

# ALLELOPATHIC EFFECT OF COMMON LAMBSQUARTER (*CHENOPODIUM ALBUM*) ON SEEDLING GROWTH OF DIFFERENT MAIZE VARIETIES

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**ABSTRACT.** Common Lambsquarter (*Chenopodium album*) is the most damaging weed of maize crop and it affect maize growth not only through competitive approach but it also releases allelopathic chemicals in the environment and suppress growth of maize and other crop plants in the vicinity. This study was aimed to evaluate different concentration of Lambsquarter water extract (0, 50 and 100 %) on seedling growth of three maize varieties (Akbar, Afgoi, and Golden) in vitro condition. The study was designed in complete randomized design (CRD) with two factorial arrangements and replicated thrice. The result showed that allelopathic effect of Lambsquarter on germination, root and shoot dry weight of all three varieties was highly significant. Among varieties, the Afgoi showed minimum germination at 50% while the Golden showed minimum germination at 100% concentration. In case of root dry weight, Afgoi and Akbar were more suppressed as compared to Golden at 50% concentration but at 100% concentration, the Afgoi and Golden were reduced non-significantly over Akbar. Shoot dry weight of Akbar and Golden were decreased non-significantly at both concentrations except Afgoi that was more reduced at 50 % than 100% concentration. Stem diameter of only Akbar variety was reduced non-significantly on both concentrations. While, its effect on root and shoot length was inhibitory as well stimulatory. Root length of Akbar at 50% and Afgoi at 100% concentration were increased while the others were reduced. It was concluded, that the allelopathic potential of Lambsquarter can further be evaluated as a tool for weed management in screening out different varieties showing resistance against the water extract of this weed and the most resistant variety can be selected as competitive strategy.

**Key words:** Allelopathy, Lambsquarter, maize varieties, concentration, seedlings growth,

## INTRODUCTION

Weed infestation is one of the most important yield reducing factors and has caused more than 100 billion dollars' economic loss worldwide [1]. Because of their high competitive potential of acclimatization to the environment [2], not only there is competition between the crop and various weeds for nutrients, water, air, light and space but this competition also releases different types of allelochemicals which affect the germination and crop yield [3: 4]. The weeds in nature release various toxic compounds in the environment while protecting themselves from the enemy. They use this allelopathic mechanism as a competitive strategy to suppress the growth of crop resulting into availability of resources available for themselves [5]. The allelochemicals are released from different parts of plant in the form of volatilization, leachates from leaf during rain or dew formation and reach to the surface of soil beneath the plant canopy. Roots also excrete exudates containing these allelochemicals which affect the growth of other plants in the vicinity [6]. Use of allelopathy in weed management is a novel tool for sustainable crop production system and is environment friendly [7]. The allelochemicals present in different parts of plant (root, stem, leaves, and flowers) could be used as plant water extract for making herbicides [8]. The inhibitory effect of allelochemicals is complex involving the interaction of different classes of allelochemicals like, amino acids, alkoids, carbohydrates, flavonoids, phenolic compounds, steroids and terpenoids. The interaction of different allelochemicals produce more allelopathic effect as compared to single class compound [9]. The prominent effects of allelochemicals reduce radical and shoot growth [10] which is caused by phenolic

