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Allelopathic effects of *Lantana Camara* extract on weeds and cultivated crops: A systematic review

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ABSTRACT

The current review was aimed at investigating the potential of *Lantana camara* extract as an effective alternative for synthetic herbicides to control weeds and also establishing the effects of allelochemicals in the extract on the germination and growth of cultivated crops. The researchers assessed abstracts and articles published from 2011 to 2022. The review has established that although *L. camara* extract has allelopathic properties to suppress the germination and growth of weeds in the fields. However, the extract is not entirely selective for the plants it inhibits; as a result, it also suppresses the growth of cultivated crops. Therefore, the review recommends that the extract should only be used on crops whose germination and growth cannot be suppressed by it. There is a need to establish the proper timing of the application of the extract to avoid the suppression of germination and early seedling growth in cultivated crops. More studies have been done on the effects of extract on plants in the Poaceae, Fabaceae, and Brassicaceae families. Therefore, more research has to be done to evaluate the allelopathic effects of *L. camara* extract on agronomic crops under Onagraceae , Solanaceae, Asteraceae, Convolvulaceae, Euphorbiaceae, Malvaceae, and Amaranthaceae families.There is limited information on the effects of the *L. camara* extract on the yields of the crops; as such, this review recommends that further research be conducted to evaluate the effects of the allelochemicals of *L. camara* on the yields of the cultivated crops in the fields where the extract has been applied.

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INTRODUCTION

In both developing and developed nations, weeds constitute the most significant biotic limitations on agricultural production. Weeds tend to compete with cultivated plants for moisture, light, nutrients, and space (Hossain and Begum, 2015). They are also hosts of pathogens that cause diseases in cultivated plants (Ofosu et al., 2023) and could reduce the yield of the crops by 20–50% (Kaur et al., 2019). Weeds also deteriorate the quality of the produce, even leading to crop failure (Varshney et al., 2012). As a result, they pose a serious concern for crop productivity, and contemporary agriculture must manage them effectively to prevent yield losses and guarantee food security (Bajwa, 2015). Weed management is an important agronomic activity in agricultural farming. Because of manpower shortages in the agricultural sector, the use of pesticides to decrease weed densities is becoming more common around the world (Hasan et al., 2021). The use of herbicides in agriculture fields and forestry to control weeds has increased since the mid-20th century (Al-Samarai et al., 2018). Despite the fact that herbicides are regarded as a highly successful tool for weed management, they have resulted in a change in the phytosociological composition of weeds and the selection of herbicide-resistant biotypes, in addition to having environmental and human health consequences. Herbicides breakdown slowly in nature, causing them to accumulate in soil and the environment (Ustuner et al., 2020). These residues have accumulated in the environment as a result of the long-term, widespread usage of these chemicals, which is alarmingly contaminating ecosystems and harming the biota as well as affecting humans. Synthetic herbicides are reported to affect endangered birds, arthropods, frogs, tadpoles, mammals, insects, etc. They have also been reported to increase risks for cancer, disrupt the endocrine system, affect the kidneys, and decrease sperm count in humans (Ustuner et al., 2020; Marin-Morales et al., 2013; Rahman, 2020). Therefore, due to ongoing human exposure to low concentrations of herbicides that accumulate through diet, there is growing interest worldwide to minimize the use of synthetic herbicides in agriculture. The use of bioherbicides made from plants that contain phytotoxic allelochemicals as an effective substitute for synthetic herbicides, which are hazardous to the environment, is an emerging strategy for sustainable management of weeds in agriculture (Hasan et al., 2021). Phytotoxic plant extracts or metabolites impair the integrity of cell membranes and crucial metabolic processes in plants. Several studies have evaluated the effects of phytotoxic allelochemicals on different plants (Khamare et al., 2022; Hasan et al., 2021). For example, allelochemicals of extracts of black walnut (*Juglans nigra* L.), tree of heaven (*Ailanthus altissima (Mill.)*), *rice* (*Oryza sativa* L.), sorghum (*Sorghum bicolor* L.), carrot grass (*Parthenium hysterophorus* L.), lantana (*Lantana camara* L.), ragweed (*Ambrosia trifida* L.*)*, neem **(***Azadirachta indica* L.) , finger-grass (*Digitaria sanguinalis* (L.) Scop), gum trees (Eucalyptus species), tall fescue grass (Festuca species), *etc.* have been shown to inhibit weed growth (Šućur et al., 2021; Uddin et al., 2014; Zhou et al., 2013; Salam & Kato-Noguchi, 2010). *L. camara* is a plant species that belongs to the family Verbenaceae. This species is native to tropical and subtropical regions of South and Central America and has been introduced into other countries as a hedge and ornamental plant. It is one of the invasive plant species whose extract has been studied as a plant-based bioherbicide (Kato-Noguchi and Kurniadie, 2021). This invasive plant is allelopathic as it releases certain bioactive secondary metabolites, which include alkaloids, flavonoids, phenols, tannins, saponins, carbohydrates, amino acids, steroids, terpenoids, and proteins (Bashir et al., 2019; Ezzat et al., 2020). These are released by rainfall leachates, plant residue breakdown, root exudation, and volatilization from living plant components into the surrounding environments and the rhizosphere soil of the plants to inhibit the growth of other plants (Belz, 2007).The extract of *L. camara* has been found to be positive in suppressing germination as well as the growth of weeds (Mabasa et al., 2017). Results of several studies have recommended the use of *L. camara* extract in controlling weeds in fields as an alternative to synthetic herbicides (Verdeguer Sancho et al., 2018; Anwar et al., 2019). However, although the allelopathy of the extract of *L. camara* is reported to be effective in controlling weeds, other studies have shown that the extract of *L. camara* is also capable of suppressing the germination, growth, and dry matter accumulation of many cultivated crops in the fields (Nawab & Yogamoorthi, 2016; Julio et al., 2019; Ngonadi et al., 2019). Therefore, the present study reviews and analyzes the allelopathic effects of *L. camara* on cultivated plants from the articles published online over the past decade.

