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In-Field Evaluation Of Allelopathic Weed Management On Selected Crops Of Uttarakhand, India

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Abstract: The present study aims to evaluate the impact of four invasive weeds found in Uttarakhand, namely *Chenopodium album* (CA), *Eupatorium adenophorum*, *Lantana camara* (LC), and *Cynodondactylon* (CD), on the growth parameters of key agricultural crops in the region, including Wheat (*Triticum aestivum* L), Barley (*Hordeum vulgare*), Toria (*Brassica campetris*), and Lentils (*Lens culinaris*). By examining the allelopathic effects of these weeds on specific crops, the study seeks to provide insights for improved crop management practices in Uttarakhand.

Keywords: allelopathy • herbicide • allelochemicals • weeds • crops

Introduction

Allelopathy refers to the occurrence where one plant influences the growth of neighboring plants through the release of secondary metabolites known as allelochemicals. These compounds are produced and released by plants through processes like leaching, volatilization, decomposition, and root exudation. The allelochemicals can have herbicidal properties, inhibiting the growth of certain plants, or they can act as growth enhancers for agricultural crops (Putnam 1988).Therefore, these naturally occurring allelochemicals hold potential as alternative herbicides or growth-promoting agents in agricultural practices. Most research on allelopathy has focused on the effect of interactions among weed species (Newman and Rovira, 1975), weeds and crops (Turk and Tawaha, 2003), and crop species.

Weeds pose a significant challenge to agricultural fields as they adversely affect crop growth and productivity. These undesired plants compete with cultivated crops for essential resources such as light, minerals, and nutrients. This competition often results in reduced growth and yield of desirable crops. In the Kharif season, which typically occurs between November and December, major arable crops like wheat, barley, lentils, and toria are sown, making them particularly susceptible to the negative impact of weeds. Efforts to manage and control weeds are crucial to ensure optimal growth and productivity of these crops during this season.

Wheat is infested by a high number of weeds; however, the most important of these may include: *Bromus* species *Avenafatua* L., *Phalaris minor* Retz., *Capsella bursa-pastoris* (L.) Medik, *Lolium* species, *Chenopodium album* L., *Cirsium arvense*(L.) Scop., *Veronica* species, *Lamium* species, *Galium* species, etc. The decrease in grain yield of wheat caused by weeds likely has a range of 18–29% (Oerke, 2006). Other than causing yield losses, weeds also cause hindrances in the agronomic management of wheat thereby increasing its cost of production.

The decrease in grain yield of wheat caused by weeds likely has a range of 18–29% (Oerke, 2006). Other than causing yield losses, weeds also cause hindrances in the agronomic management of wheat and increase its cost of production.

Globally the barley production is about 65 million hectares with 75% of the area in North Africa, Europe, western, and south-western Asia; North America contributes to about 10% of the area. Wheat is grown in rotation with Barley which results in an apparent residual weed control observed in the wheat crop for ≤ 2 years (Légère and Stevenson, 2002).

Toria (*Brassica rapa* syn. *Brassica campestris* L. *var*.toria) is also one of the important oilseed crops. The productivity of Toria has been declining over the past several years. Depletion of organic matter, intensive cropping, and coarse texture soils, low microbial activity, low cation exchange capacity (CEC), moderate to strong acidic soil reaction, and high leaching losses during monsoon season are the soil-related constraints in declining the maize-toria productivity in Chitwan and neighboring districts of India (Shrivastava et al., 2001). Dominant weed species recorded in the toria field are wild onion, *Orobanchea egyptica*, *Vicia sativa*, *Chenopodium album*, *Anagalis arvensis*, *Fumaria parviflora*, and *Circium arvense*.

Many factors are responsible for the decline in yield productivity of Lentil (*Lens culinaris* Medik.), including minimal use of fertilizers, poor distribution of rainfall, lack of effective weed control measures, low soil levels, and a lack of basic knowledge of weed management in lentil production (Kantar et al., 1998). As the duration of the weed-free period increased vis-à-vis decreased duration of the weed-infested period, an increase in yields was observed.

