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Shimaa Abd El-Razek Rashed

Alexandria University Faculty of Science

Salama Edarier (✉ salama_eldarier@alexu.edu.eg)

Alexandria University Faculty of Science <https://orcid.org/0000-0003-4702-1936>

Reham Mohamed Mostafa

Banha University: Banha University

Heba Sayed Essawy

Banha University: Banha University

Roufaida Mohamed Elghobashy

Alexandria University Faculty of Education

Original Article

Keywords: Sustainable development, invasive species, Anticancer, Bioherbicides, Drought resistance.

Posted Date: October 31st, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-2186286/v1>

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Advantage Applications for Using some Invasive Species in Sustainable Development in Egypt

Rashed Shimaab Abd El-Razek¹, El-Darier Salama Mohamed^{1*}, Mostafa Reham Mohamed², Essawy Heba Sayed² and Elghobashy Roufaida Mohamed³

1 Botany and Microbiology Department, Faculty of Science, Alexandria University, Alexandria, Egypt.
(shimaabdelrazek8@gmail.com, salama_eldarier@alexu.edu.eg), 01222251150, 01122227446.

2 Botany Department, Faculty of Science, Benha University, Egypt. (Dr.rehammohamed74@gmail.com,
hebsamyessawy@live.com), 01009088666, 01116009994.

3 Biology and Geology Department, Faculty of Education, Alexandria University, Alexandria, Egypt.
(roufaidasaad@alexu.edu.eg), 01221338239.

*Correspondence:

* **Corresponding Author:** Salama M. El-Darier

ABSTRACT

Background: The present study was concerned with the control (advantage concept) of five most problematic invasive species (*Arctium lappa*, *Datura innoxia*, *Lantana camara*, *Prosopis juliflora* and *Retama raetam*) in Egypt. The main objective is to manage and control these species by maximizing and researching their medicinal, agricultural and economic profits. Different approaches of interest were carried out through the probable use of *A. lappa*, *D. innoxia* and *P. juliflora* in medicine as anticancer agents.

Results: From the agriculture sustainability point of view, high extract concentration levels of *L. camara* was used with success to suppress and reduce the germination and growth of *Phalaris minor* (noxious weed in wheat fields) to be used as ecofriendly bioherbicides. Contrariwise, *R. raetam* was applied on specific low extract concentration to increase the productivity of some crop species such as *Hordeum vulgare* under water shortage strategies via stimulating the drought resistance.

Conclusion: It is possible to set up various factories for this purpose with the aim of transforming these plants from types harmful to the environment and humans into exporting types for many products that are used medically and agriculturally.

Key words: Sustainable development; invasive species; Anticancer; Bioherbicides; Drought resistance.

INTRODUCTION

30 The term invasive alien species (IAS) is defined variously by different sources in different contexts (IUCN, 2012;
31 Simberloff *et al.*, 2013). According to Colautti and Macisaac (2004), invasive or introduced or alien plant species is
32 a plant that is not native to a specific location and which has a tendency to spread to a degree believed to cause damage to
33 the environment, human economy or human health. IAS is a global problem that largely relates to human activities and human
34 settlements (Szumanska *et al.*, 2021). It considered being main direct drivers of biodiversity loss across the globe which
35 negatively impact biodiversity by altering ecosystem processes and have been estimated to cost our economies hundreds of
36 billions of dollars each year. Conversely, some invasions offer potential commercial benefits and it been shown to provide
37 rich source of natural bioactive compounds with anticorrosion, antimicrobial, antitumor, antiviral and antioxidant activities
38 (Shanab *et al.*, 2012). Other invasive plants can also be harvested and utilized as a source of bioenergy (Hulme, 2010;
39 Richardson and Rejmánek, 2011).

40 Invasive species introductions from geographic region to another must be controlled through some establishing rules
41 (the first solution) (Perrings *et al.*, 2005). The second solution involves managing introduced populations before they
42 become established. More seriously, the third solution based on maximization of benefits; in this way not only reduces
43 pressure on native resources, but also creates options for improving rural livelihoods (Rojas-Sandoval and Ackerman,
44 2021).

45 In this paper, five recorded invasive species (*Arctium lappa*, *Datura innoxia*, *Lantana camara*, *Prosopis juliflora* and
46 *Retama raetam*) were considered as case studies. They were outlined to illustrate how we can effectively implement the
47 concept of sustainability for managing the detrimental effect of invasive species. The study mandates to consider
48 sustainability principles when developing funding schemes, management agendas, and policy.

49 *Arctium lappa* L., commonly known as the greater burdock, is a species from Asteraceae that grows in Europe, Asia,
50 and North America. It grows especially in the ruderal places, near the water reservoirs, roadsides, and outbuildings
51 (Skowronska *et al.*, 2021). It is being recommended as a healthy and nutritive food. It is a beneficial component of the diet,
52 mainly due to the content of many polyphenolic compounds, known for their health-promoting properties (Coman and
53 Vondar, 2019). It has been widely reported for its antioxidant properties; however, very little is known for its exact
54 mechanisms underlying the anticancer activity (Gurunanselage Don and Yap, 2019).

55 *Datura innoxia* Mill. belonging to Solanaceae comprising of annual or perennial herbs, and rarely shrubs or trees.
56 *Datura* is a cosmopolitan weed of cultivated fields, gardens, waste places, barnyards, and other disturbed habitats. It is one
57 of several invasive *Datura* species including *D. ferox*, *D. metel* and *D. stramonium*, that achieve high densities and are
58 difficult to control. It is toxic to animals and humans, with all plant parts and seeds containing toxic alkaloids (Semir Maslo
59 and Šemso Šarić, 2019). It is characterized by its narcotic, hallucinogenic, and medicinal properties, as well as its effects in

human poisonings and it has been used in both human and veterinary medicine and in folk medicine (Dupin and Smith 2018).

Lantana camara L. belonging to Verbenaceae. It is a perennial shrub native to tropical America and has been introduced into many other countries as an ornamental and hedge plant. The species has been spreading quickly and has naturalized in more than 60 countries as an invasive noxious weed. It is considered to be one of the world's 100 worst alien species. Allelochemicals are present in all parts of the plant, on their releasing in surrounding; these chemicals interfere with germination of many species (Kumar *et al.*, 2011). The species has the ability to cause shifts in species distribution and composition when it invades other ecosystems (Choyal and Sharma, 2011). The extracts of the species can suppress the germination and growth of other plant species (Kato-Noguchi and Kurniadie, 2021).

Prosopis juliflora (Sw.) DC. belonging to Fabaceae and it is a xerophyte plant in its native habitats. It is a deep rooted, sand dune stabilizer and now it has become one of the world's 100 most dominant invasive (Becker *et al.*, 2016). Preeti *et al.* (2015) reported that the plant contains antibacterial, antifungal, anticancer, antioxidant, antimicrobial activities. It's a wonderful tree for fuel, charcoal, firewood, and Timber. It serves as one of the main sources of fuel for the rural people due to its excellent burning qualities. Despite of all these uses, it is known as serious invasive weed in most of the parts of world.

