Effect of *Chenopodium album* root, shoot, leaf and bud aqueous extracts on physical and biochemical parameters of wheat seedlings

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Abstract
Allelopathy is the type of interaction where two organisms interact with each other in positive or negative manner and are secondary metabolites mediated. Varieties of crops and weeds have been reported to possess allelopathic effect on growth of other plant species. To replace the harsh effect of the fertilizers in the agricultural field, use of the biostimulants is rapidly being used. Plant-biostimulants are substances and materials which can modify physiological processes of plants in a way that they help in growth, development and/or stress tolerance response. So, allelochemicals when applied to the low concentration can have stimulatory effect on growth and development of plants.

Therefore, various aqueous extracts of Chenopodium album plant part are used to investigate its role as stimulatory or inhibitory effect on wheat crop seeds. Aqueous extracts of Chenopodium album at six different concentrations (10 mg/mL, 25 mg/mL, 50 mg/mL and 100 mg/mL, 15 mg/mL and 200 mg/mL along with Control) of leaf, shoot, root and buds of Chenopodium album were tested on wheat seedling. Leaf, shoot, root and bud extract showed best morphological result in varied concentration i.e. 50 mg/mL, 50 mg/mL, 25 mg/mL and 100 mg/mL in all the parameters i.e. shoot length, root length, wet weight and dry weight of root and shoot respectively. Different biochemical parameters were measured like chlorophyll estimation, proline, total dissolve sugar and protein content in selected concentration of extract. Among all the extracts, shoot extract showed the best quality of seeds when biochemical parameters were measured. Results of our study suggest that the effect of weeds was beneficial on wheat crops at lower concentration of extract.

Keywords: Allelopathy, *Chenopodium album*, biostimulants, wheat, morphological parameters, biochemical parameters.

Introduction

India is agricultural based country facing the dilemma of severe scarcity of food, fodder, fuel, fiber etc. One of the most probable reasons is sudden increase in population, less availability of cultivable land, soil fertility and pollution of land, water and air. As a result of this, the productivity of agricultural as well as forest ecosystems has been affected strongly. Despite of all the above mentioned factor the core of deprivation is soil fertility and successful invasion of numerous unusual weeds. Allelochemicals are the secondary metabolites which are not required for metabolism of the allelopathic organism. The biochemical release from the plants is known as allelochemicals. In different parts of the plants, allelochemicals are found in different concentration (leaves, stems, roots, seeds, flowers, buds).

There are several reports that some weed species have allelopathic effects on seeds germination and seedlings growth economically important crop plants.[3,22] Allelochemicals inhibit the growth of some species at certain concentration. It might be possible that the allelochemicals stimulate the growth of same and different species at some other concentration. Allelopathy accounts for beneficiary and detrimental biochemical relations amongst plants.[13,23]

A weed is a plant growing in the 'wrong place' where it is not wanted or where it causes harm. Generally, weeds are grown in crop field, gardens, lawns and parks. In this study we concentrate on weed grown with the crop of Wheat as *Chenopodium album* (Bathua). The effect of weed on crops may be positive or negative. *Chenopodium album* is a common weed of wheat which may release allelochemicals into the soil which may exhibit inhibitory or stimulatory effects on germination and growth of other neighbouring plants. Allelopathic effects of *C. album* on wheat (*T. aestivum*) with reduced germination (%) decreased shoot and root length.[20] Other studies include effecting growth of radish[10], gram[21] and safflower.[25]

This study was undertaken with the aim of evaluating different concentrations of fresh aqueous extracts of *C. album* (prepare from different parts of weed) for their effectiveness on growth and yield of *T. aestivum*, measuring the different physical and biochemical parameters.

Material and Methods

Work plan: Seeds of *Triticum aestivm* (Wheat) variety Raj 4238 were collected from Rajasthan Agriculture Research Institute (RARI), Durgapura, Jaipur, Rajasthan. Seeds were grown in Petri plates with various concentrations of different extracts prepared from weed. After this, different morphological and biochemical parameters were measured. Different physical parameters were measured like root length, shoot length, root fresh weight, shoot fresh weight,

root dry weight and shoot dry weight. After that appropriate concentration of weed extract was selected and wheat seedlings were grown in that for the measurement of various biochemical parameters like chlorophyll estimation, proline estimation, total sugar estimation, protein estimation by Bradford's method.

Preparation of weed Extracts: *Chenopodium album* weed was chosen because availability of this weed was easy and grown with wheat seeds. Plants of *Chenopodium album* was collected from fields nearby. Different parts of *C. album* were separated. Plant material (leaves, roots, stems, buds) were washed three times with distilled water and then transferred in a beaker containing $HgCl_2$ and left for 0-30 sec. After that plant material was again washed 3-4 times with distilled water. Plant material was spread on blotting paper and was left for 10-15 days for drying. After drying, different parts of plant were crushed separately in mortar and pestle and stored and autoclaved. To prepare the extract, 1gm powder of plant material was soaked overnight in 100ml of autoclaved distilled water. During this soaking, the plant metabolites released in distilled water and stored at 4°C.

Preparation of Petri plates: Filter papers were cut in the shape of Petri plates. One filter paper was placed in the Petri plate and then a thin layer of cotton and then again one filter paper placed on cotton due to which a sandwich of filter paper and cotton was prepared. These Petri plates were autoclaved at 121°C at 15 psi for 15 min. After autoclaving, these Petri plates were placed in hot air oven at 45°C for 2 hours.

Sterilization of seeds: Sterilization of seeds was done under laminar air flow, then wheat seeds were washed 3-4 times with autoclaved distilled water, then washed with $HgCl_2$ for 0-30 sec and then again washed with autoclaved hood opened distilled water 3-4 times and without storing, seeds were plated in autoclaved Petri plates as mentioned above.

Seed Germination Test: The seed germination of test species was carried out in Petri plates with 3 biological replicates of each concentration and 3 replicates of control (Distilled water). Ten seeds of test species are kept in all replicates of control and treatments. Six concentrations of extract were prepared as 10mg, 25 mg, 50 mg, 100 mg, 150 mg and 200 mg. Extracts were diluted with autoclaved distilled water and 10ml of diluted extract of each concentration was added in each replicate of different concentration while control was treated with distilled water. These Petri plates were wrapped in aluminium foil and incubated in dark for two days at an average room temperature of 25-27°C.