Though Parthenium weed (*Parthenium hysterophorus* L.) is not a major weed of wheat crop presently, but is suspected to become one and may cause great production losses to the crop in the near future due to its highly invasive nature. Parthenium is seen to be infesting various crops and is able to cause significant yield losses in crops such as sorghum (Tamado & Milberg, 2004), maize (Bhatt et al., 1994), and wheat (Agarwal & Anand, 1992). More than 40% yield losses have been reported in crops by parthenium (Khosla &Sobti, 1981). The weed has also been found to deteriorate quality, decline the market price of crop products, and cause significant economic losses to the producers (Chippendale & Panetta, 1994).

Eupatorium adenophorum Spr. (Crofton weed) is a native of Mexico which is a closed group of invasive, notorious weeds of the Asteraceae family distributed worldwide (Trounce & Dyason, 2003). Recently, its colonization of the agriculture and forest landscape of the central Himalayas has become a severe threat not only to agricultural productivity but also to the biodiversity of this ecologically fragile region (Joshi et al., 2014). This region is the renowned repository of many traditional crop species, their numerous varieties, and around 40 diverse species of crops comprising pulses, pseudocereals, cereals, millets, and oilseeds (Saxena et al., 2005). Today this region is facing both ecological and economic threats caused by weed invasion and dwindling agricultural productivity.

Material and Methods

Experimental Site description

The field trial was conducted in the experimental block at the Department of Biotechnology Govind Ballabh Pant Institute of Engineering and Technology,Ghurdauri, Pauri, Uttarakhand. The experiment was conducted between August 2022 to August 2023. The field station is located at an altitude of about 1800 m above mean sea level, lying between 29° 45’ to 30°15 N latitude and 78° 24’ to 79° 23’ E longitude under mid-hill zones of Uttarakhand, India. The climate of the region is a humid temperate-type climate with a mean annual precipitation of 1278.4 mm distributed over 54 rainy days. The mean

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annual minimum and maximum temperature are14.26° ºC and 29.18, respectively. The soil of the experimental block was silt clay loam in texture having slightly acidic pH (6.0 to 8.5), low in available nitrogen (210.0 to218.0 kg/ha) and available phosphorous (11.5 to 13.5 kg/ha), and rich in available potash (408.0 to 418.0 kg/ha).

The plant species

Four invasive weeds viz. *Chenopodium album* (CA), *Eupatorium adenophorum* (EA), *Lantana camara* (LC), and *Cynodondactylon* (CD), and four common crops *Triticum aestivum* (wheat) (V.L. Gehun-802), *Hordeum vulgare* (barley) (PRB-802), *Brassica campetris*(V.L. Toria-3), and *Lens culinaris* (lentil) (V.L. Massor-126) were selected for the study. All seeds were surface sterilized with 1% sodium hypochlorite and pre-treated with hot water for 24h before sowing.

Aqueous extract preparation

Freshly fallen senescent leaves of selected weeds were collected from old plants in the morning hours in adjacent field around college campus. The leaves collected were washed thoroughly with water. The leaves were macerated in a grinder and boiled for 20 minutes. The solution obtained was filtered with 2 layers of muslin cloth. The filtrate was then used for experimental work. The leaf aqueous extracts (LAE) of weeds were sprayed after 20 days of germination of all four crops.

Experimental design

The experiment was conducted in the Factorial Randomized Block Design (RBD) during the *Kharif and rabi* seasons under rainfed conditions from November to May. In the experimental field, 4 mini-plots of 2.5 m x 2 m divided into four rows of spacing 40x30 cm between rows, were established; 50 seeds of each V.L. Gehun-802 (wheat), PRB-802 (barley), V.L. Toria-3 (toria), and V.L. Massor-126 (lentil) were separately sown in each mini-plot. The mini-plots were enclosed by plastic mesh to prohibit rodents and other animals. The heights of germinated seedlings and other crop parameters were recorded after two months. The experiments were performed in four replicates. The plants were allowed to grow in the mini plots till harvest. The vegetative growth parameters of wheat and barley such as (a) development of the total number of green leaves per plant, (b) height of the plant, (c) total length of leaves, (d) Ear length, (e) number of tillers, and (f) test weight were recorded after 45 days of germination in both control and treated sets. The growth and yield parameters of toria and lentils such as (a) number of heads per plant (b) number of seeds per head, (c) Test weight in grams, and (d) seed yield per siliqua e) height of the plant and f) number of plant per m^2 were recorded at the time of harvest in both control and treated sets.

