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ALLELOPATHIC EFFECTS OF AQUEOUS EXTRACT OF SHOOT AND ROOT OF LICORICE (GLYCYRRHIZA GLABRA L.) AND PIGWEED (AMARANTHUS RETROFLEXUS L.) ON GERMINATION CHARACTERISTIC AND SEEDLING GROWTH OF CORN AND CHICKPEA

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ABSTRACT: In order to investigate the allelophatic effects of shoot and root aqueous extract of licorice (*Glycyrrhiza glabra* L.) and pigweed (*Amaranthus retroflexus* L.) on seed germination and seedling characteristic of Corn *(Zea maize L.)* and Chickpea*(Cicer arietinum L .),* a research was conducted based on completely randomized design with four replications, in research laboratory of faculty of agriculture, University of Kerman, Iran in 2010. Treatments were four levels (25, 50, 75 and 100%) of leaf, stem, flower and root water extracts weeds (*Glycyrrhiza glabra* L.) and (*Amaranthus retroflexus* L.) with distilled water as control. Results showed that there were allelopathic effects in Velvet flower and Glycyrrhizin, effect of aqueous extract of different plant parts on germination traits of maize and chickpea was not similar. Increasing the aqueous extract concentrations of separated Velvet flower and Glycyrrhizin plant parts significantly inhibited maize and chickpea percentage and rate of germination, length of radical and hypocotyls and increased time to 10 and 90% of germination. The degree of allelopathic effects of different Velvet flower and Glycyrrhizin plant parts can be classified in order of decreasing inhibition as follows: stem, leaf, flower and root, and between two medicinal plants, Glycyrrhizin indicated more allelopathic effects on germination traits.

Keywords: Allelopathy, Germination, Seedling growth, Weeds, Crop plants

INTRODUCTION

Weeds usually cause to descend the desirable performances around 15 % annually by making disturbance in different agriculture products growth. Not only might the natural competition for achieving the suitable light, water and nourishment lead to decrease the growth of plants also, other elements and factors like Allelopathy item would influence on mentioned challenges and in most cases; the unhealthiness and sickness lands problem have been yielded by plant's exudates (Misawa and Goodbody, 1996).
In common definition, the Allelopathy is any direct or indirect, useful or useless effects of plants on other ambient plants by germinating and growing via created chemical materials and its transmittal. (Rice, 1984). All plant sections and organs include of leaves, stems, roots, rhizome, flowers, fruits and seeds by and large comprise the allelopathy potential but seemingly, the leafs are the main parts for producing allelopathy materials and have maximum subsequently the roots have minimum quantity (Sisodia and Siddiqui, 2010; Rice, 1984). Generally the plants release such materials to surrounding area during plant's debris decomposition through root exudates, evaporation and leaching (Narwal and Tauro, 1994; Sisodia and Siddiqui, 2010).
Allelopathic substances exuded by various parts of plants might affect on germination and seedling growth through different mechanisms for example; decreasing in metabolic activity of radical and hypocotyl, preventing or stopping the hormonal activity, slowing down the absorption of nutrients, decreasing Photosynthesis and Respiration and finally reducing the permeability of cell membranes and preventing the enzyme activity. (Rice 1974; Jefferson and Pennacchio, 2003).
Corn, wheat and rice are respectively most important world's grains and Chickpea is a legume berry which is psychrophile and widely cultivated in different parts of the world, including Iran. This plant plays distinctive role in stabilizing and frequency of production system due to having efficient effects in Increasing the soil fertility besides well-known its food consumptions (Soltani et al., 2006).

Licorice *(Glycyrrhiza glabra L.)* is recognized perennial plant from Fabaceae family and cultivated as a medical plant in several countries , in Iran and specially in dry lands of Kermanshah, Ilam, Fars , Arak and Isfahan provinces it has introduced as destructive weeds in wheat and peas farms (Nezam Abadi et al, 2006).

Pigweed (*Amaranthus retroflexus* L.) is one of the most common weeds in popular farms generally and because of having high potential in seed production keeps on its undesirable effects and existence for long times. This plant totally is considered as a major weed in new agriculture world so that slows down the optimum and expected performance of other plants competitively (Mitich, 1997). On the other hand, allelopathic assessment in practical form in farms is difficult affair because in fact, plant growth process is usually eventuated with both allelopathic effects and competition (Weston, 1996). As a few and rare studies have been done in field of licorice and pigweed 's allelopathic capacity so far, the current paper is concentrated on evaluation of above mentioned capacity and its outcomes on Corn and Chickpea seedlings in vitro.

