Available online at www.notulaebiologicae.ro

Print ISSN 2067-3205; Electronic 2067-3264

Not Sci Biol, 2011, 3(2):114-118

Notulae Scientia Biologicae

AcademicPres

Allelopathic Effects of Aqueous Extract of Leaf Stem and Root of *Sorghum bicolor* on Seed Germination and Seedling Growth of *Vigna radiata* L.

Amir MOOSAVI[1], Reza TAVAKKOL AFSHARI[2], Abouzar ASADI[3], Mohammad Hossain GHARINEH[1]

[1]*Ramin Agriculture and Natural Resources University, Department of Agronomy and Plant Breeding, Ahwaz, Iran; Amir.msa@gmail.com*

[2]*University of Tehran, Department of Agronomy and Plant Breeding, Pardis of Agriculture and Natural Resources, Tehran, Iran; Tavakkol@ut.ac.ir*

[3]*University of Tarbiat Modares, Department of Agronomy and Plant Breeding, Tehran, Iran*

Abstract

Seed germination under field conditions is highly influenced by the presence of other plants. Allelopathy is an important mechanism of plant competition, by producing phytotoxins to the plant environment in order to decline other plants' growth. Soil sickness problem in farm lands is also known as an allelopathic effect or even autotoxicity. The toxicity of released allelochemicals by a plant in the environment is attributed to its function of concentration, age and metabolic stage. In this study we investigate the effect (5, 20, 35 and 50 g l^{-1}) of leaf, stem and root water extract of sorghum on seed germination and seedling growth of mung bean. The results of the experiment showed that allelopathic effect of different concentrations was not significant for germination percentage, but germination rate and mean germination time decreased significantly by increasing the concentration of allelopathic extracts; also, there was a clear allelopathic effect of sorghum extract on seedling growth of mung bean. 50 g l^{-1} sorghum stem extract exhibited the highest inhibitory effect on root and shoot growth of mung bean. Among all parts of sorghum, stem extracts showed the highest allelopatic effect on seedling growth. Root extract showed higher inhibitory effect than leaf extracts.

Keywords: allelopathy, germination characteristics, mung bean, root length, sorghum

Introduction

Mung bean (*Vigna radiata* L.) is an important legume crop grown in Iran and has high nutritious value due to its high protein content. This warm season legume originated from India and is still grown on large areas there; it is also cultivated in several countries from Asia, Africa, and South America (Myers, 2000). Other names given to this crop are green gram or golden gram in international research publications. Mung beans are rich in protein content, around 25% of the seed by weight. The amino acid profile of Mung bean is similar to other bean crops. Weed infestation is, however, one of the major factors limiting mung bean growth and development in agricultural farms. Allelopathy is a natural and environment friendly technique, which have a potential to be a new approach for weed control in sustainable agriculture. Sorghum (*Sorghum bicolor* L. Moench) is well-recognized as an allelopathic crop. *Sorghum halepens* (L.) is a summer, large, perennial grass which could propagate by its own seeds or rhizomes. It belongs to the Mediterranean region, but *Sorghum halepens* has become well adopted in warm regions of the world (McWhorter, 1989). The successful dispersal of this weed is attributed to its rapid growth rate, high seed reproduction potential, efficient utilization of resources and its great allelopathic substances (Asgharipour and Armin, 2010). Sorghum is also a great forage crop which has a high potential in forage production in Iran. Mature sorghum produces a large number of water-soluble allelochemicals.

Allelochemicals escape from plants in different ways; four major methods by which allochemichals releases from mother plants could be summarized as: 1) leaching- in this way inhibitor components could be produced by dead or alive parts of plants; 2) volatilization- by which terpenes components are released from the leaves of some plant species; 3) decomposition- in this method allelochemicals are released from plant residue; and 4) exudation-in this way high quantities of organic compounds release from roots of several crop and non-crop species which acts as an inhibitor for the growth of other plants (Gill *et al.*, 1993).

This study was conducted in order to evaluate the allelopathic potential of sorghum aqueous extract on seed germination characteristics and seedling growth of mung bean.

Material and methods

To study the allelopathic effects of sorghum water extract on seed germination and seedling growth of mung bean, an experiment was carried out in Seed Science Laboratory, Department of Agronomy and Plant Breeding,

Received 10 April 2011; accepted 09 May 2011

Agriculture and Natural Resources University of Ramin, Iran.

