ISSN (Online): 2349-1183; ISSN (Print): 2349-9265
TROPICAL PLANT RESEARCH
The Journal of the Society for Tropical Plant Research

6(1): 152–156, 2019
DOI: 10.22271/tpr.2019.v6.i1.022

Research article

Germination and seedlings growth of Corn (*Zea mays* L.) to allelopathic effects of rice (*Oryza sativa* L.)

Mohamad Hesam Shahrajabian[1,2,3]*, Mehdi Khoshkharam[1], Wenli Sun[2,3] and Qi Cheng[2,3]

[1]Department of Agronomy and Plant Breeding, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran
[2]Biotechnology Research Institute, Chinese Academy of Agricultural Sciences, Beijing-100081, China
[3]Nitrogen Fixation Laboratory, Qi Institute, Building C4, No. 555 Chuangye, Jiaxing-314000, Zhejiang, China

***Corresponding Author: hesamshahrajabian@gmail.com [Accepted: 20 April 2019]

Abstract: Allelopathy is the direct or indirect effect of plants through chemical compounds produced by the plants itself. . An experiment was conducted to study the allelopathic effect of plant organs extract (leaf, stem, root and total), and different rice extract densities (0%, 25%, 50% and 100%) on the germination and seedling growth of corn with four replications was used. Treatments included Different plant organ extract showed significant impact on germination rate, germination percentage, coleoptile weight, radicle weight, radicle length and coleoptile length of corn. Rice extract densities effect on germination percentage, coleoptiles weight, radicle weight, radicle length and coleoptiles length was significant. The interaction between rice extract and plant organs had significant effect on radicle weight and coleoptiles length. Control treatment (0% rice extract density) had obtained the highest germination rate, germination percentage, coleoptiles weight, radical weight, radical length and coleoptiles length. All experimental characteristics decreased with increase rice extract densities. The higher values for germination rate, germination percentage, coleoptile weight, radicle weight, radicle length and coleoptiles length was related to stem extract, followed by root, leaf and total extract. According to the results of this trial, it can be concluded that one of the reasons of the decrease of cultivated plants operation after rice, is the presence of allelopathic materials in herbaceous remains of this plant.
Keywords: Germination - Seedling growth - Corn - Rice - Allelopathy.

[Cite as: Shahrajabian MH, Khoshkharam M, Sun W & Cheng Q (2019) Germination and seedlings growth of Corn (*Zea mays* L.) to allelopathic effects of rice (*Oryza sativa* L.). *Tropical Plant Research* 6(1): 152–156]

INTRODUCTION

Corn (*Zea mays* L.) is one the most important cereal crops grown in Iran, and its demand for food, animal and industrial use is increasing rapidly as population increased (Khoshkharam *et al*. 2010, Esfandiary *et al*. 2011, Soleymani *et al*. 2011, Soleymani *et al*. 2012a,b). It is the third important food crop in the world (Esfandiary *et al*. 2012, Soleymani & Shahrajabian 2012a,b, Soleymani & Shahrajabian 2013, Soleymani *et al*. 2016, Shahrajabian *et al*. 2017). Rice is also the most stable food for more than half of the world, and it is the second most important food in Iran (Shahri *et al*. 2012, Yazdpour *et al*. 2012). Rice has allelopathic potential against weeds and crops (Ma *et al*. 2014, AmirulAlam *et al*. 2018). In an ecological system, allelochemicals produced by one crop species can influence the growth, productivity and yield of other crops of the same crop (Chopra *et al*. 2017, Sitthinoi *et al*. 2017). Allelopathy has been considered not only as an environmentally friendly approach for weed control but also as a potential reason causing autotoxicity in crop production (Ma *et al*. 2014). A number of compounds, such as phenolic acids, fatty acids, phenylalkanoic acids, hydroxaicacids, terpenes, indoles, and the labdane-related diterpenoidmomilactones, have been identified as potential rice allelochemicals (Khanh *et al*. 2007, Kato-Noguchi & Peters 2013). RashedMohasel *et al*. (2009) reported that the leaves and corms extract of saafron reduced plant height, leaf weight and stem weight of redroot pigweed

Received: 15 January 2019 Published online: 30 April 2019
https://doi.org/10.22271/tpr.2019.v6.i1.022

and lambs quarter. Sitthinoi *et al*. (2017) demonstrated the allelopathic effect of jungle rice extracts on the seed germination and seedling growth or rice. Therefore, the aim of this study was to survey the allelopathic effects of rice (*Oryza sativa* L.) on germination and seedling growth of corn (*Zea mays* L.).

