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Review

Allelopathic properties of *Lantana camara*

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ABSTRACT

Lantana camara **is regarded both as a notorious weed and a popular ornamental garden plant. Allelopathy involves both inhibitory and stimulatory biochemical interactions between plants.** ***Lantana*** **allelopathic effect studies have been done with many crops, trees, shrub and weeds under both laboratory and field conditions to determine their allelopathic potential and its use. Allelochemicals of** ***Lantana*** **inhibited the germination, growth and metabolism of crops, weeds and bryophytes and vegetables.**

Keywords: Allelopathy, crops, germination, growth, *Lantana camara*, weeds.

INTRODUCTION

Lantana camara is a significant weed of which there are some 650 varieties in over 60 countries. It is established and expanding in many regions of the world. *Lantana* (from the Latin *lento*, to bend) probably derives from the ancient Latin name of the genus *Viburnum* which it resembles a little in foliage and inflorescence. *Lantana camara* is a notorious, noxious and invasive weed belonging to verbenaceae family. *Lantana camara* is one of the ten worst weeds of the world, which is a native of tropical and subtropical America. The species was introduced in India from Sri Lanka in 1809. *Lantana* was introduced to India at the National Botanical Gardens, Calcutta in 1807 as an ornamental plant. *Lantana camara* L. is an invasive weed that is wide spread in India (Anaya AL and Pelayo-Benavides HR, 1997).

Its morphological variation and it occurrence all over the warmer parts of the world many different names have been reported for various forms of *L. camara* (Table 1).

Ecosystems threatened by *Lantana camara* include frontal dune and near by community types such as mangroves, sedge and health land, wood lands associated with melaleucas, banksias and casuarinas, as well open wood land and forest communities (Benson JS and Howell J, 1994; Stock DH and Wild CH, 2002 and Van Oosterhout E, 2004).

Allelopathy is the influence of one plant upon another plant growing in its vicinity by the release of certain metabolic toxic products in the environment. It covers biochemicals interactions, both beneficial and harmful, between plant species including fungi and bacteria. Allelopathy refers to the direct or indirect chemical effects of one plant on the germination, growth, or development of neighboring plant. Allelopathy can be regarded as a component of biological control in which plants are used to reduce the vigour and development of other plants. Many of these compounds are phytotoxic and have potential as herbicides or as templates for new herbicides classes. These allelochemicals offer great potential for pesticides because they are free from problems associated with present pesticides. Therefore, allelochemicals are current areas of research for development of new pesticides (herbicides, insecticides, nematicides, fungicides).

MORPHOLOGICAL CHARCTERISTICS

Stem: *Lantana* has arching stems that are square in cross-section, with pithy centers and short, backwardly hooked prickles. Weedy *Lantana* is a much branched, thicket-forming shrub, 2–4 m tall. The woody stems are square in cross-section and hairy when young but become cylindrical and up to 150 mm thick with age.

Leaf: The leaves are 2–10 cm long with toothed edges, bright green on the upper surface and paler green, hairy

Table1. International Common names of *Lantana*.

Country	Common names
Australia	Lantana, Pink-edgered lantana.
Brazil	cambara de espinto, Camara, Cidreirarana
Colombia	Sanguinaria, Venturosa, Gurupacha, Cariaquita, Carraquillo
Canary islands	Camara, Venturosa..
Cambodia	Ach man
China	Common lantana.
German	Wandelroeschen),
Guatemala	Yellow sage, ach man, White sage, Tembelekan, Talatala, Siete negritos, Prickly lantana, Pha-ka-krong, Large leaf Lantana, Cuasquito, Cambara, deespinto, Bunga taya ayam.
Guyana	Sweet sage
India	Aruppu, Bunch berry,Gandheriya, *Lantana*, Pahj phuli, Wild stage
Jamaica	flowered sage.
Mexico	Skastajat stuki, Orozuz, orozus, Frutilla
Malaysia	angel lips, blacksage, bunga tayi .
Nicaragua	Cuasquito
Puerto Rico	Cuencas deoro
Panama	Pasarin, Pasarrirn..
Rwanda	Maviyakuku.
Rodrigues islands	Vielle fille
Spanish	Galapagos Islands- prickly lantana, shrub verbean, supirrosa
Trinidad	white sage.
Thailand	Pha-ka-krong , Hedge flower, Phakaa drong
Tanzania	Kiwepe, Mkinda, Mvuti.
Tahiti	latora moa
USA	lantana, lantana wildtype, largeleaf lantana .
Venda	Tshidzim bambule
Westindies	Bonboye, Big sage, Cariaquito, Kayakit, Mille fleurs, Ti-plomb, Verveine, Wild stage

Source: 43.

and strongly veined on the underside. They grow opposite one another along the stems, and their size and shape depends on the type of *Lantana*, and the availability of moisture.The leaves of *Lantana camara* are rough and hairy with aromatic smell when grind.

Root: Root system is very strong with a main tap root and a mat of many shallow side roots.

Flower: It flower grows in on the axils near the stem. The flowers have various colours, it starts to bear flower with pale colour and change to orange when they are old. The inflorescences (clusters of 20–40 individual flowers) are about 2.5 cm in diameter. Flowering occurs between August and March, or all year round if adequate moisture and light are available.

Fruit: Fruit small, greenish-blue black, blackish, drupaceous, shining, with two nutlets, almost throughout the year.

TAXONOMY AND CLIMATIC REQUIREMENTS

Classification

Kingdom	*Plantae* – Plants
Subkingdom	*Tracheobionta* – Vascular plants
Superdivision	*Spermatophyta* – Seed plants
Division	*Magnoliophyta* – Flowering plants
Class	*Magnoliopsida* – Dicotyledons
Subclass	*Asteridae*
Order	*Lamiales*
Family	*Verbenaceae* – Verbena family
Genus	*Lantana* L. – lantana
Species	*Lantana camara* L. – lantana

Family Verbenaceae: The Verbenaceae family includes around 75 genera and 3000 species of herb, shrubs and trees of tropical and subtropical parts of the world. *Lantana*, there are a number of Australian genera that contain weedy species including *Phyla* (lippia), *Verbena* (purpletop/verbena) and *Stachytarpheta* (snakeweed) (Parsons WT and Cuthbertson EG, 2001).

