EVALUATION OF PHYTOTOXIC POTENTIAL OF SELECTED PLANTS AGAINST WEEDS

ANWAR, T.[1*] – ILYAS, N.[1] – QURESHI, R.[1] – QURESHI, H.[1,2] – GILANI, N.[3] – KHAN, S.[4] – KHAN, S. A.[5] – FATIMAH, H.[6] – WASEEM, M.[6] – MAQSOOD, M.[1]

[1]*Department of Botany, Pir Mehr Ali Shah Arid Agriculture University, Murree Road, Shamsabad, Rawalpindi-46300 Punjab, Pakistan*

[2]*Department of Botany, Government Post Graduate College (Women), Sub-Campus University of Gujrat, Satellite Town, Rawalpindi-46300, Punjab, Pakistan*

[3]*Department of Zoology, Pir Mehr Ali Shah Arid Agriculture University, Murree Road, Shamsabad, Rawalpindi-46300, Punjab, Pakistan*

[4]*Department of Environmental Sciences, Gomal University, Dera Ismail Khan-29050, Khyber Pakhtunkhwa, Pakistan*

[5]*Department of Earth and Environmental Sciences, Bahria University, Islamabad Campus, Shangrilla Road, Sector E-8, Islamabad-44000, Pakistan*

[6]*Department of Biology, Allama Iqbal Open University, H-8, Islamabad-44000, Pakistan*

**Corresponding author*
e-mail: drtauseefanwar@gmail.com; phone: +92-33-3686-0562

(Received ; 27th Feb 2019; accepted 10th Apr 2019)

Abstract. Huge amounts of synthetic chemical herbicides are used to manage weeds. Heavy doses of synthetic chemicals for weed control are encouraging herbicidal resistance in weeds, risking human health and environment. Natural compounds, known as "bio herbicides" are environmentally safe herbicides, based on compounds produced by living organisms. The study was aimed to evaluate allelopathic activity of leaf powder of *Rhazya stricta, Pinus roxburghii, Carica papaya* and *Lantana camara* against selected weeds viz. *Phalaris minor, Avena fatua, Chenopodium album, Euphorbia helioscopia* and *Rumex dentatus* on 0.75 (w/v) agar, soil and filter paper at concentration of 10 and 50 mg leaf powder. Germination percentage (%), radicle length (cm) and plumule length (cm) were parameters to assess allelopathic potential. The STATISTIX 9 software was used to analyse data. Based on results, it was concluded that selected plants possesses potential inhibitory effects. Detailed analysis is required to establish allelopathic potential and onward application to be used as phytoherbicide.
Keywords: *factors affecting wheat production, weed infestation, harms of synthetic compounds, natural herbicides, growth retardation*

Introduction

Food security depends upon a sustainable agricultural production and higher levels of yield. It may also enable the agricultural sector less vulnerable to the threat of climate change (Shah et al., 2016). Agriculture is the backbone of Pakistan's economy. This sector gave 20.9% of the Gross Domestic Product (GDP) for the fiscal year 2014-15. Moreover, agriculture is a source of income for 43.5% of the village population of the country. Wheat (*Triticum aestivum* L.) is one of the most important cereal crops of the world. Its role is quite important in the provision of human

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

nutrition. Wheat caters to about 73% of the caloric portion of a common person's average diet. Its contents include starch (59-89%), protein (10-15.4%), fat (1.4-2.1%), inorganic ions (1.3-2.2%) and vitamins E and B-complex (Rueda-Ayala et al., 2011). As the world is progressively converting into a global village, globalization and market connectivity are presenting new hindrances in growth and development. The average annual production of wheat is quite low in Pakistan in comparison to other agricultural economies. There might be two ways for increasing wheat production: either by adding more area in cultivation or increasing its production per hectare. The first option is not practicable due to other essential crops, limited availability of the irrigation water occupation of the fertile soils by expanding cities. In this case, wheat production in Pakistan can only be increased by getting higher production per hectare. This can be obtained by efficient agricultural methods. There are many factors, which cause hindrance in wheat production, such as delayed sowing, less amount of fertilizers, water shortage, non-availability of better seed, diseases and dry periods.

Weed infestation is a serious threat to wheat production caused lowering wheat yield. If weeds management strategies are not devised, greater production losses in wheat yield can take place (Khan et al., 2016). It has been shown that wheat farmers are offering very little time and attention to the weed management practices, consequently, 15 to 25% wheat grain losses occur. Weeds are, at large, in causing annual damage of about 10% in agricultural yields globally (Cavero et al., 2011). In Pakistan, weeds cause 45% loss in wheat production (Anwar et al., 2016). In Pakistan, however, annual economic loss, due to weeds in agricultural production is estimated around 18.2 billion dollars. Including, 3-6 billion dollars spent on weeds control methods. There are around 30 different weed species generally found in the wheat crop, becoming the sources of losses. As the smaller farmers lack related tact and necessary resources, it becomes quite impossible to remove these weeds from the cultivated field. Weed harms most of the crops and grain. Moreover, it remains as a perennial problem in Pakistan's agriculture sector (Mubarik et al., 2015). According to an estimate, grain produce in Pakistan can be enhanced by up to 41% if weeds are managed properly. The controlling weeds through traditional methods is time consuming, weather hinged and exhibit more labour cost. While modern weed control techniques have not been up to the mark in solving this problem (Arafat et al., 2015).