MATERIALS AND METHODS

This research accomplished in seed technology laboratory of Faculty of Agriculture, Islamic Azad university of Isfahan in 2018 (latitude 32° 40' N, longitude 51° 58' E, and 1570 m elevation). A factorial layout within completely randomized design with four replications was used. Treatments included plant organs extract (leaf, stem, root and total), and different rice extract densities (Lenjan Cultivar) includes 4 levels of 0%, 25%, 50% and 100%. Rice plants were collected from experimental fields. The samples were cleaned, dried, ground and then put into water for almost 48 hours to obtain the extract. The aqueous extract was prepared by adding 100 g of ground rice straw into 1 L distilled water for 48 hours. The extract were filtered through muslim cloth and then through Whatman No. 1 filter paper. The seeds of corn (SC 704) were put in sodium hypocoloid 5% during 10 minutes and then they were washed by distilled water. Seeds soaked in distilled water used as control treatment. For germination test, 20 seeds were put in 12 cm petridishes on two layers of filter paper and 5 ml of distilled water for control and 5 ml from levels of expected extract were added to it. The lids of containers with the temperature 25°C were prepared (12 hours in the day and 12 hours in the night). Every day, the germinated seeds were numbered in the certain time. The criterion of radical exit germination has been considered 1 mm. At the end of germination test, the length of radical and coleoptiles were measured. Both radical length (root) and plumule (shoot) length was measured using a ruler in cm. Also, at the end, the extreme percent of germination and the rate of germination were accounted. For counting the length of radical and coleoptiles, 10 germinated seeds were taken out from petridishes and measured. For accounting germination rate, from the second day, unit when the seeds did not germinate, the germinated seeds were counted per 24 hours and on time.

The germination rate was defined as following equation,

$$GR = \Sigma \frac{N}{\Sigma(n \times g)}$$

Where, n is the number of germinated seed on growth day and g is the number of germination seedsAnalysis of variance (ANOVA) was used to determine the significant differences. The Multiple Range Test of Duncan performed the separation means (P<0.05). All statistics was performed with the SAS statistical software.

RESULTS AND DISCUSSION

The influence of rice extract was significant on germination percentage, coleoptile weight, radicle weight, radicle length and coleoptiles length. Germination rate was not significantly influenced by rice extract. All experimental characteristics, namely germination rate, germination percentage, coleoptiles weight, radicle weight, radicle length and coleoptiles length was significantly influenced by plant organs. The interaction between rice extract and plant organs had meaningful effect on radicle weight and coleoptile length. However, germination rate, germination percentage, coleoptiles weight and radicle length was not significantly affected by rice extract and plant organs interaction (Table 1). Soleymani & Shahrajabian (2012c) also reported the significant influence of sesame extract density and plant organs on germination percentage, coleoptile weight, radical and coleoptile length.

Table 1. Analysis of variance for experimental characteristics.

S.O.V.	d.f.	Germination rate	Germination percentage	Coleoptile weight	Radicle weight	Radicle length	Coleoptile length
Replication	2	0.82	25.41	0.000023	0.00000004	0.09	0.12
Rice extract (a)	3	0.59^{ns}	670.08**	0.000515**	0.00003736**	13.1**	10.42**
Plant organs (b)	3	11.53**	1121.28**	0.000314**	0.00011698**	1.2**	3.03**
a×b	9	0.56^{ns}	61.11^{ns}	0.000019^{ns}	0.00000207*	0.22^{ns}	0.56*
Error	30	1.3	48.54	0.000024	0.00000083	0.15	0.25

Note: ^{ns}- Non significant, *- Significant at 0.05 significant in F-tests, ** Significant at 0.001 significant in F-test, d.f.- Degree of freedom.

