Current Journal of Applied Science and Technology

40(26): 11-18, 2021; Article no.CJAST.74664
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Allelopathic Effects of Extract *Robinia pseudoacacia* L. and *Chenopodium album* L. on Germination of Tomato (*Solanum lycopersicum* L.)

Sanida Bektić[1*], Samira Huseinović[1], Jasminka Husanović[2] and Senad Memić[3]

[1]University of Tuzla, Faculty of Science, Univerzitetska 4, 75 000 Tuzla, Bosnia and Herzegovina.
[2]University of Tuzla, Faculty of Technology, Univerzitetska 7, 75000 Tuzla, Bosnia and Herzegovina.
[3]JP Komus D.O.O. Gračanica Golači BB, 75326 Gračanica, Bosnia and Herzegovina.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2021/v40i2631520
Editor(s):
(1) Dr. Bishun Deo Prasad, Dr. Rajendra Prasad Central Agricultural University, India.
Reviewers:
(1) Kowthar Gad Aly El-Rokiek, National Research Centre, Egypt.
(2) Muhammad Adamu, Federal University Dutse, Nigeria.
Complete Peer review History: https://www.sdiarticle4.com/review-history/74664

Original Research Article

Received 20 July 2021
Accepted 30 September 2021
Published 06 October 2021

ABSTRACT

Allelopathy can have an important applicaiton in areas of agriculture, especially in integrated protection from weeds, by using of allelopathic crops in different ways. In this research allelopathic effects of invasive species acacia (*Robinia pseudoacacia* L.) and white goosefood (*Chenopodium album* L.) are explored on germination of tomato (*Solanum lycopersicum* L.). Water extracts of dry leaves of white goosefoot and acacia are prepared according tothe method : Norsworthy (2003). Experiment has been made in controlled laboratory conditions. Results of this research show that acacia and white goosefood have negative allelopathy potential and they act inhibitory on germination of tomatoes. Research of allelopathy and allelopathic relationships of weed species and agricultural cultures represents a big challenge for those people who are working in food production, and at the same time can be an instrument of ecologically sustainable agriculture.

Keywords: Allelopathy; water extracts; Robinia pseudoacacia; Chenopodium album.

**Corresponding author: E-mail: sanida.bektic76@gmail.com;*

1. INTRODUCTION

Modern researches are focused on finding different alternative measures in fight against weends weeds which inflict great damage in agricultural production, which contributes to loss of yield of big 34% [1]. Therefore, allelopathy can have an important application in area of agriculture, especially in integrated protection of weeds, by using allelopathic crops in different ways [2].

Effect of allelopathy primarily depends on a plant which produces allelochemicals, on which allelochemicals have effects [3], and many other factors, such as concentration of allelochemicals, way of releasing, plant part, state of biomass and others [4,5,6]. Depending on a plant species, dry plant parts usually show stronger allelopathic potential [7]. Presence of allelochemicals was established in most parts of the plants, that is plant tissue and root, stem, bark, bloom, fruit and seeds [8] and in different concentrations [9]. Due to intensive and non-selectual usage of herbicides, allelopathy can be sustained alternative in management of agricultural yields [10].

*Robinia pseudoacacia L.(*acacia) is deciduous tree from family Fabaceae. It originates from North America where it was, in the begining of 17th of century, introduced to France, and thence it was spread across Europe. Due to symbiosis with bacterias which fix nitrogen it can grow in poor soil and conquer degraded areas early [11]. Nasir et al. [12] proved that lack of vegetation under acacia trees is outcome of allelopathic activities. Isolated allelopathic chemicals (robinetin, myricetin and quercetin) from leaves and other parts of a plant can have a great allelopathic impact in invasion of acacia to bigger areas. Researches have shown that reduction of biodiversity has the most harmful effects of biological invasions [13,14]. Soltys et al. [3] proved that allelochemical cyanamide (which is produced by acacia) can be used as a natural herbicide in cultures which are not very sensitive to cyanamide.