compounds that decrease adenosine triphosphate (ATP) production. The low ATP lowers the respiration resulting in different physiological changes which alternatively reduce growth and dry matter. Most allelopathic compounds affect seed germination by altering the enzymatic activities. Similarly, *Cynodon dactylon* and *Chenopodium album* containing flavonoids are responsible for reduced seed germination and disruption of ATP production, leading to low energy transmission [11]. In vitro study was conducted by Razaie and [12] on the allelopathic effect of *Chenopodium album* on safflower. Shoot water extract of *Chenopodium album* indicated reduced germination (80%), seedling dry weight (52.5%), plant height (19.07%) and root dry weight (92.5%) as compared to the control where no weed extract was applied. Similar study was also conducted by [13] showed that the allelopathic effect of *Chenopodium album* on growth of cucumber, onion, tomato and sunflower was from 68 to 85, 47 and 51%. [14] demonstrated the allelopathic effect of *Chenopodium album* seeds on maize germination by placing 10 seeds of maize with each 0, 200, 400 and 600 seeds of Common Lambsquarter at equal distance. The results showed that increasing the number of weed seeds decreased germination of maize seeds significantly and reduced the length of coleoptile, radical, adventitious roots as well as the number of roots. The use of allelopathic research in agriculture is to carry out screening of crops and weeds and ultimately for determining its potential to suppress weeds. For this purpose, different weed extracts are used to test the allelopathic effect on seed germination and growth of plants in laboratory, followed by greenhouse and/or field studies which can further be used for identification and

isolation of allelochemicals. These studies are helpful in developing synthetic herbicides [9]. Keeping in view the importance of allelopathy in weed management, the present study was carried out to assess the impact of Common Lambquarter water extract on initial growth and response of maize varieties.

## MATERIALS AND METHODS

An in vitro study was conducted at the seed testing laboratory, Department of Agronomy, Sindh Agriculture University Tandojam, Pakistan during 2013 to investigate the allelopathic effect of Common Lambs quarter water extract on seedling growth of different maize varieties. The study was designed in a complete randomized design (CRD) with factorial arrangement consisting of three maize varieties (Akbar, Afgoi and Golden) and three concentration of Common Lambsquarter water extracts (0, 50 and 100 %) replicated thrice. Common Lambsquarter water extract was prepared according to the method described by [12]. Fresh weed plants of Common Lambsquarter were collected from the Agronomy Research Field, Sindh Agriculture University Tandojam. The roots were removed and shoots were washed with distilled, dried in oven on 80 °C for 48 hours and ground. A 5 g portion of powdered material was soaked in 100 ml sterilized distilled water for 48 hours, centrifuged at 6000 rpm for 30 minutes at 10°C and filtered through whatman filter paper number 42. The original extract was considered as 100% concentrated, further diluted to 50 and 0 % and stored in sterilized plastic vials at 4 °C for subsequent use in the study. The Petri dishes were washed and packed with brown paper and sterilized in oven at 60 °C for one hour. Similarly, the sand used in the experiment was sterilized for 20 minutes at 120 °C and 15 bar in the Plant Pathology Laboratory, Sindh Agriculture University Tandojam. The seeds of three maize varieties were disinfected superficially by 70% ethanol for three minutes and then washed four times with sterilized distilled water. Before sowing the seed, hands and surrounding material was washed with ethanol to avoid contamination. Twenty seeds of each variety were sown in each sterilized petri dishes filled with sterilized sand. Five ml of Lambsquarter water extract was applied to each petridish, further soaked with distilled water and placed in the germinator at 25°C. The petri dishes were checked regularly and soaked with distilled water as required. After 12 days, the germination %, shoot length, root length, stem diameter, root dry weight and shoot dry weight were recorded and statistically analysed using computer software programme Statix 8.1 (MathSoft Inc., Cambridge, MA, USA).

## RESULTS

Allelopathic effect of Common Lambsquarter water extract on seedling growth of three maize varieties (Akbar, Afgoi and Golden) was statistically significant (Table 1 & Fig.1). All the study factors germination, shoot and root length, shoot and root dry weight except stem diameter were influenced by the different concentration of water

extract of Common Lambsquarter. The range, mean and coefficient of variance of these maize growth parameters are given in table 1.