Synthetic chemicals are in wider use for controlling weeds. These chemicals may enhance crop production, but concurrently these may have a negative effect on the environment as well as upon human health. In addition to these, the heading up of synthetic herbicides resistant weeds is another major area of concern. Excessive use of herbicides for controlling weeds during the last few years is becoming one of the noteworthy ecological and environmental threats for the world. Herbicide remnants in crops, soil and underground water which causes an evolution of various resistant weed biotypes, and linked health threats are some of the huge dangers that scientists are facing these days in devising various weed management techniques. Due to the negative effect of using synthetic chemicals, one may highly be in demand the new classes of chemicals, especially, biodegradable products such as those originating from plants, which have the potential of getting developed as herbicides (Aryakia et al., 2015). Allelopathy is a natural and eco-friendly technique. This strategy might be one of the very efficient tools for weed management and thereby increasing crop production (Kamran et al., 2017). Natural herbicides obtained from allelopathic

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

plants can help in reducing usage of synthetic herbicides for weed control. Consequently, these may cause less pollution, better agricultural products as well as alleviate human health concerns. The most commonly available allelochemicals are cinnamic and benzoic acids, alkaloids, flavonoids, phenolics, glucosionates and various terpenes. These compounds are called as phytotoxic (Khan et al., 2014).

R. stricta, belongs to family Apocynaceae. It is poisonous perennial evergreen shrub of desert and possess tannins, triterpenes, glycosides, volatile bases and alkaloids (Ebid, 2016). *L. camara* belongs to family Verbenaceae, possess phenolic, alkaloids and aromatic compounds (Dobhal et al., 2010). *C. papaya* belongs to family Caricaceae. It possess organic acids, alkaloids, tannins and flavonoids (Canini et al., 2007). *P. roxburghii* belongs to family Pinaceae. Pinus needles possess phytochemicals like isopimaric acid, abietic acid, friedelin, car-3-ene, α-pinene, β-pinene, Longifolene, β- sitosterol, cetyl alcohol (Zafar et al., 2010).

Keeping all this in view, the present study was performed to evaluate *Rhazya stricta* Decne, *Lantana camara* L., *Carica papaya* L. and *Pinus roxburghii* Sarg., for their allelopathic activity against major weeds viz. *Phalaris minor, Avena fatua, Chenopodium album*, *Euphorbia helioscopia* and *Rumex dentatus*.

Materials and methods

Allelopathic potential of leaves of selected plants viz., *R. stricta*, *P. roxburgii*, *C. papaya*, *L. camara* was evaluated. Fresh leaves (~400 gm) for each species were collected (73°02’ E longitude and 33°36’ N latitude) during March-April, 2018. Collected plant material was washed under running tap water and dried at 30 °C in laboratory that was crushed using heavy duty blender to make fine powder (mesh size 2 mm) and preserved in air tight plastic zip lock bags (Ramsumair et al., 2014; Anwar et al., 2016). Seeds of test weeds viz. *Phalaris minor, Avena fatua, Chenopodium album, Euphorbia helioscopia* and *Rumex dentatus* were procured from the Barani Agricultural Research Institute (BARI), Pakistan. Seeds were surface sterilized by 2% solution of Sodium hypochlorite (NaOCl) (Biljana and Kragujevac, 2015). The sandwich method was followed by Fujii et al. (2003, 2004). Five ml of 0.75 percent (w/v) agar (Nalge Nunc Intl., Roskilde, Denmark, gelling temperature 30-31 °C) was poured in each well of the six-welled (10 cm^2 area per well) multi-dish plastic plate. The agar solution was left for solidification. Leaf powder of each test species @ 10 and 50 mg were placed in suitable wells of the plate and were roofed by a thin layer of 0.75 percent (w/v) agar. After solidification, 10 seeds of each test species were placed on agar gel in each well of the plate. The multi-well plastic plates were then wrapped with the plastic tape and incubated in the growth chamber (NTS Model MI-25S) at room temperature for 15 days. In the control treatment, only agar gel without dried leaves powder was used as a seed bed for test species seeds. Each treatment was replicated five times. The same procedure was repeated to screen phytoxic activity of plants using soil (25 gm/petri dish) and filter paper (Whatman filter paper 1) as medium (*Fig. 1*). Germination percentages (%), lengths of radicle and plumule (cm) for each test species were calculated by comparing with control (Anwar et al., 2017). The statistical analysis was carried out using STATISTIX 9 and means were separated by Fisher’s protected LSD test (Nekonam et al., 2014).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

Figure 1. *Test species seeds in petri dishes ready to be incubated (treated with plant powder and wrapped in aluminium foil)*

Results and discussion

Allelopathic potential of R. stricta

The data revealed that *R. dentatus, C. album* and *P. minor* showed 31%, 28% and 25% seed germination inhibition respectively as compared to control on filter paper, whereas, no significant effect on seed germination percentage of *A. fatua* and *E. Helioscopia* was observed. *R. dentatus*, *C. album* and *P. minor* showed 41%, 38%, and 33% germination inhibition respectively as compared to control in *R. stricta* leaf powder applied into soil. The results declared that maximum (98%) germination was shown by *A. fatua* and *E. Helioscopia* while minimum germination was noted for *R. dentatus* i.e. 69% and 59% on filter paper and soil, respectively. Highest germination reduction was noted for *R. dentatus* (35%), followed by *P. minor* (31%) and *C. album* (30%) at 10 mg conc. Similarly, the highest germination reduction was noted for *R. dentatus* (37%), followed by *P. minor* (32%) and *C. album* (30%) at 50 mg conc. The statistical data concluded that minimum germination was noted for *R. dentatus* i.e. 65% and 63% at 10 mg and at 50 mg conc., respectively. The statistics also recommended that with the increase of concentration, the inhibitory effect was progressively increased for *R. dentatus*, *C. album* and *P. minor* (*Table 1a*).

