STUDIES ON BIOPESTICIDAL PROPERTIES AND COMPOSTING BEHAVIOUR OF *Parthenium hysterophorous* L.

Thesis

by

SAYEED NABI ATTAYEE

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in

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CERTIFICATE – I

This is to certify that the thesis entitled **"Studies on biopesticidal properties and composting behavior of *Parthenium hysterophorous* L."** submitted in partial fulfillment of the requirements for the award of degree of **MASTER OF SCIENCE** in **ENVIRONMENTAL SCIENCE** to Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni-173 230, Solan (Himachal Pradesh) is a bonafide record of research work carried out by **Mr. Sayeed Nabi Attayee** (**F-2013-14-M**) under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of investigation have been fully acknowledged.

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This is to certify that the thesis entitled, **"Studies on biopesticidal properties and composting behavior of *Parthenium hysterophorous* L."** submitted by **Mr. Sayeed Nabi Attayee** (**F-2013-14-M**) to Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni-173 230, Solan (Himachal Pradesh) in partial fulfillment of the requirements for the award of degree of **MASTER OF SCIENCE** in **ENVIRONMENTAL SCIENCE** has been approved by the Student's Advisory Committee after the thesis viva-voce examination in collaboration with the external examiner.

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Place: Nauni-Solan
Date July, 2015 **(*Sayeed Nabi Attayee)***

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ABBREVATIONS USED

C/N	Carbon Nitrogen ratio
EC	Electrical Conductivity
PH	Power of Hydrogen
OC	Organic Carbon
NPK	Nitrogen, Phosphorus and Potassium
CRD	Completely Randomized Design
%	percent
N/S	Non-significant

Chapter-1

INTRODUCTION

Parthenium hysterophorous L. family Astreraceae is an exotic species said to be originated in Mexico, Argentina and accidently introduced in India in 1955 in Pune through the imported food grains. It is commonly known as "Congress Grass" but also known by different names viz., white top, white head, congress grass or carrot grass, bitter weed etc. It has become neutralized and spreading at an alarming rate all over India (Sivakumar *et al*., 2009) and can adopt any climate easily. Its success of spreading lies in its huge biotic potential and ability to enormous proliferating capability, remarkable power of generation and capability to overcome environmental resistance as a result of which it can complete about three generations in a year. The enormous capability of reproduction of the weed is reflected by production of nearly 100,000 seeds per plant. The weed after its luxuriant growth dies and the biomass with the harmful chemicals is mixed in the supporting soil or nearby area.

It is a real problem in orchards, short structure crops with spacing (Joshi, 1991) and also causes substantive losses in the yield of agriculture (Dhawan *et al*., 1998) and prefers moist and shady habitats, particularly those which are rich in organic matter are most vulnerable to its infestation. It is capable of growing on a wide range of soil types ranging from sandy to heavy clays, but favors' the latter (Dale, 1981) and in areas with summer rainfall greater than 500 mm per annum (Chamberlain and Gittens, 2004).

It can cause a total habitat change in native grasslands, the understorey of open woodlands and along rivers and floods. Owing to its fast spread it has become a problematic issue to humans all around the world. Moreover, it is not liked by animals and hence growing and spreading at a very fast rate, the lack of natural enemies of the weed is also contributing to its rapid spread.

The plant contains several important chemical constituents viz., histamine, Sapanin, Glucosides, Triterpenes, toxins etc and has the potential to decrease the crop productivity, fodder scarcity and biodiversity depletion. It has allelopathic effect and inhibits the germination and growth of neighbouring plants by releasing various allelochemicals such as

water soluble phenolics and sesquiterpenes lectons including parthenin and coronopilin. Direct contact with plant or plant parts living or dead, cause dermatitis in humans. Presence of pollens in the air cause diseases like hay fever, eczema, asthma in humans. Parthenin the active ingredient of Parthenium cause bitter milk disease in live stocks fed on grains mixed with *P. hysterophorous*.

At present it is one of the most troublesome and obnoxious weed of wasteland, forest, pasture, agricultural lands in India and spreading rapidly throughout the country (Bakthavathsalam and Geetha, 2004). Several attempts have been made for its prevention, eradication and control, but to date without success (Kavita and Nagendra, 2000).

Composting of organic waste is gaining popularity now days to get rid of organic waste. Though it is not a new technology, but amongst the waste management strategies it is gaining interest as a suitable option for manures with economic and environment profit (Kishore *et al.*, 2010). Since the economic use of *Parthenium* in impaired by its toxic property, therefore, its compositing can be an useful alternative and it can be used as a soil conditioner. The compost prepared from *P. hysterophorous* has high level of macro and micronutrient it contains two times more nitrogen, phorphorous and potassium than Farm Yard Manure (Angiras, 2008). A large variety of mesophilic, thermotolerant and thermophilic aerobic microorganisms including bacteria, actinomycetes, yeasts and fungi have been reported in organic compost. Now days, earthworms are being used for breakdown of organic residues viz., sewage sludge, animal manure, crop residues, industrial refuge etc the technique is called as vermicomposting. Vermicompost of *P. hysterophorous* using the earthworm species *Eisenia foietida* is being practiced .

Due to the presence of various toxins and chemical compounds the leaf leachets of the plant has great potential as antimicrobial compounds against microorganisms and can be used in the treatment of various infectious diseases. It was used as a folk remedy against ulcerated sores, certain skin diseases, fever and anemia. It is also reported to have antifeedant, nematicidal, herbicidal, antifungal, antimicrobial, antimalarial, antiviral and antibacterial activities against variety of organisms. The environmental biologists have identified its cholinesterase antigonistic properties which can be used in control of insects and worms (Dhawan and Dhawan, 1995). Parthenin present in the plant is toxic to insects viz., termites, cockroaches, migratory grasshoppers, pulse beetles and other phytophagous insect-pests.

Since, last two decades *P. hysterophorous* has emerged as a serious weed of pastures, grasslands and cultivable crops in temperate and subtropical conditions of Himachal Pradesh. Therefore, the present investigation was undertaken with the following objectives.

OBJECTIVES

- To evaluate the biopesticidal properties of *Parthenium hysterophorous* L.
- To study the composting behaviour of *Parthenium hysterophorous* L.

Chapter-2

REVIEW OF LITERATURE

The relevant literature pertaining to the present investigation entitled, **"Studies on biopesticidal properties and composting behavior of *Parthenium hysterophorous* L.)"** is reviewed in this chapter under following headings:

2.1 BIO-PESTICIDAL PROPERTIES OF *P. hysterophorous*

2.2 COMPOSITING OF *P. hysterophorous* AND UTILITY OF COMPOST IN AGRICULTURE

P. hysterophorous L. (Asteraceae) is an exotic species originated in Mexico, Argentina and commonly known as Congress Grass, Carrot Weed, Star Weed and Bitter Weed. The species which is also known as Peterson's Curse or Santa-Maria Feverfew, has spread rapidly and extensively throughout the world since 1970 (Evans, 1997). It is capable of growing on a wide range of soil types ranging from sandy to heavy clays, but favors' the latter (Dale, 1981) and in areas with summer rainfall greater than 500 mm per annum (Chamberlain and Gittens, 2004). It can cause total habitat change in native grasslands, the under storey of open woodlands and along rivers and flood plains (Chippendale and Panetta, 1994). It was accidentally introduced in India along with the imported foodgrains in the mid 1950's (Dhawan and Dhawan, 1996), it has how been documented as invasive weed in India (Chandras and Vartak, 1970). Germination of the species can occur at temperatures between 10^{o}C and 25^{o}C, and has high germination ability throughout the year (Tamado *et al.*, 2002), completing about three germination in a year. The weed left as such in the same area acts as a seed bank because of its higher seed production capacity and extended dormancy period (Haseler, 1976). The seed of the weed remain viable up to two years while in soil, germinate with the beginning of monsoon and reaches the flowering stage within a month (Dhawan and Dhawan 1995a; Navie *et al.*, 1996 and Tamado *et al.*, 2002). The enormous capability of reproduction of the weed is reflected by production of large amount of seed. One of the most effective methods for its management is its

large scale utilization. The weed has been well documented for its insecticidal (Gajendran & Gopalan, 1982), nematicidal (Bala *et al.,* 1986) and herbicidal (Pandey *et al.,* 1993) properties.

2.1 BIO-PESTICIDAL PROPERTIES OF *P. hysterophorous*

Parthenium acts as a feeding deterrent to the adult of *Dysdercus koenigii F., Tribolium castaneum Hbst, Phthorimaea operculella* (Zell), L. (Sharma and Joshi, 1977).

Gajendra and Gopalan (1981) observed the ovicidal activity of leaf and inflorescence extracts of *P. hysterophorous* against *S. litura,* the extracts blocked the cleavage process in eggs.

According to a study conducted by Hasan and Jain (1984), the aqueous extract of leaves of *P. hysterophorus* killed more nematodes i.e. root knot nematodes *Meloidogyne incognita* (Kofoid and white) and *Helicotylendus dihyslera* than the stem and root extracts. At the lowest effective concentration (1:50) of leaf extract 1.5 per cent mortality was observed after 25 and 48 hours of exposure for *M. incognita* and *H. dihyslera,* respectively.

