Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 7, 2021, Pages. 1752 - 1765
Received 05 May 2021; Accepted 01 June 2021.

Comparative Weed Control by Allelopathic Influence of Sunflower and Johnson Grass Residues and Aquatic Extracts

Lalchand[1], Aijaz Ahmed Soomro[1], Mahmooda Buriro[1], Qamaruddin Chachar[2], Muhammad Nawaz Kandhro[1]

[1]Department of Agronomy, Sindh Agriculture University, Tandojam, Pakistan
[2]Department of Plant Physiology Sindh Agriculture University, Tandojam,

*Corresponding author: lalchand2@yahoo.com

Abstract

The impact of weeds has tremendously reduced per hectare yield of different crops due to their competition for water, nutrients and placement. Application of herbicides particularly in cereals and vegetables is unsafe as these are directly consumed by human beings and sometimes from the soil residues are transported to water bodies and mixed with the drinking water. Therefore, keeping in view this study was framed with objectives to determine plants with high allelochemical properties that may be further applied in the field crops to control weed population through their allelopathic properties. The laboratory experiments were carried out in Seed Testing Laboratory, Department of Agronomy, Sindh Agriculture University Tandojam. The allelopathic impact of sunflower and johnson grass on germination and seedling growth of purple nutsedge (*Cyperuns rotundus* L.) and jungle rice (*Echinochloa colonum* L.) was studied and the results were found statistically significant ($P<0.05$) under various treatments. The results depicted that allelopathic influence of sunflower and johnson grass residues and aquatic extract on purple nutsedge produced minimum seed germination (%), root length (cm), seedling vigor index, leaves seedling^{-1}, leaf length (cm), leaf area (cm^2) with johnson grass aquatic extract 15 mL kg^{-1} soil. Minimum shoot length (cm), fresh biomass (g) and dry biomass (g) per seedling was recorded with sunflower aquatic extract at 15 mL kg^{-1} soil. The influence on jungle rice resulted minimum seed germination (%) and root length (cm) with sunflower aquatic extract at 15 mL kg^{-1} soil. The minimum shoot length (cm), seedling vigor index, leaves seedling^{-1} and dry biomass (g seedling^{-1}) was determined in johnson grass aquatic extract 15 mL kg^{-1} soil. The minimum leaf length (cm) was recorded with johnson grass residue incorporation at 15 g kg^{-1} soil. The smallest leaf area (cm^2) and fresh biomass (g seedling^{-1}) was recorded in sunflower residue incorporation at 15 g kg^{-1}soil. It is concluded from the study that sunflower and johnson grass residues and aquatic extract restricted the germination and normal growth of targeted weeds. Therefore, aquatic extracts of sunflower and johnson grass may be practiced in crop fields as alternate of herbicide which is not only economical but also environment friendly.

Keywords: Allelopathy, sunflower, johnson grass, maize, weeds

INTRODUCTION

Allelochemicals have capability to suppress harmful weeds by the development of environment friendly compounds. Since excessive use of herbicides in crops pose worldwide risks to health and the natural ecosystem, there is need to discover substitute measures for weed control (Pejman *et al.*, 2011). The release of allelochemical from different plant organs like roots, stems, leaves, flowers and seeds of living and decayed plants may affect growth and population of weeds (Tesio and Ferrero, 2010). The structure and the mechanism by which allelopathic chemicals respond, varies in different plant species, due to this fact these may possibly be brought in use in future for the new herbicides development. (Weston, 2005). The allelopethic behaviour in crop plants may be determined and be applied successfully in field crops for weed management. There

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 7, 2021, Pages. 1752 - 1765
Received 05 May 2021; Accepted 01 June 2021.

are some specific plants which inhibit growth of some weed species and the compounds released from their residues inhibit germination of weed seeds. The presences of allelochemicals in some plants have already been demonstrated and their role to address weed problems have also been identified (Bhadoria, 2011). A large amount of the chemical substances formed by allelopathic plants are extremely toxic in nature and these may be brought in use as effective possible herbicides (Troc *et al*., 2011). It has been determined that sunflower naturally posses strong allelopathic behavior because certain chemical compounds are produced from their leaf extract such as lactones, sesquiterpene and terpenes (Gao *et al*., 2008).

The adaptation of plant allelopathy to address the weed problems in the field has been generally accepted as an effective approach since it is an environment friendly and economical method. This natural weed control mechanism relies on allelochemicals, the micro organisms and their biological interactions and exploring the link between allelochemicals and specific microbes which are responsible to accelerate the application of allelopathic features in farming (Li *et al*., 2020). Allelopathy is one of the substantial mechanisms of plant disruption which is facilitated by the accumulation of phytotoxins produced by the plants to the environment. The strong chemical substances are produced and released into the environment especially into the rhizosphere in adequate amounts affecting neighbouring plants (Ambika, 2012). The allelopathy and competition are difficult to distinguish in the field level but both are well documented in the studies under controlled circumstances (Awan *et al*., 2009). Many scientists have studied the detrimental role of some of the plants and their residues on the emergence and development of higher plants and crop productivity. The issues of monoculture farming, auto toxicity and mulching toxicity have been documented. Bhadoria (2011) determined the option of application of allelopathic plants to control weed growth at farm level. Also, Cheema *et al*., (2012) described the key role of allelochemicals for pest management. Allelopathy has direct or indirect association with soil micro organisms which form the large amount of nitrogen for other plants and organisms (Dang *et al*., 2010). Allelochemicals produced by many crops have interaction with germination, growth and development of the other crops. These findings are significant for the chosing suitable sequence of crop rotation (Hura *et al*., 2007; Jamil *et al*., 2009; Farooq *et al*., 2011).