The data revealed that *R. dentatus* (41%) and *A. fatua* (38%) exhibited radicle length inhibition in *R. stricta* leaf powder on filter paper, whereas, no significant effect on radicle length of *P. minor, E. helioscopia* and *C. album* showing resistance to dry powder. It is also clear from the result that *R. dentatus* (49%) and *A. fatua* (46%) showed and radicle length inhibition respectively as compared to control in powder applied into soil. The results also declared that maximum (98%) radicle length was noted for *P. minor, E. helioscopia* and *C. album.* In the present study, it was demonstrated that minimum radicle length was noted for *R. dentatus* i.e. 59% and 51% on filter paper and soil, respectively. The experimental results of the current study indicated on agar the highest radicle length reduction was noted for *A. fatua* (40%), followed by *R. dentatus* (39%) at 10 mg conc. Similarly, the highest radicle length reduction was noted for *R. dentatus* (47%), followed by *A. fatua* (46%) at 50 mg conc. The statistical data concluded that minimum radicle length was noted for *A. fatua* i.e. 53% and *R. dentatus* i.e. 60% at 10 mg and at 50 mg conc., respectively (*Table 1b*).

The data revealed that *A. fatua* (32%) and *R. dentatus* (31%) exhibited significant plumule length inhibition in *R. stricta* leaf powder on filter paper, whereas, no

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

significant effect on plumule length of *P. minor*, *E. helioscopia* and *C. album* showing resistance to dry powder. It is also clear from the result that *R. dentatus* (34%) and *A. fatua* (33%) showed and plumule length inhibition respectively as compared to control in powder applied into soil. The results also declared that maximum (98%) plumule length was noted for *P. minor*, *E. helioscopia* and *C. album.* The results of the current study indicated on agar highest plumule length reduction was noted for *A. fatua* (30%) and *R. dentatus* (28%) at 10 mg conc. Similarly, highest plumule length reduction was noted for followed by *R. dentatus* (32%) and *A. fatua* (31%) at 50 mg concentration (*Table 1c*).

It was noted that maximum germination was observed for *A. fatua* and *E. helioscopia*. While minimum germination noticed for *C. album*. The maximum radicle length was noted for *P. minor, E. helioscopia* and *C. album*. While minimum radicle length was noted for *R. dentatus*. The data revealed that the maximum plumule length was observed for *P. minor, E. helioscopia* and *C. album*. Inderjit and Duke (2003) studied the effect of allelochemicals from the leaf powder of *R. stricta* on the weed species. The findings of current study were in accordance with that of Hussain et al. (2011) who noted similar allelopathic effects by other plants. Batish et al. (2002) observed phytotoxicity of *R. stricta* might be due to allelochemicals leached from its leaves in natural environment.

Table 1. *Allelopathic potential of R. stricta leaf powder against tested species on filter paper, soil and agar (a) germination percentage (b) radicle length (c) plumule length*

(a) Germination percentage		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	83	61	62	84	58
	Control	85	89	83	86	81
Soil	50 mg	84	53	56	85	51
	Control	86	90	84	87	82
Agar	10 mg	85	58	59	84	57
	50 mg	84	56	58	83	56
	Control	86	89	85	85	80
(b) Radicle length (cm)		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	5.59	5.46	8.14	7.52	9.16
	Control	9.12	9.19	8.29	7.93	9.29
Soil	50 mg	5.04	4.69	8.22	7.26	9.13
	Control	9.31	9.21	8.39	7.33	9.32
Agar	10 mg	5.56	5.75	8.42	7.65	9.84
	50 mg	5.02	5.01	8.31	7.32	9.64
	Control	9.24	9.43	8.54	7.91	9.93
(a) Plumule length (cm)		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	5.76	6.25	8.09	9.02	7.19
	Control	8.45	9.12	8.13	9.12	7.45
Soil	50 mg	5.41	5.99	8.89	9.2	7.64
	Control	8.07	9.1	8.95	9.32	7.92
Agar	10 mg	5.94	6.46	8.78	9.22	7.69
	50 mg	5.85	6.13	8.68	9.11	7.51
	Control	8.49	9.03	8.96	9.33	7.85

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

Allelopathic potential of L. camara

The data revealed that *A. fatua* (60%), *R. dentatus* (58%), *P. minor* (54%) and *E. helioscopia* (53%) possessed significant germination in *L. camara* leaf powder on filter paper, whereas, no significant effect on germination of *C. album* showing resistance to dry powder. It is also clear from the result that *E. helioscopia* (65%), *P. minor* (64%), *A. fatua* (64%) and *R. dentatus* (61%) showed inhibition respectively as compared to control in powder applied into soil. The results also declared that maximum (95%) germination was noted for *C. album.* In the present study, it was demonstrated that minimum germination was noted for *A. fatua* (40%) and *E. helioscopia* (35%) on filter paper and soil, respectively. The experimental results of the current study indicated on agar the highest germination reduction was noted for *E. helioscopia* (59%), followed by *P. minor* (58%), *R. dentatus* (56%) and *A. fatua* (56%) at 10 mg conc. Similarly, the highest germination reduction was noted for *E. helioscopia* (63%), followed by *P. minor* (62%), *A. fatua* (60%) and *R. dentatus* (59%) at 50 mg conc. The statistical data concluded that minimum germination was noted for *E. helioscopia* i.e. 41% and 37% at 10 mg and at 50 mg conc., respectively. The statistics also recommended that with the increase of concentration, the inhibitory effect was progressively increased for *E. helioscopia*, *P. minor, A. fatua* and *R. dentatus*. The statistical results recommended that the germination percentage *C. album* were completely resistant to dry powder (*Table 2a*).