Ahmed and Bhattacharya (1991) studied the growth-regulating effects of powdered leaves of *P. hysterophorous* against *Spilosoma oblique* when incorporated into diets.

In a study by Solunke and Deshpande (1991) Lemon butterfly *Papilio demoleus* larvae were fed on Citrus leaves dipped in permethrin and aqueous extracts of *Ficus religiosa, Monchoria hastaetolia, P. hysterophorus, Azadirachta indica, Calotropis gigantea* and *Datura stramonium.* Permethrin produced the best results (mean mortality 85.4% after 72 h) followed by *P. hysterophorus* extract (mean mortality 52.8%).

Petroleum eter extreact of *Bouganvillea spectabilis* wild, *P. hysterphorus* L. and *A. indica* at 0.5 per cent gave cent per cent protection to brinjal leaves against third instar of hadda bettle after 24 hrs. of treatment (Janardhan *et al*., 1992).

Rao *et al.* (1992) reported antifeedant and insecticidal properties of *P. hysterophorous* against brinjal spotted leaf beetle at 0.2 and 0.5 per cent concentrations. Mortality after 24 hours at both the concentrations was 100 per cent.

According to a study conducted by Bhathal and Singh (1994) *Petunia hybrida, P. hysterophorous, Chrysanthemum morifolum*, Neemark and Neemgourd caused immediate mortality of third instar nymph of mustard aphid, *Lipaphis erysimi* (73-87%) and resulted in developmental abnormalities in the form of abnormal adults.

Soa *et al.* (1995) isolated sesquiterpene lactones from *Parthenium* and evaluated their toxicity to *Tenebrio molitor* larvae.

Pure Parthenium as well as extract of different parts of *P. hysterophorous* have Phytotoxic effect on many aquatic (Pandey *et al*., 1996) and terrestrial weeds (Acharya and Rahman, 1997).

Parthenium acts as a feeding deterrent to the sixth instar larvae of *Spodoptera litura* (F) (Datta and Saxena, 1997).

A. indica (5%) and *P. hysterophorous* (5%) showed strong antifeedant activity against sorghum midge when applied at 90 per cent and panicle emergence stage (Ameta and Gupta, 1998).

Datta and Saxena (2001) evaluated eleven sesquiterpene lactone derivatives of Parthenium derived from *P. hysterophorous* against 6^{th} instar larvae of *S. litura* and adults of *Callosobruchus chinensis* (insecticidal), *Cassia tora* (phytotoxic) and against the Juvenile stage (J_2) of *M. incognita* (nematcidal).

Singh *et al.* (2003) studied the antifeedent and toxic effects of ten plant extracts including *P. hysterophorous* on tobacco caterpillar. Larval mortality due to bioactive plant extracts was observed at 24, 48 and 72 hours after treatment. Larval mortality after 72 hours with ethyl acetate extract of *P. hysterophorous* was found to be about 73.23 per cent.

Rai *et al*., (2003) studied the antifungal potential of different extracts of *P. hysterophorus* against human pathogenic fungi and other fungal pathogens which were found to be sensitive to sesquiterpene lactones present as active agent in *P. hysterophorus.*

According to the wealth of India report (2003), Parthenin and some of its derivatives were evaluated for antimalarial activity against a multi drug resistant strain of *Plasmodium falciparum*. Parthenin and related compounds had significant antimalarial action. According to the same report Parthenium extract exhibits significant antiviral action against potato virus Y which extensively damages the chilli crops. Parthenin could be used as an effective control agent against potato virus Y.

Bajwa *et al.* (2004) studied the allelopathic potential of *P. hysterophorous* against pathogenic fungal species. Fungal growth was inhibited only when Parthenium extracts were used at lower concentration, whereas, aqueous extract at higher concentrations (60% and 70%) stimulated biomass production of the fungal species.

Wiesner *et al.* (2007) utilized water extract of Parthenium leaves for controlling mustard aphid *Lipaphis erysimi* feeding on (*Brassica juncea*) and recorded tremendous reduction in the number of *L. erysimi* which was attributed to the effect of phenolics present in *P. hysterophorous.*

Kumar *et al*. (2011) studied the efficacy of leaf extracts of *P. hysterophorus* in acetone, benzene, petroleum ether, diethyl ether and hexane for fertility and behavioral response of female adults of Dengue fever vector *Aedes aegeypti.* Diethyl ether extract was most effective causing 99.70 per cent repellency, 100 per cent ovicidal effect (egg mortality) and highest level of reduced fecundity followed by benzene, whereas, hexane and acetone extracts had a least oviposition deterrence (70-74%) and negligible egg mortality (8-9%). Petroleum ether extracts had moderate mortality (93.2%) and ovicidal effect (41%).

Wrich *et al.* (2012) evaluated the insecticidal effect of water and ethanol extract of secondary plant compounds in *P. hysterophorus* against *Myzus persicae* when applied on host plants and reported 60 and 96 per cent mortality of aqueous and ethanol extracts, respectively

within 48 hours. Further, in extract treated best plants *Brassica chinensis*, Phenolic acids were transported systematically and aphid mortality was 100 per cent four days after treatment.

Mech *et al*. (2013) studied the activity of Petroleum ether, chloroform and methanol extracts obtained from the leaves of *P. hysterophorus* L. against red spider mite, *Oligonychus coffeae* on Tea. The methanol extract showed highest mortality against the adults of *O. coffeae* followed by petroleum ether and chloroform extracts. The LC_{50} value of methanol extract against the adult mite was 0.12 per cent after 48 hrs. It is reported as a promising source for controlling *O. coffeae.*

Tesfu and Emana (2013) evaluated the toxicity of different parts of *P. hysterophorus* against *C. chinensis* on chick pea under laboratory conditions. The highest dose (2g/50 gm seed) of inflorescence, leaf and stem powder of *Parthenium* caused 76.67, 73.33 and 56.67 per cent mortality of adults, respectively after 96 hrs. of exposure. Highest per cent inhibition (83.33%) in adult emergence was observed in case of leaf powder treated chickpea seeds, whereas, the lowest (52.78%) in case of stem powder. The research indicated potential use of *P. hysterophorus* for protection of legumes during storage.

Summarwar and Pandey (2015) reported the dose dependent ovicidal effect of Neem extracts to *S. litura.* According to the study highest mortality within 48 hrs (83.82 and 100%, respectively) of hatching was observed in larvae emerged from eggs treated with leaf extract and seed extract of *Azadirachta indica* at the concentration of 2 per cent.

2.2 COMPOSTING OF *P. hysterophorous* AND UTILITY OF THE COMPOST IN AGRICULTURE

Sudhakar (1984) reported that the effect of Parthenium green leaf manure on plant height of main crop of rice was comparatively less as compared to other green manures like lantana and sun hemp whereas, in the ratoon crop Parthenium green leaf manure was suppresser in influencing the plant height.

Gupta *et al.* (1986) reported that the integrated use of Parthenium compost and Azotobacter increased nitrogen, phosphorus, potassium and sulphur acquisition in wheat than urea and Parthenium compost.

The weed is also used for oxalic acid and biogas production (Gunaseelan, 1987; Bhan *et al.* 1997) and can also be managed by using it as green manure. It is able to extract nutrients even from nutrient deficient soils. It has very high level of nitrogen (3%), phosphorus (0.2%), potassium (4.5%) and other macro and micro-nutrients. It can be used as a green manure for field crops.

Apurva *et al.* (2010) prepared milli-compost by using *Harphaphe haydeniana* for composition of Parthenium and compared it with ordinary Parthenium compost (OPC). Application of OPC exerted harmful effects on the early growth and development of *Triticum aestivum,* whereas, milli-compost exerted more beneficial effects due to its higher nutrient contents and least amount of allelopathic chemicals present in it. *P. hysterophorous* has high concentration of N, P, K, Zn, Ca, Mg, Fe and Chlorophyll content that makes it suitable for composting.

Chauhan and Joshi (2010) prepared compost from Congress grass (*P. hysterophorus* Linn.), water hyacinth (*Eichhornia crassipes*) and bhang (*Cannabis sativa* Linn.) using worms. High increase in nitrogen, potassium, phosphorus and a high decrease in organic carbon, C/N, C/P ratio in the experiment having *Eisenia fetida* was observed.

Kishor *et al.* (2010a &b) composited Parthenium along with *Azotobacter chroococcum*. Application of 100 per cent nitrogen through composted Parthenium resulted in significant reduction is plant height, tillers and root volume of wheat plant and ultimately reduction in grain and straw yield of wheat.

Sangwan *et al.* (2010) transformed sugar mill sludge (PM) and Parthenium avended with biogas plant slurry (BPS) into vermicompst employing *E. fetida*. In all the waste mixtures, a decrease in pH, TOC, and C/N ratio, maximum worm biomass and growth rate was attained in 25 per cent PM + 50 per cent BPS + 25 per cent Parthenium weed “Waste Mixture” and the

results indicated that Parthenium along with PM could be converted into good quality manure by earthworms if mixed in appropriate ratio with BPS.