Chenopodium album L. (white goosefoot) is an annual herbaceous plant from family Chenopodiaceae. It is a cosmopolitan weed in more than 40 types of crops [15]. The tree is tall and strong, and grows over 1 meter in height. The leaves are oblong, with serrated edge and a long petiole. The flowers are small, greenish, gathered in panicle blooms. They bloom from july to september. One plant can produce huge number of seeds annually – up to 800 000 (3-20 000 in average) [16]. Earlier researches show that presence of white goosefoot in soil can cause reduction of wheat growth [17], green salad [18], alfalfa [19], and other species of crops [20]. Research of Rezaei and Yarnia [21] has clearly shown that *Chenopodium album* had the biggest effect to decrease of mass of dry roots and shoots, length of roots and bimass of saffron.

Primary goal of this research is to examine allelopathic effect of water extract of invasive species of acacia (*Robinia pseudoacacia* L.) and weed species of white goosefoot (*Chenopodium album L.*) on germination and development of very important agriculatural culture of tomato (*Solanum lycopersicum* L.). Allelopathic effect was determined through an experiment, which is done in a controlled laboratory conditions.

2. MATERIAL AND METHODS

The research was conducted in 2020 in the laboratory for food technology at the Faculty of Technology in Tuzla, in laboratory for plant physiology of Science and Mathematics faculty in Tuzla.

For the preparation of extracts used sheets of the weed species white goosefoot (*Chenopodium album* L.) and invasive species of acacia (*Robinia pseudoacacia* L.). Plant material was properly disinfected in running water. The leaves were air dried and then in an oven constantly at a temperature of 70 ° C, 3 days for 8 hours, and they were stored in a desiccator in the meantime. Stalks were removed from dried leaves, then they were grounded to powder with mortar and pestle. Aqueous leaf extracts of white goosefoot and acacia were prepared according to the method of Norsworth (2003), by submerging 100 grams of chopped and dried leaves in 1000 ml of distilled water. The resulting mixtures were in a laboratory for 24 hours at room temperature (22 (± 2) ° C). After the he aqueous extracts were filtered through multilayer sterile gauze to remove rough particles, after which they were transferred to sterile plastic containers. From the base extract 3% and 5% solutions were prepared immediately before use.

In the experiment, seed material of the test plant species from the family Solanaceae was used, tomato (*Solanum lycopersicum L.)* variety Saint Pierre. Before the experiment, the seed is disinfected in 90% ethanol and distilled water, and then washed in a solution of isosan. After disinfection, the seeds of each species were immersed separately in distilled water in a glass beaker and left overnight to swell.

The experiment was performed under controlled laboratory conditions. In each Petri dish diameter 90 mm, 30 tomato seeds were evenly distributed. Then, the same of certain extract was added , while the control filter paper was moistened with distilled water. Petri dishes with the seeds were transferred to an incubator at 25 ° C and in the absence of light. The experiment was performed in three series of repetitions. Germination percentage was monitored every 24 hours for a period of 6 days. On demand, the seeds were watered with a suitable aqueous solution to prevent drying out.

At the end of the evaluation period, fresh root mass (g) and fresh shoot mass were weighed. Allelopathic influence was assessed by measuring the following parameters:

a) Total germination (%) (calculated for each replication according to the formula G = (number of germinated seeds / total number of seeds) x100)
b) Average germination time (MGT) calculated according to the equation MGT = ∑ (Dn) / ∑ n; where n is the number of seeds germinated on day D, and D is the number of days from the beginning of germination.
c) Germination index (GI) was calculated using the formula GI = number of germinated seeds /days of first count + ... + number of germinated seeds / final number of days
d) Fresh mass of seedlings (g) using analytical scale (0.1g)
e) Comparative length of root and shoot of seedlings; photographs of seedlings on the substrate of millimeter paper.

The collected data were processed by computer in Excel.

3. RESULTS AND DISCUSSION

3.1 Allelopathic Effects of Acacia and White Goosefoot on Germination of Tomato

Aqueous extracts prepared from the dry mass of acacia leaves and white goosefoot showed negative allelopathic effect on tomato seed germination (Fig. 1).