***Lantana* Genus:** The genus *Lantana* L. (Verbenaceae) includes between 40 (Hooker JD, 1973) and 150 (Mabberley DJ, 1997) species. Within the genus *Lantana*, four distinct groups are recognized. The *Lantana* sections *Calliorheas*, *Sarcolippia* and *Rhytocamara* contain the *Lippia*-like species, with the latter two sections containing only a few species each. *Lantana* section *Calliorheas* is more diverse and widespread. *Calliorheas* includes *L. montevidensis* (Sprengel) Briquet, a weed in some countries, having been naturalised in Australia, Africa and parts of India, as well as *L. indica* Roxburgh, *L. rugosa* Thunberg and *L. mearnsii* Moldenke. The *L. camara* complex contains the primary weedy lantana commonly referred to as *L. camara* L. *sensu lato* and has a pantropical distribution.

Lantana camara grows well in a range of warmer areas of the world, particularly temperate, subtropical and tropical areas. It occurs in diverse habitats and on a variety of soil types. It generally grows best in open unshaded situations such as wastelands, rainforest edges, beachfronts, and forests recovering from fire or logging. Disturbed areas such as beside roads, railway tracks and canals are also favorable for the species. *Lantana camara* grows best under conditions of constant rainfall or soil moisture, particularly in areas which receive in excess of 900 mm of rain.

ALLELOPATHIC EFFECT

Allelopathic plants (*Lantana camara*) inhibited or suppress germination, growth, development or metabolism of crops due to secretion of allelochemicals to the rhizosphere of neighboring crop plants (Qasem JR, 2006). Various phenolic compounds inhibited cell division. It is also possible that cell elongation was affected by extracts of weed residues. Many phytotoxic allelochemicals have been isolated, identified, and found to influence a number of physiological reactions. These allelochemicals affected many cellular processes in target plant species, including disruption of membrane permeability (Galindo et al., 1999), ion uptake (Lehman ME and Blum U, 1999), inhibition of electron transport in both photosynthesis and the respiratory chain (Abarahim et al., 2000; Calera et al., 1995 and Penuelas et al., 1996), cause damage to DNA and protein, alterations of some enzymatic activities (Anaya AL and Pelayo-Benavides HR, 1997 and Cruz-Ortega et al., 1998) and ultimately lead to programmed cell death (Ding et al., 2007).

Effect on germination: Seed germination one of the critical stage in the life history of any individual species. The generative and aggressive capacity of a species are infect determined the percentage values of survival in the natural environment. Seeds imbibed in aqueous extracts of leaf, stem and root of *Lantana camara* showed inhibition in seed germination. It is evident from the data that allelochemicals present in *L.camara* might inhibit the process of seed and spore germination.

- **Bryophytes:** Very little work has been done on allelopathic effect of *Lantana* on bryophytes. Choyal and Sharma (Choyal R and Sharma S, 2011) determined regeneration from apical explants of *Pogonatum aloides* with leaf, stem and root extract of *L. camara* in half knop’s liquid culture mediumon 10th, 20th and 30th day. Maximum regeneration was observed in control. The regeneration percentage decreased with increase in extract concentration of *Lantana camara* (L). The leaf extract was found to exhibit maximum inhibitory effect followed by the stem and root extracts. The apical explants showed the greatest potential for regeneration followed by the middle and basal explants. The alllelochemicals present in different plant parts of *Lantana camara* affected the process of spore germination of *Riccia billardieri mont etness* Its root, stem and leaf contain some harmful chemicals, which inhibited the spore germination of while the leaf extract affected the process most adversely. Maximum spore germination was observed in control and with the increase in concentration of extract the percentage of germination decreases (Chaudhary et al., 2007). *Lantana camara* leaf, stem and root contain some harmful allelochemicals, which inhibited the germination of *Funaria hygrometrica.* The inhibition of regeneration process in different explant of *Funaria hygrometrica* was found in the decreasing order of apical, basal and middle explant. (Chaudhary BL and Vyas V, 2004 and Choyal R and Sharma S, 2011). The inhibitory effect of different concentration of *Lantana camara* root, stem and leaf extract on germination of *Physcomitrium japonicum*. Leaf extract of *Lantana* inhibit maximum spore germination followed by stem and root (Chaudhary BL and Bhansali EVA, 2002). The water extracts of leaf, stem and root of *Lantana camara* adversely affected the spore germination of *Plagiochasma appendiculatum.* Extract of *Lantana camara* leaf has the most pronounced effect on spore germination followed by the stem and root extracts (Chaudhary BL and Agarwal N, 2002). The extracts of root, stem and leaf of *Lantana camara* proved inhibitory for germination of the spore of *Asterella angusta steph* a thalloid liverwort (Kothari M and Chaudhary BL, 2001).

- **Crops, vegetables, weeds and other plants:** The different concentrations of *Lantana camara* leaf extracts caused significant inhibitory effect on germination of agricultural crop *Oryza sativa, Triticum aestivum, Vigna sinensis, Cucurbita pepo* L., *Abelmoschus esculentus*, *Amaranthus tricolor and* forest crops *Acacia auriculiformis*, *Paraserianthes falcataria*, *Albizia procera*. The highest inhibitory effect was found in *Cucurbita pepo* and *A.tricolor* at 100% treatment. The maximum relative germination ratio was found in *A. esculentus* at 25% treatment while the minimum was occurred in *Cucurbita pepo* at 25% treatment (Hossain MK and Alam NMD, 2010). The allelopathic effects of different concentrations of aqueous leaf extracts and leaf leachates from leaves of *L. camara* were inhibitory to all parameters *viz.*, seed germination to metabolism of mung bean seeds (Maiti et al., 2010). Leaf extract of *Lantana camara* L. showed a wide variation in the reduction of the germination rate of seeds of both the vegetable species, radish (*Raphanus sativus* L.) and spinach (*Spinacia oleracea* L.) over the control. The 100% concentration of leaf extract showed maximum inhibition followed by 50% leaf extract. The soaking drying treatment of these seeds with *Lantana* leaf extract for 6 hours enhanced T50 value

  Aqueous extracts of all parts of *Lantana camara* have strong allelopathic effect on the germination of *Pennisetum americanum*, *Lactucasativa* (L.) and *Setaria italica* (L.) (Hussain et al., 2011). Maiti *et al.* (Maiti et al., 2010) found that the leaf extracts of *L. camara* rendered adverse effects on mung bean seeds with respect to the physiology and biochemistry of seed germination. Here the membrane structures might be impaired by the leaf extract and leaf leachate phytotoxins.

  The extracts of roots, stem and leaf have significant effect on seed germination. The process of germination decreased as the concentration in the medium increased from 1% to 5%. Leaf extract of *Lantana camara* had greater inhibition on the germination of *Phaseolus mungo* as compared to the extracts of stem and root. The root extract has minimum effect on seed germination. 5% leaf extract of *Lantana camara* caused maximum germination inhibition over control (Vijay B and Jain BK, 2010).