Yadav and Garg (2011) prepared compost of *P. hysterophorous* mixed with cow dung in different ratios (25%, 50% and 75%) using *E. fetida* in a 18 week experiment. In all the treatments, decrease in pH, OC total and C:N ratio, but increase in EC, N total, P available, Ca total, K total and heavy metals was recorded. The cocoon production and growth rate (biomass gain/worm/day) were maximum in 100% cow dung. The results indicated that Parthenium can be a raw material for vermicomposting if mixed with cow dung in appropriate quantity.

Khaket *et al.* (2012) composted Parthenium along with *Eichhornia* which is also an uncontrolled weed. The combined composting of Parthenium and *Erichhornia* reduced the allelopathic effect and increased the nutrient quality thus, making the compost promising for organic farming and bioremediation. The biochemical and enzymatic analysis of the compost indicate significant increase in N, P, K and polyphenol oxidase in combined compost.

Vijayakumari and Hiranmai (2012) evaluated the influence of fresh, composted and vermicomposted parthenium and poultry manure on the growth characteristics of Sesame (*Sesamum indicum*). The largest roots of Sesame were in composted poultry manure and in composted Parthenium, whereas, maximum fresh and dry weights were in vermicomposted Parthenium.

Bhoyar (2013) assessed the manorial and composting value of Parthenium, as compared to FYM, Parthenium compost contained 1.05, 0.84, 1.11 and 12.68 per cent N, P, K and OC, respectively as compared to 0.5, 0.2, 0.5, and 3-5 per cent in FYM. Besides burning or destruction of the weed, composting served dual purpose of eradication of the weed for better utilization as compost, for better crop production and could be a good source of employment and income for villagers.

Rajiv *et al.* (2013) prepared Parthenium compost along with cow dung in the ratio of 1:4 and 1:3. According to experiments conducted on the quality of compost, the pH, EC and moisture content (%) recorded for Parthenium and cow dung (in the ratio 3:1) was 6.52, 0.20 (dSm^{-1}) and 42.54, respectively, as compared to 6.50, 0.20 (dSm^{-1}) and 41.25 for Parthenium

alone. They further studied the allelopathic effect on germination and growth of *Arachis hypogeae* L. Highest concentration of cow dung mixed Parthenium [Parthenium: Cow dung (1:4 and 1:3)] compost, respectively showed similar soil physical properties along with 96% of seed germination, highest growth level of radicles (87.2 and 85.3 mm) and plumule length (22 and 21.8 mm) when compared to other treatments and control.

Chapter-3

MATERIALS AND METHODS

The present investigation entitled **"Studies on biopesticidal properties and composting behavior or *Parthenium hysterophorous* L."** was conducted at experimental farm and laboratory conditions of the department of Environmental Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni-Solan during the period 2014-2015.

3.1 COMPOSITING OF PARTHENIUM

Raw Material

Before flowering fresh *P. hysterophorous* was collected from in and around fallow lands of UHF campus during April month of 2014. The collected plants were chopped into small pieces for composting.

Compositing

The experiment for composting of Parthenium was conducted in cardboard boxes of 50 x 35 cm (Length x Breadth) and height 30 cm size with completely randomized design. The experiment consisted of five treatments with different combinations of Parthenium, organic material (agricultural waste), cow dung and earthworm inoculum. Each treatment was replicated four times. The treatment particulars were as following:

Treatments Code	Details of treatments
T_1	Parthenium alone
T_2	Parthenium+ Cow dung (3:1)
T_3	Parthenium+ Cow dung+ Earthworms (3:1)
T_4	Parthenium+ Cow dung+ Agriculture waste [(3(1.5+1.5):1]
T_5	Parthenium+ Cow dung+ Agriculture waste+ Earthworm [3(1.5+1.5):1]

In the first treatment (T_1) chopped Parthenium plant alone were put in the compost box. In the second treatment (T_2) the bedding was prepared by mixing of partially decomposed cow dung with chopped Parthenium in the ratio of 3:1 (w/w). In the third

treatment (T_3) the bedding was prepared by mixing chopped Parthenium + Cow dung + Earthworms @ (200g per replication). In the fourth treatment (T_4) chopped Parthenium + Cow dung + Agriculture waste in the ratio [3(1.5+1.5):1] was used, whereas, in the fifth treatment (T_5) chopped Parthenium +Cow dung+ Agriculture waste + Earthworm were used in the ratio [3(1.5+1.5):1+200 g earthworm].

One year old cow dung was used in experiment because fresh cow dung can be dangerous for earthworm due to decomposition process as heat is generated during the process that can kill earthworms. The boxes were placed under a shed, covered with jute bags on the top to maintain proper heat and humidity. Moisture content was maintained to about 60 per cent by sprinkling water at alternate days, a thorough turning of the compost was made after 15 days to improve aeration. The composting period was noted and the composting samples from each treatment were collected from the centre of each compost box for physico-chemical analysis. The samples were taken from the middle of the compost box and were thoroughly mixed and kept under shade for further studies.

Analysis of physico-chemical properties: The physico-chemical properties of compost such as pH, electrical conductivity, C/N ratio, Organic Carbon content, NPK content, were analysed using standard methods.

pH

The samples were dried at room temperature and grinded, 4 g of grinded sample was taken from each replication, to which 40 ml of distilled water was added, kept for 24 hours and reading taken in PH meter.

EC (Electrical Conductivity)

4 g dried and grinded sample of compost was mixed with 40 ml distilled water, kept overnight and electrical conductivity was estimated with the help of microprocessor based conductivity tabs meter.

Preparation of compost boxes

PLATE 1

Layout of experiment for *P. hysterophorous* composting

PLATE 2

Composting of *P. hysterophorous*

PLATE 3

Sampling of Parthenium compost

PLATE 4

OC (Organic Carbon)

1 g of ash compost sample was taken in 250 ml conical flask to which 10 ml of $K_2Cr_2O_7$ solution and 20 ml of concentrated H_2SO_4 was added with constant swirling of the flask while adding. The flask was left as such for completion of the reaction. 1 g of NaF powder or 10 ml of orthophosphoric acid (which are flocculating agents) was added followed by addition of 100 ml of distilled water and vigorous shaking. 10 drops of diphenylamine indicator were added which gave violet colour to the suspension titrate, the end point in the titration process was change of the colour from violet to bright green. The volume of ferrous ammonium sulphate solution used was quantified and results calculated. A blank titration was also run simultaneously.

Calculations:

Weight of compost taken = S g (1g)

Vol. of N/2 FAS solution used for the blank titration = x ml (blank)

Vol. of N/2 FAS solution used for titration the excess $K_2Cr_20_7$ = y ml (volume of sample)

Vol. of 1N $K_2Cr_2O_7$ used for the oxidation of carbon $= \frac{(X-Y)}{2}$

1 ml. of 1N $K_2Cr_2O_7$=0.003 g of organic carbon

% organic carbon in the soil = Ax100/76 »Ax 100/76 = A x 1.31 = B

% organic matter = Bx 1.724

Nitrogen

Digestion: One gram well dried and ground compost sample was used for estimation of nitrogen. The samples were digested on automatic digestion system using one gram of digestion mixture and 20 ml of concentrated sulphuric acid. The digestion mixture was prepared by mixing 400 parts potassium sulphate and 20 part copper sulphate. The boiling of samples was continued till the appearance of light blue color. The samples were cooled and diluted to 100 ml with distilled water. The excess of 0.02N H_2SO_4 was titrated in the conical flask against 0.02N NaOH. The end point was the change of colour from pink to yellow.

Potassium and Phosphorous

Digestion: One gram of dried and ground sample was transferred into 250 ml conical flasks 20 ml of diacid mixture comprising of 4 parts of Nitric acid and 1 part of Perchloric acid was added to these flasks. The samples were digested on electric hot plate. The digestion continued till 2-3 ml of clear digested material was left in the conical flasks. After complete digestion, the samples were diluted to 100 ml with the help of distilled water.

Phosphorous was estimated by Vanado molybdo phosphoric acid method (Jackson, 1973). Five ml of extract (digested sample) was taken in 25 ml of volumetric flask. To this flask 20 ml of working solution was added and final volume was made to 25 ml with distilled water. The contents were mixed and used for estimation of phosphorous on Spectronic-20 at 470 nm wavelength using red filter. The colour intensity (yellow) was recorded and the phosphorous content was depicted with the help of standard curve.

The potassium in plant tissue was estimated on flame photometer (Jackson, 1973). The digested samples were diluted to 100 ml with distilled water, 5 ml of this prepared sample was diluted to 50 ml with distilled water. The samples vis-à-vis standards were fed one by one to the instrument and readings were recorded in percent.

C/N (Carbon Nitrogen) ratio

It was calculated by the following formula:

$$\text{C/N ratio} = \frac{\text{Total carbon (\%)}}{\text{total nitrogen (\%)}}$$

Earthworm Biomass Count

The total number of earthworm from the treatment three and five were counted and weighed and expressed as total number of earthworms per treatment.

