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Allelopathic effect of corn, alfalfa, redroot pigweed and bermuda grass on germination and growth of rye

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Abstract

This study was to investigate the effects of the extract from different parts of alfalfa, corn, bermuda grass and redroot pigweed at different stages of growth and in different amounts of extract on rye. For this purpose, a factorial experiment was carried out during 2010-2011. The factors included: type of plant at four levels: 1- corn 2- alfalfa 3- redroot pigweed 4- bermuda grass, The second factor: phase of the plant harvest for prepare extracts at two levels: 1- harvesting in vegetable growth 2- harvest at the beginning of flowering, Third factor: extracts from different crop organs at three levels: 1- extracts from the leaves 2- extracts from the stem 3- extracts from the root, The fourth factor: different concentrations of extracts from the organs of plants at four levels: 1- extract concentration of 5 percent 2- extract concentration of 10 percent 3- extract concentration of 15 percent 4- extract concentration of 20 percent. The results of the study show that materials produced from the leaves, stems and roots of bermuda grass, redroot pigweed, corn and alfalfa germination, and growth of rye affected. Most reduction on germination rye by extracts from alfalfa leaves and roots of bermuda grass obtained. Alfalfa extracts from the vegetative stage had more effect than reproductive stage, but bermuda grass extracts hadn't effect on germination and seedling growth of rye.

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Introduction

Crops are different competitive strategies that reflect their adaptation to environmental changes induced by the competitors. One of these strategies is allelopathy. Allelopathy directly effects can depend the concentration of allelochmicals, growth conditions, etc is different (Robakowski and Bielinis, 2011). But Allelopathic properties in crops, in addition crop species, to several factors such as light and food availability for both crop donor and recipient and environmental factors depend. A number of allelopathic compounds in various stages of growth accumulated assemble a number of compounds depends on the extent to which time of day and season (Grades, 2011). Cereal seed germination depends on the activity of α-amylase that adjusted breaks down starch, which is essential for respiratory metabolism. Research has shown that allelopathic compounds activity of α-amylase of on seed germination is stopped, causing the germination stop. Evaluation with electron microscopy showed that the germination of seeds treated root cells has greater amounts of unsaturated fatty acids (Gniazdowska and Bogatek, 2005). Srivastava *et al.* (2011) reported that allelopathic compounds from water uptake by crops to prevent and seed germination reduced. Weir *et al.* (2004) expressed the allelopathic compounds can affect the ATP complex. Allelochimicals effect on respiration and photosynthesis, ATP production decreased, which alter other cellular processes that require energy can change (Gniazdowska and Bogatek, 2005). Knox *et al.* (2011) reported that the allelopathic compounds, nitrogen uptake and protein synthesis in the crop reduces. Also, reduce crop growth in the presence of allelopathic compounds in connection with disrupt mitosis or tumble structure is like nuclear and mitochondrial caused (Gniazdowska and Bogatek, 2005). Allelopathic compounds involved in the formation of cytoplasm structures can reduce root growth (Soltys *et al.*, 2011). These compounds Microtubular structure of inside the cells commix (Ma *et al.*, 2011). Several processes that affect allelopathic compounds are change, ultimately leading to reduced growth in crops (Weir *et al.*, 2004). Allelopathic properties of crops in alfalfa, corn, pigweed and *cynodon dactylon* in the process and growth, development of crops has been proved (Ferreira, 2011; Minorsky, 2002; Bouchagier and Efthimiadis, 2010).

Rye is one of the most important weeds in wheat and its control is very important. Allelopathic potential of different plants such as alfalfa, corn, redroot pigweed and bermuda grass to rye germination and growth control, major purpose of this paper. Also, in this review consider is the effect of different concentrations obtained from different parts of alfalfa, corn, redroot pigweed and bermuda grass at different times on germination and seedling growth of the rye.

Materials and method

Alfalfa and corn as a representative of C_3 and C_4 crops and two weeds redroot pigweed and bermuda grass as well as a representative of weeds. This study arranged a factorial experiment based on completely randomized design with 3 replications. Treatments in this experiment were**:** First factor: type of plant at four levels: 1- corn 2- alfalfa 3- redroot pigweed 4- bermuda grass**,** The second factor: phase of the plant harvest for prepare extracts at two levels: 1- harvesting in vegetable growth 2- harvest at the beginning of flowering, Third factor: extracts from different crop organs at three levels: 1- extracts from the leaves 2- extracts from the stem 3- extracts from the root**,** The fourth factor: different concentrations of extracts from the organs of plants at four levels: 1- extract concentration of 5 percent 2- extract concentration of 10 percent 3- extract concentration of 15 percent 4- extract concentration of 20 percent.