Germination of tomato seed was inhibited significantly by the use of extracts of acacia and white goosefoot (Fig.1), and the highest inhibitory impact was showed by 5% water extract of leaf of white goosefoot which reduced total germination by 68,86 %. Mallik and Tesfai [22] state that water extracts of the dry above-ground mass of white goosefoot (*Chenopodium album* L.) in concentration of 1% reduced growth of soy for 5,8%, 29,0 % and 14,5%, and the depth seedlings in average of 12,5%. Results showed that water extracts of white goosefoot have inhibitory effect on germination of chickpeaks (*Cicerarietinum* L.) [23]. Rahimzadeh et al. [24] stated that the aqueous extracts of the roots of *Chenopodium album* L. significantly reduced germination rate, germination percentage, shoot length, root lenght and dry mass of seedlings of lentils (*Lens culinaris* Med*.).* Majeed et al. [25] show that different concentrations of aqueous extracts of *Chenopodium album* decreased wheat plant height, number of shoots, number of spikelets, number and yield of grains, and weight of 1000 grains, especially in higher concentrations, while lower concentrations (less than 25%) had stimulatory effects.

Aqueous extract of acacia leaves at a concentration of 5% reduced the germination of tomatoes in large extent by 51.10%. Previous results [12] showsed that the extracts of acacia leaves have an inhibitory effect on the germination and growth of test plants, suggesting to its possible allelopathic action which contributes to the invasiveness of the species. Aqueous extracts of dry leaves of acacia and white goosefoot in a concentration of 3% had a lower allelopathic effect on the germination of tomato seeds.

3.2 Average Tomato Germination Time (MGT)

During the 6 days state of germination and growth of tomato seeds was monitored, as expected the seeds of the control treatment germinated the fastest. Average time of tomato germination in control treatment and treatments of different concentrations of aqueous solutions of acacia and white goosefoot , expressed in days is presented in Fig. 2.

Tomato seeds treated with aqueous extracts of acacia and white goosefoot needed some more time to germinate, which is manifested the best in the average time of seed germination of tomatoes in 5% aqueous acacia extract which was 5.4 days. Average tomato germination time in the treatment with 3% aqueous acacia extract was 5 days, while fthe germination of tomato seeds in 5% and 3% water extracts of goosefoot, on average, took 4.25 days and 4.51 days, respectively.

3.3 Tomato Germination Index (GI)

Germination index (GI) is the method of analysis that describes the ratio of percentage of germination and germination rate the best. Germination percentage and average germination time are not sufficient indicators for germination activities within a certain time frame. Germination index of control treatment and aqueous extracts of acacia and white goosefoot is presented in Fig. 3.

The lowest germination index was recorded in tomato seed treatments with 5% aqueous extracts of acacia and white goosefoot, which confirms the above views that it is allelopathic effect in terms of inhibition of germination and growth more effective at higher concentrations of extract (Fig.4, 5, 6, 7, 8 and 9).

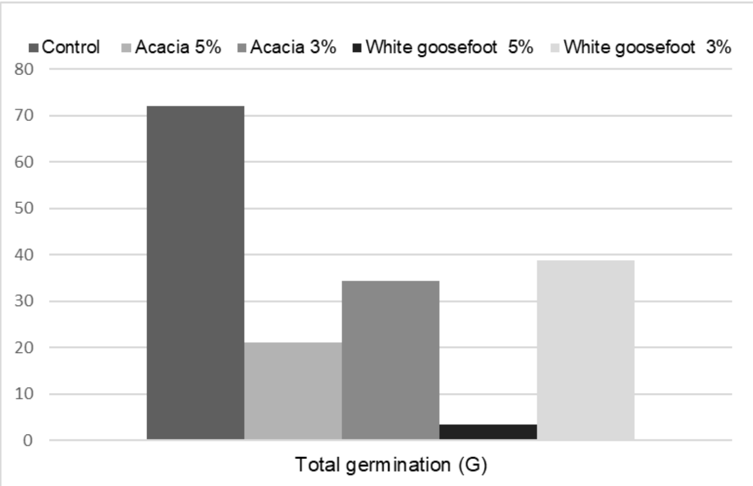

Fig. 1. Impact of water extracts of acacia and white goosefoot on germination of tomato seed

