INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
IJPAES
Volume-4, Issue-3, July-Sept-2014
ISSN 2231-4490

Coden : IJPAES www.ijpaes.com
Received: 4th April-2014 *Revised: 24th May-2014* *Accepted: 25th May-2014*
Research article

ALLELOPATHIC ACTIVITY OF RYE (*SECALECEREALE*) AND COMMON VETCH (*VICIAVILLOSA*) ON CORN AND SOME WEED SPECIES

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ABSTRACT: Biological management of weeds has become an interesting priority for many farmers and researchers across the globe. In order to determine germination and early growth response of some weed species and corn to presence of rye and common vetch residues in soil, an outdoor pot study was conducted at Faculty of Agriculture and Natural Resources, Razi University, Kermanshah, Iran in 2013. Treatments were included of addition of ground residues of rye and common vetch and a mixture of them to pots containing seeds of *Echinochloacrus-galli*, *Setariaviridis*, *Chenopodium album*, *Amaranthusretroflexus*, *Xanthium strumarium*, and *Zeamays*. According to the results addition of rye and common vetch residues resulted in reducing the shoot and root dry weight of all tested weeds while corn was not affected. Mixing residue of rye and common vetch resulted in the highest reduction of weight of shoot and root of all treated weed species. It can be suggested that incorporating of rye and common vetch residues into the soil can reduce the population and competition of weeds in corn. Both rye and common vetch selectively reduced weeds seed germination of weed species while corn was not significantly influenced.
Key words: Corn, Residue, Root, Shoot, Weed.

INTRODUCTION

Allelopathy could be used as an important component of new weed management systems [1]. Several plant species have repeatedly demonstrated allelopathic potential against weeds [2, 3, 4, 5, 6, 7]. Among as many as allelopathic plants, in Iranian agricultural systems, a lot of attention has been given to rye (*Secalecereale* L.) and common vetch (*Viciavillosa* Roth) for being used as allelopathic tools due their specific properties. Both of them release significant quantities of allelopathic growth inhibitors into the environment [8, 9]. Rye is often used as an allelopathic cover crop because of its extensive root system, tall growing habit, production of abundant biomass and high tolerance to adverse growing condition [10,11]. Common vetch is of particular interest to farmers because, in addition to suppressing weed germination and early growth, it provides nitrogen to the agro system [12, 13]. Many works have reported inhibitory effect of rye and common vetch in the petri-dish bioassays while there is uncertainty regarding results in real farm conditions [14, 15, 16, 17]. Several approaches are commonly used to investigate allelopathic potential of one component; however soil engaging ones are rare [18, 19].

Generally, availability of allelochemicals in soil is affected by physical, chemical and microbial activities in soil [16, 20, 21]. So it is necessary to evaluate the real allelopathic potential of a plant species under soil circumstances. Therefore the objective of this study was to determine germination and growth response of some weed species and corn in soils incorporated by rye and common vetch residues.

MATERIALS AND METHODS

Rye and common vetch residues were prepared by harvesting foliage and root tissues of mature plants from the Research farm located at the Faculty of Agricultural and Neutral Resources, Razi University, Kermanshah (34°18′51″N, 47°03′54″E; elevation 4557 ft.), Iran. Foliage and root were harvested in mid-May 2013 when plants were in the pre-blooming growth stage. Foliage was harvested by cutting all aboveground biomass from randomly selected plots.

After clipping foliage, the top 15 cm of soil containing root system was removed and root biomass was separated from soil with water. Foliage and root samples were placed on a table and dried at room temperature then were ground with a mill equipped with a 1-mm-mesh sieve. Ground foliage and root samples were placed in plastic bags and stored in dark at 4°C refrigerator until later tests. The amount of rye and common vetch foliage and root residues were determined based on shoot and root yield (wt/wt) in the field from which the samples were collected. According this calculation, rye and common vetch residues were added to 150 g-containing pots at the rates of 4.8 and 2.4 g, respectively. In addition mixed residues of both species were added to each pot at 3.6 g per 150 g soil. Designated amounts of foliage and root residues were mixed together.