  The different concentration (10%, 25%, 50%, 75%, 100%) of aqueous leaf extracts caused significant inhibitory effect on germination of *Brassica juncea*, *Raphanus sativus*, *Cucumis sativusL*, *Cicer arietinum* L, *Phaseolus mungo and Vigna unguiculata*. With the increase of concentration, the inhibitory effect was progressively increased. In all cases maximum inhibitory effect was found at 100% concentration. The leaf extract of *Lantana camara* delayed the germination significantly in all the receptor crops compared to the control treatment (Ahmed et al., 2007).

  Mishra and Singh (Mishra A and Singh R, 2010) reported that the extracts of leaf, stem, flower and fruit of *Lantana camara* inhibited the seed germination of *Parthenium hysterophorus* clearly indicated that the allelochemicals present in the extracts adversely affected the seed germination. Maximum seed germination observed in control. Leaf extract was found to exhibit maximum allelopathy effect followed by stem, flower and fruit extract.

  High concentration of *Lantana camara* root leachate caused marked inhibition of germination of mungbean (Shaukat SS and Siddiqui IA, 2002).The significant effect of *Lantana camera* leaf extract on germination of *Melilotus alba* which recorded the lowest germination, lower than the control (Oudhia P, 2000). The effects of the aqueous leachates of leaves of *Lantana camara* with a high phytotoxicity on the barnyard grass, tomato, amaranth plants. Leachates of *Lantana camara* also inhibited germination of barnyard grass 95 percent, tomato 80 percent and amaranth 77.5 percent (Anaya et al., 1997).Germination of Chinese cabbage, chili and rape decreased progressively when exposed to increasing concentration of aqueous *Lantana* extract (Sahid BI and Sugau BJ, 1993).

  The process of germination includes radical emergence and seeding growth. The embryo is activated by imbibition of water as a result gibberellin is produced. α – amylase is an important starch degrading enzyme in the endosperm of cereal grains. The synthesis of this enzyme during germination is regulated by gibberellic acid. The harmful effect of higher extract concentration on growth parameters might be due to excess of allelochemicals which inhibit gibberellin and IAA (Indole-acetic acid) induced growth.

  Many investigators have suggested phenolics as the cause of inhibition of metabolic process during germination. Possible damage of plasma membrane as a result of seed pretreatment with the leaf extracts and leaf leachates of *L. camara* can be substantiated from the higher leaching of amino acids and soluble carbohydrates from the water imbibed seeds. Along with the changes in leaching of soluble substances from pretreated seeds a proportional shift in metabolism of the germinating mung bean seeds was observed in seed kernels and the allelopathic action of the leaf extracts and leaf leachates possibly played a significant role in the deterioration of the germinating seeds. Results clearly showed that the levels of proteins as well as activities of the enzymes dehydrogenase and catalase declined in the treated seed samples with leaf extracts and leaf leachates for 24 hrs. The levels of amino acids and soluble carbohydrates as well as activity of amylase significantly increased in the pretreated seed samples than control ones. Physiological processes inhibited and delayed the germination as well as growth of mung bean under the influence of allelochemicals present in leaf extracts and leaf leachates. These chemicals interfere with various physiobiochemical processes of seed germination, root elongation, plant growth as well as various metabolic activities of many species.

Effect on growth and chlorophyll, protein and carbohydrate

- **Crops, vegetables, weeds, lower plants and trees:** Water soluble allelochemicals of *Lantana camara* inhibited the initial growth of both the agricultural (*Oryza sativa, Triticum aestivum*, *Vigna sinensis*, *Cucurbita pepo*, *Abelmoschus esculentus*, *Amaranthus tricolor* and forest crops (*Acacia auriculiformis*, *Paraserianthes falcataria*, *Albizia procera)* in the laboratory conditions (Hossain MK and Alam NMD, 2010) (table2, 3).

  Leaf extract showed pronounced inhibition of shoot length, root length, leaf area; fresh and dry weight of the *Parthenium hysterophorus*. The inhibitory effect was strictly concentration dependant. Maximum inhibitions in growth were observed in 100% aqueous leaf extract. Maximum growth of shoot and root were observed 850% and 150% increased respectively in control. In 25% extract the plant growth were observed 53.33% increased in shoot and 17.64% increased in root over control. Minimum percentage increase 6.66% in shoot length and 3.12% in root length were recorded in 50% concentration, but in 100% extract concentration the plant growth was completely suppressed after single spray. Maximum leaf area of *Parthenium hysterophorus* was observed 185% increased in control. The leaf area was decreased after aqueous leaf extract spray on plant. In 25% concentration aqueous leaf extract the leaf area were observed 43.47% increased and in 33% concentration leaf area were observed 17.18% increased over control (Mishra A, 2012).

Allelopathic effects of different concentrations of leaf-litter dust of *Lantana camara* on the vegetative growth parameters (development of total number of leaves per plant, height of the plant, total leaf area, leaf area index) and components of yield (production of number of heads per plant, production of seeds per head, weight of seeds, seed yield per plant) of niger (*Guizotia abyssinica*).The phenolic compounds leached from the dusts might have interfered in oxidoreduction reactions, nucleotide biosynthesis and other vital functions, controlling and/or preventing gibberellin's biosynthesis, and accumulation of growth regulators in the cells causing inhibitory effect and vegetative growth and grain development during reproductive phase, which ultimately might have reflected on seed weight (Gantayet et al., 2011).

The extracts of *Lantana camara* different parts such as leaf, stem, flower and fruit inhibited growth of *Parthenium hyaterophorus*. Leaf extract of *Lantana camara* inhibited early growth control followed by stem and flower (Mishra A and Singh R, 2009). Leaf extract of *Lantana camara* increased amino acids, soluble carbohydrate levels as well asamylase enzyme in *Miosa pudica* seeds pretreated with leaf extract (Maiti et al., 2008). Dawood and Taie (Dawood MG and Taie HAA, 2009) reported that *Lantana* treatments caused non significant decrease in oil content of lupine seeds.

Allelopathic potential of leaf extracts and leaf leachates of *Lantana camara* L. on growth of mungbean plant. The plant growth performance includes root length, shoot length, internodal length, leaf number, fresh weight and dry weight. The growth parameters were significantly reduced in seedling which was raised from seeds pretreated with leaf extracts and leaf leachates of each concentration. The biochemical changes include: protein, chlorophyll content as well as activity of catalase enzyme. The growth parameters were significantly reduced in seedlings which were raised from seeds pretreated with leaf extracts and leaf leachates of each concentration. A drastic reduction of proteins and chlorophyll as well as catalase was clearly recorded (Maiti et al., 2010).