Recovery percentage

The compost prepared in each treatment was weighed at the end of the experiment and total composting period noted.

Biopesticidal studies of *P. hysterophorous*

Collection: leaves of *P. hysterophorous* were collected during the month of March-April 2014, shade dried under laboratory conditions, grinded and powdered.

Extraction of *P. hysterophorous*

The plant material was extracted in solvents according to the method used by Singh (1996). The oven dried leaves/drupes were crushed in blender to make powder. 100 g of powder was taken in a conical flask (500 ml) and 300 ml of desired solvent was added to it. These flasks were kept at room temperature for 48 hrs and were shaken occasionally in between. These extracts were filtered through Whatman filter paper No. 1 and filtrate was evaporated in oven at 30-35^{o}C. Finally the amount of active material obtained was worked out by pre and post evaporation weighing of Petri plate.

The crude extracts obtained above were dissolved in acetone (6% w/v) to make stock solution. These stock solutions were stored in reagent bottles under refrigeration.

Preparation of working concentrations

The stock solution of *P. hysterophorous* extracts obtained above was further diluted with acetone to make the desired concentrations and emulsifier (Triton X-100, 5%) was also added to it.

Testing of Extracts

The extracts were tested against two phytophagous insects viz., Cabbage butterfly (*Pieris brassicae*) and Tobacco caterpillar (*Spodoptera litura*) common on vegetable crops and against phytopathogens.

Toxicity studies of extracts to insect pests

The eggs and first instar larvae were collected from the field and extracts tested for ovicidal and larvacidal effect. The pure culture of *S. litura* was maintained under laboratory conditions from field collected eggs, whereas, *P. brassicae* eggs and larvae were directly collected from the field.

Toxicity studies of extracts to phytopathogens

The pure cultures of phytopathogens (*Alternaria alternate, Sclerotium rolfsii, Fusarium oxysporum, Penicillium expansum, Rhizopus stolonifer, Aspergillus niger*) were collected from the Department of Plant Pathology of the aforesaid university. Potato Dextrose Agar (PDA) was used as medium for sub culturing the microbes.

The plant parts of healthy *P. hysterophorus* were collected, washed thoroughly with tap water, surface sterilized with 0.02 per cent mercuric chloride, repeatedly washed with sterilized water and later cut into small pieces. Stock solution of the plant was prepared by macerating one hundred grams of plant tissue using pestle and mortar by adding equal amount (100 ml) of sterilized distilled water (1: 1, w/v). The pulverized mass was squeezed through the three layers of cheese cloth and the supernatant was filtered through Whatman filter paper No.41. The flasks were tightly plugged with nonabsorbent cotton, wrapped with aluminum foil and autoclaved at 15psi for 20 minutes and kept under UV light for one hour. Inhibitory effect of plant extract was assessed using poisoned food technique. Double strength of potato dextrose agar medium and solution of 10 per cent concentration was prepared by adding appropriate quantity of sterile distilled water into the stock solution, separately. For bioassay, equal quantity of the prepared double strength potato dextrose agar medium and double strength 10 per cent stock solution were poured in sterilized Petri plate under aseptic conditions. The without plant extract medium served as control. For each treatment three replications were maintained. These plates were inoculated with 5mm discs of freshly grown cultures of the plant pathogens and incubated at $25\pm1^{\circ}C$. The colony diameter in each treatment was measured on the fifth day after inoculation and the per cent inhibition of each phytopathogen was calculated by the following formula (Vincent, 1947).

$$\text{Growth Inhibition (\%)} = \frac{\text{Diameter of colony in control (mm) - diameter of colony in treatment (mm)}}{\text{Diameter of colony in control (mm)}} \times 100$$

The data was recorded in triplicates and subjected to statistical analysis.

STATISTICAL ANALYSIS

The data emanating from the above experiments were subjected to statistical analysis as suggested by Gomez and Gomez (1984).

Collection, drying and grinding of *P. hysterophorous* L.

PLATE 5

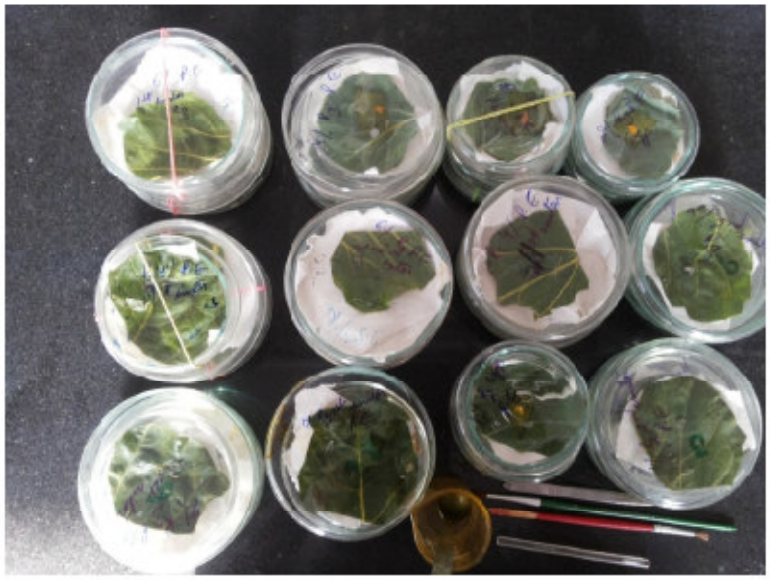
Extraction of *P. hysterophorous*

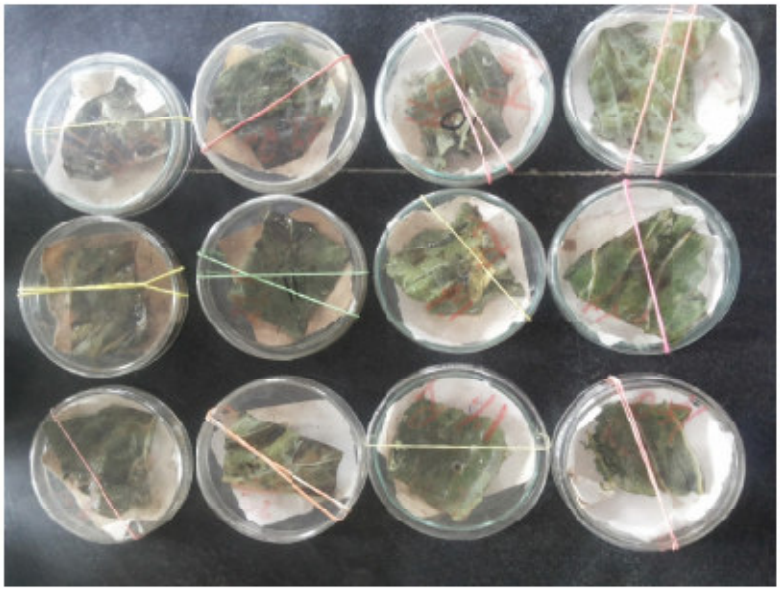
PLATE 6

Egg masses of Pieris brassicae (a)

Larvae of *Spodoptera litura* (b)

PLATE 7





Testing of *P. hysterophorous* for biopesticidal properties

PLATE 8

Chapter-4

EXPERIMENTAL RESULTS

The present investigation **"Studies on biopesticidal properties and composting behaviour of *Parthenium hysterophorous* L."** was conducted during 2014-15. The results obtained are presented in this chapter under following headings.

4.1 Biopesticidal properties of *P. hysterophorous* L.

4.2 Compositing behaviour of *P. hysterophorous* L.

4.1 BIOPESTICIDAL PROPERTIES OF *P. hysterophorous* L.

The results pertaining to ovicidal effect of petroleum ether and aqueous extracts of *P. hysterophorous* on *Pieris brassicae* are presented in Table 1. No per cent hatching of *P. brassicae* was recorded at 5.0 per cent (T_1) of both the extracts, whereas, 83.11 and 64.83 per cent mortality was recorded at T_5 (Control) of petroleum ether and aqueous extract, respectively. The values differed significantly from their respective treatments. At 2.5 per cent (T_2) of petroleum other extract of *P. hysterophorous* 4.17% per cent egg hatching was recorded which was statistically at par with T3 (1.0%) and T_4 (0.5%).

Table 1. Ovicidal effect of petroleum ether and aqueous extract of *Parthenium hysterophorous* L. on *Pieris brassicae*

Treatment	Percent egg hatching after 48 hrs	
	Petroleum ether extract	Aqueous extract
T_1 (5.0%)	0.00 (0.00)*	0.00 (0.00)
T_2 (2.5%)	4.17 (6.90)	10.32 (15.43)
T_3 (1.0%)	19.00 (25.32)	18.12 (25.18)
T_4 (0.5%)	15.60 (19.16)	46.31 (42.31)
T_5 (Control)	83.11 (65.76)	84.83 (55.75)
$CD_{0.05}$	**18.33**	**28.91**

* *Values in parenthesis are arc sine transformation*

Similarly, the percentage egg hatching after 48 hrs in aqueous extract was 10.32 per cent at T_2, 18.12 per cent at T_3 and 46.31 per cent at T_4 the values were statistically at par with each other.

