# Allelopathic Effects of *Guizotia abyssinica* on seed germination of *Amaranthus tricolor*

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***Abstract*- The present aim of the study is to evaluate allelopathic effects *Guizotia abyssinica* aqueous extracts on seed germination of *Amaranthus tricolor* using different methods such as soaking method, root exudates and different stages of plant and plant residues. The results showed that the per cent germination of *A. tricolor* seeds is significantly inhibited by 10% and 5 % concentration of *G. abyssinica* root and shoot extracts. Shoot extract was found to be more potent that root extracts. Seed soaking method results revealed that 24 h soaking period affected the germination to a higher degree followed by 12 h and 6 h. the extracts prepared from mature plants significantly inhibited germination of *A. tricolor* seeds. The root exudates collected at the age of 15 days was inhibitory followed by 10 and 5 days old exudates. The effect of root and shoot residues of niger plant demonstrated concentration dependant inhibitory activity. Shoot residue was found to be more effective than root. From the present study it is quite evident that, the extracts of shoot and roots, root exudates and residues of *G. abyssinica* are more effective in reducing the germination and growth of *A. tricolor.***

***Index Terms*: *Guizotia abyssinica;* allelopathic effect; *Amaranthus tricolor***

## I. INTRODUCTION

In general, environmental factors such as light, temperature water and habitat influence the growth of plant. But in some cases due to the secretion of certain chemical components into the soil the growth was inhibited. Here the donor plant benefitted and the receiver can be affected. This mechanism is known as allelopathy. This type of chemical signalling or interactions are widely known in different plant groups ranging from algae, lichens, and crops as well as annual and perennial weeds [1, 2]. Allelochemical secreted by weeds reduced the growth and development of crop, cause economic loss. Thus weed control measures become inevitable to get income gain [3].

For the present study we selected Niger plant (*Guizotia abyssinica*) to test its allelopathic effect on seed germination of weed plant *Amaranthus tricolor*. Niger plant is a herbaceous plant belongs to the family Asteraceae, cultivated for edible oil obtained from its seed. The species of genus Amaranthus widely distributed in tropical and sub-tropical and temperate regions of the world. Few species of *Amaranthus* are grown as green leafy vegetables and some are serious weeds in agriculture crops. *Amaranthus tricolor* (Syn. *A. gangeticus)* known as Chinese spinach, grown in India and China [4]. Several *Amaranthus* species such as *A. tricolor* [5] *A. retroflexus* L. reported as potent weeds in agriculture crops.

## II. MATERIALS AND METHODS

### *Plant material*

The seeds of crop plant *Guizotia abyssinica* were procured from Andhra Pradesh Seed Development Corporation, Ananthapuramu. The plant material was collected from the field grown *G. abyssinica,* surface sterilized with 0.1% mercuric chloride and air dried in the laboratory. Dried plant material was separated into roots and shoots, chopped into fine pieces and stored in air tight containers at 4 ºC.

### *Preparation of Aqueous Extract*

The extracts were prepared by taking 10 g of chopped part in 100ml distilled water in sterilized beakers. The beakers were kept for 72h at 10 – 15 ºC. Aqueous extracts thus obtained were filtered through Whatman No.1 filter papers and the volume was made up to 100 ml. This was labelled as pure extracts or stock solutions. A part of this stock solution was further diluted (0.1, 10 times) with distilled water to get 10, 5 and 1 per cent solutions.

### *Presowing Hardening*

The hardening treatment of consisted of soaking of *Amaranthus tricolor* in solutions of different concentrations of root and shoot extracts of *G. abyssinica* plant for 6h, 12h and 24h. Seeds soaked in distilled water served as controls. After completion of the treatment the seeds were washed with distilled water and placed in sterilized petri dishes of 10cm diameter which were lined with double layer of filter paper. All the petri dishes were moistened with distilled water for the germination of seeds. The percentage of seed germination was calculated.

***Influence of Different Developmental Stages and Tissues types of Guizotia on test species***

Three developmental stages of *G. abyssinica* plants such as vegetative, flowering and harvesting stages were selected for the present experiment. Plants of the three stages collected from population grown in departmental garden and plants of each stage were surface sterilized with 0.1 % mercuric chloride and air dried. The dried plants were separated into root and shoot and the water extracts were prepared as described earlier. Allelopathic effects were assessed by employing the extracts on seeds of *A. tricolor*.