Statistical analysis

The data were interpreted via ANOVA analysis of Factorial Randomized Block Design and carried out among the different pairs of dependent and independent variables. The least significant difference test at $P \leq 0.05$ was used to compare the treatment means by using SPSS software.

Results

Effect of LAE on the height of the crop plants

In the present investigation, the observed plant height (cms) in the four crop plants showed a slight reduction due to effect of weed extract as compared to the control. The effect of aqueous extracts of EA, CD, CA, and LC on barley has recorded a decrease of 4.7%, 3.5%, 9.7%, and 13.2% plant height respectively as illustrated in Table 1. Highest reduction in plant height (19.3%) was displayed by toria as compared to lentils and barley when treated with the aqueous extracts of EA. Further, a decline of 9.4%, 2.2%, and 8.5 % was recorded when toria was treated with extracts of CA, CD, and LC (Table 2). The highest reduction of plant height of 25.5% was observed in wheat when treated with extracts of LC as compared to other weeds extracts(refer to Table 3). The weed extracts have negatively impacted the crop growth pattern. However, the leaf extract of *C. album* showed no impact on the lentils while the other weeds EA, CD, and LC have shown a decline of 7.2%, 9.6%, and 12 % respectively in the lentil plant height (Table 4).

Effect of LAE on the total number of Ears per plant

Table 1. Allelopathic effect of leaf aqueous extract of weeds on physical parameters of Barley in field conditions

Weed treatment	Plant ht.(cms)	Number of Ear	No. of tillers	No. of leaves/plant	Length of leaves	Test weight (in gms)
Control	80.0±6.12	9.4±0.54	3.4±0.54	4.4±0.54	29.0±1.0	16.28
Chenopodium album	76.2±5.54 (-9.7)	9.2±1.30(-2)	3.0±0.70(-11.7)	4.2±0.44(-4.5)	20.8±4.32(-28.9)	12.50(-23)
E. adenophorum	77.2±4.25 (-4.7)	8.8±1.30(-6)	3.0±0.70(-11.7)	4.4±0.54(-0)	27.4±3.28(-5.5)	14.82(-8.9)
Cynodondactylon	72.2±3.25 (-3.5)	9.4±0.54(-0)	3.0±0.83(-11.7)	4.4±0.54(-0)	25.6±2.30(-11.7)	15.90(-2.3)
Lantana camara	69.4±3.11 (-13.2)	9.0±0.70(-4)	2.8±0.44(-17.6)	4.2±0.44(-4.5)	25.6±3.84(-11.7)	11.80(-27)

Note: Each value is means of 3 replicates ± SE ; Value in parenthesis indicates %inhibition (-) over control

The data from Table 1illustrated a significant effect of leaf extract of different weed species on the number of ears per plant. The maximumreduction of 6% in barley was observed when sprayed with aqueous EA leaf extracts while the extracts of CD did not affect ears per plant of barley. In the case of wheat, the highest decline of 29.16% in ears per plant was observed when sprayed with LAE of LC followedby decline of 12%, 20%, and 22% when sprayed with the LAE of CA, CD,and EA respectively as compared with control (Table 3).

Table 2: Allelopathic effect of leaf aqueous extract of weeds on physical parameters of Toria in field conditions

Weed treatment	Plant ht (cms)	No. of seeds yield/pod	No. of pods/ plant	No. of branch/plant	No. of plant/m2	Test weight(in gms)
Control	63.2±7.56	16±0.54	28±11.66	3.6±0.54	42	16.28
Chenopodium album	57.2±9.41 (-9.4)	11±0.51(-31.2)	28±5.54(-0)	3.2±0.44(-11)	41(-2)	12.50(-23)
E. adenophorum	51±6.74 (-19.3)	12±1.22(-25)	26±1.87(-7)	3.4±0.89(-5)	31(-26)	14.82(-8.9)
Cynodondactylon	61.8±9.52 (-2.2)	11±0.83(-31.2)	21±4.87(-25)	3.0(-16.6)	38(-9.5)	15.90(-2.3)
Lantana camara	57.8±6.97 (-8.5)	13±1.30(-18.75)	27±7.66(-3.5)	3.4±0.89(-5)	41(-2)	11.80(-2.7)

