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ORIGINAL ARTICLE

Allelopathic Potential of *Acacia modesta* Wall., on the Growth of three *Brassica* Species

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ABSTRACT

Background: Allelopathy is the process of a plant's chemical release into the environment having direct or indirect, beneficial or negative effects on another plant. In the present work, we investigated the allelopathic interaction of *Acacia modesta* in the different extracts to show significant effects regarding the growth and germination of test species.

Objective: The main objective of this research is to study how the allelopathic activity of *Acacia modesta* affects the growth of three Brassica species in various extracts (Aqueous extracts, litter & mulching).

Methodology: Fresh leaves of *Acacia modesta* were collected from the Botanical Garden, Islamia College Peshawar, dried in the shade, and ground, whereas the glass ware was rinsed and sterilized for at least 4 hours at 170°C. Seeds of the *Brassica* crop were used and checked for viability in H_2O. The Petri dishes were incubated at 25°C for 72 hours, then the effects of various extracts were examined, and lastly, readings from the Petri dishes were obtained.

Results: According to our findings, the leaf extracts of *Acacia modesta* had a substantial effect on the germination and growth of *Brassica* species. *Brassica campestris* (10g/48h dry & 5g/24h fresh), *Brassica napus* (10g/24h), and *Brassica juncea* (10g/48h dry & 5g/48h fresh) leaf extracts have a greater effect than the control.

Conclusion: Our outcomes concluded that in comparison of the test species in all the experiments, *Brassica campestris* and *Brassica juncea* were highly affected by the allelopathy of *A. modesta* which necessitates further evaluation.

Keywords	*Address of Correspondence	Article info.
Acacia Modesta, Allelopathic Potential, Aqueous Extract, Brassica Crop, Germination.	*nomiflora@uop.edu.pk barkatullah@icp.edu.pk*	*Received: June 10, 2022 Accepted: March 18, 2023*

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INTRODUCTION

Allelopathy is a biochemical phenomenon in which one or more chemicals released by one species affect the germination, growth, survival, and reproduction of other species[1]. It is explicitly or implicitly, negative or beneficial effects of chemical compounds released into the environment on one plant upon another[2]. Plant distribution, community development, intercrop evolution, and biodiversity are affected by allelopathy[3]. Algae, fungi, and

different microbes, as well as higher plants, are now recognized targets of allelochemicals in the plant kingdom[4]. Allelopathic interaction can be a key role in species distribution and diversity within plant communities, as well as in the success of invasive plants[5], such as water hyacinth, spotted knapweed[6], and garlic mustard[7]. Although it is also regarded to be one of the indirect reasons for agricultural cropping barriers. Animals should also be included in the allelopathic donor and recipient[8]. Allelochemicals, which are non-nutritive compounds generated mostly as secondary metabolites of plants or as microbial breakdown products, are the active medium of allelopathy. It is indeed largely comprised of distinct chemical families[9]. Plant growth regulators such as salicylic acid, gibberellic acid, and ethylene are instances of allele chemicals. It could be expressed in roots, stems, leaves, flowers, and fruits, where it suppresses root development, shoot growth, germination, and nutrient uptake[10]. Plant defense systems against weeds and herbivores depend primarily on allelochemicals with negative allelopathic effects[11].

Most phenolic allelochemicals have the ability to promote IAA oxidase activity while inhibiting the interaction of POD with IAA, bound GA, or IAA to impact endogenous hormone levels[12]. Allelochemicals can have a variety of effects on other plants. The earliest evident indicators of allelopathy stress are a delay or decrease in seed germination, as well as inhibition of root and shoot development[13]. Allelochemicals can enhance or inhibit plant germination and growth, facilitating crop production with minimal phytotoxic levels, and residues in water and soil, making wastewater treatment and recycling easier[4,14,15]. Allelochemicals are a good alternative to synthetic herbicides since they have no residual or harmful effects, despite the fact that many allelochemicals have low effects and specificity[11]. Allelopathic crops are already being employed in agriculture as crop rotation components, intercropping crops, cover crops, as well as green manure[16]. Allelopathy has been used successfully in agricultural production in Pakistan in recent years[4,17]. Allelopathy has piqued the interest of allelopathic researchers due to its appropriate application toward improving crop productivity and environmental protection through environmentally friendly control of weeds, insect pests, crop diseases, nitrogen conservation in croplands, and the synthesis of novel agrochemicals based on allele chemicals. Straw mulching, for example, is an allelopathic application that provides long-term weed control while mitigating agriculture's environmental impact[16,18]. As a ground cover species, allelopathic plants give an eco-friendly option[19].