The results pertaining to ovicidal effect of petroleum ether and aqueous extract of *P. hysterophorous* on *Spodoptera litura* are presented in Table 2. Percent egg hatching in petroleum ether extract and aqueous extracts of Parthenium ranged from 21.43-92.08 and 22.31-83.61 per cent at T_1 (5.0%) and T_5 (control). Treatment T_4 (0.5%) having 75.06 per cent egg hatching of *S. litura* after 48 hrs was at par with control, whereas, treatment T_2 (2.5%) and T_3 (1.0%) with 18.16 and 41.92 per cent egg hatching in petroleum ether extract were also at par with each other.

Table 2. Ovicidal effect of petroleum ether and aqueous extract of *Parthenium hysterophorous* L. on *Spodoptera litura*

Treatment	Percent egg hatching after 48 hrs	
	Petroleum ether extract	Aqueous extract
T_1 (5.0%)	21.43 (27.09)*	22.31 (28.09)
T_2 (2.5%)	18.16 (24.55)	27.39 (31.52)
T_3 (1.0%)	41.92 (40.04)	43.32 (41.14)
T_4 (0.5%)	75.06 (60.28)	57.25 (45.34)
T_5 (Control)	92.08 (76.55)	83.61 (66.42)
$CD_{0.05}$	**16.90**	**NS**

* *Values in parenthesis are arc sine transformation*

The results for percent egg hatching after 48 hrs were non-significant statistically, though highest percent egg hatching (57.25%) other from control, was in T_4 (0.5%) and lowest (22.31%) at T_1 (5.0%).

The data on percent mortality of first instar larvae of *P. brassicae* after 24 and 48 hrs of application when fed on cabbage leaves treated with petroleum ether extract of *P. hysterophorous* is presented in Table 3. After 24 and 48 hrs of the treatment percent mortality of first instar ranged 56.67-0.00 per cent from 100-0.00 per cent, respectively after 48 hrs, whereas, statistically highest mortality of 100 per cent was recorded at T_1 (5.0%) and T_2 (2.5%), treatments T_3 (1.0%) and T_4 (0.5%) having 76.67% and 63.33% mortality were statistically at par with each other. After 24 hrs no significant difference was observed among the treatments w.r.t. percent mortality though at T_1 (5.0%) 56.67 per cent mortality was recorded followed by 50.00 at T_2 (2.5%) after 24 hrs whereas no mortality was recorded at T_5 (Control).

Table 3. Effect of petroleum ether extract of *Parthenium hysterophorous* on first instar of *Pieris brassicae*

Treatment	Percent mortality	
	24 hours	48 hours
T_1 (5.0%)	56.67 (48.41)*	100.00 (90.00)
T_2 (2.5%)	50.00 (44.19)	100.00 (90.00)
T_3 (1.0%)	40.00 (38.05)	76.67 (66.13)
T_4 (0.5%)	36.67 (31.91)	63.33 (52.83)
T_5 (Control)	0.00 (0.00)	0.00 (0.00)
$CD_{0.05}$	**NS**	**19.47**

* *Values in parenthesis are arc sine transformation*

The data on percent mortality of second instar of *P. brassicae* when fed on leaves treated with petroleum ether extract of *P. hysterophorous* is presented in Table 4. Maximum mortality of 46.67 and 73.33 per cent was recorded at T_1 (5.0%) and T_2 (2.5%) after 24 and 48 hrs, respectively. Treatments T_1 and T_2 were statistically at par with each other, though, after 48 hrs treatment T_2 (2.5%) recorded highest mortality of 73.33 per cent. No percent mortality of second instar was observed at control of both the intervals. The treatments T_3, T_4 and T_5 were statistically at par with each other at 24 hrs interval, whereas, T_4 and T_5 were at par statistically after 48 hrs.

Table 4. Effect of petroleum ether extract of *Parthenium hysterophorous* on second instar of *Pieris brassicae*

Treatment	Percent mortality	
	24 hours	48 hours
T_1 (5.0%)	46.67 (42.27)*	50.00 (43.98)
T_2 (2.5%)	40.00 (39.13)	73.33 (58.98)
T_3 (1.0%)	13.33 (17.70)	23.33 (28.76)
T_4 (0.5%)	13.33 (17.20)	16.66 (19.91)
T_5 (Control)	0.00 (0.00)	0.00 (0.00)
$CD_{0.05}$	**26.80**	**23.71**

* *Values in parenthesis are arc sine transformation*

The effect of aqueous extract of *P. hysterophorous* on percent mortality of first instar of *P. brassicae* after 24 and 48 hrs of exposure to treated leaves is presented in Table 5. After 24 hrs of exposure there was significant difference among the treatments with highest mortality of 66.67 per cent in T_1 (5.0%) and lowest 30.00 per cent in T_3 (1.0%), whereas, no

mortality 0.00 per cent was recorded in control. Treatments T_1 (5.0%), T_2 (2.5%) and T_3 (1.0%) were statistically at par in toxic effect after 48 hrs. No mortality was recorded at T_4 (0.5%) at both the intervals.

Table 5. Effect of aqueous extract of *Parthenium hysterophorous* on first instar of *Pieris brassicae*

Treatment	Percent mortality	
	24 hours	**48 hours**
T_1 (5.0%)	66.67 (54.96)*	73.34 (63.83)
T_2 (2.5%)	53.33 (46.90)	60.00 (50.91)
T_3 (1.0%)	30.00 (32.98)	53.33 (47.28)
T_4 (0.5%)	0.00 (0.00)	0.00 (0.00)
T_5 (Control)	0.00 (0.00)	0.00 (0.00)
$CD_{0.05}$	**9.68**	**23.47**

* *Values in parenthesis are arc sine transformation*

Table 6 shows the effect of aqueous extract of *P. hysterophorous* on second instar of *P. Brassicae.* Statistically, highest mortality of 66.67 per cent was recorded in treatment T_5 (5.0%) followed by T_4 (40.00%) and T_3 (23.33%) at 24 hrs interval whereas, at 48 hrs interval 70.00 per cent mortality was recorded at treatment T_1 and T_2 which differed statistically from all other treatments at the same interval. The treatments T_4 and T_5 were statistically at par with each other at both the intervals. No mortality was recorded in control (T_5) at 24 hrs and 48 hrs interval.

Table 6. Effect of aqueous extract of *Parthenium hysterophorous* on second instar of *Pieris brassicae*

Treatment	Percent mortality	
	24 hours	**48 hours**
T_1 (5.0%)	66.67 (54.96)*	70.00 (56.76)
T_2 (2.5%)	40.00 (39.08)	70.00 (57.26)
T_3 (1.0%)	23.33 (28.76)	40.00 (39.04)
T_4 (0.5%)	10.00 (11.6)	13.33 (21.13)
T_5 (Control)	0.00 (0.00)	0.00 (0.00)
$CD_{0.05}$	**11.44**	**19.90**

* *Values in parenthesis are arc sine transformation*

The data presented in Table 7 on effect of petroleum ether extract of *P. hysterophorous* on percent mortality of first instar of *S. litura* was non-significant at 24 and

48 hrs of treatment, though, percent mortality ranged from 0.00-33.33% and 0.00-50.00 per cent after 24 hrs and 48 hrs, respectively.

Table 7. Effect of petroleum ether extract of *Parthenium hysterophorous* on first instar of *Spodoptera litura*

Treatment	Percent mortality	
	24 hours	48 hours
T_1 (5.0%)	33.33 (34.20)*	50.00 (49.21)
T_2 (2.5%)	23.33 (23.84)	26.67 (30.28)
T_3 (1.0%)	16.67 (19.21)	23.33 (28.06)
T_4 (0.5%)	10.00 (11.07)	26.67 (30.28)
T_5 (Control)	0.00 (0.00)	0.00 (0.00)
$CD_{0.05}$	**NS**	**NS**

* *Values in parenthesis are arc sine transformation*

The data pertaining to the effect of aqueous extract of *P. hysterophorous* on first instar of *S. litura* after 24 and 48 hrs of treatment is presented in Table 8. At both the intervals, treatment T_1 (5.0%) and T_2 (2.5%) were statistically at par with each other though highest mortality was recorded in treatment T_1 (5.0%) i.e. 53.33 per cent and 60.00 per cent, respectively. No mortality was recorded at T_5 (control) i.e. 0.00 per cent, whereas, 13.33 and 26.67 per cent mortality was recorded at T_4 (0.5%), after 24 and 48 hrs, respectively.