***Collection of Root Exudates***

The collection of root exudates of *G. abyssinica* plant seedlings was done as per the method of [6]. A desiccator (20 cm – diameter) was autoclaved and 350 ml of sterilized distilled water was added to bring the water level to the bottom of the perforated porcelain disk that conventionally hold samples above the desiccant. A layer of sterile moist cheese cloth was placed on top of the porcelain disk and seeds of *G. abyssinica* which had been surface-sterilized were eventually distributed on top of the cheese cloth where the perforations on the disk were made. The lid was placed on the desiccator and it was located under fluorescent light approximately 150$wm^{-2}$ and at 27±5 ºC temperature. As *G. abyssinica* seeds germinated, they were allowed to grow for 15 days to a height of 9-10 cm with roots of 5-6 cm length protruding into the water. The water was withdrawn from the desiccator at respective intervals 5, 10 and 15 days from the day of germination. Water collected from desiccator was concentrated on a rotor evaporator to a volume of 30 ml and a part of this concentrate was tested for Allelopathic activity against germinating *A. tricolor* seeds in petri dish assays. Distilled water was used as control.

***Residue Incorporation Studies***

For the residue incorporation studies earthen pots (6.5” x 5.5” size) containing 1 kg of sterilized silica sand and 5, 2.5 and 1 % of finely ground root and shoot residue of niger seed were maintained under natural photoperiod of about 12-14h with a temperature of 28± 4 ºC in the botanical garden. A control was maintained without residue. The pots were irrigated once a day with distilled water. The pots were incubated for 15 days for decomposition of the residues. The seeds of *A. tricolor* were surface sterilized and raised in pots. After the seedlings emerged, the plants were thinned to 3 per pot and the plants were maintained for 45 days from the day of seeding emergence. The pots were irrigated once a day with distilled water and twice a week with Hoagland’s nutrient solution [7]. Maximum care was taken to ensure that the amount of water added was slightly less than field capacity. The pots were arranged in a randomized complete block experimental design with three triplicates to avoid drainage of leachates during experimentation.

All the plants were harvested at an interval of 15 days. The pots were flooded with water, the sand was loosened slowly and the plants were uprooted carefully. After each harvest (i.e. 15, 30 and 45 day – old plants), the plants were thoroughly washed with water and separated into root and shoot. Prior to this, seed germination was recorded. Morphological parameters such as seedling growth (root and shoot length) leaf area, dry mass production and some physiological parameters were studied. The results were averaged of three replicates.

## III. RESULTS AND DISCUSSION

The present aim of the study is to evaluate allelopathic effects *Guizotia abyssinica* aqueous extracts on seed germination of *Amaranthus tricolor* using different methods such as soaking method, root exudates and different stages of plant and plant residues. The results showed that the per cent germination of *A. tricolor* seeds is significantly inhibited by 10% and 5 % concentration of *G. abyssinica* root and shoot extracts. Shoot extract was found to be more potent that root extracts. However, the per cent germination was not so much affected by lower concentration (1%) of all the extracts. The initial toxicity observed on 1$^{st}$ day was alleviated by the end of 4$^{th}$ day. The inhibitory effect of all the extracts was thus found to be concentration dependant. All the concentrations of shoot extracts absolutely inhibited the germination of *A. tricolor* on 1$^{st}$ day. The degree of inhibition was alleviated gradually with increasing days of incubation. Shoot extracts was found to be more potent (Fig. 1).

Seeds of Amaranthus were soaked in root and shoot extracts of *Guizotia* for different time intervals and the per cent germination was considered as the primary criterion for toxicity. Figure 2 demonstrated that higher concentrations i.e. 10 and 5 % decreased the per cent germination after 6h, 12h and 24 h and the inhibition was alleviated by the end of 4$^{th}$ day. Among the three treatments, seeds soaked for 24h period affected the germination to a higher degree followed by 12h and 6h. To evaluate the most potent stage of donor plant, the aqueous extracts of vegetative, flowering and mature stages of *Guizotia* were prepared and their effect was studied on *A. tricolour*. Among the three stages, the extracts prepared from mature plants showed significant inhibition in both plants to varying degrees. The higher concentrations (10 & 5 %) of all treatments inhibited the per cent germination, whereas lower concentration (1%) of root extracts prepared from the vegetative and flowering stages stimulated the germination on all days of observation in *A. tricolour* (Figure 3).