A. modesta is an important plant of the family Fabaceae. It is locally called palosa and found in Afghanistan, India, and Pakistan (Punjab, Baluchistan, and Khyber Pakhtunkhwa). The wood of *A. modesta* is used to treat leprosy, wounds, dysentery, and venereal diseases[20, 21]. Traditionally, the ash from the wood of *A. modesta* was used to relieve severe muscle pain. A mixture of gum with wheat flour, almonds, and butter was given to women after giving birth. Due to the antimicrobial properties of the branches of *A. modesta* they have been used as miswak. Due to its healing properties, gum has been used for back pain and sex[22]. Hussain *et al*[23] reported *A. modesta* for the treatment of cough, fuel, and also for skeletal-muscular problems by Murad *et al*[24].

The genus Brassica in the family Brassicaceae includes about 40 species, some of which are commercially important as oil seeds, leaf and stem vegetables, condiments, forage, fodder, and green manure[25]. Many crop species are included in the Brassica genus, which provide edible roots, leaves, stems, buds, flowers, and seed[26]. Almost all parts of a *Brassica* plant have been developed to be edible including roots, stems, buds, leaves, flowers, and seeds[27]. The main purposes of this work are to present the allelopathic potential of *A. modesta* on the growth of some *Brassica* species to demonstrate the effect of allelopathy on soil microorganisms and to highlight critical issues for further study.

MATERIALS AND METHODS

Collection of Samples

Fresh leaves of *A. modesta* were collected from the Botanical Garden, Islamia College University Peshawar, dried in shade at room temperature (25˚-30˚C) for a week, crushed with the help of an electric grinder, and glass wares were washed with tap water and sterilized at 170˚C for at least 4 hours. Seeds of *B. campestris*, *B. napus* &*B. juncea* were used as test species in all the experiments. The seeds of these test species were first checked for viability in water based on the fact that the seeds which

were settled down in the water-filled beaker were considered viable. The Petri dishes were always incubated at 25˚for 72 h.

Effects of Aqueous Extracts

About five and ten grams of the powder extracts were separately soaked in100 ml distilled water at 25˚C for 24 and 48 h and filtered to get aqueous extracts. These extracts were tested against *B. campestris, B. napus,* and *B. juncea*, on two-fold of filter paper in Petri dishes. The filter paper was moistened with the aqueous extracts, while distilled water was used as a control. There were three replicates, each with 10 seeds. The Petri dishes were incubated at 25˚C. After 7 days, the percent germination, length of plumule, and length of radical were observed. Ten seedlings were randomly taken out for fresh and dry weight determination and moisture contents. Seedlings were dried at 65˚ C for 72 h.

Effects of Litter

Five grams of crushed litter from leaves were placed in Petri dishes and topped with single filter paper. The Petri dishes were provided with 5ml of distilled water. In control treatment, many fine pieces of filter paper were used.

Effects of Mulching

Five gram crushed dried leaves were placed in plastic glasses which were half filled with soil. For each treatment, three replicates, each with 10 seeds were used and the control was half filled with sterilized sand. The plastic glass was incubated at 25˚C and observed for germination. After 7 days growth of plumule and radical were measured. Ten seedlings were randomly taken out for fresh and dry weight. Seedlings were dried at 65˚C for 72h.

Data Analysis and Observations

The reading from the Petri dishes and the glasses were taken during the 24hrs and 48hrs of incubation. The seeds which were germinated were counted in each Petri dish. With the help of a ruler, the plumule and radical length of the germinated seeds were measured. From the data, mean value was calculated and recorded from each Petri dishes and glass of both control and test species. Stimulatory and inhibitory effects of both fresh and dry leaves extract, litter and mulching on germination percentage, plumule growth, radical growth, fresh weight and dry weight and moisture contents of test species were also observed.

Statistical Analysis

All the data were statically analyzed through one-way analysis of variance (ANOVA) using the statistical software SPPS.

significantly different at $\alpha < 0.05$, * non-significantly different at $\alpha < 0.05$. All the data are expressed as Mean ± S.D of three replicates.