Twenty seeds of barnyardgrass (*Echinochloacrus-galli*), green foxtail (*Setariaviridis*), lambsquarters (*Chenopodium album*), redroot pigweed (*Amaranthusretroflexus*), common cocklebur (*Xanthium strumarium*), and corn (*Zea mays*)were sown in each pot. A non-treated check for comprising also was included. Pots containing above mentioned weeds and corn were placed in ambient air under natural condition. All pots were irrigated as needed during the experiment. Completely randomized design with four replications was used in all experiments. Each experiment was conducted twice. The number of germinated seeds in each pot was recorded and germinated seedlings were thinned to 1 plant per pot. Additional seeds that germinated after 10 days from planting were recorded and removed [22].

Mean germination time (MGT) and mean germination rate (MGR) were calculated from following equations:

$$\text{Equation (1) } MGT = \sum Di\, ni / \sum Ni$$

$$\text{Equation (2) } MGR = 1/MGT*100$$

Where, Di: Number of Ithday, ni: Number of germinated seeds atIthday, and Ni: Number of total seeds germinated on the last day

At the end of the study weed shoots were clipped at the soil surface, and were oven-dried at 70°C for 48 hours. The data represent the average of the two experiments for each study because no experiment by treatment interaction occurred. Data were subjected to ANOVA and mean values were separated using Fisher's protected LSD test.

RESULTS

According the results of this study addition of rye and common vetch residues in to the soil resulted in reducing the shoot and root of all tested weeds while corn was not affected (Table 1). These results are similar to those of works which have demonstrated that rye and common vetch could prevent seed germination and seedling early growth of many weed species [10, 18]. However, soil containing studies are not a lot [16, 23, 24].

Table 1.Effect of common vetch and rye residues on early growth parameters of *Echinochloacrus-galli, Setariaviridis, Chenopodium album, Amaranthusretroflexus, Xanthium strumarium* and *Zea mays.*

Allelopathic treatments	Treated Plant Species											
	Echinochloa crus-galli		*Setariaviridis*		*Chenopodium album*		*Amaranthusretroflexus*		*Xanthium strumarium*		*Zea mays*	
	Shoot Dry Weight(g)	Root Dry Weight(g)	Shoot Dry Weight(g)	Root Dry Weight(g)	Shoot Dry Weight(g)	Root Dry Weight(g)	Shoot Dry Weight(g)	Root Dry Weight(g)	Shoot Dry Weight(g)	Root Dry Weight(g)	Shoot Dry Weight(g)	Root Dry Weight(g)
vetch	0.11	0.13	0.07	0.29	0.05	0.16	0.06	0.31	0.49	0.30	0.47	1.88
Rye	0.04	0.06	0.03	0.05	0.04	0.06	0.03	0.04	0.24	0.10	0.42	1.44
Rye+vetch	0.02	0.03	0.03	0.02	0.03	0.02	0.05	0.03	0.61	0.16	0.54	1.42
control	0.06	0.05	0.04	0.06	0.04	0.05	0.04	0.06	0.56	0.25	0.59	1.90
LSD(0.05)	0.01	0.001	0.02	0.02	0.01	0.001	0.01	0.02	0.05	0.04	0.03	0.53

Shoot dry weight of all weed species germinated in soil contained vetch except with common cocklebur to debris of vetch and rye and mixture was lower than control (Table 1). In most cases mixing residues of rye and common vetch resulted in the highest reduction in shoot and root dry weights of all treated weed species (Table 1). Such result also has been reported by other researchers[8]. Although different weed species responded to allelochemicals variously, probably depending on their seed sizes[25, 26.In this study, all weed species were affected by allelopathic plants but corn root dry weight was not negatively affected by presence of allelochemical (Table 1). This can be attributed to allelopathic plant selectivity and the higher corn seed size (a lower surface to volume ratio) as compared whit the weed species under study. Shoot and root growth of different weed species responded differently to allelopathic plant residues showing the different sensitivities of plant species and organs to allelochemicals (Table 1). In this study dry weight of shoot and root as indicators of early growth of seedling were affected by allelopathic materials.