After two days, these Petri plates were placed in plant tissue culture racks under 16 hours of photoperiod. The results of root length, shoot length, seedling length, wet weight and dry weight of both roots and shoots were calculated after 7 days of transfer to plant tissue culture racks. Observation was done for the better growth of seedlings as compared to control of all the extracts in all the concentration being studied. With that selected concentrations, different biochemical parameters were measured for all the extracts of *C. album.*

Chlorophyll estimation: Chlorophyll estimation was made according to Arnon.[2] Leaf sample was crushed with 80% acetone with the help of mortar and pestle, then the solution was incubated in water bath for 15 min. at 60 C^0, after that the solution was centrifuged at 5000 rpm for 5 minutes. Absorbance was recorded at 645nm (Chl a), 663nm (Chl b) and 663nm and 645 (Cartenoids). The levels of chlorophyll 'a' and chlorophyll 'b' were determined using the equation given below:

Chlorophyll 'a' (μ/g/ml) = (12.7 x O.D. at 663 nm) – (2.69 x O.D. at 645 nm)
Chlorophyll 'b' (μ/g/ml) = (22.9 x O.D. at 645 nm) - (4.08 x O.D. at 663 nm)

The cartenoids content was calculated using the following equation of Kirk and Allen[19].

$$C = (A_{480} + (0.114 \times A_{663}) - (0.638 \times A_{645})) \times V / 1000xW$$

where c is total caretenoids, A is absorbance at given wavelength, v is volume in mL of acetone and W is weight of tissue in gms.

Protein Estimation: Protein estimation was done according to Bradford's method.[5] Bradford's Reagent was prepared first: 0.01g G-250 in 5 ml ethanol+8.5 mL ortho-phosphoric acid + 87.5 ml distilled water. Standard solution of Bovine Serum Albumin (BSA) was prepared for preparing the standard graph. Protein estimation was carried out using the following steps: 0.1 ml of sample solution was taken and 0.9 ml of 0.1M Na-P buffer was added to it. Appropriate aliquots of BSA solution were pipette out. Blank was prepared for calibration. 5 ml Bradford reagent was added in each tube. Absorbance was recorded at 595 nm. Protein concentration was determined using a standard curve of Bovine Serum Albumin (BSA) by using the following equation:

$y = 1.073x – 0.068;$

where y is absorbance recorded of the sample and x is protein concentration in mg/ml.

Sugar Estimation: Sugar estimation was done according to Dubois method.[12] 1 ml of plant extract was taken in test tube and 3 ml of 96% H_2SO_4 was added to it, after that 1 ml of 5% phenol was added in it. The solution was mixed and was kept in water bath for 20 min at 25-30^{0}C. Absorbance was taken at 490nm. Blank was prepared using 1 ml D.W+ 3ml 96% H_2SO_4+1 ml phenol. Total concentration of sugar was determined by using the equation from the standard curve:

$y = 0.033x - 0.003$

where y is absorbance recorded of the sample and x is sugar concentration in mg/ml.

Proline Estimation: Proline estimation was done according to Bates et al.[4] 0.5g of plant material was extracted by homogenizing in 10 ml of 3% aqueous sulphosylic acid. The homogenous was filtered. 2 ml of filtrate was taken in a test tube. 2ml of glacial acetic acid and 2 ml of ninhydrin were added into it. The solution was heated in the boiling water bath for 1 hr. The reaction was terminated by placing the tube in ice bath. 4 ml of toluene was added to the reaction mixture and was stirred well for 20-30 sec. The toluene layer was separated and was warmed at the room temperature. The red colour intensity was measured at 520nm. Amount of proline in the test sample was calculated from the standard curve by using the following equation: Proline = [(µg proline/mL × mL toluene)]/ [115.5 µg/umole]/ [(g sample/5].

Results and Discussion

Morphological analysis: Different concentrations of extracts of leaf, root, shoot and bud of *C. album* reduced root length, shoot length, seedling length, no. of roots, fresh and dry weight of roots and shoots especially at higher concentrations. However, concentrations i.e. 50mg/ml and 100 mg/ml had stimulatory effects on all these parameters (Table 1, 2, 3 and 4).

Table 1
Effect of Leaf extract of *Chenopodium album* on physical parameters of wheat seedlings (mean value of triplicates)

Conc. mg/mL	Root length	Shoot length	Seedling length	Shoot wet wt.	Root wet wt.	Shoot dry wt.	Root dry wt.
Control	2.18	4.34	6.52	0.332	0.148	0.055	0.023
10 mg	3.05	3.7	6.75	0.871	0.341	0.152	0.11
25 mg	2.64	3.69	6.33	0.733	0.471	0.138	0.099
50 mg	2.99	4.92	7.91	0.963	0.568	0.17	0.124
100 mg	2.87	4.09	6.96	0.783	0.379	0.126	0.077
150 mg	3.01	4.89	7.9	0.769	0.558	0.116	0.117
200 mg	2.78	4.4	7.18	0.915	0.623	0.138	0.125

Table 2
Effect of Shoot extract of *Chenopodium album* on physical parameters of wheat seedlings (mean value of triplicates)

Conc. mg/mL	Root length	Shoot length	Seedling length	Shoot wet wt.	Root wet wt.	Shoot dry wt.	Root dry wt.
Control	5.14	7.14	12.28	2.206	1.273	0.373	0.274
10 mg	5.34	7.95	13.29	1.829	0.894	0.315	0.226
25 mg	5.63	8.63	14.26	2.102	1.569	0.364	0.277
50 mg	5.48	9.02	14.5	2.373	1.228	0.396	0.251
100 mg	5.34	7.81	13.15	1.931	1.281	0.352	0.268
150 mg	5.29	8.96	14.25	1.963	0.899	0.387	0.262
200 mg	5.32	8.82	14.14	2.314	1.298	0.387	0.249

Table 3
Effect of Root extract of *Chenopodium album* on physical parameters of wheat seedlings (mean value of triplicates)

Conc. mg/mL	Root length	Shoot length	Seedling length	Shoot wet wt.	Root wet wt.	Shoot dry wt.	Root dry wt.
Control	7.02	9.19	16.21	1.45	1.56	0.245	0.221
10 mg	7.03	9.1	16.13	1.59	1.47	0.303	0.223
25 mg	7.34	9.64	16.98	1.85	1.56	0.275	0.244
50 mg	6.24	9.01	15.25	1.63	1.9	0.3	0.212
100 mg	6.23	8.72	14.95	1.65	1.51	0.295	0.196
150 mg	5.44	7.28	12.72	1.52	1.68	0.252	0.201
200 mg	6.37	8.8	15.17	1.5	1.85	0.244	0.194

Effect of leaf extract on wheat seedlings: The lower concentrations of leaf extract of *C. album* (10-50mg/ml) could effectively improve the growth performance of wheat seedlings. The shoot length, root length, total seedling length, fresh weight and dry weight of root and shoot of wheat seedlings were significantly enhanced by the treatment of leaf extract with a concentration lower than 50 mg/ml (Table 1). The maximal shoot length (4.92 cm, fig. 1b), total seedling length (7.91 cm, fig. 1c), fresh weight of shoot (0.963 g/30 seedlings, fig. 1d), dry weight of shoots (0.17g/30 seedlings, fig. 1e) were increased by 0.58 cm, 1.39 cm, 0.631 g and 0.115 g under the treatment of 50 mg/ml of leaf extract compared with the control. The optimal value of the root length (3.05 cm, fig. 1a), fresh weight of roots (0.623 gm/30 seedlings, fig. 1d) and dry weight of roots (0.125 g/30 seedlings, fig. 1e) was obtained in the treatment of 10 mg/ml of leaf extract which increased by 0.87 cm, 0.475 gm and 0.102 gm compared with the control.