Retama raetam (Forssk.) Webb & Berthel belonging to Fabaceae. The plant is a desert shrub that grows abundantly in North-African countries, Palestine and Syria. it is well known as drought tolerant species with wide range of traditional medicinal uses. Assimilating green branches and small leaves are drop very quickly to conserve water loss. The different parts of this plant exhibited medicinal properties such as antioxidant, antifungal, antibacterial, antiviral, antihypertensive, diuretic, antiseptic, hypoglycemic, anti-inflammatory and body weight lowering (Al-Sharari *et al.*, 2020). El-Darier and Ahmed (2015a) and El-Darier *et al.* (2018) indicated that the natural crude powder of *R. raetam* can be applied to reduce the adverse effect of drought stress on other plants. Shortage in water supply is the most significant challenge that meets agriculture worldwide (WWDR, 2015).

MATERIALS AND METHODS

Collection of plant materials

The plant samples of *A. lappa* and *D. innoxia* were collected from Nubaria region (72 km southwest of Alexandria), while the samples of *P. juliflora* were collected from Matruh region (300Km west of Alexandria). *Lantana camara* samples were collected from the Botanic Garden of the Faculty of Science, Alexandria University; Alexandria, Egypt. On the other hand, shoots of *R. raetam* have been collected from Dabaa region (about 180 km west of Alexandria) during the vegetative and flowering stage (Figure 1).

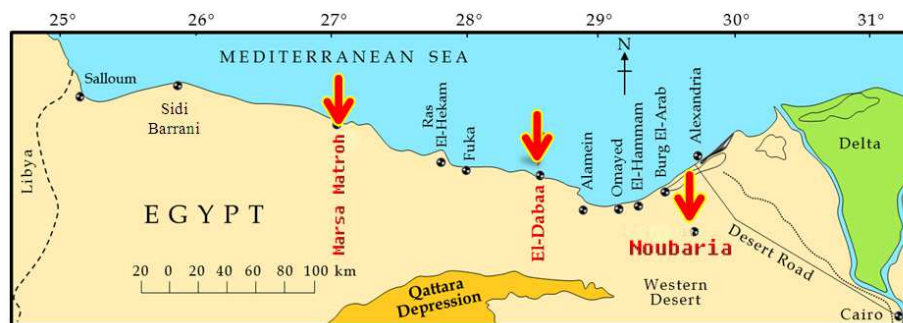


Figure (1): Map indicating the location of the study sites.

Preparation of the plant materials

The plant samples of *A. lappa*, *D. innoxia* and *P. juliflora* were oven dried at 60°C for 5 days and then grinded to be powdered using Wiley mill (Model 4-GMI). Healthy leaves of *L. camara* were selected carefully, washed in running tap water for removing the surface contaminants and dust and dried at room temperature for three days in shade. After drying the leaves were powdered using electric blender. On the other hand, shoots of *R. raetam* have been dried in shade then ground in a Wiley Mill and seeds of *Hordeum vulgare* (as a recipient species) were purchased from the national Research Center, El-Dokki, Giza, Egypt.

Preparation of plant extracts

Alcoholic extract of *A. lappa*, *D. innoxia* and *P. juliflora* were prepared by soaking of 250 g of the grinding plant materials in 95% absolute ethyl alcohol for 48 hr. After soaking, the alcohol was removed by rotary evaporator and concentrated extract was used for further experiments (El-Darier and Abdelhady, 2017). Then the effect of these extract on several carcinoma cell lines was accessed. Stock aqueous extract for *L. camara* (cold and hot) and *R. raetam* (cold) were obtained by soaking 50 g leaf powder in 500 ml distilled water (10%, w/v) at room temperature (20± 2°C) for 24 h with occasional shaking. The mixtures were filtered through two layers of cheesecloth and were centrifuged for 20 min at 5000 rpm to remove particulate materials. The purified extracts were adjusted to 6.8 with 1 M HCl and were kept in the refrigerator at 5°C until used (Al-Charchafchi *et al.*, 2007). The extract of *L. camara* would be considered as full strength concentration (100%) and from each series of dilutions (10, 25, 50 and 75%) were prepared in addition to the control (0%) and tested for their effects on germination and seedling growth of *Phalaris minor*. On the other hand, series of dilutions (5, 10, 15, 20 and 40%) of *R. raetam* were prepared from the stock solution beside the control (distilled water). The allopathic potential of *R. raetam* shoots aqueous extract is used to manage water as a natural resource in *Hordeum vulgare* agro-ecosystems.

Phytochemical screening

Phytochemical screening for the samples of *A. lappa*, *D. innoxia* and *P. juliflora* was performed using standard phytochemical procedures. Thirty-gram dry powder was taken and ethanol or water was added so that the plant material got totally immersed in the solvent (Khan *et al.*, 2010). The extraction period was prolonged for 72 hours. At the completion of the extraction, the extract was filtered through Whatman No. 1 filter paper and the solvent was evaporated. Later, each of the test samples was processed further to use to evaluate the presence of carbohydrates, total proteins, saponins, tannins, flavonoids, phenols, alkaloids triterpenes, sterols and amino acids. Before doing so each test sample was reconstituted in the respective solvents and divided into aliquots to perform the qualitative tests (Deepa *et al.*, 2013).

Estimation of anti-proliferative activity

Five cancer cell lines were selected to test the anticancer effect of ethanolic extract of *A. lappa* that are Prostate cancer (PC3), Breast cancer (MCF7), Liver cancer (HEPG2), Colon cancer (HCT 116), Lung cancer (H1299) and whereas four lines were selected for testing the anticancer potentiality of *D. innoxia* which are Lung carcinoma (A549), Breast carcinoma (MCF 7), Liver carcinoma (HEPG2) and Colon carcinoma (HCT-116). Furthermore, seven lines were chosen for testing the anticancer potentiality of *P. juliflora* which are Lung cancer (A549), Laryngeal cancer (HEP2), Colon cancer (HCT116), Breast cancer (MCF7), Cervical cancer (HELA), Prostate cancer (PC3) and Liver cancer (HEPG2). This experiment was tested at the Pharmacology Unit, Cancer Biology Department, National Cancer Institute, Cairo University. Potential cytotoxicity of all extracts was tested using the method of Skehan *et al.* (1990). Growth inhibition percentages (GIP) were calculated according to the general equation of Mosmann (1983).

$$\text{GIP} = [100 - (\text{Percent survival cells} / \text{control cells} \times 100)]$$

Germination bioassay

Petri-dish experiment was applied to investigate the potential allelopathic effects of cold and hot *L. camara* aqueous extracts on germination percentage (GP), seed germination index (SGI) as well as plumule (PL) and radicle (RL) lengths of *Phalaris minor*. Ten seeds from the weed were arranged in 9 cm diameter Petri-dishes on 2 discs of Whatman No.1 filter paper under normal laboratory conditions with day temperature range of 25- 30°C and night temperature range 20-25°C. Five mL of the extract were added daily to three replicates. GP, RL and PL were recorded daily for seven successive days. On the other hand, Petri-dish experiment was applied to investigate the potential allelopathic effects of *R. raetam* shoot aqueous extracts on seed germination index (SGI) and seed vigor index (SVI) as well as coleoptile (CL) and radicle (RL) lengths of *H. vulgare*. The experiment was designed as last mentioned for *L. camara*. SGI, SVI, RL and PL were recorded daily for successive five days.

