Mesopotamia J. of Agric ISSN: 2224-9796 (Online) ISSN: 1815 – 316 X (Print) Vol. (40) No. (2) 2011

THE ALLELOPATHIC POTENTIAL OF JONSONGRASS *Sorghum halepense* (L.) Pers. TO CONTROL SOME WEED SPECIES

Iqbal Murad Thahir
College of Agric.
Univ. of Salahaddin

Anwar Othman Ghafoor
College of Education Science
Univ. of Salahaddin

ABSTRACT

This study was designed to evaluate allelopathic substances extracted from shoot, rhizome and inflorescence of johnsongrass which obtained and evaluated for controlling seed germination and early seedling growth of four different weed species, namely, wild oat **(***Avena fatua* L.**)**, ryegrass **(***Lolium temulentum* Gaud**.)**, grass pea (*Lathyrus sativa* L.) and syrian cephalaria **(***Cephalaria syriaca* (L.) Schard. The results indicated that the percent of seed germination and early seedling growth of all weed species were significantly lower under three extracted substances as compared to those control of treatment. However, rhizome extract exhibited the highest impact, mainly on the length and weight of radicals in comparison to the length and weight of plumule, which is exhibited radical growth of wild oat, ryegrass and syrian cephalaria 100%. This study demonstrates that under restricted conditions, the potential exists for inhabiting percent weed germination and early seed growth but indicates that weed origins need to be factored in modifying allelopathic responses may be used as a bioherbicide.

INTRODUCTION

Allelopathy is a natural and environment-friendly technique which may prove useful as a unique tool for weed management (Rice, 1984 and Cheema *et al.,* 1997). It involves direct or in-direct (harmful or beneficial) effects of one plant upon another through the production of secondary chemical compounds that technically escape into the environment in sufficient quantity and with enough persistence to cause the enrolled effects (Cheema *et al.,* 1997and Khalid *et al.,* 2002). Potential use of allelopathic sorghum was reported and well documented by several investigators (Alsaadawi *et al.,* 1986, Panasiuk *et al.,* 1986 and Einhellig and Souza, 1992). Most of the allelopathic substance that has been used is identified as an inhibitor till now. This inhibition is caused by phytotoxic substances that are actively released from living plants into the environment through root exudation, leaching and volatilization and passively liberated through decomposition of plant residues (Rice, 1984). Similarities between natural allelochemicals and synthetic herbicides on plant suggest that allelopathy has potential use for weed management as cover or smother crops; allelopathic rotational or companion crops (Putnam and Duke, 1978 and Barnes and Putnam, 1986); toxic extracts from allelopathic plants mulch or incorporation of crop residues (Putnam, 1988 and Vasilakoglou *et al.,* 2005) natural herbicides (Lovett, 1990). Contemporary research in allelopathy

Received 30 / 1 / 2011 accepted 6 / 6 / 2011.

focuses on isolating, identifying and quantifying specific active allelochemicals. Once these substances are identified and characterized they can be used either as natural herbicides or as models for developing new and environment friendly herbicides. Johnsongrass is well known for its allelopathic compounds. Several phenols and terpenoids have been reported in various species of Sorghum (Abdul-Wahab and Rice, 1967 Duke *et al.*, 2000 and Einhellig and Souza, 1992).

The present study designed to evaluate the allelopathic potential and the possibility of utilizing the plant parts (shoot, rhizomes and inflorescences) of johnsongrass as a new herbicide against problematic weeds which accompany wheat such as wild oat, ryegrass, grass pea and syrian cephalaria.

MATERIALS AND METHODS

I. Plant material: Plant shoots (leaves and stem) and inflorescences samples were collected at flowering stage from johnsongrass (*Sorghum halepense (L.*) Pers) grown at the experimental farm of the College of Agriculture, Salahaddin University in July 2008, while rhizome samples from the same plant were collected at booting stage.

II. Aqueous extract preparation: Collected plant samples were washed with distilled water to remove debris, dehydrated at 40°C for 72 hours, and milled into fine powder through 1.0 mm sieve. Five grams of the residue powders of shoot, rhizomes and inflorescences were separately placed into glass bottles and extracted in 100 ml distill water for 72 hours at 20°C. The resulting mixtures were then strained through 4 layers of muslin cloth, vacuum-filtered, and stored in a freezer for later use. These extracted filtrates were designated as 100 % strength (Ghafoor 2002).