The data revealed that *C. album*, *P. minor* and *A. fatua* showing 52%, 5% and 50% radicle length inhibition respectively as compared to control in *L. camara* leaf powder on filter paper, whereas, no significant effect on radicle length of *R. dentatus* and *E. helioscopia* showing resistance to dry powder. It is also clear from the result that *C. album*, *P. minor* and *A. fatua* showed 55%, 53% and 52% radicle length inhibition respectively as compared to control in powder applied into soil. The results also declared that maximum (98%) radicle length was noted for *R. dentatus* and *E. helioscopia.* In the present study, it was demonstrated that minimum radicle length was noted for *C. album* i.e. 48% and 45% on filter paper and soil, respectively. The results of the current study indicated on agar the highest radicle length reduction was noted for *P. minor* (36%), followed by *A. fatua* (33%) and *C. album* (32%) at 10 mg conc. Similarly, the highest radicle length reduction was noted for *C. album* (53%), followed by *P. minor* (51%) *A. fatua* (50%) at 50 mg conc. The statistical data concluded that minimum radicle length was noted for *P. minor* (64%) and *C. album* (37%) at 10 mg and at 50 mg conc., respectively (*Table 2b*).

The data revealed that *E. helioscopia*, *C. album*, *R. dentatus* and *A. fatua* showing 54%, 53%, 51% and 50% plumule length inhibition respectively as compared to control in *L. camara* leaf powder on filter paper, whereas, no significant effect on plumule length of *P. minor* showing resistance to dry powder. It is also clear from the result that *E. helioscopia, C. album, A. fatua* and *R. dentatus* showed 64%, 61%, 59% and 56% plumule length inhibition respectively as compared to control in powder applied into soil. The results also declared that maximum (98%) plumule length was noted for *P. minor.* In the present study, it was demonstrated that minimum plumule length was noted for *E. helioscopia* i.e. 46% and 36% on filter paper and soil, respectively. The experimental results of the current study indicated on agar the highest plumule length reduction was noted for *R. dentatus* (43%), followed by *E. helioscopia* (42%), *C. album* (42%) and *A. fatua* (37%) at 10 mg conc. Similarly, the highest plumule length reduction was noted for *C. album* (59%), followed by *E. helioscopia* (57%), *A. fatua*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

(56%) and *R. dentatus* (55%) at 50 mg conc. The statistical data concluded that minimum plumule length was noted for *R. dentatus* (67%) and *C. album* (41%) at 10 mg and at 50 mg conc., respectively (*Table 2c*).

Table 2. *Allelopathic potential of L. camara leaf powder against tested species on filter paper, soil and agar (a) germination percentage (b) radicle length (c) plumule length*

(a) Germination percentage (%)		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	34	37	39	43	80
	Control	80	89	85	91	83
Soil	50 mg	29	35	31	32	81
	Control	81	90	86	92	84
Agar	10 mg	36	40	36	38	83
	50 mg	33	37	33	34	81
	Control	82	91	86	93	85
(b) Radicle length (cm)		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	4.58	7.91	4.01	9.1	4.41
	Control	9.11	7.98	8.19	9.2	9.21
Soil	50 mg	4.36	7.94	3.86	9.3	4.26
	Control	9.13	8	8.21	9.4	9.41
Agar	10 mg	6.12	8.2	5.25	9.4	6.57
	50 mg	4.61	8.19	4.07	9.2	4.51
	Control	9.15	8.21	8.23	9.6	9.62
(c) Plumule length (cm)		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	3.98	4.61	10.1	3.29	4.59
	Control	8.01	9.48	10.2	7.09	9.71
Soil	50 mg	3.26	3.94	10.3	3.26	3.86
	Control	8.03	9	10.4	9.01	10.01
Agar	10 mg	5.02	5.2	10.4	4.15	5.87
	50 mg	3.51	4.19	10.2	3.06	4.21
	Control	8.05	9.21	10.6	7.13	10.2

It was detected that maximum germination was observed for *C. album*. The analysis further indicated that minimum germination was noted for *A. fatua* and *E. helioscopia* on filter paper and soil being most sensitive to *L. camara* leaf powder. It was detected that maximum radicle length was observed for *R. dentatus* and *E. helioscopia*. The analysis further indicated that minimum radicle length was noted for *C. album* showed being most sensitive to *L. camara* leaf powder. It was detected that maximum plumule length was observed for *P. minor*. The analysis further indicated that minimum plumule length was noted for *E. helioscopia* showed being most sensitive among all the test species. The leaf powder of *L. camara* had inhibitory potential on germination, radicle and plumule length of radish and lettuce (Qiaoying et al., 2009). The leaf powder of *L. camara* suppressed the seed germination and plumule elongation of *P. hysterophorus* (Mishra and Singh, 2012). Das et al. (2012) also noticed inhibition linked with the production of allelochemicals from the *L. camara* leaves that inhibit growth of adjacent

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

plants by outcompeting for soil nutrients and altering micro environment by forming dense thickets. Allelopathy is a form of plant interference that can significantly influence ecosystem and agro ecosystem dynamics (Michelangelo et al., 2016).