Growth bioassay

Pot experiment was performed to test the effect of different levels (control, 3 and 5 %) of *R. raetam* shoot crude powder on some growth parameters (number of tillers and spikes, grains yield, shoot dry weight and grain harvest index of *H. vulgare*. Ten seeds of the recipient species were sown in plastic pots (16 cm in diameter and 15 cm height) with about 1000 g of clay loam soil. Treatments were arranged in a completely randomized block design with three replicates. The plants were watered different water field capacities (25%, 50% and 75%). After 21 days, the homogenous seedlings were harvested.

Calculations

Germination percentage (GP) = number of germinated seeds/total number of seeds × 100.

Seed germination index (SGI) = $\sum TiNi/S$ (Scott *et al.*, 1984).

As *Ti* is the number of days after sowing, *Ni* is the number of seeds germinated on day *i*, *S* is the total number of seeds planted.

Seedling vigour index (SVI) = [Seedling length (cm) × germination percentage]/100 Elouaer and Hannachi (2012).

Grain harvest index (HI) = Grain yield/Total biomass × 100 Grain harvest index (HI) Kemanian *et al.* (2007).

Estimation of phenolic derivatives in *Hordeum vulgare* seedlings

Percentage of some phenolic compounds (mg/kg DW) in *H. vulgare* seedling as affected by *R. raetam* shoots crude powder under different water holding capacities (25, 50 and 75%) were estimated. *H. vulgare* seedlings were analyzed to determine the gallic acid (Sultana *et al.*, 2012), protocatechuic acid (Khan *et al.*, 2015), catechin (Cheong *et al.*, 2005), vanillic acid (Grieman *et al.*, 2015), caffeic acid (Sarier and Gökbulut, 2008), epicatechin (Saito *et al.*, 2006), p-coumaric acid, ferulic acid (Kováčová and Malinová, 2007), sinapinic acid, tocopherol (Hrádková *et al.*, 2013), syringic acid and salicylic acid (Zhang *et al.*, 2013).

RESULTS

Phytochemical Screening of *Arctium lappa*, *Datura innoxia* and *Prosopis juliflora*

A quantitative and qualitative phytochemical screening was carried out to demonstrate the concentration (%) of some secondary metabolites in leaves ethanolic extracts of *A. lappa*, *D. innoxia* and *P. juliflora*. Data in **Table 1** illustrates the presence and absence of some phytochemicals for the three species. It was obvious that total saponins and phenolics attained the highest concentration followed by flavonoids and alkaloids in *A. lappa*. Although, carbohydrates, tannins, proteins and glycosides are estimated in low concentrations; while steroids and terpenes are absent. data showed that *D. innoxia* leaves ethanolic extracts constitutes significant amounts of total phenolics and flavonoids. The qualitative analysis of *P. Juliflora* recorded that steroids attained the highest concentration, while alkaloids and phenolics reached moderate concentrations. However, coumarins, flavonoids, proteins, tannins and terpenes achieved lowest concentrations. While, carbohydrates and

cardiac glycosides are absent. On the other hand, quantitatively *P. juliflora* attained the highest concentration (16 %) of flavonoids in contrast to the lowest value (0.33 %) of tannins.

Table 1. Qualitative and some Quantitative phytochemical screening of leaves ethanolic extract of *Arctium lappa*, *Datura innoxia* and *Prosopis juliflora*.

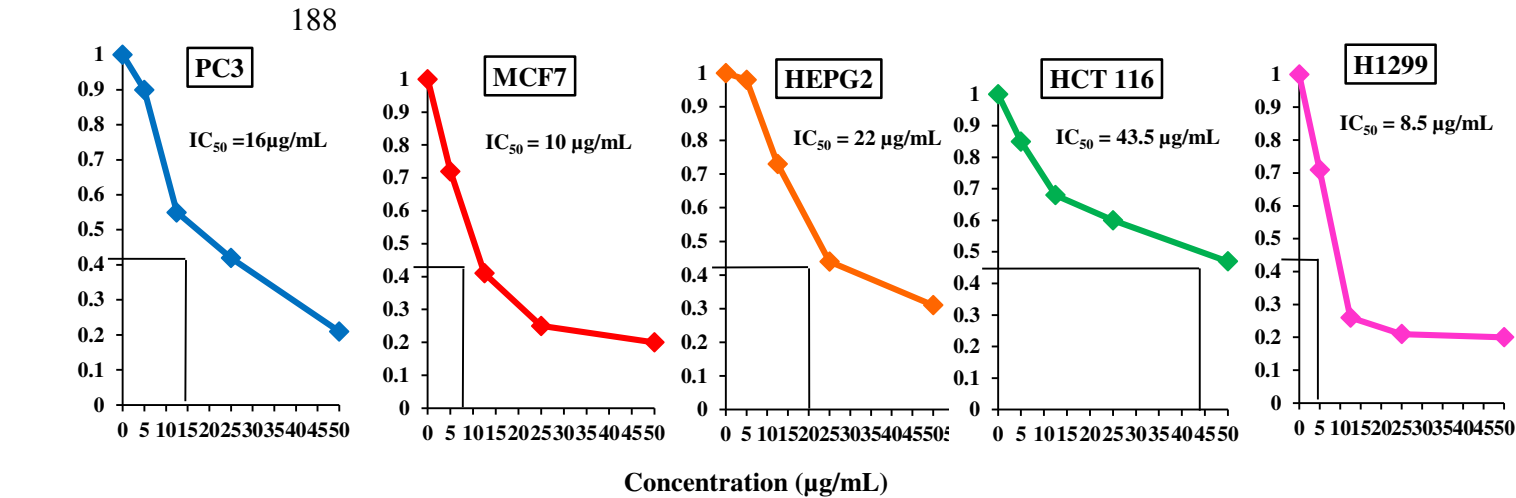
Parameters	<i>Arctium lappa</i>		<i>Datura innoxia</i>		<i>Prosopis juliflora</i>	
	Qualitative analysis	Quantitative analysis (%)	Qualitative analysis	Quantitative analysis (%)	Qualitative analysis	Quantitative analysis (%)
Alkaloids	++	2.24 ± 0.08	+		++	3.6 ± 0.06
Carbohydrates	+		+		-	
Glycosides	+				-	
Saponins	+++	26.47 ± 0.06	+		++	2.2 ± 0.23
Flavonoids	++	5.82 ± 0.13	++	258.3± 1.8		16 ± 0.39
Phenolics	+++	10.15 ± 0.05	+++	452.5± 0.9	++	0.66 ± 0.11
Proteins	+		+	12.9 ± 0.23	+	
Steroids	-		-		+++	
Tannins	+		+		+	0.33 ± 0.07
Terpenes	-		+		+	
Coumarins					+	
Amino acids			+			

(+); low concentration, (++) moderate concentration, (+++) high concentration, (-); absent

