Allelopathic Influences of Celosia argentea L. on Carbohydrate Metabolism in Germinating Seeds of Vigna radiata L.

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Abstract:

Celosia argentea L., dominant weed reported from crop field in Islampur of Sangli district of Maharashtra, India. It has been evaluated for its allelopathic potentiality against green gram (Vigna radiata L.). The laboratory experiments were conducted to assess carbohydrates during seed germination of green gram after treating with different concentrations (1, 2, 5, 10 and 20%) of stem, leaf and inflorescence aqueous leachates of C. argentea separately. This study revealed that the sugar and starch content in germinating seeds of green gram was inhibited under the treatment of aqueous inflorescence and leaf leachates of C. argentea. However, 1, 2 and 5% root leachates recorded the total sugar (0.712, 0.729 and 0.698g.100g–1) and starch (1.984, 1.763 and 1.651g.100g–1) was slightly higher than the control. The activity of enzyme α-amylase was increased after treatment of the aqueous leachates of all plant parts. This study indicated that some allelochemicals are present in aqueous leachates of C. argentea and it imposed on carbohydrates and stimulates the activity of α-amylase.

Keywords: Allelopathy, Allelochemicals, α-amylase, Carbohydrate, Vigna radiata L., Sugar, Starch.

Introduction

Qualitative and quantitative changes were associated with several metabolic pathways during seed germination and seedling growth [1]. Seed germination is linked with degradation and mobilization of stored food molecules for developmental processes [2, 3]. The carbohydrates are one of the utilizes for seedling growth and the synthesis of various metabolic products [4].

Majority of weeds hamper the growth of the main crop through releasing chemical substances called as allelochemicals [5]. These often affect on growth dynamics of the crop [6] cease metabolic processes as photosynthesis, respiration, mineral uptake [7], fluctuation in carbohydrate contents [8] through allelopathic mechanism [9]. Allelopathy signifies either negatively or positive interactions between the plants results into inhibitory or stimulatory effect on adjacent plants.

Green gram (Vigna radiata L., family Leguminosae, subfamily Fabaceae), multipurpose crop and survive under dry conditions. It occupies a prominent position in regular diet due to its protein content. India produced more than 70% of world requirement of green gram. But its crop fields are affected by many weeds, which C. argentea is one of them. The weed, Celosia argentea L. is an exotic flowering herb belonging to Amaranthaceae predominately interferes in crop field of cereals and legumes [10].

In this connection, the attempt was made to study the influence of aqueous leachates of plant parts of C. argentea L. on carbohydrate content viz. total sugar and starch of green gram. In addition to this, the activity of enzyme α-amylase was also studied.
This endeavor meant for understanding weed crops interactions and open new area for additionally investigation on this foundation.

**Materials and Methods**

**Preparation of aqueous leachates of *C. argentea* plant parts:**

The weed, *C. argentea* was collected from green gram fields of Islampur, Sangli district of Maharashtra, India [17° 15' - 18° 01' N latitude and 74° 12' - 74° 74' E longitude] and washed with tap water to remove dirt and soil particles. The plant parts such as leaves, roots and inflorescence were separated and shade dried for 10 days. Dried parts were powered with the help of grinder and stored in the polythene bag. The leachates were prepared by taking 10g of fine powdered each concentration and incubation period, triplicate sets were arranged and each treatment was poured in 100ml distilled water as pure leachates. Then surface sterilized seeds were soaked for treatments in 1 to 20% concentrations of plant excess of the chemical. Then surface sterilized seeds were rinsed with distilled water for several times to remove such particles.

'Svaibhav' were selected and procured from an authorized shop of Shetkari Sahakari Sangh Pvt. Ltd, Kolhapur. The seeds were surface sterilized with 1% sodium hypo-chloride for 10 min, then rinsed with distilled water for several times to remove excess of the chemical. Then surface sterilized seeds were soaked for treatments in 0% concentration and incubation period, triplicate sets were arranged and placed in the laboratory under normal temperature for germination, for 72h. The analysis of carbohydrates and bioassay for enzyme α-amylase was carried out after 72h of germination.

**Seed treatment with aqueous Leachates:**

Healthy, uniform seeds of green gram variety ‘Vaibhav’ were selected and procured from an authorized shop of Shetkari Sahakari Sangh Pvt. Ltd, Kolhapur. The seeds were surface sterilized with 1% sodium hypo-chloride for 10 min, then rinsed with distilled water for several times to remove excess of the chemical. Then surface sterilized seeds were soaked for treatments in 1 to 20% concentrations of plant leachates for 6h. The seeds soaked in distilled water were used as a control. These treated seeds were placed on wet blotting paper in petri plate (9.0 cm diameter) and covered with a lid. At each concentration and incubation period, triplicate sets were arranged and placed in the laboratory under normal temperature for germination, for 72h. The analysis of carbohydrates and bioassay for enzyme α-amylase was carried out through a modified method of Katsumi and Fukuhara [12].