III. Bioassay screening of plant extracts: Seeds of four types of weeds were placed in 9.0 cm diameter Petri dishes, moistened with 5.0 ml of different extracts obtained from plants, while control received distilled water in equal amount. Petri dishes were placed in a dark place at 20± 2°C for 10 days. Ten seeds were used per each treatment and replicated four times. Length of radical and plumule with dry weights were recorded at the end of 10 days period. All data were statistically analyzed using F. Test and differences between treatments comparing by Duncan's Multiple Range Test at 1% level of probability (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The data in crude aqueous extract bioassays were statistically analyzed and revealed strong allelopathic potential against selected weed species under investigation with slight variation. The results were divided into two main parts:

I-The effect of water extracts of johnsongrass plant on the germination and early seedlings growth of monocotyledon weed species:

a. Wild oat (*Avena fatua* L.): The water that has been extracted from different parts of Johnsongrass showed significant differences in the percentage of germination and oat early seedlings growth as shown in Table 1. The level of inhibition from each plant partwas varied for the germination of oat seeds, the highest level of shoot extracts inhibited seed germination by 47.5% compared with control. While the effects of allelopathic potential from rhizomes and inflorescences extracts showed similar trends on this character with less effect, however their values reached to 23.5 and 26.5% respectively. Highly significant reduction of radical length for oat has appeared under the effects of shoot and rhizome extracts. Their effects prevented the growth of radical Oat. There was a significant effect of shoot and rhizome extracts on the dry weight of oat shoot and these resulted in a significant inhibition of dry weight of plumule of oat by 60% and 46.5% respectively. However, inflorescence extract did not affect on the dry weight as compared with control treatment. The three extracted parts of oat dry weight showed the same effects that have been mentioned above. The lower difference has been observed between control and inflorescence extract. The reason for this might be due to a different concentration of allelochemical compounds in each part of the plant. This observation has also been confirmed by (Gonzale *et al.,* 1997). It was reported that sorgoleone inhibited electron transfer between QA and QB at the reducing site of PSII.

Table (1): Effect of water extract residues of johnsongrass on germination percentage and early seedlings growth of wild oat.

Extracts	Germination (%)	Plumule length (cm)	Radical length (cm)	Plumule dry weight (mg)	Radical dry weight (mg)
Control	85.00 a	10.00 a	9.00 a	4.58 a	1.68 a
Shoot	37.50 c	3.20 c	0.00 c	1.83 b	0.00 b
Rhizome	65.00 b	9.60 a	0.00 c	2.45 b	0.00 b
Inflorescence	62.50 b	8.00 b	6.50 b	4.00 a	1.35 a

b. Ryegrass (*Lolium temulentum* Gaud.): The germination of Ryegrass seed was influenced by using different levels of the aqueous extracts of johnsongrass plant (Table 2). The results revealed significant reduction in the percent of germination when extracts of both rhizome and shoot extracts reached 29 and 36% reduction respectively, when compared to control ,which has no different with the extract of inflorescences. The hypocotyls length has been greatly affected by the extract of all parts of johnsongrass, except of inflorescence effect. The effect of all extracts on hypocotyl length had similar effect of the value of germination with small increment. However, rhizomes extract had a great inhibition effect which reduced up 83% when compared with control treatment. Their effects have been continued on the radical length. These affected the growth of ryegrass radical, but shoot extract did not allowed ryegrass radical longer than 0.63 cm compared with control treatment which reached to 6 cm. The results did not show any difference between inflorescence extract and control for this character. The results of dry weight (mg) for both radical and hypocotyls have followed the same effect of its length in response to the four treatments implemented in this work.

II-The effect of water extracts of johnsongrass plant on germination and seedlings growth of dicotyledons weed species:

a. Grass pea (*Lathyrus sativa* L.): Table (3) presents the effect of water extracts from different parts of johnsongrass on germination and early seedlings growth of grass pea.

Table (2): Effect of water extracts residues of johnsongrass on germination and early seedlings growth of ryegrass.

Extracts	Germination (%)	Plumule length (cm)	Radical length (cm)	Plumule dry weight (mg)	Radical dry weight (mg)
Control	95.00 a	10.25 a	6.00 a	2.58 a	0.68 a
Shoot	67.50 b	3.00 b	0.63 b	1.10 b	0.10 b
Rhizome	60.50 c	1.75 c	0.00 c	0.85 c	0.00 c
Inflorescence	97.50 a	11.50 a	7.00 a	2.68 a	0.68 a

Seed germination and early seedling growth of tested weed species were high significantly inhibited at 5% concentration compared with control treatment. The highest inhibition of germination percentage obtained when rhizome extract was applied and, with drastic inhibition when shoot extract was used. The percentage inhibition was reached up to 86.5% and 67.6% respectively, while there was no difference between control and inflorescence extracts. However, the water extracts of rhizome and shoot had the same impact on the length of hypocotyls and they were reached to the value of 40.7% when comparing with control treatment which also didn't show differences with the extracts of inflorescences. Water extract of all parts (shoot, rhizome and inflorescences) were led to significant reduction in the length of grass pea radicals (3.70, 2.75 and1.75cm) respectively compared with radical length 4.75cm in control. The data shows no significant effects between shoot and inflorescence extracts. The effective consequences of the three parts of johnsongrass were reflectable on both dry weight of radical and hypocotyls on their length. Significant reductions have been noticed in the dry weight for both of them by using the water extract of shoot and rhizome compared with the application of inflorescence water extracts and control which had

Table (3): Effect of water extract residues of johnsongrass on germination and early seedlings growth of grass pea.

