PAPER • **OPEN ACCESS**

Allelopathic Actions of *Laurus nobilis* on Seed Germination and Growth of Some Crop and Weed Species

To cite this article: S W Hamad *et al* 2023 *IOP Conf. Ser.: Earth Environ. Sci.* **1252** 012043

Allelopathic Actions of *Laurus nobilis* on Seed Germination and Growth of Some Crop and Weed Species

S W Hamad[1,2], S A Rasul[1], K Y Naby[1], I M Dhahir[1], M D Abdulrahman[2], S H Bapir[3]

[1]Department of Field Crops and Medicinal Plants, College of Agricultural Engineering Sciences, Salahaddin University- Erbil, Kurdistan Region, Iraq
[2]Biology Education Department, Faculty of Education, Tishk International University-Erbil, Kurdistan Region, Iraq
[3]Department of Horticulture, College of Agricultural Engineering Sciences, University of Raparin, Rania, Kurdistan Region, Iraq

Corresponding Author's Email: saber.hamad@su.edu.krd

Abstract: Allelopathy is a biochemical process that plants excrete several types of substances which have allelopathic effects on seed germination and seedling growth of other plants. This experiment was conducted to examine allelopathic effects of bay laurel (*Laurus nobilis*) aqueous shoot extract on seed germination and seedling growth of rapeseed (*Brassica napus*), wheat (*Triticum aestivum*), mung bean (*Vigna radiata*) and corn (*Zea mays*). The study was performed in sanitized petri dishes for seven days at $22C^0$. The experimental design was arranged for completely randomized design (CRD). In terms of concentrations, (0%, 2.5, 5%, 7.5% and 10%) were chosen for this experiment. The results showed that big concentrations (7.5% and 10%) aqueous shoot extracts of Laurus nobilis had significant inhibitory effect on seed germination while the least concentration (%2.5) caused the lowest significant influence in seed germination parameter. Other study parameters such as shoot length, root length, shoot dry weight, and root dry weight were significantly affected at concentrations (7.5 and 10%). The results illustrated that the two dicots, *B. napus* and *V. radiata* turned out to be the most sensitive studied plants to the application of *B. nobilis* aqueous shoot extracts. The findings of this experiment suggest that common bay laurel can be recommended to use as an alternative herbicide in the future.

1. Introduction

Allelopathy is defined as any direct influence or a non-direct harmful or advantageous beneficial of a plant or a microorganism on physiological activities of other organisms by allelochemical production and the release to the neighbouring environment [1]. This circumstance of plants experience the influence on other plants by releasing phytochemicals was first mentioned by Theophrastus in 370 BC [2, 3]. The term of Allelopathy was first mentioned by Molisch [4] in 1937. Based on the previous records that are related to the production of allelochemicals, there are numerous of secondary plant metabolite which are meant to have bioherbicidal activities[5, 6]. For example, some of allelochemical compounds, such as, alkaloids and phenolic compounds are important for plant activities, for example, germinating seed and plant growth activities [2, 5, 7].

Plants, that have ability to release chemical compounds, should be able to produce chemical compounds which are named allelochemicals, that has be delivered into the surroundings which must be capable of reaching its chemicals for the process of delivery so that they are able to make an effect to another organism[11]. Various methods are found for delivering allelopathic active compounds to the environment, for example, leaching, leaf volatile, root exudation as well as the decomposition of plants [1, 8]. According to the current scientific studies, using chemical herbicides causes a range of risks to neighbouring that have negative influence on human health and disqualifies water, and it brings complications to soil microorganisms [9]. Further to the previous complications, about 470

weed species are resistant to synthetic herbicides which are no longer effective. Therefore , to avoid such an expected problem, plants that have bio-active compounds can be used as an alternative herbicide for reducing weed appearance, which allelopathy might be expected to be a possible tool to minimize appearance of weeds and improve yield [10, 13].

Laurus nobilis is an evergreen tree and aromatic large shrub with green, globous smooth leaves, which belongs to Lauraceae plant family, as it has been used for the bay seasoning in cooking, and it is native to the Mediterranean region with several common name (Sweet Bay, Grecian Laurel, bay laurel, or simply laurel) [14]. In some cases, laurel reported as poisonous plant because it has a hydrocyanic acid which causes serious complications, and it is slow growing which typically grow 10-20cm per year, only requires a light trim in summer and reach a mature height of 25-55 feet [15]. Bay laurel plants are the best known for using in the kitchen [15]. Bay laurel used in much medical research because the leaves have many benefits for human body which contain a height amount of calcium, magnesium, and potassium which are essential for surviving [14,16]. The aim of this study was to evaluate bioherbicidal influence of aqueous shoot extract of Bay laurel on seed germination process and growth parameters of two monocotyledonous and two monocotyledonous plants.