RESULTS

Effect of Dry Leaves Aqueous Extracts on Agronomic Features

In a test species (*B. campestris*), it was observed that the treatments at 5g/24h of aqueous extracts germination percentage (53.33±5.77) declined significantly, plumule length (4.9±2.70) decline highly significantly and radical length (2±0.78) was also declined highly significantly as compared to control (83.33±11.54, 36.5±4, 20.9±2.51). Similarly, at 10g/24h aqueous extracts treatment, germination percentage (50±10) reduced significantly, plumule length (5.07±2.57) reduced highly significantly and, radical length (2±0.78) was also reduced highly significantly, while at 5g/48h aqueous extracts treatment, germination percentage (53.33±5.77) reduced significantly, plumule length (13.7±8.45) reduced significantly, radical length (5.5±3.72) reduced significantly. At 10g/48h aqueous extracts treatment, germination percentage (46.66±4.71) reduced significantly, plumule length (2±0.57) declined highly significantly, radical length (1.4±0.50) declined highly significantly.

The fresh weight of all the treatments reduced less significantly as compared to control except 5g/24h which stimulated less significantly, the dry weight of all the treatments reduced less significantly except 10g/24h which stimulated less significantly, moisture contents reduced in all treatment significantly as compared to control except 5g/24h which stimulated significantly (Table **1**).

Table1. Effect of aqueous extracts of *A. modesta* leaf powder on agronomic features of *B. campestris.*

S. No	Treatments	% Germination	Plumule Growth (Mm)	Radical Growth (Mm)	% Fresh Weight	% Dry Weight	% Mc
1	Control	83.33±11.54	36.5±4	20.9±2.51	0.73	0.40	0.33
2	Rre 5g/24h	53.33±5.77**	4.9±2.70***	2±0.78***	0.75	0.38	0.37
3	Rre 10g/24h	50±10**	5.07±2.57***	2±0.78***	0.70	0.60	0.10
4	Rre 5g/48h	53.33±5.77**	13.7±8.45**	5.5±3.72**	0.61	0.30	0.31
5	Rre 10g/48h	46.66±4.71**	2±0.57***	1.4±0.50***	0.45	0.19	0.26

**Significantly different at α < 0.05, ***non-significantly different at α < 0.05. All the data are expressed as Mean ± S.D of three replicates.

Table 2. Effect of aqueous extracts of *A. modesta* fresh leaves on agronomic features of *B. campestris.*

S. No	Treatments	% Germination	Plumule Growth (mm)	Radical Growth (mm)	% Fresh Weight	% Dry Weight	% MC
1.	Control	83.33±9.43	36.5±4	20.9±2.51	0.73	0.44	0.29
2.	RRE 5g/24h	43.33±4.71**	4.4±2.62***	7±3.24**	0.48	0.13	0.35
3.	RRE 10g/24h	46.67±4.71**	7.17±2.31***	7.8±1.13***	0.52	0.25	0.27
4.	RRE 5g/48h	46.67±4.71**	7.47±3.91***	4.87±2.85***	0.45	0.24	0.21
5.	RRE 10g/24h	53.33±4.71**	15±2.16***	11.27±1.61**	0.61	0.30	0.31

**Significantly different at α < 0.05, ***non-significantly different at α < 0.05. All the data are expressed as Mean ± S.D of three replicates.

In a test species, (*B. campestris*) the treatments 5g/24h of aqueous extracts germination percentage (43.33±4.71) declined significantly, plumule length (4.4±2.62) declined highly significantly and radical length (7±3.24) significantly reduced as compared to control (83.33±11.54, 36.5±4, 20.9±2.51). Similarly, at 10g/24h aqueous extracts, germination percentage (46.67±4.71) reduced significantly, plumule length (7.17±2.31) and radical length (7.8±1.13) reduced high significantly, while at 5g/48h aqueous extracts germination percentage (46.67±4.71) reduced significantly, plumule length (46.67±4.71) and radical length (4.87±2.85) high significantly reduce. Hence, at 10g/48h aqueous extracts germination percentage (53.33±4.71) reduced significantly, plumule length (15±2.16) declined highly significantly, radical length (11.27±1.61) significantly reduced, fresh weight and dry weight of all the treatments reduced less significantly as compared to control, moisture contents reduced in all treatments less significantly as compared to control except 5g/24h which stimulated significantly (Table **2**).