The highest germination rate was related to control treatment (control treatment) (2.33%), which had no significant differences with other treatments. Germination percentage was decreased significantly with increase in rice extract density from 0% to 100% rice extract density. Germination percentage in 0%, 25%, 50% and 100% of rice extract density was 72.47%, 55.34%, 68.73% and 62.87%, respectively. Germination is the most sensitive stage in the life cycles of plant and uniform germination is essential to having a good green area and crop growth (Soleymani & Shahrajabian 2012c,d, Soleymani & Shahrajabian 2018). The higher values for both coleoptile weight and radicle weight was obtained for control treatment (0%), followed by other treatments. There were significant differences between 0% of rice extract with other treatments. The highest radicle length and coleoptiles length was 6.00 mm, and 4.20 mm, which was obtained for control treatment. Both radicle length and coleoptiles length was decreased significantly from application of 0% to 100% rice extract density. Afridi *et al*. (2013) also found that rice straw extract reduced the root length, shoot length, fresh biomass of the associated. The maximum and the minimum germination rate was related to stem (3.23%), and total plant extract (0.95%), which had meaningful differences with each other. Germination rate in root and leaf extract was 2.47% and 1.71%, respectively. Although, the maximum germination percentage was obtained for stem extract (74.03%), its difference with root extract (71.36%) was not significant. The minimum germination percentage was achieved in total plant extract (53.09%), which had significant differences with all other treatments. Afridi *et al*. (2013) reported that rice straw extract activity was due to the synergistic effects of various allelochemicals which inhibited and restricted the germination and growth of the plants. The highest and the lowest value of coleoptile weight was related to stem (0.031 mg), and total (0.020 mg), which had meaningful differences with each other. There was no meaningful difference between stem and root extract, and also between leaf and total plant extract. The higher values for radicle weight was obtained for stem (0.011 mg), followed by root (0.006 mg), leaf (0.005 mg) and total plant extract (0.004 mg), respectively. Furthermore, all differences between treatments were significant. Stem extract had obtained the highest value of radicle length (4.79 mm), and coleoptiles length (3.38 mm), which had significant differences with leaf and total plant extracts. However, its difference with root extract was not significant. The minimum radicle length and coleoptiles length which was 4.04 mm, and 2.32 mm, was related to total plant extract (Table 2). Sitthinoi *et al*. (2017) reported that the extracts from the shoot part of jungle rice had a greater inhibitory effect on the root length and seedling dry weight than those from the root part. The highest germination rate (3.57%), germination percentage (81.21%), coleoptiles weight (0.041 mg), radicle weight (0.0151 mg), radicle length (6.40 mm), and coleoptile length (5.03 mm) was related to interaction between control treatment (0% of rice extract density) and stem extract (Table 2).

Table 2. Mean comparison of germination rate (%), germination percentage (%), coleoptile weight (mg), radical weight (mg), radical length (mm) and coleoptile length (mm).