2. Materials and Methods

2.1. Collecting Samples

Bay laurel plants were collected in a local supermarket in Erbil-Kurdistan Region of Iraq at the maturity stage in Spring- 2022. The samples were cut into small pieces (5cm). The samples then left for the air-dried purpose for two weeks. The After air-dried samples were grounded using coffee grinder into fine particles to be ready for the experiment.

2.2. Preparation of Aqueous extract

Aqueous shoot extracts of the air-dried samples of bay laurel were arranged through the mix of 10 grams of bay laurel shoot with 100 ml of distilled water. The samples then put into a shaker machine for the better mixing and then the extract was left shaking overnight. Centrifugate (1000 rpm) was used for the shoot extracts for ten mins after filtration by utilizing filter paper. The supernatant was gone through filtration by using a micropore filter (0.45 µm). Finally, the resultant was obtained and then kept in a fridge at temperature 4°C until use.

2.3. Seed germination Experiment

Rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*) were used for this experiment. Their seeds were collected from College of Agricultural Engineering Sciences/ Salahaddin University in Erbil. For avoiding contamination, the seeds were sterilized with sodium hypochlorite (10%) and then washed and rinsed three times in distilled water.

2.4. Bioassay

For this experiment, 10 seeds of the studied plants were put in petri dishes with 9 cm diameter separately and Whatman No.1 filter paper was placed under the seeds. Bay laurel shoot extracts were added to the seeds inside petri dishes as 5 ml of different of concentrations (2.5%, 5.0%, 7.5%, and 10%) were utilized and added to the seed samples which they were the petri dish treatments. For the control petri dish treatments, they received 5 ml deionized water only. The experiment was composed of three replications of every seed sample which include control and test treatments. During bioassay, petri dishes were placed in a growth chamber incubation at 22°C. After 7 days, seed germination percentage, shoot length and root length, shoot dry weight and root dry weight of the germinated seeds were measured.

2.5. Statistical Analysis

The findings of this experiment were calculated by utilizing ANOVA general linear model (Minitab software, version 17). Completely randomized design (CRD) was chosen with minimum 3 replications. Tukey's test ($P \leq 0.05$) was chosen for the determination of significant differences.

3. Results and Discussion

3.1. Effect of bay laurel on seed germination

Figure 1 illustrates the influence of bay laurel shoot aqueous extracts at different concentrations on seed germination of rapeseed (*Brassica napus*), wheat (*Triticum aestivum*), mung bean (*Vigna radiata*) and corn (*Zea mays*). The findings showed that shoot aqueous extracts of bay laurel recorded significant inhibition on seed germination of all the studied plants at concentrations (7.5% and 10%) (Figure 6 and 7). The highest effect was recorded by *B. napus* which was significantly inhibited by all the studied concentrations (2.5, 5%, 7.5% and 10%).