Each value is mean of 3 replicates ± SE ; Value in parenthesis indicates %inhibition (-) over control

Effect of LAE on the number of tillers

In the current study, a 17.6% decrease in the number of tillers was observed in barley when treated with aqueous extracts of LC, and a reduction of 11.7% was noted in the number of tillers when exposed to leaf extracts of CA, CD, and EA, in comparison to the control (Table 1). In the case of wheat, a 23% reduction in the number of tillers was seen when treated with aqueous leaf extract from EA, CD, and LC. Conversely, only a 7.6% reduction was observed when wheat was treated with aqueous leaf extracts of CA, compared to the control, as illustrated in Table 3

Table 3. Allelopathic effect of leaf aqueous extract of weeds on physical parameters of Wheat in field conditions

Weed treatment	Plant ht.(cms)	Number of Ear	No. of tillers	No. of leaves/plant	Length of leaves	Test weight(in gms)
Control	68.8±6.68	9.6±1.67	2.6±0.54	4.4±0.54	22.6±1.14	19.32
Chenopodium album	65.6±3.57 (-4.6)	8.4±0.89(-12)	2.4±0.54(-23)	4.0(-9)	18.4±1.14(-18.5)	11.33(-41.35)
E. adenophorum	59.6±7.92 (-13.3)	7.6±1.34(-22)	2.0(-7.6)	4.0(-9)	18.8±4.32(-20.2)	14.01(-27.4)
Cynodondactylon	58.4±6.42 (-15)	7.4±0.54(-20)	2.0(-7.6)	4.0(-9)	17±2.54(-24.7)	12.33(-36.18)
Lantana camara	51.2±7.25 (-25.5)	6.8±0.83(-29.16)	2.0(-7.6)	4.2±0.44(-4.5)	17.8±4.76(-21.2)	8.16(-57.7)

Each value is means of 3 replicates ± SE ; Value in parenthesis indicates %inhibition (-) over control

Effect of LAE on the number of leaves/plant

In barley, the application of LAE from LC and CA resulted in a 4.5% reduction in the number of leaves per plant. However, there was no significant effect on barley when sprayed with the aqueous extracts of EA and CD (Table 1). However, in wheat, there was a 9% reduction in the number of leaves per plant when treated with LAE from CA, EA, and CD, while the extracts of LC showed a 4.5% reduction (Table 3).

Table 4. Allelopathic effect of leaf aqueous extract of weeds on physical parameters of Lentils

Weed treatment	Plant ht (cms)	No. of seeds yield/pod	No. of pods/ plant	No. of branch/plant	No. of plant/m2	Test weight(in gms)
Control	25.0±2.54	2.33	27.2±5.76	4.6±0.89	40	35.28
Chenopodium album	25.2±2.38 (-0)	2.13(-8.5)	19.6±2.19(27.9)	4.4±1.14(-4)	38(-5)	30.10(-14.6)
E. adenophorum	23.2±2.58 (-7.2)	1.97(-15.4)	20.8±4.38(-23.5)	3.8±0.44(--17.3)	36(-10)	28.56(-19)
Cynodondactylon	22.6±2.50(-9.6)	1.86(-20.1)	23±6.92(-15.4)	3.8±1.09(-17.3)	36(-10)	26.93(-23.6)
Lantana camara	22.0±2.23 (-12)	1.67(-28.3)	21.6±2.96(-20.5)	4.0±0.70(-13)	38(-5)	19.26(-45.4)

Each value is the means of 3 replicates ± SE ; Value in parenthesis indicates %inhibition (-) over control

Effect of LAE on Length of leaves

In barley, there was a substantial decrease in the length of leaves when treated with different aqueous extracts. Specifically, a 28.9% reduction in leaf length was observed in barley treated with CA extracts. A decrease of 5.5% was noted in barley treated with EA extracts, while a reduction of 11.7% was recorded in barley treated with CD and LC extracts, as indicated in Table 1.

