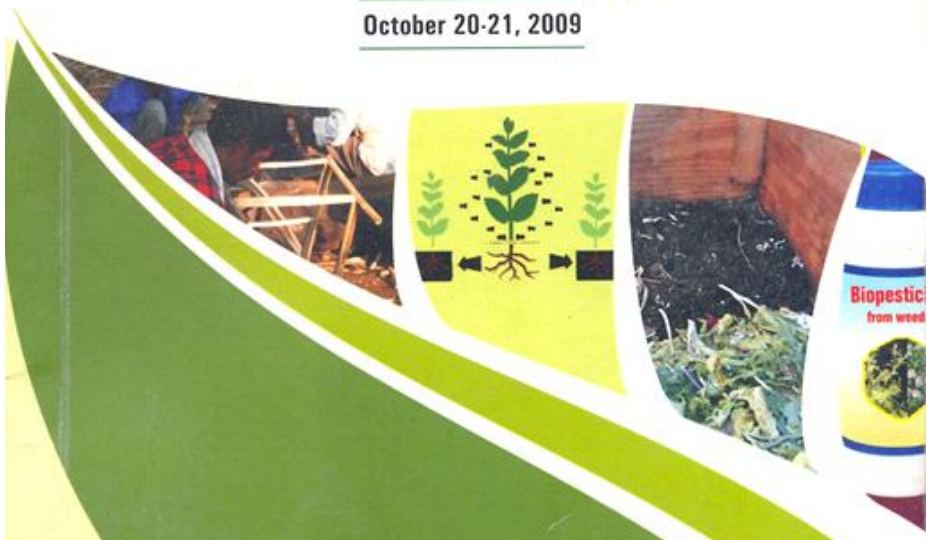
# NATIONAL CONSULTATION ON WEED UTILIZATION

October 20-21, 2009




# ABSTRACTS

Organized by
Directorate of Weed Science Research
Jabalpur, Madhya Pradesh

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# ABSTRACTS

**Editors**
Jay G. Varshney
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# Content

## Invited papers.







## Contributory papers.

Invited Papers

# Role of weeds in soil conservation

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Soil erosion causes degradation of natural resources and adversely affects the productivity level. About 57 percent of geographical area in the country is affected by various types of land degradation problems. Soil and water are the prime important resources among the natural resources whose efficient management is vital for economic growth and development of any country to addressing the poverty related problems. The gap in supply and demand for food products are becoming widening with the increasing population growth and reducing per capita availability of productive cultivable land. The mechanical and biological measures are well known recommended soil and water conservation measures and widely adopted by the farming community. Use of locally available plant resources which is of unique character are being exploited and utilized for various purposes including soil erosion control. Weed biomass provide protection to the soil in various forms by reducing erosivity of rainfall/run-off and erodibility of soil through dissipation of rainfall energy, surface litter, obstructing overland flow, root binding and improving physico-chemical conditions of soil. Some species of weeds are recommended as a vegetative barrier, preventive and rehabilitative measures for mass erosion control and rehabilitation of mine spoiled areas. Many of the grass species have good canopy and soil binding capacity theirby reducing surface runoff and soil loss.

Results of the several studies revealed that use of weed biomass for conservation measures increased crops yield by 6 to 110 percent, reduced runoff upto 41 per cent and soil loss upto 56 percent over control, reduction in evaporative losses and nutrients loss through leaching, increased water

and nutrient use efficiency, suppressed further growth of weeds. In fruit crops, it improves fruit quality, reduced flower and fruit drop apart from increasing in growth, *etc* when some species are used in erosion control, mulching and green manuring.

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# Weed utilization for mulching

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Any material applied to the soil surface for protection or improvement of the area covered is called mulch. Mulches have always been around as an agricultural and horticultural tool. Traditionally crop residues were recycled as mulch for crop production as no extra cost was involved to obtain them. In the recent past, the attempts are also being made to utilize the weeds as mulch for crop production and soil reclamation purpose. Plenty of lantana and water hyacinth biomass is available in India and the reports showed the prospects of these weeds to be used as the good mulching materials for agricultural sites. Mulch of these materials can be used not only to conserve soil moisture but also as a good nutrient source. Nematode suppressing ability as exhibited by the extracts of these materials could be an added advantage.

The research reports from the north-western part of India showed the usefulness of Lantana mulch for increasing rice, wheat and maize production. It was found superior in terms of grain yield advantage while compared with other mulching materials, *viz.* pine and oak leaves, and FYM application in wheat. It increased the phosphorus use efficiency in wheat and provided economic advantage over polyethylene mulch. Improvement in soil health in terms of increased soil organic C and available N content was noticed due to lantana mulching. The better performance of bell pepper under Lantana mulch was noticed at water deficit condition. Lantana mulch was better than the post harvest tillage as a soil water conservation practice in wheat. Better quality of rice and wheat grains in terms of N, P, K and soluble sugar content were produced with Lantana mulch compared to FYM application.

Water hyacinth was found suitable as a mulching material for various crops, *viz*. potato, tomato, okra, tobacco, *Colocasia*, green gram, banana,

*etc*. It has also showed superiority in terms of crop yield while compared with various other organic mulches *viz*. rice straw, spent straw, thatch grass, coir pith and maize stalk, sawdust, *etc*. under different cropping situations.

The economics of utilizing these weeds as mulch have not yet been reported. However, direct benefit is expected in long run in terms of reduced requirement of inorganic inputs, better soil health and quality of produce as indicated by long term experiment. In the greater interest of the environment and agricultural sustainability, remunerative initiative is desirable from public funded agencies for the farmers expected to use these materials as mulch.

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# Use of weeds for compost and vermicompost production

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Productivity of the soils can not be sustained with the fertilizer alone. Organic manures must also form part of the manorial schedule to maintain the productivity of the soils. Because of intensive farming system, the depletion of soil nutrients occurs to a greater degree leading to imbalance in availability of nutrients, loss of soil fertility and drastic reduction in crop productivity. The concept of organic waste management and its recycling for plant nutrient supply is becoming more essential for meeting partial requirement of plant nutrients and sustaining soil health through improvement of physico-chemical properties and microbial diversity of soil.

Composting is the most widely applicable process of handling biodegradable organic wastes. Composting provides a way not only of reducing amount of waste that needs to be disposed of, but also of converting it in to a product that is useful for crop production. Vermicomposting technology is an aspect of biotechnology involving the use of earthworms for recycling of non-toxic organic waste to the soil.

Crop growth and yield is influenced by biotic and abiotic factors. Generally, weeds compete with crops for nutrients, space, energy and sunlight *etc* which eventually reflects on the performance of the crop. Hence, weeds are one of the important factors in affecting crop yield. It removes substantial amount of nutrients from the soil depending on the density and species of weeds.

Succulent weeds which otherwise compete with crops can also be used for vermi-composting. Some weeds like Lantana, Eupatorium also have insecticidal/ properties and can help reducing the risks of insect attacks to crops in which vermi-compost prepared from these weeds is added.

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# Phytoremediation of contaminated sites using weeds

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Phytoremediation technologies are very promising and are applicable to prevent, control and remediate the contaminated sites using terrestrial and aquatic plants. In order to clean up the environment through various approaches of phytoremediation, use of suitable potential plants is of prime importance. Among the macrophytes in polluted sites, the very survival of weed species with increased biomass in contaminated land as well as in water bodies is a testimony that they have the ability of absorbing and extracting heavy metals. Weedy plants unlike crop plants do not require plant protection measures and can sustain under stress condition of both nutrients and water. The present paper is a comprehensive review which discusses possible utilization of weed species to extract, stabilize, filtrate, degrade and volatilize the pollutants from contaminated and degraded natural resources i.e land and water.

Depending on the macrophyte based treatment, floating weeds such as water hyacinth (*Eichhornia crassipes*) in a surface and emergent type of aquatic weeds like *Phragmits vava* in a sub-surface wetland were found capable of decreasing various test indicators for water quality ex. electrical conductivity (EC), biological oxygen demand, chemical oxygen demand and heavy metals like zinc, copper, cadmium, and nickel to the levels that allow the use of the purified water for irrigation purposes, are reviewed. It also gives an insight into the work done by the authors which focuses on the phytoextraction of metals from contaminated site like mine spoil using grasses, mustard species for metal removal from the contaminated soil. With regard to phytoremediation of waste water, weed survey work pertaining to indentification of weed species for rhizofiltration of drain and pond water, is



also highlighted. Weeds have great potential in phytoremediation of non-cropped sites and for its exploitation of potential in field soils, development of hybrid by breeding weed species with the commercial field crops is the option. In degradation of compounds in calcareous alkali soils and in stabilization runoff water originated from cropped and non-cropped area (mining) potential use of weeds can be explored. However, management of metal contaminated weed biomass is still a challenge. To avoid metal entry into food chain, possible uses of such metal rich weed biomass for paper, pulp, biogas, bio-ore and ethanol production are also discussed.

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# Weed as fibre- a special reference to khimp

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Weed is not a class of crops which can yield high quality fibre; yet there are a few weeds that yield good quality fibre. To name a few such weed types are grass, shrubs and bushes. Khimp plant is one such bushy plant that grows in arid climate for use as animal fodder, soil cover to control wind erosion and stabilizing sand dunes and as fibre to make ropes traditionally besides strings and weave nets apart from other non-textile applications like paper due to its short staple length of 21.5 mm. This paper deals with in brief the total aspect of khimp plant covering its habitat, area, fibre yield, chemical composition, physical / mechanical properties, comparison with other textile fibres and scope of application. Studies at NIRJAFT, Kolkata under ICAR have shown that khimp fibre is rich in cellulose (75%) in bast, rich in lignin (16%) in woody stick required for plant's upright position. Fibre is fine, strong and extensible to make khimp fibre fit for both textile and non-textile uses.

