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Exploring future scopes and potential uses of *Parthenium hysterophorus* (Linn.) – A scientific approach

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ABSTRACT

Parthenium hysterophorus (Linn.) of a neo-tropical origin has achieved a major weed status in all the countries within a relatively short period. It is erect and much branched annual herb to known for its notorious role as environmental, medical and agricultural hazards. Its allelopathic nature can drastically reduce the crop production and aggressive dominance of this weed threatens biodiversity. Despite loss of agricultural yield and health hazards it confers many health benefits viz. remedy for skin inflammation, rheumatic pain, diarrhoea, urinary tract infections, dysentery, neuralgia and many more. The plant contains a large number of important bioactive compounds, mainly sesquiterpene lactones and flavonoids. It has multiple pharmacologic properties such as anticancer, cardiotonic, antispasmodic, and an emmenagogue. The aim of this study is to discuss several prominent biological and toxicological utilities of *Parthenium hysterophorus* and possible effective control measures that can be implemented as well as to unravel the latent beneficial prospects of this weed.

Key Words- *Parthenium hysterophorus*, Sesquiterpene lactones, Allelopathy, Pharmacology, Cardiotonic.

Introduction-

Plant *Parthenium hysterophorus L.* (Asteraceae) is labelled as serious and problematic need of pasture, wastelands and agricultural field in world, commonly called as congress grass, carrot weed,

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white top Chatak Chandni, broom brush, gajari and safed topi. It is among the top ten worst weeds of the world because of its invasiveness, potential for spread and economic and environment impacts and has been listed in the global invasive species database (Callaway *et al*.,2004; Kapoor,2012). It is an aggressive weed which invades wastelands, roadside, railway track and residential areas. Hence it forms predominant exotic vegetation by replacing the existing native flora. Competitive ability and a possible allelopathic mechanism have been attributed to be the main reasons for the colonizing habit of this weed (Rice, 1984). It is native to the subtropics of North and South America but now it is widely occurring and occupied almost all the parts of world such as in Asia (Bangladesh, India, Israel, Pakistan, Nepal, Southern China, Sri Lanka, Taiwan and Vietnam), Africa, Australia and Pacific Islands (Dhileepan and Senaratne, 2006).

In India it has invaded almost all the states with a high level of invasion in Haryana, Punjab and U.P. This alien weed is believed to have been entered into India as contaminants in PL 480 wheat imported from the USA in 1950. In India the weed was first pointed out in Pune (Maharashtra) by Prof. Paranjpe in 1951. This weed is an emerging threat in several Asian countries. According to Kanchan (1979) and Pandey (1994), Parthenium is one of the best-known examples of plant invaders in the world. It is an annual herb, erect up to 2m in height, branched stem and covered with trichomes. *Parthenium* weed is a prolific seed producer, giving it potential to build up a large seed bank very quickly. Is has potential to invade the dominant indigenous natural flora in a wide range of habitats and agro-climatic regions (Oudhia, 2000). *Parthenium* by virtue of its luxurious growth behaviour and ability to compete with useful plants poses a serious problem both in cropped and un-cropped situations. The impact of *Parthenium* on environment, biodiversity, agricultural production, livestock and human being is very important.

This weed is considered to be a cause of allergic respiratory problems, contact dermatitis, mutagen city in human and livestock. Direct contact with plant or its pollens in the air cause air borns contact dermatitis (Agarwal and D'Souja, 2009) fever and asthma (Lonkar *et al.,* 1974; Rodriguez *et al.,* 1976 a). Livestock is also allergic and suceptible to *Parthenium hysterophorus.* Phytochemicals present in almost all the parts of plant such as leaves, trichomes, inflorescence and pollens. These are alkaloids, sesquiterpene lactones, kaempferal, p-coumaric acid and caffeic acid (Kohli *et al.,* 2006;

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The Wealth of India NISCOM, 2003), parthenin and coronopillin present in leaves and stems are responsible various allergies. The active ingredient parthenin (Rodriguez, 1975) is responsible for bitter milk disease in livestock fed on grass mixed with *Parthenium.* Besides this *Parthenium* has shown several prominent biological activities in animals and human models that give this plant an importance as folk medicinal plant. The aim of this review article is to explore effective future scope and the latent beneficial prospects of this weed.