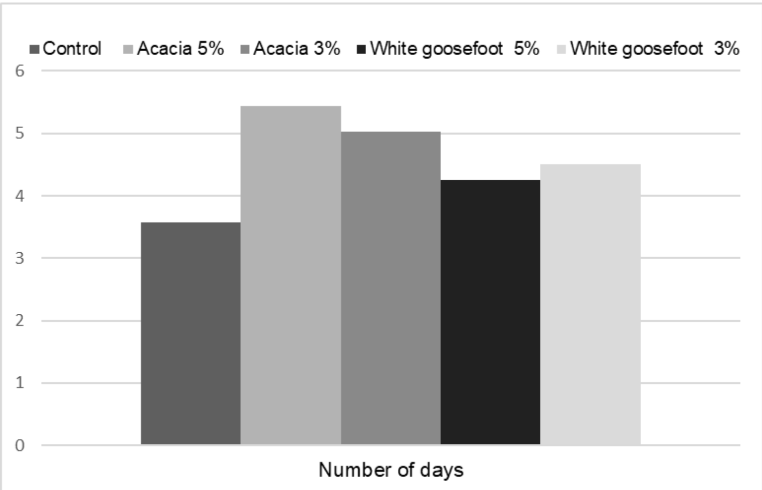

Fig. 2. Average germination time of tomato in controled threatment and threatments of different concentrations of water suspensions of acacia and white goosefoot, expressed in days

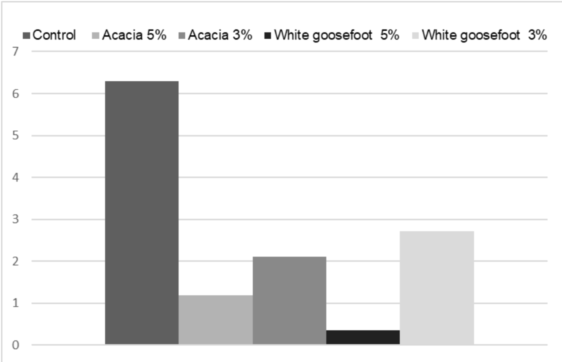

Fig. 3. Germination index of control treatment and treatment with aqueous extracts of acacia and white goosefoot

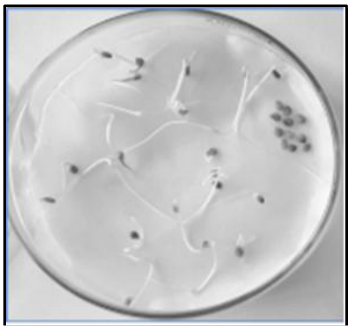

Fig.4 Control threatment

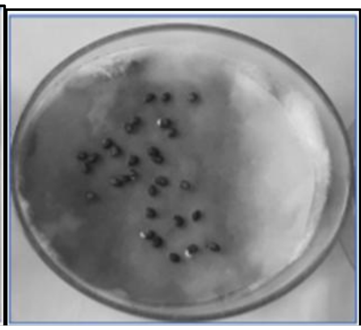

Fig. 5% water extract of acacia

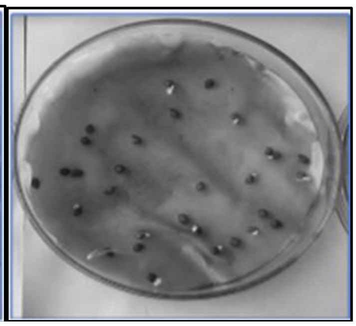

Fig. 6. 5% water extract of white goosefoot

Fig. 7. Control threatment

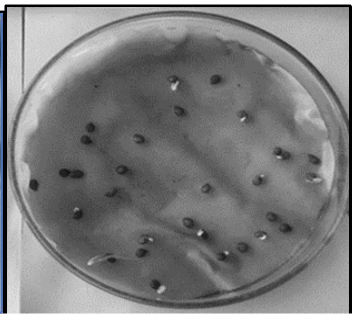

Fig.8. 3% water extract of acacia

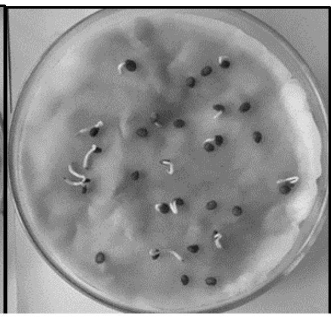

Fig. 9. 3% water extract of white goosefoot

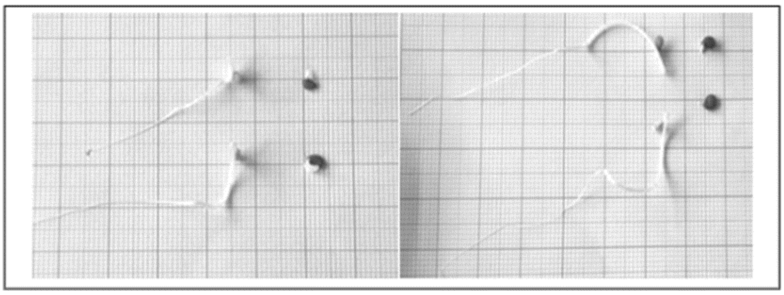

Fig.10. Root length of control treatment seedlings and root length of treated 5%aqueous acacia extract (left); Root length of control treatment seedlings and length of root treated with 5% aqueous extract of white goosefoot (right)

