Research Article

Allelopathic effect of *Sorghum bicolor* powder and fresh *Chenopodium album* water extract on seedling growth of sunflower under the agro-climatic conditions of Tandojam, Sindh-Pakistan

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Abstract

The study was carried out during 2013 to examine the allelopathic effect of *Sorghum bicolor* powder and fresh *Chenopodium album* water extract on seedling growth of sunflower. The experiment was conducted in a 3 replicated completely randomized design (CRD), using sunflower variety HO⁻¹. Seven treatments were examined which included: T₁= Control (untreated), T₂= Fresh *C. album* water extract concentration 30%, T₃= *S. bicolor* Powder water extract concentration 30%, T₄= Fresh *C. album*+ Powder *S. bicolor* WEC 30+30%, T₅= Fresh *C. album*+ *S. bicolor* Powder WEC 60+60%, T₆= Fresh *C. album* water extract concentration 100% and T₇= *S. bicolor* Powder water extract concentration 100%. The results revealed that germination of seed (%), length of shoot(cm), length of root(cm), fresh weight of shoot(g), fresh weight of root(g), dry weight of shoot(mg) and dry weight of root(mg) were significantly affected by allelopathic effects *S. bicolor* and *C. album* extracts. The seed treatment with *S. bicolor* powder water extract concentration (100%) resulted in the lowest germination of seed of sunflower (56.51%), length of shoot (8.82cm), length of root (1.060 cm), fresh weight of shoot (5.947 g), fresh weight of root (0.6067g), dry weight of shoot (610.00mg), and dry weight of root (95.00mg). The allelopathic effect of Fresh *C. album* water extract concentration (100%), ranked second, Fresh *C. album*+ *S. bicolor* Powder WEC 60+60% ranked 3rd, Fresh *C. album*+ Powder *S. bicolor* WEC 30+30% ranked 4th, *S. bicolor* Powder water extract concentration 30% ranked 5th, Fresh *C. album* water extract concentration 30% ranked 6th and control ranked 7th for all the parameters investigated. It is concluded that *C. album*+ Powder *S. bicolor* extracts could effectively be used not only to suppress the weeds in sunflower.

Keywords: Allelopathic; *Chenopodium album*; Seedling growth; *Sorghum bicolor*; Water extract

Introduction

Sunflower (*Helianthus annuus* L.) is a seed grown twice a year for short seasons, with a development period of 19-120 days. It blends well into current cropping systems and can be cultivated without any big crop being replaced [1, 2]. Sunflower produced 3.255 million tonnes of edible oil annually, including 0.507 million tones of local production and 2.748 million tons of import share [3]. Sunflower has the capacity to fill the difference between edible oil demand and supply and is well suited to Pakistan's agro-ecological conditions, which were introduced in Pakistan in the 1960s and have become the country's main oilseed crop [4]. Germination of sorghum and sunflower species decreased with a rise in extract concentration and germination was 35 and 20 percent respectively in sunflower and sorghum with 10 percent extract concentration. Increased concentration also reduced shoot and root duration and dry weight [5]. From numerous sunflower cultivars, more than 200 natural allelopathic compounds have been isolated. Reduction of the radical and hypocotyl duration of mustard seedling induced by sunflower leaf extracts [6] has shown that sunflower components greatly inhibit the germination of *Solanum nigrum* L. Being a seed of brief period and economic value. Weed control is one of the key components of crop husbandry toward potential yields and is the main cause of poor crop yields per unit area. Decrease in cotton yields of 16-53 per cent due to weed infestation, recorded by Baloglu *et al.* [7]. Established strategies for weed control are either costly or risky. Chemical weed control can trigger contamination, whereas hand weeding is labour intensive and expensive.