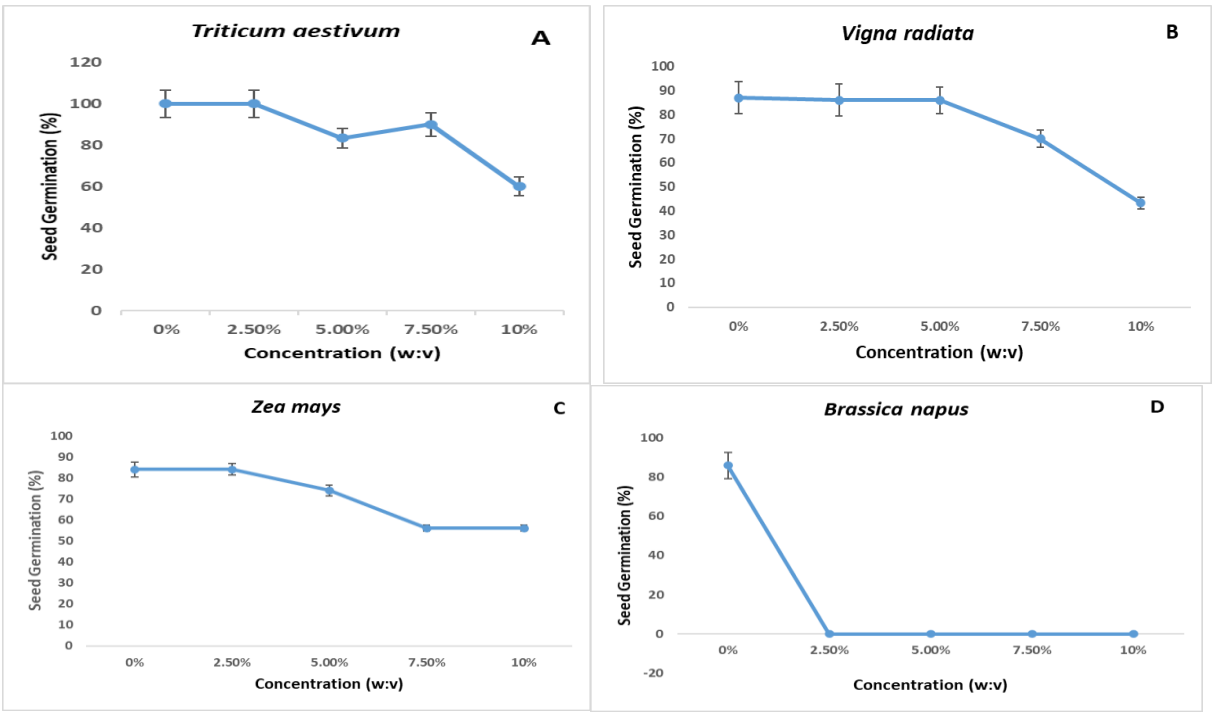

Figure 1. Effect of bay laurel shoots extracts at concentrations (0%, 2.5, 5%, 7.5% and 10%) on seed germination of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*). The results refer to the means of 3 replications. Standard Error was referring error bars. Tukey's test ($P \leq 0.05$) was used to determine the significant differences.

3.2. Effect of bay laurel on shoot length

The findings of this study (Figure 2) show that bay laurel shoot extracts at 5%, 7.5% and 10% concentrations significantly inhibited shoot length of all the examined species. Shoot length of *B. napus* was the most sensitive example and significantly influenced by the evaluation of all the concentrations of *L. nobilis* shoot aqueous extracts (Figure 6 and 7).

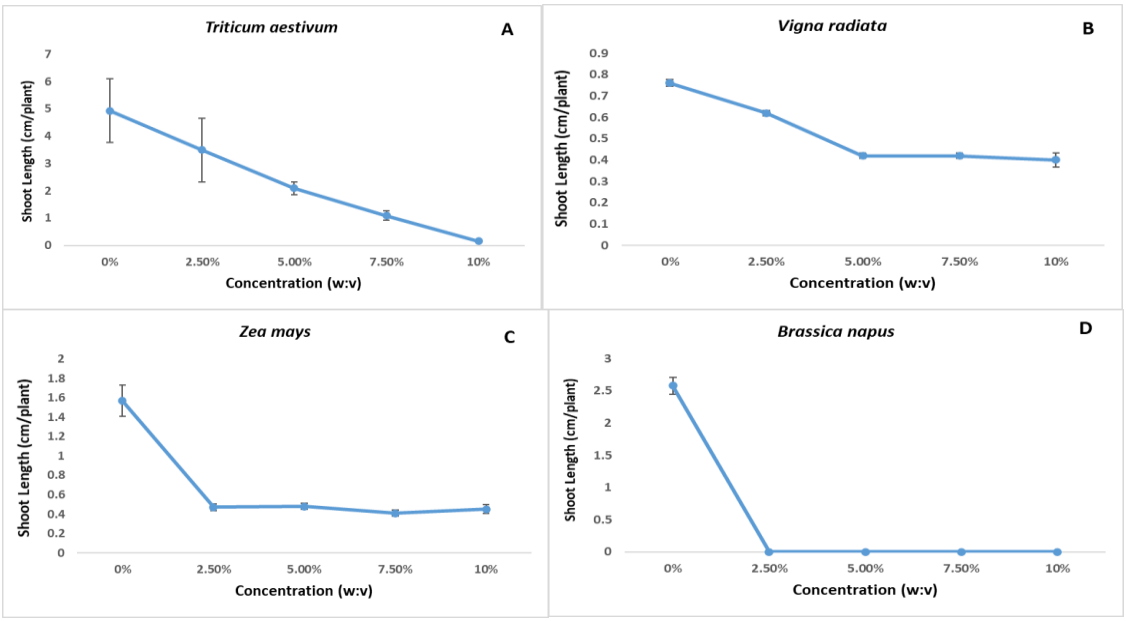

Figure 2. Effect of bay laurel shoots extracts at concentrations (0%, 2.5, 5%, 7.5% and 10%) on shoot length of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*). The results refer to the means of 3 replications. Standard Error was referring error bars. Tukey's test ($P \leq 0.05$) was used to determine the significant differences.