Table 4
Effect of Bud extract of *Chenopodium album* on physical parameters of wheat seedlings (mean value of triplicates)

Conc. mg/mL	Root length	Shoot length	Seedling length	Shoot wet wt.	Root wet wt.	Shoot dry wt.	Root dry wt.
Control	4.87	7.96	12.43	1.219	1.439	0.246	0.267
10 mg	5.48	6.38	11.86	1.514	1.417	0.24	0.246
25 mg	6.25	6.41	12.66	2.195	1.618	0.395	0.253
50 mg	6.12	6.8	12.92	1.643	1.755	0.314	0.278
100 mg	7.71	8.95	16.66	1.743	2.72	0.292	0.369
150 mg	4.99	7.89	12.88	1.726	1.18	0.314	0.279
200 mg	5.21	7.55	12.76	1.876	1.712	0.338	0.241

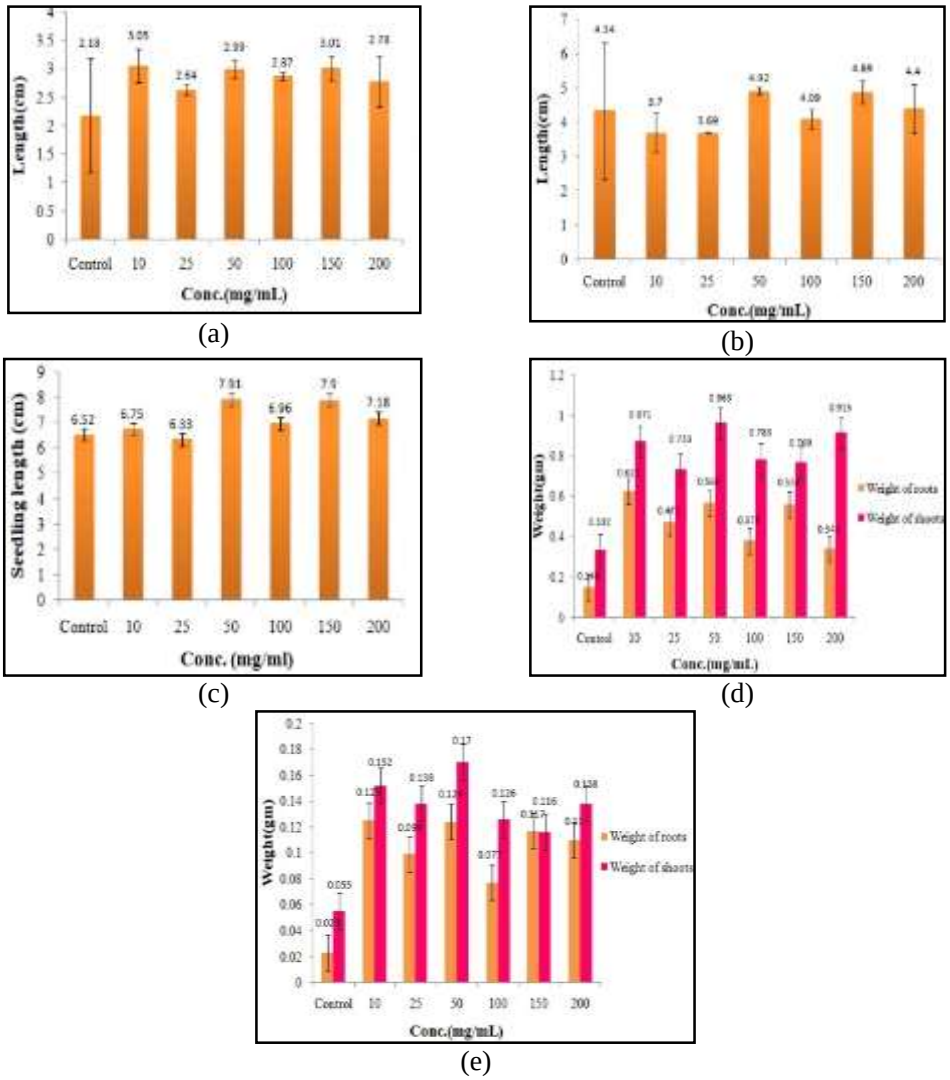

Figure 1: Effects of leaf extract on (a) root length, (b) shoot length, (c) seedling length, (d) fresh weight of roots and shoots and (e) dry weight of roots and shoots of wheat seedlings. Values are mean ± SD (n = 30 seedlings).

Effect of shoot extract on wheat seedlings: The maximal root length (5.63 cm, fig. 2a), root wet weight (1.569 gm/30 seedlings, fig. 2d), root dry weight (0.277 gm/30 seedlings, fig. 2e), were obtained in 25 mg/mL which increased by 0.49 cm,0.296 gm and 0.003 gm correspondingly. The optimal shoot length (9.02 cm, fig.2b), seedling length (14.5 cm, fig. 2c) fresh weight of shoot (2.373 gm/30 seedlings, fig. 2d) and shoot dry weight (0.396 gm/30 seedlings, fig. 2e) were obtained in the treatment of 50 mg/ml extract of *C. album* which increased by 1.88 cm, 2.22 cm, 0.167 gm and 0.023 gm correspondingly.

Effect of root extract on wheat seedlings: The lower concentrations of root extract of *C. album* (10-25 mg/ml) could effectively improve the growth performance of wheat seedlings. The shoot length, root length, total seedling length, fresh weight and dry weight of root and shoot of wheat seedlings were significantly enhanced by the treatment of leaf extract with a concentration lower than 25 mg/ml (Table 3). The maximal root length (7.34 cm, fig. 3a), shoot length (9.64 cm, fig. 3b), total seedling length (16.98 cm, fig. 3c), fresh weight of shoot (1.85 gm/30 seedlings, fig. 3d), dry weight of roots (0.244 gm/30 seedlings, fig. 3e) were increased by 0.32 cm, 0.45 cm, 0.77 cm, 0.4 gm and 0.023 gm under the treatment of 25 mg/ml of root extract compared with the control.