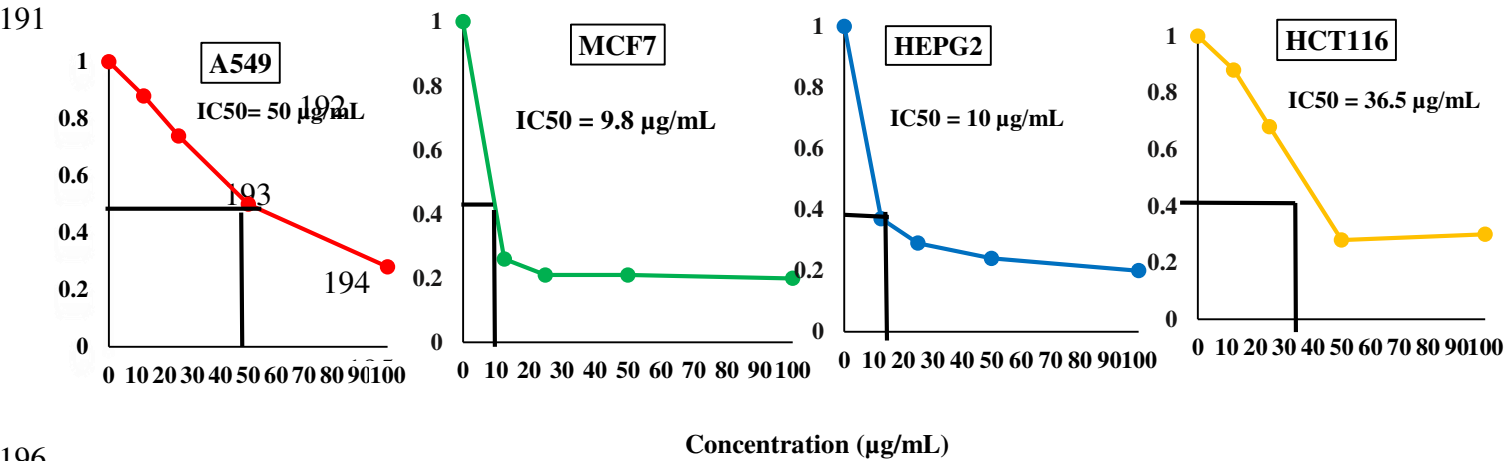
Estimation of anti-proliferated activity of *Arctium lappa*, *Datura innoxia* and *Prosopis juliflora*

Data showed that the increasing in concentrations of *A. lappa* ethanolic extract increases the inhibition of growth of cancer cell lines. IC₅₀ values were recorded as 16, 10, 22, 43.5 and 8.5µg/mL, for PC3, MCF7, HEPG2, HCT116 and H1299, respectively. Accordingly, *A. lappa* has a great inhibitory effect on H1299, MCF7, and PC3 while has a fair and weak effects on HEPG2 and HCT116, respectively (**Figure 2**). In continuation, *D. innoxia* shoots ethanolic extract was tested against A549, MCF 7, HEPG2 and HCT-116 carcinoma cell lines. Visually, the viability of cancer cell lines was significantly reduced as concentration of the extract increased. Accordingly, the obtained results in **Figure (3)** showed that the incubation of *D. innoxia* was significantly inhibited the cell proliferation of MCF 7 with IC₅₀= 9.8 µg/mL. However, the cell proliferation of HEP-G2 and HCT-116 cell lines were moderately suppressed with IC₅₀ values 10 and 36.5 µg/mL, respectively. While, A549 exhibited the lowest inhibition record with IC₅₀= 50µg/ml. As shown in **Figure 4**, IC₅₀ of *P. juliflora* extract on A549, HEP2, HCT116, MCF7, HELA, PC3 and HEPG2 were 15, 9.5, 2.5, 4, 9.7, 6 and 2.5µg/mL, respectively. Accordingly, the inhibitory

186 effect of *P. juliflora* can be ordered ascending as follow HCT116=HEPG2<MCF7<PC3<HEP2<HELA<A549. From these
187 results, it is clear that the extract of *P. juliflora* has an inordinate inhibitory effect on most cancer cell lines.



189 **Figure2.** Effect of different concentrations of *Arctium lappa* ethanolic extract on Prostate (PC3), Breast (MCF7), Liver
190 (HEPG2), Colon (HCT116) and Lung (H1299) carcinoma cell lines.



196 **Figure 3.** Effect of different concentrations of *Datura innoxia* shoots ethanolic extract (DISEE) on Lung (A549), Breast
197 (MCF 7), Liver (HEP-G2), and Colon (HCT-116) Carcinoma cell lines.

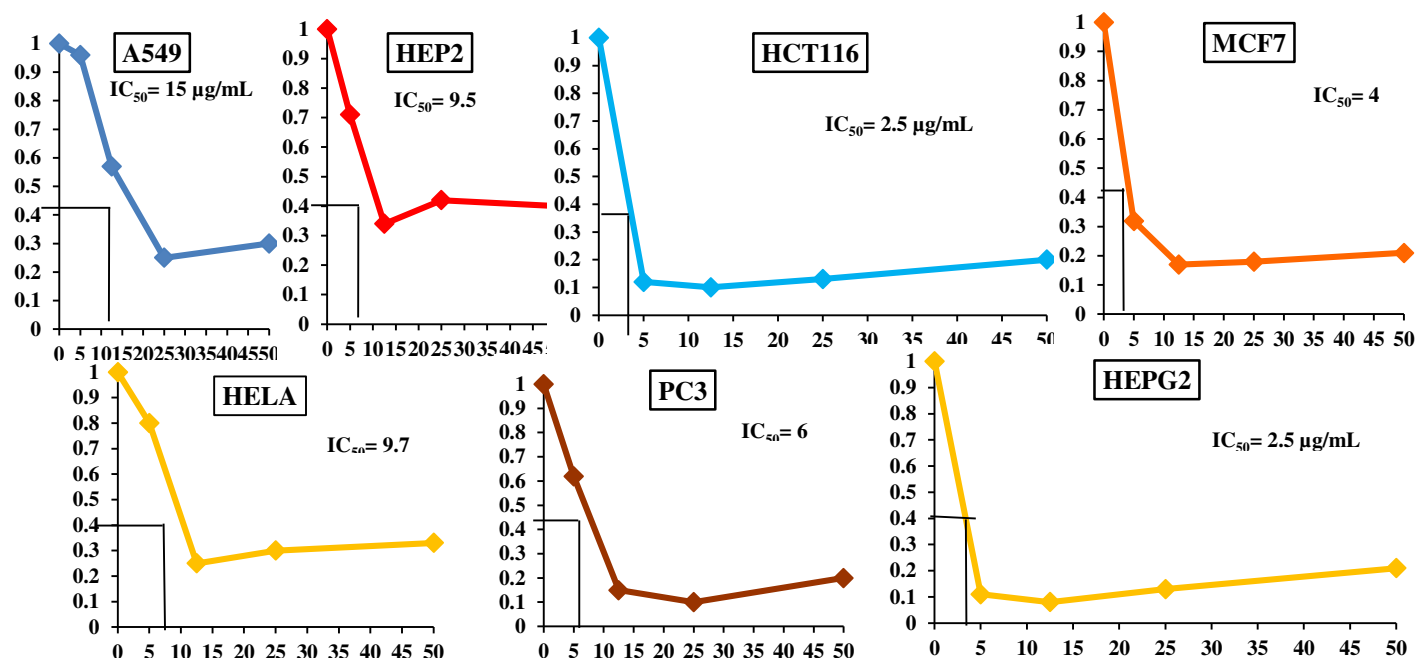


Figure 4. Effect of different concentrations of *Prosopis juliflora* ethanolic extract on Lung (A549), Laryngeal (HEP2), Colon (HCT116), Breast (MCF7), Cervical (HELA), Prostate (PC3) and Liver (HEPG2) carcinoma cell lines.