MATERIALS AND METHODS

To study the allelopathic effects different parts of licorice and Pigweed on seed germination and seedling growth of Corn (Single cross 704) and Chickpea *(Cicer arietinum L .)*, an experiment was conducted based on completely randomized design with four replications, in research laboratory of faculty of agriculture, University of Kerman in 2010. As a logic accuracy is needed to convergent the obtained results, the test was performed for two times.

Preparation of water extracts solutions

Aerial parts of licorice and pigweed were collected from the Kerman region's farms (Iran), in flowering time. Leafs, stems, flowers and roots of plants were separated. The plant material was dried in an oven at 70°C for 48 h. Then the dried material was ground in a grinder and passed through a 40 mesh screen. To prepare the extract, 500 ml of distilled waters with 30 gr powder obtained from grinded substances of organs were separately mixed and , put for 24hours via Shaker device that operated at 300 rpm performance and subsequently after passing materials through a Whatman filter paper No.1 the obtained substance were diluted in order to achieve the desired treatments.

Treatment concentrations were prepared using control (0 %) and 25%, 50%, 75% and100 % of the original dose for dried material. Corn and Chickpea seeds were obtained from the Center for Agricultural Research in Kerman. They were sterilised with sodium hypochloride (10%) and washed by distilled water. Twenty (Corn and Chickpea) seeds were sown in 9 cm Petri dishes lined with filter paper, and 10 ml of each treatment solution was added. The filter papers were constantly moistened with the appropriate extracts. Finally Petri dishes were closed with parafilm and transferred to a growth chamber (set at 15-25 °C, 12-12 hours (day/night) for 10 days. Germination (daily), shoot and root length, and dry weights were calculated for all treatments. To calculate the percentage and rate of germination , the Germin (Soltani and Maddah, 2010) program was used. This program computes the time that is needed to getting 10, 50 and 90 % of maximum level (D10, D50, and D90) for germination process through its curve interpolating with respect to time. Also the germination rate in this program has been calculated through time reverse to 50% of germination (1/D50)) (Soltani *et al.,* 2002).

Statistical analyze

Data were analyzed statistically using analysis of variance with SAS. Comparisons of treatment means were performed using a protected Least Significant Difference (LSD), at $p = 0.05$. And finally the figures depicted by Excel program.

RESULTS

According to variance analysis, the kind of organ and different applied densities of aqua extracts significantly affect on percentage, rate, time of beginning & ending of germination, length of radical and hypocotyls, But the interaction effect of organs and different applied densities was not significant on aforementioned characters (Table 1).

Percentage and rate of germination

Current evaluations indicate on that, stem and leaf's extracts has maximum, flower and root has minimum effect in preventative behavior on Corn and Chickpea's germination rate and percentage (figures 1 and 2). Aqua extracts from 0 to 100, germination percentage

for the Corn tends to 58 and 68% respectively and similarly, for Chickpea its range propels to 27 and 58% . The rates also vary in which the Corn experiences the descending tendency from 57 and 36 and Chickpea 32 and 53 (Figures 1 and 2). Explicitly; it can be understood that aforementioned aqua extracts have major influences on germination percentage and minor influences on germination rates. Usage of aqua extract obtained from leaf, stem, root and flower eventuates to reduce in length of radical and hypocotyls in both crop plants. Length of radical and hypocotyls Corn was not significantly influenced by aqua extract different organs of licorice and pigweed (table 1, and figures 3 and 4).

Table 1. The degree of freedom and mean square maize and chickpea germination traits under experiment treatments