The optimal fresh weight of root (1.9 gm/30 seedlings, fig. 3d) was obtained in the treatment of 50 mg/ml of root extract and dry weight of shoot (0.303 gm/30 seedlings, fig. 3e) was obtained in the treatment of 10 mg/ml, which increased by 0.34 gm and 0.058 gm when compared with the control.

Effect of bud extract on wheat seedlings: The maximal shoot wet weight (2.195 gm/30 seedlings, fig. 4d), shoot dry weight (0.395 gm, /30 seedlings fig. 4e) and total seedling length (16.66 cm, fig. 4c) were obtained in 25 mg/mL, which got increased by 0.976 gm, 0.149 gm, 4.23 cm when compared to the control respectively. The optimal root length (7.71 cm, fig. 4a), shoot length (8.95 cm, fig. 4b), fresh weight of roots (2.72 gm/30 seedlings, fig. 4d) and dry weight of roots (0.369 gm/30 seedlings, fig. 4e) were found in 100 mg/mL extract of *C. album*, which got increased by 2.84 cm, 0.99 cm, 1.281 gm and 0.102 gm correspondingly.

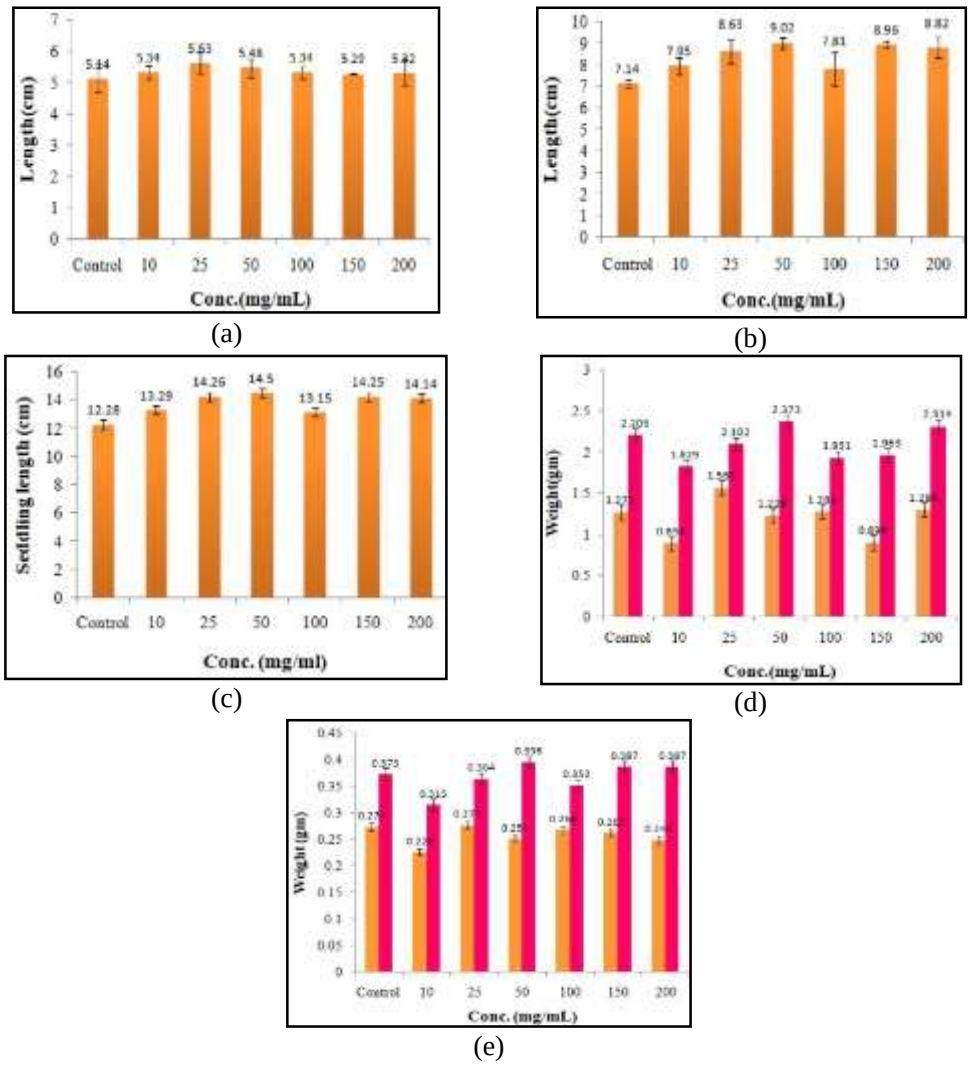

Figure 2: Effects shoot extract on (a) root length, (b) shoot length, (c) seedling length, (d) fresh weight of roots and shoots and (e) dry weight of roots and shoots of wheat seedlings. Values are mean ± SD (n = 30 seedlings).