In wheat, it was observed that the most significant reduction in leaf length, amounting to 24.7%, was seen in wheat when treated with CD extracts (Table 3). Furthermore, a decrease of 18.5%, 20.2%, and 21.2% in leaf length was noted in wheat when sprayed with the aqueous extracts of CA, EA, and LC, respectively.

Table 5. Analysis of variance of surveyed germination attributes of Barley

Source of variance	Degree of freedom (df)	Sum of square (ss)	Mean Sum of square (ms)	F calculated (Fv)	Result
replication	2.0	.2823437	.1411719		
A (Parameters)	4.0	137.2482	34.31205	347.3467	**
B(Extract treatment)	4.0	312.7357	78.18392	791.4692	**
A*b	16.0	52547.61	3284.225	33246.77	**
Err	48.0	4.741597	.9878328E-01		
Total	74.0	53002.61			
Sem1=.8115141E-01		sem2= .8115141E-01		sem3= .1814601	
cd1 at 1%	.3078426		cd1 at 5%	.2307550	
cd2 at 1%	.3078426		cd2 at 5%	.2307550	
cd3 at 1%	.6883569		cd3 at 5%	.5159839	
cv=1.297551					

Note: If cv is greater than 20 that means irrelevant data; * and** are significant in 5% and 1% levels respectively

Effect of LAE on the development of the number of pods/plant

In the case of toria, the application of the aqueous extract of CA did not have any significant effect on the number of pods per plant. However, a 25% decrease in the number of pods per plant was observed when toria was sprayed with the aqueous extracts of CD (Table 2).

For lentils, the most substantial reduction, amounting to 27.9%, in the number of pods per plant was observed when treated with the aqueous extracts of CA. Furthermore, a decrease of 23.5%, 20.5%, and 15.4% in the number of pods per plant of lentils was recorded when treated with the extracts of EA, LC, and CD, respectively (Table 4).

Table 6. Analysis of variance of surveyed germination attributes of Toria

Source of variance	Degree of freedom (df)	Sum of square (ss)	Mean Sum of square (ms)	F calculated (Fv)	Result
replication	2.0	.3223437	.1611719		
A	4.0	537.0440	134.2610	2583.000	**
B	4.0	362.0273	90.50684	1741.229	**
A*b	16.0	26883.83	1680.239	32325.53	**

Err	48.0	2.494978	.5197871E-01		
Total	74.0	27785.71			
Sem1=.5886635E-01		sem2= .5886635E-01		sem3= .1316292	
cd1 at 1%	.2233056		cd1 at 5%	.1673872	
cd2 at 1%	.2233056		cd2 at 5%	.1673872	
cd3 at 1%	.4993266		cd3 at 5%	.3742891	
cv=.8487605					

Note: If cv is greater than 20 that means irrelevant data; * and** are significant in 5% and 1% levels respectively

Effect of LAE on Development of numbers of seed yield/siliqua

In the case of toria, a significant decrease in the number of seeds per siliqua was observed, with a 31.2% reduction when treated with CA and CD aqueous extracts. Further, a decrease of 25% and 18.75% was recorded in toria when treated with EA and LC extracts, respectively (Table 2).

For lentils, the most substantial reduction in the number of seeds per siliqua was 28.3%, which was observed when treated with LC extracts (Table 4).

Effect of LAE on the number of branches per plant

The aqueous CD and CA extracts caused a decline of 16.6% and 11.1 % respectively in the number of branches per plant when sprayed on toria plants, whereas both the aqueous extracts of EA and LC, did not cause much decline (5%) (Table 2). Lentils displayed the highest, reduction of 17.3% in the number of branches per plant when treated with the aqueous extracts of EA and CD (Table 4).

Effect of LAE on number of plant/m2

In toria, a notable reduction of 26% in the plant count per square meter was observed when treated with aqueous EA extracts. However, only a negligible reduction of 2% was observed in toria when treated with aqueous CA and LC extracts, as indicated in Table 2.