Problems created by Plant *Parthenium hysterophorus weed*-

Parthenium weed affects the viability of primary production-both livestock and grain enterprises as well as causing health problems for humans and animals.

Impact on agricultural viability-

Parthenium weed is a serious problem on pastures and crops. Khan *et al.,* (2012) reported that the seed germination and seedling growth of wheat was the most inhibited one by the *Parthenium* root, stem and leaf extracts. Maharjan *et al.,* (2007) found that leaf extracts of *Parthenium hysterophorus*exhibited significant inhibitory effects on seed germination and growth of three cereal crops i.e., *Oryza sativa, Triticum aestivum and Zeamays.*

Impact on Biodiversity-

It is a threat to the biodiversity known to exert significant impact on the natural communities as they cause their displacement and hence exert imbalance in the natural and agricultural ecosystem (Sakai *et al.,* 2001). Phytotoxins (allelochemicals) of *Parthenium* plant are released from decomposing biomass and root exudates in the soil, which suppresses the growth and productivity of surrounding crops because it exerts strong allelopathic effect. Its infestation in grasslands is more critical as it affects both the quantity and quality of forage. The pollen deposition is reported to inhibit fruit or seed setting in crops like tomato, brinjal, beans, capsicum and maize.

Impact on Soil micro flora-

The weed is known to inhibit the growth and activity of nitrogen fixing bacteria like Rhizobium, Azotobacter and nitrifying bacteria like Nitro-somonas. Leaf and root leachates,

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parthenin, anisic acid, vanillic acid and fumaric acid inhibited nitrate production (Sukhada *et al.*, 1981). The native soil algal flora was found to be inhibited by the addition of powdered air-dried leaves, inflorescence and roots of *Parthenium* (Megharaj *et al.*, 1987).

Impact on Livestock-

Carrot weed possess a chemical sesquiterpene lactone which induces severe allergic dermatitis and other symptoms (Swain and William, 1977). Cattles grazed on *Parthenium* resulting in impairment of both quality and quantity of milk. It can taint sheep meat and make dairy milk unpalatable due to its irritating odour. It can cause dermatitis with skin lesions on all animals including horses and cattle, mouth ulcer with excessive salivation if eaten, eye irritation in working dogs, loss of condition in farm animals, death due to rupturing and haemorrhaging of internal tissue and organs (Anonymous, 2004). *Parthenium* toxicity involves alopecia and dermatitis of the face, muzzle, neck, eyes, thorax, abdomen and brisket region and causes salivation, anorexia, diarrhoea and death in extreme cases (Kadhane *et al.*, 1992). Stock animals especially horse, suffer from allergic skin reactions while grazing in infested paddocks. Alopecia, anaemia, decreased body weight, leucocytosis, lymphocytosis and neutropenia was noticed in rabbits by Prakash *et al.*, (2002 a). Congestion in abomasums, liver and lungs in goats was observed by Qureshi *et al.*, (1980).

Impact on Human Health-

When human beings frequently come in contact with this weed, it may cause allergy, dermatitis, eczema, black spots and blisters around eyes, burning rings blister over skin, redness of skin and asthma. Pollen grains of *Parthenium* can cause respiratory problems which may leads to nasobranchial allergy. Hay fever (rhinitis) and asthma are very common type severity induced by *Parthenium*. Tanner and Mattocks, (1987) revealed that contaminated animal feed leads to tainted milk and the hepatotoxic parthenin reacts synergistically with copper causing Indian childhood cirrhosis (ICC). Hepatic copper accumulation is a characteristic of the disease. Parthenin has enhanced toxicity due to the presence of a cyclopentene group that can cause chromosomal damage in animal cells, uncoupled phosphorylation and inhibit the key cellular enzymes (Evans, 1997). Wiesner *et al.*, (2007) indicated that *Parthenium* cause general illness, irritation and pustules on hand

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balls, stretching and cracking of skin and stomach pains in humans. The common allergens found in the weed are parthenin, coronopillin, tetraneuris and ambrosin. Other toxic and adverse effects created by *Parthenium* administration have been well documented. Hypersensitivity (Srinivas and Lakshmi, 2007 b), atopic dermatitis (Davis *et al.,* 2011; Kumar *et al.,* 2012), as central nervous system depressant, loss of immunity in animals by (Jha *et al.,* 2011) decreasing the WBC (Neha *et al.,* 2010) are causes due to *Parthenium* extract. Ulceration in alimentary tract of cattle and buffaloes autopsy have been revealed (Narasinhan *et al.*, 1977)

Management by Utiliazation-

One of the most effective methods to manage the *Parthenium* is large scale utilization of this weed. However, it is necessary to control the problematic weed *Parthenium hysterophorus* in time before spreading because of its negative impact on natural and agro eco-system.