Allelopathic potential of C. papaya

The data revealed that *A. fatua*, *P. minor* and *E. helioscopia* showing 39%, 38% and 33% germination inhibition respectively as compared to control in *C. papaya* leaf powder on filter paper, whereas, no significant effect on germination of *R. dentatus* and *C. album* showing resistance to dry powder. It is also clear from the result that *E. helioscopia*, *P. minor* and *A. fatua* showed 51%, 49% and 47% germination inhibition respectively as compared to control in powder applied into soil. The results also declared that maximum (98%) germination was noted for *R. dentatus* and *C. album*. In the present study, it was demonstrated that minimum germination was noted for *A. fatua* (61%) and *E. helioscopia* (49%) on filter paper and soil, respectively. The experimental results of the current study indicated on agar the highest germination reduction was noted for *P. minor* (41%), followed by *A. fatua* (38%) and *E. helioscopia* (36%) at 10 mg conc. Similarly, the highest germination reduction was noted for *A. fatua* (51%), followed by *P. minor* (49%) and *E. helioscopia* (47%) at 50 mg conc. The statistical data concluded that minimum germination was noted for *P. minor* (59%) and *A. fatua* (49%) at 10 mg and at 50 mg conc., respectively. The statistics also recommended that with the increase of concentration, the inhibitory effect was progressively increased for *A. fatua*, *P. minor* and *E. helioscopia*. The statistical results recommended that the germination *R. dentatus* and *C. album* were completely resistant (*Table 3a*).

The data revealed that *P. minor* and *R. dentatus* showing 51%, 41% and 30% radicle length inhibition respectively as compared to control in *C. papaya* leaf powder on filter paper, whereas, no significant effect on radicle length of *C. album*, *A. fatua* and *E. helioscopia* showing resistance to dry powder. It is also clear from the result that, *R. dentatus* and *P. minor* showed 55%, 41% and 35% radicle length inhibition respectively as compared to control in powder applied into soil. The results also declared that maximum (98%) radicle length was noted for *C. album*, *A. fatua* and *E. helioscopia*. The experimental results of the current study indicated on agar the highest radicle length reduction was noted for *P. minor* (35%) and *R. dentatus* (31%) at 10 mg conc. Similarly, the highest radicle length reduction was noted for *P. minor* (45%) and *R. dentatus* (42%) at 50 mg concentration (*Table 3b*).

The data revealed that *P. minor* (31%) and *C. album* (30%) showing plumule length inhibition as compared to control in *C. papaya* leaf powder on filter paper, whereas, no significant effect on plumule length of *A. fatua*, *R. dentatus* and *E. helioscopia* showing resistance to dry powder. It is also clear from the result that *C. album* and *P. minor* showed 45% and 33% plumule length inhibition respectively as compared to control in powder applied into soil. The results also declared that maximum (96%) plumule length was noted for *A. fatua*, *R. dentatus* and *E. helioscopia*. In the present study, it was demonstrated that minimum plumule length was noted for *P. minor* (69%) and *C. album* (55%) on filter paper and soil, respectively. The experimental results of the current study indicated on agar the highest plumule length reduction was noted for *C. album* (41%), followed by *P. minor* (30%) at 10 mg conc. Similarly, the highest plumule length reduction was noted for *C. album* (50%), followed by *P. minor* (43%) at 50 mg conc. The statistical data concluded that minimum plumule length was noted for *C. album* i.e. 59% and 50% at 10 mg and at 50 mg conc., respectively (*Table 3c*).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

***Table 3.** Allelopathic potential of C. papaya leaf powder against tested species on filter paper, soil and agar (a) germination percentage (b) radicle length (c) plumule length*

(a) Germination percentage (%)		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	54	69	49	51	81
	Control	89	71	79	76	84
Soil	50 mg	48	70	41	39	82
	Control	91	73	81	79	86
Agar	10 mg	57	74	49	52	88
	50 mg	46	72	42	43	86
	Control	93	75	83	81	89
(b) Radicle length (cm)		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	8.23	4.92	4.32	8.15	7.33
	Control	8.34	7.07	7.27	8.37	7.45
Soil	50 mg	8.32	4.28	4.9	8.38	7.54
	Control	8.56	7.23	7.59	8.58	7.68
Agar	10 mg	8.65	5.19	5.15	8.34	7.49
	50 mg	8.64	4.38	4.36	8.56	7.67
	Control	8.67	7.49	7.87	8.86	7.83
(c) Plumule length (cm)		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	7.99	7.17	5.6	7.21	5.8
	Control	8.01	7.19	8.17	7.35	8.31
Soil	50 mg	8.09	7.24	5.44	7.46	4.46
	Control	8.12	7.38	8.12	7.59	8.07
Agar	10 mg	8.23	7.43	5.86	7.83	4.72
	50 mg	8.21	7.41	4.75	7.81	4.06
	Control	8.25	7.45	8.39	7.85	8.06

It was detected that maximum germination was observed for *R. dentatus* and *C. album*. The analysis further indicated that minimum germination was noted for *A. fatua* and *E. helioscopia* on filter paper and soil, being most sensitive to *C. papaya* leaf powder. It was detected that maximum radicle length was observed for *C. album*, *A. fatua* and *E. helioscopia*. Similar, results were obtained in bioassays with lettuce seeds (Gherardi and Valio, 1976; Chow and Lin, 1991) and by Reyes et al. (1980) with cucumber seeds. Chow and Lin (1991) used extracts of papaya, which showed that there is a higher concentration of inhibitors in the sarcotesta, canceling the germination of lettuce seeds, which had already been observed by Gherardi and Valio (1976). They excluded the possibility that the germination inhibitor present in the sarcophagus of papaya seeds was abscisic acid, stating that such inhibitors are phenolic in nature.