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# Utility of weeds as medicinal plants

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Importance of medicinal and aromatic plants as a source of drug for improving health and curing aliments is well recognized all over the world. These herbal medicines are in great demand in both developed and developing countries in primary health care because of their great efficacy and little or no side effects. The turnover of the herbal medicine in India is about US $ 1 billion with a meager export of about US $ 80 million per year, which is growing at 7% per annum (Kamboj, 2000, Nautiyal, 2002). Several annual and perennial plant species grow spontaneously under natural habitats and man made altered habitats. The plant species which grow spontaneously in cropped fields or any other areas where they are not required due to use of the land for other purposes and cause more harms as compared to benefits are considered as weeds. These weeds are to be removed time to time from cropped or non cropped area to get the desired benefits from that area. The most of these weed species have specific medicinal values and offers a range of time tested, nature derived herbal remedies for several ailments of human and pet animals. Some of these spontaneously grown species are used in folk lore by indigenous herbalists and in Indian system of medicine *viz*. Ayurveda, Homeopathy, Unani and Sidha. Certain weeds have high demands by drug manufactures e.g. Zandu, Baidynath, Dabour, Hamdard, Gurukul Kangdi, Patanjali Yogpeeth *etc*. and also locally used by indigenous Vaidyas. In view of the medicinal importance some of the weed species like *Withania sommnifera* as aphrodisiac, *Abelmoschu moschatus* as cardiotonic and in aroma, *Phyllantnus amarus* in jaundice and liver disorders, *Eclipta alba* as hair tonic, in liver and spleen disorder, *Bacopa monieri* and *Convolvulus pluricaulis* in memory and mental disorder, *Andrographis paniculata* as

febrifguge , *Ocimum canum* and *Ocimum gratissimum* in fever, cough and skin diseases, *Tribulis terristeris* as aphrodisiac and diuretic, *Solanum nigrum* in liver disorder and swellings *and Solanum xanthocarpum* in bronchitis and asthma have high demand. The raw drug material is not available from the natural resources and these are to be cultivated like other food and oil seeds crops are under cultivation. While weeding of the traditionally grown crops, the weed species having medicinal importance are thrown away but they should be colleted separately and marketed. The awareness among farmers and farm labourers regarding utility of weeds as medicinal plants needs to be created to improve the health and economics. In this paper the medicinal values of more than 100 important weed species are described which should be protected in the natural habitats and nurtured in the herbal gardens so that they may not loss due to regular weeding operations for maintaining weed free field conditions. The medicinal weeds can be cultivated by fitting them into the existing cropping systems. Some of the medicinal weeds with short growing season that coincides with the fallow period between two crops can be grown as pure crop and the other can be grown as intercrops for efficient utilization of the land for higher net returns. Since many medicinal weeds are available in the natural ecosystem for commercial exploitation, doubts are raised about whether the cultivated produce would have viable market. Therefore, the studies on technologies for conservation, cultivation, processing, storage, marketing and economics of these weeds are also required to increase the productivity of raw drug material with improved active principles and assess the profitability from cultivation and processing of these weeds at farm level.

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# Value addition of lignocelluloses substrate from Parthenium and Lantana

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Weeds are the plants which grow where they are not desired. Parthenium *hysterophorus* L., (Helianthae: Asteraceae), commonly known as Parthenium, congress grass, gajar ghas or carrot weed and *Lantana camara* L. (Verbenaceae) are such plants. They have achieved status of ”Worst Weeds”. They not only affect crop production, animal husbandry, and biodiversity but also pose serious health risks. Ever since these weeds became a menace in India and other countries efforts are being made to manage the weed by a number of methods such as mechanical, legal, biological and chemical But so far no single method has been proved satisfactory, as each method has inbuilt limitations, for instance,. high cost, impracticability, environmental safety, temporary relief *etc*. Alternatively, luxuriant growth and vigorous survival make these weeds of potential economic value for utilization of its abundantly available biomass into value added products offering thereby an efficient and effective method for their management.

Cellulose is an established chemical feedstock for production of cellulose derivatives for a variety of applications. The conventional sources of cellulose include cotton linters and wood pulp which now-a-days are discouraged on account of the cost of the former and environment conservative regulations associated with the latter. Further, renewable raw materials are gaining considerable importance because of the limited existing quantities of fossil supplies. In this regard, cellulose-rich biomass derived from the non conventional sources such as weeds, fibers, bamboos and wastes from agriculture and forests *etc*., acquires enormous significance, as alternative chemical feedstock, since it consists of cellulose, hemicellulose,

and lignin, which contain many functional groups suitable to chemical transformation. Etherification of cellulose through methylation, carboxymethylation, cynaoethylation, hydroxypropylation, single or mixed, is one of the most important routes of cellulose transformation. Chemical composition and rheological characteristics make possible the selection of the transformed cellulose to serve special applications.

A survey of the literature reveals that lingo cellulose biomass from non conventional sources such as agricultural wastes e.g. rice straw, sugarcane bagasse, saw dust cotton stables, orange mesocarp, *Eichoria crassipes* and agave have been used as a base material for production of cellulose derivatives differing in their properties using different set of reaction conditions depending upon the degree of polymerization and composition of the cellulosic material. The goal of these modifications has been to increase the utilization of this abundantly available ligno cellulose biomass as a feedstock.

Prompted by these facts and in context of our research programme on isolation of cellulose from different sources and its subsequent transformation into value added products, possibility for value addition of lignocellulosic biomass of *Lantana camara* and Parthenium *hysterophorus* for their utilization was examined and results are reported. Proximate analysis of these materials was conducted and processes were standardized for production of alpha cellulose on I kg batch scale. The %yield, Av. DP and %á-cellulose contents of the obtained celluloses were found in the range of 35-40, 400- 825, > 90 (Brightness 80% ISO), respectively. The obtained celluloses were transformed into hand made paper which demonstrated its suitability to produce hand bags, carry bags, decorative articles *etc*. Processes were also optimized for production of cold water soluble carboxymethyl celluloses (CMC) and hydroxypropyl cellulose (HPC) using these celluloses. The optimized products were characterized by IR spectra. Rheological studies of 1% and 2% solutions of the optimized CMCs showed their non-Newtonian pseudo plastic behavior.

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# Weeds Utilization for energy production

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Weeds are plants that are undesirable to human activity at a particular time and place, and therefore, weeds will always be associated with human endeavours. In agriculture, weeds cause huge reductions in crop yields, increase cost of cultivation, reduce input efficiency, interfere with agricultural operations, impair quality and act as alternate hosts for several insect pests, diseases and nematodes. Weeds are of major concern as they compete with crops for environmental resources available in limited supply, *i.e*. nutrients, water and light. It has been estimated that on a global basis weeds are considered responsible for c.10% reduction of crop yield, with losses in the tropics possibly exceeding 15%.

Utilization of weed for useful purpose is being considered as an alternative approach of weed management. The present review discusses about the possibility of utilization of weed for energy generation by employing suitable conversion technology. Weed is a biomass that can be subdivided to either cellulosic or lingo-cellulosic in nature from energy conversion point of view. Use of weeds for energy also has twofold advantage. It ensures useful disposal of weeds in one hand and on the other hand, it is a renewable biomass resource not in competition with food crops for land as the case used to be for conventional energy crops and plants. Weed biomass for energy generation can have multiple benefits both in terms of socio-economic and environmental and has local and global perspectives too.

Biomass has a wide resource base and as such has the flexibility for conversion by different technologies/pathways. It can be converted to solid, liquid and gaseous fuels by employing either thermo-chemical or biochemical conversion pathways. Each of the technology is a mature one and utilization of a technology depends upon the feedstocks type and quality, process

parameters and end-use requirements. Weed biomass being cellulosic or lingo-cellulosic in nature can be feedstocks for anaerobic digestion, briquetting/ compaction and pyrolysis/carbonization. Deoxy-liquefaction is also another recently developed technology suitably applied for thermo-chemical conversion of some aquatic weeds for energy generation.

In one of the works on weed utilization for energy generation, *Ipomoea carnea* synonym *Ipomoea fistulosa* (family: Convolvulaceae), a noxious weed found in the wetlands of tropical regions having its origin in Tropical America is being studied. It is an evergreen semi-woody shrub, toxic to livestock. This weed has been spreading rapidly in many low-lying areas of north east India and has been creating problems by covering large patches of agricultural fields and also by blocking the passage of many canals and streams and thereby causing artificial flood in the rainy season. With a view to utilize this harmful weed for fuel purposes, its woody stems were first converted to charcoal through the process of pyrolysis and then the charcoal produced was compacted to solid fuel. Pyrolysis experiments were carried out in laboratory scale reactors specially designed for the purpose in the temperatures ranging from 350 to 600 $^{0}$C and at constant heating rate of 5 $^{0}$C/min. Yield, density, ash content, volatile matter, fixed carbon content and calorific value of the charcoal samples produced were evaluated. Charcoal yield ranged from 24.23% to 37.89 wt% and caloriûc value varied from 17.29 to 33.47 MJ/Kg. Conversion of charcoal ûnes to solid fuel improved combustion quality. Mass balance experiments of pyrolytic decomposition products of *I. carnea* yielded much higher percentages of non-condensable liquid (59.2–61.8 wt%) as compared to those of tar (4.2–4.8 wt%) and gas (7.3–8.2 wt%) fractions. It can be concluded that this harmful weed shows good potential as the raw material for production of charcoal. However, as the density of the charcoal was found to be low, the charcoal ûnes need to be converted to solid fuel to improve its combustion properties.This work can be summarized by asserting that weed biomass can be a valuable resource as biomass energy feedstock.