			Velvet flower - Chickpea				
	df	Germination %	R50	Radicle L cm	Hypocotyl L cm	Time to 10% G (hr)	Time to 90% G (hr)
Organ	3	2184.5 ***	0.000014 **	3.43 *	1.2 *	1155.1 **	226.4 ns
Concentration	4	3060.6 ***	0.000047 ***	10.37 ***	2.08 ***	721.3 *	435.51 ns
O×C	12	152.29 ns	0.0000043 ns	0.822 ns	0.328 ns	114.29 ns	650.51 ns
Error	60	88.7	0.0000061	1.36	0.412	266.64	575.7
			Glycyrrhiza - Chickpea				
Organ	3	1381.67 ***	0.000094 ***	0.861 ns	0.541 *	730.94 ***	1594.5 *
Concentration	4	3534.37 ***	0.000055 ***	8.272 ***	2.202 ***	267.8 *	780.52 ns
O×C	12	91.04 ns	0.000008 ns	1.736 ns	0.582 ns	124.53 ns	464.55 ns
Error	60	75	0.0000071	0.981	0.251	92.61	811.14
			Velvet flower - Maize				
Organ	3	2064.08 ***	0.00011 ***	6.235 ns	0.451 ns	450.5 *	6731.73 ***
Concentration	4	2866.87 ***	0.000074 ***	100.37 ***	22.546 ***	218.21 *	1538.2 *
O×C	12	146.8 ns	0.000009 ns	8.842 ns	3.621 ns	173.21 ns	1015.6 ns
Error	60	102.91	0.0000041	14.23	3.97	157.19	732.73
			Glycyrrhiza - Maize				
Organ	3	6153.3 ***	0.000023 *	5.77 ns	3.01 ns	609.68 *	687.85 ns
Concentration	4	3837.5 ***	0.000016 *	161.86 ***	51.41 ***	539.86 ns	3720.67 *
O×C	12	882.51 ns	0.000011 ns	13.13 ns	2.623 ns	377.76 ns	2148.76 ns
Error	60	178.33	0.0000072	19.15	6.374	298.13	1783.93

*, ** and *** significant at the 5%, 1% and 0.1% levels of probability, respectively.

According to different organs; stem, leaf ,flower and root has respectively stronger preventative property and effect on length of radical and hypocotyls by increasing density of each organs, the length of radical and hypocotyls of both crop plants reduced.

From 0 to 100, the Corn's radical length decreases 65 and 86% and Chickpea 32 and 48% respectively. Similarly; hypocotyl length of Corn and Chickpea going drops around 63 and 85, 32 and 53 respectively in corresponded with 0 to 100% of applied aqua-extracts.

The root has less allelopathic properties than stem, leaf and flower because using utmost density of root's aqua extract causes to decrease in Corn's radical length around 55 and 54% and for Chickpea 22 and 27%. In a similar manner; Corn's hypocotyl length 50 and 55% and Chickpea about 9 and 32 % slowing down can be viewed in comparison with control (figures 3 and 4).

Time to beginning and ending of germination In according figures 5 and 6, stem and leaf have maximum and flower and root have minimum effect on preventative

properties on time to beginning and time to ending of germination. The Time to beginning of germination for Corn 34 and 58% and for Chickpea 57 and 32% increases in respect with density increment of aqua extract applied in range of 0 to 100%. More over; licorice aqua extract has stronger effects on Corn and pigweed aqua extract on Chickpea in aspect of preventative properties (figure 5). The study results state that the time to end of germination was less affected by the density of various aqua extract organs (figure 6).

DISCUSSION

The results have shown that pigweed and licorice seemingly have negative and undesirable effects in aspect of allelopathic properties so that they have no the same effects on germination of Corn and Chickpea yielded by their aqua extracts organs. this investigation shows that increment of aqua-extracts main germination items like rate and percentage Corn and Chickpea‘s germination will be decreased as the same way that demonstrated by Chung and Miller (1995) and Turk and Tawaha (2002), about alfafa (*Medicago sativa L.*) and black mustard *(Sinapis arvensis L.)* plants respectively. Hen et al (2008), announced that among extracts obtained from different ginger’s organs, stem and leaf respectively comprise maximum effects in preventative property on soybean and shallot germination. Length of radical and hypocotyl of Corn and Chickpea were decreased by usage of pigweed and licorice’s exudates so that, licorice has stronger effect on above mentioned lengths rather than pigweed. Because of having more allelopathic properties in licorice different organs compared to pigweed. Moreover, Corn’s length of length of radical and hypocotyl have been affected drastically rather than Chickpea which demonstrates the Corn is more prone for affecting by allelopatic compositions and properties in comparison with Chickpea.

Turk and Tawaha (2002), reported that radical’s length is more susceptible compared to hypocotyl under influence of allelopathic compositions and properties because the root is first organ of plant deals with allelopathic materials and toxin compounds. Based on the above items, it is concluded that in order to slow down the disadvantages and damages of pigweed and licorice‘s allepathic properties and effects on Corn and Chickpea, it is recommended to consider the these plants allelopathic effects on germination index if these plants want to be used as alternative medical plants beside of Corn and Chickpea in shape of weeds.