In the case of lentils, there was a 10% reduction in the number of plants per square meter when treated with aqueous extracts of EA and CD, as presented in Table 4

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Table 7. Analysis of variance of surveyed germination attributes of Wheat.

Source of variance	Degree of freedom (df)	Sum of square (ss)	Mean Sum of square (ms)	F calculated (Fv)	Result
replication	2.0	.2893750	.1446875		
A	4.0	145.5531	36.38828	367.1947	**
B	4.0	382.1469	95.53672	964.0625	**
A*b	16.0	33965.79	2122.862	21421.83	**
Err	48.0	4.756707	.9909806E-01		
Total	74.0	34498.54			
Sem1=.8128060E-01		**sem2= .8128060E-01**		**sem3= .1817490**	
cd1 at 1%	.3083327		**cd1 at 5%**	.2311224	
cd2 at 1%	.3083327		**cd2 at 5%**	.2311224	
cd3 at 1%	.6894528		**cd3 at 5%**	.5168054	
cv=1.584354					

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Note: If cv is greater than 20 that means irrelevant data; * and** are significant in 5% and 1% levels respectively

Effect of LAE on test weight(gm)

Test weight is a crucial indicator of crop yield, and the influence of aqueous weed extracts on test weight had similar effects on barley and toria, as illustrated in Tables 1 and 2. There was an observed reduction in test weight (23%, 8.9%, 2.3%, and 27%) in both toria and barley when treated with aqueous extracts of CA, EA, CD, and LC, respectively. However, the most significant reductions were recorded in wheat and lentils when treated with LC extracts, with reductions of 57.7% and 45.4%, as presented in Tables 3 and 4 respectively.

The analysis of variance (ANOVA) for different weed LAE (Leaf Aqueous Extracts) from the four weeds on four different crops showed significant effects on all the studied growth and yield parameters. The interactions between the treatments were also significant at a 5% level of significance. The treatment of different weed extracts on crops varied significantly, as indicated in Tables 5, 6, 7, and 8.

Table 8. Analysis of variance of surveyed germination attributes of Lentils**.**

Source of variance	Degree of freedom (df)	Sum of square (ss)	Mean Sum of square (ms)	F calculated (Fv)	Result
replication	2.0	.1842187	.9210937E-01	1141.596	
A	4.0	351.9513	87.98782	3312.679	**
B	4.0	1021.291	255.3227	8980.657	**
A*b	16.0	11074.86	692.1786		**
err	48.0	3.699570	.7707439E-01		
total	74.0	12451.98			
Sem1=.7168189E-01		sem2= .7168189E-01		sem3= .1602856	
cd1 at 1%	.2719205		cd1 at 5%	.2038283	
cd2 at 1%	.2719205		cd2 at 5%	.2038283	
cd3 at 1%	.6080328		cd3 at 5%	.4557740	
cv=1.373481					

Note: If cv is greater than 20 that means irrelevant data; * and** are significant in 5% and 1% levels respectively

Discussion

The findings of this study demonstrated that all the weed extracts have shown different impacts on the different crop germination attributes. The aqueous extracts of EA, CA, LC, and CD exhibited strong inhibitory allelopathic effects on the germination process of wheat as compared to other crops. All of these weeds displayed allelopathic activities on food crops, with LC exhibiting the highest overall activity, followed by CA, EA, and CD. Specifically, the EA extracts resulted in a significant reduction of 27.4% in wheat test weight and a 23% decrease in tiller count. In the case of toria, there was a notable reduction of 26% in plants/m^2 by EA extracts. Similarly, Tijani-Eniola and Fawusi, 1989 demonstrated allelopathic effects of crude methanolic extract of EA on seed germination and seedling growth of tomatoes. Zhao et al., 2009 also reported that EA contains a large number of allelochemicals, especially in the leaves, which inhibit the growth of many plants in nurseries and plantations. Many sesquiterpene derivatives, inhibitory to some plants have been extracted and isolated from EA (Baruah et al., 1994). It was observed that the terpenes inhibit growth by suppressing cell elongation and cell division.