Preparation of water extracts solutions

Leafs, stems and roots of field grown sorghum plant were separated from plants at maturity. The plant material was dried in an oven at 70°C for 48 h. Then the dried material was ground in a grinder and passed through a 40 mesh screen. The allelopathic water extract concentrations were prepared by adding 5, 20, 35 and 50 g powder of each plant part to 1 liter of distilled water, and kept in at 25°C. After 24 hour, the solutions were filtrated and centrifuged at 12000 rpm, after which clean and pure extracts were collected.

Germination test

Germination test of *Vigna Radiata* was performed in Petri dishes in lab germinator based on ISTA rules (1999), for seven days at 25°C. Fifty healthy *Vigna radiata* seeds were put in petri dishes and sorghum extracts were applied to each individual Petri dish; distilled water was used as control treatment. Germination percentage, germination rate, shoot, root and seedling length were measured after the day 7. Germination rate and mean germination time and were calculated with Ellis and Robert equation, (1981).

Statistical analyze

The design of the experiment was randomize complete blocks, in four replications. Data of germination percentage were subjected to data transformation in order to uniform the variance of data. Minitab 16 software and Excel 2010 were used for analyzing the data of the experiment and drawing graphs.

Results and discussion

Germination percentage

The results of the experiment showed that there was no significant effect of all allelopathic concentrations on seed germination and germination characteristics of mung bean, as shown in Fig. 1. The highest germination percentage was observed in control treatment and the lowest was observed at 20 g l^{-1} of stem and root extract. It is interesting that there is no significant reduction in germination percentage for the different concentrations, while there are some reports saying that sorghum extract could significantly decrease germination percentage in some crops. Cheema and Ahmad (1992) reported that sorghum water extract inhibited germination of certain weed species.

Germination rate

Germination rate was significantly influenced by the different treatments. The highest germination rate was observed at 20 g l^{-1} leaf extract, which had no significant difference with control treatment, and the lowest was observed at 50 g l^{-1} stem extract (Fig. 2). Among all treatments, stem extracts exhibited a lower germination rate compared to the others.

Mean germination time (MGT)

Mean germination time increased with the concentration of treatments; the highest MGT was observed at 50 g l^{-1} root extract (Fig. 3). Mean germiantion time was influenced by root more than the other parts of Sorhum, even though this infuence was not statistically significant. The only significant difference was observed in control treatment, which exhibited the lowest MGT (Fig. 3).

Root length

Root length was significantly influenced by the treatments. The most effective reduction among all treatments was observed at stem extracts (Fig. 4). Concentrations of 5, 20, 35 g l^{-1} sorghum leaf water extract and control treatment exhibited the highest root length respectively, while the lowest root length was exhibited by 35, 50 and 20 g l^{-1} sorghum stem extract.

Our results show that the length of mung bean roots is more sensitive to sorghum stem extract than the one of leaf or root (Fig. 4).