The aqueous extracts of leaf, flower and fruit of *L. Camara* has allelopathic effects on seedling growth and dry matter production of radish and lettuce. The effects were concentration-dependent (Qiaoying et al., 2009). All parts of *Lantana camara* had significant effect on root and shoot lengths of a *Phaseolus mungo*. Concentration of the extracts increases the root and shoots lengths decrease. Maximum

Table2. Allelopathic effects of *Lantana camara* extract, leachates and residues on germination and growth of bryophytes, fungi, bacteria and weeds

Treatments **_Lantana_ extracts /leachates/ Residues**	**Test species**	**Nature of inhibitory/stimulatory**
	Bryophytes	
Leaf, stem and root extract	*Pogonatum aloides*, *Riccia billardieri*, *Funariahygrometrica*,*Plagiochasma appendiculatum*	Inhibited seed germination
	Fungi	
Twigs	*Phytophthora infestans*	
	Aspergillus niger	Inhibited growth
Root lcachatcs	*Fusarium solani and*	
	Rhizoctonia solani	
Leaf, stem and root aqueous extract	*Cyclosorus dentatus*	Suppressed growth
Leaf, stem and root aqueous extract	*A.angusta, B.cellulare*	Inhibited the exine bursting rhizoid and protonemal initiation of spores
Volatile chemicals	*Mucor nucedo*	Inhibited spore germination
		Controls the spores concentration
	Bacteria	Inhibited growth
Essential oil of air-dried leaves	*Candida albican*, *Bacillus subtilis*, *Staphylococcus typhi*, *Pseudomonas aeruginosa* and *Bacillus aureus*	
Aqueous and organic extracts of leaves		
	Klebsiella pneumoniae, *Proteus vulgaris, Vibrio cholereae, Salmonella typhi, E.coli, Enterobactor aerogens*	Inhibited growth
Extract of flower, leaf, stem and root		Inhibited the growth
	Staphylococcus aureus, and Staphylococcus saprohiticus	
	weeds	
Leaf, stem and root extract	*Parthenium hysterophorus,*	Inhibited seed germination and growth
Aqueous extract	*Eichhornia crassipes*	Inhibited growth
Leaf extracts	*Lemna minor*	Inhibited germination and seedling growth
Aqueous extract	*Melilotus alba*	Inhibited growth
Aqueous extract	*Lolium multiflorum*	Inhibited germination and seedling growth
Foliar leachates	*Morrenia odorata*	Inhibited germination and seedling growth

Source: 3

Table3. Phytotoxic effects of *Lantana camara* extract, leachates and residues on germination and growth of crops.

Treatments *Lantana* **extracts /leachates/ Residues**	**Test species**	**Nature of inhibitory/stimulatory**	**Reference**
Leaf extract	*Oryza sativa, Triticum aestivum*, *Vigna sinensis*, *Cucurbita pepo*, *Amaranthus tricolor*	Inhibited germination and seedling growth	40
Root, stem and leaf extract	*Phaseolus mungo*	Inhibited germination and seedling growth	94
leaf extracts	*Brassica juncea*, *Raphanus sativus*, *Cucumis sativusL*, *Cicer arietinum* L, *Phaseolus mungo and Vigna unguiculata*	Inhibited germination and seedling growth	2
leaf extract	*Raphanus sativus* L. and *Spinacia oleracea*	Inhibited germination	68
Leaf, flower and fruit Extracts	radish and lettuce	Inhibited germination, seedling growth and reduced dry matter production	73

decrease was noted with 5% leaf extract as compared to stem and root extracts. Shoot lengths were more affected than root lengths. Maximum allelochemicals are present in leaf leachates (Vijay B and Jain BK, 2010). The different concentrations aqueous extracts of *Lantana camara* inhibited the growth of *Brassica juncea*, *Raphanus sativus*, *Cucumis sativusL*, *Cicer arietinum* L, *Phaseolus mungo* and *Vigna unguiculata.* The inhibitory effect was much pronounced in root and lateral root development rather than shoot and germination (Ahmed et al., 2007). The growth of the aquatic weed *Eichhornia crassipes* and the alga *Microcystis aeruginosa* may be inhibited by fallen leaves of *Lantana camara*. The extracts of *Lantana camara* leaves and their fractions reduced the biomass of *Eichhornia crassipes* and *Microcystis aeruginosa* within 7 days under laboratory conditions (Kong et al., 2006). Allelochemical treatment significantly decreased plant biomass together with reduced leaf area and stunt plant growth. Allelochemicals also have detrimental effects on cell division and enlargement; eventually induce a reduction in leaf area (Zhou YH and YH JQ, 2006). The aqueous extracts from fresh and dry leaves of *Lantana camera* inhibited the growth of water hyacinth and killed the plant within six days because of salicylic acid which is major allelochmicals in *Lantana* (Zhung et al., 2005).

Lantana camara aqueous extract induced the greatest inhibition in bean and tomato radicle growth, 41% and 81%, respectively, and modified 15 proteins in bean roots and 11 in tomato roots (Cruz-Ortega et al., 2004). The allelochemicals of leaf stem and root of *Lantana camara* inhibited the growth of *Funaria hygrometrica* Hedw. Maximum regeneration was observed in control. Leaf extract was found to exhibit maximum inhibitory effect followed by stem and root extract (Chaudhary BL and Vyas V, 2004). 3% aqueous leachate (w/v) of *Lantana* twigs was allelopathic to the growth of water hyacinth and killed water hyacinth after 21 days under the experimental conditions. Leachate concentrations from 1-3% of Lantana were highly toxic to water hyacinth plant. Leachate from young *Lantana* twigs with prickly orange, pink and yellow flowers was more toxic than leachate from mature twigs. Water hyacinth showed chlorosis, necrotic spots on the leaves, leaf folding, and reduced growth development. Root growth was highly reduced, showing symptoms of damaged roots, black root tips, shrunken root hairs, and decaying root pockets (Saxena KM, 2000). Phytotoxicity of the allelochemicals is due to nitrogen depletion and could be overcome by the addition of access nitrogen in the soil, N depletion were involved in the inhibition of crop growth (Shaukat SS and Siddiqui IA, 2002). Aqueous extract of *Lantana camara* induced an overall increase in protein synthesis in roots of *Zea mays*, *Phaseolus vulgaris* and *Lycopersicom esculentum* (Romero-Romero et al., 2002). The aqueous leachates of leaves of Lantana *camara* inhibited radicle growth of the barnyard grass, tomato, amaranth plants

The radicle growth was inhibited barnyard grass 41.9%, amaranth 32.4% and tomato 17.8% by these treatments (Anaya et al., 1997). The aqueous leaves extracts of *Lantana camara* was phytotoxic to growth of rape, chiness cabbage, spinach and chili (Sahid BI and Sugau BJ, 1993).