Growth inhibition percentage (GIP)

Figure (5A) showed that the proliferation of PC3, MCF 7, HEP-G2, HCT116 and H1299 carcinoma cell lines were significantly inhibited by *A. lappa* plant extract in a concentration-dependent manner in 48 h, with suppression percentage ranged from 2 to 80% according to the applied extract concentration. 50% concentration of the plant extract achieved the highest inhibition percentage (80%) on MCF7 and H1299 cell lines. The proliferation of A549, MCF 7, HEP-G2, HCT-116 carcinoma cell lines were significantly inhibited by *D. innoxia* extract with more than 80% suppression at concentration 100% (**Figure 5B**). In addition, **Figure (5C)** showed the proliferation of A549, HEP2, HCT116, MCF7, HELA, PC3 and HEPG2 carcinoma cell lines were significantly inhibited by the *P. juliflora* extract with suppression percentage ranged from 4 to 90% according to the applied extract concentration. The plant extract can cause high inhibition percentages 68, 89, and 88 in case of MCF7, HEPG2 and HCT116 respectively; with low concentration of 5%. The highest GIP (90%) was achieved in case of PC3 cell line by applying concentration of 25% of the plant extract.

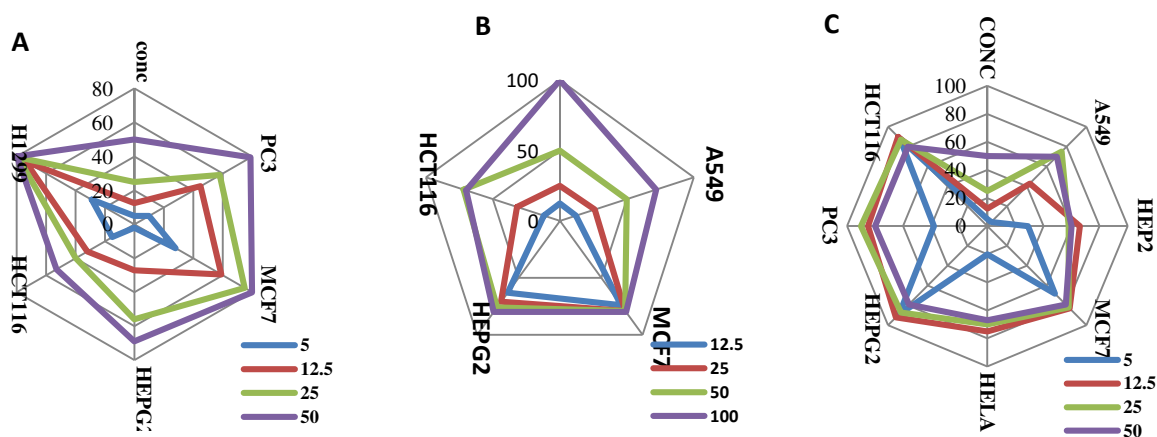
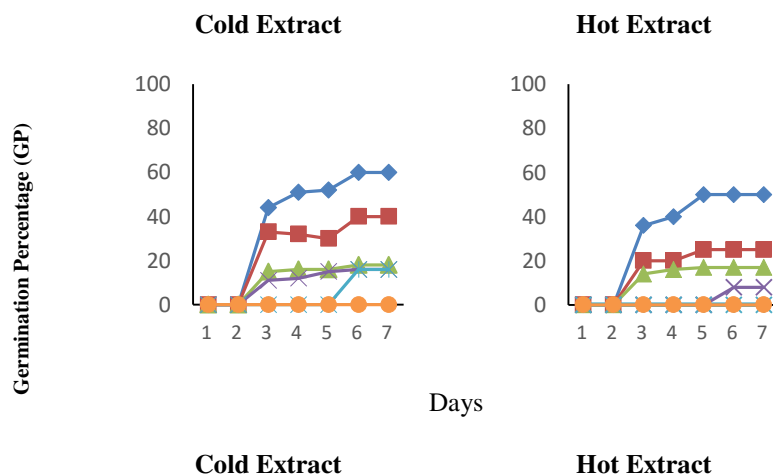


Figure 5. In vitro cytotoxicity of A:) *Arctium lappa* ethanolic extracts against five carcinoma cell lines in the SRB assay using radar method. **PC3:** prostate carcinoma cell line, **MCF 7:** breast, **HEPG2:** liver, **HCT116:** colon and **H1299:** lung carcinoma cell lines. B:) *Datura innoxia* shoots ethanolic extract against four human cell lines. **A549:** Lung, **MCF 7:** Breast, **HEP-G2:** Liver, and **HCT-116:** Colon Carcinoma cell lines. C:) *Prosopis juliflora* ethanolic extracts against seven carcinoma cell lines. **A549:** lung, **HEP2:** laryngeal, **HCT116:** colon, **MCF7:** breast, **HELA:** cervical, **PC3:** prostate and **HEPG2:** liver carcinoma cell lines.

Bioherbicide potential of *Lantana camara*

Figure 6 illustrated that the germination percentage (GP) and seed germination index (SGI) of *P. minor* was significantly affected by cold and hot *L. camara* aqueous extracts. It was also clear that hot aqueous extract had greater inhibitory effect on the germination of *P. minor* than cold extract. The inhibitory effect on the germination was proportional to the concentration of the extract as the higher concentration had the strongest inhibitory effect for both cold and hot extracts. For example, after 5 days the GP of *P. minor* was reduced from 50% (at control) to less than 30 and 15% in the case of 10 and 25% hot extracts respectively. Increasing concentration of the extracts may completely inhibit the germination process.



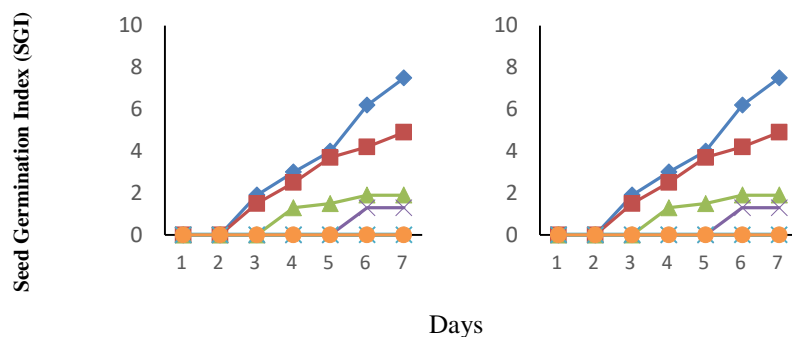


Figure 6. Allelopathic effects of different concentrations of *Lantana camara* cold and hot aqueous extracts on germination percentage of *Phalaris minor* (weed species). (P -value = 0.01 as evaluated by t -test).