Sunflower is known to be a strong allelopathic plant which has significant compounds with identified allelopathic nature for other plants (Zahir and Abdul, 2014). Phenolic compounds, terpenoids and flavonoids are the main allelopathic compounds present in sunflower (Macias *et al*., 2004; Gawronska*et al*., 2007). With the application of various extracts of sunflower and other plants for the management of rice weeds, grasses and sedges, the root and shoot length, accumulation of biomass and chlorophyll amount was significantly reduced (Khaliq *et al*., 2013). Wild barely showed respond by significant decrease in germination, seedling growth and biomass when the sunflower residues and aquatic extracts were applied (Ashrafi *et al*., 2008). Certain water soluble allelochemical compounds are available in sunflower plants, which are responsible to reduce the emergence and growth of other plant species. This strategy could be adopted in weed control programme.

The compounds available in sunflower having inhibitory nature and are responsible for the allellopathicity against weed species could be adopted as a possible natural herbicide, but prior to this these allelochemicals must be first explored and examined as necessary to learn their proper mode of action (Ashrafi *et al.*, 2008). However, the weed population was increased in control plots during five years but the rate of growth was recorded less in sunflower plots. The data showed a little variation in different sunflower genotypes.

Johnson grass has inhibitory effect on different plants through its solid suppressive performance and strong allelopathic capabilities (Huang *et al*., 2015). The occurrence of cyanogenic, Phenolic and glycogenic components in johnson grass are responsible of the suppression of crop plants (Stef *et al.,* 2013). The substances having allelopathic characteristics derived from johnson grass shoot, rhizome and inflorescence discontinued germination and plant growth of four different weed species namely, rye grass wild oat, grass pea and syrian cephalaria (Iqbal and Anwer, 2011). Johnson grass allelopathy found to reduce diversity of the native species (Rout *et al.,* 2013). Acciaresi and Guiamet (2010) determined that, due to the release of large amount of toxic chemicals from root zones and decaying vegetation of high density of johnson grass resulted reduced germination and growth of some crops. These findings have also been justified in the study carried out by using different concentrations of aqueous extracts obtained from different tissues of johnson grass (Nouri *et al.* ,2012). Later on more allelopathic inhibition was reported by other researchers in cotton upto 86% and up to 64% in maize. A great allelopathic response has also been determined in the root exudates of johnson grass (Rout and Chrzanowski, 2009). Nouri *et al*. (2012) determined that johnson grass plant parts extract decreased the fresh weight of wheat plants. Similarly, Rout and Chrzanowski (2009) determined the linkage of nitrogen fixing action with johnson grass and explored that this may enhance its performance to invade ecosystem by changes in soil biogeochemistry. The existence of johnson grass in any field crop may leave allelopathic characteristics for the successive crops like soybean and maize (Soufan and Almouemar, 2009; Stef *et al.*, 2015) accordingly, its agronomic impacts cannot be limited upto only single season the allelopathic effects of the roots and residues may exist for prolonged period.

The practice of unnecessary and incessant application of herbicides has caused a resistant in weed populations and to address such issue there is need to explore allelopathic potential of crop plants (Ferreira and Reinhardt, 2010). When herbicide applied in combination with water extracts, worked effectively and the results could be helpful to minimize herbicide doses (Razzaq *et al.,* 2012). Ejaz *et al*. (2015) reported that extracts of sorghum, sunflower and congress grass leaves can be applied twice with the interval of 30 and 60 days to control weeds and to enhance wheat yield upto 52% and 53%, respectively. Afridi *et al*. (2013) revealed that aquatic extract concentrations significantly reduced weed population and even more response was observed with the increased aquatic extract concentrations. Elahi *et al.* (2011) showed that application of increased concentration of aqueous extract exhibited inhibitory effect on weeds because of increased phenolic compound which suppressed weeds density.

Weed management by using allelopathy may practically be applied by either spraying or incorporating aqueous extracts of plants (Farooq *et al*., 2011). Sunflower being an important allelopathic crop releases many important allelopathic substances which inhibit the growth of neighbouring plants with its high allelopathic behaviour and they inhibit seed germination (Kamal and Bano, 2008). Weed density and biomass is reduced ranging from 19 to 49 %, by using allopathic plants. Allelopathy has been effectively applied to control weeds of cotton, sunflower and mungbean fields. Weeds management by application of aquatic extract of allelopathic plant enhanced yield from 15 to 25 %. Application of plant extracts in combination with weedicides is more useful for controlling weeds than sole application (Cheema *et al*., 2012). When sunflower aquatic extract (100%) was applied, wheat production increased upto 7% and weed dry weight reduced upto 51%. The foliar spray of mulberry water extract (100%) inhibited seedling growth of Bermuda grass and increased wheat growth.

The weed management by synthetic herbicides is increasing day by day for immediate results and to control the losses cause by the weeds (Khaliq *et al*., 2013). The injudicious use of herbicides is comparatively higher as compared to developed nations because there is lack of awareness about the safe use of such agro-chemicals (Tariq *et al.*, 2007). The herbicide degrades slowly in natural environment, which lead to its accumulation in the soil and environment (Ustuner *et al*., 2020). The alternative strategies for weed management are required so

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 7, 2021, Pages. 1752 - 1765
Received 05 May 2021; Accepted 01 June 2021.

that use of synthetic herbicides could be minimized (Farooq *et al*., 2011). Therefore integrated weed management approach may be adopted for obtaining best results (Fahad *et al*., 2015).