3.3. Effect of bay laurel on root length

The results from Figure 3 indicate that the root length of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*) were significantly affected using *L. nobilis* shoot aqueous extracts at the biggest concentration (10%). Furthermore, most significant reduction was recorded by the effect of *L. nobilis* aqueous extracts on root length of *Brassica napus*.

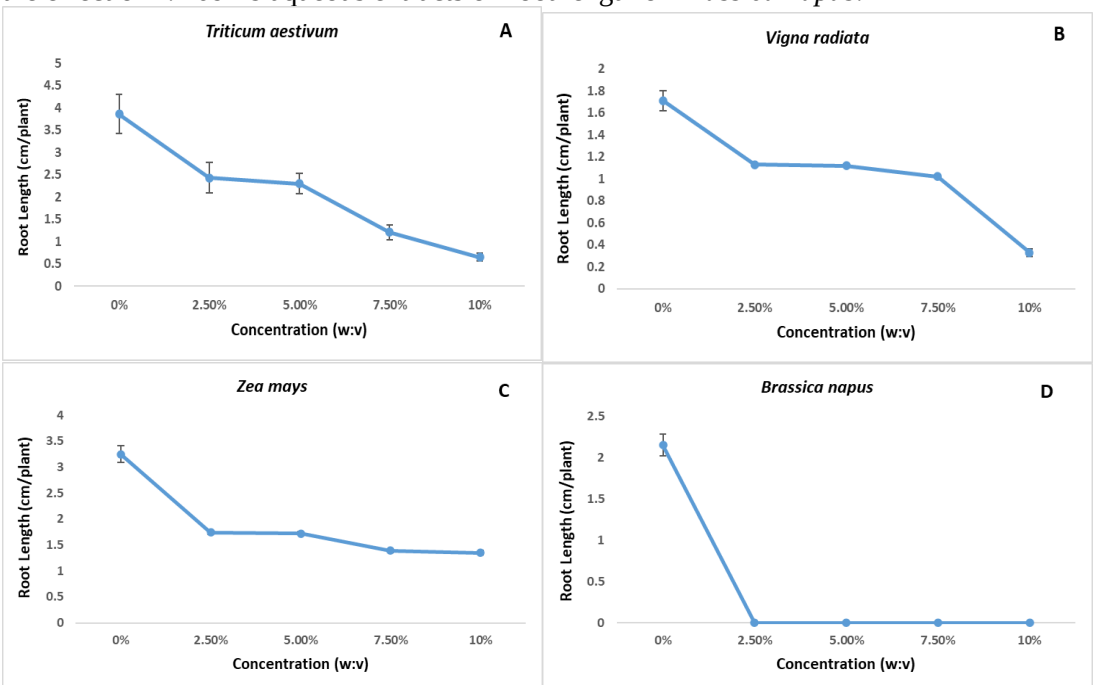

Figure 3. Effect of bay laurel shoots extracts at concentrations (0%, 2.5, 5%, 7.5% and 10%) on root length of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*). The results refer to the means of 3 replications. Standard Error was referring error bars. Tukey's test ($P \leq 0.05$) was used to determine the significant differences.

3.4. Effect of bay laurel on shoot dry weight

Figure 4 illustrates the influence of bay laurel (*Laurus nobilis*) aqueous shoot extract at different concentrations on the dry weight of shoots of *B. napus*, *T. aestivum*, *V. radiata* and *Z. mays*. The results show that the dry weight of the shoots of all the studied plants were recorded to have a reduction in shoot dry weight significantly by the application of higher concentrations (7.5% and 10%). Among the studied species, *B. napus* was totally affected using aqueous shoot extract ($P < 0.001$) of *L. nobilis* at all concentrations when compared with other plants as they were less significantly reduced.