MATERIALS and METHODS

A boolean search engine strategy was used in this review to search for papers that were used for analysis. Plant science and agronomy electronic journal databases were used to retrieve published articles. The focus was on Google Scholar, the Web of Science, and Science Direct. Specifically, the researcher focused on experimental studies that examined the effects of *L. camara* extract on weeds and cultivated crops between 2013 and 2022. An iterative search using the combination of the following search terms was conducted: "allelopathic potential of *L. camara*", "inhibitory effects of *L. camara*" and "*L. camara* extracts ", with the following Boolean operators: 'AND', 'NOT, and 'OR'. Articles that were published before and after the established period were discarded. In this review, a total of 162 peer-reviewed original studies were found, out of which only 26 were analysed and evaluated.

RESULTS and DISCUSSION

Effects of *Lantana camara* extract on agronomic crops in the Fabaceae family

This section tries to review studies on the potential effects of *L. camara* extract on agronomic crops. The leaf aqueous extract of *L. camara* registered a suppression effect on the germination potency of the black gram (*Vigna mungo* L.) (Nawab & Yogamoorthi, 2016). It was found that the germination index and tolerance index were suppressed as the concentration of aqueous leaf extract increased. In a similar study, Bhattacharya et al. (2020) also found that both the leaf and stem extract of *L. camara* inhibited the seed germination and the growth of the seedlings of cowpea (*Vigna unguiculata* (L.) Walp). Sharma et al. (2017) conducted a similar study to determine the impact of lantana leaf powder on chickpea (*Cicer arietinum* L.) and mung bean (*Vigna radiatus* (L.) R. Wilczek) growth. The findings demonstrated that the leaf powder had distinct effects on germination and vegetative growth. Green gram is more susceptible to *L. camara* leaf powder as compared to chicken pea.

Significant suppression of the vegetative growth and yield of the mung bean was also recorded by Gantayet et al. (2014). These vegetative growth parameters include the number of leaves per plant, height of the plant, total leaf area, leaf area index, and yield components, which include the production of the number of heads per plant, the production of seeds per head, the weight of the seeds, and the seed yield per plant. Furthermore, Julio et al. (2019) indicated that mung bean seedling development and germination were significantly decreased at doses of 10%, 25%, 50%, 75%, and 100% of *L. camara* leaf extracts. Similarly, the extract inhibited the germination as well as the chlorophyll content of the mung bean seeds (Kumar & Devashree, 2018). The inhibitory effect of *L. camara* leaf extract was also recorded on the seedling growth of butterfly peas (*Centrosema pubescens*) with increasing extract concentrations (Rusdy and Ako, 2017). In a study by Alemu et al. (2016), it was discovered that a concentrated aqueous leaf extract from *L. camara* hindered the germination of haricot beans (*Phaseolus vulgaris* L.) in terms of day of germination, length of plumule, fresh weight of shoot, and germination index. Effects of *L. camara* on growth of hypocotyl and radicle of pigeon pea (*Cajanus cajan* L. Millsp.) and green gram were tested by Kumbhar & Patel (2013), who found that after 10 days, it was discovered that hypocotyl growth of green gram was accelerated in 1% and 3% concentrations of lantana water extract, but pigeon pea was restrained in all concentrations of lantana water extract. It was also discovered that high concentrations (5% and 10%) considerably reduced the growth of radicals in all of the test crops. Significant inhibitory effects of *L. camara* leaf and seed extracts were registered on germination, elongation rate of roots and shoots, and biomass of peas (*Pisum sativum* L.) at different concentrations (10, 20, 30, 40, and 50%) (Kar et al., 2014).