The weed population controlled by residues of allelopathic plants is a safe strategy and improves soil health (Khalil *et al*., 2010). Crop residues are the main source of nutrients supply. They play a vital role for improvement of water holding capacity of soil as well as increase nutrients supply. Moreover, application of crop residues can also nourish rhizosphere, decrease input cost and limits greenhouse gases emissions (Sharma, 2011). The soil incorporation of crop residues also provides additional benefits like slow release of nutrients and maintain soil temperature (Bajgai *et al*., 2015). Xiao *et al*. (2020) explored that soluble and insoluble allelopathic substances in soil provided a deep insight into microflora variation. Microbes may responsible for allelochemicals expulsion in the soil and addition of residues inhibited specific microbial population.

Environmental degradation, resistance developed in weeds against most of the weedicides and their serious health hazards has drawn the attention of the researchers to develop substitute for the existing weed management practices (Jabran *et al*., 2010). In such circumstances to practice known allelopathic plant extracts in combination with less concentration of herbicides for weed management has now became accepted fact (Jabran *et al*., 2008). Pejman *et al*. (2011) explored that sunflower allelopathic components can act as substitute herbicide against known harmful broad and narrow leaf weeds.

The reviewed studies suggested that effect of allelopathy by applying weed extract may inhibit weeds growth if applied alone. However, if herbicides are applied in combination with the plant extract, considerable economic benefits can be achieved for the growers and the environment. In view of the above facts and findings, the present research was carried out to explore the potential of sunflower and johnson grass residues and aquatic extract applications for weed control.

MATERIALS AND METHODS

Target weeds

i. Purple nutsedge (*Cyperuns rotundus* L.)

ii. Jungle rice (*Echinochloa colonum* L.)

Experimental design = Completely randomized design (CRD)

Replications = Three (3)

Preparation of aquatic extracts

The residues of sunflower and johnson grass roots and shoots in the ratio of 1:10 (w/v) were milled in milling portion of juicer blender to prepare their powder. Then, the powder was soaked in water for 24 hours. The extract was filtered through muslin cloth to separate the remaining of the poweder from the extract and concentrated upto 20 times through boiling at 100 ^{0}C on the burner for easy handling and application (Cheema, 2008; Awan *et al*., 2009).

Method of application

Sunflower and johnson grass plants from field were harvested, dried and drenched in water at the ratio of 1:10 w/v for 24 hours. Then the extracts were filtered through muslin cloth and

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 7, 2021, Pages. 1752 - 1765
Received 05 May 2021; Accepted 01 June 2021.

concentrated to 20 times by boiling at 100^{o}C on gas burner to reduce the volume of extract (Hussain *et al*., 2016). The johnson grass and sunflower water extract was sprayed by hand sprayer (Cheema *et al*., 2002; Awan *et al*., 2009).

Growing of *Cyperus rotundus* L. and *Echinochloa colonum* L.

Fifteen tubers, rhizomes and seeds of *Cyperus rotundus* L. and *Echinochloa colonum* L., were sown into the sand boxes, respectively. The root and shoot water extracts of sunflower and johnson grass, each @ 10 mL and 15 mL per kg of soil was sprayed in five equal splits on 0, 1, 3, 7, and 14 days after sowing. The sand boxes were placed in the laboratory at room temperature.

Treatments = 9

T_1 = Untreated (Control as check)
T_2 = Sunflower residue (powder) incorporation at 10 g kg^{-1} soil
T_3 = Sunflower residue (powder) incorporation at 15 g kg^{-1} soil
T_4 = Sunflower aquatic extract at 10 mL kg^{-1} soil
T_5 = Sunflower aquatic extract at 15 mL kg^{-1} soil
T_6 = Johnson grass residue (powder) incorporation at 10 g kg^{-1} soil
T_7 = Johnson grass residue (powder) incorporation at 15 g kg^{-1} soil
T_8 = Johnson grass aquatic extract at 10 mL kg^{-1} soil
T_9 = Johnson grass aquatic extract at 15 mL kg^{-1} soil

Observations recorded

Seed germination (%)

The germinated seedlings were counted 03 weeks after sowing.

Total germinated seeds / total number of seeds.

Root length (cm)

The seedling root length was recorded by measuring tape.

Shoot length (cm)

The seeding shoot length was recorded by measuring tape.

Seedling vigor index

The seedlings were taken from each treatment at random of three replications and were weighed.

Leaves seedling $^{-1}$

The number of seedlings was counted after 03 weeks of sowing before uprooted.

Leaf length (cm)

The leaf length was recorded by measuring tape.

Leaf area (cm^2)

Leaf area of five randomly selected plants from each treatment was determined through length and breadth method multiplied by 0.75, which is a constant factor (Montgomey, 1911; Pagano and Maddonni, 2007).

Leaf area cm^{-2} = length x breadth x factor (0.75)

Fresh biomass (g seedling^{-1})

The seedling fresh weight was weighed at time of uprooted after 03 weeks of sowing.

Dry biomass (g seedling^{-1})

The oven dried seedling weight was recorded at time of uprooted after 03 weeks of sowing.

Statistical analysis

The data recorded from each plot was subjected to statistical analysis by applying Statistic 8.1 software (Statistix, 2006). Least significant difference (LSD) test was used to compare treatments superiority where it was necessary.

RESULTS

Allelopathic effect on purple nutsedge

The allelopathic influence of sunflower and johnson grass residues and aquatic extract on *Cyperus rotundus* L. was recorded and the results are shown in Table-1, 2 & 3.