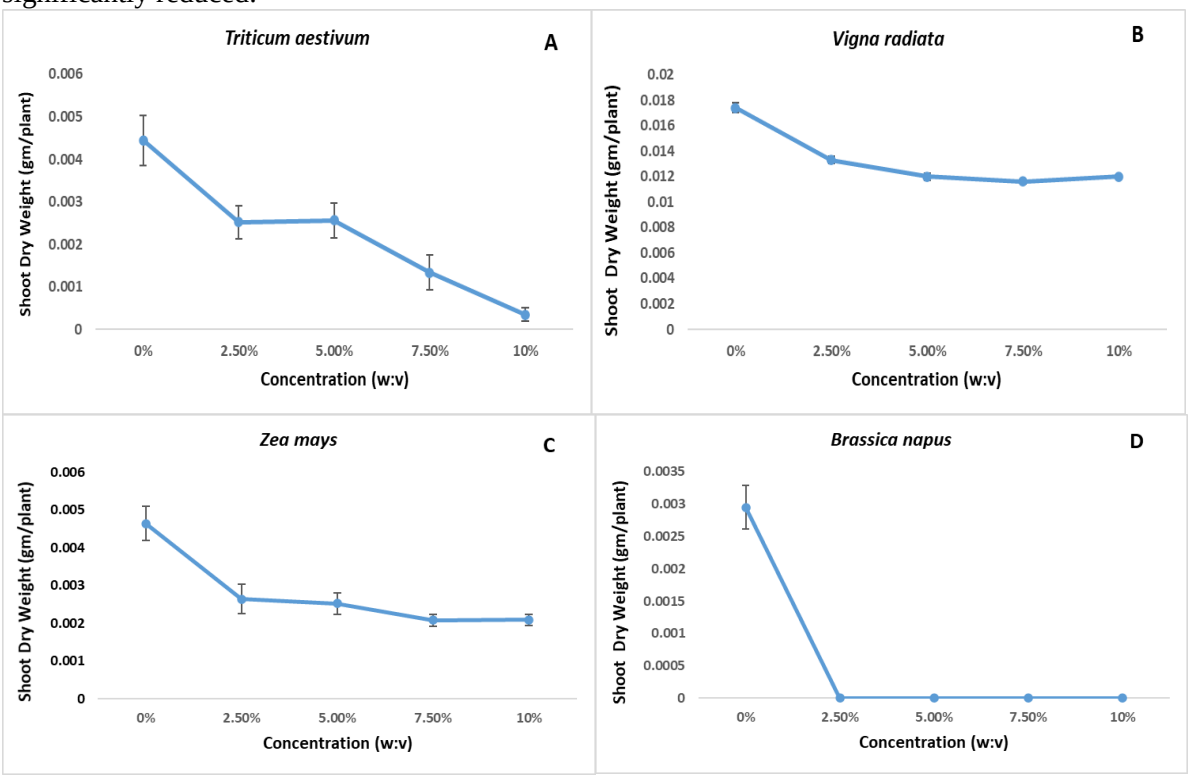

Figure 4. Effect of bay laurel shoots extracts at concentrations (0%, 2.5, 5%, 7.5% and 10%) on shoot dry weight of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*). The results refer to the means of 3 replications. Standard Error was referring error bars. Tukey's test ($P \leq 0.05$) was utilized to determine the significant differences.

3.5. Effect of bay laurel on root dry weight

Figure 5 indicate that toot oven dry weight of *Brassica napus*, *Triticum aestivum*, *Vigna radiata* and *Zea mays* were significantly ($P < 0.001$) reduced by the concentrations 5% 7.5% and 10 % of shoot aqueous extracts of *L. nobilis* shoot aqueous extracts. In addition, the findings of this study show that root dry weight of *B. napus* had more significant reduction compared to other examined species.