Additionally, as shown in **Figure 7** both plumule (PL) and radicle (RL) lengths of *P. minor* were affected negatively due to the addition of the cold and hot extracts of *L. camara*. For instance, PL was reduced after 4 days of sowing from more than 7.5 cm (control) to less than 2.5 cm due to 75% cold aqueous extract and from about 8 cm (control) to less than 2 cm due to 50% hot aqueous extract. RL of *P. minor* was also reduced after 4 days from sowing from more than 4.5 cm (control) to less than 2.5 cm due to 75% cold aqueous extract and from 4 cm (control) to 0.5 cm due to 50% of hot aqueous extract.

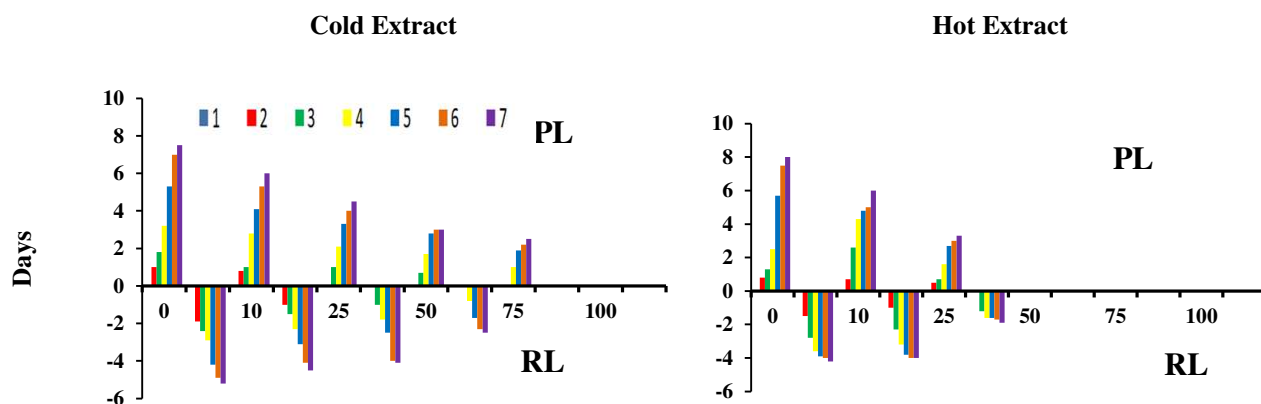


Figure 7. Allelopathic effects of different concentrations of *Lantana camara* cold and hot aqueous extracts on plumule and radicle lengths of the weed species *Phalaris minor*. (P -value = 0.06 as evaluated by t -test).

Drought control potential of *Retama raetam*

The allelopathic potential of *R. raetam* shoot aqueous extract on seed germination index (SGI), seedling vigour index (SVI) as well as coleoptile (CL) and radicle (RL) lengths of *H. vulgare* are illustrated in **Figure 8**. Data confirmed that SGI, SVI, CL and RL attained significant ($P \leq 0.05$) increase at 1, 2 and 3% extract concentration levels with specific maximum at 3% level. Thereafter, the values related to the three parameters exhibited a significant decrease at 4 and 5% concentration levels to reach the minimum at the highest concentration level of the extract (5%).

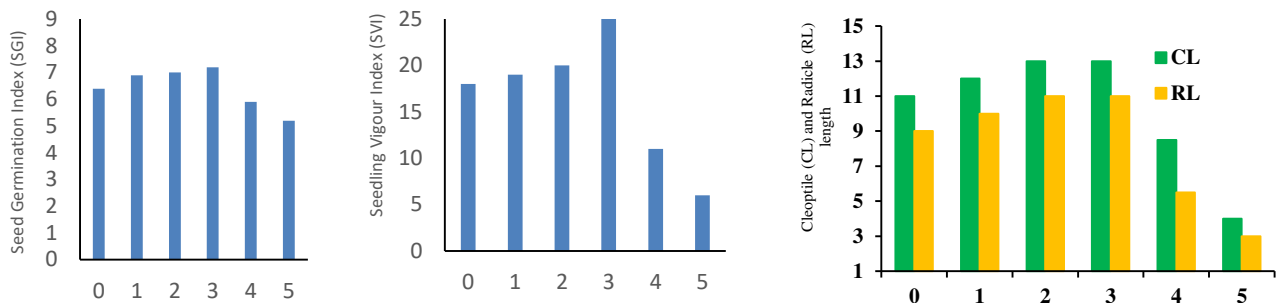


Figure 8. Variation in seed germination index (SGI), Seed vigour index (SVI), coleoptile length (CL) and radicle length (RL) of *Hordeum vulgare* grains (five days after sowing) as affected by different concentration levels of *Retama raetam* shoots aqueous extracts.

Growth bioassay

A corresponding allelopathic effect of the different concentrations of *R. raetam* shoot crude powder (control, 3% and 5%) on number of tillers and spikes, grains yield, shoot dry weight and grain harvest index of *H. vulgare* grains under different water field capacities (25%, 50% and 75%) was recorded (**Figure 9**). The values of all the previous parameters attained the highest level at 3% concentration level of the extract and the lowest soil water field capacity (25%) compared to control. On contrary, at the maximum extract concentration level (5%) and soil water field capacity (75%) the data recorded the minimum values related to the above mentioned growth criteria.

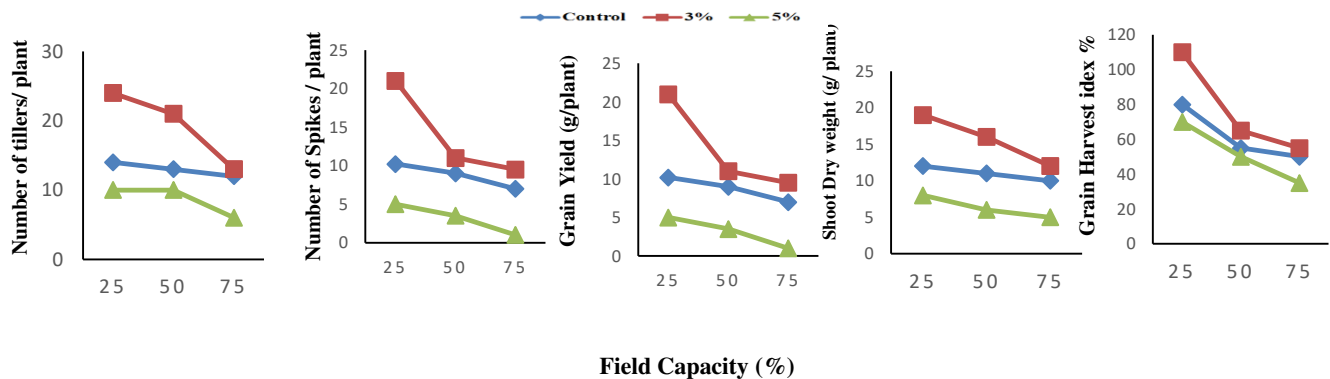


Figure 9. Effect of *Retama raetam* shoots crude powder under different water field capacities on some growth parameters of *Hordeum vulgare*.