After harvesting the crops at any stage of the relevant components, including roots, stems and leaves were split and separate and washed**.** Each of the parts (leaves, stems and roots) dried in the electric oven at 60 ^{oC} For 48 hours and then, the prepared powder, ground and to avoid contamination with the smallest sieve (mesh 100) were screened. To prepare the extract, 20 g of crop material in 100 ml distilled

water put and then immersed For 24 hours straight. The extract concentration was 5% for other concentrations of this extract was used as the parent extract**.** The test environment included a plate number 291 (4×2×3×4+1×3 each) with three replications.

A method based on the rules was ISTA (*International Seed Testing Association*), the standard germination test. Seeds were in control conditions with distilled water and uniformity of germination has been evaluated**.** Then treatments consisted of extracts four crops studied. A standard germination test in Petri dishes in between the paper at 25 ^{oC} for 10 days was performed. Seeds of rye after surface sterilized by 5% hypo chloride sodium to 50 number seeds put in Petri and treatments define was added. For separation the osmotic effect of the extract solution of allochimical extracts the electrical conductivity measurement using the relationship between $log\Psi o = 1.016+1.065\ log$ EC osmotic potential solutions have been calculated (Gupta, 2002). Then, using polyethylene glycol 6000, osmotic potential all extract same with osmotic potential 20%. Germination tests with 5 mm are defined. Seed number and length of root, shoot and seedling measured. Using data from the germination test, germination rate, percent and root to shoot ratio changes were evaluated**.**

Results and discussion

Different concentrations of extracts from various organs and growth stages of plants had a significant effect on all traits (Table 1).

Based on the results of this study among various crop extracts, only the bermuda grass extract in growing stages haven't significant differences. Extracts from the flowering stage in corn and redroot pigweed and extracts from the vegetative growth stage of alfalfa had more allelopathic properties on seedling length (Fig. 1). Allelopathic compounds had affected on cell division, elongation, cell wall structure and permeability of the membrane, so reduced growth (Zhang and Mu, 2008). Based on the results of this review, extract concentration of 20 percent had more affected on the seedling length. At all concentrations, except 5%, root and leaf extract had the most effect on seedling length. Based on the results of this study, root and leaf extract at concentrations of 20% reduced seedling length about 61 and 63% respectively. Extract of stem in this concentration reduced 37% seedling length. Adding each part of extract concentration (root, stem and leaf) decreased rye seedling length as by 2.446, 1.1838, and 2.5515 unit respectively (Fig. 2). Results showed that the rye seedlings length with increasing concentration of extracts decreased. Most of the reduction in seedling length obtained with extracts concentration of 20%. Bermuda grass and alfalfa extract with 5% concentration had significantly decreasing in seedling length; But corn and redroot pigweed extract with 5% concentration had not significant effect on the seedling length of rye. Adding each part of extract concentration of corn, alfalfa, redroot pigweed and bermuda grass decreased rye seedling length as by 1.4106, 2.4841, 2.2156 and 2.1316 unit respectively (Fig. 3).

Smith *et al.*, (2001) reported that the residuals of bermuda grass, decreased seedling length and dry weight of barley, mustard and wheat. Sorghum and cotton extracts reduced germination and growth in redroot pigweed. Based on the results of this study, the highest effect on the seedling length obtained with leaf and root extract respectively. In leaf extract treatment, between allelopathic properties of extracts from the early stages of flowering and vegetative growth weren't observed significant differences. But at the root and stem extracts from vegetative growth stage had more allelopathic properties than extracts from flowering stage (Fig. 4).

Redroot pigweed can be allelopathic properties and allocation in photosynthetic substances to adaptability different levels of nitrogen change. Considering that soil nitrogen levels in the crop season are variable, the allelopathic properties are altered also.

Table 1. Analysis variance of plants extract on rye characteristics.