In a test species (*B. napus*) the treatments 5g/24h of aqueous extracts in dry leaves, germination percentage (93.33±5.77) reduced significantly, plumule length (26.77±10.11) less significantly reduce and radical length (14.4±2.56) decline highly significantly as compared to control (96.67±5.77, 48.33±2.78, 48.37±5.34). However at 10g/24h aqueous extracts germination percentage (86.67±9.43) reduced significantly, plumule length (12.77±0.66) and radical length (9.77±1.68) reduced high significantly, similarly at 5g/48h aqueous extracts germination percentage (9.77±1.68) reduced significantly, plumule length (29.53±1.42) and radical length (13.47±2.59) high significantly reduce, while at 10g/48h aqueous extracts germination percentage (90±8.16) reduced significantly, plumule length (24.7±10.49) decline less significantly, radical length (11.87±5.34) decline highly significantly, fresh weight and dry weight of all the treatments reduced less significantly as compared to control, moisture contents reduced in all treatment less significantly as compared to control (Table **3**).

In a test species (*B. napus*) the treatments 5g/24h of fresh leaves aqueous extracts germination percentage (93.33±9.43) decline less significantly, plumule length (30.5±2.71) decline highly significantly and radical length (45.47±1.90) less significantly reduce as compared to control (96.67±4.71, 48.33±2.78, 48.37±5.34) and at 10g/24h aqueous extracts germination percentage (90±8.16) reduced significantly, plumule length (32.87±6.08) reduced less significantly, radical length (28.87±6.05) reduced significantly, at 5g/48h aqueous extracts germination percentage (90±14.14) reduced less significantly, plumule length (62.3±1.53) stimulated highly significantly, radical length (48.27±10.47) reduced less significantly, at 10g/48h aqueous extracts germination percentage (90±8.16) reduced significantly, plumule length (56.8±1.87) and radical length (35.9±10.08) significantly reduce, fresh weight and dry weight of all the treatments less significantly reduce as compared to control, moisture contents reduced in all treatment less significantly as compared to control except 5g/24h and 5g/48h which stimulated significantly (Table **4**).

Table 3. Effect of dry leaves of *A. modesta* against agronomic features of *B. napus* (Dry leaves).

S. No	Treatments	% Germination	Plumule Growth (mm)	Radical Growth (mm)	% Fresh Weight	% Dry Weight	% MC
1.	Control	96.67±5.77	48.33±2.78	48.37±5.34	0.94	0.60	0.34
2.	5g/24h	93.33±5.77**	26.77±10.11*	14.4±2.56***	0.73	0.44	0.29
3.	10g/24h	86.67±9.43**	12.77±0.66***	9.77±1.68***	0.63	0.37	0.26
4.	5g/48h	83.33±4.71**	29.53±1.42***	13.47±2.59***	0.71	0.43	0.28
5.	10g/48h	90±8.16**	24.7±10.49*	11.87±5.34***	0.66	0.35	0.31

**Significantly different at α < 0.05, ***non-significantly different at α < 0.05. All the data are expressed as Mean ± S.D of three replicates.

Table 4. Effect of fresh leaves of *A. modesta* against agronomic features of *B. napus* (Fresh leaves).

S. No	Treatments	% Germination	Plumule Growth (mm)	Radical Growth (mm)	% Fresh Weight	% Dry Weight	% MC
1.	Control	96.67±4.71	48.33±2.78	48.37±5.34	0.94	0.64	0.30
2.	RRE 5g/24h	93.33±9.43*	30.5±2.71***	45.47±1.90*	0.76	0.30	0.46
3.	RRE 10g/24h	90±8.16**	32.87±6.08*	28.87±6.05**	0.64	0.46	0.18
4.	RRE 5g/48h	90±14.14*	62.3±1.53***	48.27±10.47*	0.83	0.41	0.42
5.	RRE 10g/48h	90±8.16**	56.8±1.87**	35.9±10.08**	0.78	0.52	0.26

**Significantly different at α < 0.05, ***non-significantly different at α < 0.05. All the data are expressed as Mean ± S.D of three replicates.

Table 5. Effect of dry leaves of *A. modesta* against agronomic features of *B. juncea* (Dry leaves).