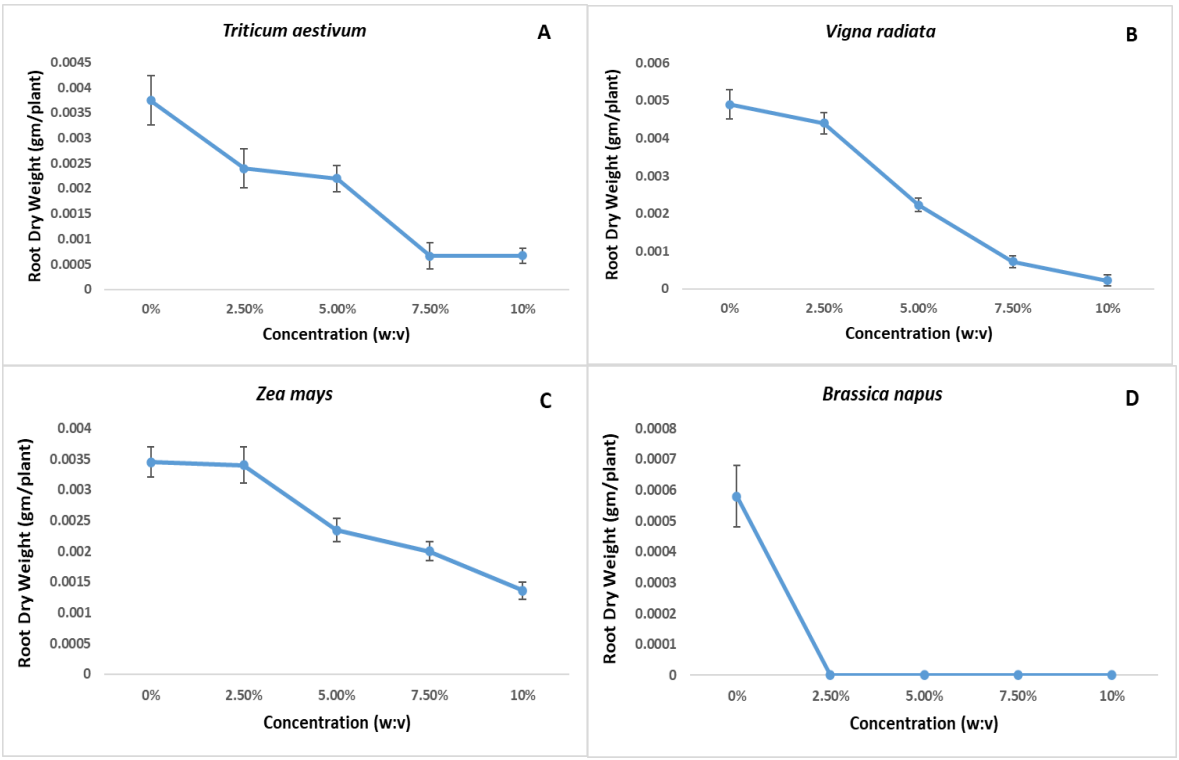

Figure 5. Effect of bay laurel shoots extracts at concentrations (0%, 2.5, 5%, 7.5% and 10%) on root dry weight of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*). The results refer to the means of 3 replications. Standard Error was referring error bars. Tukey's test ($P \leq 0.05$) was used to determine the significant differences.

Figure 6. Effect of bay laurel shoot aqueous extracts at concentrations (%2.5, %5, %7.5, %10) on growth parameters of *Brassica napus* and *Triticum aestivum*.

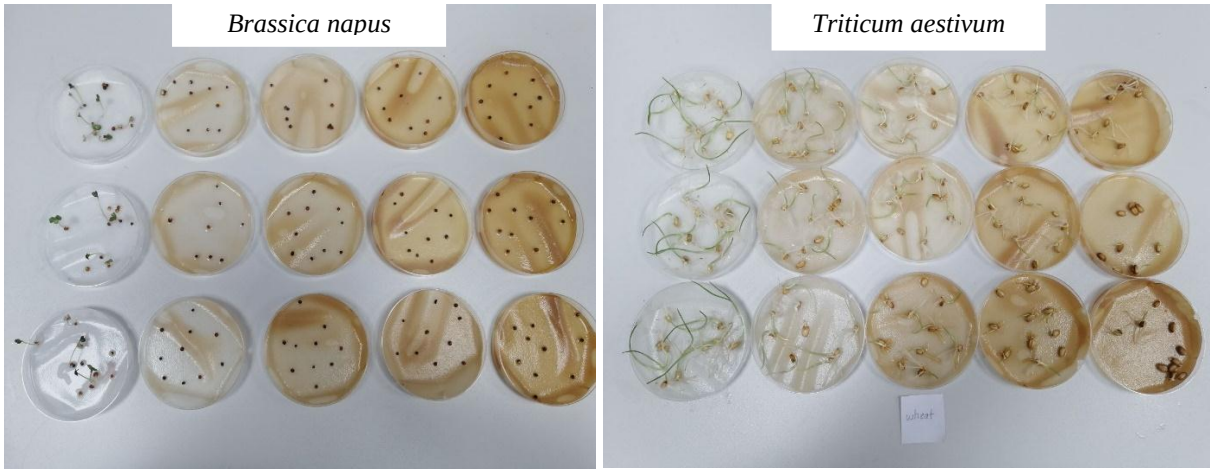

Figure 7. Effect of bay laurel shoot aqueous extracts at concentrations (%2.5, %5, %7.5, %10) on seed germination process *Brassica napus* and *Triticum aestivum.*