S.O.V	df	Germination percent	Germination rate	Seedling dry weight	Seedling length	Root / shoot
Crop type	3	4933.768**	607.459**	0.001**	122.360**	0.072
Growth stage	1	666.672	7.101	0.0	26.228*	1.201**
Crop type*stage	3	3835.594**	773.904**	0.002**	230.745**	0.011
Crop organ	2	3163.762**	329.957**	0.002**	143.289**	0.041
Crop type* Crop organ	6	1512.162**	180.080**	0.0**	47.336**	0.067
stage* Crop organ	2	438.313	106.277*	0.0**	16.884	0.243*
Crop type* Crop organ* stage	6	1158.256*	53.070	0.0**	23.866**	0.060
concentration	4	14586.564**	2309.587**	0.008**	768.450**	0.053
Concentration*crop	12	372.764	47.624	0.0**	15.453**	0.078
Concentration*stage	4	266.610	13.168	0.0	3.676	0.027
Concentration*stage*crop	12	793.054	77.808**	0.0**	21.311**	0.045
Concentration*organ	8	1128.843*	137.714**	0.0**	39.538**	0.027
Concentration*organ*crop	24	623.465	43.837*	0.0**	6.942	0.048
Concentration*organ*stage	8	431.643	21.412	0.0	4.648	0.027
Concentration*organ*stage*crop	24	967.536**	47.711*	0.0**	9.064*	0.047
Error	240	464.114	27.898	0.0	5.602	0.064
c.v. (%)		25.81	23.0	21.33	21.74	21.59

* and**: significant at 5% and 1% levels, respectively, ns: non -significant

Alfalfa extracts from various stages had significant difference on seedling dry weight. Seedling dry weight by alfalfa extracts from vegetative growth stage was 44% lower (Fig. 5). Storage complex during the stress allelopathic is stopped or delayed. This act during germination leads to respiratory substrate and ATP shortage (Vasilakoglou *et al.*, 2005). Results showed that 5 and 10 percent extract from different crop had not significant difference on seedling dry weight. Extract concentration of 15% and 20% from roots and leaves caused a significant decrease in seedling dry weight. Root and leaf extract concentration of 20 percent had 67 percent

reducing than the average control treatments on seedling dry weight. Linear regression showed that adding each part of extract concentration (root, stem and leaf) decreased rye seedling dry weight as by 0.0081, 0.0038 and 0.0081 unit respectively (Fig 6). Allelopathic compounds are transported into storage compounds to seedling reduced and seedling growth is reduced. Number of cells in a tissue reflects the sink strength of the tissue (Lu *et al.*, 2011). The germination stage mitotic activity is intense probably compound during germination and seedling establishment had important role. Seedling dry weight with increasing concentrations of various crop extracts decreased significantly. The highest decreases in seedling dry weight by extract concentrations of 20% were observed. Adding each part of extract concentration of corn, alfalfa, redroot pigweed and bermuda grass decreased rye seedling

dry weight as by 0.0047, 0.0082, 0.0071 and 0.0067 unit respectively (Fig. 7). Weir *et al.*, (2004) expressed the allelopathic compounds can affect the ATP complex. Reported that the alpha - pinene may be have more than one mechanism that one of them was their interaction with the electron flow in cytochrome, so the allelopathic compounds in this way can reduce the energy needed for seedling growth.

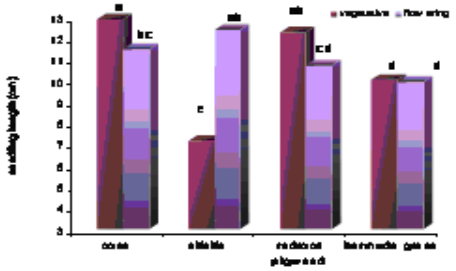

Fig. 1. Effect of plants extract in various growth stages on rye seedling length.

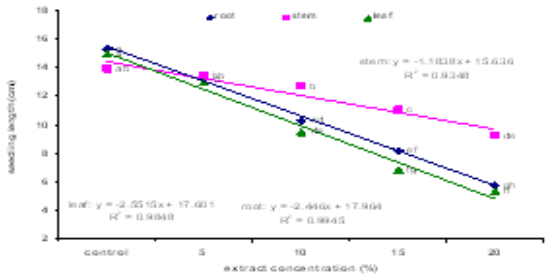

Fig.2. Effect of different organs extract concentrations on rye seedling length.

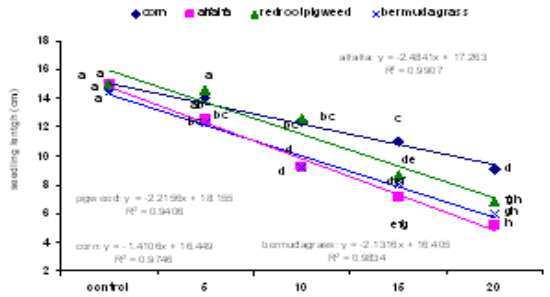

Fig. 3. Effect of plants extract concentration on rye seedling length.