By reducing these indexes, the initial growth of weeds will be reduced which in turn would help to crops overtaking weeds. Early season growth has great impact on success of a plant species in capturing soil nutrition and sunlight [27, 28]. Thus by sowing rye and common vetch and incorporating them into the soil before corn planting, weed competition would be alleviated.

Table 2. Seed germination traits of *Echinochloacrus-galli*, *Setariaviridis*, *Chenopodium album*, *Amaranthusretroflexus*, *Xanthium strumarium*, and *Zea mays* as affected by incorporated of common vetch, rye and mixture of both into the soil.

	Echinochloa crus-galli			Setariaviridis			Chenopodium album			Amaranthusretroflexus			Xanthium strumarium			Zea mays		
Allelopathic plants	MGR (per day)	MGT	GER%	MGR (per day)	MGT	GER %	MGR (per day)	MGT	GER %	MGR (per day)	MGT	GER %	MGR (per day)	MGT	GER %	MGR (per day)	MG	GER%
Common vetch	24.05	8.65	11.8	31.08	9.25	11.28	25.80	9.96	10.20	23.85	8.41	12.4	47.25	12.19	8.35	49.93	11.9	11.97
Rye	24.05	9.14	11.9	21.03	10.49	9.75	14.50	7.66	15.00	14.80	5.87	12.7	37.35	8.58	5.54	32.75	15.2	15.24
Rye+ vetch	29.40	10.39	9.76	22.03	10.12	10.49	13.50	7.92	9.75	19.15	8.84	13.6	43.45	15.13	7.00	32.10	9.69	9.70
control	34.60	9.89	105	29.75	9.68	10.85	34.55	9.43	10.96	28.18	10.28	10.2	61.35	14.62	6.54	55.75	16.3	16.31
LSD(0.05)	4.5	1.3	2	2.3	1.08	1	3.23	1.2	2	3.4	1.2	2.03	3	4.98	1	2	2	2.2

Abbreviations: MGR, mean germination rate; MGT, mean germination time; GER%, germination percentage.

Results showed that for all weed species the highest seed germination parameters were related to control (Table 2).In the other words, using the residue of common vetch and rye and mixture of both suppressed seed germination of weeds. However, seed germination of corn was not affected by allelopathic plant added to the soil. Therefore it could be concluded that these materials act as selective weed suppressing agents in corn field. Similar results were also reported by other researchers [9, 13]. Among seed germination properties, in general, mean germination time was more sensitive to presence of mixture of both allelopathic plants rather than alone (Table 2). This could be due to synergism between rye and common vetch in view of their allelopathic activities. When compared with control, in all weed species, germination percentage did not respond to allelochemicals meaningfully. For allallelopathic treatments, among weed species the lowest percentage of mean germination time and mean germination rate relative to control was belonged to common cocklebur (Table 2).Generally, in real field conditions, a vast range of edaphic and environmental factors affect allelopathic activity of allelochemicals in soil [16]. Common vetch tissue has higher amounts of nitrogen; this probably explains why mixing rye and common vetch resulted in higher inhibitory effect on seed germination. Furthermore common vetch can serve as a source of food for soil microbes which are especially important in residue decomposition[20].In the other hand, rye has a lot of BOA ((2(3H)-Benzoxazolinone)) that is highly toxic to some weed seeds [11, 24, 29]. In general the most effective manner by which allelopathic material would reduce the pressure of weeds in farms is by preventing the germination and diminishing the early growth of seedlings[15].

CONCLUSION

According to the results of this study, it can be suggested that incorporated rye and common vetch as green manuresin to the soil can reduce the population and competition of weeds in warm season crops such as corn. Furthermore, these green manures add organic matter to the soil which in turn enhances crop growth and yield.

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