Table 8. Effect of aqueous extract of *Parthenium hysterophorous* on first instar of *Spodoptera litura*

Treatment	Percent mortality	
	24 hours	48 hours
T_1 (5.0%)	53.33 (47.19)*	60.00 (51.12)
T_2 (2.5%)	43.33 (41.13)	53.33 (46.90)
T_3 (1.0%)	23.33 (28.27)	26.00 (17.06
T_4 (0.5%)	13.33 (17.70)	26.67 (30.77)
T_5 (Control)	0.00 (0.00)	0.00 (0.00)
$CD_{0.05}$	**19.02**	**13.04**

* *Values in parenthesis are arc sine transformation*

The perusal of data in Table 9 revealed that the effect of *P. hysterophorus* extract on mycelia growth of plant pathogens was significant. When compared with control, *P. hysterophorus* extract was significantly more effective in inhibiting the mycelia growth of the phytopathogens. The maximum per cent growth inhibition was showed in *Sclerotium rolfsii* 59.49 per cent followed by *Fusarium oxysporum* (58.62%), *Penicillium expansum* (53.07%)

and *Alternaria alternate (*35.61%), while the least per cent growth inhibition was recorded in *Rhizopus stolonifer* (26.73%)and *Aspergillus niger* (29.32%).

Table 9. Growth inhibition of phytopathogens by the aqueous extract of *Parthenium hysterophorus* at 10 per cent

Phytopathogen	Per cent Growth Inhibition
Alternaria alternate	35.61 (6.05)*
Sclerotium rolfsii	59.49 (7.77)
Fusarium oxysporum	58.62 (7.72)
Aspergillus niger	29.32 (5.50)
Penicillium expansum	53.07 (7.35)
Rhizopus stolonifer	26.73 (5.36)
$CD_{0.05}$	**1.39**

* *Values in parenthesis are arc sine transformation*

4.2 COMPOSITING BEHAVIOUR OF *P. hysterophorous* L.

The compost prepared from Parthenium was dark brown and free flowing. The composting period was of approximately 18 months. The results for physico-chemical parameters of compost and recovery percentage of compost is presented in Table 10a & 10b. The pH and electrical conductivity (dSm^{-1}) at different concentrations ranged from 7.04-8.11 and 1.82-2.94, respectively (Table 10a). There was no-significant difference among the treatments for both the parameters. Both pH (8.11) and EC (2.94 dSm^{-1}) were highest for treatment T_3 (Parthenium + Cow dung + Earthworm) and lowest 7.04 and 1.82 dSm^{-1} for T_4 (Parthenium + Cow dung + Agriculture waste), respectively. In treatment T_1 where Parthenium alone was used the pH and EC values were 7.87 and 2.68 dSm^{-1}, respectively.

Table 10a. Physico-chemical characteristics of *Parthenium hysterophorus* compost

Treatment		pH	EC (dSm^{-1})
T_1	Parthenium alone	7.87	2.68
T_2	Parthenium + Cow dung 3:1	7.57	2.67
T_3	Parthenium + Cow dung + Earthworms	8.11	2.94
T_4	Parthenium + Cow dung + Agriculture waste	7.04	1.82
T_5	Parthenium + Cow dung + Agriculture waste + Earthworms	7.46	2.03
$CD_{0.05}$		**NS**	**NS**

The results on per cent concentration of N, P, K and Organic Carbon, C/N ratio and per cent recovery of compost are presented in Table 10b. The Nitrogen (N%), Phosphorous (P%) and potash (K%) percent content ranged from 1.52-1.94 per cent, 0.37-1.30 per cent

Analysis of Parthenium compost

PLATE 9

Analysis of Parthenium compost

PLATE 10

and 1.23-3.07 per cent, respectively. There was no-significant difference among the treatments for nitrogen and phosphorus percent content.

The phosphorous content for compost prepared from Parthenium alone was 0.37 (T_1) whereas, in T_3 *(*Parthenium + Cow dung + Earthworm) it was 130 more than other treatment combinations. Highest K percent content (3.07%) was observed in T_5 which was statistically at par with T_4 (2.39%), T_3 (3.02%) and T_2 (2.01%). Whereas, lowest concentration (1.23%) was recorded for T_1 (Parthenium alone) which was statistically at par with T_2 (2.01%). There was non-significant difference among the treatments for per cent organic carbon and C/N ratio. Per cent organic carbon (54.92%) and C/N ratio (36.50) was highest in treatment T_2 where Parthenium and cow dung were used followed by T_1 where Parthenium alone was composted. Both the per cent organic carbon (21.25) and C/N ratio (11.03) were lowest in treatment T_5 (Parthenium + Cow dung + Agriculture waste + Earthworm) for T_1 (Parthenium alone) the per cent organic carbon and C/N ration recorded was 49.5 and 33.67, respectively.

The recovery percentage (Table 10b) of the prepared compost was maximum in T_3 where earthworms were added to Parthenium and Cow dung. Whereas, treatment T_4 (Parthenium + Cow dung + Agriculture waste) had the lowest recovery of 42.18%. The recovery percentage for T_1 (Parthenium alone), T_2 (Parthenium + Cow dung) and T_5 (Parthenium + Cow dung + Agriculture waste + Earthworm) was 47.47, 52.23 and 51.40 per cent, respectively.

Table 10b. Physico-chemical characteristics of *Parthenium hysterophorus* compost

Treatment		N%	P%	K%	Organic carbon (%)	C/N ratio	%recovery
T_1	Parthenium alone	1.58 (1.60)*	0.37 (1.16)*	1.23 (1.48)	49.50 (44.56)*	33.67	47.47
T_2	Parthenium + Cow dung 3:1	1.62 (1.54)	0.40 (1.18)	2.01 (1.72)	44.92 (47.82)	22.73	52.23
T_3	Parthenium + Cow dung + Earthworms	1.81 (1.67)	1.30 (0.72)	3.02 (2.00)	26.00 (30.29)	16.72	62.77
T_4	Parthenium + Cow dung + Agriculture waste	1.64 (1.62)	0.40 (1.18)	2.39 (1.83)	29.75 (31.70)	16.98	42.18
T_5	Parthenium + Cow dung + Agriculture waste + Earthworms	1.94 (1.71)	0.80 (1.34)	3.07 (2.01)	21.25 (26.82)	11.03	51.40
$CD_{0.05}$		**NS**	**NS**	**0.29**	**NS**	**NS**	**NS**

** values in parenthesis are square root transformation*

** values in parenthesis are arcsine transformation*

Powder of *P. hysterophorous* (a)

Compost of *P. hysterophorous* (b)

PLATE 11

Chapter-5

DISCUSSION

The present studies entitled, **"Studies on biopesticidal properties and composting behaviour of *Parthenium hysterophorous* L."** have great significance in eradication and utilization of Parthenium in Agro-horticultural eco-system. The results of the recent investigation are discussed in the following paragraphs:

5.1 TO EVALUATE THE BIOPESTICIDAL PROPERTIES OF *Parthenium hysterophorous.*

Ovicidal effect (per cent egg hatching) of *P. hysterophorous* was studied against *P. brassicae* and *S. litura*. At treatment T_1 (5.0%) of petroleum ether and aqueous extracts of *P. hysterophorous*, no percent egg hatching (0.00%) for the eggs of *P. brassicae* was recorded after 48 hrs (Table 1). There was an increasing trend in percent egg hatching with decrease in concentrations of *P. hysterophorous*. Maximum percent egg hatching 83.11 and 84.83 per cent was recorded in treatment T_5 of both the extracts. The results on the effectiveness of *P. hysterophorous* extracts draw considerable support from the findings of Sandhu *et al.* (1994) who reported 45.1 per cent egg hatching of *P. brassicae* on cabbage plants treated with chloroform methanol fraction of *Melia azedarach.* Among the different solvents in their study alcoholic extracts exhibited highest ovicidal action as minimum egg hatchability (34.85%) was observed followed by aqueous (76.36%) and petroleum ether (94.04%).

The per cent egg hatching in petroleum ether extract and aqueous extract of *P. hysterophorous* for *S. litura* ranged from 21.43-92.08 per cent and 22.31-83.61 per cent, respectively (Table 2). Apart from control, treatment T_4 (2.5%) recorded 75.06 and 57.25% percent egg hatching after 48 hrs in petroleum ether and aqueous extract of *P. hysterophorous*, respectively. The present results reporting the effectiveness of petroleum ether extract of *P. hysterophorous* are in line with the findings of Kumar *et al*. (2011) where petroleum ether extract of *P. hysterophorous* resulted in 93.2 per cent diminished fecundity and 41.0 per cent ovicidal effect for *Aedes aegypti.* The toxic effects of plant extracts are also reported by many workers, Summerwar and Pandey (2015) reported 94.66 per cent egg mortality of *S. litura* when treated with 2.0 per cent seed extract of *Azadirachta indica*.

Rani (1994) also observed alcoholic extracts of different plants to be more effective against eggs of Potato tuber moth (*Phthorimaea operculella* (Zell), probably because of greater solubility of active principles of the plants in alcohol as compare to other solvents.

Statistically, highest mortality of 100 per cent was recorded at T_1 (5.0%) and (2.5%) treatments after 48 hrs of exposure for first instar larvae of *P. brassicae* to leaves treated with petroleum ether extract of *P. hysterophorous* (Table 3), whereas, only 56.67 per cent mortality was recorded at the same concentration after 24 hrs.