The result described that sunflower and johnson grass residue (powder) and aquatic extract treatments exhibited marked ($P<0.05$) phytotoxic impact on germination and other growth parameters of purple nutsedge. The minimum seed germination (46.53%), root length (4.78 cm), seedling vigor index (623), leaves seedling^{-1}(5.46), leaf length (9.68 cm), leaf area (1.57 cm^2) was recorded in johnson grass aquatic extract 15 mL kg^{-1} soil. Similarly, minimum shoot length (13.25 cm), fresh biomass (4.61 g seedling^{-1}) and dry biomass (2.08 g seedling^{-1}) was recorded in sunflower aquatic extract at 15 mL kg^{-1} soil. However, maximum seed germination (84.54%), root length (8.28 cm), shoot length ((20.48 cm), seedling vigor index (1732), leaves seedling^{-1} (10.06), leaf length (19.06 cm), leaf area (5.97 cm^2), fresh biomass (9.36 g seedling^{-1}) and dry biomass (4.70 g seedling^{-1}) was observed in control treatment where, sunflower and johnson grass residues and aquatic extract were not applied.

The application of johnson grass and sunflower aquatic extract with slightly higher dose were found more allelopathic as compared to different doses of sunflower and johnson grass residue and application of johnson grass and sunflower aquatic extract in small quantity.

Table 1. Allelopathic effect of sunflower and johnson grass powder and aquatic extract on germination and relevant traits of purple nutsedge

Treatments	Seed germination (%)	Root Length (cm)	Shoot Length (cm)
Untreated (Control as check)	84.54a	8.28 a	20.48 a
Sunflower residue incorporation at 10 g kg^{-1} soil	68.21 b	7.07abc	15.74bcd
Sunflower residue incorporation at 15 g kg^{-1} soil	61.86b	6.11 c	16.46 bc
Sunflower aquatic extract at 10 mL kg^{-1} soil	66.11b	6.79bc	15.89 bcd
Sunflower aquatic extract at 15 mL kg^{-1} soil	58.03c	6.31bc	13.25 d
Johnson grass residue incorporation at 10 g kg^{-1} soil	62.55	7.55 ab	16.33 bc
Johnson grass residue incorporation at 15 g kg^{-1} soil	60.42bc	6.23 c	16.15 bcd
Johnson grass aquatic extract at 10 mL kg^{-1} soil	61.02bc	6.12 c	17.03 b

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 7, 2021, Pages. 1752 - 1765
Received 05 May 2021; Accepted 01 June 2021.

Johnson grass aquatic extract at 15 mL kg^{-1} soil	46.53 d	4.78 d	13.53 cd
S.E ±	3.7877	0.5946	1.4053
LSD 0.05	7.9576	1.2492	2.9523

Table 2. Allelopathic effect of sunflower and johnson grass powder and aquatic extract on agronomic traits of purple nutsedge

Treatments	Seedling vigor index	Leaves $seedling^{-1}$	Leaf length (cm)
Untreated (Control as check)	1732 a	10.06 a	19.06 a
Sunflower residue incorporation at 10 g kg^{-1} soil	1071 b	7.10 bc	16.36 ab
Sunflower residue incorporation at 15 g kg^{-1} soil	1019 b	6.46 bcd	14.78 b
Sunflower aquatic extract at 10 mL kg^{-1} soil	1059 b	7.74 b	16.08 ab
Sunflower aquatic extract at 15 mL kg^{-1} soil	772 cd	5.63 cd	15.46 ab
Johnson grass residue incorporation at 10 g kg^{-1} soil	1019 b	6.66 bcd	17.16 ab
Johnson grass residue incorporation at 15 g kg^{-1} soil	974 bc	7.16 bc	14.83 b
Johnson grass aquatic extract at 10 mL kg^{-1} soil	1042 b	6.33 bcd	13.43 b
Johnson grass aquatic extract at 15 mL kg^{-1} soil	623 d	5.46 d	9.68 c
S.E ±	107.47	0.7455	2.0032
LSD 0.05	225.79	1.5663	4.2086

Table 3. Allelopathic effect of sunflower and johnson grass powder and aquatic extract on different traits of purple nutsedge

Treatments	Leaf area (cm^2)	Fresh biomass (g $seedling^{-1}$)	Dry biomass (g $seedling^{-1}$)
Untreated (Control as check)	5.97 a	9.36 a	4.70 a
Sunflower residue incorporation at 10 g kg^{-1} soil	3.81 b	5.16 cd	4.03 ab
Sunflower residue incorporation at 15 g kg^{-1} soil	4.19 b	6.50 bcd	3.36 abc
Sunflower aquatic extract at 10 mL kg^{-1} soil	3.75 b	8.06 bc	4.13 ab
Sunflower aquatic extract at 15 mL kg^{-1} soil	3.89 b	4.61 d	2.08 c
Johnson grass residue incorporation at 10 g kg^{-1} soil	4.19 b	5.68 cd	2.85 bc
Johnson grass residue incorporation at 15 g kg^{-1} soil	3.51 b	5.39 cd	3.21 abc
Johnson grass aquatic extract at 10 mL kg^{-1} soil	3.11 bc	6.66 bc	3.33 abc
Johnson grass aquatic extract at 15 mL kg^{-1} soil	1.57 c	5.55 cd	2.75 bc
S.E ±	0.8414	0.9307	0.7260
LSD 0.05	1.7678	1.9554	1.5253

Allelopathic effect on jungle rice

The allelopathic influence of sunflower and johnson grass residues and aquatic extract on *Echinochloa colonum* L. was calculated. The results are illustrated in Table- 4, 5 & 6.