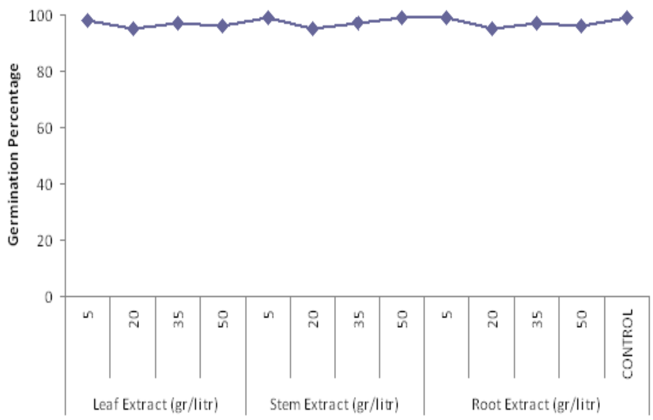

Fig. 1. The effect of sorghum extract on mung bean seed germination percentage

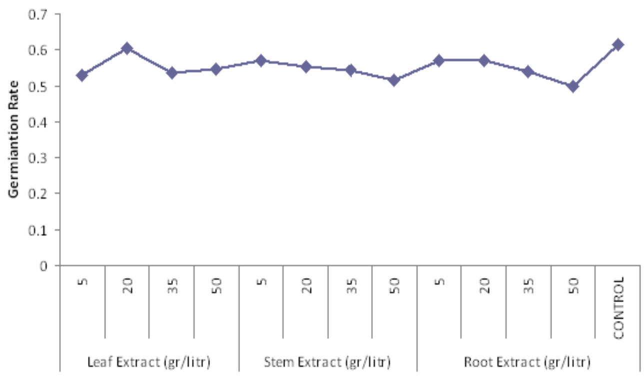

Fig. 2. The effect of sorghum extract on mung bean germination rate

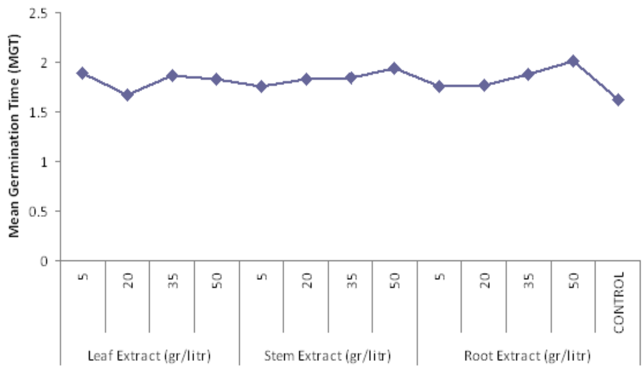

Fig. 3. The effect of sorghum extract on mung bean mean germination time

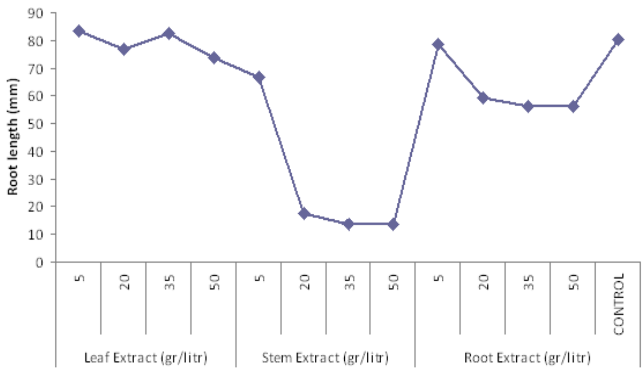

Fig. 4. The effect of sorghum extract on mung bean root

Shoot length

Shoot length was significantly influenced by the allelopathic treatments. The most effective reduction among all treatments was observed at sorghum stem extracts (Fig. 5). Concentrations of 35, 50 g l^{-1} sorghum stem water extracts exhibited the lowest length, and 20, 5, g l^{-1} leaf extracts and control treatment exhibited the highest shoot length respectively.

Our results show that shoot length of mung bean is more sensitive to stem extract of sorghum than to leaf or root (Fig. 5) and leaf extracts of sorghum might improve shoot length.

Randhawa *et al.* (2002) reported that root length of *Trianthema portulacastrum* was affected by sorghum water extract and significantly reduced by high concentration of 75 and 100% sorghum water extract. The inhibition of root growth by Aqueous extract could be attributed to the inhibitory effects of sorghum allelopathic substances present in the extract.

Seedling length

Seedling growth significantly decreased by increasing the allelopathic concentrations. The reduction pattern in seedling growth was highly similar to root growth. The most effective inhibitor for seedling growth was sorghum stem extracts. At concentration of 35 g l^{-1} stem extract, seedling length was decrease around 80% compared to control (Fig. 6). Oueslati (2003), Turk *et al.* (2003) made similar observations on other plant species.