Phenolic derivatives in *Hordeum vulgare* seedling

The data listed in **Table 2** demonstrated the concentration of some important phytochemical constituents found in *H. vulgare* as affected by applying different concentrations of *R. raetam* shoot crude powder under different field capacities. Obviously, gallic acid, protocatechuic acid, epicatechin and sinapinic acid were not detected in *H. vulgare* seedling under all applied water field capacities. While, the other derivatives attained their highest percentages at the lowest field capacities (25%) and the lowest percentages were achieved at the maximum field capacity (75%).

Table 2. Percentage of phenolic derivatives (mg/kg DW) in *Hordeum vulgare* grains as affected by *Retama raetam* shoots crude powder under different water field capacities. Data are the mean $\pm$ SD. Different letters for each water field capacity level indicate significance at probability level 0.05. **ND**= not detected.

Phenolic compound (mg/kg DW)	Field Capacity (%)		
	25%	50%	75%
Gallic acid	ND	ND	ND
Protocatechuic acid	ND	ND	ND
(+)-catechin	74.4 ^a $\pm$ 3.5	68.8 ^b $\pm$ 4.9	39.4 ^c $\pm$ 5.2
Vanillic acid	1.6 ^a $\pm$ 1.9	0.97 ^a $\pm$ 2.3	0.68 ^b $\pm$ 1.2
Caffeic acid	4.2 ^a $\pm$ 2.2	2.7 ^b $\pm$ 1.8	1.6 ^b $\pm$ 1.1
(-)-epicatechin	ND	ND	ND
p-coumaric acid	2.1 ^a $\pm$ 1.1	1.7 ^b $\pm$ 0.9	1.4 ^c $\pm$ 0.8
Ferulic acid	4.6 ^a $\pm$ 2.2	3.00 ^b $\pm$ 1.9	2.2 ^c $\pm$ 1.4
Sinapinic acid	ND	ND	ND
Tocopherol	10.22 ^a $\pm$ 4.5	7.96 ^b $\pm$ 3.4	3.2 ^c $\pm$ 2.5
Syringic acid	5.37 ^a $\pm$ 3.5	5.28 ^{ab} $\pm$ 4.5	4.9 ^b $\pm$ 2.8
Salicylic acid	2.38 ^a $\pm$ 1.8	1.5 ^b $\pm$ 1.3	1.0 ^b $\pm$ 0.7

DISCUSSION

Anticancer potentiality of *Arctium lappa* *Datura innoxia* and *Prosopis juliflora*

Cancer is still a major health issue, and the incidence of cancer related deaths is increasing around the globe (Bray *et al.*, 2018). Globally, the most commonly diagnosed types of cancer are colorectal, lung and breast that are related to death (Sung *et al.*, 2021) therefore, the public decision of treatment is by applying conservative treatments. Nevertheless, there is a promising field in cancer research, which is the discovery and progressing of new drugs from natural sources with less side effects (Zhang *et al.*, 2018). Plants are still a promising reservoir for a novel chemical compound in the cancer research area and production of new anticancer drugs such as paclitaxel and camptothecins (Desai *et al.*, 2008; Iqbal *et al.*, 2017).

Arctium lappa is used as a medicinal plant. The anticancer characteristics of *A. lappa* have been validated for extracts and isolated principles through various studies. Recent studies have established that *A. lappa* possesses a potent antiproliferative effect against various kinds of cancer cells such as human multiple myeloma (MM), human bone marrow (k562), breast (MCF-7), liver (Huh-7), oropharyngeal (HTB-43), and bladder (ECV-304) (Khakdan *et al.*, 2013; Lee *et al.*, 2019).

Gurunanselage Don and Yap (2019) reported that ethanolic root extract of *A. lappa* had strong anticancer potential and induced intrinsic apoptosis to the cancer cell lines. Similarly, **Taleb Agha et al. (2020)**; demonstrated that *A. lappa* has valuable anticancer activity and antiangiogenic properties that might be useful in breast cancer therapy. In the current trial *A. lappa* ethanolic extract revealed inhibition to growth of the several cancer cell lines (PC3, MCF7, HEPG2, HCT116 and H1299). From the survival curve it was proved that *A. lappa* has a great inhibitory effect on H1299, MCF7, and PC3 while has a fair effect on HEPG2 and has a weak effect on HCT116. **Taleb Agha et al. (2020)**; **Jung et al. (2012)** also detected the major active ingredients of *A. lappa* are lignans, sterols, terpenoids, and polyphenols. Several studies revealed that β -sitosterol (sterols) inhibited tumor growth and stimulated apoptosis in prostate cancer; in addition, it reduced the growth and metastasis in breast cancer cells. Terpenoids, such as lupeol, are reported as a potent antiangiogenic drug. In the present work; the total saponins and phenolics attained the highest concentrations followed by flavonoids and alkaloids. Although, carbohydrates, tannins, proteins and glycosides are estimated in low concentrations; while steroids and terpenes are absent.

Cheshomi et al. (2016); **Chamani et al. (2020)** estimated the cytotoxicity of *D. innoxia* against different cancer cell. However, the mode of cell death induced by *D. innoxia* extract was not detected and still needs more investigations. **Al-Zharani et al. (2021)** examined the cytotoxic abilities of *D. innoxia* ethanolic extract against colon (A549), colorectal (LoVo), breast (MCF-7) and M.D. Anderson - Metastatic Breast 231 (MDA-MB-231) cancer cell lines and it was evidenced that the extract was cytotoxic against all treated cell lines, In the present study, *D. innoxia* ethanolic extracted attain the maximum amount and diversity of biologically active phytochemicals. The cell proliferation of all cancer cell lines was significantly inhibited with lowest IC₅₀ values ranged from 9.8 μ g/mL (in case of MCF7) to 50 μ g/mL (in case of A549). *D. innoxia* extract had high potent activity against breast (MCF7) cell line. The medicinal abilities of *D. innoxia* extract could be primarily accredited to its secondary metabolites, that perform synergistically rather than as a single compound (**Al-Zharani et al., 2021**). As above-mentioned, *D. innoxia* extract contains a combination of several phytochemical compounds that exhibit anticancer effects, so it can be concluded that the anticancer effects observed in the extract are associated with the presence of these compounds.

Prabha et al. (2014); **Diarra et al. (2015)**; **Catarino et al. (2016)** and **Persia et al. (2016)** postulated that *P. juliflora* is effectively used for treatment of several diseases as well as it contains several phytochemicals such as alkaloids, phenolic compounds and flavonoids in particular. Several studies have reported the pharmaceutical activities of *P. juliflora* leaves such as its potency in inhibiting cancer cell growth, as it showed variant cytotoxic potencies of *P. juliflora* extracts against the breast/MCF-7 or the liver/HEPG2, cancer cells showing strong cytotoxic effect (**Utage et al., 2018**; **Hassan et al., 2019**).