3.4 Impact on Fresh Root Mass and Shoot Seedlings

Measurement of fresh root mass and shoot of tomato seedlings was possible only in control treatment and it averaged 0.1 grams for the root and 0.133 grams for seedlings. In treatments with aqueous acacia extract in concentrations of 5% and 3% only fresh root mass was measured in all batches, and it was averaged 0.1 gram, but for shoots in all three series it was neglible and could not be weighed on an analytical scale. Considering the low percentage of tomato germination in the treatment with 5% aqueous extract of white goosefoot it was not possible to weigh fresh mass of rootlets.

3.5 Influence on Seedling Root Length

Allelopathic imact of aqueous solutions of acacia and white goosefoot on germination and agricultural growth of tomato crops can also be assessed on the basis of seedling root length. For this purpose, representative seedlings of control treatment in parallel with seedlings treated with water solutions of acacia and white goosefoot were photographed on a graph paper backing. As expected, the longest root growth was recorded in control treatments, while rhizomes and seedlings in treatments with solutions of acacia and white goosefoot were short, small and stunted growth (Fig.10).

4. CONCLUSION

Based on the research results, the following conclusions were drawn:

- Aqueous extracts of acacia in concentrations of 5% and 3% inhibit seed germination oftomatoes. Aqueous extract prepared from dried acacia leaves in a concentration of 5% reduced tomato germination by 51.10%. A concentration of 3% reduced germinationby 37.80%.
- The greatest negative allelopathic effect was shown by the aqueous extract of white goosefoot concentration at 5% and inhibited tomato germination by 68.86%, while in concentration of 3% germination was decreased by 33.30%.
- Measurements of average germination time and germination index indicate that seeds of tomatoes treated with different concentrations of aqueous extracts of acacia and white goosefoot did not germinate equally in relation to the control treatment, although the conditions for germination were identical (absence of light, constant temperature of 25 ° C for of 6 days).
- Allelopathic effect is also observed through the fact that seedlings are treated with water extracts of acacia and white goosefoot of different concentrations differ morphologically from seedlings from the control treatment. It is about the length of the seedlings themselves, ie the presence or lack of shoots. The longest seedlings are control treatments, and the smallest are those treated with an aqueous extract of white goosefoot in a concentration of 5%.
- This research was conducted in laboratory conditions and can be used as a starting point the assumption that outdoor tomato cultivation should be organized at a greater distance of acacia, which is often present on the edges of production plots. Also, it is important to remove the weed species of white goosefoot from tomato plantations because it would in the early stages of growth and development exert a negative allelopathic effect, and significantlyreduce the desired yield of this very important agricultural crop.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Oerke EC. Crop losses to pests, Journal of Agricultural Science. 2006;144(1):31-43.
2. Chon SU, Jang HG, Kim DK, Kim YM, Boo HO, Kim, YJ. Allelopathic potential in