The bioherbicidal actions of bay laurel (*Laurus nobilis*) shoot extracts at different concentrations (0%, %2.5, %5, %7.5, and %10) on germination and early growth of rapeseed (*Brassica napus*), wheat (*Triticum aestivum*), mung bean (*Vigna radiata*) and corn (*Zea mays*) were evaluated. The reduction in seed germination, shoot length and root length, shoot oven dry weight and root oven dry weight of the examined species can be as a result of the influence of allelopathic compounds, for example phenolic acids that appear in *Laurus nobilis* shoot extracts [17]. Previous investigations were found to mention the effect of phenolic compounds on seed germination and seedling growth of plants that have a contribution with growth and its hormonal activities [18, 19]. The findings are in accordance with Yilmaz *et al* (2013) who isolated certain phenolic compounds from shoots of bay laurel plant extracts which compounds play crucial role in biological weed management [17, 20, 21]. The results regarding the allelopathic properties of the concentrations (0%, %2.5, %5, %7.5, and %10) of *L. nobilis* shoot extracts on seed germination and growth parameters of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*) illustrated that the negative influence can be increased by increasing of concentration of the *L. nobilis* shoot aqueous extract. The higher concentrations (7.5% and 10%) showed the most bioherbicidal effects on germinating seeds and seedling growth of the studied species. These findings are in accordance with the results recorded by Sharma and Satsangi [22], who mentioned that that bigger concentrations such as (50-100%) of *Helianthus annuus* shoot aqueous extracts gave more negative reduction than the lower application of the concentrations on seed germination and growth parameters of *Amaranthus viridis* and *Parthenium hysterophorus*. Seed germination and growth reduction of *B. napus, V. radiata, T. aestivum*, and *Z. mays* may be due to the appearance of allelopathic compounds in *L. nobilis* shoot extracts as this interprets that they may give negative influences on plant growth through affecting cell division and the physiological activities that are related to growth and development of plants. In addition, during the seed germination activities, the permeability of cell membrane of the evaluated plants could be suffered due to the presence of allelochemical compounds in *L. nobilis* [23]. Phytochemicals may alter respiration process and could reduce RNA and ATP concentration or they might disturb the functions of secondary messengers which are essential for seed germination and seedling growth [24]. The results of this experiment illustrated that bay laurel shoot aqueous extracts have biochemical effects on seed germination, shoot length, root length, shoot oven dry weight and root dry weight [25, 26]. Additionally, our results are in agreement with Turk and Tawaha [27], who indicated black mustard leaf aqueous extracts produce the greater allelochemical compounds and could have greater allelopathic effects. In addition, this could be due to the reason that allelochemicals which are water soluble have great negative influences from shoot aqueous extracts [28, 29, 30,31].

4. Conclusion

Our examinations of the influence of *Laurus nobilis* shoot aqueous extract at different growth stages on seed germination and seedling growth of some studied plant and weed species indicated that bay laurel (*L. nobilis)* extracts at higher concentrations (7.5 and 10%) have a greater influence on germination and growth than other studied concentrations. Dicot plants turned out to have more sensitivity than monocot studied species when bay laurel shoot aqueous extract is applied to seed germination and seedling growth. These results could lead to be alternative to using of synthetic chemicals named herbicides and it can be a production of bioherbicides for eliminating weeds henceforth.

References

[1] Einhellig F A. 1995. Allelopathy: current status and future goals.
[2] Cheng F. and Cheng Z. 2015.Research progress on the use of plant allelopathy in agriculture and the physiological and ecological mechanisms of allelopathy. *Frontiers in Plant Science*, **6**: 1020.
[3] Aliotta G, Mallik A U, and Pollio A. 2008. Historical examples of allelopathy and ethnobotany from the Mediterranean region. In Allelopathy in Sustainable Agriculture and Forestry. pp. 11-24. *Springer, New York, NY*.
[4] Molisch H.1937. Der Einfluss einer Pflanze auf die andere-Allelopathie. *Fischer, Jena*.
[5] Bogatek R, Gniazdowska A, Zakrzewska W, Oracz K, and Gawronski SW. 2006. Allelopathic effects of sunflower extracts on mustard seed germination and seedling growth. *Biologia Plantarum*, **50**:156-8.
[6] Belz R G. 2007. Allelopathy in crop/weed interactions—an update. *Pest Management Science: Formerly Pesticide Science*, **63**:308-26.
[7] Bertin C, Yang X, and Weston L A. 2003. The role of root exudates and allelochemicals in the rhizosphere. *Plant and Soil*. **256**:67-83.
[8] Kobayashi K. 2004. Factors affecting phytotoxic activity of allelochemicals in soil. *Weed Biology and Management*, **4**:1-7.
[9] Rani L, Thapa K, Kanojia N, Sharma N, Singh S, Grewal A S, Srivastav A L, and Kaushal J. 2021. An extensive review on the consequences of chemical pesticides on human health and environment. *Journal of Cleaner Production*. **10**:124657.
[10] Subtain M U, Hussain M, Tabassam M A, Ali M A, Ali M, Mohsin M, and Mubushar M. 2014. Role of allelopathy in the growth promotion of plants. *Journal of Agricultural Sciences*, **2**:141-5.
[11] Thahir I M, and Ghafoor A O. 2011. The allelopathic potential of Johnsongrass Sorghum halepense (L.) Pers. to control some weed species. *Mesopotamia Journal of Agriculture*, **40**: 16-23.
[12] Rasul S A, and Ali K A. 2020. Effect of Radish Aqueous Extract on Germination and Seedling Growth of Wheat, Wild Oat and Wild barley. *Journal of Advanced Pharmacy Education & Research*, **10**:183-189.
[13] Olofsdotter M A. 1998. Allelopathy for weed control in organic farming. *Sustainable Agriculture for Food, Energy and Industry*. 3:453-7.
[14] Foqué D, Braekman P, Pieters J G, and Nuyttens D. 2012. A vertical spray boom application technique for conical bay laurel (Laurus nobilis) plants. *Crop Protection*, **41**:113-121.
[15] Eslamian A M, Ahmady M, Ariaii P, Golestan L, and Ghorbani-HasanSaraei A. 2021. Use composite coating of chitosan-chia seed gum enriched with microliposomes of Bay laurel essential oil to increase the shelf life of quail fillets. *Food Science & Nutrition*, **9**:6524-37.
[16] Singletary K. 2021. *Bay leaf:* Potential health benefits. *Nutrition Today*, **56**:202-8.