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# Weeds as a source of biopesticides

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Biopesticides' are certain types of pesticides derived from natural sources such as animals, plants, bacteria, and certain minerals. Biopesticides are gaining popularity throughout the globe due to public awareness about environment, growing knowledge of pollution and health hazards due to synthetic pesticides and introduction of organic farming. As a result farmers and grower are looking for less harmful, non-persisting biopesticides. Extensive studies regarding pesticidal activity of weeds on crop or weeds were conducted all over the world. Phytochemicals have wide range of activities against crop pests such as weeds, nematodes, insects, microbial and fungal diseases *etc*. and thus can be used as biopesticides. In general, these compounds are less toxic to non-target species and less persistent in soil than synthetic pesticides.

Many problematic weed species such as *Xanthium strumarium,* Parthenium *hysterophorus*, *Lantana camera*, *Datura stramonium*, *Chenopodium ambrosiodes*, *Sonchus oleraceuus*, *Ageratum conyzoides, Solanum xanthocarpum, Calotropis procera, Argemoene maxicana, Solanum nigrum Chenopodium album, Ranunculus asiaticus, Ipomoea carnea, Acalypha indica, Euphorbia hirta, Ricinnus communis Sisymbrium irio etc*. show pesticidal potential due to presence of chemicals in plant tissues, including leaves, flowers, fruits, stems, roots, rhizomes, and seeds. Under certain environmental conditions the active form may be released and cause the pesticidal effects. Biopesticidal activity of pyrethrum based products has led to the discovery of many plant origin biopesticides. Various biochemicals such as acetogenins, volatile terpenoids, phenyl propanoides, quinines, coumarins, flavanoids, tannis, other phenolics, cyanogenic glucosides, steroids, alkaloids *etc*. contained in weeds generally enter into the field

environment by exudation, leaching or decomposition and showed potent biological activities.

Many formulations/extracts or phytochemicals in pure form or their synthetic analogues showed a wide range of pesticidal properties. We have isolated many bioactive molecules from weeds/plants and evaluated insecticidal and bioherbicidal activity of isolated molecules as well as various extracts against major world worst weeds such as Parthenium *histerophorus, Vicia sativa, Ischaemuem rogusum, Convolvulus arvensis, Echinochloa colona, Lathyrus sativa, Phalaris minor, Cyerus rotundus, Avena ludoviciana etc.* We found that growth of all the weeds were significantly inhibited by the phytochemicals/extracts isolated from different plants/weeds at the concentration range of 0.5 to 5 ppm and complete inhibition were achieved at 5-10 % extracts. Similar significant results were obtained with various insects.

The wide array of weed plants that produce biopesticidal compounds provides almost unlimited research opportunities for discovery of novel compounds. In order to improve the biopesticidal efficacy achieved with phytochemicals/extracts/formulations, a greater understanding of the effects of soil microbiology, soil properties and environmental conditions on the active compounds is necessary. Currently available application methods of biopesticides also need to be refined to enhance the performance of phytochemicals/extracts/formulations for microbes, bacteria, fungi, insect, nematodes, and weeds control.

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# Utilization of weeds and grasses for handmade paper and board making

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Global warming as a whole brought the whole world on a common platter to think ways and means to set right the mindless misuse of natural resources, ruthless deforestation and ever up-surging pollution levels. Handmade paper industry in India is embarking on use of recycled fibers. The major raw material for handmade paper industry in India is cotton hosiery waste or cloth cuttings generated by hosiery and garment industry. Handmade is known for its aesthetic value, texture, strength, durability, permanence, personalized touch, eco-friendly nature and exotic range. All these properties of handmade paper can also be obtained by utilizing other alternate ligno-cellulosic raw materials in the form of bast fibers like Jute, Sunn Hemp, Bhimal, Bhang and leaf fibers like Banana, pine apple, sisal *etc*. Not only that grasses like Sabai Grass, Bodha Grass, Lemon grass but agro-residues like Wheat straw, Rice straw, Bagasse *etc* can be effectively used for handmade paper making. Kumarappa National Handmade Paper Institute (KNHPI) has been engaged in applied research for the development & sustainability of handmade paper sector. One of the major issues confronting with the Indian handmade paper sector has been the availability of good quality of cellulosic raw material at competitive & reasonable price. In this context a number of ligno-cellulosic raw materials have identified which includes weeds and wild grasses. To address the above said issue, KNHPI has identified Lantana, Kheep and Kans grass as a raw material & processed as one of the priority area of its research & development activities so that growing demand of the Indian handmade paper industry can be met without disturbing the environment, social & community harmony and also converting wild waste in to wealth.

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# Use of weeds as genetic material for crop improvement

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Weeds have greater adaptation potential than crops by virtue of huge genetic diversity. If environmental and land resources change, it is almost likely that weeds will be the winner in the race and over compete the crop plants for the utilization of resources. One important point emerges from studies is that the most competitive weed in a given crop is similar in growth habit or photosynthetic pathway to that particular crop e.g. *Phalaris minor* in wheat, wild oat in oat and weedy rice and rice crop. Recently, in a pioneer study, it has been shown that weedy rice has immense potential to compete the cultivated rice in elevated $CO_2$ condition. Increasing concentration of ozone into troposphere is another concern of scientist around the world. A rise in the ozone can potentially suppress the growth of crop plant but some weeds like *Cyperus esculentus* have the potential to escape or minimize the impact of increasing ozone. Tolerance to ethanol and the ability to metabolize key intermediary substrates under anaerobic conditions makes *Echinochloa crusgalli* (L.) tolerant to flooding conditions. From the above mentioned studies, it can be inferred that weeds posses better ability to survive and perform under adverse environmental conditions which make them sturdy and highly competitive with crop plants. *Alternanthera philoxeroides* has been shown to possess capability to survive under worse environmental conditions like drought, salinity, low temperature and flooding thus can be a plant for future from the point of view of crop improvement. Now a big question arises in this context, can we exploit these attributes of weeds for the crop improvement? If yes, then there is no other alternate better than weeds simply because of the co-existence of weed and crop plants. An advantage using weeds as a source of gene(s) may be other co-ordinated regulatory aspects



of the transgene(s). As both weeds and crops grow in the same environment, so it is expected that internal machinery (at least partly) which is required for the functioning of transgene(s) might be present already in crop plants. Development and availability of the sophisticated molecular tools provide us liberty to play at molecular level and to transfer the genetic material into crop plants, thus breaking the reproductive barriers for inter-specific and inter-generic transfer of the genetic material. Competitiveness and tolerance to abiotic and biotic factors are the important traits among various weed species which can be transferred into crop plants. However, success of such approaches requires integration and collaborative efforts from all the corners of scientists to bring together expertise in weed science, molecular biology, plant physiology.

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# Weeds- valuable source of dyes

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Natural dyes have been associated with human life since time immemorial. Discovery of first synthetic dye by Sir Henry Perkin in 1856 and a number of other dyes including azo dyes in the subsequent years resulted in sharp decline in commercial production of the dyes of vegetable origin across the world. Their use became minimum in the twentieth century. But, most of the synthetic dyes cause environmental pollution during their production and use. Moreover, the fabrics dyed with azo dyes may cause different kinds of skin turmoil. Environmental awareness as well as presence of toxicity in synthetic dyes has revived the interest in biodegradable, environment friendly, non-toxic and aesthetically appealing natural dyes.

Dye yielding plants are important bioresources having huge economic potential since the demand for natural dyes in dyeing of different fabrics, in food processing, cosmetics and pharmaceutical industries have been swiftly emerging. Natural colors have been found in leaves, flowers, bark, roots and fruits of many plant families. Thus it is of immense importance to find the additional sources of natural dyes, which are available in plenty and hitherto waste material. This paper describes the utilization of the following weeds for extraction of dyes *Ageratum conyzoides*, aerial parts (~14%), *Lantana camara* leaves (~14 %), Parthenium *hysterophorus* aerial parts (~13%) and *Eupatorium glandulusum* aerial parts (18.2%) which imparts good shades on silk, wool and cotton with varying color fastness properties.

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# Utilization of weeds as a source of potential allelochemicals

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Weeds represent highly successful organisms that form an important part of the natural and agroecosystems. From the evolutionary point of view they are considered as pioneers of secondary succession, colonizers, and competitors, taking advantage of human made habitats, and highly responsive to change in environmental conditions in such a beneficial and advantageous way enabling them to survive and grow in nature. Though weeds in one way are known to cause a number of harms in agro-ecosystems not in terms of drastic reduction in crop yield but also in utilization of human energy and resources and increased expenditure to alleviate the problems caused by them. However, noxious characteristics of weeds exerts by being production of very active phytotoxins that could be allelochemicals providing them an advantage in plant-plant competition and survive in adverse situations hence, can be utilized for benefits of agro-ecosystem. Allelopathic weeds can be used as an effective tool for weed pathogen and pest management in increasing agricultural production. This can successfully be achieved by using the allelopathic weeds as allelopathic cover or smother crops, allelopathic rational or companion crops, mulch or incor-poration of crop residues, production of allelopathic crop cultivars with weed suppressing potential, and as sources of natural herbicides. A number of weed species were reported to contain a vast repository of biologically active allelocompounds. Some of these compounds are often unique and possess tremendous activity. Numerous examples of individual phytotoxins and crude exract preparation of allelopathic weeds with weed and pathogen management are provided. Unique class of

allelocompounds of certain weed species having tremendous capability to utilize them either as a natural herbicide or as a template for development of synthetic herbicide has also been discussed. This paper briefly reviews the allelopathic utilization of weeds and also discusses the reality of allelopathic prospects by presenting recent achievements of their use in practice.