Allelopathy is a biological process in which one or more biochemicals that impair the development, life, and reproduction of other species are created by an organism. These

biochemicals are classified as allelochemicals and may have consequences on the target species that are favourable (positive allelopathy) or harmful (negative allelopathy). Allelochemicals are a subset of secondary metabolites [8] which are not necessary for the allelopathic organism's metabolism (i.e. growth, development and reproduction). An significant aspect of plant defence against herbivory is allelochemicals with harmful allelopathic results [9]. Hesammi [10] observed that allelopathy, by the release of chemicals, relates to the overt or indirect influence of plants on other plants and plays an important role in many agro-ecosystems. In both natural and human-made environments, allelopathic interactions have been documented to play a crucial role. Similarly, Baloglu *et al.* [7] observed that allelopathy is a significant element that helps to assess the distribution and abundance of organisms within populations. In the success of several introduced plants, allelopathy is often helpful; spotted knapweed, *Centaurea maculosa*, Asteraceae family, Nut sedge, *Cyperus* sp. The Cyperaceae family.

Sorghum is an aggressive and stubborn weed that thrives in troubled soils [11]. Besides the competitive potential of *Sorghum halepense*, the development of allelopathic substances is well known [12, 13]. Osmotic pressure is isolated from the allelopathic impact of *Sorghum halepense* extracts and maize (*Zea mays*) production plants. Mahmood *et al.* [14] found that wild sorghum extracts had important and different allelopathic effects on the germination of maize grain. Mudassir *et al.* [15] confirmed that germinating, seeding and growing seedlings measured the resistance of *Sorghum halepense* (Johnsongrass). The allelopathic impact of *Sorghum halepense*'s leaf and stem on wheat seedling length growth was recorded by [16]. Newman [17] suggested that it is

feasible to use allelopathic responses as a bioherbicide for the allelopathic impact of Sorghum halepense leaf and stem. The current research was planned to investigate the influence of Johnsongrass (*Sorghum halepense* L.) allelopathic weed on the growth and seedling of maize.

Materials and Methods

The laboratory experiment was conducted at seed testing laboratory, Agronomy Department, Sindh Agriculture University Tandojam. Experiment was performed in CRD with three replicates. Variety HO-1 was tested for various sunflower traits. The *sorghum bicolor* powder concentration was prepared by using 300 ml distilled water and 30gram sunflower powder. The 50 gram of fresh *chenopodium album* plants was soaked in 300 ml distilled water for 12 hours then sunflower seeds soaked in calculated allelopathic concentration percentage basis for 2.5 hours. The seeds sown in Petridishes and was kept in germinator for 25 days. The data of all parameters was taken. The treatments are given under:

Treatments

(water extract concentrations *Chenopodium album* and *Sorghum bicolor*) = 7

T₁ = Control (untreated)

T₂ = Fresh *C. album* water extract concentration 30%

T₃ = *S. bicolor* Powder water extract concentration 30%

T₄ = Fresh *C. album*+ Powder *S. bicolor* WEC 30+30%

T₅ = Fresh *C. album*+ *S. bicolor* Powder WEC 60+60%

T₆ = Fresh *C. album* water extract concentration 100%

T₇ = *S. bicolor* Powder water extract concentration 100%

Statistical analysis

Data was obtained were utilized for the analysis by ANOVA method using Statistix 8.1 version.

Results and Discussions

Germination of seed (%)

The result for germination % has affected by allelopathic concentrations of fresh Lambs quarter (*C. album* L.) and Sorghum (*S. bicolor* L.) powder water extract concentrations on sunflower. The (Fig. 1) showed statistically significant for germination %. The results for germination of seed showed significant response towards different allelopathic water extract concentrations. The maximum mean germination of seed % (82.44 and 80.72) was recorded in control (non treated) and @ application of fresh *C. album* water extract concentration 30% followed by (78.57 and 75.150) @ applications of *S. bicolor* Powder water extract concentration 30% Fresh *C. album*+ Powder *S. bicolor* WEC 30+30% and the minimum germination of seed % (56.51) was observed @ allelopathic applications of *S. bicolor* powder water extract concentration 100%, respectively. Further results revealed that the allelopathic applications of Fresh *C. album*+ *S. bicolor* Powder WEC 60+60% and fresh *C. album* water extract concentration 100% also showed significant response to germination of seed% of sunflower.