The root exudates of *Guizotia* were collected at the time intervals of 5, 10, 15 days. The solutions were collected and used to test their effect on germination and also to evaluate the most effective root exudate on *A. tricolour* seeds. Root exudates from 15$^{th}$ and 10 day old plants showed significant inhibition in all days. No significant inhibition of germination was observed with root exudates collected from 5- day old plants. On the contrary root exudates from 5-

day old plants stimulated the germination on 3rd day in *A. tricolour* seeds (Fig. 4). The effect of root and shoot residue of *Guizotia* were tested on some toxicity criteria in *A. tricolour*. We observed that higher concentrations (2.5 and 5 %) of root and shoot residues inhibited the germination significantly to varying degrees of inhibition on all days of observation. The lower concentration (1%) stimulated the germination in some cases. The inhibitory effect was observed to be concentration dependant, which was alleviated by the end of 8th day from 3rd day of sowing. Shoot residue was found to be more effective. It is significant to note that 5% of shoot extract absolutely reduced the germination of *A. tricolour* on 3rd, 4th, and 5th day of from 3rd day of sowing (Fig. 5).

It is clear from the results that the higher concentrations of different aqueous extracts, root exudates and residues of *Guizotia* inhibited the germination of *A. tricolour*. The lower concentration of all extracts from different sources of phytotoxicity in majority of the cases did not affect the germination. Thus the test plants responded differently to the various extracts. Allelopathic potential of a plant may vary with phase of the development of the other plants growing around it. Many Angiosperm plants were reported to retard the germination and growth of their neighbouring plant species [3, 8,9, 10] (Allelopathy in many cases plays a far greater role than competition in inhibiting the germination and growth [11]. There are several reports regarding the effect of aqueous extracts of weeds on germination of different crop plants [ 12, 13, 14, 15], aqueous extracts, root exudates and residues of crop plants on seed germination of weeds and crop plants [16, 17, 18, 19, 20] The present observation are in accordance with the reports of Sanchita Bhattacharya et al., [13] who found that the aqueous extracts of stem and leaf of *Lantana camara* L. and *Cyanthillium cinereum* appeared to be strongly inhibited the germination of seeds of *Abelmoschus esculentus* L. and *Vigna unguiculata* L. The hardening of both crop and weed seeds with aqueous extracts of Guizotia was done by soaking the seeds for different time intervals. Among them, soaking for 24 h affected the germination of *A. tricolor* to a higher degree and soaking for 6h affect to a less extent. Hence the 24h soaking period is optimal for controlling *A. tricolor*. Our present findings showed that the mature plant extracts exhibited maximum inhibitory activity towards the germination of *A. tricolor* seeds. The results are in agreement with observations made by Kanchan and Jayachandra [21] and Wardle et al., [22] regarding the most potent developmental stage of donor plant.

## IV. Conclusion

In present study we evaluated the allelopathic effects *Guizotia abyssinica* aqueous extracts on seed germination of *Amaranthus tricolor* using different methods such as soaking method, root exudates and different stages of plant and plant residues. The results showed that different parts at various concentrations of Niger plant strongly inhibited the seed germination of *A. tricolour*. From the present study it is quite evident that, the extracts of shoot and roots, root exudates and residues of *G. abyssinica* are more effective in reducing the germination and growth of *A. tricolor*. Further studies are required to identify the active principle responsible for Allelopathic effects of Niger plant.