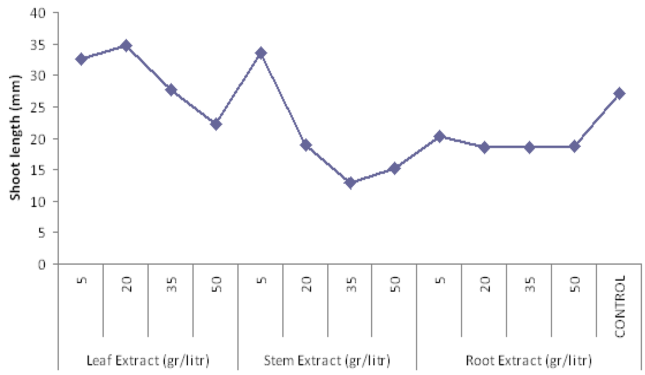

Fig. 5. The effect of sorghum extract on mung bean shoot

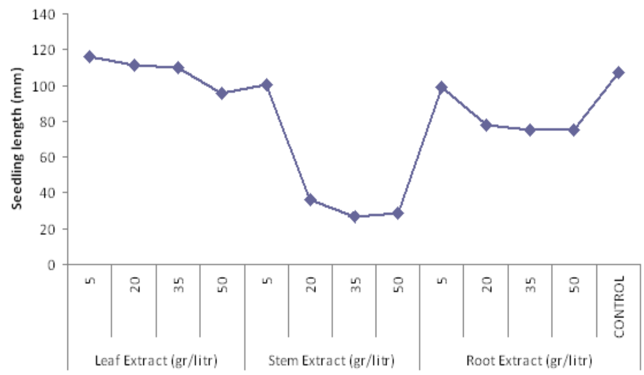

Fig. 6. The effect of sorghum extract on mung bean seedling

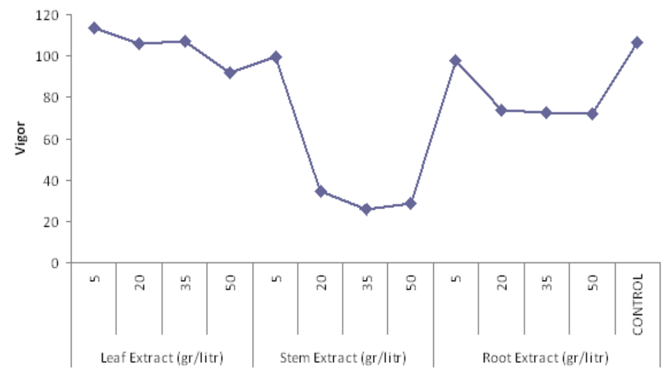

Fig. 7. The effect of sorghum extract on mung bean seed vigor

Vigor

Seedling vigor was significantly affected by the different concentrations of sorghum extracts. stem extract of sorghum showed the highest reduction in mung bean seedlings; root extracts of sorghum also reduced seedling vigor, but there was no significant reduciton in leaf exteracts except for 50 g l^{-1} compared to control (Fig. 7).

The allelopathic effect could happen because of some secondary metabolites, which reacted with one another, there is some reports which supporting the idea that the allelochemicals could be synthesized by either the shikimic acid or acetate pathways (Rice, 1984, 1985; Rizvi and Rizvi, 1992; Olofsdotter *et al.*, 1995). Some of the allelochemical are belonging to ferulic acid and phenolic acids family, including o-hydroxyphenylacetic acid (Geally *et al.*, 2000; Chung *et al.*, 2001). These chemicals inhibited seed germination and seedling growth of barnyardgrass (Chung *et al.*, 2002). This study suggests that the allelopathic present in sorghum stems, leaves, and straws may reduce the final yield of mung bean in farms by inhibiting seedling growth and decreasing seed vigor. So, it is important to remove all sorghum straws from fields, specially stem and root parts. Channappagoudar *et al.* (2005) reported that the seedling vigour index in soybean and sunflower was significantly decreased, this indicating the allelopathic effect of the weeds. They also mentioned that the higher concentrations produced lower vigor index in all the crops. The increased inhibitory effect on germination characteristics at higher concentration of weed extract may be due to an increase in the concentration of allelochemicals, coming from phenolic acids compounds like, P-hydroxy benzoic acid, p-coumaric acid, caffeic acid, o-coumaric acid and ferulic acid, Similar results were reported by Singh *et al.* (1989), Uppar *et al.* (1993), Leela (1995) and Beres and Kazinczi (2000).

Sa´nchez-Moreiras *et al.* (2004) suggested that allelopathy in cereals of the *Gramineae* family was attributed mostly to hydroxamic. Sorgoleone is responsible for allelochemical agent from sorghum roots and heliannuols, annuolides, tambulin, and heliannones were identified as allelochemicals from sunflower (Vyvyan, 2002).

Conclusions

From the study it can be concluded that stem and root aqueous extract of sorghum had greater inhibitory effect on germination rate, seedling length and seedling vigour index of mung bean. So planting mung bean in fields which were previously cultivated by sorghum, is not recommended, and farmers should highly notice how much of sorghum straws remain in the field before planting any crop, specially mung bean.