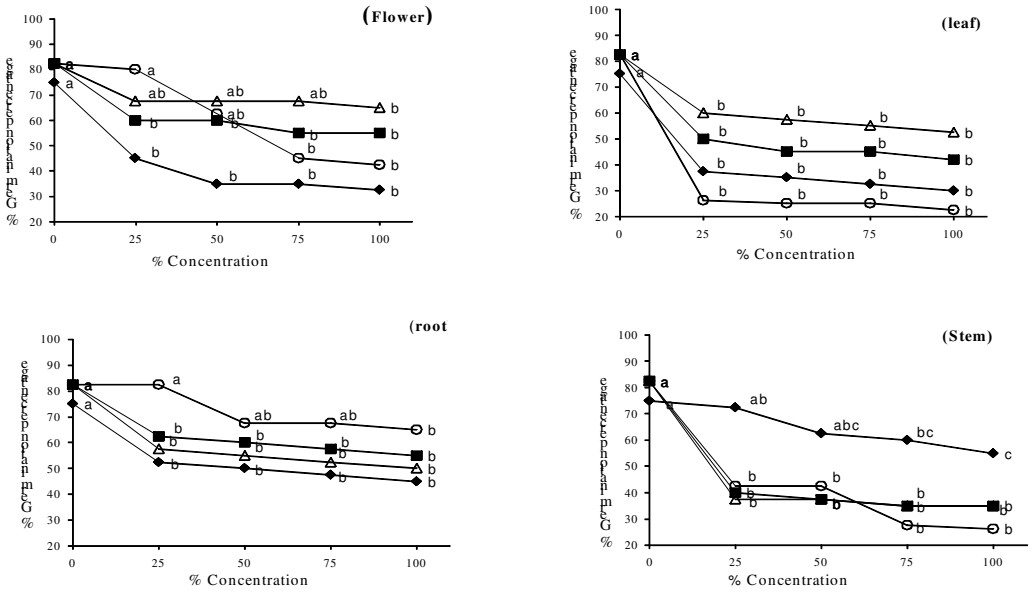

Fig. 1. Effect of different concentration of aqueous extracts of different organs of pigweed and Glycyrrhiza on seeds germination percentage of Corn and chickpea. Different superscript symbols along a curve represent significant difference among themselves at P<0.05.
◆ pigweed – Chickpea, ○ Glycyrrhiza – Corn, ■ Glycyrrhiza – Chickpea, Δ pigweed - Corn

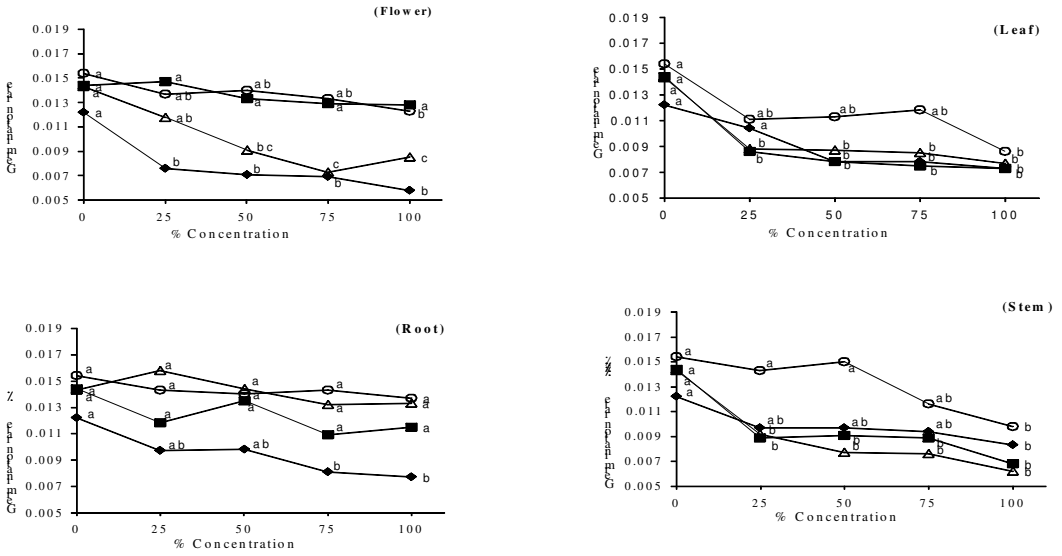

Fig. 2. Effect of different concentration of aqueous extracts of different organs of pigweed and Glycyrrhiza on seeds germination rate of Corn and chickpea. Different superscript symbols along a curve represent significant difference among themselves at P<0.05.
◆ pigweed – Chickpea, ○ Glycyrrhiza – Corn, ■ Glycyrrhiza – Chickpea, Δ pigweed - Corn