The results showed that sunflower and johnson grass residue and aquatic extract treatments showed marked (P<0.05) phytotoxic impact on germination and other growth parameters of jungle rice. The minimum seed germination (54.82%) and root length (4.71 cm) was observed in sunflower aquatic extract at 15 mL kg^{-1} soil whereas, minimum shoot length (10.60 cm), seedling vigor index (597), leaves $seedling^{-1}$ (7.16) and dry biomass (1.23 g $seedling^{-1}$) was determined in johnson grass aquatic extract 15 mL kg^{-1} soil. The minimum leaf length (7.55 cm) was recorded in johnson grass residue incorporation at 15 g kg^{-1}soil. The smallest leaf area (2.18 cm^2) and fresh biomass (4.40 g $seedling^{-1}$) was recorded in sunflower residue incorporation at 15 g kg^{-1} soil. However, maximum seed germination (86.05%), root length (7.13 cm), shoot length (21.48 cm), seedling vigor index (1844), leaves $seedling^{-1}$(15.58), leaf length (15.86 cm), leaf area (5.13 cm^2), fresh biomass (11.45 g $seedling^{-1}$) and dry biomass (3.49 g $seedling^{-1}$) was observed in control treatment where, sunflower and johnson grass residue and aquatic extract were not applied.

The overall results showed that increased dose of johnson grass aquatic extract and sunflower aquatic extract applications significantly reduced germination traits of jungle rice.

Table 4 .Allelopathic effect of sunflower and johnson grass powder and aquatic extract on germination and relevant traits of jungle rice

Treatments	Seed germination (%)	Root Length (cm)	Shoot Length (cm)
Untreated (Control as check)	86.05 a	7.13 a	21.48 a
Sunflower residue incorporation at 10 g kg^{-1} soil	64.02 bc	7.20 a	17.69 b
Sunflower residue incorporation at 15 g kg^{-1} soil	55.91 bc	5.60 b	16.03 bc
Sunflower aquatic extract at 10 mL kg^{-1} soil	66.30 b	5.83 ab	15.93 bc
Sunflower aquatic extract at 15 mL kg^{-1} soil	54.82 c	4.71 b	11.58 e
Johnson grass residue incorporation at 10 g kg^{-1} soil	62.82 bc	5.65 b	14.69 cd
Johnson grass residue incorporation at 15 g kg^{-1} soil	55.25 bc	5.06 b	12.81 de
Johnson grass aquatic extract at 10 mL kg^{-1} soil	62.97 bc	5,12 b	17.03 bc
Johnson grass aquatic extract at 15 mL kg^{-1} soil	56.11 bc	5.38 b	10.60 e
S.E ±	5.3197	0.6711	1.2800
LSD 0.05	11.176	1.4100	2.6892

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 7, 2021, Pages. 1752 - 1765
Received 05 May 2021; Accepted 01 June 2021.

Table 5. Allelopathic effect of sunflower and johnson grass powder and aquatic extract on agronomic traits of jungle rice

Treatments	Seedling vigor index	Leaves seedling^{-1}	Leaf length (cm)
Untreated (Control as check)	1844 a	15.58 a	15.86 a
Sunflower residue incorporation at 10 g kg^{-1} soil	1132 b	12.42 ab	12.75 abc
Sunflower residue incorporation at 15 g kg^{-1} soil	894 c	11.80 abc	8.73 cd
Sunflower aquatic extract at 10 mL kg^{-1} soil	1051 bc	11.03 abc	12.11 abc
Sunflower aquatic extract at 15 mL kg^{-1} soil	636 c	9.26 bc	13.03 ab
Johnson grass residue incorporation at 10 g kg^{-1} soil	926 c	10.43 abc	12.06 abc
Johnson grass residue incorporation at 15 g kg^{-1} soil	702 d	6.92 c	7.55 d
Johnson grass aquatic extract at 10 mL kg^{-1} soil	1068 bc	8.47 bc	9.70 bcd
Johnson grass aquatic extract at 15 mL kg^{-1} soil	597 d	7.16 c	9.74 bcd
S.E ±	87.385	2.4940	2.0386
LSD 0.05	183.59	5.2398	4.2830

Table 6. Allelopathic effect of sunflower and johnson grass powder and aquatic extract on different traits of jungle rice

Treatments	Leaf area (cm^2)	Fresh biomass (g seedling^{-1})	Dry biomass (g seedling^{-1})
Untreated (Control as check)	5.13 a	11.45 a	3.49 a
Sunflower residue incorporation at 10 g kg^{-1} soil	3.92 abc	6.67 bcde	3.30 ab
Sunflower residue incorporation at 15 g kg^{-1} soil	2.18 c	4.40 e	2.86 abc
Sunflower aquatic extract at 10 mL kg^{-1} soil	3.63 bc	8.86 b	2.66 abc
Sunflower aquatic extract at 15 mL kg^{-1} soil	4.06 ab	5.25 de	2.10 cde
Johnson grass residue incorporation at 10 g kg^{-1} soil	3.60 abc	7.98 bc	2.26 cd
Johnson grass residue incorporation at 15 g kg^{-1} soil	2.84 bc	6.37 bcde	3.21 abc
Johnson grass aquatic extract at 10 mL kg^{-1} soil	2.75 bc	7.32 bcd	1.40 de
Johnson grass aquatic extract at 15 mL kg^{-1} soil	2.63 bc	5.92 de	1.23 e
S.E ±	0.8349	1.1915	0.4190
LSD 0.05	1.7541	2.5032	0.8803

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 7, 2021, Pages. 1752 - 1765
Received 05 May 2021; Accepted 01 June 2021.

DISCUSSION

The allelochemicals could be manipulated and applied for weed management and turned towards an environment friendly and sustainable agricultural production system (Farooq *et al.*, 2020). Dahiya *et al*. (2017) depicted that allelopathic substances, if available in crop genotypes, may reduce the required practices for weed management, particularly application of herbicide. Allelochemicals act through direct interference with physiological functions of 'receiver' such as seed germination, root growth, shoot growth and stem growth.