S. No	Treatments	% Germination	Plumule Growth (mm)	Radical Growth (mm)	% Fresh Weight	% Dry Weight	% MC
1.	Control	96.67±4.71	62.07±6.96	49.83±3.83	0.91	0.70	0.21
2.	RRE 5g/24h	70±8.16**	14.53±5.69***	10.17±4.66***	0.43	0.20	0.23
3.	RRE 10g/24h	76.67±17**	9.97±3.25***	7.3±3.20***	0.60	0.30	0.30
4.	RRE 5g/48h	56.67±4.71***	7.07±2.36***	3.33±1.65***	0.31	0.10	0.21
5.	RRE 10g/48h	53.33±4.71***	4.77±1.09***	2.47±0.96***	0.28	0.10	0.18

**Significantly different at α < 0.05, ***non-significantly different at α < 0.05. All the data are expressed as Mean ± S.D of three replicates.

Table 6. Effect of fresh leaves of *A. modesta* against agronomic features of *B. juncea* (Fresh leaves).

S. No	Treatments	% Germination	Plumule Growth (mm)	Radical Growth (mm)	% Fresh Weight	% Dry Weight	% MC
1.	Control	96.67±4.71	62.07±6.96	49.83±3.83	0.91	0.70	0.21
2.	RRE 5g/24h	90±8.16**	22.1±4.52***	22.1±8.80**	0.83	0.51	0.32
3.	RRE 10g/24h	76.67±12.47**	11.37±9.71***	13.2±5.76***	0'72	0.40	0.33
4.	RRE 5g/48h	66.67±12.47*	15.5±8.13***	6.9±3.64***	0.75	0.50	0.25
5.	RRE 10g/48h	76.66±4.71**	25.8±4.49***	13.67±1.77***	o.81	0.50	0.31

**Significantly different at α < 0.05, ***non-significantly different at α < 0.05. All the data are expressed as Mean ± S.D of three replicates.

In a test species, (*B. juncea*) the treatment having 5g/24 (70±8.16) and 10g/24h (76.67±17) germination percentage reduced significantly while the plumule length of all the concentrations 5g/24h (14.53±5.69), 5g/48h (7.07±2.36), 10g/24h (9.97±3.25) and 10g/48h (4.77±1.09) reduced more significantly and radical length of all the concentrations are also reduced high significantly as compared to control (96.67±4.71, 62.07±6.96, 49.83±3.83). The germination percentage of 5g/48h (56.67±4.71) and 10g/48h (53.33±4.71) reduced high significantly. Fresh weight and dry weight of all the treatments reduced significantly as compared to the control, moisture contents of the 5g/24h and 10g/24h stimulated significantly while the 5g/48h and 10g/48h reduced less significantly as compared to the control (Table **5**).

In a test species (*B. juncea*) the treatments 5g/24h of fresh leaves aqueous extracts germination percentage (90±8.16) reduced significantly, plumule length (22.1±4.52) high significantly reduce and radical length (22.1±8.80) decline significantly as compared to control (96.67±4.71, 62.07±6.96, 49.83±3.83) and at 10g/24h aqueous extracts germination percentage (76.67±12.47) reduced significantly, plumule length (11.37±9.71) and radical length (13.2±5.76) reduced high significantly, at 5g/48h aqueous extracts germination percentage (66.67±12.47) reduced less significantly, plumule length (15.5±8.13) and radical length (6.9±3.64) high significantly reduce, at 10g/48h aqueous extracts germination percentage (76.66±4.71) reduced less significantly, plumule length (225.8±4.49) and radical length (13.67±1.77) decline high significantly, fresh weight and dry weight of all the treatments reduced less significantly as compared to control, moisture contents in all treatment stimulated significantly as compared to control (Table **6**).

Effect of Litter on Agronomic Features of Three *Brassica* Species

Litter inhibited less significantly the germination percentage (53.33±12.47) of *B. campestris*, the plumule growth (8.4±1.08) was high significantly declined and the radical growth (2.9±0.22) was high significantly reduced as

compared to the control (80±8.16, 36.5±4.00, 20.9±2.51). The fresh weight, dry weight, and moisture content were less significantly reduced as compared to the control. Litter stimulated the germination percentage (96.67±4.71) of *B. napus*, the plumule growth (26.9±6.13) and the radical growth (17.77±9.66) significantly reduced as compared to the control (96.66±4.71, 48.33±2.78, 48.37±5.34). Moisture content (%), fresh & dry weight were less significantly reduced as compared to the control Litter inhibited highly significantly the germination percentage (53.33±4.71) of *B. juncea* and the plumule growth (13.67±3.80) whereas, the radical growth (7.03±0.31) was highly significantly reduced as compared to the control (93.33±9.42, 62.07±6.96, 49.83±3.83). The fresh weight and dry weight were less significantly reduced as compared to the control and moisture content was stimulated less significantly as compared to the control (Table **7**).