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# Weed as a bioindicator of climate change

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Direct effects of global warming as a result of accumulation of green house gases in the atmosphere are distinctly evident on various climatic parameters. All organisms are influenced by climatic events. Use of indicator species or communities is crucial for defining the level of climate change. Weeds are naturally occurring vegetation exposed to an open competitive environment. Climate sensitivity of specific weeds makes them potential bioindicators of climate change. Researches that have been carried out in different places around the world have revealed that changing climatic conditions have significant bearing on the morphology, phonology, physiology and biochemistry of weeds. Differential behaviour of weed species in their response to climate change have opened up their potential as good bioindicator of climate change.

Change in geographical distribution, modifying the characters and vulnerability to extinction are the broad indicative phenomena by which climate change can be tracked. Those weed species which can show such indications without much time lag can be used as effective bioindicators of climate change.

Rising levels of carbon dioxide are likely to change the biology of weeds leading to spread of weedy, invasive species and species diversity. Changed growth behaviour , photosynthetic rate, biomass production, biochemical composition of sensitive weeds in response to rising atmospheric $CO_2$ , temperature and other resultant climatic phenomena have widely recorded by various workers. Certain field examples of weed shift and modified behaviour due to climate change have also been cited.

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# Weeds: should we destroy them with herbicides or use them for value addition

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The soil supports the growth of platns, be it monocot,dicot or the one growing in water. The unwanted ones in a wanted place assumes significance since they complete for water and nutrients and hence to be removed. Should we make a concerted effort in treating them as raw materials to prepare silage, fodder, compost, vermicompost, to raise edible mushrooms, to produce biogas, to prepare pulp and paper *etc*. Preparation of compost or vermicompost from weeds available in cropped lands appears to be the ideal option than many possibilities. Energy from aquatic weeds has not been found to be economical. Preparation of pulp and paper from perennial grasses is possibility in the coming years.

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# Scope and opportunities of weed utilization in Himachal Pradesh

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Himachal Pradesh being a hilly state is gifted with plenty of land that cannot be put under cultivation. Such lands are under orchards, pastures, grasslands, forests and wastelands constituting about 80.2 per cent of the total geographical area (55,673 sq. kms. of the state). Since most of these lands do not receive frequent cultivation and intensive care of the owners, the alien invasive weeds like Lantana camara, Ageratum honstonianum, parthenium hysterophorus, Chromolaena adenophorum, Bidens filosa and Erigeron canadensis have invaded most of these areas causing threat to plant biodiversity by competitive and allelopathic effects and health hazard to human and animal health. These weeds are spreading like a wild fire due to their propagation by seeds and vegetative means and dissemination by wind, water, animals, machinery etc.

As a part of integrated technologies developed for management of bushy type weed species, the tall growing weed species are required to be cut and the cut biomass can be utilized for any useful purpose. Field experiments have shown that as a mulch, the biomass of these weeds helps to modify the hydrothermal regime of the soil in favour of crops and to check the germination and growth of associated weeds. In an experiment on organic potato, Chromolaena mulch in integration with application of FYM 37.5 t/ha produced significantly higher potato tuber yield and effective control of weeds. Similarly, beneficial effects of Lantana mulch on wheat and soybean and on yield of rainfed rabi crops have been reported under mid hill conditions of Himachal Pradesh. Utilization of Lantana and Ageratum with dung in 3:2 ratio, respectively for higher biogas production than dung alone. The long term study in rice-wheat cropping system have shown that application of

25 percent of recommended Nitrogen through Lantana twigs and 75 percent N through fertilizers in transplanted rice increased the productivity of rice and wheat over 100 per cent use of recommended nitrogen through fertilizer. Field studies have shown that application of 5 tonnes of green Lantana per hectare to wheat crop saved 30 kg N/ha. Compost with nitrogen content higher than 2% was produced by processing green material with small amounts of animal dung and rock phosphate. The study on conversion of biomass of Lantana, Chromolaena and Parthenium weeds into vermicompost and their use in organic potato increased the potato tuber yield). Because of toxic alkaloides present in Parthenium and Ageratum, application of their 10 per cent dust on healthy potato tubers in storage helped in protecting the tubers from potato tuber moth attack upto 120 days of storage . Apart from these, the cut biomass of Lantana and Chromolaena is also being used as a fuel wood by the poor farmers of the state. Because of the small holdings, hills farmers utilize second flush of weeds growing in cultivated crops as a green fodder for the cattle. These studies indicate that utilization of weed biomass can be an effective component of integrated technology to manage weeds in cropped and non-cropped ecosystems. Hilly states like Himachal Pradesh has rich scope and opportunity to convert large biomass of these obnoxious weeds into useful resource on commercial scale with the help of local public under NAREGA and with involvement of NGOs in the area.

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# Industrial utility- a tag that attract stakeholder involvement for control of invasive weed

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The control of aquatic weed water hyacinth (*Eichhornia crassipes* Murt. (Solms)) is constrained with multiple factors and accordingly, utility assumes significance as a two pronged strategy that tags control measures with the benefit of utility, attracting the involvement of all stakeholders. The fairly high content of cellulose with lesser lignin (49 to 64% of cellulose varying with different parts of the plant and 6 to 8% of lignin) lends scope for extraction of nanofibers and the same is attempted through DBT funded research project implemented by a Consortium headed by Department of Agronomy, Annamalai University. Nanofibers have been extracted and are being characterised for use in acoustics, medical dressings *etc*. chemo-mechanical, separation, isolation by heat treatment and electrospinning methods are employed for separation of nanofibers. Comparison of the weed as bio-compost, animal feed and mulch revealed that bio-composting proves better. Other weeds that are being used for varied purposes and that holds scope for further exploitation like *Cyperus hexalis* for furniture and mat making in suburbs of Chidambaram town in Tamilnadu, *Hemidesmas indicus* for flavour in soft drinks, *Prosopis juliflora* for good quality fuel and seaweed *Gracilaria edulis* for agar making and bio fuel are also discussed in this paper.

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# Possible use of giant reed, *Arundo donax* for phytoremediation of runoff water in a catchment area.

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The water erosion leads to the loss of the fertile top soil and in extreme cases, exposure of the subsoil occurs under agricultural as well as non-agricultural site such as mining. Along with the soil lost in the runoff, nutrients and heavy metals are carried away particularly in the lower reaches of the catchment. As a result, heavy weed infestation and silting occurs in the different kinds of water bodies such as reservoirs, tanks, lakes, ponds and rivers. It is estimated that about 7 million hectares area of water bodies is infested with aquatic weeds. In this respect phytoremediation as a plant based technologies are very promising and are applicable to prevent, control and remediate the contaminated sites for water quality up-gradation using terrestrial and aquatic weedy plants. An investigation was therefore carried out at DWSR, Jabalpur to test the efficacy of giant reed, *Arundo donax* in a sub-surface wetland model treated with drain water. The waste water analysed for various water quality parameters *viz*, iron, manganese, nickel, copper, nitrates, chlorides, phosphates were in the range of 1.52-2.0, 0.62-0.8, 0.22-0.34, 0.29-0.32, 50-56, 55-70 and 8-10 mg/L respectively. As compared with the permissible limit, the concentrations of manganese, nickel, copper and nitrates exceeded the prescribed standard limit of FAO. It was observed that the reed plant was grown with a well spread entangling root system in a gravel medium (without soil) and no clogging was occurred as a result of which the water is easily passed out through the outlet of the filter bed. As far as the treatment of waste water in a wetland model is concerned, after treatment the reed plant except chlorides and alkalinity reduced the concentrations of nitrate, phosphate, nickel and copper to the extent of 70, 42.8, 55.8 and 40.6 per cent respectively as compared to the untreated waste water. Having ability to grow successfully in a gravel medium and phytoextracting potential for pollutants, *Aundo donax* can be used for biological treatment and stabilization of runoff water in the catchment area of the field and mining.

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# Nutrient content of weeds and response of field crops to weeds' usage as compost and green manure in southern Karnataka

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Weeds produce huge biomass on its own without any assistance from mankind, mine out sizeable quantities of unavailable nutrients and convert them into available form when the biomass is used as compost or green manure in field crops. This would also serve as alternate strategy to contain the weed menace and also lower further spread by curtailing seed production. Weeds compost, if properly decomposed will not aid in spread of weeds. Thus weeds biomass usage as compost with proper decomposition can be profitably used to supplement farm yard manure's usage in crop production. In this regard, attempts were made to evaluate weeds' usage as compost and green manure in field crops in relation to FYM and green manure.

Field experiments were conducted to know nutrients contents of weeds, to know the weed utility as compost and green manure and response in field crops – finger millet, transplanted rice, sprouted rice, maize – sunflower and rice-rice systems in the University of Agricultural Sciences, Bangalore during 2003 to 2008. Weeds – *Chromolaena odorata,* Parthenium *hysterophorus, Cassia uniflora,* possessed higher or comparable nutrients' contents – N (1.6 to 2.63%), P (0.41 to 0.46%), K (1.3 to 2.1%), Ca (1.23 to 1.78%), Mg (0.28 to 0.43%) and S (0.14 to 0.24%) than cow dung (0.68%, 0.48, 0.6, 1.06, 0.25 and 0.12%, respectively) and traditional green manure crops - *Glyricidia maculata* and Sun hemp (2.0 to 3.0%, 0.22 to 0.38, 1.5 to 1.9, 1.4 to 2.2, 0.43 to 0.73 and 0.08 to 0.27%, respectively).