Allelopathy is one of the factors that affect on germination and seedling establishment. This study crop extracts had significantly effect on rye germination. Like other traits, the greatest effect on germination, extract alfalfa by vegetative growth stage was obtained. In other crops allelopathic properties of extracts from in various stages growth and development hadn't significant differences (Fig 8). This trait bermuda grass and alfalfa extract had highest allelopathic properties. Enzymes changes had effect on transfer storage compounds during germination. By increasing extracts concentrations Rye seed germination increased also. But Between rate allelopathic properties from different parts crops had not significant differences. In 10 percent Concentration stem extract had no significant effect, while root and leaf extracts of 23 and 20 percent reduction in the percentage germination of rye caused. But with increasing concentrations of extract, the allelopathic properties of stem increased. But statistically between the allelopathic properties of root and leaf concentrations 20% and 10% had not significant difference. Linear regression showed that adding each part of extract concentration (root, stem and leaf) decreased rye germination percent as by 9.189, 6.439 and 9.521 unit respectively (Fig 9). The results showed that the effective concentration affecting on seed germination, depending on the location of production will be different. Srivastava *et al.*, (2011) Reported that allelopathic compounds from water uptake by crops is prevented, leading to lower seed germination. The results of this study extract from all organs pigweed had significant decrease in root, seedling length and fresh and dry weight seedling caused. Germination rate Rye was susceptible to these extracts (Fig. 10).

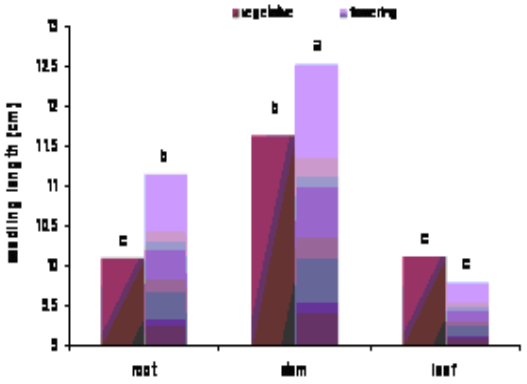

Fig. 4. Effect of different organs extract in various growth stages on rye seedling length.

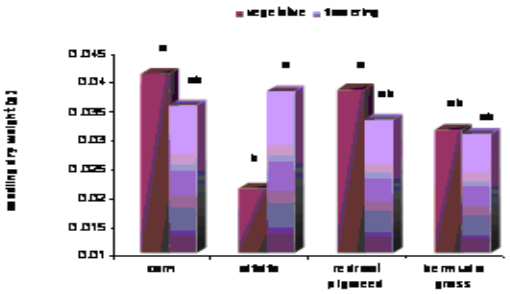

Fig. 5. Effect of plants extract in various growth stages on rye seedling dry weight

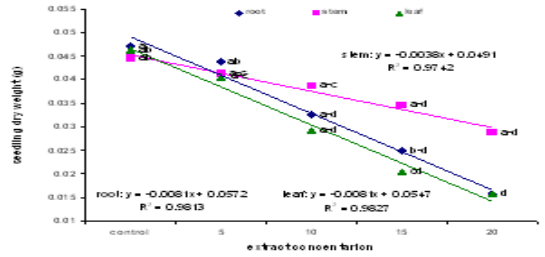

Fig.6. Effect of different organs extract concentrations on rye seedlings dry weigh.