Sesquiterpene lactones exhibit a wide spectrum of biological activities, which include cytotoxic, antitumour, allergen, antimicrobial, antifeedant, phytotoxic and insecticidal properties (Rodriguez *et al.,* 1976 a). The sesquiterpene lactone parthenin is the main secondary metabolite of *Parthenium hysterophorus*. Parthenin the major sesquiterpene lactone becomes useful when properly processed. The early reports suggest that parthenin can be used in pest and pathogen control, either by itself or as a lead compound for the development of active and more selective analogues (de la Fuente *et al.,* 2000; Datta and Saxena, 2001; Fazal *et al.,* 2011).

Health Benefits of *Parthenium hysterophorus*-

In the Dictionary of Economic Plants in India *Parthenium hysterophorus*is described as a weed to be used as tonic, febrifuge and emmenagogue. The decoction of *Parthenium hysterophorus* has been used in traditional medicines to treat fever, diarrhoea, neurologic disorders, urinary tract infections, dysentery and anti-malarial (Surib-Fakim *et al.,* 1996). Ethnobotanically, it is used by some tribes as remedy for inflammation, eczema, skin rashes, herpes, rheumatic pain, cold heart troubles and gynaecological ailments. The odour of the plant is disagreeble to bees and they can be easily kept away by carrying a handful of *Parthenium* flower heads. *Parthenium* is reported as promising remedy against hepatic amoebiasis (Sharma and Bhutani, 1988). Mew *et al.,* (1982)

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demonstrated that sub-lethal dosesof Parthenin exhibited anti-tumour activity in mice. Plant has been found to be pharmacologically active as analgesic in muscular rheumatism, therapeutic for neuralgia and as vermifuge (Maishi *et al.,* 1998). Plant exhibits significant medicinal attributes including anti-cancer property (Venkataish *et al.,* 2003) and hypoglycaemic activity against alloxan – induced diabetic rats (Patel *et al.,* 2008). So, flower extract of this weed can be used for developing drug for diabetes meelitus.

Insecticidal-

Parthenin is known to show activity against termites, cockroaches (Tilak, 1977) as well as migratory grasshoppers, *melanoplus sanguinipes* (Picman *et al.,* 1981). The environmental biologist have identified its cholinesterase antagonistic properties which can be used in control of insects and worms (Dhawan and Dhawan, 1995).

Nematicidal-

Extract of *Parthenium hysterophorus* show toxicity against root knot nematodes and chitwood (Hasan and Jain, 1984). Crushed leaves admixed into the soil are used to reduced root galling in papaya caused by *M.incognita* (de la Fuente *et al.,* 2000).

Antifeedant-

Parthenium has been shown to act as a feeding deterrent to the adult of *Dysdercus Koenigii F., Trribolium castaneum* and sixth instar larva of *Spodoptera litura* (Datta and Saxena, 1997).

Antifungal-

Rai and Upadhyay, (1880) and Rai, (1993, 1994, 1995) investigated antifungal potential of different extracts of *Parthenium hysterophorus* against human pathogenic fungi. The dermatophytes and other fungal pathogens have been found to be sensitive to sesquiterpene lactones (Rai *et al.,* 2003).

Bioherbicide-

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Allelochemicals or plant derived chemicals offers a great potential for the pesticides because they are comparatively safer for the environment. Tefera, (2002); Stephen and Sowerby, (1996) have documented the importance of *Parthenium* as a potential source of herbicide. Plant shows phytotoxic effects on many aquatics and as well as terrestrial weeds (Khosla *et al.,* 1980; Kumari, 1990; Singh *et al.,* 1992).

Antiamoebic-

Parthenin has been found to show acute toxicity to the cultured organisms like Entamoeba histolytica. It has activity comparable to that of metronodazola (Sharma and Bhutani, 1988).

Antimalarial

Parthenin and some of its derivatives were found resistant of *Plasmodium Falciparum*. It has significant antimalarial action (The Wealth of India, 2003).