Various phenolic compounds inhibited cell division. It is also possible that cell elongation was affected by extracts of weed residues. Regulation of the concentration of hormones, such as auxins and gibberellins, is also important for normal plant cell growth and morphogenesis. A few phenolic compoundes have also been reported to have auxin- protective activity, which leads to the accumulation of auxin. These allelochemicals act by inhibiting the peroxidase- and oxidase- catalyzed oxidation of auxin (Mato et al., 1994 and Cvikrova et al., 1996). The inhibitory effect on plant height might be due to checking or inhibition of biosynthesis of gibberellins, which are responsible for cell-elongation and plant height. Many allelochemicals inhibited gibberellin and indoleacetic acid induced growth. Ferulic acid, p-coumaric acid, vanillic acid and the coumarin inhibit the growth induced by gibberellin. Some flavonoids inhibit the mineral absorption. Many phenolic compounds are able to bring about alterations in the hormonal balance of the receiving plant, which in certain cases lead to an inhibition of the growth. The benzoic acid has deep effect on membranes. They are able to bring about changes in the polarity which would bring about alterations in the structure and permeability of the same.

Chlorophylls are the core component of pigment-protein complexes embedded in the photosynthetic membranes and play a major role in the photosynthesis. Any changes in chlorophyll content are expected to bring about change in photosynthesis. Reduced chlorophyll content in allelochemical-treated plants has been frequently reported, allelochemicals may reduce chlorophyll accumulation in three ways: the inhibition of chlorophyll synthesis, the stimulation of chlorophyll degradation, and both (Zhou YH and YH JQ, 2006). Einhellig (1995) and Einhellig *et al.,* (1993) reported that phytotoxic mechanisms induced by allelochemicals are the inhibition of photosynthesis and oxygen evolution through interactions with component of photosystem II. Chlorosis and necrosis caused the loss of chlorophyll from leaves. Drooping of leaves and twigs also decreases the photosynthetic area exposed to light. Depletion of chlorophyll is due to phytotoxic effects of allelochemicals. Chlorophyll contents of *Parthenium hysterophorus* were inhibited with the treatment of different concentrations leaf, stem and root aqueous extract of *Lantana camara.* Phytotoxicity was directly proportional to the concentration of the extracts and higher concentration had the stranger inhibitory effect. Maximum reduction in chlorophyll contents were observed in 100% aqueous leaf extract. Minimum reduction in chlorophyll contents were observed in 25% aqueous root extracts (Mishra A, 2012).

Aqueous *Lantana* leachate generally reduced in chlorophyll 20-23% in treated water hyacinths after 21 days (Saxena KM, 2000). Qiong *et al*., (2006) reported that *Lantana* leaf extract considerably reduced the chlorophyll content and induced progressive tissue damage in water hyacinth leaves.The chlorophyll content decreased significantly 5d after *Lantana* leaf extract treatment. The average chlorophyll a,b and a+b contents in young leaves were 46%-52% of the control, and in mature leaves were 32-54% of the control. Plant growth and productivity are usually correlated to both the total leaf area and the photosynthetic rate per unit of leaf. Zhou and Yu (Zhou YH and YH JQ, 2006) reported that it has been well documented that allelochemical treatment significantly decreased plant biomass together with reduced leaf area and stunt plant growth.

Allelochemicals might inhibit the photosynthesis in intact plant and microorganisms. Inhibition of photosynthetic process results in depletion of food reserve i.e. carbohydrate and protein. Allelochemicals of *Lantana camara* damage to protein and alterations of some enzymatic activities. Muscolo *et al*. (Muscolo et al., 2001) was reported that phenolic compounds such as vanillic, p-coumeric, p- hydroxybenzoic acid were able to inhibit the enzymatic activity of all or several of the enzymatic monitored. This suggested that the decrease in enzymatic activity is a secondary effect of these compounds, which might be caused by general protein damage leading to decreased enzymatic activity.

Effect on biodiversity: Invasive alien plants have become a serious threat to plant biodiversity in many parts of the world (Mack et al., 2000). *Lantana* that ranked top in terms of highest impacting invasive species (Batianoff GN and Butler DW, 2003) and considered one of the worlds 100 worst invasive alien species, has spread in almost all the areas in the dry deciduous region (Sharma GP and Raghubanshi AS, 2006). Sharma *et al.,* (2005a) reported that invasion of native communities by exotic species has been among the most intractable ecological problems of recent years. It is a global scale problem experienced by natural ecosystems and is considered as the second largest threat to global biodiversity. *Lantana* poses a serious problem to flora and fauna because of its toxic substances and it contains certain allelopathic compounds. *Lantana camara* is aggressively growing in forest, agriculture, tea garden and wastelands of all over the country (Ahmed et al., 2007). Sharma *et al.* (Sharma et al., 2005b and Sharma et al., 2005a) reported that its strong alleopathic properties, *Lantana* has the potential to interrupt regeneration process of other species by decreasing germination, reducing early growth rates and selectively increasing mortality of other plant species. *Lantana* infests natural ecosystem, block natural succession process and reduce biodiversity. As the density of *Lantana* in forest increases, species richness decreases (Lamb D, 1991 and Fensham et al., 1994).

Ecosystems threatened by *Lantana camara* include frontal dune and near by community types such as mangroves, sedge and heath lands, wood lands associated with melaleucas, banksias and casuarinas as well open woodlands and forest communities (Benson JS and Howell J, 1994; Stock DH and Wild CH, 2002 and Van Oosterhout E, 2004).

Coutts-Smith and Downey (Coutts-Smith AJ and Downey PO, 2006) found that *Lantana camara* was a threat 83 threatened plant species, two threatened animal species and 11 threatened ecological communities in New South Wales (NSW), whereas 15 threatened ecological communities are listed in the final determination of *Lantana camara* as a key threatening process (Department of Environment and Conservation, 2006). Swarbrick *et al.,* (1998) recorded that *Lantana camara* is rarely a problem in established exotic pine plantation because it is shaded out whereas light penetration is much higher in hoop pine plantations. *Lantana* has been implicated in the poisoning of cattle, buffalo, sheep, goats, horses, dogs, guinea pigs and captive red kangaroos.

PHARMACOLOGICAL ACTIVITY

Antibacterial, fungicidal and nematicidal activity: Chemical compounds isolated from extracts of *L. camara* are reported to have shown to exhibit antimicrobial, fungicidal and nematicidal activity. *L.camara* is used as a traditional medicine for the treatment of infection diseases. Sonibare and Effiong (Sonibare OO and Effiong I, 2008) reported that the essential oil shows activity against *P. mirabilis* and *B. subtilis* at minimum inhibitory concentration (MIC) value of 1000 ppm. It shows activity against *P. aeruginosa*, *C. albican*, *S. typhi*, and *B. aureus* at MIC value of 10000 ppm.