At Hebbal on red sandy loam soil, use of enriched compost of *Chromolaena* at 7.5 t/ha along with 100% recommended fertilizer dose (RDF)



in finger millet gave grain yield (4362 kg/ha) similar to FYM + RDF (4360 kg/ha), while additional yield was obtained in groundnut (2991 kg/ha) over FYM usage (2706 kg/ha). Usage of compost of *Chromolaena* saved the cost on FYM usage by Rs. 1500/ha and gave additional benefit of Rs. 5700/ha in groundnut. Similarly in transplanted rice in coastal alluvium soil of Karnataka, use of *Chromolaena's* biomass as green manure at 10 t/ha + 100% RDF gave yield (4325 kg/ha) similar to FYM at 5 t/ha + 100% RDF (4260 kg/ha), apart from saving Rs. 1500/ha over FYM usage. In drum seeded rice (direct seeding of sprouted rice using drum seeder) in coastal alluvium soil during 2003 -04, use of *Chromolaena's* biomass as green manure at 10 t/ha + 100% RDF gave yield (3729 kg/ha) higher than FYM at 5 t/ha + 100% RDF (3373 kg/ha), as a result of higher biomass of micro-organisms in the soil (3603 as against 1883 C µg/g soil in FYM), dehydrogenase (107 as against 83 µg TPF/g soil in FYM) and phosphatase activities (152 as against 98 µg PNP/g soil in FYM). In another trial in aerobic rice at Kathalagere, use of weeds – *Chromolaena odorata,* Parthenium *hysterophorus, Cassia uniflora* as green manure at 10 t/ha + RDF gave yield (5241 to 5507 kg/ha) similar to plot receiving 10 t/ha of Glyricidia and FYM + RDF (5427 to 5461 kg/ha), apart from saving cost of Rs. 3800/ha and giving additional returns of Rs. 2268 to 4123/ha over FYM's usage.

In maize - sunflower system at Hebbal on red sandy loam soil for 2006 to 2007, use of composts of *Chromolaena,* Parthenium and *Cassia* at 10 t/ha along with RDF gave yields (6192 to 6301 kg/ha) similar to plot receiving FYM at 10 t/ha + RDF (6343 kg/ha). In the succeeding sunflower crop, use of composts of *Chromolaena,* Parthenium and *Cassia* at 10 t/ha along with RDF gave yields (1818 to 1867 kg/ha) similar to plot receiving FYM at 10 t/ha + RDF (1801 kg/ha).

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# Evaluation of Parthenium composts on the productivity of maize-sunflower cropping system

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Field experiments were conducted at Coimbatore during *kharif* and *rabi* seasons of 2005–06 to evaluate the Parthenium compost on the productivity of maize and its residual effect on the productivity of succeeding sunflower in maize-sunflower cropping system Five sources of organic manure, *viz*., farmyard manure at 12.5t/ha, pit aerobic Parthenium compost at 5t/ha, pit anaerobic Parthenium compost at 5t/ha, heap anaerobic Parthenium compost at 5t/ha and Parthenium vermicompost at 5t/ha were included in main plots. Nitrogen (N), Phosphorus (P), Potassium (K) levels (135:62.5:50 kg/ha) *viz*., 100, 75 and 50 per cent recommended level with no inorganic fertilizer were assigned to subplots. Conjoint application of organics and inorganics (100 per cent NPK) sustained soil fertility and improved the crop productivity. Parthenium vermicompost especially increased the soil available N, P and K. Considerable nutrient build up in soil was discernible at the end of maize crop compared to initial status. Among the organics greater increase was realized in Parthenium vermicompost application. Basal application of Parthenium vermicompost at 5t/ha rated as the best organics followed by pit anaerobic Parthenium compost at 5t/ha. Basal application of Parthenium vermicompost at 5t/ha combined with 100 per cent of the recommended NPK (135:62.5:50 kg/ha) as P and K basal along with 25 per cent N as basal, the remaining 50 per cent and 25 per cent of N at 25 DAS and 45 DAS to maize, 100 per cent of the recommended NPK (40:20:20 kg/ha) as P and K basal along with 50 per cent N as basal, the remaining 50 per cent N at 45 DAS to succeeding sunflower in maize-sunflower cropping system could increase the productivity of maize and sunflower with better soil fertility and economic returns.

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# Response of summer Sunflower to different level of Parthenium compost and fertilizer levels

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The field experiment was conducted to study the effect of Parthenium compost and fertilizer levels on seed and oil yield of sunflower (*Helianthus annuus L.*) in summer season on medium black soil of Marathwada region of Maharashtra state. The experiment was laid out factorial randomized block design on experimental farm of Department of Agronomy, Marathwada Agricultural University, Parbhani, (M.S.). The treatment comprised two levels of Parthenium compost *viz*. ($C_1$) 5 t/ha and ($C_2$) 10 t/ha and five levels of fertilizers *viz*. ($F_0$) 00 kg NPK/ha , ($F_1$)25 % of RDF, ($F_2$) 50 % of RDF, ($F_3$) 75 % of RDF and ($F_4$) 100 % of RDF, wherein recommended dose of fertilizer nutrients (NPK) for sunflower in this experiment was 60 : 30 : 30 kg NPK/ha. The results showed that lowest number of parthenium weeds were emerged in lowest level of parthenium compost i.e. 5 t/ha and highest level of fertilizers i.e. 100% of RDF. Whereas the lowest weed count regarding parthenium weeds was observed in combination of 75% RDF & 5 t/ha parthenium compost. The study revealed that yield attributing characters, seed and oil yield were favoured and influenced significantly with the increasing level of both Parthenium compost and fertilizer levels. The significantly highest capitulum and thalamus weight per plant, weight and number field and total seeds per plant, test weight, capitulum yield, seed and oil yield were found with highest level of Parthenium compost (i.e. 10 t/ha ) and 75 % of RDF followed by 100% of RDF individually. Whereas the interaction effect was also found significant wherein the combination of 10 t/ha of Parathenium compost and 75% of RDF recorded highest rates for yield attributing characters and seed and oil yield of sunflower in summer season.

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# Ecorestoration of soil and water, production of oils and employment generation by utilizing weed plants

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Weeds are individualist and opportunist interfering with human goals since the earliest days of human civilization. It causes serious ecological problems and are capable of altering the ecosystem, displacing the native flora and fauna. In the present global scenario the story of agriculture is a story of struggle because of global warming effects. Weed management has a great role in this system as it causes 11.5 % crop production losses, the amount by which India and Bangladesh could easily be feed up. Thus, to obtain a sustainable production weeds should be managed – this is a herculean task. But human played trump card-developed several methods through pre (weed prevention) and post infested (weed control like physical consists of manual and mechanical, ecological including cultural, biological and chemical besides the weed eradication). The integrated approach is obviously the better one where weed utilization is one of the best technologies to manage the weeds. This could supply us more quality produces, enrich our soil health, proper use of the biodiversity and safe environment. By proper managing the weeds through the weed utilization more and more employment generation are possible as well as the national drainage of huge money against nutrients and pesticides could be saved. In the world, several research findings have shown the advantages of proper utilization of weeds as food, fodder, organic manure, biopesticides, biofuel, biodiesel, biogas, developing medicines commercially by many pharma companies. In West Bengal, many farmers are utilizing the weeds for the above mentioned purposes and some research works were carried out at BCKV with help of local NGOs to improve the technology. Some of the examples are use of *Cyperus rotunds* nut oil in



incense (Agarbati) sticks; *Eclipta* oil as hair dye; *Cassia fistula* as ornaments; *Calotropis gigantea* as herbal medicine, biopesticides and in garland making; *Typha latifolia* in making thatching, Chatai *etc*.; *Cyperus pilosus*, *Cyperus papyrus* and *Clinogyne dichotoma* in making mats; *Amaranthus viridis*, *Alternanthera philoxeroides*, *Oxalis corniculata*, *Marsilea quardifolia*, *Chenopodium album*, *Melilotus alba / indica* , *Ipomoea reptans*, *Portuleca oleracea*, *Centella asiatica*, *Bacopa monnieria*, *Andrographis paniculata*, *Trapa bispinosa*, *Corms* of *Sagittaria sagittifolia*, *Eleocharis dulcis*, *Colocasia esculenta*, *Amorpholus campanulatus*, *Alocasia indica*, *Ipomoea batatas etc*. as food and vegetables; *Nelumbo nucifera*, *Nymphaea odorata*, *Calotropis gigantea*, *Heliotropium indicum*, *Croton sparsiflorus*, *Leucas aspera*, *Cynodon dactylon*, *Tridax procumbans*, *Allium vineale*, *Gynandropsis pentaphylla etc*. along with newly evolved DETTOL and TOK BHINDI plants as herbal medicine; Parthenium *hysterophorus*, *Eicchornia crassipes*, *Pistia stratiotes*, *Polygonum glabrum etc*. along with many other green weed plants as compost making; Azolla pinnata, Anabena circinalis & Lemna minor as biofertilizer; Echinochloa colona, Cyperus difformis, Eclipta alba, Parthenium and Calotropis in biopesticides; Jatropha curcas/sinensis/gossypifolia as biodiesel and Parthenium and Eicchornia crassipes in biogas; Aeschynomene aspera and Jussiaea repens in shola and garland preparation. More survey and surveillance in weed utilization could be effective to find the ITKs and also the biodiversity uses in modern agriculture.