The aqueous extract at concentrations of 10%, 25%, and 50% suppressed the germination potency as well as root and shoot growth of chicken pea and lentils (*Lens culinaris* Medik.*)* (Talhi et al., 2020). Alkaloids and phenolic chemicals are thought to be the cause of the inhibitory action of the aqueous extract. Furthermore, Acharya et al. (2022) did a study to screen the allelophetic effects of *L. camara* extract on lentils. It was observed that the extract caused a critical inhibitory effect on germination and seedling growth.

In a similar study on chicken pea, it was discovered that higher concentrations of leaf extract have irregularly suppressed the growth of chicken pea compared to lower concentrations in terms of seed germination, root length, and shoot length. A study on chicken pea by Sadak (2019) showed that 5% of the aqueous leaf extract of lantana promoted the growth, yield, and nutritional value of chicken pea. The increase in the concentration of the extract resulted in significant growth and a subsequent increase in the photosynthetic pigments of the chicken pea, but some growth characteristics declined when the concentration of the extract reached 15%. The length of the root (radicle) was more inhibited than the shoot length (plumule). Different concentrations of aqueous extract of *L. camara* (10%, 25%, 50%, 75%, and 100%) also showed inhibitory effects on germination, root, and shoot elongation of fenugreek (*Trigonella foenum-graceum* L.) (Mishra, 2013). Results of a study on cowpea by Ngonadi et al. (2019) showed that germination percentage and the lengths of radicles and plumules of cowpea decreased with an increase in the concentration of *L. camara* extract.

Effects of *Lantana camara* extracts on agronomic crops under Poaceae family

This section reviews papers on the allelopathic inhibitory effects of *L. camara* extract on cultivated crops in the Poaceae family. The allelopathic effects of *L. camara* on vegetative growth and germination of maize (*Zea mays* L.) seeds were evaluated in a study, and results indicate that germination percentage and growth of radicle and plumule all declined as concentrations rose. The leaf extract showed a greater reduction in germination and growth (Ngonadi et al., 2019).

However, aqueous extracts did not show a substantial effect on the germination of maize and finger millet (*Eleusine coracana* (L.) Gaertn.), but a reduction in the germination of teff (*Eragrostis tef* L.) was recorded at a 75% concentration of extract. All extract doses increased maize plant shoot growth, but the shoot growth of teff and finger millet was not substantially impacted by the leaf extracts (Tadele, 2014). Callus extract of *L. camara* significantly reduced maize germination, but it was less effective than sorghum (*Sorghum bicolor* L.) (Veraplakorn, 2017). Allelochemicals, primarily alkaloid and phenolic compounds, from *L. camara* have been shown to interfere with seed germination and early seedling growth in a variety of plant species. This is accomplished by reducing water and nutrient uptake and increasing shoot turgor pressure (Barkosky and Einhellig, 2003). In a pot culture experiment by Enyew and Raja (2015), it was found that the powder significantly inhibits the germination potency and growth length of shoots and roots, the thickness of stems, and the biomass of durum wheat (*Triticum turgidum* L.) and maize. The aqueous extract of *L. camara* was tested for its ability to inhibit germination potency and growth of the length of shoots and roots of durum wheat and barley (*Hordeum vulgare* L.). The results indicated that the suppression effect is proportional to the extract's concentration (Talhi et al., 2020). Bhattacharya et al. (2020) also found that both the leaf and stem extracts of *L. camara* inhibited seed germination and the growth of the seedlings of durum wheat.

