

Botanical Herbicides: An Approach towards Agricultural Sustainability

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SUMMARY

For global food security, biological management for the improvement of soil & plant health is the underlying concept. The weed pest alone causes 11.5 & 12.5 % production losses in global & national agriculture. Among the various alternatives of traditional hand weeding management practices through physical, ecological, biological in integration with chemical herbicides are gaining ground. Chemical herbicides no doubt have been a boon to farmers, but in the long run continuous inorganic use in agriculture has posed a significant threat to the natural environment. With the rising consciousness of organic food and policy support towards sustainable agriculture, incorporation of more eco-friendly and sustainable weed management practices, among which botanical plant extracts offer a new dimension through the production of an excellent source of biologically active natural products. In India Teak, Akand, Tak Bhindi, Jui phul, Bamboo, Gajar ghash, Jangli Dhan, Ban makao, Cocklebur, etc. extracts are used in paddy, soyabean and many other crops. Plant extracts potentially possess multiple phytotoxic components and hence multiple modes of herbicidal actions, making it more difficult for weeds to develop herbicide resistance and most products show wide windows of crop safety. Hence botanicals can be a new regime to promote sustainability in safe agriculture.

INTRODUCTION

The Plant world comprises a rich storehouse of bio-chemicals that could be tapped as pesticides. The total number may exceed 4 million. Of these, only 10,000 are secondary metabolites. Allelopathy, the term coined by Prof. Hans Molisch, a German Plant Physiologist in 1937, is a new field of science. Plants have acquired a complex eco-physiological strategy that allows them to directly or indirectly modify the growth and development of other plants by releasing chemicals into the environment, this phenomenon is known as allelopathy. Allelochemicals inhibit the growth and development of the plants primarily in two ways- Autotoxy (allelochemicals of the same plant inhibit the growth and development of the seedlings of the same plant e.g., *Parthenium hysterophorus*) and Teletoxy (allelochemicals of some plants inhibit the seedling germination and development of other plants e.g. *Lantana camera*). Plants typically biosynthesize these compounds as secondary metabolites, which, in addition to act as ecological factors that regulate the composition and dynamics of plant communities, can also be used directly to control the growth of weeds or in other words can serve as a source of natural herbicides. Weeds constitute a major obstacle to the productivity of numerous crops. Nowadays with respect to the ill effects of synthetic pesticides to human health & environment, some safer pesticides (blue & green labeled) are available in the market. Natural phytotoxins derived from plants may represent an alternative to the use of synthetic herbicides. These compounds are advantageous because they are biodegradable, have great structural diversity and complexity, demonstrate diversity in their sites of action and are safer for non-target organisms. Furthermore, these phytotoxins have different levels of action, and the combination of different modes and multiple levels of action make these substances effective for the control of weeds.

Natural Products for Weed Management

Today, herbicides account for more than half of the volume of all agricultural pesticides applied in the developed world and the public has expressed concern about the potential health and environmental impact of these compounds. Partly due to this, organic agriculture has received a recent surge in popularity.

Plant bioagents with herbicidal activity

Several plants or their parts are directly used to control many pests particularly weed pests through natural allelochemicals e.g. *Cassia tora /uniflora /occidentalis*; *Amaranthus spinosus*; *Sida spinosa*; *Tephrosia purpurea*; *Croton sparsiflorus*; *Tagetes erecta /patula*; *Kochia scoparia*. *Cymbopogon flexuosus* etc. are used to manage invasive weed *Parthenium hysterophorus*. Similarly, many plants like *Lantana camera*, *Bambusa vulgaris* etc. with their natural allelochemicals inhibit germination and restrict the invasion of many weed pests in surrounding areas without any detrimental effect on the desired cultivated crops.

Probable mechanism of action of botanicals

- **Protein Synthesis / Microtubule assembly inhibitors:** It inhibits the assemblification of microtubules, and polymerization of tubulin (the major protein content) which is very much essential for the formation of the cell wall. As a result arrestation of cell division, formation of polynucleate cells and eventually inhibition of root and plant growth.
- **Fatty acid (Lipid) Biosynthesis:** ACEase (Acetyl Elongase) inhibition (Very long fatty acid chain inhibition). The chemicals inhibit the cell division and elongation in seedling shoots before they emerge above ground.