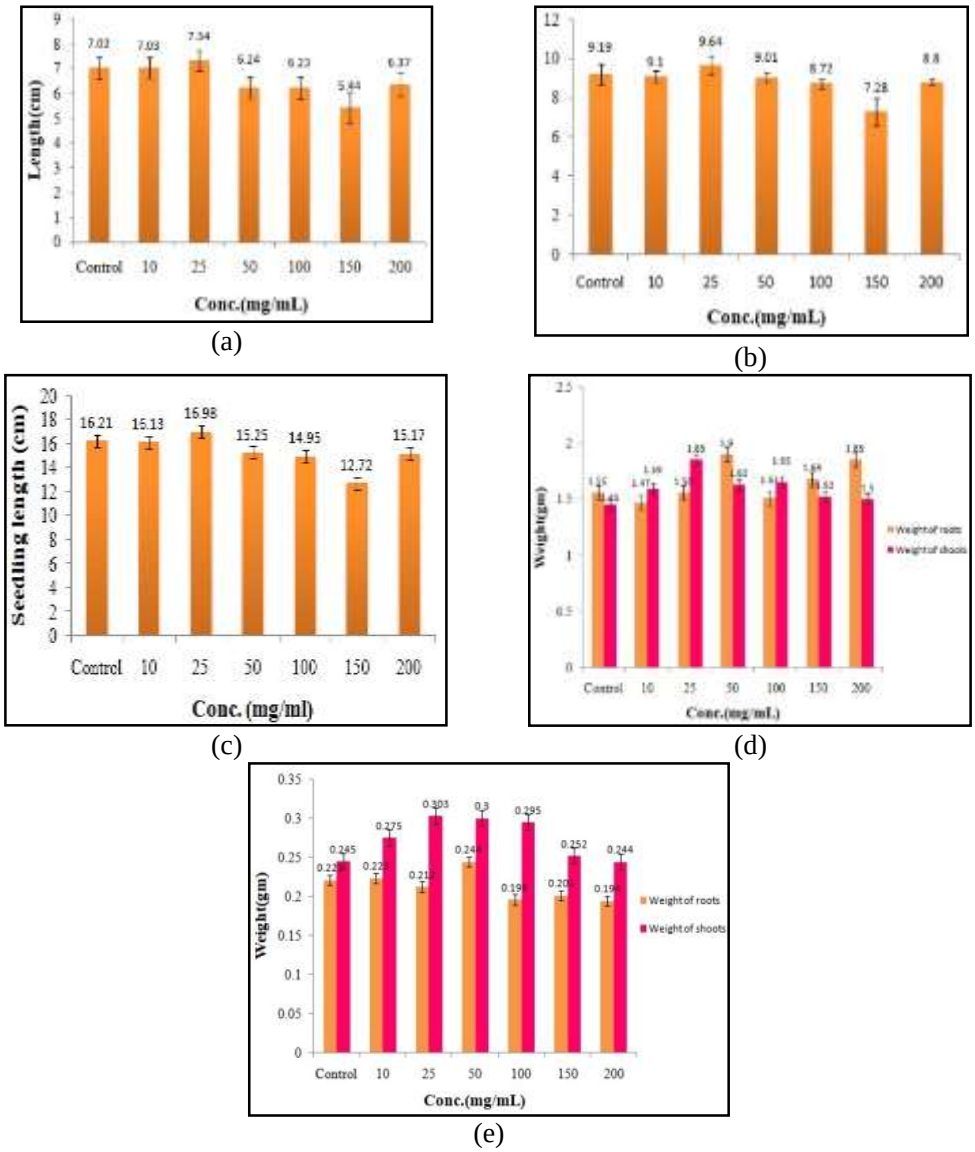

Figure 3: Effects root extract on (a) root length, (b) shoot length, (c) seedling length, (d) fresh weight of roots and shoots and (e) dry weight of roots and shoots of wheat seedlings. Values are mean ± SD (n = 30 seedlings)

Biochemical analysis: The biochemical analysis of the extract of *C. album* (leaf, shoot, root, bud), chlorophyll estimation, total soluble sugar estimation, protein estimation and proline estimation was carried out as mentioned earlier. In this study, along with the control, two concentrations were selected for performing biochemical analysis, one is where we get a better performance in physical parameter as concluded with the results of physical parameters and another is the highest concentration taken in this study that is 200mg/ml.

Effect of leaf extract on wheat seedlings: Concentration selected of leaf extract to perform different biochemical parameters was 50 mg/mL because at this concentration, best morphological results were obtained. Chlorophyll content in wheat seedlings was found to be highest in 50 mg/ml as compared to the control and 200 mg/mL. Content of chl a, chl b and carotenoid in 50 mg/ml was 0.137 mg/ml, 0.075 mg/ml and 0.045 mg/ml (fig. 5a) respectively.

The increased chlorophylls in treated plants indicate that application of *C. album* could decrease chlorophylls degradation and delay plant senescence. Leaf extract does not show any considerable effect on the proline, sugar and protein content as it is highest in control as compared to the other concentration used i.e. 50 mg/ml and 200 mg/ml but the content of all 3 is higher when compared to only 200 mg/ml, therefore, at higher concentrations, the quality of seed is getting inhibited and leaf is not showing any remarkable effect.

Effect of shoot extract on wheat seedlings: Concentration selected for shoot extract to perform different biochemical parameters was 50 mg/mL because at this concentration, best morphological results were obtained. Chlorophyll content in wheat seedlings was found to be highest in 50 mg/ml as compared to the control and 200 mg/mL. Content of chl a, chl b and carotenoid in 50 mg/ml was 0.093 mg/ml, 0.103 mg/ml and 0.035 mg/ml (fig. 6a) respectively.

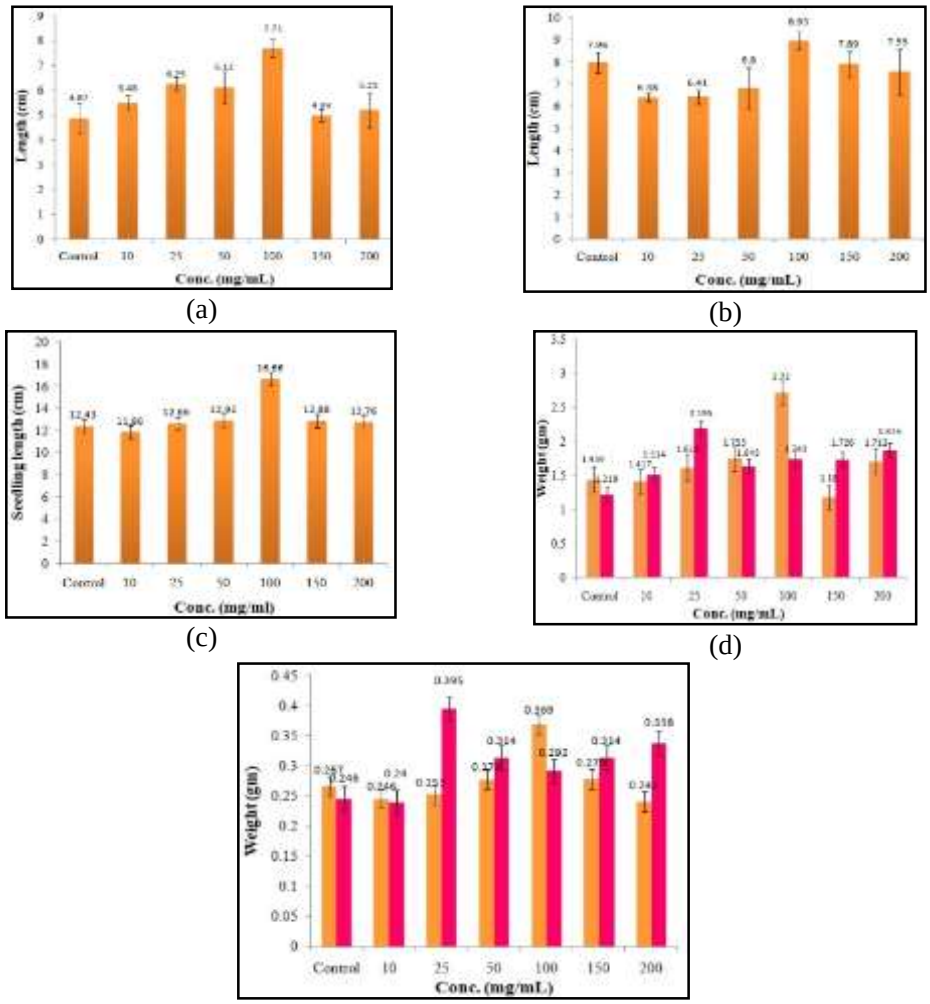

Figure 4: Effects root extract on (a) root length, (b) shoot length, (c) seedling length, (d) fresh weight of roots and shoots and (e) dry weight of roots and shoots of wheat seedlings. Values are mean ± SD (n = 30 seedlings).