**Statistical analysis**

The analysis was carried out in three replicates for all determinations. The mean and standard deviations were calculated. The data were analyzed by one-way analysis variance (ANOVA) multiple comparison procedures of the treatment means was performed by Duncan Multiple Range test. The significance of the differences was defined as P<0.05.

**Results**

The results of this experiment is recorded in table 1 and explained as below.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total Sugar (g.100g⁻¹)</th>
<th>Starch (g.100g⁻¹)</th>
<th>α-Amylase (µg amylopectin hydrolysed min⁻¹.g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.696±0.025d</td>
<td>1.420±0.031cd</td>
<td>0.94 ±0.008 a</td>
</tr>
<tr>
<td>Inflorescence leachates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%</td>
<td>0.260±0.019c</td>
<td>1.361± 0.038 c</td>
<td>1.12±0.026 ab</td>
</tr>
<tr>
<td>2%</td>
<td>0.178±0.013b</td>
<td>0.883±0.012 ab</td>
<td>1.37±0.037 b</td>
</tr>
<tr>
<td>5%</td>
<td>0.156±0.024b</td>
<td>0.678±0.025ab</td>
<td>1.52±0.043 b</td>
</tr>
<tr>
<td>10%</td>
<td>0.120±0.018b</td>
<td>0.545±0.019ab</td>
<td>2.27±0.065 c</td>
</tr>
<tr>
<td>20%</td>
<td>0.090±0.007a</td>
<td>0.357±0.011a</td>
<td>1.97±0.068bc</td>
</tr>
<tr>
<td>Leaf leachates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%</td>
<td>0.370±0.014c</td>
<td>1.242±0.047 c</td>
<td>0.99±0.026 a</td>
</tr>
<tr>
<td>2%</td>
<td>0.289±0.010c</td>
<td>1.156±0.057 c</td>
<td>1.10±0.021b</td>
</tr>
<tr>
<td>5%</td>
<td>0.243±0.019c</td>
<td>0.951±0.023ab</td>
<td>1.32±0.024 b</td>
</tr>
<tr>
<td>10%</td>
<td>0.136±0.015b</td>
<td>0.768±0.029ab</td>
<td>1.59±0.019 b</td>
</tr>
<tr>
<td>20%</td>
<td>0.050±0.009a</td>
<td>0.647±0.025ab</td>
<td>1.48±0.016 b</td>
</tr>
<tr>
<td>Root leachates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%</td>
<td>0.712±0.022d</td>
<td>1.984±0.074cd</td>
<td>1.28±0.037 b</td>
</tr>
<tr>
<td>2%</td>
<td>0.729±0.025d</td>
<td>1.763±0.069cd</td>
<td>1.34±0.039 b</td>
</tr>
<tr>
<td>5%</td>
<td>0.698±0.021d</td>
<td>1.651±0.077cd</td>
<td>1.73±0.046abc</td>
</tr>
<tr>
<td>10%</td>
<td>0.531±0.027d</td>
<td>1.410±0.052cd</td>
<td>2.19±0.053ab</td>
</tr>
<tr>
<td>20%</td>
<td>0.323±0.013c</td>
<td>1.013±0.043c</td>
<td>1.34±0.049 b</td>
</tr>
</tbody>
</table>

*Values in the columns followed by Duncan’s the same letters (s) are not significantly different (p< 0.05) according to Duncan’s Multiple range test (DMRT).

**Table 1:** Effect of aqueous leachates of *C. argentea* L. on carbohydrate content and activity of α-amylase in germinating seeds of *Vigna radiata* L.

**Total Sugar:** The total sugar content in seedlings of green gram is decreased after treating it with different concentrations of inflorescence and leaf leachates of *C. argentea*. The results were recorded for inflorescence leachates as 0.260, 0.178, 0.156, 0.120, and 0.090g.100g⁻¹ for 1 to 20% concentrations; however leaf leachates treatment showed 0.370, 0.289, 0.243, 0.136 and 0.050g.100g⁻¹ for respective concentrations.
The inflorescence and leaf leachates were detrimentally acted on total sugar content in green gram as they are showed inhibitory effect. The root leachate treatment recorded 0.712, 0.729, 0.698, 0.531 and 0.323g.100g⁻¹ of total sugar when treated with 1 to 20% concentrations. Here in this treatment, the 1, 2 and 5% root leachates recorded the total sugar (0.712, 0.729, and 0.698g.100g⁻¹) are higher than the control (0.696g.100g⁻¹). It clearly indicated that 1, 2 and 5% root leachates are stimulatory on total sugar of green gram.