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**List of figure**

Figure 1

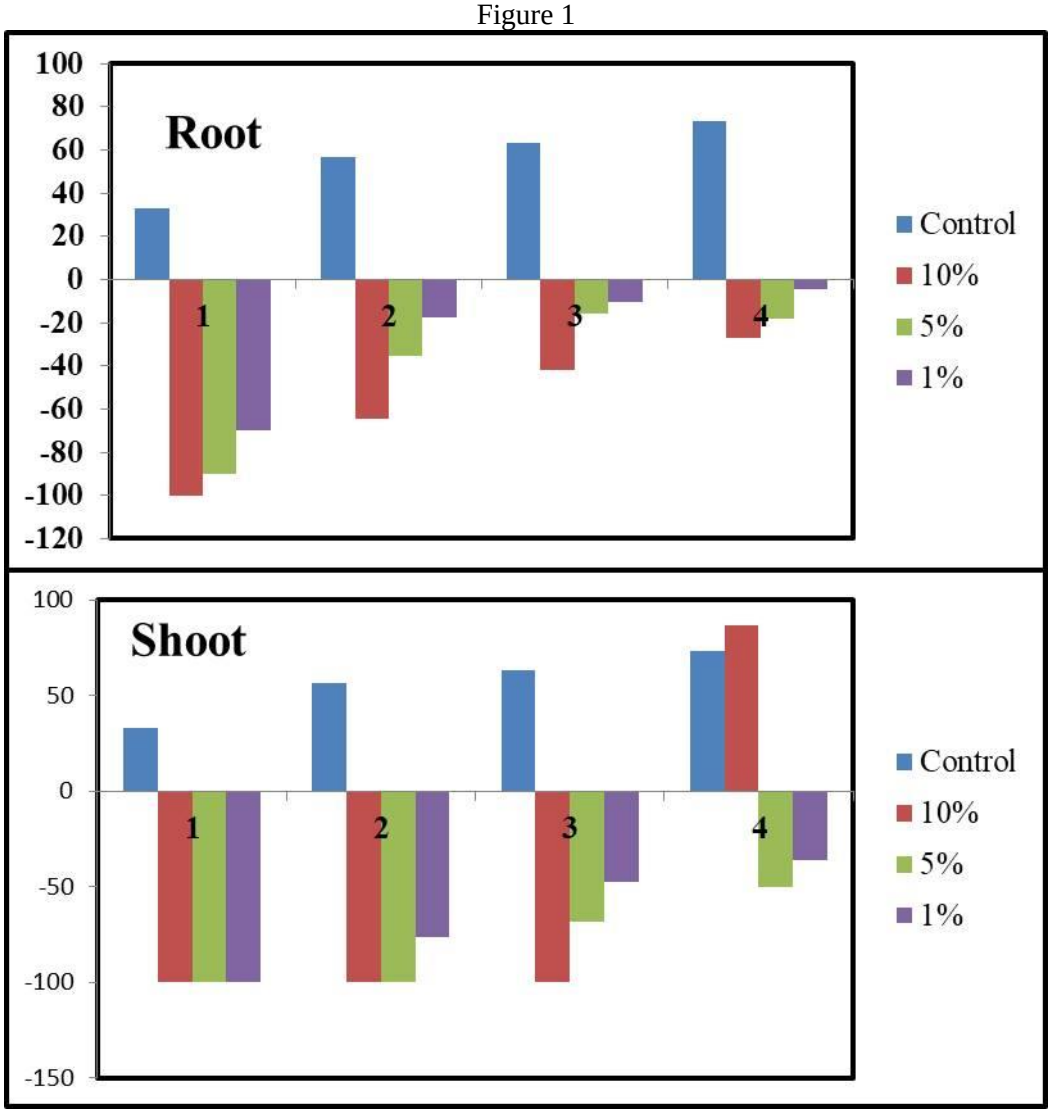
Root
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
1
2
3
4
Control
10%
5%
1%
Shoot
100
50
0
-50
-100
-150
1
2
3
4
Control
10%
5%
1%