Effect of Mulching on Agronomic Features of Three *Brassica* Species

Mulching inhibited highly significantly the germination percentage (36.67±4.71) of *B. campestris*, the plumule growth (5.83±2.18) was highly significantly declined and radical growth (1.4±0.54) was significantly reduced as compared to the control (83.33±9.43, 26.5±2.16, 10.77±2.07). The fresh and dry weigh were less significantly reduced as compared to the control and moisture content was stimulated less significantly as compared to the control. Mulching inhibited significantly the germination percentage (70±14.14) of *B. napus*, the plumule growth (6.87±0.87) was stimulated significantly, and radical growth (4.13±0.31) was significantly reduced as compared to the control (86.67±4.71, 6.1±0.36, 4.5±0.43). The fresh and dry weight and moisture content were less significantly reduced as compared to the control. Mulching inhibited significantly the germination percentage (63.33±12.47) of *B. juncea*, the plumule growth (9.53±5.32) and radical growth (5.03±1.92) was significantly reduced as compared to the control (83.33±12.47, 27.73±5.44, 8.17±1.02). The fresh and dry weight and moisture content were less significantly reduced as compared to the control (Table **8**).

Table 7. Effect of litter on agronomic features of three *Brassica* species.

S. No	Treatments	% Germination	Plumule Growth (mm)	Radical Growth (mm)	% Fresh Weight	% Dry Weight	% MC
B. campestris							
1.	Control	80±8.16	36.5±4.00	20.9±2.51	0.73	0.40	0.33
2.	Litter	53.33±12.47*	8.4±1.08***	2.9±0.22***	0.53	0.30	0.23
B. napus							
1.	Control	96.66±4.71	48.33±2.78	48.37±5.34	0.79	0.62	0.17
2.	Litter	96.67±4.71**	26.9±6.13**	17.77±9.66**	0.62	0.41	0.21
B. juncea							
1.	Control	93.33±9.42	62.07±6.96	49.83±3.83	0.76	0.53	0.23
2.	Litter	53.33±4.71***	13.67±3.80***	7.03±0.31***	0.62	0.36	0.26

**Significantly different at $\alpha < 0.05$, ***non-significantly different at $\alpha < 0.05$. All the data are expressed as Mean ± S.D of three replicates.

Table 8. Effect of mulching on agronomic features of three *Brassica* species.

S. No	Treatments	% Germination	Plumule Growth (mm)	Radical Growth (mm)	% Fresh Weight	% Dry Weight	% MC
B. campestris							
1.	Control	83.33±9.43	26.5±2.16	10.77±2.07	0.71	0.31	0.40
2.	Soil	36.67±4.71***	5.83±2.18***	1.4±0.54**	0.65	0.25	0.45
B. napus							
1.	Control	86.67±4.71	6.1±0.36	4.5±0.43	0.92	0.57	0.35
2.	Soil	70±14.14**	6.87±0.87**	4.13±0.31**	0.77	0.47	0.30
B. juncea							
1.	Control	83.33±12.47	27.73±5.44	8.17±1.02	0.88	0.69	0.19
2.	Soil	63.33±12.47**	9.53±5.32**	5.03±1.92**	0.81	0.63	0.18

Significantly different at α < 0.05, * non-significantly different at α < 0.05. All the data are expressed as Mean ± S.D of three replicates.

DISCUSSION

Allelopathy is defined as an interaction between plants through chemical pathways[28].Recently, allelopathy has gained the status of a well-established and emerging discipline. In the last few decades, a great deal of research has been done in a wide variety of allelopathy areas[29]. Many varieties of the cruciferous family (Brassicaceae) are known to have allelopathic potential. In the present study, extracts obtained from *B. campestris*, *B. napus* and B. juncea plants were used to investigate the inhibitory effects on the growth of *A. modesta* (Fabaceae). However, it has been known that the Brassicaceae family has allelopathic effects on many plant species in the Fabaceae family[30,31].

In the present study, results showed that the germination percentage was inhibited in all concentrations of extracts but the germination was found to be declined significantly after 48h as compared to 24h. Similarly, the germination was stimulated in *B. campestris* in 5g and 10g/48h by applying fresh leaf extract. Our result agrees with the work of Naveed *et al*[32]. All tested concentrations and duration of dry and fresh leaf extracts highly significantly decreased the plumule growth of *B. campestris* and in 5g/48h, both in fresh and dry leaf extracts, the plumule growth was stimulated; same result was shown by Hussain *et al*[33,34].