Plant extracts (raw, aqueous, methanolic etc.)

These are used to control weed pest through allelochemical activities and are normally called as 'Botanicals' e.g. raw extracts of *Parthenium hysterophorus*; aqueous extracts of *Bambusa vulgaris*; methanol extracts of *Tectona grandis* etc. To enhance the bioefficacy, these botanicals can also be used in a mixture e.g. mixture of aqueous extracts of *Bambusa vulgaris* + *Parthenium hysterophorus*.

Procedure of preparation raw extract from the following natural plants

Parthenium hysterophorus (Stem & Leaf), *Calotropis procera/gigantea* (Stem & Leaf), *Ageratum conyzoides/haustonianum* (Stem & Leaf), *Melilotus alba / indica* (Stem & Leaf) *Echinochloa colona* (Stem & Leaf), *Cyperus difformis* (Young plant), *Physalis minima* (Stem & Leaf), *Blumeala cera* (Stem & Leaf) *Tephrosia purpurea* (Leaf), *Jasminum officinale* (Leaf), *Carica papaya* (PapayaLeaf), *Hibiscus sabdariffa* (Leaf), *Ocimum basilicum* (Young twigs), *Tagetes patula*, (Young plant), *Cannabis sativa* (Young plant)

- Collect the green natural plants and from it separate the required specific green part.
- Measured the required part (X kg) and from it take 900 g sample.
- Bruise the sample in "Hamaldista" adding 100 ml fresh water.
- With the help of fine mesh collect the juice or raw extract.
- Keep the actual raw extracts in a safe container

Procedure for Preparation of Aqueous extract from the following natural plants

Parthenium hysterophorus (Whole plant), *Calotropis procera/ gigantea* (Stem & Leaf), *Xanthium strumarium* (Fruit & leaf), *Sorghum halepense* (Stem & Leaf), *Melilotus alba / indica* (Stem & Leaf) *Blumea lacera*, (Stem & Leaf), *Ageratum conyzoides/ haustonianum* (Stem & Leaf), *Echinochloa colona*

(Stem & Leaf), *Physalis minima* (Stem & Leaf), *Tephrosia purpurea* (Leaf), *Cyperus rotundus* (Whole plant), *Cyperus difformis* (Whole plant), *Jasminum officinale* leaf), *Papaya* (Leaf), *Hibiscus subdarifa* (Leaf), *Tectona grandis* (Leaf), *Bambusa vulgaris* (Root & Leaf), *Datura stramonium* (Stem & Leaf)

- Collect the required natural plants and separate the necessitated plant parts
- Dry these plant materials and dried up plant parts grind in grinder machine
- 100 g powder placed into the glass container and adds 900 ml water in the glass container
- Overnight soak this container and then boil this for two hours at 600 C
- After proper boiling, the plant parts are separated by filter paper and keep the aqueous extract in a safe container

Preparation of spray solution and spraying it in suitable field as pre emergence

- Select a fresh field with sufficient moist condition and measure area to be sprayed
- Fixed spraying sites of minimum 100 m² in this field. Then sites are demarcated with pegs
- Identify weed flora of the demarcated area and make a density list of weed flora species wise
- Measure the raw or aqueous extracts for spraying @ 100 ml per lit of water for the area to be sprayed and water must be 1 lit per 20 m²
- Before spraying add 0.25% nonionic surfactant (e.g. Tween- 80, 20, etc.) with the ready spray sample.
- Spray the solution in moist soil as PE (within 1 DAS/DAP/DAT) and Spray at earliest after preparation (within an hour)
- After two weeks take observation about the bioefficacy on weed plants

CONCLUSION

Biological management for the enhancement of soil and plant health is the basic concept for maintaining sustainability in the environment and agriculture. Keeping in view the detrimental effects of chemical herbicides on mankind and the environment, natural phytotoxins derived from plants may represent an alternative to the use of synthetic herbicides. The botanicals are advantageous because they are biodegradable, have great structural diversity and complexity, demonstrate diversity in their sites of action and are safer for non-target organisms. But availability of botanical herbicides at the rural market with proper formulation along with improved thinking through awareness and training programmes of stakeholders and farmers is urgently needed to exploit the potentiality of eco-safe botanical herbicides.

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