Antibacterial and Antiviral

Chopra, (1960) investigated that the volatile oil containing sesqiterpene and flavanoids found highly effective against gram positive and gram negative bacteria.Parthenin might find use as an effective agent against potato virus Y (The wealth of India, 2003).

Trypanocidal-

Crude ethanolic extract of plant shows activities against Trypanosoma evansi. The extract exerts antitrypanosomal effect at intra-peritoneal doses of 100 and 300 mg/kg body weight when used for treatment of infected rats (Talakal *et al.,* 1995).

Anti-Inflammatory-

Oral administration of *Parthenium hysterophorus* extract led to significant antinociceptive and anti-inflammatory effects against acetic acid – induced writhing in mice and carragunan – induced paw edema in rats (Jain and Kukarni, 1899).

Antioxidant Activity-

Methanolicand ethanolic extract of *Parthenium hysterophorus* showed antioxidant activity (N. *et al.,* 2010). Acetone extract was found to have higher antioxidant activity than methanol and chloroform extracts showed significant antioxidant activity in rats (Pandey *et al.,* 2012).

Anticancer and Cytotoxic Activity-

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Anticancer and cytotoxic properties of *Parthenium hysterophorus* are the bright potential in oncology as anticancer therapeutic. The methanolic flower extract exhibited antitumor effects in host mice bearing transplantable lymphocytic leukemia (Mukherjee and Chatterjee, 1993). Methanol, Ethanol, Chloroform and Aqueous were found that all extracts were significantly cytotoxic to the investigated human cancerous cell lines ovary, lung, prostate, breast and CNS.

Wound healing and Thrombolytic Activity-

Externally leaf paste application of *Parthenium hysterophorus* showed wound healing activity (Kumar *et al.*, 2012).Crude methanollic extract of *Parthenium hysterophorus* showed significant thrombolytic effect comparable to standard thrombolytic agent, streptokinase (Al-mamum *et al.*, 2010). Parthenolids and some other metabolites were reported as the inhibitor of human blood platelet function (Hewlett *et al.*, 1996).

Against Mosquitoes-

Parthenium hysterophorus feeding reduced the survival time and fecundity of Anopheles gambiae, the primary vector for Plasmodium falciparum, due to presence of low sugar content (Manda *et al.*, 2007). The ethanolic extract of leaves showed 83-90% larvaecidal activity against Anopheles stephensi larvae (Ahmad *et al.*, 2011).

Prevention and Treatment of Migraine Rheumatiod Arthritis

Parthenium hysterophorus was reported after many clinical trials that it inhibits granule secretion in blood platelets, which is related with the etiology of migraine (Heptinstall *et al.*, 1985). A preparation with ginger is effective for treating migraines during the early pain phase (Kuhn and Winston, 2007).similarly *Parthenium hysterophorus* was reported to inhibit granule secretion in blood neutrophils, which is related with the etiology of Rheumatoid arthritis (Heptinstall et al., 1985).

As Food-

Theleaf protein from this plant is reported to be better than cereal and legume proteins. It is used as spices in many parts of world. The leaf protein concentrate contains protein 48-54%, either

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extract 11-13% ash 6-8% etc. (Khan *et al.,* 2011). Parthenin free dried fibres of the plant contain 1.6-2.4% of N_2 and can be sued as cattle feed (Narasimhan *et al.,* 1993).

Possible utilization and future scope of *Parthenium hysterophorus*-

Role of *Parthenium hysterophorus* in enhancement of crop productivity-

Allelopathy can be used to increase crop production at minimal expenses and to diminish the current reliance on synthetic agrochemicals that degrade the environmental quality. The allelochemicals can be exploited as herbicides, insecticides, nematicides, fungicides and growth regulator. Pesticidal potential has been established in terms of ovicidal and anti-fleedant effects (Datta and Saxena, 2001). The allelochemicals also provide defence against herbivorous predators.