lettuce (*Lactuca sativa* L.) plants. Scientia Horticulturae. 2005; 106 (3): 309-317.
3. Soltys D, Krasuska U, Bogatek R, Gniazdowska A. Allelochemicals as Bioherbicides - Present and Perspectives. In: Herbicides–Current Research and Case Studies in Use. Price, A.J., Kelton, J.A. (ur.), CC BY. 2013;517-542.
4. Xuan TD, Tawata S, Hong NH, Khanh TD, Chung IM. Assessment of phytotoxic action of *Ageratum conyzoides* L. (billy goat weed) on weeds. Crop Protection. 2004;23:915-922.
5. Marinov-Serafimov P. Determination of allelopathic effect of some invasive weed species on germination and initial development of grain legume crops. Pesticides and Phytomedicine. 2010;25(3):251-259.
6. Baličević R, Ravlić M, Živković T. Allelopathic effect of invasive species giant goldenrod (*Solidago gigantea* Ait.) on crops and weeds. Herbologia. 2015;15(1):19-29.
7. Ravlić M, Baličević R, Lucić I. Allelopathic effect of parsley (*Petroselinum crispum* Mill.) cogermination, water extracts and residues on hoary cress (*Lepidium draba* (L.) Desv.). Poljoprivreda. 2014;20(1):22-26.
8. Sisodia S, Siddiqui MB. Allelopathic effect by aqueous extracts of different parts of *Croton bonplandianum* Baill. on some crop and weed plants. Journal of Agricultural Extension and Rural Development. 2010;2:22-28.
9. Gatti AB, Ferreira AG, Arduin M, De Andrade G, Perez SC. Allelopathic effects of aqueous extracts of *Artistolochia esperanzae* O. Kuntze on development of *Sesamum indicum* L. seedlings. Acta Botanica Brasilica. 2010;24:454–461.
10. Kremer JR, Ben-Hammouda M. Allelopathic plants. 19. Barley (*Hordeum vulgare* L). Allelopathy Jornal. 2009;24(2):225–242.
11. Rahmonov O. The chemical composition of plant litter of black locust (*Robinia pseudoacacia* L.) and its ecological role in sandy ecosystems. Acta Ecologica Sinica. 2009;29(4):237-243.
12. Nasir H, Iqbal Z, Hiradate S, Fujii Y. Allelopathic potential of *Robinia pseudo-acacia* L. Journal Chemical Ecology. 2005;(9):2179-2192.
13. Sax DF, Gaines SD, Brown JH. Species invasions exceed extinctions on islands worldwide: a comparative study of plants and birds. The American Naturalis. 2002;160:766-783.
14. Davis M.A. Biotic globalization: does competition from introduced species threaten biodiversity? Bioscience. 2003;53:481-489.
15. Holm LG, Plucknett DL, Pancho JV, Herberger JP. The world's worst weeds: Distribution and biology. Univ. Press Hawaii, Honolulu. 1977; 84-91.
16. Šarić T. Weeds and their destruction by herbicides. (Seventh, supplemented edition), NIP Zadrugar, Sarajevo; 1991.
17. Bhatia RK, Gill HS, Bandari, SC, Khurana A.S. Allelopathic interactions of some tropical weeds. Indian Journal of Weed Science. 1984;64:321-325.
18. Souto XE, Gonzales L, Reigosa M.J, Preliminary study of the allelopathic potential of twelve weed species. In: Actas de la Reunion de la Sociedad Espanola de Malherbolgia: Univ. de Vigo, Vigo, Spain. 1990;199-206.
19. Muminovic S. Allelopathic effects of weed extracts on germination of crop seeds. Fragmenta Herbologica Jugoslavica. 1990;19:93-102.
20. Reinhardt CF, Meissner R, Labuschagne N. Allelopathic interactions between *Chenopodium album* L. and certain crop species. South African Journal of Plant and Soil. 1994;11: 45-49.
21. Rezaei F, Yarnia M. Allelopathic effects of *Chenopodium album*, *Amaranthus retroflexus* and *Cynodon dactylon* on germination and growth of safflower. Jounal of Food Agriculture and Environment. 2009;7(2):516-521.
22. Mallik MAB, Tesfai K. Allelopathic effect of common weeds on soybean growth and soybean-Bradyrhizobium symbiosis. Plant and Soil. 1988;112 (2):177-182.
23. Šćepanović M, Barić K, Galzina N, Goršić M, Ostojić Z. Alelopatski utjecaj korovnih vrsta *Abutilon theophrasti* Med. i *Datura stramonium* L. na početni razvoj kukuruza. Agronomski glasnik. 2007: 459-472.
24. Rahimzadeh F, Tobeh A, Jamaati-e-Somarin S. Study of allelopathic effects of aqueous extracts of roots and seeds of goosefoot, red-root amaranth and field bindweed on germination and growth of lentil seedlings. International Journal of Agronomy and Plant Production. 2012;3(9):318-326.

25. Majeed A, Chandhry Z, Muhammad Z. Allelopathic assessment of fresh aqueous extracts of *Chenopodium album* L. for growth and yield of wheat (*Triticum aestivum* L.). Pakistan Journal of Botany. 2012;44(1):165-167.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/74664