Allelopathic potential of P. roxburghii

The data revealed that *C. album* and *A. fatua* showing 52%, 47% and 44% germination inhibition respectively as compared to control in *P. roxburghii* needles

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

powder on filter paper while on soil *C. album* and *A. fatua* showing 55%, 48% and 46% germination inhibition, whereas, no significant effect on germination of *R. dentatus, P. minor* and *E. helioscopia* showing resistance to dry powder. The results also declared that maximum (97%) germination was noted for *R. dentatus, P. minor* and *E. helioscopia.* The experimental results of the current study indicated on agar the highest germination reduction was noted for *C. album* (36%) and *A. fatua* (35%) at 10 mg conc. Similarly, the highest germination reduction was noted for *C. album* (48%) and *A. fatua* (43%) at 50 mg conc. The statistics also recommended that with the increase of concentration, the inhibitory effect was progressively increased for *C. album* and *A. fatua*. The statistical results recommended that the germination of *P. minor, E. helioscopia* and *R. dentatus* were completely resistant to dry powder (*Table 4a*).

The data revealed that *C. album* and *R. dentatus* showing 35% and 32% radicle length inhibition respectively as compared to control in *P. roxburghii* needles powder on filter paper, whereas, no significant effect on radicle length of *A. fatua, P. minor* and *E. helioscopia* showing resistance to dry powder. It is also clear from the result that *C. album* and *R. dentatus* showed 45% and 42% radicle length inhibition respectively as compared to control in powder applied into soil. The results also declared that maximum (96%) radicle length was noted for *A. fatua, P. minor* and *E. helioscopia.* In the present study, it was demonstrated that minimum radicle length was noted for *C. album* i.e. 65% and 55% on filter paper and soil, respectively. The experimental results of the current study indicated on agar the highest radicle length reduction was noted for *R. dentatus* (35%), followed by *C. album* (34%) at 10 mg conc. Similarly, the highest radicle length reduction was noted for *R. dentatus* (41%), followed by *C. album* (36%) at 50 mg conc. The statistical data concluded that minimum radicle length was noted for *R. dentatus* i.e. 65% and 59% at 10 mg and at 50 mg conc., respectively (*Table 4b*).

The data revealed that *A. fatua* (39%) and *R. dentatus* (37%) showing plumule length inhibition respectively as compared to control in *P. roxburghii* needles powder on filter paper, whereas, no significant effect on plumule length of *C. album*, *E. helioscopia* and *P. minor* showing resistance to dry powder. It is also clear from the result that *R. dentatus* (49%) and *A. fatua* (46%) showed and plumule length inhibition respectively as compared to control in powder applied into soil. The results also declared that maximum (95%) plumule length was noted for *C. album*, *E. helioscopia* and *P. minor*. In the present study, it was demonstrated that minimum plumule length was noted for *A. fatua* (61%) and *R. dentatus* (51%) on filter paper and soil, respectively. The results of the current study indicated on agar the highest plumule length reduction was noted for *R. dentatus* (42%), followed by *A. fatua* (40%) at 10 mg conc. Similarly, the highest plumule length reduction was noted for *R. dentatus* (49%), followed by *A. fatua* (44%) at 50 mg conc. The statistical data concluded that minimum plumule length was noted for *R. dentatus* measuring 68% and 61% at 10 mg and at 50 mg conc., respectively (*Table 4c*). The data attained from statistical analysis revealed that maximum germination was observed for *R. dentatus, P. minor* and *E. helioscopia.* The data attained from statistical analysis revealed that maximum radicle length was observed for *A. fatua, P. minor* and *E. helioscopia*. In the present study it was demonstrated that radicle length was noted for *C. album*. It was noted that maximum plumule length was observed for *C. album, E. helioscopia* and *P. minor.* In the present study it was demonstrated that minimum plumule length was noted for *A. fatua* and *R. dentatus* on filter and soil respectively. Blum (1998) observed that *P. divaricata* and *P. resinosa* needles leachates suggestively checked seedling growth and germination of *Epilobium*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

angustifolium, Agropyron repens and *Phleum pretense. The* seedling growth of *Lepidium virginicum* was significantly checked by *P. roxburghii* needles (Williams and Hoagland, 1982). The mechanism of retardation on the seedling growth produced by phytochemicals checked cell elongation and division (Node et al., 2003). Similarly, *P. densiflora* cones have high biological activity against select plant species (Lee and Monsi, 1963).

Table 4. *Allelopathic potential of P. roxburghii needles powder against tested species on filter paper, soil and agar (a) germination percentage (b) radicle length (c) plumule length*

(a) Germination percentage (%)		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	44	86	74	83	48
	Control	78	88	79	84	91
Soil	50 mg	43	87	80	85	45
	Control	80	90	81	86	93
Agar	10 mg	54	93	82	88	60
	50 mg	47	91	80	86	49
	Control	83	93	83	89	95
(b) Radicle length (cm)		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	7.21	5.63	8.6	7.23	5.98
	Control	7.29	8.23	8.82	7.33	9.15
Soil	50 mg	7.46	4.91	8.54	7.41	5.09
	Control	7.68	8.4	8.93	7.56	9.23
Agar	10 mg	7.54	5.71	8.85	7.46	6.15
	50 mg	7.41	5.25	8.63	7.39	5.93
	Control	7.89	8.83	8.99	7.78	9.31
(c) Plumule length (cm)		***A. fatua***	***R. dentatus***	***P. minor***	***E. helioscopia***	***C. album***
Filter paper	10 mg	5.8	5.91	8.15	9.19	8.28
	Control	9.48	9.44	8.27	9.25	8.4
Soil	50 mg	4.95	4.85	8.56	9.52	8.49
	Control	9.09	9.6	8.68	9.62	8.68
Agar	10 mg	5.82	5.72	8.9	9.8	8.82
	50 mg	5.38	5.05	8.92	9.82	8.81
	Control	9.69	9.86	8.95	9.84	8.87