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# Nutrient enrichment of Parthenium through vermicomposting

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Parthenium (Parthenium *hysterophorus*) popularly known as congress grass or carrot grass has taken the most dreaded position among the various weeds of the world. It is considered as an exotic poisonous, allergic and aggressive weed creating threat to environment and biodiversity. Parthenium as a weed has tremendous potential for biomass production both under crop fallow and non-cropped situations. The residues of weed biomass into value added compost may have the potential to improve soil fertility and crop productivity. Accordingly, an field experiment was conducted at Coimbatore during *kharif* and *rabi* seasons of 2005–'06 to evaluate the nutrient addition due to composting of Parthenium. The composting methods for the Parthenium materials with semi solid cow dung and duration of decomposition to make good quality compost for use as nutrients. Different composting methods like, pit aerobic, pit anaerobic, heap anaerobic and vermicompost methods were tried for composting in Parthenium. Nutrient supply potenetial of these compost were compared with farmyard manure (FYM). Among the organic manures, Parthenium vermicompost at 5t/ha found most favourable and followed by pit anaerobic Parthenium compost at 5t/ha. The nutrient content like nitrogen, phosphorus and potassium were higher in composted Parthenium produced by different methods when compared to FYM. Enrichment in soil available N, P and K at the end each crops were observed with combined use of organics and inorganic N. The conjoint use of organics particularly with Parthenium vermicompost and pit anaerobic Parthenium compost and 100 per cent of the recommended NPK supplied for individual crops in the cropping system will improve the growth, yield attributes and yield.

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# Prospects of utilization of lantana residue for wheat (var. WH 147) production

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Lantana (*Lantana camara* L.) is an obnoxious weed of world wide occurrence. The weed infests diverse niches including agricultural-, pastoral, wasteland- and forest-ecosystems. Among various strategies envisaged and explored for the management of the weed, self perpetuating ecofriendly approaches or the ones involving utilization especially for crop production or rewarding in one way or the other, have promising prospects. The present investigation was undertaken for exploring utilization of the weed leaf residue for wheat (var. WH 147) production.

The Lantana leaves were collected from the stands of the weed around the Directorate of Weed Science Research, dried in the shade for a week and ground to fine powder (about 80 mesh). The Lantana leaf residue (LR) was stored in polythene bags (500 gauges) until used. The LR was applied at nil with or without recommended dose of fertilizers (RFD) (N, P, K; 120, 60, 60 kg/ha, respectively), 3.3, 6.6, 9.9 and 13.3 tan/ha (dry) as a top dressing before crop sowing in plots (3x4 m) each in triplicate in randomized block design for two successive years in the *Rabi* seasons of 2002-3 and 2003-4. The seed rate was 100 kg/ha, and plant to plant and row to row distances were 5 and 20 cm, respectively. The crop was irrigated through sprinkler immediately after sowing, and flood irrigated 15, 30 and 45 days after sowing and then at grain filling stage. Weed incidence (number and biomass) was monitored 30 days after sowing. Soil pH, EC, bioassay of soil solution for inhibitory activity using lemna (*Lemna pausicostata* Hegelm.), organic carbon, total and available N, P, K, water and methanol soluble total phenolics, microbial enumeration (colony forming units of fungi, bacteria and

*Azotobacter*), respiration, and dehydrogenase, urease, acid and alkaline-phosphatases were monitored 30, 60 and 90 days after sowing.

The results revealed that higher levels of the LR reduced the weed incidence. Both the number and biomass of the weeds declined. Distribution of weed species across the treatments was unaffected. The weed incidence was reduced to about one third the control value at the highest levels of the LR (13.3 tan/ha). At this level of the LR, the yield of wheat was reduced to a level below the control and much below the values obtained with the RFD. Soil pH was unchanged and EC, organic carbon, total and available N, P and K, total phenolics (both water and methanol soluble), microbial population (colony forming units of fungi, bacteria and *Azotobacter*), respiration, and dehydrogenase-, urease-, acid- and alkaline-phosphatases increased with the LR. However, there was no obvious increase in crop (grain, straw or biological) yield due to the LR application. Thus, though the LR supplemented the soil with nutrients and appeared to improve soil health parameters yet there was no improvement in the crop yield. The LR had inhibited the crop production and thus, possibility of utilization of the weed for the production of wheat is ruled out.

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# Biomass production and nutrient composition of major weeds under different crops

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Field experiment conducted to assess the weed biomass and nutrient composition of major weeds under different crops. In maize field *Trianthema portulacastrum* recorded 58% of total biomass and removed highest NPK of 31, 2.6 and 25 kg/ha. However, highest density was observed for *Dactyloctenium aegyptium* that removed 4.5, 0.4 and 3.2 NPK kg/ha. *Trianthema portulacastrum* only weed species was found in sugarcane field. Its density and biomass were 86 and 1535 kg/ha respectively with NPK removal of 55, 5 and 44 kg/ha respectively. Among the weed species observed in groundnut, *Trianthema portulacastrum* recorded higher density with 56% of total biomass. It removed highest NPK of 31.4, 2.03 and 19.6 kg/ha as compared to *Dactyloctenium aegyptium* and *Cyperus rotundus* which recorded 43% and less than 1% of total weed biomass respectively. Total number of weed species found in sunflower field was four and 80 % of weed biomass and highest density was recorded by *Dactyloctenium aegyptium*. Total removal of NPK put together was 40 kg/ha, which was higher than that of other species found in the sunflower field. In soybean, *Trianthema portulacastrum* registering highest density (114), and dry matter content (24 kg/ha). Since the weeds observed were les than 21 days old, their biomass and total nutrient removal were less. Total numbers of six weed species were found in cowpea field. Nearly, 48 kg/ha of NPK put together were removed by *Trianthema portulacastrum* with density of 30/sq.mt. All other weed species recorded less than one-kilogram of Nor P or K /ha. Dry mater content of weeds ranging from 33 to 1553 kg/ha was recorded in various cropped field. Maximum nutrient removal of 55.2, 4.60 and 44.5 NPK kg/ha by *Trianthema portulacastrum* was observed in sugarcane field.

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# Nutrient supply potential enhancement of water hyacinth by composting techniques

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Even though weeds are undesirable in respect of its competition with crops for energy, nutrients, space, *etc*., they could be utilized for various purposes. In this regard, weeds could be used as manure by converting them to compost with bio-inoculants and other ingredients that act as decomposer. Weed biomass at their tender age may serve as a substrate for preparation of vermicompost which, in turn, will also encourage in indirect management of weeds. Hence, an experiment has been carried out to study the biomass production and nutrient supply potentials of composted water hyacinth during 2006-07 at the Department of Agronomy, TNAU, Coimbatore.

Biological characters of water hyacinth indicated that the mother plants grow very fast from one week after inoculation up to six weeks after that the growth rate decreased and it involved in seed maturation, senescence and ramet production. But the ramets emerged from third week onwards and they involve in fast growth up to six weeks because of this continuous growth process the multiplication of water hyacinth resulted in very high rate of biomass production. Composting of water hyacinth biomass had resulted in concentrated manure with narrow C: N ratio as well as higher nutrient contents as compared to fresh water hyacinth. Increase in nitrogen content from 1.21 to 2.39% with reduced C: N ratio of 17.1 was recorded in vermicompost prepared with water hyacinth. P and K contents of composted water hyacinth were 40 to 50 % more than in raw material. Desirable reduction in the C: N ratio was observed in the enriched compost manure. Results showed the potentiality of utilizing weed biomass for the production of quality vermicompost within relatively short period of time in comparison to conventional composting method.

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# Utilization of Parthenium and water hyacinth as a bio-nutrient source in rice crop

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A field experiment was carried out at Rajendra Agricultural University, Pusa, Samastipur, Bihar during *kharif* seasons from 2004 to 2006 to assess the weed utility as a bio-nutrient source in rice cultivation. The results revealed that among organic sources, the use of *water hyacinth* (2.5t/ha) + FYM (5t/ha) recorded the maximum growth, yield attributes and grain and straw yields of rice which was closely followed by *water hyacinth* (2.5t/ha) + vermicompost (1t/ha), Parthenium (2.5t/ha)+Vermicompost (1t/ha), Parthenium (2.5t/ha) + FYM (5t/ha) and *water hyacinth* (2.5t/ha) + Poultry manure (1t/ha). The maximum net return (Rs.11148/ha) and benefit : cost ratio (1.61:1) were also recorded by *water hyacinth* (2.5t/ha) + FYM (5t/ha). The highest available N (185.67 kg ha), available P (26.38 kg ha) and exchangeable K (525.6 kg ha) were recorded by *Eichhornia* (2.5 t/ha) + FYM (5t/ha). *Water hyacinth* or Parthenium either alone or in combination with other organic sources had a better utility as a bio-nutrient source. Among the inorganic levels, application of 100%, RDF produced significantly higher grain and straw yields as compared to other nutrient levels. Application of 100 percent recommended dose of NPK recorded significantly higher net return (Rs. 10974/ha) over 50 percent RDF which was closely followed by 75 percent RDF. 100 percent NPK application had significant and beneficial effect on rice grain yield and improved the soil NPK status. The interaction effects between organic sources and inorganic levels were found to be non-significant.

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# Utilization of Parthenium for sessile joyweed preparation of vermi compost

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Parthenium *hysterophorus* commonly known as gajarghas, congress grass, fever few, white cap, white top, *etc*. It has achieve the status of "Worst Weed" in Maharashtra as it not only affects crop production but also poses serious health risk. Efforts are being made to manage the weed by a number of methods such as mechanical, legal and biological *etc*. But so far no single method has been provide satisfactory, as each method has inbuilt limitations such as highest cost,*etc*. These consideration demands to develop the utilization of parthenium.