The aqueous extract of LC demonstrated the highest negative impact, with a significant decrease of 57.7% in the test weight of wheat and 45.4% in lentils. Further, there was a 25% reduction in height and a 29.16% decrease in the ear length of wheat due to the LC extract.The current results align with the research of Acchireddy et al. (1985) and Casado (1995), who indicated that *L. camara* is an allelopathic weed. This means that *L. Camara* can impede the germination and growth of other plants, especially seedlings. This inhibitory effect is attributed to the presence of phenolic acids (Narwal 1994) or the release of phytotoxic chemicals from *L. camara's* leaf litter and roots (Hossain and Alam2010).In studies conducted by other researchers, such as Jabeen and Ahmed (2009), and Hossain and Alam (2010), it was suggested that leaf extracts from *L. camara* indeed exhibit allelopathic effects on the germination and growth behavior of agricultural crops, including *Triticum aestivum* (common wheat) and *Cucurbita pepo* (zucchini or squash). These findings further support the notion that *L. camara* can have a negative impact on the development of other plant species and crops. Crops treated with CA extracts displayed significant allelopathic activity. The maximum reduction of 41.35% was observed in wheat test weight followed by a 31.2% reduction in seed yield of toria and a 23 % reduction in test weight of barley and toria by the extracts of CA. The allelopathic activity of CAappears to be associated with the presence of phenolic and alkaloid compounds found in its leaves. In a study by Malik et al. (1994), it was noted that the germination and growth of radish and wheat were inhibited when exposed to an aqueous air-dried extract of *C. album*. This effect was attributed to the presence of seven phenolic compounds in the test plant, with chlorogenic acid identified as the primary phytotoxin responsible for the observed inhibition.

Likewise, in research conducted by Cutillo et al. (2003), seven cinnamic acid amides were isolated from *C. album*, and their impact on the germination and growth of *Lactuca sativa* (lettuce), *Lycopersicon esculentum* (tomato), and *Allium cepa* (onion) was assessed. Their findings revealed a reduction in the germination and growth of all these plant species, indicating the allelopathic potential of the compounds from *C. album*.

The CD extracts has shown a 36.18% reduction in the test weight of wheat and also reduces the seed yield of toria by 31.2%. *C. dactylon* is of particular importance in the pasture ecosystem because of its capacity to fix considerable amounts of nitrogen. One significant challenge often encountered in such pastures is the potential for significant invasion by other weed species. This becomes more pronounced when the forage species within the pasture are weakened due to stress or disturbance, resulting in the formation of high-intensity vegetation gaps (Panetta & Wardle, 1992). Coumarins and phenolic acids, compounds present in all the weed species under investigation, can alter a plant's water status by restricting the development of root hairs (Kruse et al., 2000). The decrease in the osmotic potential of the cell sap has direct consequences on various aspects of plant growth, including the size of leaves, longitudinal growth of roots and shoots. Moreover, it has the effect of closing stomata (Dos et al., 2004), which in turn reduces the intake of carbon dioxide (CO_2) during photosynthesis, resulting in a decline in overall plant photosynthetic activity (Colpas et al., 2003).

Conclusion

Crops like wheat, barley, lentils, and toria play a vital role in ensuring global food security. However, weeds pose a significant threat to these crops, leading to reduced yields. One approach to address this issue is the cultivation of crop varieties that possess allelopathic activity, which can serve as a cultural weed control method. This environment friendly approach requires no additional inputs or expenses. In this study, the allelopathic weeds EA, LC, CA, and CD were found to negatively impact wheat growth parameters such as leaf length, seed yield, test weight, ear length, number of tillers, and height. Among these weeds, the leaf extracts of LC, CA, CD, and EA exhibited a stronger inhibitory effect on wheat test weight compared to other crops examined. Therefore, farmers need to prioritize the management of these weed species on their farms to mitigate their adverse effects on crops. **Future prospects**

Further research is needed to investigate the specific role of allelochemicals on different crops. The active compound(s) responsible for the inhibitory activity of the extracts need to be identified, and the effect of these weeds on germination and seedling growth in the natural environment should be examined. Furthermore, it is important to investigate the underlying mechanisms through which allelochemicals inhibit the growth parameters.

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