Xavier and Arun (Xavier FT and Arun RV, 2007) reported that *in vitro* antibacterial activity of aqueous and organic extracts of *L.camara* leaves were investigated against various clinical pathogens. The ethanol and ethylacetale extract of *L.camara* leaf effectively inhibited the growth of both gram negative and positive bacteria. The disc diffusion method showed significant zones of inhibition against the test bacteria. The ethanolic leaf extracts exhibited greater inhibition against the test bacteria. The zone of inhibition was higher in *Staphylococcus aureus* (19.0mm), *Klebsiella pneumoniae* (18.6mm) and *Proteus vulgaris* (14.2mm). Moderate inhibition was associated with DH5α (11mm), K_{12} (11.0 mm), *Vibrio cholereae* (10.3 mm), *Salmonella typhi* (19.3 mm), *E.coli* (8.6 mm), *Enterobactor aerogens* (8.6mm) and very poor inhibition was observed against Stapylococcus epidermitis (2.6).

The essential oil of *Lantana camara* exhibited prominent antibacterial activity against all the bacterial strains tested. Gram positive *Bacillus cereus*, *Bacillus subtilis* and *Staphylococcus aureus* were the most sensitive strains to *L. camara* essential oil. Nevertheless, Gram negative *Klebsiella pneumonia* and *Pseudomonas aeruginosa* were not susceptible to the essential oil at lower concentration. A matter-of-fact, Gram-positive bacterium was more sensitive to the essential oils than gram-negative bacteria (Saikia AK and Sahoo RK, 2011).

The extract of flower, leaf, stem and root of *Lantana camara.L* showed antibacterial activity against *Escherichia coli, pseudomonas aeruginosa, staphylococcus aureus, and staphylococcus saprohiticus* (Kumarasamyraja et al., 2012)**.** *Lantana Camara* flower extract posses strong antibacterial activity All few types' yellow, lavender, red and white *lantana camara.L* flowers displayed almost similar antibacterial activities. Petroleum ether root extract shown less antibacterial activity on *pseudomonas aeruginosa* and *staphylococcus saprophiticus*. The chloroform extract produced a moderate inhibition zone against *staphylococcus aureus* (5m). Chloroform stem extract showed inhibitory effect against *staphylococcus saprophiticus* (Ganjewala et al., 2009).

The methanol leaf extract of *L. camara* has the best activity among the three extracts investigated against three strains of *M. tuberculosis*; H37Rv, TMC-331and the wild strain, (28-25271). The methanolic extract of *L. camara* showed activity against the rifampicin resistant strain (Kumarasamyraja et al., 2012**).**

The organic extracts of the leaf parts of *Lantana camara* against the two bacterial species

and one fungal specie were investigated in a cup plate agar diffusion method. The methanol extract of leaves of *Lantana camara* exhibited high activity against *E.coli* and *S.aureus* and almost moderately active against *A.niger* (Barsagade NB and Wagh GN, 2010). A higher concentration of *L. camara* extract more than 25 mg/ml was required to inhibit growth and (AFB1) produced by the toxigenic *A. flavus* isolate (Mostafa et al., 2011). The extracts of *L. camara* inhibited the growth of *P. infestans* (Maharjan et al., 2010).

L.camara has good antifungal property against *Alternaria sps.* Three different concentration of extacts viz. 10mg/ml, 15mg/ml and 20mg/ml were used. Maximum inhibition was seen in *Lantana camara* at 20mg/ml concentration. The activity can be positively correlated to the dose, as there is decreased radial growth of fungi with increased dose. Lowest radial growth was observed in at 20 mg/ml i.e. 1.5 cm while at 20 mg/ml showed radial growth of 2 cm (Srivastava D and Singh P, 2011).

The mortality of *Sitophilus zeamais* (*Coleoptera curculionidae*) by leaves of *Lantana camara*. Decomposed leaves of *Lantana camara* caused marked changes in the fungal community structure of the soil and the endorhiza, favouring fungal species that exhibited strong nematicidal and hatch-inhibiting activity (Bouda et al., 2001). Leaf extract and decomposed leaves of *Lantana camara* not only inhibited germination but also caused marked suppression of several root- infecting fungi (Shaukat et al., 2001) Root leachate of *Lantana camara* has the potential to control soilborne root-infecting fungi (*F. Solani and R. solani*) (Shaukat SS and Siddiqui IA, 2002).

Begum *et al*., (Begum et al., 2008b) isolated seven compounds from the aerial parts of *L. camara* L., and tested them for nematicidal activity against the root-knot nematode *Meloidogyne incognita*. The lantanolic acid, pomolic acid and lantoic acid showed 100% mortality at 1.0% concentration after 24 h, while camarin, camarinin, lantacin and ursolic acid exhibited 100% mortality at 1.0% concentration after 48 h.

Antioxidant Activity: Premature leaves of *L. camara* L. on twigs are very active in the biosynthesis and accumulation of secondary metabolites and, hence, exhibit greater potential antioxidant activity (DPPH scavenging activity, 62%). It was also found that older leaves had less antioxidant activity (55%), indicating loss of secondary metabolites as result of leaf senescence (Bhakta D and Ganjewala D, 2009). Bhakta and Ganjewala (2009) reported the methanolic extract prepared from leaves I and III position exhibited significantly higher antioxidant activity than leaves present from IV to V position. The anti oxidant activity of Methanolic extract of *lantana camara.L* has been reported. The study showed in terms of DPPH radical scavenging activity and nitric oxide free radical scavenging method (Mayee R and Thosar A, 2011).

Insecticidal activity: Essential oil obtained from the leaves of *Lantana camara* showed insecticidal activity against mosquito vectors (Dua et al., 2010). The essential oils from leaves of *L. camara* L. and *L. montevidensis* Briq. were tested for larvicidal activity against A. aegypti larvae at the third developmental stage (Costa et al., 2010). The methanol and ethanol extracts of leaves and flowers of *L. camara* L. and showed mosquito larvicidal activity against 3rd and 4th instar larvae of the mosquito species A. aegypti and C. quinquefasciatus. Extracts at 1.0 mg/mL caused maximal mortality in A. aegypti exposed for 24 h. In the case of C. quinquefasciatus, maximal mortality was seen when the concentration was increased to 3.0 mg/mL (Kumar MS and Maneemegalai S, 2008). The methanol and ethanol flower extract of *Lantana camara* was found to have higher rate of larvicidal rate against *Aedes aegypti*, where as in the *Culex quinquefasciatus* variety, the concentration of extracts have to be increased for better larvicidal effect. A methanolic extract of *L. camara* L. was tested on larval weight, pupation and adult emergence of cabbage butterfly (Sharma S and Mehta PK, 2009a).