Extracts	Emergence (%)	hypocotyls length (cm)	Radical length (cm)	Hypocotyls dry weight (mg)	Radical dry weight (mg)
Control	85.00 a	6.75 a	4.75 a	3.95 a	2.95 a
Shoot	27.50 b	4.00 b	1.05 c	3.00 b	1.35 b
Rhizome	11.50 c	4.00 b	2.00 c	2.35 c	1.85 b
Inflorescence	87.50 a	6.00 a	3.00 b	3.65 a	2.80 a

the same effect conform with (Qasem, 2001, Irshad and Cheema, 2002 and Mahmood and Cheema, 2004) found that sorghum mulch significantly reduced the density and dry biomass of one of the world's worst weed (*Cyperus rotundus*).

b. Syrian cephalaria (*Cephalaria syriaca* (L.) Schard: Seed germination and seedlings growth of *C.syriaca* (radical and hypocotyls) were significantly inhibited completely under aqueous extract of rhizome. Less effect was observed on shoot extract on seed germination which reached 77% as compared with control. Also the water extracts of inflorescences were caused less significant inhibitions than water aqueous extracts of rhizome and shoot. The significant inhibitions of hypocotyl length observed for aqueous extract of shoot and inflorescences were about 80% and 33% respectively in comparing to control, whereas suppression of radical length 60% was less affected by water extract of inflorescence (Table 4). Statistical analysis of the data showed that the shoot extracts had significant effects on plant dry weight compared with control and inflorescence extracts, but the result of radical dry weight were completely inhibited by rhizome extract while no significant inhibition between inflorescence extracts and control were showed.

Table (4) Effect of water extracts residues of johnsongrass on germination and early seedling growth of syrian cephalaria.

Extracts	Emergence (%)	hypocotyls Length (cm)	Radical Length (cm)	hypocotyls Dry Weight (mg)	Radical Dry Weight (mg)
Control	87.50 a	7.50 a	5.00 a	8.05 a	1.38 a
Shoot	20.00 c	1.50 c	0.00 c	1.58 b	0.00 c
Rhizome	0.00 d	0.00 d	0.00 c	0.00 c	0.00 c
Inflorescence	52.50 b	5.00 b	2.00 b	7.20 a	1.33 a

In this study rhizome extracts were more toxic to some weeds than shoot and inflorescence extracts. The reduction in dry biomass clearly indicates the phytotoxic effects of johnsongrass allelochemicals. Variable results were observed among the selected part of the plants inducing the phytotoxic effects against weeds. These observations are in accordance with the previously

documented studies (Ghafoor and Thahir, 2010 and Vasilakoglou *et al.,* 2005). Also, the extracts had significant
effect on syrian cephalaria and oat than grass pea and ryegrass. The fractionation guided bioassays also proved that leaves are most effective source of allelochemicals to be used as natural herbicides. Most of the studies have focused on showing allelopathic effects of particular plants on a given weed species in Petri dish and/or pot experiments. But, it is expected that allelopathy will be used under field conditions or to develop a compound extracted from allelopathic plants. Researchers in Iraq should follow the mainstream activities such as ecological studies and chemical studies. Allelopathic compounds are released in greater amount when plants are under stress (Tang *et al.,* 1995 and Einhellig, 1996). This implies that external stress conditions may regulate these genes, promote the biosynthesis of the allelochemicals and stimulate the movement of allelopathic compounds from inside the plant into the outside environment. Weed control becomes more complicated even when considering management of invasive weeds in natural and urban areas, where economic, environmental, or human risk concerns may entirely preclude the use of chemical herbicides. The results of the indoor experiments of this study clearly explained that the inhibitory substances are existing in extracts of Johnsongrass rhizomes and foliage. These substances of either weedy species in addition to their strong potential for resource-based competition on weed grown under study.

الجهد الأليلوباثي للسفرندة *Sorghum halepense* (L.) Pers في مكافحة بعض أنواع الأدغال

اقبال مراد ظاهر أنور عثمان غفور
كلية الزراعة كلية التربية للعلوم
جامعة صلاح الدين

الخلاصة

صممت هذه الدراسة لتقييم الجهد الأليلوباثي لمستخلصات متبقيات الأجزاء الخضرية والجذرية والثمرية للسفرندة (*Sorghum halepense* (L.) Pers) في الانبات والمراحل المبكرة لنمو بادرات اربعة أنواع من الدغال وهي الشوفان البري (*Avena fatua* L.) والرويطة (*Lolium temulentum* Gaud.) والهرطمان (*Lathyrus sativa* L.) والزيوان (*Cephalaria syriaca* (L.) Schard)). أظهرت النتائج انخفاضاً معنوياً في انبات ونمو بادرات الأدغال الأربعة تحت تاثير مستخلصات المتبقيات الثلاثة المستخدمة مقارنة بمعاملة المقارنة. كان لمستخلص الرايزومات أعلى تاثير تثبيطي في طول الجذير ووزنه وأكثر من طول الرويشة ووزنها ومنع نمو جذير الشوفان البري والرويطة والزيوان بنسبة ١٠٠% كما أوضحت الدراسة امكانية الاعتماد على مستخلص السفرندة في مكافحة الأدغال بدلاً من المبيدات.

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ISSN: 2224-9796 (Online)
ISSN: 1815 – 316 X (Print)
Vol. (40) No. (2) 2011

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