Weed biomass is one of the potential sources of organic matter and nutrients if properly utilized. In recent times, increased emphasis has been put globally for integrated use of biofertilizers and organic manures.

An experiment was conducted during 2007-08 at DWSR centre, M.A.U.Parbhani for development of biocomposites from invasive weeds such as Parthenium *hysterophorus* and *Alternenthera sessilis*. The cement concrete tank of 40 kg capacity were used for preparing vermi-compost. The weed biomass were collected and kept under sunlight for 15 days and were chopped into small pieces. The cement tanks up to 2 cm were filled with surface soil. The chopped biomass of weeds and partially decomposed cow dung in the ratio of 6:4 and 1 kg earthworm were added layer wise and cover with gunny cloth. Watering was done regularly for keeping the tank in moist condition. Mixing was done weekly for aeration. After formation of granular structure of the material, the samples were taken out for NPK analysis. The N content in the vermicompost produced from Parthenium *hysterophorus* and *Alternenthera sessilis* weed biomass is 1.40 and 1.30; P content ranged from 0.25 and 0.30 and K content is 0.90 and 0.70 which is higher than fresh biomass as well as cow dung.

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# Weed utilization of *kharif* weeds in Bhopal and Hoshangabad districts of Madhya Pradesh

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Weeds are the constraints in successful crop production. They compete with crop plants for nutrients, water and space and ultimately reduce crop productivity. Hence management of weed is essential. Despite this some weeds are also beneficial. Keeping this in view a weed survey was conducted to know the weed flora and their utilization in Bhopal and Hoshangabad districts of Madhya Pradesh from $5^{th}$-$12^{th}$ of October, 2009 in the major *kharif* crops under the net work programme of DWSR, Jabalpur by the Gwalior centre. For knowing local names and the uses of weeds in the study area farmers were interviewed and related information obtained was compiled and presented in the text. It was concluded that most of the monocot weeds (grasses) are used as green fodder/hay and for making sheds. Similarly most of the dicot weeds are also used as medicines, vegetables, feed, fuel and compost making. Further it is suggested that if the said weeds are removed from the cropped area timely for their local uses resulting in reducing weed intensity and productivity/ profit of the farmer's field will enhance.

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# Ragweed Parthenium residue to facilitate wheat (var. WH 147) production

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Ragweed parthenium (Parthenium *hysterophorus* L.) is one of the noxious and toxic weeds of world wide occurrence. The weed which continues to spread throughout the length and width of the country has assumed the status of the national problem weed in India. The weed has become an inherent component of the ecosystems and has also become a natural recourse. Exploring ecofriendly utilization the weed in crop production would be an attractive possibility for its management by using it as a natural resource. The present investigation was planned to investigate possible utilization of the weed residue for production of wheat (var. WH 147).

The ragweed Parthenium plants at preflowering stage were uprooted, washed off soil from roots briskly, chopped to small pieces, dried in the shade for a week and ground to about 80-mesh. The ragweed parthenium residue (PR) was stored in 500 gauge polythene bags at ambient temperature until used. The PR was applied at nil with or without recommended dose of fertilizers (RFD) (N, P, K; 120, 60, 60 kg ha, respectively), 3.3, 6.6, 9.9 and 13.3 tan/ha (dry) as a top dressing before crop sowing in plots (3x4 m) each in triplicate in randomized block design for two successive years in the *Rabi* seasons of 2002-3 and 2003-4. The seed rate was 100 kg/ha, and plant to plant and row to row distances were 5 and 20 cm, respectively. The crop was irrigated through sprinkler immediately after sowing, and flood irrigated 15, 30 and 45 days after sowing and then at grain filling stage. Observations were recorded on species wise weed incidence (number and biomass) 30 days after sowing. Soil pH, EC, bioassay of soil solution for inhibitory activity using lemna (*Lemna pausicostata* Hegelm.), organic carbon, total and available N, P, K, water and methanol soluble total phenolics, microbial enumeration (colony forming units of fungi, bacteria and *Azotobacter*), respiration, and dehydrogenase-, urease-, acid- and alkaline-phosphatases were monitored 30, 60 and 90 days after sowing.



The results revealed that higher levels of the PR reduced the weed incidence (biomass). Distribution of weed species was unaffected by the PR. The weed incidence was reduced at the highest level of the PR (13.3 tan/ha) to about less than half the level in the control or the RFD. The grain, straw and biological yields of wheat at and above 6.6 tan/ha were above control and comparable to the RFD. Soil pH was unchanged and EC, organic carbon, total and available N, P and K, total phenolics (both water and methanol soluble), microbial population (colony forming units of fungi, bacteria and *Azotobacter*), respiration, and dehydrogenase-, urease-, acid- and alkaline-phosphatases increased with the PR. The values of these in the RFD were comparable to the PR at and above 6.6 quintal/ha. Thus, at and above 6.6 tan/ha the PR enhanced the wheat production over control to as much as in the RFD. Therefore the PR application at this level could substitute the RFD and the potential of utilization of the PR in wheat production is evident.

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# Role of weeds/vegetative cover for soil and water conservation in degraded lands of forests

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Degraded lands are not able to produce the required bio-mass on their top cover and soil erosion takes place. Total geographical area of the country is about 329 m. ha and out of which 107 m. ha constitute degraded land. These lands located in uplands are usually responsible for floods and high sediments load in downstream reaches which have the most productive and fertile agricultural lands. For resource conservation and maintaining sustainable productivity in these degraded land, vegetation, weed cover and rehabitilisation of weeds constitute a very important conservation activity for soil and water. The weeds used for their establishment as vegetative cover on hill slopes and degraded site conditions is to enhance productivity of site for producing fodder, fire wood *etc*. and to reduce the erosive action of high intensity storms by providing canopy cover for soil and water conservation, which in turn to reduce the sediment load of surface runoff occurring from these areas. In these areas soil is quite friable and likely to wash away. In order to avoid this, it is essential to establish grasses like *Cenchrus ciliaris, Dicanthium annulatun, Enlaliopsis binata, Chrysopogon fulvus, Lasirus sindicus etc*. This should always be done before onset of mansoons. Improvement of soil moister regimes in degraded land provides ample opportunities for seeds and seedling to establish themselves. Aggressive growth of weeds like *Lantana camera,* Parthenium *hysterophorus*, *Chromoloena odoratam* help in rapid biomass increase, higher organic carbon levels and reduction of soil erosion. Study conducted in OUAT Bhubaneswar during 2002 and 2003 in light textured eroded sloppy land, indicated that use of *vetiver* grass in v-ditches is recommended as the best in-situ moisture conservation measures for rainfed upland farming system in sloppy land of Orissa.

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# Possible utilization of weeds for treating animal ailments

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Weeds have always been treated to have negative connotation in crop production. For generations, the weeds have been utilized for treating both human and animal ailments as well as products made from wild plants play a role in the economies of many rural communities. Proper identification of weedy plants for curing animal diseases and wounds leads to a significant results. There are readily available known weeds such as Parthenium *hysterophorus, Dhatura alba, Cassia fistula, Commelina benghalensis, Phyllanthus niruri, Achyranthus aspera, Lecucus linifolia* which are widely used as indigenous technical knowledge to cure/ treat animal ailments. Traditional knowledge base is being exploited/ utilized by many pharma companies in developing medicines commercially. In some countries, Parthenium is applied externally on skin disorders and a decoction of the plant is often taken internally as a remedy for a wide variety of ailments. The decoction is used as a flea repellent both for dogs and other animals. About 2-3 dhatura leaves with wheat breads are given to cattle twice daily for curing diarrhea, a paste of *Commelina benghalensis* leaves and four powered seeds of *Cassia fistula* is added to filterate of 250 g its bark in water and is given to animals suffering from swollen stomach which recovers completely in 3-4 days. *Phyllanthus niruri* leaves are tied in worm-infected part of the animal body and worm die due to leaf extract of phyllanthus. A paste of 8-10 *Leucus* flowers heals the wounds and immediate recovery was observed. Unwarranted elimination of weeds may pose serious threat to biodiversity. Hence, the preservation and protection of of the traditional knowledge are critical for the future well beings of the community and weeds can be a source of income.

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# Utilization of the pigments available from weeds

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There has been an increasing trend towards replacement of synthetic colorants by natural pigments, because of natural pigments' safety and health benefits, and strong consumer demand for more natural products. For an instance, betacyanins from red beet (*Beta vulgaris*) have been extensively used in the food industry worldwide for many years. Moreover, recent studies have shown that beet betacyanins can be classified as dietary cationized antioxidants. For this advantage the market of natural pigments is increasing day by day and for the sustainable development of the market it is worthwhile to search for and develop new sources of natural colorants. The main resource of the natural colorants is indeed plant kingdom. Being the member of this kingdom the weed flora can also impart a potential role to produce natural pigments.