Figure 2

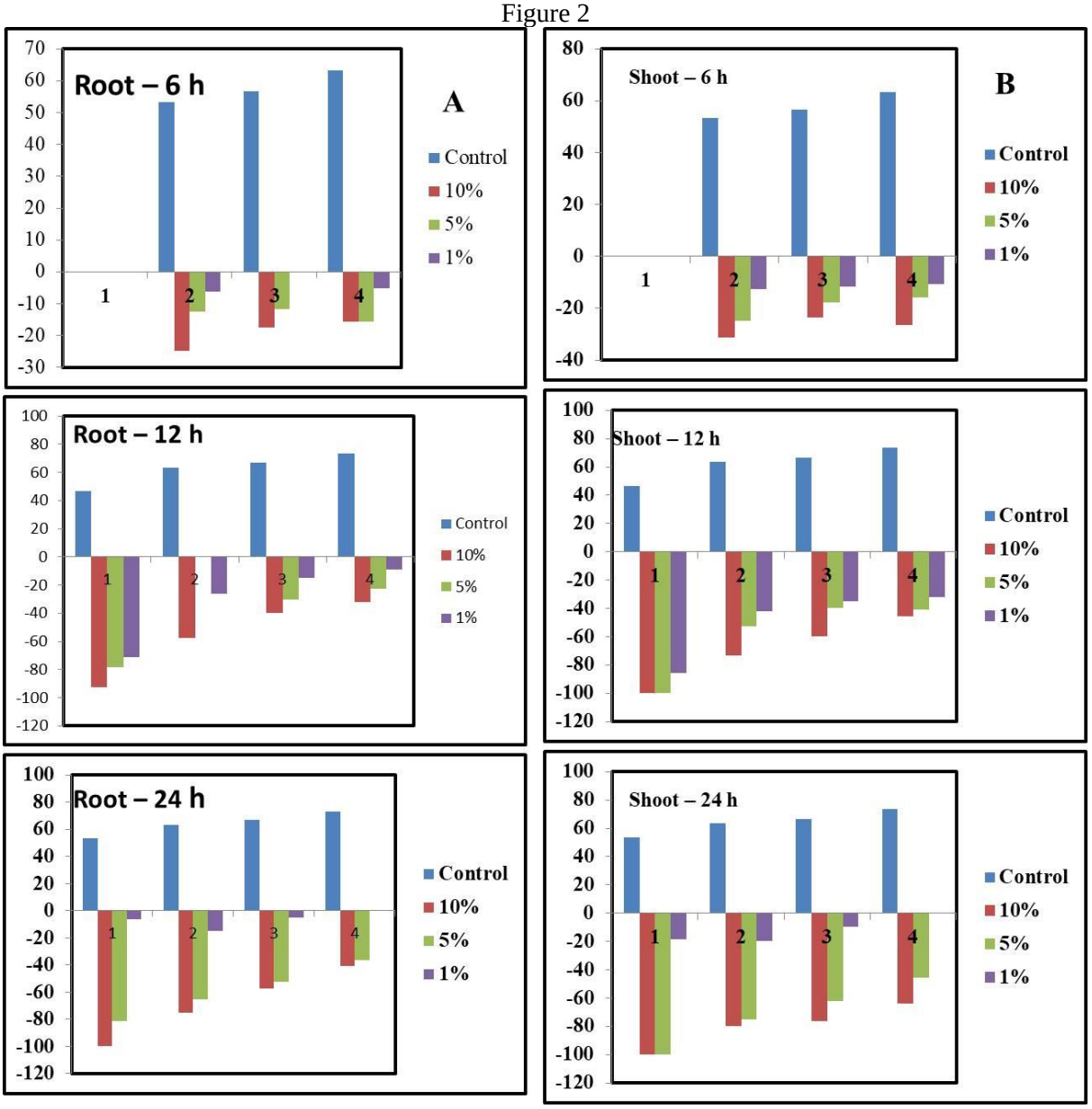
Root – 6 h
A
Control
10%
5%
1%
Shoot – 6 h
B
Root – 12 h
Shoot – 12 h
Root – 24 h
Shoot – 24 h