The study results of laboratory research on allelopathic influence of sunflower and johnson grass residues and aquatic extract on purple nutsedege (*Cyperus rotundus* L.) revealed that minimum seed germination (%), root length (cm), seedling vigor index, leaves seedling^{-1}, leaf length (cm), leaf area (cm^2) was recorded with johnson grass aquatic extract 15 mL kg^{-1} soil. Similarly, minimum shoot length (cm), fresh biomass (g seedling^{-1}) and dry biomass (g seedling^{-1}) was recorded with sunflower aquatic extract at 5 mL kg^{-1} soil. These results corroborated with Huang *et al*. (2015) reported that johnson grass is well known for its damaging impacts on the growth and development of neighboring plants through its strong competitive abilities and allelopathic potential. Therefore, Rashid *et al*. (2020) depicted that the aquatic extract of allelopathic plants, exhibited extra inhibitory effect on seed germination, germination time, shoot length and dry biomass of the tested species. It has been widely reported in cropped areas, causing severe yield losses in economically important crops including wheat (*Triticum aestivum* L.), soybean (*Glycine max* L.), maize (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), vegetables, and fruits (Uremis *et al*. 2009). The maximum values were recorded in weedy check (no weeding treatment). The application of johnson grass and sunflower aquatic extract with slightly higher dose was found more allelopathic as compared to different doses of sunflower and johnson grass residue and application of johnson grass and sunflower aquatic extract in small quantity.

The allelopathic influence of sunflower and johnson grass residues and aquatic extract on jungle rice (*Echinochloa colonum* L.) was also tested and determined minimum seed germination (%) and root length (cm) was observed in sunflower aquatic extract at 15 mL kg^{-1} soil. These results are in close with the findings of Rawat *et al*. (2017) who reported that pot culture and laboratory studies have revealed that inclusion of sunflower considerably lowered the weed density. Whereas, minimum shoot length (cm), seedling vigor index, leaves seedling^{-1} and dry biomass (g seedling^{-1}) was determined with johnson grass aquatic extract 15 mL kg^{-1} soil. The minimum leaf length (cm) was recorded in johnson grass residue incorporation at 15 g kg^{-1}soil. The results are also confirmed with the findings of Yar *et al*. (2020) found significant effect of sorghum extracts and sorghum powder on jungle rice. The smallest leaf area (cm^2) and fresh biomass (g seedling^{-1}) was recorded in sunflower residue (powder) incorporation at 15 g kg^{-1} soil. Similar results are also reported by Rawat *et al*. (2017) that rhizosphere soil of sunflower highly restricted the weed germination, population and biomass. However, maximum weed trait values were recorded in weedy check (no weeding treatment). The overall results showed that increased dose of johnson grass aquatic extract and sunflower aquatic extract applications significantly reduced germination traits of jungle rice.

Conclusion

The sunflower and johnson grass residues and aquatic extracts are useful for the management of different weed species. Therefore these may be applied to control weeds in different crops for enhancement of growth and yield parameters to overcome the issues of food security for human beings that is based on low input, high production and environment friendly.

Acknowledgement

All authors are indebted to the Department of Agronomy, Sindh Agriculture University, Tandojam for providing necessary facilities to complete this novel study for achieving the PhD research objectives timely and efficiently.

REFERENCES

Acciaresi, H.A. and J.J. Guiamet. 2010. Below and above-ground growth and biomass allocation in maize and *Sorghum halepense* in response to soil water competition: Maize and *Sorghum halepense* in competition for water. Weed Research, 50, 481–492.

Afridi, R.A., M.A. Khan, Z. Hussain, S. Saleem, S. Khan, K. Afridi and M. Ali. 2013. Allelopathic effects of rice straw extract on different crops and weeds. ARPN Journal of Agriculture, Biology and Science, 8 (5): 418– 411.

Ambika, S.R. 2012. Multifaceted attributes of allelochemicals and mechanism of allelopathy. International Allelopathy: Current Trends and Future Applications: 113–143.

Ashrafi, Z.Y., Sadeghi, S., Mashhadi, H.R. and Hassan, M.A. 2008. Allelopathic effects of sunflower (*Helianthus annuus*) on germination and growth of Wild Barley (*Hordeum spontaneum*). Journal of Agricultural Technology, 4 (1): 219-229.

Awan, I.U., M.A. Khan, M. Zareef and E.A. Khan. 2009. Weed management in sunflower with allelopathic water extract and reduced doses of herbicide. Pakistan Journal of Weed Science Research, 15: 19–30.

Bajgai, Y. 2015. Comparison of organic and conventional managements on yields, nutrients and weeds in a corn-cabbage rotation. Renewable Agricultural Food System, 30:132-42.

Bhadoria, P.B.S. 2011. Allelopathy: A natural way towards weed management. American Journal of Experimental Agriculture, 1(1): 7-20.

Cheema, Z.A., A. Khaliq and M. Farooq. 2008. Sorghum allelopathy for weed management in wheat. Allelopathy in Sustainable Agriculture and Forestry. pp. 255-270.

Cheema, Z.A., A. Khaliq and M. Tariq. 2002. Evaluation of concentrated Sorgaab alone and in combination with reduced rates of three pre-emergence herbicides for weed control in cotton (*Gossypium hirsutum* L.). International Journal of Agriculture and Biology, 4 (4):549-552.

Cheema, Z.A., M. Farooq and A. Khaliq, 2012. Application of allelopathy in crop production: Success Story from Pakistan. International Allelopathy: Current Trends and Future Applications: 113–143.