Fresh weight, dry weight, and moisture contents in all test species were found to be significantly decreased by the aqueous extracts of leaves. In all concentrations and duration, radical growth was reduced in *B. campestris and B. juncea* by the leaves extracts, this result agrees with the result of Barkatullah *et al*[35]. In our result, the 10gm extract significantly reduced the seed germination as compared to 5 gm in *B. campestris*. It is now clear that as the concentration of plant material increased (from 5 g to 10 g), the allelopathic potential also increased. A Similar result was obtained by Hadi *et al*[2].Therefore, our result also revealed that the stimulatory effect causes an increase in plumule and radical growth of *B. napus* by using a low concentration of *A. modesta* leaves extracts (5g/24), this conclusion agrees with the result of Zeng *et al*[36]. The plumule and radical growth of test species *B. campestris and B. juncea* was significantly retarded. It can be concluded that the reason for the differences in the effect of different application times on the germination of *A. modesta* and different tissues (plumule and radical) of the extracts of the Brassica species used in the study is due to species diversity. Additionly, the data obtained may indicate that there may be a toxic effect due to excessive accumulation of allelochemicals with increasing time. This

result agrees with the result of Ali *et al*[37], Khan *et al*[38], Hussain *et al*[35].In *B. campestris* and *B. juncea,* the aqueous extracts of leaves reduced the germination at both concentrations (5 and 10g) and durations (24 and 48h), this conclusion agrees with the result of Barkatullah *et al*[35,39]. In a test species, *B. campestris* the germination percentage and the radical length reduced significantly at high concentrations(10g) of *A. modesta* leaves extracts as compared to the control, this result agrees with Kabir *et al*[40]. This may be due to the root's direct contact with the extract and then the effect of its chemical content, which has an inhibitory effect. Ion uptake and growth are the most energy-consuming processes in plant cells. Moreover, the root is the first organ in the rhizosphere to come into contact with allelochemicals, so the effect of allelochemicals onion uptake is particularly important. There is also much data on the effect of allelochemicals on membrane-bound enzymes. Proton-pumping ATPase membrane (H^+-ATPase). H^+-ATPase inhibition causes a reduction in mineral and water uptake by the roots and ultimately leads to a strong effect on basic plant functions such as photosynthesis, respiration, or protein synthesis, eventually leading to reduced growth[41]. The germination of test species declines significantly. The plumule and radical growth declined significantly. Fresh and dry weights of test species were inhibited much more than their moisture contents. The moisture content showed a marked increase in its value. The same results were reported by Humayun *et al*[42], Natalia *et al*[43], and Masoodi *et al*[44].In litter and mulching, the germination percentage, plumule and radical growth of all three test species except *B. napus* in litter inhibited significantly, our results agree with the result of Barkatullah *et al*[35]. When the litter was added, the germination, plumule growth radical growth, fresh weight, and dry weight of both the tested plants *B. campestris* and *B. juncea* were decreased by the plant litter[35]. Hayat *et al*[45] also studied the radicle length and plumule length in the wheat plant. Bibi *et al*[46], and Shakir *et al*[47] reported different agronomic attributes in the wheat plant (fresh weight, dry weight, % germination, and moisture content), in Spinach by Ma *et al*[48]. Bibi *et al*[49] studied the growth parameters in *Avena sativa*.

CONCLUSION

Allelopathic potential of *A. modesta* was investigated against *Brassica campestris, B. napus,* and *B. juncea* in the form of aqueous extracts, litter, and mulching. It was concluded from the three experiments that the leaves of *Acacia modesta* were stimulated and inhibited the growth and germination of some test species. In *Brassica campestris* (10g/48h dry and 5g/24h fresh), *B. napus* (10g/24h), and *B. juncea* (10g/48h dry and 5g/48h fresh) leaves extracts showed more effect, as it reduced germination percentage, plumule and radical growth and fresh and dry weight of the seedlings in all the test species as compared to the control. *B. campestris* and *B. juncea* were highly affected by the allelopathy of *A. modesta* in all three experiments, while *B. napus* was comparatively less affected.

CONFLICT OF INTEREST

No conflict of interest.

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LIST OF ABBREVIATION

None

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