Figure 3

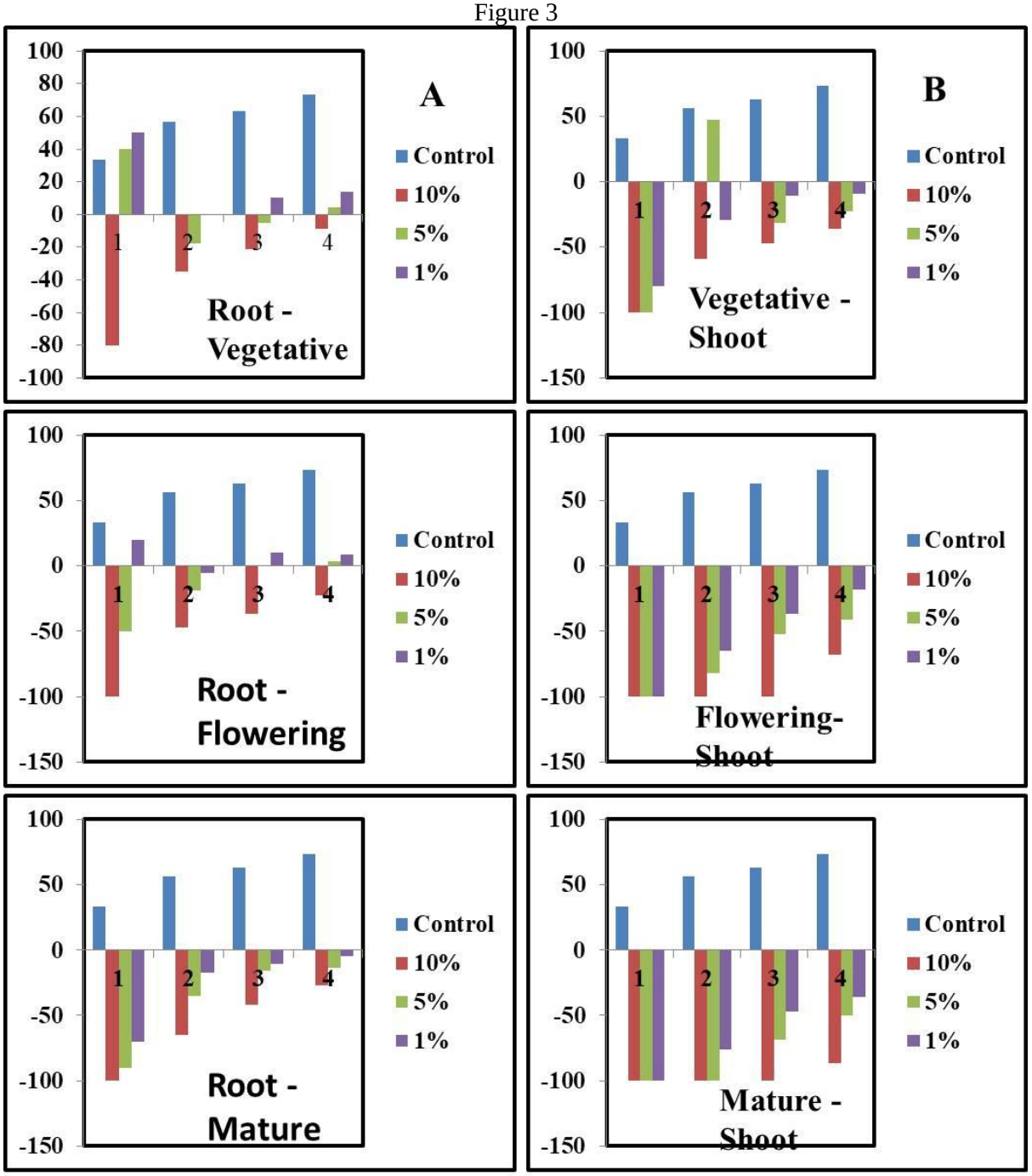
A
Root - Vegetative
B
Vegetative - Shoot
Root - Flowering
Flowering- Shoot
Root - Mature
Mature - Shoot
Control
10%
5%
1%

Figure 4

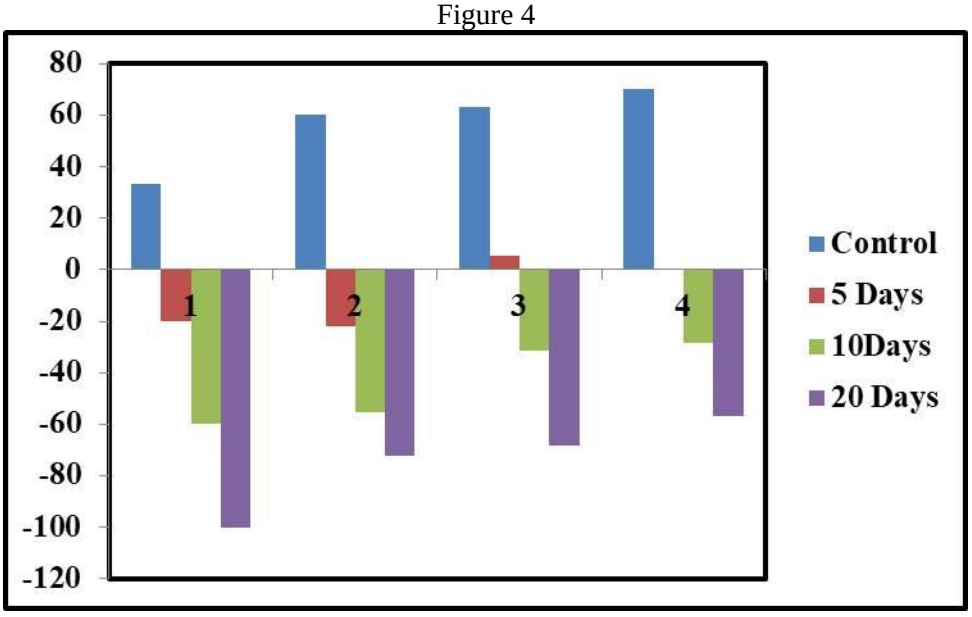


Figure 5