Length of shoot (cm)

The result for length of shoot (cm) has affected by allelopathic concentrations of fresh Lambs quarter (*Chenopodium album* L.) and Sorghum (*Sorghum bicolor* L.) powder water extract concentrations on sunflower. The (Fig. 2) showed statistically significant for length of shoot (cm). The results for sunflower plant length of shoot (cm) showed significant response towards different allelopathic water extract concentrations. The maximum mean length of shoot cm (23.44) was recorded in control (nontreated) followed by (21.82) length of shoot cm @ application of fresh *C. album* water extract concentration 30% whereas the minimum length of shoot cm (8.820) @

allelopathic application of fresh *C. album* water extract concentration 100%, respectively. The results further revealed that the allelopathic water extract concentrations applications *S. bicolor* powder water extract concentration 30%,

fresh *C. album*+ Powder *S. bicolor* WEC 30+30%, Fresh *C. album*+ *S. bicolor* powder WEC 60+60% and fresh *C. album* water extract concentration 100% were showed significant response to sunflower length of shoot cm.

Means sharing different superscripts indicates significant difference at $p < 0.05$.

Figure 1. Effect of allelopathic plants water extract concentrations on germination of seed (%) of sunflower

Means sharing different superscripts indicates significant difference at $p < 0.05$.

Figure 2. Effect of allelopathic plants water extract concentrations on length of shoot (cm) of sunflower

Length of root (cm)

The result for length of root (cm) has affected by allelopathic concentrations of fresh Lambs quarter (*Chenopodium album* L.) and Sorghum (*Sorghum bicolor* L.) powder water extract concentrations on sunflower. The (Fig. 3) showed statistically significant for length of root (cm). The results for sunflower plant length of root (cm) showed significant response towards different allelopathic water extract concentrations. The maximum mean length of root cm (5.843 and 5.657) was recorded in control (nontreated) and fresh *C. album*

water extract concentration 30% followed by (4.830) and the minimum values for length of root cm (1.060) was observed @ allelopathic water extract concentration applications of *S. bicolor* Powder water extract 100%. The results further revealed that the allelopathic water extract concentration viz. Fresh *C. album*+ Powder *S. bicolor* WEC 30+30%, Fresh *C. album*+ *S. bicolor* Powder WEC 60+60% and Fresh *C. album* water extract concentration 100% also showed significant response to length of root cm of sunflower.

Means sharing different superscripts indicates significant difference at $p < 0.05$.

Figure 3. Effect of allelopathic plants water extract concentrations on length of root (cm) of sunflower

Fresh weight of shoot (g)

The result for fresh weight of shoot (g) has affected by allelopathic concentrations of fresh Lambs quarter (*Chenopodium album* L.) and Sorghum (*Sorghum bicolor* L.) powder water extract concentrations on sunflower. The (Fig. 4) showed statistically significant for fresh weight of shoot (g). The results for fresh weight of shoot (g) showed significant response to different allelopathic water extract concentrations. The maximum

mean fresh weight of shoot g (15.47) was recorded in control (nontreated) followed by (12.90) @ applications of fresh *C. album* water extract concentration 30% and the minimum values for fresh weight of shoot g (5.947) was observed @ allelopathic water extract concentration applications of *S. bicolor* powder water concentration extract 100%, respectively. Further results revealed that other allelopathic concentrations viz. *S. bicolor* Powder water extract concentration

30%, Fresh *C. album*+ Powder *S. bicolor* WEC 30+30%, Fresh *C. album*+ *S. bicolor* Powder WEC 60+60% and fresh *C. album*

water extract concentration 100% showed significant response to fresh weight of shoot (g) of sunflower.

Means sharing different superscripts indicates significant difference at $p < 0.05$.