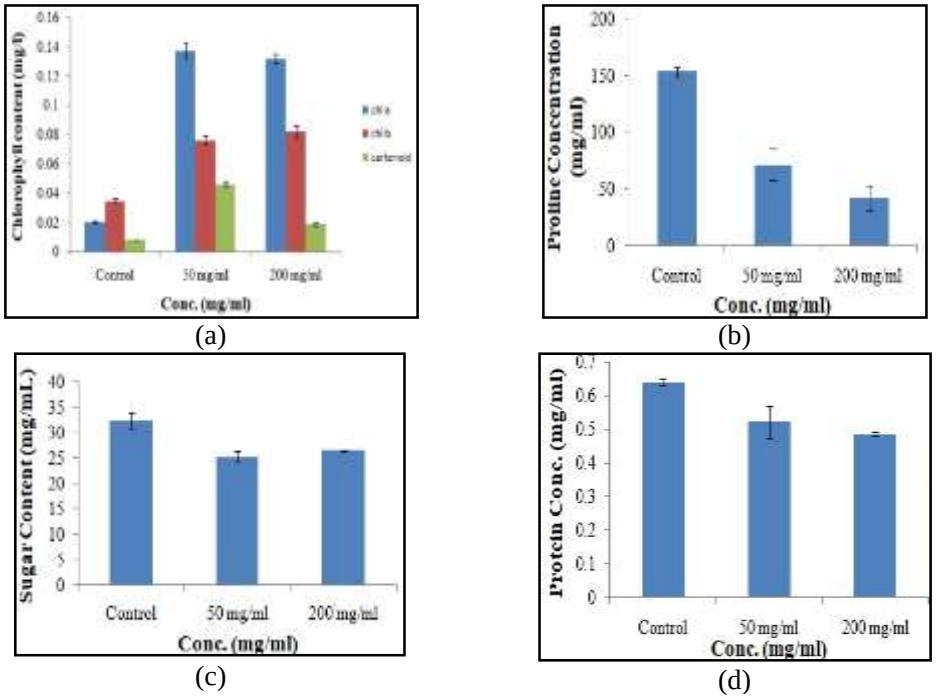

Figure 5: Effects of leaf extract of *C. album* on (a) chlorophyll content, (b) Proline, (c) soluble sugar and (d) soluble protein contents in wheat seedlings

The increased chlorophylls in treated plants indicate that application of *C. album* could decrease chlorophylls degradation and delay plant senescence. Proline concentration also gets increased in 50 mg/mL of shoot extract i.e. 138.33 mg/mL (fig. 6b) as compared to control and 200 mg/mL. Increased proline concentration generally protects the plant from different kind of stress. Sugar concentration also gets increased in the selected concentration of shoot extract of *C. album* i.e. 50 mg/mL. The amount of total dissolved sugar present in this was 14.9 mg/mL (fig. 6c) which got increased when compared to control and 200 mg/mL.

Sugar is mainly the essential component of plant nutrition found during photosynthesis and its amount gets decreased as it is highly sensitive to environmental stress. Protein concentration also gets increased in 50 mg/mL i.e. 1.22 mg/mL (fig. 6d) as compared to control and 200 mg/mL. Protein concentration in plants gets decreased due to the inhibition of incorporation of amino acids caused due to stress. Protein content also increases due to activity of genes involved in various enzymatic activities.

Effect of root extract on wheat seedlings: Concentration selected of root extract to perform different biochemical parameters was 25 mg/mL because at this concentration, best morphological results were obtained.

Chlorophyll content in wheat seedlings in case of root extract somewhat shows different amount of chl a, chl b and carotenoid when compared to control, 25 mg/mL and 200 mg/mL. Content of chl a, chl b and carotenoid in 25 mg/ml was 0.008 mg/ml, 0.153 mg/ml and 0.022 mg/ml (fig. 7a) respectively. Amount of chl a and carotenoid got decreased when compared to control and 200 mg/ml whereas the amount of chl b gets increased. Proline concentration was found to be approximately equal in control and 25 mg/mL of shoot extract i.e. 561.66 mg/mL (fig. 7b) but it gets rapidly decreased in 200 mg/mL of concentration. Increased proline concentration generally protects the plants from different kinds of stress. Sugar concentration gets increased in the selected concentration of root extract of *C. album* i.e. 25 mg/mL. The amount of total dissolved sugar present in was 35.62 mg/mL (fig. 7c) which got increased when compared to control and 200 mg/mL.

Sugar is mainly the essential component of plant nutrition found during photosynthesis and its amount gets decreased as it is highly sensitive to environmental stress. Protein concentration also gets increased in 25 mg/mL i.e. 0.112 mg/mL (fig. 7d) as compared to control and 200 mg/mL. Protein concentration in plants gets decreased due to the inhibition of incorporation of amino acids caused due to water stress. Protein content also gets decreased due to nitrate reductase activity.

Effect of bud extract on wheat seedlings: Concentration selected of bud extract to perform different biochemical parameters was 100 mg/mL because at this concentration, best morphological results were obtained. Chlorophyll content in wheat seedlings was found to be highest in 100 mg/ml as compared to the control and 200 mg/mL. Content of chl a, chl b and carotenoid in 100 mg/ml was 0.129 mg/ml, 0.134 mg/ml and 0.04 mg/ml (fig. 8a) respectively. The increased chlorophylls in treated plants indicate that application of *C. album* could decrease chlorophylls degradation and delay plant senescence. Proline concentration also gets increased in 100 mg/mL of bud extract i.e. 442.16 mg/mL (fig. 8b) as compared to control and 200 mg/mL. Increased proline concentration generally protects the plant from different kinds of stress.