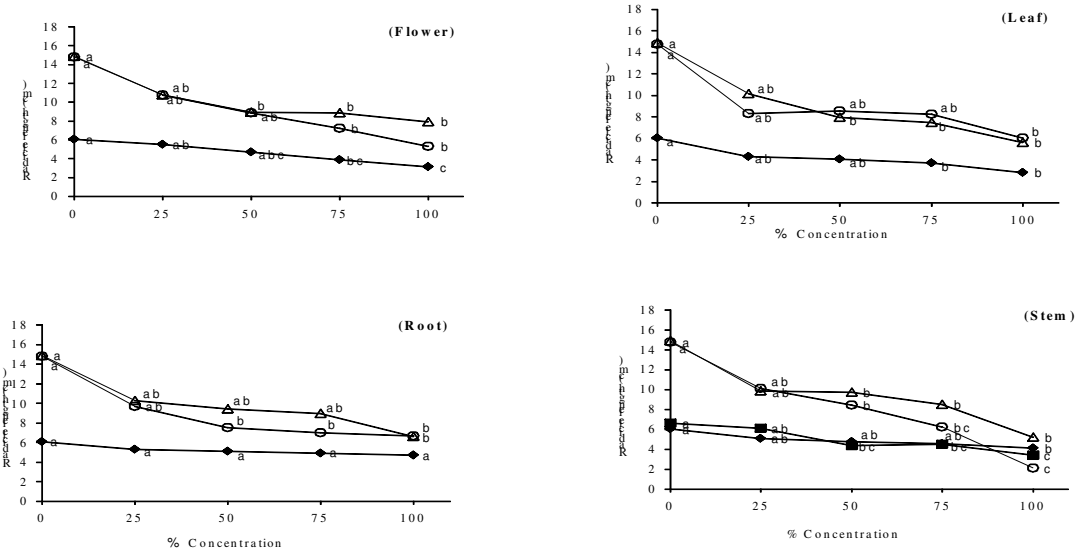

Fig. 3. Effect of different concentration of aqueous extracts of different organs of pigweed and Glycyrrhiza on radical length of corn and chickpea. Different superscript symbols along a curve represent significant difference among themselves at P<0.05.

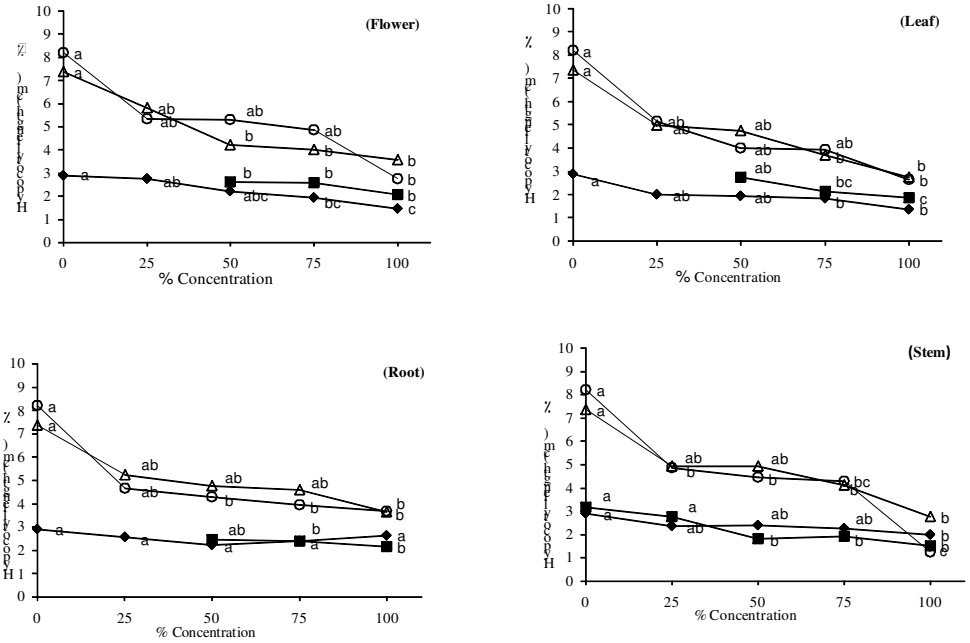

Fig. 4. Effect of different concentration of aqueous extracts of different organs of pigweed and Glycyrrhiza on hypocotyl length of Corn and chickpea. Different superscript symbols along a curve represent significant difference among themselves at P<0.05.