Anticancer and cytotoxic activity: *Lantana camara* leaf extract and root extract had roughly equaled anti proliferative activity on human leukemia jurkat cells. Morphological examinations indicated apotosis induction of the mechanisam of activity on jurkat cells. A crude extract of *L. camara* L. leaves had a cytotoxic effect on HeLa cells at 36 h (at 100 µg/ mL) to 72 h (at 25 µg/mL), by employing the 3-(4,5dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) cell viability assay (Srivastava et al., 2010). Dichloromethane extracts of leaves from *L. camara* L. (colors of flowers: pink and orange) were tested for *in vitro* cytotoxicity against human WI-38 fibroblasts. The dichloromethane extracts showed IC50 values of 69.5±12.1 and 97.2±2.4 µg/mL for *L. camara* with pink and orange flowers, respectively (Jonville et al., 2008).

ALLELOCHEMICALS OF *LANTANA CAMARA*

Allelochemicals of *Lantana* have already been isolated and documented by many scientists. Allelochemicals are present in leaves, stem, roots, fruits and flowers of *Lantana camara* (Table 4 below) (Gopie-shkhanna V and Kannabiran K, 2007 and Wahab A, 2004). The chemical compounds present in *Lantana camara* extracts include mono and sesquiterpenes, flavinoids, iridoid glycoside, furanonaphoquinones, sthsteroids triterpenes and diterpenes.

Yi *et al.,* (2005) reported the presence of several phenolic compounds in lantana leaf extract identified by HPLC as salicylic, gentisic, β-resorcylic acid, vanillic, caffeic, ferulic, phydroxybenzoic acids, coumarin and 6-methyl coumarin. Lantadene A and lantadene B as more potent allelochemicals. Allelopathic chemicals from *Lantana camara* are able to repel other plant. Lantadene A and B are the most common and salicylic acid is recorded as one the major toxins. Essential oil from leaves, flower & fruit of *Lantana Camara* were analyzed by GC and GCMS. It identified 52, 50 & 37 constituents respectively. Trans -β caryophyllene (17.65%, 21.80%, 21.42%), sabinene (9.11%, 14.18%, 1.13%), α -humulene (7.14%, 9.29%, 9.97%), bicyclogermacrene (5.77%, 8.49%, 2.18%) were the major components of all

Table4. Chemical constituents of *Lantana camara* all parts

S.No	Compound Name	Biological Activity	Reference
1	β-pinene	Inhibiting the seed germination, growth and antibacterial activity.	78,88
2	β-sitosterol	Not determine	41
3	Betulonic acid	Not determine	41
4	Betulinic acid	Not determine	41
5	Caffeic acid	suppress root-infecting fungi and root-knot nematode.	80
6	Calceolarioside	Not determine	37
7	Camaraside	Not determine	95
8	Camarinic acid	Antimutagenic , antimicrobial and nematicidal activity.	95
9	Camaric acid	Nematicidal activity	95
10	Campesterol	Not determine	41
11	1,8-Cineole	Inhibiting the growth of plant.	78
12	Cinnamic acid	Inhibited the activity of plasma H+-ATPase, PPase and inhibit the process of seed germination.	99, 78
13	Dipentene	Inhibiting the growth of plant.	78
14	8-epiloganin	Not determine	37
15	Ferulic acid	Reduced chlorophyll contents in soybean leaf and inhibit the process of seed germination.	78
16	Geniposide	Inhibited hepatoxicity and the DNA repair synthesis induced by aflatoxin B1 in rat primary hepatocytes.	37
17	Hispidulin	Not determine	41
18	Icterogenic acid	Toxic to sheep, cattle, goats.	37
19	Isonuomioside A	Not determine	37
20	Isoverbascoside	Not determine	37
21	Lamiridoside	Not determine	37
22	Lantadene A, B,C	Death of horses, cattle, sheep, goats and rabbits by failure of liver and other organs.	37
23	Lantanilic acid	Nematicidal activity.	95
24	Lantanolic acid	Not determine	37
25	Linaroside	Antimicrobial and Nematicidal activity.	95
26	Lantanoside	Antimicrobial and Nematicidal activity.	95
27	Lantic acid	Not determine	37
28	Linaroside	Antibacterial activity	95
29	Myristic acid	Inhibiting the growth of plants	78
30	Oleanolic acid	Hepatoprotective, Anti-flammatory, antimicrobial, antiulcer, antifertility, Antimicrobial and Nematicidal activity.	95
31	Oleanonic acid	Inhibit the growth of mouse melanoma cells in cultures and Herpes simplex virus type I and II in vitro.	95
32	Palmitic acid	Inhibiting the growth of vegetables.	78
33	ρ-Coumaric acid	suppress root-infecting fungi , root-knot nematode , inhibit the process of seed germination and inhibit the growth of morning glory.	80, 78, 96
34	Pectolinarigenin	Not determine	41
35	Pectolinarin	Not determine	41
36	ρ-hydroxybenzoic acid	Inhibit the enzymatic activity, Nematicidal activity.	81, 96
37	Theveside	Not determine	37
38	Ursonic acid	Inhibit the growth of mouse melanoma cells in cultures and Herpes simplex virus type I and II in vitro.	95
39	Ursolic acid	Inhibitors of human leucocyte elastase,	37
40	Verbascoside	Inhibitor of protein kinase and possesses antitumor activity.	37
41	Vanillic acid	Inhibit the enzymatic activity.	96

Table5. Chemical constituents of *Lantana camara* leaf flower and fruit essential oil.