### Germination

Germination percentage in Akbar was ranged from 12.33 to 40.88% with mean value of 24.92%, Afgoi was ranged from 8.22 to 93.44 % with mean value of 36.54% and golden was ranged from 12.33 to 100.0 % with mean value of 45.29%. The minimum mean germination was recorded in Akbar variety and maximum was in Golden variety. The three level of *Chenopodium album* water extract concentration (0, 50 & 100%) on germination of three maize varieties are depicted in Fig.1a. on zero concentration where only distilled water was used (control) indicated variations among the three varieties. The highest germination was note in Golden and minimum was in Akbar but at 50% concentration the germination of all three varieties were suppressed significantly. Among them, Afgoi was suppressed more followed by Akbar and Golden was suppressed in rank third. Whereas, at 100% concentration the germination in Golden was suppressed more followed by Afgoi and Akbar.

### Root and shoot length

Root length of Akbar was ranged from 11.49 to 19.62 cm with mean value of 15.22 cm, Afgoi was ranged from 12.95 to 20.78 cm with mean value 16.69 cm and Golden was ranged from 9.21 to 26.02 cm with mean value 16.20. Among the three varieties, Akbar showed minimum root length and maximum was in Afgoi which were statistically similar to Golden. Shoot length of Akbar was ranged from 18.35 to 32.90 cm with mean value of 24.91, Afgoi was ranged from 18.33 to 33.25 cm with mean value of 24.51 and Golden was ranged from 17.91 to 27.80 cm with mean value of 22.79 cm. Minimum shoot length was observed in Golden while the other two varieties were higher non-significantly. In untreated (control) seedlings of three maize varieties showed different behavior with respect to root and shoot length in which the Golden variety indicated highest root length followed by Afgoi and Akbar but shoot length was highest in Akbar followed by Afgoi and Golden (Fig. 1b & c). Whereas, the 50% concentration of *Chenopodium album revealed* water extract showed allelopathic effect in a contradictory way i.e. stimulated root length in Akbar variety but suppressed root length of Afgoi followed by Golden. In contrast, the shoot length of Akbar was reduced followed by Golden but the shoot length of Afgoi was not affected at 50% concentration. The water extract of *Chenopodium album* at 100% concentration indicated stimulatory effect on root length of Afgoi but decreased the root length of Golden substantially followed by Akbar. Whereas, shoot length of Golden was increased at 100% concentration but non-significantly decreased shoot length in Afgoi and Akbar variety.

### Stem diameter

Stem diameter of the three maize varieties was not affected by the allelopathic compounds present in the water extract of *Chenopodium album*. So, in Akbar variety the stem diameter was ranged from 0.21 to 0.37 cm with mean value of 0.28 cm, in Afgoi it was ranged from 0.24 to 0.35

cm with mean value of 0.30 cm and in Golden the stem diameter was ranged from 0.23 to 0.35 cm. Root dry weight of three maize varieties was highly affected by the water extract of *Chenopodium album*. The water extract of *Chenopodium album* at various concentrations did not affect stem diameter of maize seedlings except the Akbar variety (Fig. 1d). At 0 % Concentration, the stem diameter of Akbar was higher over Afgoi and Golden, whereas it was reduced at 50 and 100 % concentration non-significantly but the other two varieties (Afgoi & Golden) remain unaffected at these concentrations.

