahaya (2010). The plumule length and radicle length of five randomly selected plants were measured and mean values calculated. Fresh plants parts were weighed on Mettler Toledo balance to obtain fresh weights of plant parts. The plants parts were then packaged in separate envelopes and dried at 80˚C in a Gallen Kamp (model IH-150) incubator to constant weight to obtain the dry weight. All experiments were conducted in five replicates and the data obtained were subjected to Analysis of Variance (ANOVA).

3. Results

The germination of *Sorghum bicolor* treated with the aqueous extracts of *Tithonia diversifolia* was found to be lower than the germination of seeds in the control and the reduction of the germination percentage of the test crop was in the order of 100% methanol extract > 50% methanol extract >100% water extract (Figure 1). The plumule and radicle lengths of the seedlings in the aqueous extract of *Tithonia diversifolia* is shown in Table 1. Analysis of the data showed that the different extracts significantly reduced the plumule and radicle lengths, plumule fresh weight and radicle dry weight of the test crop at $P< 0.05$. The methanolic extract was more phytotoxic than the water extract and the inhibitory activity of the various extracts was concentration dependent since inhibition of these growth parameters increased as the concentration increased. The phytochemical screening of the extracts indicated that both water and methanol extracts had flavonoids, tannins, terpenoids, glycosides and phenols .In addition to these the methanol extracts showed positive results for saponins and alkaloids (Table 2). The phenols content (0.31%) in the shoot of *T. diversifolia* at 12 weeks of growth in 100% water regime was the highest followed by alkaloids, tannins and flavonoids. The phytochemicals contents in the shoot of *T. diversifolia* in the 50% water regime was higher than that in the shoot of *T. diversifolia* grown in 100% water regime. The phenols content increased in the extracts during the period of growth (Table 3).

Table 1. Effect of aqueous extracts of *T. diversifolia* on the growth of the seedlings of *Sorghum bicolor*

Parameters (mean values)	Control (CONT)	100% methanol extract (Me100%)	50% methanol extract (Me50%)	100% water extract (We100%)	50% Water extract (We50%)	F	Sig
Plumule Length (cm)	4.62	1.16	1.76	2.70	3.16	402.66	0.00*
Radicle Length(cm)	5.74	1.04	2.54	1.64	3.70	318.74	0.00*
Plumule Fresh Weight (g)	0.33	0.25	0.29	0.36	0.32	4.274	.012*
Radicle Fresh Weight(g)	0.03	0.02	0.02	0.03	0.02	2.778	.055
Plumule Dry Weight (g)	0.04	0.03	0.03	0.03	0.04	2.263	.098
Radicle Dry Weight (g)	0.01	0.02	0.01	0.01	0.02	5.627	.003*

*Significant at $P < 0.05$

Table 2. Phytochemical screening of the extracts of the shoots of *Tithonia diversifolia*

Phytoconstituents	Leaves extract	
	Water	Methanol
Glycosides	+	+
Tannin	+	+
Flavonoids	+	+
Saponin	-	+
Phenol	+	+
Terpenoid	+	+
Alkaloid	-	+

+ present,- absent

Table 3. Quantity of allelochemicals in *Tithonia diversifolia* grown under 100% and 50% water at 6th 9th and 12th weeks growth stages

	100% water at 6th week	100% water at 9th week	100% water at 12th week	50% water at 6th week	50% water at 9th week	50% water at 12th week
Phenol (%)	0.15 ± 0.01	0.17 ± .01	0.31 ± .04	0.23 ± .01	0.26 ± .03	0.35 ± .01
Tannin (%)	0.07 ± .03	0.10 ±.01	0.14 ±.01	0.21 ±.04	0.30 ± .01	0.27 ± .03
Flavonoid (%)	0.03 ± .01	0.08 ±.03	0.06 ±.01	0.10 ± .01	0.15 ± .01	0.12± .01
Alkaloid (%)	0.18 ± .01	0.25 ±.01	0.28 ±.03	0.42 ± .01	0.40 ± .03	0.40 ± .01