◆ pigweed – Chickpea, ○ Glycyrrhiza – Corn, ■ Glycyrrhiza – Chickpea, Δ pigweed - Corn

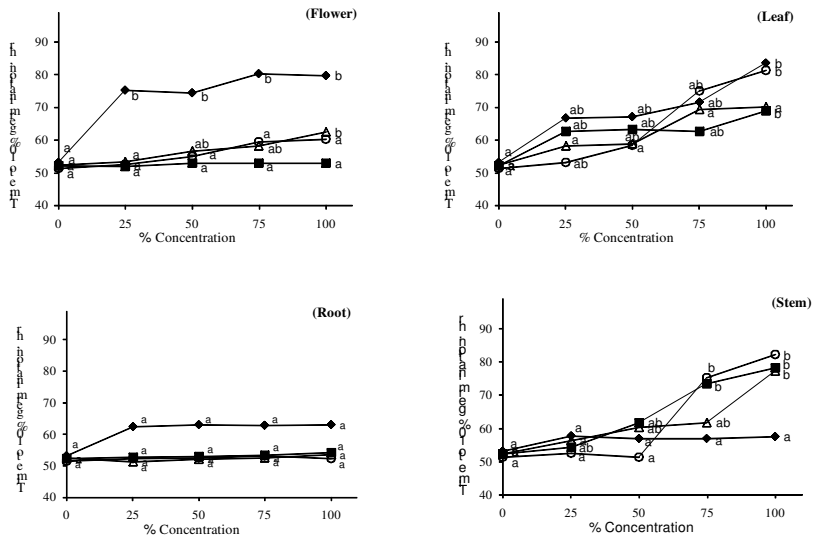

Fig. 5. Effect of different concentration of aqueous extracts of different organs of pigweed and Glycyrrhiza on time to 10% germination of corn and chickpea. Different superscript symbols along a curve represent significant difference among themselves at P<0.05.

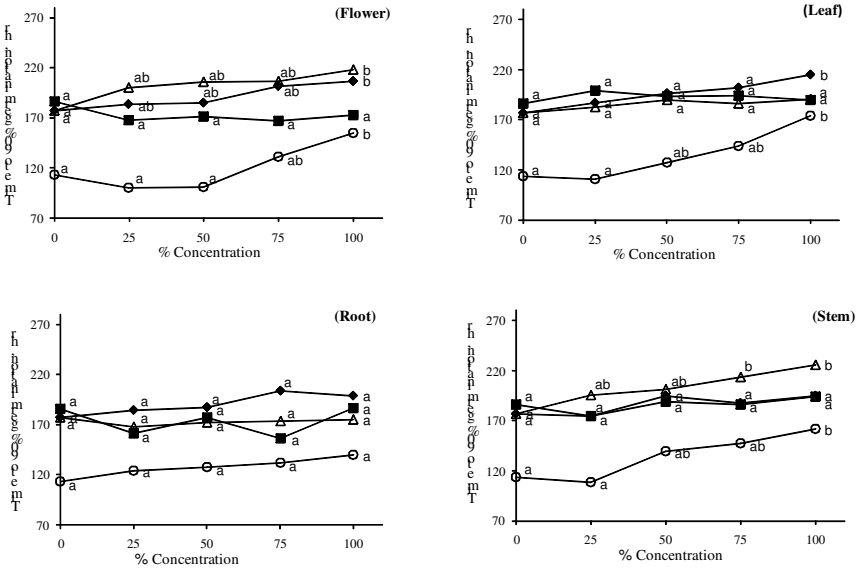

Fig. 6. Effect of different concentration of aqueous extracts of different organs of pigweed and Glycyrrhiza on time to 90% germination of corn and chickpea. Different superscript symbols along a curve represent significant difference among themselves at P<0.05.

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