Figure 4. Effect of allelopathic plants water extract concentrations on fresh weight of shoot (g) of sunflower

Fresh weight of root (g)

The result for fresh weight of root (g) has affected by allelopathic concentrations of fresh Lambs quarter (*Chenopodium album* L.) and Sorghum (*Sorghum bicolor* L.) powder water extract concentrations on sunflower. The (Fig. 5) showed statistically significant for fresh weight of root (g). The results for fresh weight of root (g) showed significant response to different allelopathic water extract concentrations. The maximum mean fresh weight of root g (0.9067) was recorded in control (nontreated) followed by (0.7833) @ applications of fresh *C. album* water extract concentration 30% and the minimum value for fresh weight of root g (0.6067) was observed @ allelopathic water extract concentration applications of *S. bicolor* powder water concentration extract 100%, respectively. Further results revealed that other allelopathic concentrations viz. *S. bicolor* Powder water extract concentration

30%, Fresh *C. album*+ Powder *S. bicolor* WEC 30+30%, Fresh *C. album*+ *S. bicolor* Powder WEC 60+60%, Fresh *C. album* water extract concentration 100% and *S. bicolor* Powder water extract concentration 100% were showed non-significant response to each other for fresh weight of root (g), respectively.

Dry weight of shoot (mg)

The result for dry weight of shoot (mg) has affected by allelopathic concentrations of fresh Lambs quarter (*Chenopodium album* L.) and Sorghum (*Sorghum bicolor* L.) powder water extract concentrations on sunflower. The (Fig. 6) showed statistically significant for dry weight of shoot (mg). The results for dry weight of shoot (mg) showed significant response to different allelopathic water extract concentrations. The maximum mean dry weight of shoot mg (894.0) was recorded in control (nontreated) followed by (812.0) @ applications of fresh

C. album water extract concentration 30% and the minimum value for dry weight of shoot mg (610.0) was recorded @ allelopathic water extract concentration applications of *S. bicolor* powder water extract concentration 100%. Further results revealed that other allelopathic concentrations viz. *S. bicolor* Powder water

extract concentration 30%, Fresh *C. album*+ Powder *S. bicolor* WEC 30+30%, Fresh *C. album*+ *S. bicolor* Powder WEC 60+60%, Fresh *C. album* water extract concentration 100% and *S. bicolor* Powder water extract concentration 100% were showed non-significant response to each other for dry weight of shoot (mg), respectively.

Means sharing different superscripts indicates significant difference at $p < 0.05$.

Figure 5. Effect of allelopathic plants water extract concentrations on fresh weight of root (g) of sunflower

Means sharing different superscripts indicates significant difference at $p < 0.05$.

Figure 6. Effect of allelopathic plants water extract concentrations on dry weight of shoot (mg) of sunflower

Dry weight of root (mg)

The result for dry weight of root (mg) has affected by allelopathic concentrations of fresh Lambs quarter (*Chenopodium album* L.) and Sorghum (*Sorghum bicolor* L.) powder water extract concentrations on sunflower. The (Fig. 7) showed statistically significant for dry weight of root (mg). The results for dry weight of shoot (mg) showed significant response to different allelopathic water extract concentrations. The maximum mean dry weight of root mg (293.0) was recorded in control (nontreated) followed by (227.0) @ applications of fresh *C. album* water extract concentration 30% and the

minimum value for dry weight of root mg (95.00) was recorded @ allelopathic water extract concentration applications of *S. bicolor* powder water concentration extract 100%. Further results revealed that other allelopathic concentrations viz. *S. bicolor* Powder water extract concentration 30%, Fresh *C. album*+ Powder *S. bicolor* WEC 30+30%, Fresh *C. album*+ *S. bicolor* Powder WEC 60+60%, Fresh *C. album* water extract concentration 100% and *S. bicolor* Powder water extract concentration 100% were showed non-significant response to each other for dry weight of root (mg), respectively.

Means sharing different superscripts indicates significant difference at $p < 0.05$.

Figure 7. Effect of allelopathic plants water extract concentrations on dry weight of root (mg) of sunflower