Dahiya, S., S. Kumar, R.S. Khedwal and S.R. Jakhar 2017. Allelopathy for sustainable weed management. Journal of Pharmacognosy and Phytochemistry. SP1: 832-837.

Dang, Q.L., G.Y. Lee, Y.H. Choi, G.J. Choi, K.S. Jang, M.S. Park, H.S. Soh, Y.H. Han, C.H. Lim and J.C. Kim. 2010. Insecticidal activities of crude extracts and phospholipids from *Chenopodium ficifolium* against melon and cotton aphid, Aphis gossypii. Crop Protection, 29: 1124-1129

Ejaz, A.K., A.Z. Khakwani, M. Munir and Ghazanfarullah, 2015. Effects of allelopathic chemicals extracted from various plant leaves on weed control and wheat crop productivity. Pakistan Journal of Botany, 47(2): 735-740.

Elahi, M., Z.A. Cheema, S.M.A. Basra and Q. Ali. 2011. Use of allelopathic extracts of sorghum, sunflower, rice and brassica herbage for weed control in wheat (*Triticum aestivum* L.). International Journal of Agro Veterinary and Medical Science, 5 (5): 488-496.

Fahad, S. 2015. Weed growth and crop yield loss in wheat as influenced by row spacing and weed emergence times. Crop Protection, 71: 101-8.

Farooq, M., M. Habib, A. Rehman, A. Wahid and R. Munir, 2011. Employing aqueous allelopathic extracts of sunflower in improving salinity tolerance in rice. Journal Agricultural Society Science, 7: 75-80.

Farooq N., T. Abbas, A.Tanveer, K. Jabran. 2020. Allelopathy for Weed Management International Merillon JM., Ramawat K. (eds) Co-Evolution of Secondary Metabolities. pp. 505-519.

Ferreira, M.I. and C.F. Reinhardt. 2010. Field assessment of crop residues for allelopathic effects on both crops and weeds. Agronomy Journal, 102 (6): 1593-1600.

Gao, Y., C. Zheng, Y. Li, C. Fan, G. Tu and J. Gao. 2008. Chemical constituents from leaves of allelopathic cultivar sunflower in China. Chemistry of Natural Compounds, 44 (6): 773-775.

Gawronska, H., D. Ciarka, W. Bernat and S.W. Gawronski.2007. Sunflower desirable Allelopathic crops for sustainable and organic agriculture? New Concepts and Metrology in Allelopathy. (Eds.): Fujii, Y. and S. Hiradate.Science Publishers, Inc., Enfield, NH, pp. 185-210.

Huang, H, T. Ling, S. Wei and C. Zhang. 2015. A new 4-oxazolidinone from *Sorghum halepense* (L.) Pers. Record of Natural Products, 9: 247-250.

Hura, T., S. Grzesiak, K. Hura, E. Thimt, K. Tokarz and M. Wedzony, 2007. Physiological and biochemical tools useful in drought tolerance detection in genotypes of winter triticale: accumulation of ferulic acid correlates with drought tolerance. Annals of Botany, 100 (4): 767-775.

Hussain, S.S., E.A. Khan; S.Hussain, A.Nadeem, K.Jabbar, G.U. Sadozai. 2016. Allelopathic sorghum water extract helps to improve yield of sunflower (*Helianthus annuus* L.) Pakistan Journal of Botany 48(3): 1197-1202.

Jabran, K., Z.A. Cheema, M. Farooq, S.M.A. Basra, M. Hussain and H. Rehman. 2008. Tank mixing of allelopathic crop water extracts with pendimethalin helps in the management of weeds in canola *(Brassica napus)* field. International Journal of Agriculture and Biology, 10 (3):1255-1260.

Jabran, K., M. Farooq, M. Hussain, H. Rehman and M.A. Ali. 2010. Wild oat (*Avena fatua* L.) and canary grass (*Phalaris minor* Ritz.) management through allelopathy. Journal of Plant Protection Research, 50 (1): 42-45.

Jamil, M., Z.A. Cheema, M.N. Mushtaq, M. Farooq and M.A. Cheema, 2009.Alternative control of wildoat and canary grass in wheat fields by allelopathic plant water extracts. Agronomy for Sustainable Development, 29: 475-482

Kamal, J. and A. Bano. 2008. Allelopathic potential of sunflower (*Helianthus annuus* L.) on soil metals and its leaves extracts on physiology of wheat (*Triticum aestivum* L.) seedlings. African Journal of Biotechnology, 7(18): 3261–3265.

Khaliq, A., A. Matloob, M.B. Khan and A. Tanveer, 2013.Differential suppression of rice weeds by allelopathic plant aqueous extracts. Planta Daninha, 31 (1): 21-28.

Khalil, S.K., T. Mehmood, A. Rehman, S.Wahab, A.Z. Khan, M. Zubair, F. Muhammad, N.Khan, Amanullah and I.H. Khalil. 2010. Utilization of allelopathy and planting geometry for weed management and dry matter production of maize. Pakistan Journal of Botany, 42 (2): 791-803.

Kobayashi, K., D. Itaya, P. Mahatamnuchoke and T. Pornprom. 2008. Allelopathic potential of itchgrass (*Rottboellia exaltata* L. f.) powder incorporated into soil. Weed Biology and Management 8 (1): 64–68.

Li, Y,. X. Jian, Y. Li, X. Zeng, L. Xu, M.U. Khan and W. Lin. 2020. OsPAL2-1 Mediates allelopathic interactions between rice and specific microorganisms in the rhizosphere ecosystem. Frontiers in Microbiology: Plant Pathogen interactions. https://doi.org/10.3389/fmicb.2020.01411.