**Starch:** The similar trend in the effect of plant parts of *C. argentea* is observed on starch content of green gram. The starch content in seedling of green gram is inhibited after treatment of leachates of plant parts (inflorescence, leaf, and root) of *C. argentea* except 1, 2 and 5% root leachates.

The starch contents, 1.361, 0.883, 0.678, 0.545 and 0.357g.100g⁻¹ were recorded at 1 to 20% inflorescence leachate treatment; 1.242, 1.156, 0.951, 0.768 and 0.647g.100g⁻¹ recorded for leaf leachates concentrations and 1.984, 1.763, 1.651, 1.410 and 1.013g.100g⁻¹ for root leachates. The amount of starch reported at 1, 2 and 5% root leachates (1.984, 1.763 and 1.651g.100g⁻¹) were more than control, indicated that these concentrations are stimulatory for starch synthesis in green gram.

**Activity of Amylase:** The activity of α-amylase enzyme gradually increased with increasing concentrations of leachates. The activity of α-amylase is recorded as 1.12, 1.37, 1.52, 2.27 and 1.97µg amylase hydrolyzed min⁻¹g⁻¹ after treatment of 1 to 20% inflorescence leachate of *C. argentea*. Similarly, the activity of α-amylase as 0.99, 1.10, 1.30, 1.59 and 1.48µg amylase hydrolyzed min⁻¹g⁻¹ was recorded at 1 to 20% leaf leachates of *C. argentea*. However, the trend of increase in activity of amylase was continuous in a treatment of root leachates. The activity of α-amylase is recorded as 1.28, 1.34, 1.73, 2.19 and 1.34µg amylase hydrolysed min⁻¹g⁻¹ after the treatment of 1 to 20% root leachates of *C. argentea*.

**Discussion**

The results presented in Table. 1 is discussed herewith. The inflorescence and leaf leachates are detrimentally acting on total sugar and starch content in green gram as they are showing inhibitory effect, however, 1, 2 and 5% root leachates recorded increment in the total sugars and starch content than the control.

It clearly indicated that 1, 2 and 5% root leachates are stimulatory on total sugar and starch of green gram. Similar results were reported in chickpea seeds with increased concentrations of petal leachates of *Delonix regia* [13] however, reduction in total soluble sugar content in chickpea seedlings with the treatment of 100% (v/v) leaf leachates of *A. auriculiformis, A. occidentale, A. lebbek, E. citridora, E. officinalis, S. robusta* also reported [14].

With the agreements to our results, *Synedrella* leaf leachates responsible for reduction of the starch content in tomato and brinjal seedlings at lower concentrations and enhancement at higher concentrations [15].

Pawar and Chavan were reported the degradation of starch might be due to the enhanced action of α- amylase during the process of germination, which hydrolyzed the starch into simple carbohydrate [16]. Gulzar and Siddiqui found that total carbohydrate content was increased in allelopathic treated plants [17]. The result of our study demonstrated that the amount of starch and total sugar bothered after seed treatment of *Celosia argentea* leaf extricates.

The activity of α-amylase increased after treatment of aqueous leachates of parts viz. inflorescence, leaf, and roots of *C. argentea*. This enzyme most commonly endorsed with the initial attack on starch granules and is responsible for initiating the mobilization of starch in germinating seeds [18]. Similar to our work, Pawar and Chavan were examined the impact of leaf leachates of *Eucalyptus globulus, Moringa oleifera, Parthenium hysterophorus* and *Glycine max* on seedling of *Sorghum bicolor* and detailed diminished the activity of α-amylase [16]. Kengar and Patil were recorded stimulated activity of α-amylase within germinating seeds of *Lens Culanaris* after treatment of various aqueous leaf leachates of *C. argentea* [19]. Madane and Patil were also reported similar results to our work in *Cajanus cajan* and *Cicer arietinum* seeds during germination after treatment of *E. odoratum* at lower concentrations [20]. The leachates regulates the expression and activity of the enzymes required for efficient germination and secondary metabolic activities in germinating seed ascribed as presence of allelochemicals [21, 22].

**Conclusion**

The 1, 2 and 5% aqueous root leachate of *C. argentea* showed the slightly significant allelopathic effect on total sugar and starch content of green gram however the leaf and inflorescence leachates are inhibitory in actions. The allelochemicals present in the plant parts are different and are the differential activity. The screening and determination of these allelochemicals is the further approach to this study.

**References**