#### Root and Shoot dry weight

The root dry weight of Akbar variety ranged from 0.44 to 1.79 g with mean value of 0.97 g, Afgoi was ranged from 0.18 to 3.26 with mean value of 1.19 g, and Golden was ranged from 0.51 to 2.82 g with mean value of 1.45 g. The minimum root dry weight was indicated in Afgoi and maximum was in Golden. Similarly, shoot dry weight of Akbar was ranged from 0.19-0.78 g with mean value of 0.39 g, Afgoi was ranged from 0.09 to 1.44 with mean value of 0.51 g and Golden was ranged from 0.15 to 1.18 g with mean value of 0.51. The minimum shoot dry weight was noted in Akbar while the other two varieties showed higher shoot dry weight which were statistically alike from each other. The root and shoot dry weight of seedlings of three maize varieties revealed variability at different concentration of *Chenopodium album* water extract (Fig. 1e & f). In untreated (control) seedlings, the maximum root and shoot dry weight was observed in Afgoi variety followed by Golden and minimum was in Akbar. However, at 50% concentration, the root and shoot dry weight of Afgoi variety was highly suppressed followed by Akbar but in case of Golden the root dry weight was less suppressed as compared to shoot dry weight. Whereas, the 100% concentration of *Chenopodium album* water extract indicated different pattern of suppression in root and shoot dry weight of all the three maize varieties which is depicted in Fig. 1e & f. In case of root dry weight, the Afgoi and Golden were suppressed that were statistically at par from each other but the Akbar was reduced to a lesser extent. While, the shoot dry weight of Golden was reduced non-significantly at both 50 and 100% concentration of water extract which were higher as compared to the shoot dry weight of Afgoi and Akbar at both level of *Chenopodium album* water extract. The evaluation of the root and shoot dry weight of the three maize varieties on three levels of water extract of *Chenopodium album* showed that the Afgoi was the most susceptible variety in this regard.

#### Relationship between growth parameters

The Pearson correlation between some growth parameters of three maize varieties as presented in Table 2 revealed that germination percent, root length, shoot length, stem diameter, root and shoot dry weight of Akbar variety were positively and significantly correlated among each other with 'r' value ranging between 0.68 and 0.98 except in case of germination with shoot length and root length with root and shoot dry weight. In case of Afgoi, positive and significant correlations were observed between

germination and root and shoot dry weight, root length and shoot length and stem diameter, shoot length and stem diameter and root and shoot dry weight with 'r' values ranging between 0.85 and 1.00. The correlation trend for Golden was more or less similar to that of Afgoi, except in case of root length and germination which were not only correlated among each other with and r value of 0.94 but with root (r 0.97 and 0.98) and shoot dry weight (r 1.00 and 0.95).