Some recent studies indicating the phytotoxic/allelopathic effect of weeds include Parthenium hysterophorus (Saranya et al., 2019), Brassica napus (Rodriguez et al., 2016), Raphanus raphanistrum (Ali, 2016) and Ageratum conyzoides (Kumar et al., 2018). All these studies indicate the release of phototoxic chemicals. Based on this, studies were further extended to explore the impact of selected species, as they possessed greater phytotoxicity on the emergence and growth of weed plants in wheat crop.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

Conclusions

Present results indicated that water leachates from leaves of selected plants at higher concentrations reduce the seed germination, radicle and plumule length of weeds associated with the wheat crop. Results provided evidence about herbicidal potential of tested plant species viz. *L. camara*, *P. roxburghhii* and *C. Papaya* against weeds of wheat crop (*Avena fatua*, *Phalaris minor, Chenopodium album* and *Rumex dentatus*) while *R. stricta* was proved non-promising in the case as it affected growth parameters of wheat as well. Since *L. camara*, *P. roxburghhii* and *C. Papaya* inhibited growth of weeds without affecting wheat, the study seems effective than the other ones published in previous literature. Further work is, however, recommended to appraise the potential inhibitory effects of allelochemicals from the these plants in field.

REFERENCES

[1] Ali, K. A. (2016): Allelopathic potential of radish (*Raphanus sativus* L.) on germination and growth of some crop and weed plants. – Int. J. Biosci. 9: 394-403.

[2] Anwar, T., Khalid, S., Saeed, M., Mazhar, R., Qureshi, H., Rashid, M. (2016): Allelopathic interference of leaf powder and aqueous extracts of hostile weed: *Parthenium hysterophorus* (Asteraceae). – Sci. Int. 4: 86-93.

[3] Anwar, T., Khalid, S., Panni, M. K., Qureshi, H., Rashid, M. (2017): Allelopathic effect of Euphorbia helioscopia on *Avena fatua, Rumex dentatus, Helianthus annuus, Zea mays* and *Triticum aestivum*. – Pak. J. Weed Sci. Res. 23: 165-177.

[4] Arafat, Y., Khalid, S., Lin, W., Fang, C., Sadia, S., Ali, N., Azeem, S. J. (2015): Allelopathic evaluation of selected plants extract against broad and narrow leaves weeds and their associated crops. – Acad. J. Agric. Res. 3: 226-234.

[5] Aryakia, E., Naghavi, M. R., Farahmand, Z., Fazeli, S. A. H. S. (2015): Evaluating allelopathic effects of some plant species in tissue culture media as an accurate method for selection of tolerant plant and screening of bioherbicides. – J. Agr. Sci. Tech. 17: 1011-1023.

[6] Batish, D. R., Singh, H. P., Kohli, R. K., Saxena, D. B., Kaur, S. (2002): Allelopathic effect of parthenium against two weedy species, *Avena fatua* and *Bidens pilosa*. – Environ. Exp. Bot. 47: 149-155.

[7] Biljana, M. B., Kragujevac, D. Z. J. (2015): Allelopathic relations of selected cereal and vegetable species during seed germination and seedling growth. – J. Sci. 37: 135-142.

[8] Blum, U. (1998): Effects of microbial utilization of phenolic acids and their phenolic acid breakdown products on allelopathic interactions. – J. Chem. Ecol. 24: 685-708.

[9] Canini, A., Alesiani, D., Arcangelo, G., Tagliatesta, P. (2007): Gas chromatography-mass spectrometry analysis of phenolic compounds from *Carica papaya* L. leaf. – J. Food Compos. Anal. 20: 584-590.

[10] Cavero, J., Zaragoza, C., Cirujeda, A., Anzalone, A., Faci, J. M., Blanco, O. (2011): Selectivity and weed control efficacy of some herbicides applied to sprinkler irrigated rice (*Oryza sativa* L.). – Spanish J. Agric. Res. 9: 597-605.

[11] Chow, Y. J., Lin, C. H. (1991): p-Hydroxybenzoic acid the major phenolic germination inhibitor of papaya seed. – Seed Sci. Techn., Zürich 19: 167-174.

[12] Das, C. R., Mondal, N. K., Aditya, P., Datta, J. K., Banerjee, A., Das, K. (2012): Allelopathic potentialities of leachates of leaf litter of some selected tree species on gram seeds under laboratory conditions. – Asian. J. Exp. Biol. Sci. 3: 59-65.