The germination and growth of the seedlings of rice (*Oryza sativa* L.) and common wheat (*Triticum aestivum* L.) were suppressed by the extract of *L. camara.* However, rice plants had the lowest rates of germination and seedling growth, whereas common wheat plants had the least impact when treated with a concentration of 10% of the extract (Acharya et al., 2022). The results of treating seeds with *L. camara* leaf aqueous extract show that *L. camara* has a greater allelopathic effect on common wheat through the inhibition of seed germination and seedling growth at higher concentrations (6%

and 8%) than at lower concentrations (2% and 4%) (Chauhan et al., 2016). Inhibition and reduction might be brought on by the alteration in the activity of the enzymes that affect the transition of reserved chemicals and how the energy system works during germination.

Furthermore, Andotra and Devashree (2019) found that *L. camara* extract, at varying concentrations, was discovered to have an inhibiting effect on the germination potential of rice seeds. Different results were observed in a study by Ranwala et al. (2014), which registered no potential inhibitory effects of *L. camara* extract on the growth of rice seedlings. The physiological and biochemical effects of *L. camara* extract were also tested on the oat (*Avena sativa* L.) by Gindri et al. (2020), and it was discovered that the extract decreased seed viability and the germination speed index, which eventually led to solute leakage, an increase in the generation of reactive oxygen species, and lipid peroxidation. Extract concentrations greater than 2.5% suppress epicotyl development. In a related investigation, the phyto-inhibitory activity of *L. camara* aqueous extract caused the smallest germination percentage in oats (13.3%) (Hayyat et al., 2020).

Effects of *Lantana camara* extracts on agronomic crops under Brassicaceae family

Acharya et al. (2022) did a study to screen the allelopathic effects of *L. camara* extract on mustard *(Brassica campestris* L.). Findings revealed that when aqueous extract concentration increased, all species' germination rates, seedling growth, and biomass levels decreased. However, a study by Veraplakorn (2017) to evaluate the allelopathic potential of lantana leaf and callus extract revealed that the germination of Chinese mustard *(Brassica campestris var. Chinensi)* was unaffected by the leaf and callus extract. The results of the investigation by Chauhan et al. (2016) show that high concentrations of *L. camara extract* had a high suppression effect on germination and seedling growth of mustard compared to lower concentrations.

Effects of *Lantana camara* extract on agronomic crops under the Onagraceae, Solanaceae, Asteraceae, Convolvulaceae, Euphorbiaceae, Malvaceae, Solanaceae, and Amaranthaceae families

We found one study for each family under this section published within the period from 2013 to 2022. The effects of *L. camara* leachates on lettuce *(Lactuca sativa* L.*)* were evaluated in both the laboratory and greenhouse pot experiments by Manyenga et al. (2018). It was found that in the laboratory, *L. camara* leachates suppressed the germination percentage, length of the radicle, and the length of the plumule of tomatoes (*Lycopersicon esculentum* Mill.). The germination percentage and the length of the radicle of lettuce were also reduced, but the length of the plumule was not reduced by the extract. The varying concentrations had no impact on germination in the greenhouse pot experiment. Although rates of up to 30g and 40 g/pot enhanced the dry matter of lettuce and tomato, the biomass was unaffected by the rise in Lantana extract concentration up to 40 g/pot. Veraplakorn (2017) found that Lantana leaf and callus extracts were found to be more effective at suppressing the germination of water spinach (*Ipomoea aquatica* Forsk.). Inhibition of seed germination and the growth of the seedlings *of* okra (*Abelmoschus esculentus* L.) by both the leaf and stem extract of *L. camara* was also recorded by Bhattacharya et al. (2020). In a study by Manyenga et al. (2018), there was also a reduction in the germination percentage, seedling growth, and dry weight of spinach (*Spinacia oleracea* L.) (Chauhan et al., 2001). *L. camara* extract suppressed plant height and fresh weight, chlorophyll b, and total chlorophyll of chillies (*Capsicum annuum* L.) (Lande et al., 2017).

Table 1. Summary of studies for the allelopathic effects of *L. camara extracts* on cultivated crops