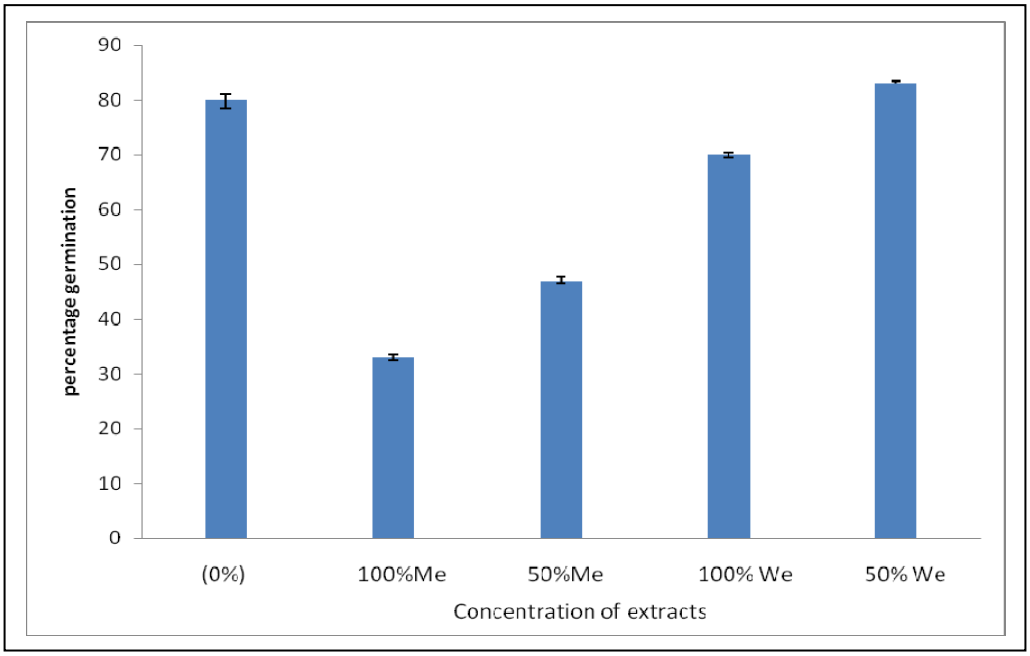

Figure 1. Effect of methanol and water extracts of *Tithonia diversifolia* on the germination of *Sorghum bicolor*

4. Discussion

In this study, the methanol and aqueous extracts of *Tithonia diversifolia* were found to reduce the germination of the seeds of *Sorghum bicolor*. This was consistent with the finding of Indergit and Dakshini (1994a) who reported that the water extracts from the roots of *Pluchea lanceolata* also in the family Asteraceae inhibited the

germination of tomato and mustard. The phytotoxic effects of the methanol extracts and water extract were dependent on concentration of the extracts. This agreed with the work of Lovett (1989) who reported that biological activities of receiver plants to allelochemicals are concentration dependent.

The shoot length, root length and shoot fresh weight of shoot of the test crop were reduced significantly at $P<0.05$ by the application of *Tithonia diversifolia* extracts. This finding agreed with an earlier result of Otusanya et al. (2007) in which the growth of *Amaranthus cruentus* was inhibited by aqueous extract of *Tithonia diversifolia.* The result was further supported by the work of Arshad et al. (2011) who reported that water and methanol extracts of *Withania somnifera* markedly suppressed the germination, root and shoot growth of *Parthenium hysterophorus*.

Currently about two-third, by volume, of the pesticides used worldwide in agricultural production are herbicides (Duke & Lydon, 1993). This indiscriminate use of herbicides for weed control has resulted in serious ecological and environmental problems as resistance, shifts in weed populations that are more closely related to the crops that they infest, minor weeds became dominant, greater environmental pollution and health hazard. Putnam et al. (1983) and Narwal (1999) opined that allelopathic research can be applied to so many current weed problems. Habib and Rahman (1988) suggested that the efficacy of toxic water extracts from allelopathic plants in weed control could be enhanced when used in combination with synthetic herbicides. Considering the wide presence of allelopathic substances in the plant parts of *Tithonia diversifolia,* therefore, the possibility exist that the extract of this weed could be used to control other weeds.

5. Conclusion

The results showed that methanolic and water extracts of *T. diversifolia* contained flavonoids, tannins, glycosides, terpenoids and phenols. In addition to these the methanol extracts showed positive results for, saponins and alkaloids. These allelochemicals were phytotoxic to germination and growth of *S. bicolor*. It is suggested that the weed should be removed from the fields where they grow in association with cultivated crops.

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