References

Asgharipour MR, Armin M (2010). Inhibitory effects of *Sorghum halepens* root and leaf extracts on germination and early seedling growth of widely used medicinal plants. Advances in Environmental Biology 4(2):316-324.

Beres I, Kazinczi G (2000). Allelopathic effects of shoot extracts and residues of weeds on field crops. Allelopathy Journal 7(1):93-98.

Channappagoudar BB, Jalageri BR, Biradar NR (2005). Allelopathic Effect of Aqueous Extracts of Weed Species on Germination and Seedling Growth of Some Crops karnataka. J Agric Sci 18(4):916-920

Cheema ZA, Ahmad S (1992). Allelopathy: A potential tool for weed management. Proc. Nat. Seminar on the Role of Plant Health and Care in Agric., p.151-156. Prod. held on Dec. 28-29, 1988 at Univ. of Agri., Faisalabad, Pub. Univ. Agri., Press, Faisalabad.

Chung IM, Ahn JK, Yun SJ (2001). Identification of allelopathic compounds from rice (*Oryza sativa* L.) straw and their biological activity. Can J Plant Sci 81:815-819.

Chung IM, Kim KH, Ahn JK, Chun SC, Kim CS, Kim JT, Kim SH (2002). Screening of allelochemicals on barnyardgrass (*Echinochloa crus-galli*) and identification of potentially allelo pathic compounds from rice (*Oryza sativa*) variety hull extracts. Crop Prot 21:913-920.

Ellis RA, Roberts EH (1981). The quantification of ageing and survival in orthodox seeds. Seed Sci Technol 9:373-409.

Geally DR, Mattice JD, Moldenhauer KA, Dilday RH (2000). Allelopathy in rice as a weed control strategy, p. 33-34. In: Abstracts of Int. Weed Sci. Congr., 3rd, Foz Do Iguassu, Brazil.

Gill LS, Anoliefo GO, Iduoze UV (1993). Allelopathic effect of aqueous extracts of siam weed on growth of cowpea. Chromoleena Newsletters 8.1.

Leela D (1995). Allelopathic effects of Purple nutsedge (*Cyperus rotundus* L.) tubers on growth of field crops. Allelopathy Journal 2:89-92.

McWhorter C (1989). History, biology, and control of johnsongrass. Reviews of Weed Science 4:85-121.

Myers R (2000). Mung beans A Food Legume Adapted to Hot, Dry Conditions. Published by the Jefferson Institute.

Olofsdotter M, Navarez D, Moody K (1995). Allelopathic potential in rice (*Oryza sativa* L.). Ann Appl Biol 127:543-560.

Oueslati O (2003). Allelopathy in two durum wheat (*Triticum durum* L.) varieties. Agric Ecosyst Environ 96:161-163.

Randhawa MA, Cheema ZA, Ali MdA (2002). Allelopathic effect of sorghum Water Extract on Germination and seedling growth of *Trianthema portulacastrum*. Int J Agric Biol 4:383-384.

Rice EL (1984). Allelopathy. 2nd ed. Academic Press, Orlando, FL.

Rice EL (1985). Allelopathy-an overview, p. 81–85. In: Cooperpathic GA (Ed.). Compounds from rice (*Oryza sativa*) variety hull extracts.

Rizvi SJH, Rizvi V (1992). Allelopathy: Basic and applied aspects. 1st ed. Chapman and Hall, London.

Sanchez-Moreiras AM, Coba de la Pena T, Martınez A, Gonzalez L, Pellisier F, Reigosa MJ (2004). Mode of action of hydroxamic acid (BOA) and other related compounds. p. 239-252. In: Macias FA *et al.* (Ed.). Allelopathy: Chemistry and mode of action of allelochemicals. CRC Press, New York.

Singh SP, Pal VR, Luka K (1989). Allelopathy in Crop Production. Journal of Agronomy and CropScience 162:236-240.

Turk MA, Shatnawi MK, Tawaha AM (2003). Inhibitory effects of aqueous extracts of black mustard on germination and growth of alfalfa. Weed Biol Manage 3:37-40.

Uppar DS, Nalini AS, Hiremath SM, Kamatar MY (1993), Allelopathic effects of weeds on germination and vigour index of wheat. Current Research 22:47-48.

Vyvyan JR (2002). Allelochemicals as leads for new herbicides and agrochemicals. Tetrahedron 58:1631-1646.