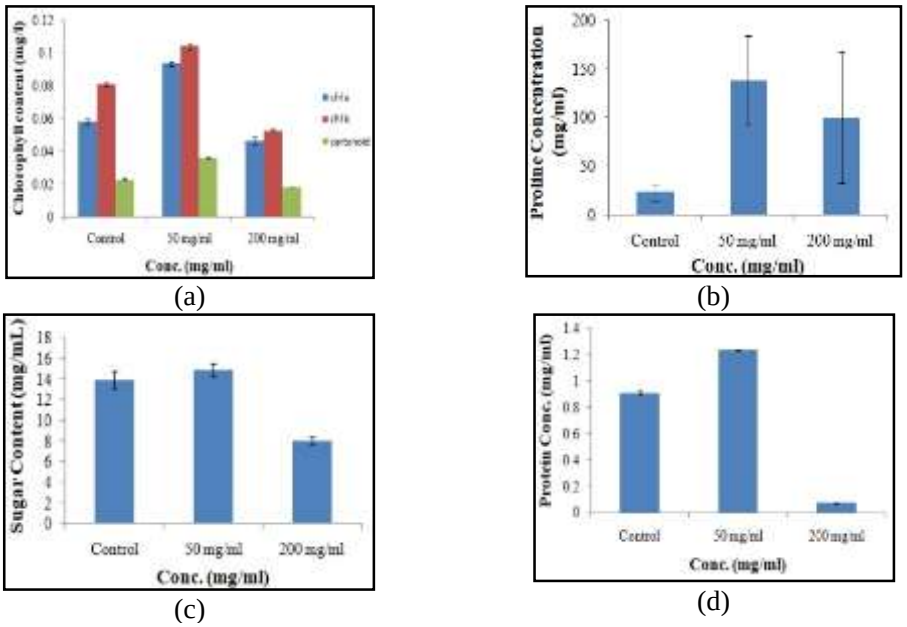

Figure 6: Effects of shoot extract of *C. album* on (a) chlorophyll content, (b) Proline, (c) soluble sugar and (d) soluble protein contents in wheat seedlings.

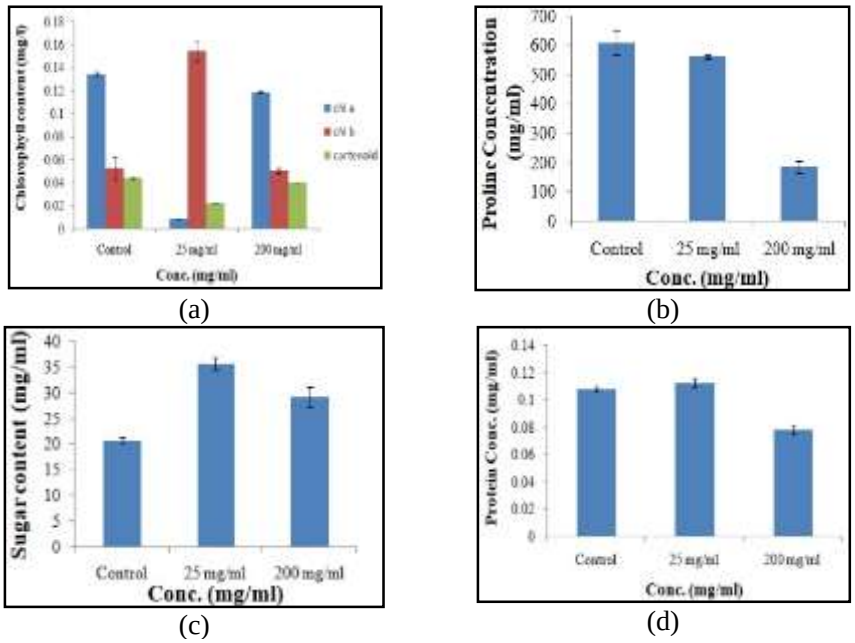

Figure 7: Effects of root extract of *C. album* on (a) chlorophyll content, (b) Proline, (c) soluble sugar and (d) soluble protein contents in wheat seedlings

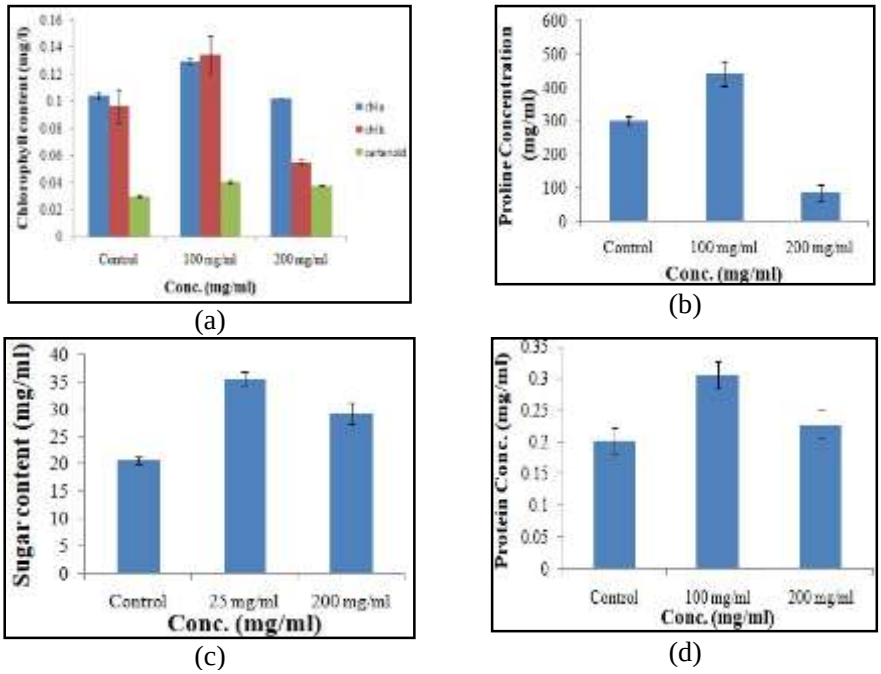

Figure 8: Effects of bud extract of *C. album* on (a) chlorophyll content, (b) Proline, (c) soluble sugar and (d) soluble protein contents in wheat seedlings

Sugar concentration was found to be almost similar in control and 100 mg/mL i.e. 40.09 mg/mL (fig. 8c) but gets increased in 200 mg/ml of concentration as compared to control and 100 mg/mL concentration of bud extract of *C. album*. Sugar is mainly the essential component of plant nutrition found during photosynthesis and its amount gets decreased as it is highly sensitive to environmental stress. Protein concentration also gets increased in 100 mg/mL i.e. 0.305 mg/mL (fig. 8d) as compared to control and 200 mg/mL. Protein concentration in plants gets decreased due to the inhibition of incorporation of amino acids caused due to water stress.

Conclusion

The experiment was conducted on wheat because it is the main cereal crop in India. Rajasthan is one of the major producers of wheat in India.[24]*Chenopodium album* was selected as weed to see allelopathic effects on wheat crops[20] as it is easily found in Rajasthan and grown with wheat crop.[8] Extracts of different parts of weed show positive effect on wheat seeds (root length, shoot length, seedling length, wet weight, dry weight). In other study done with sea weed *Ascophyllum nodosum* has proved to be growth stimulator and helps in defence from disease in tomato and sweet pepper plants.[1]

After the observation of results of physical parameters, different concentration of four extracts were chosen for biochemical parameters. The overall result was concluded on the basis of several experiments that the extracts of different parts of weed show positive effect on wheat crops. It has been shown in other studies too that plant extracts when applied in lower concentration show stimulatory effect.[6,11] Other studies have also proven that these plant extracts can be helpful on stress tolerance like work done on algal weed *Ulva lactuca* helps in salt stress tolerance of wheat.[15,16] Other than sea weeds, the allelopathic extracts have proven to be beneficial for wheat.[14] Moringa plant extracts have same effect on wheat in salt stressed condition when applied exogeneously.[26]

Lettuce also has been studied as a allelopathic agent in one study.[9] In future, these *C. album* concentrations can be studied on abiotic stressed plants and these formulations can be used by standardizing the methods on large scale.[7,17,18] This will help in reducing the weeds invasion as well as using the weeds for the crop production; together it can be step forward for sustainable environment development.