Among the members of weed flora we usually observe huge variation in external color formation in flowers and foliages. It indicates the presence of a wide range of pigments in weed plants. In general, flower color originates primarily from flavonoids and their colored class compounds, anthocyanins. Anthocyanins provide intense cyanic colors from pink to blue in the floral tissues of flowering plants. Other flavonoids, like flavones are essentially colorless and yet they provide the whiteness of white flowers and also act as co-pigments to the wide spread anthocyanins. Anthocyanins are the glycosides of anthocyanidins. Chemically all anthocyanidins are highly oxidised 2-phenyl benzopyrylium cation. This 2-phenyl benzopyrylium cation is also known as flavylium cation. The fundamental nucleus is benzopyrylium chloride. Till so far 19 anthocyanidins have been isolated, characterized and identified for the characteristic color. And these 19 anthocyanidines are mainly responsible for the production of infinite array of colors combining with sugars and



metals. For an example, the color present in the weed Lantana is due to delphinidin monoglucoside. Other than anthocyanins, carotenoids and some minor biomolecules are also responsible for imparting color in flowers and foliages. These pigments are formed in the weed physiology during evolution process for their own purpose of attracting insects for pollination. But these pigments can also be utilized for our purpose even. By virtue of their intrinsic property, pigments can absorb strongly the ultra violet fraction of sunlight and can serve as sun-screen. So, there is scope to utilize these pigments as photoquenchers in the cosmetics and different formulations of organic molecules, *viz*. pesticides, medicines, *etc*. The fact that the red betalains extracted from beet root and amaranthus are well established antioxidants indicates the availability of antioxitants and other bio-active molecules from minor weeds. Many of the pigments may also serve as antifeedants due to their disagrreable test to insect pests. Thus, pigments of weed species, whether these are anthocyanins or carotenoids or betalains, can be utilized as colorants in food; as antioxidants in nutraceuticals; as as sun-screen in cosmetics and the formulation of pesticides and pharmaceuticals; and as antifeedants in crop protection.

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# Utility of Parthenium for nutrient source for sustainable crop production and soil fertility

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Parthenium *hysterophorus* an annual weed compete the crop plants for nutrients, moisture and sunlight and affect the crop growth and yield adversely. The invasion of the cultivated fields by this weed caused on alarming signals in Maharashtra and also in our country. It belongs to family Asteraceae and a native of west indies, tropical south and north America was first reported in India from Pune and now occurs in almost all states of India. Parthenuium grows every where and now as stated above it is almost associated with every crop. This weed has the fast and laxurient vegetative growth and its plant analysis showed that it contains about 0.34% N, 0.14% P and 0.48 % K. The plant keeps flowering and seeding throughout the year and has been continuously spreading the newer areas. As it is no man's weed occupied almost areas in addition to agriculture as surrounding residences in town and cities posing health hazards *viz*. pollenosis asthma, contact dermatitis and skin irritation. The weed exudates toxic substances which appears to have been allelophathic effects on the other species in the vicinity. If such a noxious weed is allowed to grow unchecked , it is sure to loose no time in posing a serious threat to agriculture and public health.

To utilize this ob-noxious weed with its present nutrient status as a source of organic manure the compost was prepared from it after flowering and it was planned to utilize it in combination with the graded levels of fertilizers to reduce doses of chemical fertilizers on one hand and to improve the soil health on other hand.

With this background a field experiment was conducted to test Parthenium compost as a source of organic manure and to study the effect



of different levels of Parthenium compost and fertilizer levels on growth, seed and oil yield of sunflower in summer season of 1999 at Marathwada Agricultural University, Parbhani. Efforts were made to know the utility of Parthenium as source of nutrients as well as to know the ill effect, if any on growth and yield in photo insensitive, short durated and resource responsive crop like sunflower.

The parthenium compost used as source of organic manure @ 10 t/ha + 75 % of NPK through fertilizers recorded higher yield of summer sunflower. It was also observed that there were no ill effects of Parthenium compost either on crop germination or its growth or seed yield. The cost of using parthenium as organic manure was much lower at Rs. 2500/ha compared to the cost of FYM at Rs. 5200/ha and thus provided a saving of Rs. 3200/ha over traditional use of FYM. Thus the study indicated that management of parthenium through utilization as nutrient source can be achieved apart from sustainability in soil health and crop yields in crop like sunflower.

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# Effect of Parthenium compost and fertilizer levels on growth of summer sunflower

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Parthenium *hysterophorus* as annual herb which belongs to family asteraceae was first reported in India from Pune and now occurs in almost all states of India and it has attained the status of a ob-noxious, problematic weed. It compete the crop plants for nutrients, moisture and sunlight and affect the crop growth and yield adversely. This weed has the fast and laxurient vegetative growth and its plant analysis showed that it contains about 0.34% N, 0.14% P and 0.48 % K. The invasion of the cultivated fields by this weed caused on alarming rates in Maharashtra and also in our country. To utilize this ob-noxious weed with its present nutrient status as a source of organic manure the compost was prepared from it after flowering and it was utilized it in combination with the graded levels of fertilizers to reduce doses of chemical fertilizers on one hand and to improve the soil health on other hand.

The sunflower crop was selected with the consideration of increasing demand for oil seeds in our country and due to photoinsestive nature, most responsive to fertilizers, short duration and less insect and disease attack .

The field experiment was conducted at Marathwada Agricultural University, Parbhani to study the effect of parthenium compost and fertilizer levels on growth on sunflower (*Helianthus annuus L.*) in summer season. The experiment was laid in factorial randomized block design (FRBD) comprising two levels of Parthenium compost *viz.* ($C_1$) 5 t/ha and ($C_2$) 10 t/ ha and five levels of fertilizers *viz.* ($F_0$) 00 kg NPK/ha , ($F_1$) 25 % of RDF, ($F_2$) 50 % of RDF, ($F_3$) 75 % of RDF and ($F_4$) 100 % of RDF, wherein recommended dose of fertilizer nutrients (NPK) for sunflower in this experiment was 60 : 30 : 30 kg NPK/ha. The study revealed that all the



growth parameters *viz.* plant height, number of leaves per plant, leaf area per plant, capitulum diameter and total dry matter were favoured and influenced significantly due to various levels of parthenium compost and fertilizer levels individually . Wherein the highest level of parthenium compost i.e. 10 t/ha recorded highest plant height, max. number of leaves and leaf area, capitulum diameter and total dry matter per plant. The similar trend was observed with 75 % of RDF which was followed by 100% of RDF as regards the level of fertilizer nutrients . The interaction effect was also found significant wherein the combination of highest level of parthenium compost @ 10 t/ha and 75% of RDF recorded highest and favourable values of above growth parameters of sunflower crop in summer season.

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# Utilization of Parthenium as green manure and in compost making

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Parthenium is also known as Carrot grass or Congress grass or Tara grass or Sada tupi *etc*. Earlier, Parthenium need to be found in the non-crop areas but recently, it has infested severely the grazing land as well as crop field. Nowadays, tender Parthenium at juvenile stage can be used as mulch besides being used for preparing green manure, compost and vermicompost (it contains NPK more than FYM). Research results revealed that within 3-4 years Parthenium will cover the roadside adjacent field crop and orchard areas besides the fallow land area which has covered by almost more than 75-80 % and by competing with crop plants this weed will reduce the yield on an average of 30 -50 % in up and medium land situation during *summer* and *kharif* seasons. Therefore there is an urgent need to control weeds immediately. Above all of this the management of Parthenium is better through utilizing this plant as compost making or as green manure. The Parthenium compost and also use of many weeds after weeding in making compost is gradually becoming popular in these regions and continuous efforts are making to spread this technology through group meeting and training cum demonstration since 2008. Parthenium compost can be prepared with a pit of 3 ft depth x 6 ft width x 10 ft length (size can be modified keeping the depth) by covering base surface and side walls of the pit by stone chips or even by Calcium carbonate to make soil surface compact to protect the absorption of compost nutrients. 40 kg soil and 25 kg cow dung should be spread in the base of each layer of the Parthenium (4 layers a pit and each layer may be 9 inch.). Young Parthenium plants @ 50 kg spread on the surface of the pit for each layer. 500 g Urea or 3 kg rock phosphate by using 3-4 lit of water should be sprinkled over this for each layer with *Trichoderma viridi* @ 50 g.



Pit should be covered with the soil, dung and husk making a 1 – 1.5 ft dome shape and kept for 4-5 months to get well-decomposed compost. From the research experiment carried out in Incheck Farm, BCKV, Kalyani, WB during *pre-kharif* 2008-09 it has been found that Parthenium compost has higher nitrogen content (Total N – 1.21 %) over traditional compost (Total N – 0.5 %).

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# Utilization of weed plants for alternative livelihood under coastal Maharashtra (Konkan)

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Productivity of Indian orchards can be increased only when all aspects of sustainable production technology including weed utilization are used. Under the Konkan, the part of coastal Maharashtra, prevails diverse agroclimatic condition which provide great scope for cultivation of various types of fruit trees, bush plants, and numerous weed species. In orchards crops during *Kharif* season, having more vacant interplant area where, more vegetation of grasses *viz., Themeda quadrivolvis, Digitaria sangainalis Chloris barbata, Eleusine indica, Dactyloctenium aegyptium, Heteropogan contortus, Ischaemum rugosum, Oplismenus burnanni etc*. and these grasses were used to the study the productivity on farm trail in the fields of ten farmers of Hodawale Village, Dist. Sindhudurg under institution village linkage programme. The results revealed that, significantly increased monetary returns of dry and green grass at the Rs. 1075/- and Rs. 1420/- ha respectively. While board leaves weeds *viz., Urena lobata, Colocassia antiquorum, Chromolaena odorata, Mimosa pudica, Coastus specious, Cassia tora, sida accuta, Hyptis suuaveolens etc*. having more incidence and it can be utilized for vegetable purpose, fodder and green manuring. The trial was conducted in Sindhudurg district, for utilization of *C. odorata* as green manure, revealed that use of *Chromolaena odorata* as green manure along with recommended dose of fertilizer increased cashewnut yield by 20% as compared to no green manuring. Another trial conducted at Agricultural Research Station, Mulde during 1999-2000 on grazing perennial bushes and *Mimosa pudica* by goats, observed that growth suppression after feeding under fallow land was 15% and coconut garden 8% of *Mimosa pudica*.

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