S.no.	R.T	Component	Leaf	Flower	Fruit
1	10.46	Cis 3 hexenol	0.60	_	_
2	10.87	1 -Hexan- ol	0.29	_	_
3	12.88	α- thujene	0.15	_	_
4	13.31	α -pinene	0.98	0.33	-
5	14.15	Camphene	0.44	0.56	0.11
6	12.88	α -thujene	0.15	0.34	0.08
7	15.14	Sabinene	9.11	14.18	1.13
8	15.34	1-octen-3-ol	1.64	-	_
9	15.48	β –pinene	1.44	1.01	_
10	15.64	β -myrcene	1.01	1.04	_
11	16.32	Octan-3-ol	0.08	_	0.14
12	16.83	α- phellandrene	0.14	0.29	_
13	16.97	δ -3- carene	1.48	2.16	0.54
14	17.39	α -terpinene	0.12	0.28	0.19
15	17.89	ρ -cymene	0.29	0.23	_
16	18.09	Limonene	0.99	0.61	0.29
17	18.19	Cis -β- ocimene	0.78	0.75	_
18	18.48	Eucalyptol	7.53	3.68	1.25
19	18.80	trans -β- ocimene	0.75	1.37	0.14
20	19.74	γ -terpinene	0.39	1.09	0.33
21	20.71	Cis - Sabinenehydrate	0.85	0.23	0.43
22	21.45	α -terpinolene	0.28	0.26	0.11
23	22.29	Linalool	0.56	0.19	2.96
24	22.75	Trans - Sabinene hydrate	0.49	_	0.42
25	22.87	Nonanal	_	0.16	_
26	24.38	Cis-p-menth-2-en-1-ol	0.06	_	_
27	26.03	Camphor	1.56	0.18	0.26
28	27.67	Borneol	0.49	0.18	0.84
29	28.09	Terpin -4- ol	1.40	0.62	1.26
30	29.12	α -terpineol	0.49	0.06	1.29
31	38.16	Bicycloelemene	0.48	0.54	-
32	38.31	A -Terpinyl acetate	0.17	_	_
33	38.62	δ -elemene	_	0.46	_
32	39.16	α -cubebene	0.02	_	_
33	41.27	α -copaene	0.57	1.33	0.76
34	41.92	β -bourbonene	0.03	_	_
35	42.16	β -elemene	2.24	3.82	0.94
36	43.37	isocaryophyllene	0.21	0.04	_
37	43.83	α -gurjunene	_	0.04	_
38	44.67	trans -β -caryophyllene	17.65	21.80	21.42
39	44.83	γ -elemene	0.33	_	0.44
40	45.08	β -Copaene	0.55	1.14	_
41	46.05	Aromadendrene	_	0.03	_
42	47.00	α -humulene	7.14	9.29	9.97
43	47.21	Alloaromadendrene	0.35	0.51	0.37
44	47.97	γ -muurolene	0.35	0.61	0.47
45	48.57	Germacrene D	2.35	5.01	2.19
46	49.14	β -selinene	0.11	_	_
47	49.49	Viridiflorene	_	0.13	_
48	49.61	Bicyclogermacrene	5.77	8.49	2.18
49	50.54	γ -cadinene	0.08	0.04	_

Table5. *Continued*

S.no.	R.T	Component	Leaf	Flower	Fruit
50	50.74	δ -cadinene	0.32	0.98	0.52
51	52.11	Trans - Cadina 1,4 diene	_	0.03	_
52	53.28	Elemol	_	0.16	_
53	53.32	trans - Nerolidol	2.14	0.63	18.85
54	53.63	Davanone B	1.22	_	1.52
55	54.07	Germacrene B	_	0.66	_
56	55.09	Spathulinol	0.87	0.17	0.29
57	55.43	Caryophylene oxide	1.07	0.34	1.29
58	64.99	Mintsulfide	0.20	0.00	_
59	83.00	Heneicosane	_	0.10	_
60	83.62	Phytol	0.36	_	_

Source: 86

the oils (Table 5) (Singh et al., 2012). Essential oil extracted from the leaves of *L. camara* was found to possess significant insecticidal, antifeedant, antimicrobial and exhibited anthelmintic.

ECONOMICAL IMPORTANCE OF *LANTANA CAMARA*

L. camara has several uses; approximately 80% of all medicines on the market are made from plants or improved from material that originally came from plants. 90% of the world's population relies upon 20 plant species for their main source of nutrition.

Ornamental: Both weedy and non weedy varieties of *L.camara* are widely planted as ornamental plants in gardens, in particular as hedges. *Lantana* was originally introduced to most countries as a garden ornamental, and it is still popularly grown.

Alternative food and habitats sources for wildlife: *L.camara* may provide shelter and vital winter food for many native birds. *Lantana* thickets can provide a substitute habitat for birds and animals.

Medicinal uses: The different parts of *Lantana camara* can use because many chemicals are present in the treatment of many disease. *L. camara* has several uses, mainly as a herbal medicine All parts of *Lantana camara* are used contents many medicinal properties. Plant extracts are used in folk medicine for the treatment of cancers, chicken pox, measles, asthma, ulcers, swellings, eczema, tumors, high blood pressure, bilious fevers, catarrhal infections, tetanus, rheumatism, malaria, atoxy of abdominal viscera (Mishra A and Singh R, 2009) and for cure of snake-bite. *L. camara* provide the drug Herba camara.

Green herbicides / Insecticides / Biocides / Fungicides: Here has been much work conducted, especially in India, on the chemical constituents of *Lantana*; extracts from the leaves exhibit antimicrobial, fungicidal, insecticidal and nematicidal activity .Verbascoside, which possesses antimicrobial, immunosuppressive and antitumor activities, has been isolated. Lantanoside, linaroside and camarinic acid have been isolated and are being investigated as potential nematocides. In Indian sandal wood forests the shrub competes with the tree crop as well as favors the spread of sandal spike disease.

Many insect species attack flowers, flowers stalks, leaves, stems, shoots and roots. Therefore It can be used *Lantana camara* as a herbal insecticides.

Industrial uses

- Paper Industry**:** The stems of *Lantana*, if treated by the sulphate process, can be used to produce pulp for paper suitable for writing and printing.
- Rubber industry: The roots of *Lantana* contain a substance that may possibly be used for rubber manufacture.
- Its straw is used for biogas product, dung manufacture.
- Production of essential oil from it’s leafs.
- The essential oils contained in lantana have been investigated for use as a perfumery ingredient. The essential oils present in *L.camara* flowers and leaves can be extracted for use in perfumes.

Domestic uses: It is as a hedge to contain or keep out livestock *Lantana* twigs and stems serve as useful fuel for cooking and heating in many developing countries although It is less important than other fuel sources such as windrows, woodlots or natural bush.

***Lantana* in agriculture:** The plant can prevent soil compaction and erosion and is a source of organic matter for pasture renovation. *Lantana* compost at 4t/ha gave significantly higher grain yield of rice over the control due to more tillers/hill and higher growth rate (Singh KP and Angiras NN, 2005).

Lantana leaves for improving yield and chemical constituents of sunflower plants (Dawood et al., 2012).

Future Lines of Work

The natural compounds (allelochemicals) of *Lantana camara* can be beneficial or detrimental. The beneficial allelopathic effect of any weed or crop on another weed can be exploited to ecofriendly, cheap and effective green herbicides.

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