Highest mortality of second instar of *P. brassicae* on exposure to petroleum ether extract of *P. hysterophorous* was 73.33 per cent after 48 hrs in treatment T_2 (2.5%) which was at par with T_1 (5.0%), Table 4. The superiority of *P. hysterophorous* for larvicidal effect has been reported by Khan *et al.* (2014) where *Parthenium* extract proved superior to other plant extracts (Parthenium>Chrysanthemum,>Neem extract>Neem oil>Stevia) against 3rd and 4th instar larvae of *Aedes albopictus* in both the 24 and 48 hrs exposure period. The studies are also in line with the findings of Thakur and Mehta (2004) who observed complete protection to brinjal leaves from first, second and third instar larvae of hadda beetle with petroleum ether extract of *Ageratum houstonianum*. Whereas, Mech *et al*. (2013) reported highest acaricidal (mortality) effect of methanol extract of *P. hysterophorous* against the adults of *Oligonychus coffeae* followed by petroleum ether and chloroform extracts.

The data presented on effect of aqueous extract of *P. hysterophorous* on percent mortality of first and second instar of *P. brassicae* (Table 5 and 6) shows highest mortality of 66.67 and 73.34 per cent after 24 and 48 hrs, respectively at T_1 (5.0%), whereas, no mortality was recorded at 0.5 per cent. For second instar of the insect 66.67 and 70.00 per cent mortality was recorded at the same treatment after 24 and 48 hrs of exposure. Sharma and Gupta (2009) reported that ethanol extract of seeds of *M. Azedarach* protected 58.3 per cent cabbage foliage from *P. brassicae*, while *Eucalyptus* extract provided maximum protection. Ethanol extract of *A. Indica* exhibited statistically higher larval mortality at 50.0 per cent.

The effectiveness of aqueous extract of plant has been reported by Rani (1994) who reported aqueous extract of *M. azedarach* leaves causing 53.33 per cent reduction in feeding as compared to 56.67 in alcoholic and 40.00 per cent in petroleum ether of second instar larvae of *P. operculella.* Hassan and Jain (1984) reported that at the lowest effective concentration of 5.0 per cent of leaf extract *P. hysterphorous* 100 per cent mortality was

observed after 24 and 48 hrs of exposure for *Meloidogyne incognita* and *Helicotylenchus dihyrtera*.

The present results are supported by the findings of Sharma and Gupta (2009) where, aqueous extract of *A. indica* and *M. azedarach* repelled maximum number of larvae, protected 94.0 per cent and 89.2 per cent cabbage foliage, respectively.

Highest mortality of 50.00 per cent of first instar larvae of *S. litura* was recorded after 48 hrs of exposure to castor leaves treated with petroleum ether extract of *P. hysterophorous*. Whereas, after 24 hrs only 33.33 per cent mortality was recorded. Mech *et al.* (2013) reported 47.43 per cent mortality of red spider mite *Oligonychus coffeae* when fed on petroleum ether leaf extract of *P. hysterophorous* after 24 hrs. There was increase in per cent mortality of first instar after 48 hrs. The findings are in unison with the findings of Singh *et al*. (2003) who reported 73.23 per cent larval mortality of *S. litura* after 72 hours with ethyl acetate. Similarly, in a study conducted by Thakur and Mehta (2004), among various solvents, petroleum ether retained its superiority by giving highest mortality (69.99%) of third instar of hadda beetle a pest of brinjal.

The data on effect of aqueous extract of *P. hysterophorous* on first instar of *S. litura* shows 53.33 and 60.00 per cent, mortality after 24 and 48 hrs of exposure to 5.00 per cent (T_1). Only 13.33% mortality of first instar was recorded after 24 hrs at 0.5% (T_4) which increased to 26.67% after 48 hrs. The results are in agreement with the findings of Thakur and Mehta (2004) who reported better efficacy of aqueous extract of plants (56.66%) than alcoholic (35.27%) against second instar of hadda bettle. Wiesner *et al.* (2007) reported tremendous reduction in the number of *Lipaphis erysime* with aqueous extract of *Parthenium* leaves. Similarly, Wrich *et al*. (2012) also reported 60% mortality of *Myzes persicae* with aqueous extract of *P. hysterophorous*. Different studies have also demonstrated that sesquiterpene lactone derivatives of Parthenin, obtained from *P. hysterophorous* had antifeedant action against sixth instar larvae of *S. litura* (Tesfu and Emena, 2013). Furthermore, Wabale and Kharde (2010) noticed that an extract of Parthenium has a tendency of 81.87 per cent in damaging the life cycle of sugarcane woolly aphid.

In general, the ovicidal and larvicidal effect of *P. hysterophorous* was dose dependent against the two insect-pests for both the extracts. The dose dependent relationship in larval mortality is also reported by Sharma and Gupta (2009).

The significant decrease in mycelia growth of the fungus treated with *P. hysterophorus* extract was probably due to presence of antifungal compounds or ingredients in the plant extract (Farooq *et al.*, 2010; Riaz *et al.*, 2010; Kuberan *et al.*, 2012). It is also possible that the extract inhibited or altered the mode of phytopathogen's biological chemicals.

5.2 TO STUDY THE COMPOSTING BEHAVIOUR OF *P. hysterophorous* L.

The physical and chemical properties of compost prepared from *Parthenium* alone and in combination with cow dung, agriculture waste with addition of earthworm inoculum were evaluated during the study.

The PH and EC of the compost prepared at all the treatments ranged from 7.04-8.11 and 1.82-2.94, dSm^{-1}, respectively. There was non-significant difference among the treatments with respect to the two parameters.

Sangwan *et al*. (2010) reported decrease in pH of Parthenium compost prepared along with sugar mill sludge and biogas plant slurry by employing *E. fetida* as compared to compost prepared from Parthenium alone. In the present study pH values were more i.e. 8.11 when Parthenium and cow dung was composted with earthworm, but did not differ statistically from other treatments. Yadav and Garg (2011) also reported decrease in pH for compost of *P. hysterophorous* mixed with cow dung using *E. fetida*.

In the present investigation through there was no significant difference in EC value of different compost but highest value of 2.94 dsm^{-1} was recorded for compost prepared from Parthenium and cow dung by earthworms. The results find support from the findings of Yadav and Garg (2011) who also reported increase in EC value in the compost prepared from *P. hysterophorous* using *E. fetida*. Various chemical characteristics of the compost viz., N, P, K, organic carbon, C/N ratio were analysed in the present study. The treatments did not differ statistically from each other for all chemical parameters except for K Content. In the present study N and P content was high in the treatments where *E. fetida* was added for composting, similarly K content was also statistically highest in T_5 and T_3 (at par with each other) as compared to compost of Parthenium alone and other treatments. The results of Yadav and Garg (2011) supports the present findings as they also reported increase in N total, P total and K total in the compost prepared from *P. hysterophorous* with cow dung using *E. fetida* as

compared to Parthenium alone. Bhoyar (2013) also reported high compositing value of Parthenium (1.05, 0.84, 1.11 per cent N,P,K content), as compared to FYM alone (0.5, 0.2, 0.5 per cent N,P,K content). The treatments did not differ statistically from each other with respect to C/N ratio and organic carbon. Though the parameters had high value for T_2 (Parthenium + Cow dung) followed by Parthenium alone.

Whereas, compost mixtures (T_3 and T_5) where *E. fetida* was added recorded low values for organic carbon and C/N ratio. The results are in agreement with the findings of Yadav and Garg (2011) who also reported decrease in total organic carbon and C/N ratio of compost prepared from Parthenium avended with sugar mill sludge and bio gas plant slurry using *E. fetida.* The results are also in line with the findings of Khaket *et al*. (2012) who also reported significant reduction in the organic carbon and C/N ratio of compost prepared from Parthenium and *Eichhornia* each alone as well as in combination.

The percentage recovery of the compost prepared at various treatments ranged from 42.18- 62.77 per cent. It was highest (62.77) in treatment T_3 where earthworms were used for composting Parthenium and cow dung. The whole process of composting took approximately 18 months for completion. According to the study of Yadav and Garg (2011) on composting of *P. hysterophorous* mixed with cow dung using *E. fetida* the process of composting was also completed in a period of 18 weeks (4 months 2 weeks).

Chapter-6

SUMMARY AND CONCLUSION

The present investigation **"Studies on biopesticidal properties and composting behavior of *Parthenium hysterophorous* L."** were conducts during the period 2014-2015. The salient observations recorded during the course of study are summarized below:

- Instant dipping of eggs of *P. brassicae* in 5.0 per cent petroleum ether and aqueous extract of *P. hysterophorous* proved highly efficient with no (0.00 %) per cent egg hatching of *P. brassicae* eggs after 48 hours. Whereas, 83.11 and 84.83 per cent hatching was recorded at T_5 (Control) of petroleum ether and aqueous extracts, respectively.