Discussion

The present study showed that germination of seed, length of shoot, length of root, fresh weight of shoot, fresh weight of root, dry weight of shoot and dry weight of root were significantly affected by allelopathic effects *S. bicolor* and *C. album* extracts. The seed treatment with *S. bicolor* Powder water extract concentration (100%) resulted in the lowest germination of seed of sunflower (56.51%), length of shoot (8.82cm), length of root (1.060

cm), fresh weight of shoot (5.947 g), fresh weight of root (0.6067g), dry weight of shoot (610.00mg), and dry weight of root (95.00mg). The allelopathic effect of Fresh *C. album* water extract concentration (100%), ranked second, Fresh *C. album*+ *S. bicolor* Powder WEC 60+60% ranked 3rd, Fresh *C. album*+ Powder *S. bicolor* WEC 30+30% ranked 4th, *S. bicolor* Powder water extract concentration 30% ranked 5th, Fresh *C. album* water extract concentration 30% ranked 6th and control ranked 7th for all the

parameters investigated. It is concluded that *C. album*+ Powder *S. bicolor* extracts could effectively be used not only to suppress the weeds in sunflower. These observations are compatible with those of Hesammi [10], which suggested that wild sorghum extracts had important and different allelopathic effects on the germination of maize grain. Butnariu [9] confirmed that germinating, seeding, and increasing seedlings evaluated the resistance of *Sorghum halepense* (Johnsongrass). Nouri *et al.* [18] documented the allelopathic impact of *S. halepense* leaf and stem on wheat seedling length growth. Siyal *et al.* [19] suggested that as a bioherbicide, allelopathic responses to the allelopathic impact of *S. halepense* leaf and stem may be used. Similarly, Mahmood *et al.* [14] evaluated allelopathic crop water extracts against sunflower using aqueous sorghum extracts (*S. bicolor* L.), and discovered that the application of sunflower + sorghum + mulberry extracts combined with Atlantis 3.6 WG @ 7.20 g a.s/ha demonstrated a greater reduction in overall weed density (86%) and total dry weight of marijuana (88 percent). Maximum grain yield (2.90 t ha^{-1}), which was 36% higher than control (2.13 t ha^{-1}) and 3.94% higher than the prescribed herbicide dosage, was also obtained with the same treatment (2.79 t ha^{-1}). The results also revealed the superiority of this procedure with a higher net return of Rs. 71322 per hectare and a marginal return rate of 4221 percent. Mudassir *et al.* [15] recorded that the reduction in fresh weight and dry weight of all herbicide weeds was maximum (41%) whereas most allelopathic crops leachate therapies greatly reduced dry weight of total weeds by 15%. Sedigheh *et al.* [20] observed that *Chenopodium album*, *S. halepense*, helped minimize plant germination of seeds and seedling development was more extreme. Comparison of extract results with polyethylene glycol showed that the osmotic pressure of the extract was related to the reduction of germination of seed and seedling development in Johnsongrass and Common lambsquarter, while inhibition of germination of seed was due to allelochemicals in Redroot pigweed and maize. Baloglu *et al.* [7] stated that *S. bicolor* application was all-allelopathic to sunflower weeds and remained successful in reducing weed germination and growth, checked

by Siyal [21]. *Halepense*'s used its extract as an allelopathic plant and stated that the germination was not impaired by either of the extracts examined, but the existence of tropane alkaloids inhibited development. At higher alkaloid concentrations, extracts had an effect. Seedlings from *S. Halepense* produced signs of toxicity in the presence of alkaloid extracts, but some chlorotic and necrotic areas were observed in the biotest of the flower extract. Soufan and Almouemar [22] stated that wild sorghum allelopathic effects resulted in decreased germination and fresh and dry weight of the root/shoot under field conditions.

Conclusion

The allelopathic effect of Fresh *C. album* water extract concentration (100%), ranked second, Fresh *C. album*+ *S. bicolor* Powder WEC 60+60% ranked 3rd, Fresh *C. album*+ Powder *S. bicolor* WEC 30+30% ranked 4th, *S. bicolor* Powder water extract concentration 30% ranked 5th, Fresh *C. album* water extract concentration 30% ranked 6th and control ranked 7th for all the parameters investigated. It is concluded that *C. album*+ Powder *S. bicolor* extracts resulted optimum seedling growth of sunflower and could effectively be used to suppress the weeds in sunflower.

Authors' contributions

Conceived and designed the experiments: KR Kalwar & AH Sial, Performed the experiments: KR Kalwar & FM Baloch, Analyzed the data: MA Sahito, AA Korejo & BS Mengal, Contributed materials/ analysis/ tools: AL Siyal, KA Brohi & FM Baloch, Wrote the paper: AL Siyal.

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