Treatment	Germination rate	Germination percentage	Coleoptile weight	Radicle weight	Radicle length	Coleoptile length
Rice extract density (E)						
0% (E1)	2.33a	72.47a	0.034a	0.0092a	6.00a	4.20a
25% (E2)	1.87a	55.34c	0.019c	0.0050c	3.79b	2.18c
50% (E3)	2.22a	68.73a	0.026b	0.0060b	4.12b	2.98b
100% (E4)	1.93a	62.87b	0.024b	0.0050bc	3.87b	2.27c
Plant organs (O)						
Stem (O1)	3.23a	74.03a	0.031a	0.011a	4.79a	3.38a
Root (O2)	2.47ab	71.36a	0.029a	0.006b	4.57a	3.26a
Leaf (O3)	1.71bc	60.93b	0.023b	0.005c	4.38b	2.66b
Total (O4)	0.95c	53.09c	0.020b	0.004d	4.04c	2.32b
E×O						
E1O1	3.57a	81.21a	0.041a	0.0151a	6.40a	5.03a
E1O2	2.38abc	74.69ab	0.035ab	0.0074cd	5.84a	4.84a
E1O3	1.89abc	69.58abcd	0.031bc	0.0066de	5.82a	3.67b
E1O4	1.49abc	64.4bcd	0.030bcd	0.0061def	5.93a	3.24bc
E2O1	2.61abc	65.49bcd	0.028bcdef	0.0089bc	4.18bc	3.13bcde
E2O2	2.26abc	65.92bcd	0.023cdef	0.0048fghi	4.18bc	2.63cde
E2O3	1.9abc	47.77ef	0.013gh	0.0033hi	3.65cd	1.67fg
E2O4	074c	42.17f	0.010h	0.0029i	3.15d	1.29g
E3O1	3.14ab	72.61abc	0.03bcde	0.0099b	4.17bc	3.12bcde
E3O2	2.56abc	73.35abc	0.03bcde	0.0053efg	4.18bc	3.21bcd
E3O3	2.21abc	68.7abcd	0.026bcdef	0.0048fghi	4.19bc	3bcde
E3O4	0.96bc	60.25cd	0.020efg	0.0033hi	3.95bc	2.59cdef
E4O1	3.59a	76.81ab	0.027bcdef	0.0091bc	4.41b	2.25def
E4O2	2.68abc	71.46abc	0.026bcdef	0.0052efgh	4.07bc	2.37cdef
E4O3	0.85c	57.67de	0.021defg	0.0038ghi	3.86bc	2.28cdef
E4O4	0.6c	45.54ef	0.020fg	0.0029i	3.14d	2.17ef

Note: Common letters within each column do not differ significantly. E- Rice extract, O- Plant organ.

CONCLUSION

Alleopathy is any effect that is caused by plants and microorganisms on another plant as a result of the release of chemical compounds which are named allelochemicals; futherallelopathic effects on plants have no limitations because they may be direct or indirect, harmful or beneficial influence. Allelochemicals are produced by plants as a result of secondary metabolism products. Control treatment (0% rice extract density) had obtained the highest germination rate, germination percentage, coleoptiles weight, radical weight, radical length and coleoptiles length. All experimental characteristics decreased with increase rice extract densities. The higher values for germination rate, germination percentage, coleoptile weight, radicle weight, radicle length and coleoptiles length was related to stem extract, followed by root, leaf and total extract. Rice may increase the presence of secondary metabolites, all of which may have different effects on seed germination percentage. Moreover, the allelochemicals which are responsible for germination and growth reduction of different crops, should be identified in future studies.

REFERENCES

Afridi RZ, Khan MZ, Hussain Z, Saleem S, Khan S, Afridi K & Ali M (2013) Allelopathic effects of rice straw extract on different crops and weeds. *ARPN Journal of Agricultural and Biological Science* 8(5): 411–418.

AmirulAlam Md, Hakim MA, Juraimi AS, Rafii MY, Hasan MM & Aslani F (2018) Potential allelopathic effects of rice plant aqueous extracts on germination and seedling growth of some rice field common weeds. *Italian Journal of Agronomy* 13: 1066.

Chopra N, Tewari G, Tewari LM, Upreti B & Pandey N (2017) Allelopathic effect of *Echinochloa colona* L. and *Cyperus iria* L. weed extracts on the seed germination and seedling growth of rice and soybean. *Hindawi, Advances in* Agriculture 2017: Article ID 5748524.

Esfandiary M, Soleymani A & Shahrajabian MH (2012) Evaluation of yield and yield components of corn cultivars in different planting methods under semi arid condition of Iran. *Journal of Food, Agriculture and Environment* 10(2): 664–667.

Esfandiary M, Soleymani A, Shahrajabian MH & Darkhal H (2011) Effect of planting methods on grain yield and leaf orientation at different stages of corn cultivars. *Research on Crops* 12(2): 336–340.

Kato-Noguchi H & Peters RJ (2013) The role of momilactones in rice allelopathy. *Journal of Chemical Ecology* 39: 175–185.

Khanh T, Xuan T & Chung I (2007) Rice allelopathy and the possibility for weed management. *Annals of Applied Biology* 151: 325–339.