Elbehairi et al. (2020) investigated the potential anti-cancer effect of *P. juliflora* leaves extracts and identified its chemical composition. The authors concluded that the extract induced concentration-dependent cytotoxicity against MCF-7 (breast), HepG2 (liver), and LS-174T (colorectal) cancer cell lines. The ethanolic extract of *P. juliflora* in the present study elicited inhibition for the growth of A549, HEP2, HCT116, MCF7, HELA, PC3 and HEPG2 carcinoma cell lines which may provide an insight on of *P. juliflora* leaves extract which has an inordinate inhibitory effect on most cancer cell lines. In other work presented by **Mary et al. (2022)** anti-cancer activities of *P. juliflora* seeds were evaluated in various solvents such as aqueous, ethanol, and 85% ethanol. **Malik et al. (2018)** estimated that *P. juliflora* pods and leaves were rich in many crucial phytochemical constituents such as tannins, carotenoid and terpenoids. Nineteen bioactive compounds were detected. Thirteen were reported for their exhibiting anticancer activities. In the present study, it was recorded that *P. juliflora* leaves ethanolic extract comprised important phytochemical constituents such as steroids which attained the highest concentration; alkaloids and phenolics reached moderate concentrations as well as coumarins, flavonoids, proteins, tannins and terpenes.

Bioherbicide potential of *Lantana camara*

Weed management is an arduous undertaking in crop production. Integrated weed management, inclusive of the application of bioherbicides, is an emerging weed control strategy toward sustainable agriculture. *Lantana camara* L. is believed to contain efficient allelochemicals which can affect many plant species. Using allelopathic chemicals to reduce agrochemical doses could benefit humans and the environment (**Veraplakorn, 2018**). The present study indicated that cold and hot aqueous extracts of *L. camara* (donor species) exhibit strong inhibitory allelopathic effect on the germination process of *Phalaris minor* as recipient species. It was estimated that the hot extract had greater inhibitory effect on the germination of *P. minor* compared to the cold. **De Silva and Ranwala (2007)** recognized the allelopathic effect of *L. camara* germination and seedling establishment of some weeds such as *Ischaemum rugosum*, *Vernonia cinerea* and *Eleusine coracana*. Laboratory tests were conducted with boiled and un-boiled *L. camara* extracts prepared using dried leaves. The germination percentage, shoot and root development and expansion of leaves/ cotyledons for all of the weeds were significantly affected when exposed to high concentrations of *L. camara* extracts. Boiled extracts had a significantly greater effect on *V. cinerea* and *E. coracana* than the un-boiled extract. **Choyal and Sharma (2011)** illustrated that the germination percentage of *Pogonatum aloides* decreased with the increase in leaf, stem and root extracts concentration of *L. camara* and this decrement was higher in the case of leaf extract than those of stem and root. At the same time, germination and seedling growth in terms of leaf production, root biomass, shoot length, and shoot biomass of *Bauhinia petersiana* was reduced by the addition of *L. camara* leaf and root materials to soil (**Lwando, 2009**). The same results were obtained by **Mishra and Singh (2010)** on the recipient species; *P. hysterothorus*. **Nadirsha and Yogamoorthi (2016)** assessed an attempt to attain the allelopathic effects of aqueous extract of *L. camara* as a potential invasive species on growth and seedling of *Vigna mungo* L. (black gram). The leaf aqueous extract

of *L. camara* showed significant inhibitory activity on germination potency of the seed in terms of germination index, tolerance index, and seed coat shedding time; also, it caused phytotoxicity to the recipient species. Data of the current study confirmed that both plumule and radicle lengths of *P. minor* were extremely affected due to the addition of *L. camara* cold and hot extracts and this effect is concentration dependent. Several studies showed that full-strength aqueous extract of *L. camara* produced significant reduction in seedling length of all the bioassay species. Our results suggested that *L. camara* aqueous extract could be used as a potential bio-herbicide for bio-controlling of some weeds.

Drought control potential of *Retama raetam*

Egypt has long realized the inevitability of prudent management of water resources and has embarked on implementing an ambitious agenda for integrated management of water resources to achieve the sixth goal of the Sustainable Development Goals and other goals and targets related to water (SSCHR, 2022). Li *et al.* (2010) and Russo *et al.* (2014) postulated that increasing the productivity at the expense of water as a natural resource is not a sustainable or management solution. The current work investigated the allelopathic effect different concentrations of *R. raetam* shoots aqueous extracts and crude powder under different water field capacities (25%, 50% and 75%) on some growth parameters of *H. vulgare* as one of the most common economic crops in Egypt. At lower concentration, *R. raetam* extracts displayed a stimulation effect on germination percentage (GP), seed germination index (SGI), seedling vigour index (SVI) as well as coleoptile (CL) and radicle (RL) lengths of *H. vulgare* which are consistent with the results obtained by El-Darier and Ahmed (2015b); Elhag *et al.* (2015); Hegab *et al.* (2016). The lowest level of *R. raetam* residue induced an accumulation of some phenolic derivatives such as (+)-catechin, tocopherol and ferulic acid throughout experimental periods where the maximum value achieved at 3% concentration level. In contrast, the highest concentration level of *R. raetam* extracts (5%) exposed suppression influence for the growth parameters of *H. vulgare*. These results were in an agreement with studies of Algandaby *et al.* (2014); Elhag *et al.* (2015) and Negi *et al.* (2016). It was clear that there was an inversely proportional between concentration level of *R. raetam* shoots crude powder (3%) as well as water field capacity (25%) and the productivity of *H. vulgare*, also sustainability and management of water resources achieved these results agreed with Al-Hussaini (2013) and El-Darier and Ahmed (2015b); Conforti *et al.* (2004); Djeddi *et al.* (2013) In this demand, the current study estimated that there was an increasing in the phenolic compounds of *H. vulgare* seedling at 3% concentrations levels of *R. raetam* shoots crude powder and at low water field capacity (25%) which may lead to more resistance ability to drought to continue water conservation and management. It was noticeable that the percentage of (+)-catechin in *H. vulgare* seedling achieved the maximum value of about (74.4 mg/kg DW), the stimulation of *H. vulgare* seedling growth parameters and their resistance to drought may be ascribed to the maximum value of (+)-catechin in concordance with Li *et al.* (2010). This may boost the ability of the plant to increase productivity and sustainability of water as a great important natural resource.

365 **Conclusion**

366 In conclusion here, from field observations in this regard, farmers tend to get rid of these plants by uprooting because
367 it harms crops, human and animal and further leads to drying out of the soil. However, from the point of view of sustainability,
368 we must look for how to make the greatest use of these plants and consider them as an important national wealth.

369 **List of Abbreviations**

370 **IAS:** Invasive alien species, **GP:** Germination percentage, **SGI:** Seed germination index, **PL:** Plumule length, **RL:**
371 Radicle length, **SVI:** Seed vigour index, **CL:** Coleoptile length, **HI:** Grain harvest index, **GIP:** Growth inhibition percentage,
372 **DW:** Dry weight, **SD:** Standard deviation, **ND:** Not detected, **IC₅₀:** Half-maximal inhibition concentration.

373 **Statements and Declarations:**

374 **Conflict of interest:** The authors declare that they have no conflict of interest.

375 **Author contribution:** Salama M. El-Darier conceived of the presented idea. Shimaa A. Rashed, Reham M. Mostafa, Heba
376 S. Essawy and Roufaida M. Elghobashy developed the theory and performed the computations. Shimaa A. Rashed,
377 and Roufaida M. Elghobashy verified the analytical methods. All authors discussed the results and contributed to
378 the final manuscript

379 **Funding:** No funding was received for conducting this study.

380 **Acknowledgement:** The authors are highly thankful and grateful for staff members of Faculty of Science, Alexandria
381 University; for facilitating the lab work.

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