In this study between treatments, extracts from the vegetative stage alfalfa had greatest effect on germination rate. Allelopathic properties of alfalfa extracts from flowering stage declined and less decreasing than in extracts from the vegetative growth stage caused. Corn and pigweed extracts from flowering stage had more impact on germination rate. Extract of corn had less affected (Fig 11). Allelopathic compounds reducing germination and germination will be delayed also. This delay has many effects on competition and seedlings that have gained a larger size, may be incompatible under conditions such as humidity or low soil nutrient restriction may have a better compete with their neighbors (Chon *et al*., 2002). All extracts of various crops, had significant decrease in germination rate of rye. 5% concentration, all parts of the crop extract had similar decrease in germination rate rye. 10% concentration of stem extract had the same effect with a concentration of 5%. Allelopathic properties of root and leaf extract concentration, was added. Maximum reduction by root and leaf extracts with 20% concentration caused. These two treatments 53% reduction in germination rate rye was triggered. Linear regression showed that adding each part of extract concentration (root, stem and leaf) decreased rye rate of germination as by 4.295, 2.03 and 4.38 unit respectively (Fig. 12). Researchers have reported that allelopathic compounds reduce the rate of water uptake in seeds of barley wild. The researchers have stated that this reduction in water uptake can be due to reduced activity of proteases that play an important role in the hydrolysis of leaf proteins during germination and water uptake are therefore, be attributed (Plamen *et al*., 2010). Bermuda grass and corn extracts from the roots had more allelopathic properties, while leaf extract pigweed and alfalfa on the germination rate rye had more allelopathic properties. Alfalfa leaf extract had greatest affect on germination rate of rye; difference between these treatments with corn stem extract was 42% (Fig 13). Alfalfa is one of crops that an Allelopathic property is proven. Alfalfa allelopathic compounds can be used to effectively control weeds (Xuan and Tsuzuki, 2002).

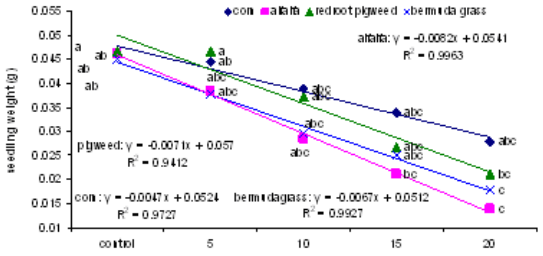

Fig. 7. Effect of plants extract concentration on rye seedling dry weight.

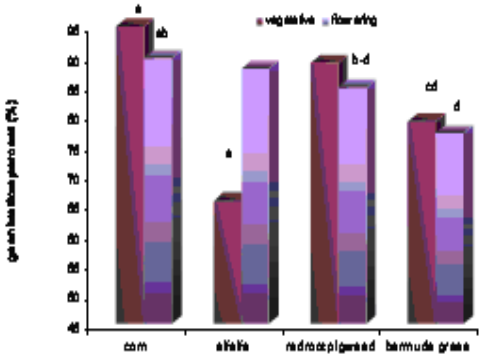

Fig. 8. Effect of plants extract in various growth stages on rye germination percent.

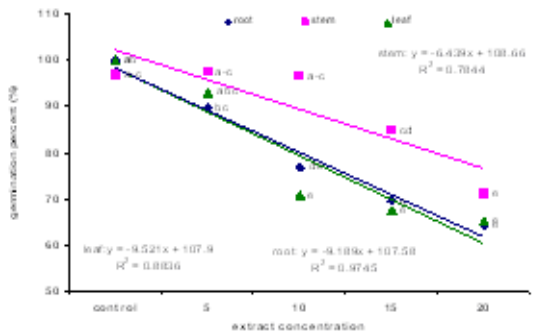

Fig. 9. Effect of different organs extract concentrations on rye germination percent.

By increasing concentration of the extracts led to increasing allelopathic properties and seed germination rate more decreased. 5% concentration of extract, only alfalfa and bermuda grass extract significant decrease in germination rate caused 16 and 13% reduced respectively. 20% alfalfa extract had most reductions in the germination rate and this trait 58 percent compared control reduced. By increasing pigweed extract highest decrease in germination rate of rye caused. In this crop 20% extract than 5% germination rate to 47 percent reduced. Adding each part of extract concentration of corn, alfalfa, redroot pigweed and bermuda grass decreased rye rate of germination as by 2.5, 4.391, 3.793 and 3.587 unit respectively (Fig 14). Allelochimicals effects on germination are through the destruction of normal cell metabolism. An organ damage by storage of materials, a process that usually occurs quickly during the early stages of germination seems under allelopathic stress is reduced or delayed (Khaliq *et al.*, 2011).

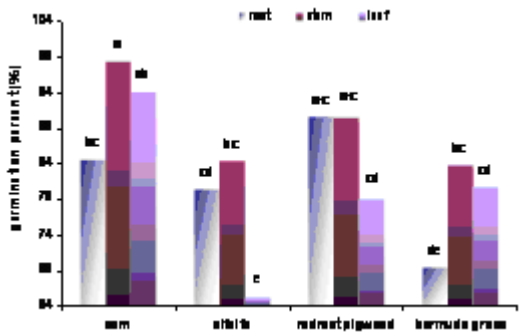

Fig. 10. Effect of different organ of plants extract on rye germination percent.