Khoshkharam M, Rezaei A, Soleymani A & Shahrajabian MH (2010) Effects of tillage and residue management on yield components and yield of maize in second cropping after barley. *Research on Crops* 11(3): 659–666.

Ma Y, Zhang M, Li Y, Shui J & Zhou Y (2014) Allelopathy of rice (*Oryza sativa* L.) root exudates and its relations with *Orobanche cumana* Wallr. And *Orobanche minor* Sm. germination. *Journal of Plant Interactions* 9(1): 722–730.

RashedMohasel MH, Gharakhlou J & Rastgou M (2009) Allelopathic effects of saffron (*Crocus sativus*) leaves and corms on seedling growth of redroot pigweed (*Amaranthus retroflexus*) and lambs quarter (*Chenopodium album*). *Iranian Journal of Field Crops Research* 7(1): 53–61.

Shahrajabian MH, Soleymani A & Khoshkharam M (2017) Influence of green manuring from different cover crops and farm yard manures on quantitative and qualitative characteristics of forage corn in low input farming. *Research on Crop Ecophysiology* 12(2): 62–68.

Shahri MM, Yazdpour H, Soleymani A, Shahrajabian MH & Sharifianzadeh M (2012) Yield and yield components of ratoon crop of rice as influenced by harvesting at different plant height and time. *Research on Crops* 13(2): 408–411.

Sitthinoi P, Lertmongkol S, Chanprasert W & Vajrodaya S (2017) Allelopathic effects of ungle rice (*Echinochloa colona* (L.) Link) extract on seed germination and seedling growth of rice. *Agriculture and Natural Resources* 51: 74–78.

Soleymani A & Shahrajabian MH (2012a) Influence of nitrogen fertilizer on ash, organic carbon, phosphorus, potassium, and fiber of forage corn intercropped by three cultivars of Berseem clover as cover crops in semi arid region of Iran. *International Journal of Biology* 4(3): 38–43.

Soleymani A & Shahrajabian MH (2012b) Forage yield and quality in intercropping of forage corn with different cultivars of berseem clover in different levels of nitrogen fertilizer. *Journal of Food, Agriculture and Environment* 10(1): 602–604.

Soleymani A & Shahrajabian MH (2012c) Study of allelopathic effects of sesame (*Sesamumindicum*) on canola (*Brassica napus*) growth and germination. *International Journal of Agriculture and Crop Sciences* 4(4): 183–186.

Soleymani A & Shahrajabian MH (2012d) Study of cold stress on the germination and seedling stage and determination of recovery in rice varieties. *International Journal of Biology* 4(4): 23–30.

Soleymani A & Shahrajabian MH (2013) The effects of nitrogen fertilizer on ash, nitrate, organic carbon, protein and total yield of forage maize in semi arid region of Iran. *Technical Journal of Engineering and Applied Sciences* 3(15): 1680–1684.

Soleymani A & Shahrajabian MH (2018) Changes in germination and seedling growth of different cultivars of cumin to drought stress. *Cercetari Agronomice in Moldova* 1(173): 91–100.

Soleymani A, Khajedin AA & Shahrajabian MH (2011) Grain yield and yield components of corn (*Zea mays* L.) hybrids in response to planting dates in semi-arid region in Isfahan. *Research on Crops* 12(1): 45–52.

Soleymani A, Khoshkharam M & Shahrajabian MH (2012b) Influence of green manures and crop residue management on yield and yield components of silage corn. *Research on Crops* 13(3): 871–876.

Soleymani A, Shahrajabian MH & Khoshkharam M (2012a) Effect of different fertility systems on fresh forage yield and qualitative traits of forage corn. *Research on Crops*13(3): 861–865.

Soleymani A, Shahrajabian MH & Khoshkharam M (2016) The impact of barely residue management and tillage on forage maize. *Romanian Agricultural Research* 33: 161–167.

Yazdpour H, Shahri MM, Soleymani A & Shahrajabian MH (2012) Effects of harvesting time and harvesting height on grain yield and agronomical characters in rice ratoon (*Oryza sativa* L.). *Journal of Food, Agriculture and Environment* 10(1): 438–440.