- Dipping of eggs of *S. litura* in petroleum and aqueous extracts resulted in 21.43 % and 22.31% egg hatching at 5.0 per cent of the extracts, respectively after 48 hours which increased with increase in concentration.

- Feeding of first instar larvae of *P. brassicae* on leaf discs treated with petroleum ether extract of *P. hysterphorous* resulted in no significant difference in mortality among treatments after 24 hrs but after 48 hrs of exposure cent per cent mortality was recorded at 5.0 and 2.5 per cent which differed statistically from all other treatments.

- The highest mortality of 46.67 per cent and 73.33 per cent was recorded for second instar larvae of *P. brassicae* after 24 and 48 hrs of exposure to petroleum ether extract at 5 and 2.5 per cent, respectively.

- Feeding of cabbage leaf discs treated with aqueous extract of *P hysterphorous* to first instar of *P. brassicae* caused highest mortality of 66.67 and 73.34 per cent at 5.0% after 24 and 48 hrs, respectively, percent mortality decreased with decrease in concentrations.

- Whereas, highest mortality of 70.00% was recorded against second instar at 5.0 per cent and 2.5 per cent aqueous extract after 48 hrs.

- There was no significant difference among the treatments in per cent mortality of first instar of *S. litura* at 24 and 48 hrs intervals when fed on castor leaves treated with different concentration of petroleum ether extract of *P. hysterophorous*, though highest mortality of 50.00 per cent was recorded after 48 hrs at 5.0 per cent. There was significant difference among the treatments in per cent mortality of first instar in aqueous extract, highest mortality of 60.00 per cent was recorded after 48 hrs at 5.0 per cent.

- The effect of *P. hysterophorous* extract on mycelia growth of plant pathogens was significant. Maximum per cent growth inhibition (59.49%) was found in *Sclerotium rolfsii*.

- The composting process of different treatments was completed in approximately 18 weeks. The compost prepared was neutral in pH, dark brown and free flowing.

- There was no significant difference among the treatments in physical parameters viz., pH and EC, through the values ranged from 7.04-8.11 and 1.82-2.94 dSm^{-1}, respectively.

- Statistically, no difference was observed among the treatment for N, P, Organic Carbon and C/N ratio of the compost, the values ranged from 1.52-1.94, 0.37-0.80, 21.25-49.50 and 11.03-33.67 per cent, respectively.

- Compost with *E. fetida* inoculums had high N, P, K content and low Organic Carbon and C/N ratio.

- The per cent recovery of compost ranged from 42.18-62.77 per cent, highest percent recovery (62.77%) was recorded for compost prepared from Parthenium mixed with

cow dung inoculated by *E. fetida* followed by Parthenium, Cow dung, Agriculture waste and Earthworm (51.40%).

Though the petroleum ether extract of *P. hysterophorous* proved effective against the first and second instar of *P. brassicae* and *S. litura*, but aqueous extract also provided reasonably good toxic action to the instars. However, for effective utilization by the farming community aqueous extract of *P. hysterophorous* can be effectively incorporated for the management of early instars of *P. brassicae* and *S. litura*. Further the compost prepared at different mixtures of Parthenium was with neutral pH, high N, P, K content and low organic carbon and C/N ratio. Therefore, Parthenium composting at low amendments with cow dung and *E. fetida* inoculums may help its eradication for better utilization.

Chapter-7

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ABSTRACT

The present investigation entitled **"Studies on biopesticidal properties and composting behaviour of *Parthenium hysterophorous* L."** was conducted at experimental farm and laboratory conditions of the department of Environmental Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni-Solan, located at 76°42" to 77°20"E longitude, 30°54" to 31°15"N latitude and at an elevation of 1453 m amsl, during the period 2014-2015. *P. hysterophorous* L. (Asteraceae) known by different names, but popularly called as Congress Grass is an exotic species which has spread rapidly and extensively throughout the world since 1970. It is capable of growing on a wide range of soil types ranging from sandy to heavy clays and in areas with summer rainfall >500 mm per annum. One of the most effective methods to manage it is the large scale utilization of the weed. The weed has been well documented for its bio-pesticidal properties, further the compost from *P. hysterophorous* contains enough quantity of various essential macro and micro plant nutrients. Therefore, in the present study bio-pesticidal properties and composting behaviour of Parthenium compost was studied. The insect-pests selected for the study were *Pieris brassicae* a serious pest of Cruciferous crops and *Spodoptera litura* a polyphagous pest. The toxicity of Parthenium to fungal pathogens viz., *Alternaria alternate, Sclerotium rolfsii, Fusarium oxysporum, Penicillium expansum, Rhizopus stolonifer, Aspergillus niger* was also studied. No per cent egg hatching of *P. brassicae* was recorded at the highest tested concentration (5.0%) of petroleum ether and aqueous extracts of *P. hysterophorous,* whereas, 21.43 and 22.31 per cent egg hatching was recorded for *S. litura* at petroleum ether and aqueous extracts at 5.0 per cent. After 48 hrs of exposure of first instar of *P. brassicae* cent per cent mortality was recorded at 5.0 and 2.5 per cent concentration. For second instar, 73.33 per cent mortality was recorded after 48 hrs at 2.5 per cent of petroleum ether extract. Aqueous extract of *P. hesterophorous* also provided good control with 73.34 per cent mortality of first and 70.00 per cent of second instar after 48 hrs of exposure. The petroleum ether extract and aqueous extract of *P. hesterophorous* provided 50.00 and 60.00 per cent mortality of first instar of *S. litura* when fed on treated castor leaves. Among the phytopathogens, 10 per cent aqueous extract of *P. hesterophorous* recorded maximum per cent growth inhibition of *Sclerotium rolfsii* (59.49%). The compost prepared at different combination was dark brown, free flowing and took approximately 18 weeks for completion. Compost with *E. fetida* inoculum had high N, P, K content and low organic carbon and C/N ratio. The per cent recovery of compost ranged from 42.18-62.77 per cent. Highest percent recovery (62.77%) was recorded for compost prepared from *Parthenium* mixed with cow dung inoculated with *E. fetida*. For effective utilization of the farming community aqueous extract of *P. hysterophorous* can be effectively incorporated for the management of early instars of *P. brassicae* and *S. litura*. Parthenium composting at low amendments with cow dung and *E. fetida* inoculum may help in its eradication for better utilization.

Signature of Major Advisor **Signature of Student**

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APENDIX-I

Analysis of Variance

pH and EC

SOURCE OF VARIATION		Ph		EC	
	DF	SS	MSS	SS	MSS
Treatment	4	2.645	0.661	3.623	0.906
Error	15	7.315	0.488	7.199	0.480

NPK

SOURCE OF VARIATION		N		P		K		Organic carbon		C/N ratio	
	DF	SS	MSS	SS	MSS	SS	MSS	SS	MSS	SS	MSS
Treatment	4	0.064	0.016	0.109	0.027	0.789	0.197	747.757	186.939	5,139.356	1,284.839
Error	15	0.597	0.040	0.185	0.012	0.555	0.037	3,150.482	210.032	11,316.203	754.414

Effect of petroleum ether extract of Parthenium on mortality of first instars of *P.brassicae*

SOURCE OF VARIATION		24 hr PE		48 hr PE		24 hr aqueous		48 hour aqueous	
	Df	SS	MSS	SS	MSS	SS	MSS	SS	MSS
Treatment	4	4,432.507	1,108.127	16,465.986	4,116.496	8,016.815	2,004.204	10,955.283	2,738.821
Error	10	4,563.341	456.334	1,117.001	111.700	275.757	27.576	1,622.713	162.271

Effect of petroleum ether extract of Parthenium on percent mortality of second instar of *P.brassicae*

SOURCE OF VARIATION		24 hr PE		48 hr PE		24 hr aqueous		48 hour aqueous	
	Df	SS	MSS	SS	MSS	SS	MSS	SS	MSS
Treatment	4	3,665.806	916.451	6,114.403	1,528.601	5,033.928	1,258.482	8,280.761	2,070.190
Error	10	2,115.497	211.550	1,655.861	165.586	385.672	38.567	1,166.448	116.645

APENDIX-II

Effect of petroleum ether extract of Parthenium on first instar of *Spodoptera litura*

SOURCE OF VARIATION	Df	24 hr PE		48 hr PE		24 hr aqueous		48 hour aqueous	
		SS	MSS	SS	MSS	SS	MSS	SS	MSS
Treatment	4	2,009.649	502.412	3,730.569	932.642	4,267.204	1,066.801	4,876.634	1,219.159
Error	10	2,917.454	291.745	3,388.452	338.845	1,065.433	106.543	500.858	50.086

Effect of petroleum ether extract of Parthenium on first instar of *Spodoptera litura*

SOURCE OF VARIATION	Df	24 hr PE		48 hr PE		24 hr aqueous		48 hour aqueous	
		SS	MSS	SS	MSS	SS	MSS	SS	MSS
Treatment	4			1,977.046	1,977.046	5,773.542	1,443.385	2,730.071	682.518
Error	10			98.940	98.940	2,459.948	245.995	3,183.247	318.325

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(SAYEED NABI ATTAYEE)