[13] Dobhal, P. K., Kohli, R. K., Batish, D. R. (2010): Evaluation of impact of *Lantana camara* L. invasion on four major woody shrubs along Nayar river of Pauri Garhwal in Himalaya. – Int. J. Biodivers. Conserv. 2: 166-172.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

[14] Ebid, A. I. (2016): Allelopathic effect of three wild species on seed germination and seedling growth of Vicia faba, Hordeum vulgare and *Triticum aestivum*. – J. Agric. Ecol. Res. Int. 6: 1-7.
[15] Fujii, Y., Parvez, S. S., Parvez, M. M., Ohmae, Y., Iida, O. (2003): Screening of 239 medicinal plant species for allelopathic activity using sandwich method. – Weed Biol. Manag. 3: 233-241.
[16] Fujii, Y., Shibuya, T., Nakatani, K., Itani, T., Hiradate, S., Parvez, M. M. (2004): Assessment method for allelopathic effect from leaf litter leachates. – Weed Biol. Manag. 4: 19-23.
[17] Gherardi, E. I., Valio, F. M. (1976): Occurrence of promoting and inhibitory substances in the seed arils of *Carica papaya* L. – J. Hortic. Sci. 51: 1-14.
[18] Hussain, M. I., González, L., Reigosa, M. J. (2011): Allelopathic potential of *Acacia melanoxylon* on the germination and root growth of native species. – Weed Biol. Manag. 11: 18-28.
[19] Inderjit and Duke, S. O. (2003): Eco physiological aspects of allelopathy. – Planta 217: 529-539.
[20] Kamran, M., Raza, A., Ali, Q., Ali, H. H., Chattha, M. S. (2017): Investigating the influence of fertilizer and allelopathic water extracts on maize and associated weeds. – Pak. J. Weed Sci. Res. 23: 361-378.
[21] Khan, I., Ali, Z., Khan, M. I., Hussain, Z., Khan, I. A., Waqas, M., Khan, R., Khan, S. (2014): Allelopathic effects of some weeds on chickpea crop. – Pak. J. Weed Sci. Res. 20: 207-211.
[22] Khan, R., Khan, M. A., Shah, S., Uddin, S., Ali, S., Ilyas, M. (2016): Bioherbicidal potential of plant extracts against weeds of wheat crop under agro-climatic conditions of Peshawar-Pakistan. – Pak. J. Weed Sci. Res. 22: 285-294.
[23] Lee, I. K., Monsi, M. (1963): Ecological studies on *Pinus densiflora* forest 1. Effects of plant substances on the floristic composition of the undergrowth. – Bet. Mag. Tokyo 76: 400-413.
[24] Michelangelo, M. T., Vidal, R. A., Junior, A. A. B., Bittencourt, H. V. H., Filho, S. S. (2016): Allelopathy: driving mechanisms governing its activity in agriculture. – J. Plant Interact. 1: 53-60.
[25] Mishra, A., Singh, R. (2012): Allelopathic effect of Lantana camara extract of different parts on seed germination of *Parthenium hysterophorus*, L. – Int. J. Plant Sci. 5: 74-75.
[26] Mubarik, S., Khan, K., Memon, R. A., Shaheen, G., Hashmatulla (2015): Allelopathic effects of important weeds on germination and growth of maize (*Zea mays* L.). – Pak. J. Weed Sci. Res. 21: 181-180.
[27] Nekonam, M. S., Kraimmojeni, H., Sharifnabi, B., Razmjoo, J., Amini, H., Bahrami, F. (2014): Assessment of some medicinal plants for their allelopathic potential against redroot pigweed (*Amaranthus retroflexus*). – J. Plant Prot. Res. 54: 90-95.
[28] Node, M., Yokotani, K. T., Suzuki, T., Kosemura, S., Hirata, H., Hirata, K., Hasegawa, K. (2003). Allelopathy of pinecone in Japanese red pine tree (*Pinus densiflora* Sieb. et Zucc.). – Weed Biol. Manag. 3: 111-116.
[29] Qiaoying, Z., Shaolin, P., Yunchun, Z. (2009): Allelopathic potential of reproductive organs of exotic weed *Lantana camara*. – Allelopathy J. 23: 213-220.
[30] Ramsumair, A., Mlambo, V., Lallo, C. H. O. (2014): Effect of drying method on the chemical composition of leaves from four tropical tree species. – Trop. Agric. (Trinidad) 91: 179-186.
[31] Reyes, M. N., Perez, A., Cuevas, J. (1980): Detecting endogenous growth regulators on the sarcotesta, sclerotesta, endosperm and embryo by paper chromatography on fresh and old papaya seeds. – J. Agri. Uni. Puerto Rico 64: 167-172.
[32] Rodriguez, D., Casagrande, G., Carmona-Galindo, V. D. (2016): Effects of black mustard allelopathy on the fitness and life history strategies of buffalo gourd in southern California. – Bios 87(3): 98-103.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696

[33] Rueda-Ayala, V. P., Rasmussen, J., Gerhards, R., Fournaise, N. E. (2011): The influence of post-emergence weed harrowing on selectivity, crop recovery and crop yield in different growth stages of winter wheat. – Weed Res. 51: 478-488.
[34] Saranya, M., Rangaraj, T., Ragavan, T., Amutha, R. (2019): Allelopathic Potential of *Parthenium hysterophorus* and *Tridax procumbens* aqueous leaf extracts on weed control and growth of Blackgram (*Vigna mungo* L.). – Int. J. Agric. Sci. 11: 7697-7700.
[35] Shah, S. H., Khan, E. A., Shah, H., Ahmed, N., Khan, J., Sadozai, G. U. (2016): Allelopathic sorghum water extract helps to improve yield of sunflower (*Helianthus annuus,* L.) – Pak. J. Bot. 48: 1197-1202.
[36] Williams, R. D., Hoagland, R. E. (1982): The effects of naturally occurring phenolic compounds on seed germination. – Weed Sci. 30: 206-212.
[37] Zafar, I., Fatima, A., Khan, S. J., Rehman, Z., Mehmud, S. (2010): GC-MS studies of needles essential oil of *Pinus roxburghii* and their antimicrobial activity from Pakistan. – Electr. J. Environ. Agric. Food Chem. 9: 468-473.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1706_1268312696