Source of extracts	Targeted plant	Effects on the plant	Reference
Leaves	*O. sativa* L.	No effect	Ranwala et al. (2014)
Leaves	*V. mungo* L.	Inhibit germination potency of the seeds	Nawab and Yogamoorthi (2016)
Leaves ,stems	*V. unguiculata* L. ,*A. esculentus* L.	Inhibit the seed germination and the growth	Bhattacharya et al. (2020)
Leaves	*C.r arietinum* L.	Inhibit growth ,yields and nutritional value	Sadak et al. (2019)
Leaves	*C. arietinum* L., *V. radiate* L.	Inhibit the germination and growth	Sharma et al. (2017)
Leaves	*P. radiatus* L.	Suppress vegetative growth	Gantayet et al. (2014)
Leaves	*V. radiata* L.	Inhibit germination and seedling growth	Julio et al. (2019)
Leaves	*V. radiata* L.	Inhibit the germination and chlorophyll content	Kumar and Devashree (2018)
Leaves	*C. pubescens*	Inhibit germination, root and shoot length, and dry matter yield	Rusdy and Ako (2017)
Leaves	*P. vulgaris* L.	Inhibit germination and growth	Alemu et al. (2016)
Leaves	*T. aestivum* L.	Inhibit growth	Kumbhar & Patel (2013).
	C. cajan L. Millsp.	Inhibit growth	
	V.radiata L.	stimulate growth	
Leaves and seeds	*P. sativum* L.	Inhibit germination, root and shoot elongation rate and relative biomass ratio	Kar et al. (2014)
Leaves	*T. turgidum* L.,*H. vulgare* L., *C. arietinum* L. ,*L. culinaris* Medik.	Inhibit germination potency of seeds and growth	Talhi et al.(2020)
Leaves	*O. sativa* L. , *T. aestivum* L., *B. campestris* L., *Lens culinaris* Medik.	Reduce germination, seedling growth and dry matter accumulation	Acharya et al. (2022)
Leaves	*T. foenum-graceum* L.	Inhibitory effect on germination, root and shoot elongation	Mishra et al.(2013)
Leaves ,shoots roots	*V. Unguiculata* (L.) Walp.	Seed germination and seedling growth	Ngonadi et al. (2019)
Leaves , stems, roots	*Z. mays* L.	Reduce germination, length of radicles and plumules	Ngonadi et al. (2019)
Leaves	*Z. mays* L.	stimulate root and shoots growth	Tadele et al.(2014)
	E. coracana (L.) Gaertn	Inhibit shoot growth	

	E. teff (Zucc.) Trotter	Inhibit root and shoot growth	
Leaves, callus	*B. campestris* var. *chinensis*, *I. aquatica* Forssk. , *Z. mays* L., *S. bicolor* L.	Inhibit on seed germination and seedling growth	Veraplakorn et al. (2017)
Leaves	*Z. mays* L.,*T. turgidum* L.	Inhibit seed germination, speed of germination, shoot and root length, stem thickness and biomass	Enyew and Raja (2015)
Leaves	*O. sativa* L.	Inhibit germination capacity	Andotra and Devashree (2019)
Leaves	*A. sativa* L.	Reduce seed germination index and seed viability	Gindri et al. (2020)
Leaves, roots, stems	*A. sativa* L.	Inhibit seed germination	Hayyat et al.(2020)
Leaves	*T. aestivum* L.	Suppress Seed germination and growth	Chauhan et al. (2016)
Leaves	*L. esculentus* Mill. , *L. sativa* L.	Inhibit germination percentage and radicle length in lab No effect on germination in greenhouse but increase dry matter	Manyenga et al. (2018)
Leaves	*C. annuum* L.	Suppress growth and lower chlorophyll b and total chlorophyll	Lande et al. (2017)

Re-evaluating the effects of *Lantana camara* extract on weeds and crops

The *L. camara* has significant allelopathic potential for suppressing weeds. This is due to the phenols present in the *L. camara* leaf extract, thus suggesting a potential for biochemical control of these noxious weeds in agriculture fields, gardens, and other locations since phenols are present in the leaf extract of *L. camara*, which may be the cause of such inhibition (Sarkar, 2022). Since synthetic herbicide have reportedly been shown to adversely affect all facets of honey bee life (Vázquez et al. (2018), delaying and reducing plant flower production which eventually results in diminished pollinator visitation (Bohnenblust et al., 2016; Belsky and Joshi, 2020; Cullen et al., 2019; Motta et al., 2018; Straw et al., 2021), affecting earthworms (Gaupp-Berghausen et al., 2015; Zaller et al., 2021), birds (Gillet al., 2018) and impacting on human health by causing cancer, increasing toxicity of reproductive system (Gillet al., 2018; Mesnage and Antoniou, 2021; Caiati et al., 2020) ,therefore, *L. camara* extract could be used to control weeds in the field as an alternative for the synthetic herbicides. This is because *L. camara* extracts as bioherbides are environmentally friendly. They have a comparatively short half-life in the environment, which is significant for reducing environmental toxicology (Manahan, 2022; Gindri et al., 2020). The use of *L. camara* extract to control weeds in the field is not only the best alternative to synthetic herbicides but also provides an opportunity to use the invasive plant species for the benefit of the farmer. As this invasive plant is being removed, its parts, i.e., leaves, stems, and roots, can be utilized to make the extract, which could be used to control weeds in the fields.