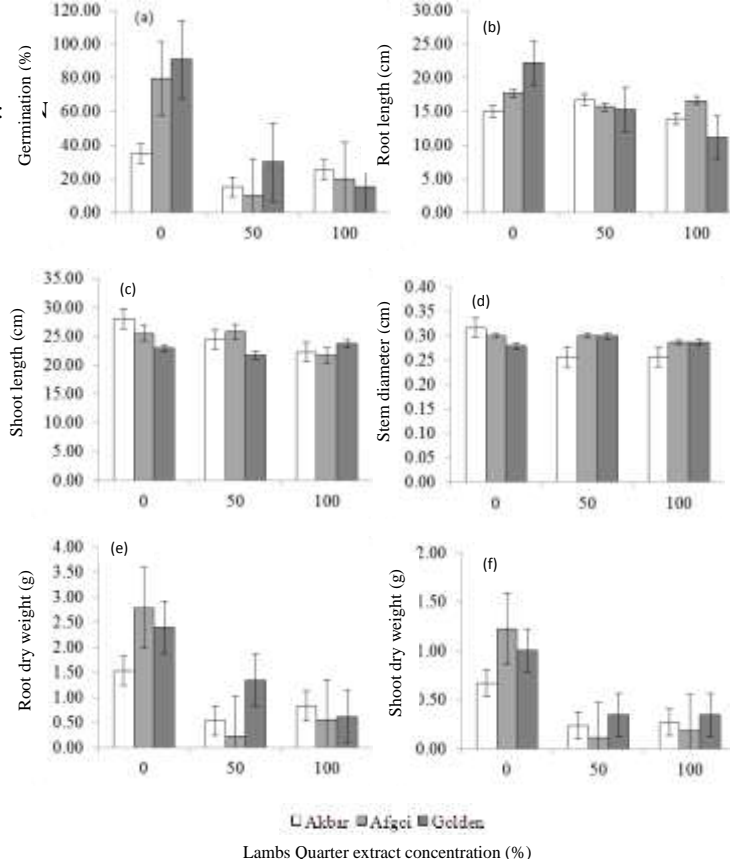
#### DISCUSSION

The allelopathic compounds are present in crop plants as well as in weeds which affect the growth and functionality/physiological activities of the neighboring plants. There are many allelopathic compounds isolated from weeds and crop plants which have the potential of natural herbicides. In light of this potentiality of weeds, the present study was conducted in laboratory to investigate the allelopathic effect of lambs quarters' water extract on growth of three maize seedlings. [15] reported that for the identification of plants species having the potential of allelopathy, the tool of chemical ecology can be used for extracting allelochemicals. In this study, the germination of all three maize varieties (Akbar, Afgoi and Golden) was affected by the allelopathic effect of lambs quarter's water extract. This suppression of germination might be due to the attack of allelochemicals in lambs quarter's water extract on growth initiating enzymes/stimulating hormones of maize seeds during germination. Similar reason of suppression by allelochemicals was reported by [16] that the target sites of the allelopathic compounds are specific. Other scientists like [17], [18] and [19] also indicated that the weeds and its various parts such as roots, stem, leaves and flower have different allelopathic effect on germination of crops and affect different growth parameters particularly the initial growth of crops. The allelopathic effect of lambs quarter's water extract on shoot length of all three maize varieties was non-significant but the root length was affected significantly. There might be a stimulatory and/or inhibitory effect of lambs quarter water extract. The stimulatory effect might be due to the increased rate of cell division (mitosis) and the inhibitory effect might be due to the reduction in cell division. So, the inhibitory effect of lambs quarter's water extract on root length is clearly depicted and it could be the decreased rate of cell divisions (mitosis). This hypothesis of reduction in mitosis due to the allelochemicals is also supported by the idea of [20] who reported that some plants oriented compounds might be responsible for suppressing the mitosis in plant. This result is also in agreement with the findings of [21] who indicated that the aqueous extracts of lambs quarter has less effect on maize seedling height. The reduction in root length by the effect of lambs quarter's water extract under this study was might be attributed to the change in pH and/or might be due to the increase in salt concentration of the growth medium which was added through aqueous extract of lambs quarter. Similar results were also reported by [22] and [23] that the allelopathic compound exist in the water extract of

weeds change the osmotic potential of the growth media that might be responsible for reduction in root length. As the germination of three maize varieties were significantly affected by lambs quarter's aqueous extract and the resulted low germination rate may led to the reduction in shoot and root fresh dry weights. Due to high germination percentage in control, dry weight of shoot and root were high. So the net assimilation of photosynthates were might be affected due to allelochemicals in the aqueous extracts of lambs quarter that resulted in reduction of dry weight of shoot and root. The same assumptions were proposed by [10] who studied the lambs quarter water extracts on wheat and reported that allelochemicals in the extracts might be resulted in the reduced photosynthesis which led to shorter plants with reduced spike lengths and lesser number of tiller plant<sup>-1</sup>. The results are also supported by the findings of [24] who investigated the allelopathic effect of lambs quarter water extract on seedlings of wheat and reported that the germination was not affected but root and shoot lengths and its respective dry weight were suppressed significantly. Another scientist, [21] who observed reduction in the dry weight of root and shoot of maize and barley seedlings due to the allelopathic effect of *Chenopodium album* and *Amaranthus spinosus*.but the height of seedlings were not affected. Similarly, [25] demonstrated that the lambs quarter extract contain allelochemicals such as Aldehydes, Alkaloids, Carotenoids, flavonoids, Steroids and Saponin which are responsible for affecting the growth parameters of maize seedlings.