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References

1. Ali O., Ramsubhag A. and Jayaraman J., Biostimulatory activities of Ascophyllum nodosum extract in tomato and sweet pepper crops in a tropical environment, *PloS One*, **14(5)**, e0216710 **(2019)**

2. Arnon D.I., Copper enzymes in isolated chloroplasts. Polyphenoloxidase in Beta vulgaris, *Plant Physiology*, **24(1)**, 1-15 (**1949)**

3. Azirak S. and Karaman S., Allelopathic effect of some essential oils and components on germination of weed species, *Acta Agriculturae Scandinavica Section B-Soil and Plant Science*, **58(1)**, 88-92 **(2008)**

4. Bates L.S., Waldren R.P. and Teare I.D., Rapid determination of free proline for water-stress studies, *Plant and Soil*, **39(1)**, 205-207 **(1973)**

5. Bradford M.M., A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding, *Analytical Biochemistry*, **72(1-2)**, 248-254 **(1976)**

6. Bulgari R., Morgutti S., Cocetta G., Negrini N., Farris S., Calcante A., Spinardi A., Ferrari E., Mignani I., Oberti R. and Ferrante A., Evaluation of borage extracts as potential biostimulant using a phenomic, agronomic, physiological and biochemical approach, *Frontiers in Plant Science*, **8**, 935 **(2017)**

7. Calvo P., Nelson L. and Kloepper J.W., Agricultural uses of plant biostimulants, *Plant and Soil*, **383(1-2)**, 3-41 **(2014)**

8. Chhokar R.S., Sharma R.K. and Sharma I., Weed management strategies in wheat-A review, *Journal of Wheat Research*, **4(2)**, 1-21 **(2012)**

9. Chon S.U., Jang H.G., Kim D.K., Kim Y.M., Boo H.O. and Kim Y.J., Allelopathic potential in lettuce (Lactuca sativa L.) plants, *Scientia Horticulturae*, **106(3)**, 309-317 **(2005)**

10. Daizy R., Harminder P.S., Nipunika R. and Ravinder K.K., Assessment of allelopathic interference of Chenopodium album through its leachates, debris extracts rhizophere and amended soil, *Arch. Agron. Soil Sci*, **52**, 705-715 **(2006)**

11. Du Jardin P., Plant biostimulants: definition, concept, main categories and regulation, *Scientia Horticulturae*, **196**, 3-14 **(2015)**

12. Dubois M., Gilles K.A., Hamilton J.K., Rebers P.T. and Smith F., Colorimetric method for determination of sugars and related substances, *Analytical Chemistry*, **28(3)**, 350-356 **(1956)**

13. Duke S.O., Ecophysiological aspects of allelopathy, *Planta*, **217(4)**, 529-539 **(2003)**

14. Farooq M., Nadeem F., Arfat M.Y., Nabeel M., Musadaq S., Cheema S.A. and Nawaz A., Exogenous application of allelopathic water extracts helps improving tolerance against terminal heat and drought stresses in bread wheat (Triticum aestivum L. Em. Thell.), *Journal of Agronomy and Crop Science*, **204(3)**, 298-312 **(2018)**

15. Hernández-Herrera R.M., Santacruz-Ruvalcaba F., Ruiz-López M.A., Norrie J. and Hernández-Carmona G., Effect of liquid seaweed extracts on growth of tomato seedlings (Solanum lycopersicum L.), *Journal of Applied Phycology*, **26(1)**, 619-628 **(2014)**

16. Ibrahim W.M., Ali R.M., Hemida K.A. and Sayed M.A., Role of Ulva lactuca extract in alleviation of salinity stress on wheat seedlings, *The Scientific World Journal*, DOI:10.1155/2014/847290 **(2014)**

17. Iqbal J., Karim F. and Hussain S., Response of wheat crop (Triticum aestivum L.) and its weeds to allelopathic crop water extracts in combination with reduced herbicide rates, *Pak. J. Agri. Sci*, **47(3)**, 309-316 **(2010)**

18. Khanh T.D., Chung M.I., Xuan T.D. and Tawata S., The exploitation of crop allelopathy in sustainable agricultural production, *Journal of Agronomy and Crop Science*, **191(3)**, 172-184 **(2005)**

19. Kirk J.T.O. and Allen R.L., Dependence of total carotenoids and chlorophyll "a" and "b" of leaf extracts in different solvents, *Biochemical Society Transactions*, **603**, 591 **(1965)**

20. Majeed A., Chaudhry Z. and Muhammad Z., Allelopathic assessment of fresh aqueous extracts of Chenopodium album L. for growth and yield of wheat (Triticum aestivum L.), *Pak. J. Bot*, **44(1)**, 165-167 **(2012)**

21. Mandal A., Tarai P., Kaushik S.K., Mahata A.C. and Chakarborti P., Allelopathic action of Rauwolfia tetraphylla L. root extracts on gram (Cicer arietinum L.) seeds, *Journal of Crop and Weed*, **9(2)**, 72-75 **(2013)**

22. Marinov-Serafimov P., Dimitrova T. and Golubinova I., Allelopathy: Element of an overall strategy for weed control, *Acta Agriculturae Serbica*, **18(35)**, 23-37 **(2013)**

23. Mushtaq W. and Siddiqui M.B., Allelopathy Studies in Weed Science in India——A Review, *International Journal of Natural Research Ecology and Management*, **2(6)**, 99-103 **(2017)**

24. Ramdas S., Singh R. and Sharma I., Exploring the performance of wheat production in India, *Journal of Wheat Research*, **4(2)**, 37-44 **(2012)**

25. Rezaie F. and Yarnia M., Allelopathic effects of Chenopodium album, Amaranthus retroflexus and Cynodon dactylon on germination and growth of safflower, *Journal of Food, Agriculture and Environment*, **7(2)**, 516-521 **(2009)**

26. Yasmeen A., Basra S.M.A., Farooq M., ur Rehman H. and Hussain N., Exogenous application of moringa leaf extract modulates the antioxidant enzyme system to improve wheat performance under saline conditions, *Plant Growth Regulation*, **69(3)**, 225-233 **(2013)**.

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