Although results of studies show that extract of *L. camara* indicates a high allelopathic potential to control weeds, other studies show that *L. camara* extract has significant inhibitory allelopathic effect on the agronomic crops especially early seedling development (Gebreyohannes, et al., 2023)**.** Results indicate that *L. camara* extracts inhibit the germination potency of the agronomic crops (Ujjwal et al., 2011; Mishra, 2013; Kumar and Devashree, 2018). The extract suppresses the germination as well as vegetative growth of the seedlings. The suppressing effects of allelochemicals during the germination and early stages of seedling growth could make crops more susceptible to other abiotic and biotic stresses, which would lower their productivity. Germination percentage and seedling growth are significantly reduced by the highest extract concentration of *L. camara* (Gebreyohannes et al., *2023*).During initial stages of seed germination, the allelochemicals prevent resources from being mobilized which eventually limit germination .Allelochemicals also reduce elongation, expansion, and division of cells, which are all essential processes for growth. Furthermore, the allelochemicals in *L. camara* extracts shorten shoot and root lengths by obstructing crucial metabolic processes that promote cell proliferation and elongation (Gebreyohannes et al., *2023*). Higher extract concentrations have detrimental effects on growth parameters because they include too many allelochemicals that prevent activity of gibberellin and IAA (indole-acetic acid), which are hormones that stimulate growth (Mishra and Tripathi, 2021).Therefore, it is possible that while extract may be intended to suppress weed in the fields it may end up effecting the non-targeted cultivated plants making its application counterproductive. Therefore, *L. camara* extract should be used judiciously. Farmers should avoid applying the extracts to the fields before the germination of the seeds of the cultivated crops.

Study by Choyal and Sharma (2011) indicate that leaf extract of *L. camara* have higher growth suppression effect compared to the extracts from stems and roots (Choyal and Sharma 2011), (Table 1). However, more studies have evaluated the allelopathic effects of *L. camara* leaf extract on cultivated crops but there are few studies on the supressing effects of *L. camara* extract from stems and roots on cultivated crops .It is important that more research should be done to evaluate the allelopathic potential of *L. camara* extracts from stems and roots. Majority of the studies have concentrated on germination, and growth of the cultivated crops but the studies on the impact of allelochemicals from *L. camara* extracts on the yields of the cultivated crops in the field where *L. camara* has been applied are very scanty. More research has been done to evaluate the allopathic effects of *L. camara* on Poacea and Fabacea families but similar research in other families of cultivable crops is lacking or non-existent. It is thereof important that more research should be done in other families of tubers and fruit vegetables. Since the studies (Chauhan et al., 2016; Talhi et al., 2020; Acharya et al., 2022) have found that seed germnation potency and growth of some cultivated crops is suppressed at high concentration of *L. camara* extract,review has established that *L. camara* has significant allelopathic abilities but there is a need to know how to use this on a wide scale and establish the reasons why chemical weedicides are still being used irrespective of their detrimental effects on humans as well as ecosystem.

CONCLUSION and RECOMMENDATIONS

This review has found that *L. camara* has significant allelopathic properties to suppress the germination and growth of weeds in the fields. It has also been established that the extract may not be selective on inhibition, and as a result, it may even inhibit the growth of cultivated crops that were not targeted. Therefore, it should only be used on crops whose germination and growth cannot be suppressed by the extract. The review recommends that more research be conducted to evaluate the allelopathic potential of stem and root extracts of *L. camara.* There is a need to establish the proper timing of the application of the extract to avoid the suppression of germination and early seedling growth in cultivated crops.

More research has been done to evaluate the allelopathic effects of L. *camara* extracts on agronomic crops under the Onagraceae, Solanaceae, Asteraceae, Convolvulaceae, Euphorbiaceae, Malvaceae, Solanaceae, and Amaranthaceae families. There is as need to conduct research to evaluate the effects of allelochemicals in *L. camara* on the yields of the cultivated crops in the fields where the extracts have been applied.

Conflict of Interest Statement

The authors have declared that that there are no competing interests.

Authors Contribution

YWN: Conceptualization, Methodology and Writing- Original draft preparation. RAM: Reviewing and Editing.

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