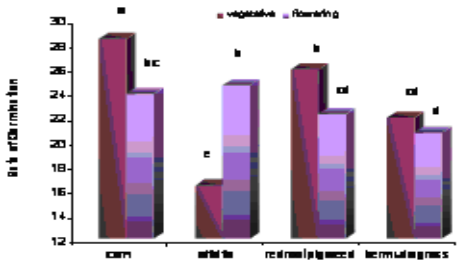

Fig. 11. Effect of plants extract in various growth stages on rye germination rate

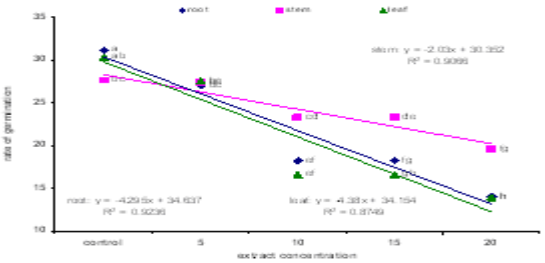

Fig. 12. Effect of different organs extract concentrations on rye germination rate

Based on the results of this review, the root extract from the vegetative stage was more allelopathic property. While the leaf extract at the beginning of flowering stage was more allelopathic properties obtained (Fig 15)

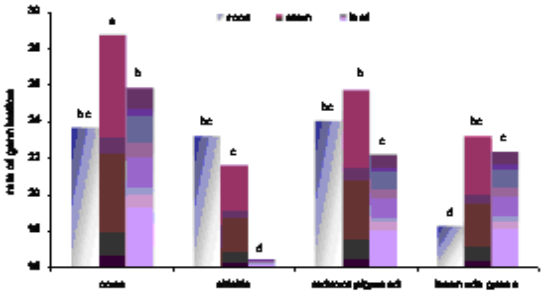

Fig. 13. Effect of different organ of plants extract on rye germination rate

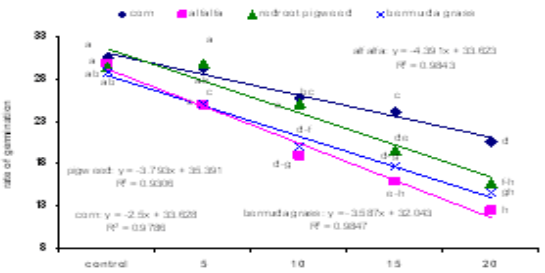

Fig. 14. Effect of plants extract concentration on rye germination rate.

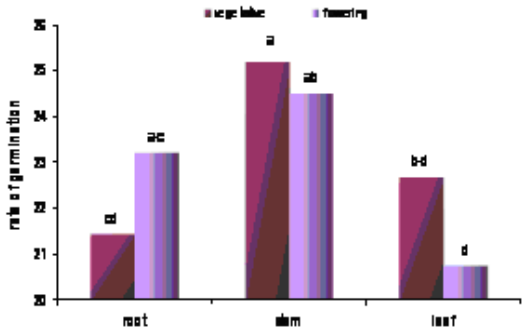

Fig. 15. Effect of different organs extract in various growth stages on rye germination rate

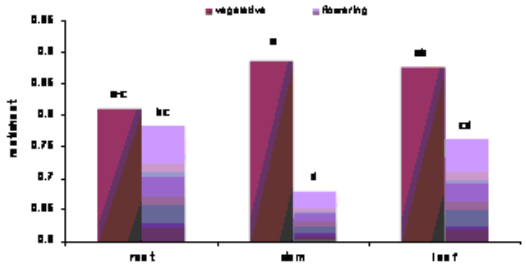

Fig. 16. Effect of different organs extract in various growth stages on rye root/ shoot ratio

Extracts from different crop parts Root to shoot ratio of rye have been reduced. In extracts of leaf and stem extracts from the early stage of flowering had more allelopathic properties of extracts from vegetative growth stage (Fig 16). Allelopathic properties Root extracts on root to shoot ratio of crops was not affected by growth stage

Conclusion

Result showed that materials produced from the leaves, stems and roots of bermuda grass, pigweed, corn and alfalfa germination and growth of rye affected. Most reduction on germination rye by extracts from alfalfa leaves and roots of bermuda grass obtained. Alfalfa extracts from the vegetative stage had more effect than reproductive stage, but bermuda grass extracts hadn't effect on the rye.

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