Kishor *et al.,* (2010) prepared compost of *Parthenium hysterophorus* in 14 weeks and assessed its manure value. Compost from this weed on application in soil enhanced its moisture level more than nitrogen, phosphorus and potassium (NPK) alone. This can be applied as organic manure (Gunaseelan, 1998). Javaid, (2008) used *Parthenium hysterophorus* weed as green manure for maize and mung bean production. *Parthenium hysterophorus* being rich in N, P, K, Ca, Mg and chlorophyll content is ideally suited for composting which is two times more than Farm Yard Manure. *Parthenium* compost aids in moisture conservation which is utilized for better root penetration and crop growth. Finally, composting *Parthenium* before flowering is a means to minimize its allelopathic inhibition potential and a management by utilization. Therefore, resource poor farmers could make use of the high nutrient content of *Parthenium* compost and could control *Parthenium* by composting (Wakjira *et al.,* 2009).

Bioremediation of heavy metals and dyes by *Parthenium hysterophorus*-

Environmental pollution with heavy metals has become a global phenomenon. Ni (II) is present in the effluents of silver refineries and storage battery industries which is a cause of lung , nose and bone cancer. Lata *et al.,* (2008) studied the adsorption capacity of *Parthenium hysterophorus* for the removal of nickel from aqueous solution. Similarly Cd (II) is extreme toxic responsible for causing renal disorder, high B.P., bone deformity and RBC's destruction. Ajmal *et al.,*

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(2006) studied the efficiency of dried powder of *Parthenium hysterophorus* as an adsorbent for removing Cd (II) from waste water. Cresol, a toxic effluent is known to cause stomach tumours, affects the CNS, Cardio-Vascular system, lungs, kidney and liver even leading to death. Activated carbon prepared from *Parthenium hysterophorus* by chemical activation using concentrated H_2So_4 is an effective adsorbent material. PAC (*Parthenium* activated carbon) has excellent cresol adsorptive characteristic (Singh *et al.*, 2008). Carbonized *Parthenium* can be used for removal of dyes, heavy metals, nitrates and phenols (Rajeshwari ans Subburam, 2002).

Eradication of weeds by *Parthenium hysterophorus*-

Salvinia, Pistia and Eichhornia choke off water bodies suffocating aquatic creature. Pandey, (1994) studied the effect of dry *Parthenium hysterophorus* leaf powder on these menacing weeds. With the increasing concentration of *Parthenium hysterophorus* extracts, the seed germination and growth of Eragrostic decreased significantly (Tefera, 2002).

***Parthenium hysterophorus* as substrate for enzyme production-**

Xylaneses are hydrolytic enzymes that cleave xylans, having industrial applications, baking and textile industry. Besides, there has been an increasing interest in using xylanases for eco-friendly bleaching of pulp in paper industries. Dwivedi et al., (2009) studied the potential of *Parthenium hysterophorus* as low cost raw material for xylanase production. It is a cheap and alternative carbon source to save costs of the enzymes production process.

***Parthenium hysterophorus* as additive with cattle manure in biogas production-**

Energy crops are likely to be future sources of digester feed stocks for methane generation. *Parthenium* was mixed with cattle manure at a 10% level and allowed to digest anaerobically at room temperature. So, it is a useful and cheap biogas production.

Welfare of livestock-

Parthenium hysterophorus can be used as a flea-repellent for riding dogs (Maishi *et al.*, 1998). This weed is a valuable source of potash, oxalic acids and high quantity of protein which can be used in animal feed (Mane *et al.*, 1986).

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Conclusion-

The noxious weed *Parthenium hysterophorus* grows in a wide variety of habitats and causes changes in above ground vegetation as well as in below ground soil nutrients. To address this problem, public awareness has to be developed and scientific approach to control the invasive weeds should be adopted. There is the need to encourage the research on the utilization potential of this weed. The target of "Management through utilization" can be achieved through joint efforts of researchers, farmers, governmental and non-governmental agencies. The discovery of the uses of this weed also could pave the way for indirect eradication of the weed. Developing a innovative and participative approach for management and control of *Parthenium* will result in future potential uses. Greenleaf manure, compost, bio-pesticide, soil amendment, bioremediation of toxic metals and dyes, source of biogas, herbicides, cheap substrate for enzyme production, nano-medicine are some of the recently discovered implications of *Parthenium hysterophorus*. The efficient,eco-friendly alternatives and new uses are coming forward of this weed. However, a *Parthenium hysterophorus* is a toxic plant, further clinical researches and investigations are essential to establish it as a standard medicinal plant. The nutritional value of the plant indicates its utility as food and fodder also. In this regard, it is touted to become a boon for the human beings, animals and crops in near future.

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