## CONCLUSION

In vitro allelopathic study of *Chenopodium album* water extract on seedling growth of three maize varieties revealed different responses statistically. The germination, root and shoot dry weight of all three varieties (Akbar, Afgoi & Golden) were severely affected by both level of water extract concentration (50 & 100 %) of *Chenopodium album*. Among varieties, the Afgoi showed minimum



germination at 50% while the Golden showed minimum germination at 100% concentration. Stem diameter of only Akbar variety was reduced non-significantly on both concentration but the other two varieties remain unaffected. While, the water extract of Lambsquarter indicated both inhibitory as well stimulatory effect on the

Figure 1. Allelopathic effect of various concentrations of Common Lambs Quarter water-extract on (a) germination, (b) root length, (c) shoot length, (d) stem diameter, (e) root dry weight and (f) shoot dry weight (g) of three maize varieties (n = 3)

the form of screening out different varieties showing resistance against the water extract of this weed and the most resistant variety can be selected as competitive strategy

Table 1. Range, mean, standard deviation and coefficient of variability of some growth parameters of three varieties of maize (n=3).

Growth parameters	Akbar	Afgoi	Golden
Germination (%)	12.33-40.88 24.92±9.49 38.08	8.22-93.44 36.54±33.46 91.56	12.33-100.00 45.29±35.50 78.37
Root length (cm)	11.49-19.62 15.22±2.60 17.11	12.95-20.78 16.69±2.66 15.95	9.21-26.02 16.20±5.46 33.69
Shoot length (cm)	18.35-32.90 24.91±4.55 18.25	18.33-30.25 24.51±4.07 16.61	17.91-27.80 22.79±3.54 15.53
Stem diameter (cm)	0.21-0.37 0.28±0.05 18.57	0.24-0.35 0.30±0.05 15.26	0.23-0.35 0.29±0.04 15.32
Root dry weight (g)	0.44-1.79 0.97±0.47 48.55	0.18-3.26 1.19±1.23 103.61	0.51-2.82 1.45±0.82 56.13

Shoot dry weight (g)	0.19-0.78 0.39±0.22 55.16	0.09-1.44 0.51±0.55 107.61	0.15-1.18 0.51±0.39 76.28
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Table 2. Pearson correlation between some growth parameters of three maize varieties (n = 3).

	Germination (%)	Root length (cm)	Shoot length (cm)	Stem diameter (cm)	Root dry weight (g)
Akbar					
Root length (cm)	0.08 **				
Shoot length (cm)	0.65 <sup>NS</sup>	0.79 **			
Stem diameter (cm)	0.79 **	0.67 *	0.98 **		
Root dry weight (g)	0.97 **	0.09 <sup>NS</sup>	0.68 *	0.79 **	
Shoot dry weight (g)	0.90 **	0.15 <sup>NS</sup>	0.72 *	0.79 **	0.98 **
Afgoi					
Root length (cm)	0.46 <sup>NS</sup>				
Shoot length (cm)	0.28 <sup>NS</sup>	0.85 **			
Stem diameter (cm)	0.22 <sup>NS</sup>	0.93 **	0.96 **		
Root dry weight (g)	1.00 **	0.45 <sup>NS</sup>	0.26 <sup>NS</sup>	0.21 <sup>NS</sup>	
Shoot dry weight (g)	1.00 **	0.43 <sup>NS</sup>	0.28 <sup>NS</sup>	0.21 <sup>NS</sup>	1.00 **
Golden					
Root length (cm)	0.94 **				
Shoot length (cm)	0.14 <sup>NS</sup>	0.38 <sup>NS</sup>			
Stem diameter (cm)	0.03 <sup>NS</sup>	0.36 <sup>NS</sup>	0.91 **		
Root dry weight (g)	0.97 **	0.98 **	0.19 <sup>NS</sup>	0.18 <sup>NS</sup>	
Shoot dry weight (g)	1.00 **	0.95 **	0.17 <sup>NS</sup>	0.07 <sup>NS</sup>	0.97 **

\*\* Significant at 1% probability level

\* Significant at 5% probability level

NS Non-significant

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