[17] Yilmaz E S, Timur M, and Aslim B. 2013. Antimicrobial, antioxidant activity of the essential oil of Bay Laurel from Hatay. *Turkey. Journal of Essential Oil Bearing Plants*, **16**:108-116.
[18] Subtain M U, Hussain M, Tabassam M A, Ali M A, Ali M, Mohsin M, and Mubushar M. 2014. Role of allelopathy in the growth promotion of plants. *Journal of Agricultural Science*, **2**:141-5.
[19] Bapir S H, and Hamad S W. 2022. Interactive Effect of Irrigation Skipping and Salicylic Acid on Yield of Sunflower (*Helianthus annuus* L.). *ZANCOJournal of Pure and Applied Sciences*, **34**:53-66.
[20] Musienko S G, and Kyslychenko V S. 2014. The quantitative content of the main groups of biologically active substances in the bay laurel raw material. *News of Pharmacy*, **1**:22-4.
[21] Eslamian A M, Ahmady M, Ariaii P, Golestan L, and Ghorbani-HasanSaraei A. 2021. Use composite coating of chitosan-chia seed gum enriched with microliposomes of Bay laurel essential oil to increase the shelf life of quail fillets. *Food Science & Nutrition*, **9**:6524-37.
[22] Sharma M, and Satsangi G P. 2013. Potential allelopathic influence of sunflower (Helianthus annuus l.) on germination and growth behavior of two weeds in-vitro condition. *International Journal of Biotechnology and Bioengineering Research*, **4**: 421-426.
[23] Bayar Y, Onaran A, Yilar M, and Gul F. 2018. Determination of the essential oil composition and the antifungal activities of bilberry (Vaccinium myrtillus L.) and bay laurel (Laurus nobilis L.). *Journal of Essential Oil Bearing Plants*, **21**:548-55.
[24] Abrahim D, Braguini W L, Kelmer-Bracht A M, and Ishii-Iwamoto E L. 2000. Effects of four monoterpenes on germination, primary root growth, and mitochondrial respiration of maize. *Journal of Chemical Ecology*, **26**:611-24.
[25] Belz R G, and Hurle K. 2004. A novel laboratory screening bioassay for crop seedling allelopathy. *Journal of Chemical Ecology*, **30**:175-98.
[26] Naby K Y, and Ali K A. 2020. Effect of sorghum [sorghum bicolor (l.) moench] aqueous extract on germination and seedling growth of wheat, wild oat, wild barley and canary grass. *Journal of Advanced Pharmacy Education & Research*, **10**:191.
[27] Turk M A, and Tawaha M. 2002. Inhibitory effects of aqueous extracts of black mustard on germination and growth of lentil. *Journal of Agronomy*.
[28] Hamad SW. 2021. Bioherbicidal Actions of Common Purslane on Seed Germination and Growth of Some Crop and Weed Species. IOP Conference Series: *Earth and Environmental Science*. 910: p. 1-7.
[29] Hamad S W. 2017. Bioherbicidal properties of sunflower (Helianthus annuus L.) and its activities in weed management. *Thesis. Newcastle University*.
[30] Hamad S W, Khorsheed K K, Anwar I, and Ibrahim D. 2022. Biochemical properties of black tea (Camellia sinensis) and its activities in controlling weeds. *Euphrates Journal of Agriculture Science*, **14**(3).
[31] Halliru B S, Abdulrahman M D, Hamad S W, and Aliero B L. 2021. Identification of weeds resistant to paraeforce(r) and aminoforce(r) herbicides. *Euphrates Journal of Agriculture Science*, **13**: 20-26.