Macias, F.A., A. Lopez, R.M. Varela, A. Torres and J.M.G.Molinillo. 2004. Bio active apocarotenoid sannuionones Fand G: structural revision of annuionones A, B and E. Phytochem., 43(3): 3057-3063.

Nouri, H., Z.A. Talab and A. Tavassoli. 2012. Effect of weed allelopathic of sorghum (*Sorghum halepense*) on germination and seedling growth of wheat, Alvand cultivar. Annals of Biological Research, 3 (3): 1283–1293.

Pejman, N., H. Karimmojeni, M. Moghanibashi and N. S. Hosseini. 2011. Allelopathic potential of sunflower on weed management in safflower and wheat. Australian Journal of Crop Sceiences, 5(11):1434-1440.

Rawat, L.S., R.K. Maikhuri, Y.M. Babuguna, N.K. Jha, P.C. and Phondani. 2017. Sunflower allelopathy for weed control in agriculture systems. Journal of Crop Science and Biotechnology 20, 45-60.

Rashid H.U., A. Khan, G. Hassan, S.U. Khan, M. Saeed, S.A. Khan, S.M. Khan and S. Hashim. 2020.Weed suppression in maize (Zea mays L.) through the allelopathic effects of sorghum (*Sorghum bicolor* (L.) Conardmoench, Sunflower (*Helianthus annuus* L.) and Parthenium (*Parthenium hysterophorus* L.) plants. Applied Ecology and Environmental Research 18(4):5187-5197.

Razzaq, A., Z.A. Cheema, K. Jabran, M. Hussain, M. Farooq and M. Zafar. 2012. Reduced herbicide doses used together with allelopathic sorghum and sunflower water extracts for weed control in wheat. Journal of Plant Protection Research, 52 (2): 281-285.

Rout, M.E. and T.H. Chrzanowsk. 2009. The invasive *Sorghum halepense* harbors endophytic N2-fixing bacteria and alters soil biogeochemistry. Plant and Soil, 315 (1), 163-172.

Rout, M.E., T.H. Chrzanowski, W.K. Smith and L. Gough. 2013. Ecological impacts of the invasive grass *Sorghum halepense* on native tall grass prairie. Biological Invasions, 15 (15): 327-329.

Sharma, P. 2011. Impact of tillage and mulch management on economics, energy requirement and crop performance in maize-wheat rotation in rainfed sub-humid inceptisols. India. European Journal of Agronomy, 34 (1): 46-51.

Soufan, R. and A. Almouemar. 2009. Allelopathic effects of some weeds on growth of maize (*Zea mays* L.). In Proceedings of the XIIIème Colloque International sur la Biologie des Mauvaises Herbes, Dijon, France, 8–10 September 2009; 414-421.

Statistix. 2006. Statistix 8 user guide, version 1.0. Analytical Software, PO Box 12185, Tallahassee FL 32317 USA. Copyright © 2006 by Analytical Software.

Stef, R,C. Bostan, A. Butu, A. Ortan, S. Rodinoand M. Butu M. 2013. Comparative characteristics of *Lupinus perenis* L. under allelochemical sorgoleone stress. Romanian Biotechnological letters, 18 (3): 8327-8332.

Stef, R., A. Cărăbet, I. Grozea, I. Radulov, D. Manea and A. Berbecea. 2015. Allelopathiceffects produced by johnson grass extracts over germination and growth of crop plants. Bull. University Agricultural Science, Veterinary and Medical. Cluj-Napoca Agriculture, 72, 239-245.

Tariq, I.M., S. Afzal, I. Hussain, N. Sultana. 2007. Pesticides exposure in Pakistan: A review. Environment International, 33 (8):1107-1122.

Tesio, F. and A. Ferrero. 2010. Allelopathy, a chance for sustainable weed management. The International Journal of Sustainable Development, World Ecology, 17 (5): 377-389.

Troc, M., D. Saja, A. Kornas, A. Zuraw and A. Skoczowsk. 2011. Journal of Thermal Anal. Calorim, 104: 141–148.

Uremis, I., M. Arslan, A. Uludag and M. Sangun. 2009. Allelopathic potentials of residues of 6 brassica species on Johnson grass [*Sorghum halepense* (L.) Pers.]. African Journal of Biotechnology, 8 (15): 3497–3501.

Ustuner.T U, AL.Sakran, K.Almhemed. 2020. Effects of herbicides on living organisms in the ecosystem and available alternative control methods. International Journal of Scientific and Research Publications, 10(8): 633-661.

Weston L.A. 2005. History and current trends in the use of allelopathy for weed management. Proceedings of the 4th World Congress on Allelopathy.15-21.

Xiao, Z.X, T. Zou, S. Lu, Z. Xu. 2020. Soil microorganisms interacting with residue-derived allelochemicals effect on seed germination. Saudi journal of Biological Sciences. (27): 1057-1065.

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 7, 2021, Pages. 1752 - 1765
Received 05 May 2021; Accepted 01 June 2021.

Yar, S., E.A.Khan, I. Hussain, B.Raza, M.S. Abbas and Z. Munazza. 2020. Allelopathic Influence of sorghum aqueous extracts and sorghum powder on germination indices and seedling vigor of hybrid corn and jungle rice. Planta Daninha, Vol.38.

Zahir, M. and A. Majeed. 2014. Allelopathic effects of aqueous extracts of sunflower on wheat (*Triticum aestivum* L.) and maize (Z*ea mays* L.). Pakistan Journal of Botany, 46 (5): 1715-1718.

Zhang, Y.L., C. E. Liang and D.W. Guo. 2005. Mulch types and their benefit in crop land ecosystems on the loess plateau in China. Journal of Plant Nutrition, 25(5):945-955.