# WEED RESEARCH IN INDIA, AND FUTURE THOUGHTS

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## THE DEVELOPMENT OF WEED SCIENCE IN INDIA

Early attempts at chemical weed control in India included the control of water hyacinth by application of steam and formalin (4) and the use of sodium arsenite in 1937 for controlling *Carthamus oxyacantha* in Punjab. In 1952 the Weed Control Section started in the Division of Agronomy at the Indian Agricultural Research Institute, and in the same year the Indian Council of Agricultural Research (ICAR) launched the first Coordinated Weed Control Scheme in eleven states to monitor the weed flora of the country and research the feasibility and effectiveness of 2,4-D, MCPA and MCPB. The overall impact of this scheme on Indian agriculture, however, remained marginal. At that time work was also being carried out by using 2,4-D to control weeds in sugarcane in Maharashtra (2, 3) and in wheat at Agra (7), whilst in Assam research started to control weeds in tea by herbicides.

With the creation of the State Agricultural Universities from the early 1960s weed science research became more general, also occurring at the ICAR Institutes, Agricultural Colleges and Central Universities.

The Indian Society of Weed Science was established in 1968, and the first number of the Indian Journal of Weed Science was published in 1969. The Society now has close links with other international weed science societies.

Real importance was given to weed science research in India from 1978-79 onwards through the USDA-PL-480-ICAR All India Coordinated Research Project. This took place in 22 locations covering all agro-climate regions of the country, in three phases. The first phase started in 1978-79 at six centres in Punjab, Karnataka, West Bengal, Madhya Pradesh, Uttar Pradesh and Himachal Pradesh, and included both fundamental and applied aspects of weed management in different field and plantation crops. The second phase started in 1982-83 when the project was extended to centres in Assam, Gujarat, Faizabad, Bangalore, Jhansi and Tamil Nadu. In the third phase from 1985-86, nine more centres were included in Bihar, Haryana, West Bengal, Uttar Pradesh, Kerala, Orissa, Andhra Pradesh and Meghalaya. After four years of funding from USDA-PL-480-ICAR, the centres are continuing weed science research work directly under the ICAR.

The latest effort to strengthen weed research in India has been the establishment of the National Research Centre for Weed Science (NRCWS) by the ICAR in 1989 at Jabalpur, as a nodal Institute in Weed Science to provide leadership in basic and applied multi-disciplinary research. The Institute is conducting research into weed management in cropping systems, the biology and agro-ecology of weeds, vegetation management in non-crop areas and aquatic environments, residue chemistry and weed physiology, and social science and the transfer of technology.

## RESULTS OF INDIAN WEED SCIENCE RESEARCH

In the beginning, screening and selection of herbicides for particular crops seem to have been the major concern. Substantial work was done to identify weed management practices for wheat, rice, sugarcane, oilseeds, pulses, maize, sorghum, cotton and plantation crops between 1963 and 1978 (Table 1).

Table 1. Herbicides recommended for different Indian crops

| Crops | Herbicides |
|---|---|
| Cereals, Oilseeds, Pulses | |
| Rice | 2,4-D, propanil, butachlor, thiobencarb, oxadiazon, pendimethalin |
| Wheat | 2,4-D, isoproturon, methabenzthiazuron, metoxuron |
| Maize | simazine, atrazine |
| Sorghum | simazine, atrazine |
| Rapeseed and Mustard | fluchloralin, isoproturon, pendimethalin |
| Sesame | alachlor, fluchloralin, pendimethalin, metolachlor |
| Groundnut | fluchloralin, pendimethalin, metolachlor |
| Pulses | fluchloralin, alachlor, pendimethalin |
| Fibre, sugar crops and plantation crops | |
| Cotton | diuron, alachlor |
| Jute | fluchloralin |
| Sugarcane | 2,4-D, atrazine, simazine |
| Tea | glyphosate, paraquat |
| Coffee | paraquat + diuron, 2,2-DPA + 2,4-D |

## CURRENT WEED SCIENCE RESEARCH IN INDIA

Weed survey and weed biology. A weed survey of different regions of the entire country will result in the preparation of weed maps. Studies have started on the biology of problematic weeds of different regions and their control

Integrated weed management in specific crops and cropping systems. The integrated approach of weed management has revealed the scope of using herbicides at reduced rates by combining them with intercultural operations, agronomic manipulation, and with growing inter-crops.

Allelopathy studies. Allelopathy studies have shown the interactions listed in Table 2.

Translocation of herbicides. The translocation pattern of foliar applied radio-labelled 2,4-D is being studied in *Oxalis latifolia, Parthenium hysterophorus* and *Solanum elaeagnifolium.*

Herbicide residue estimation and management. Herbicide residue estimation work is going on at Coimbatore, New Delhi and Kalyani, and herbicide residue management studies have started in several Agricultural Universities.

Table 2. Weeds affecting crops allelopathically in India

| Weeds | Affected plants |
|---|---|
| *Phalaris minor* (dry straw), *Chenopodium album*, *Silene conoides* | Wheat |
| Root extracts of *Trianthema portulacastrum* | Sorghum, finger millet, maize, pearl millet, red gram, sesame and cotton |
| Whole plant extracts of *Portulaca oleracea* | Okra, jowar, cluster bean, green gram and ragi |
| Extracts of *Cassia sericea* | *Parthenium hysterophorus* |

Standardisation of bioassay technique. Solution in soil cultures in laboratory conditions and soil assay in pots in bioassay experiments have been going on with several herbicides, and GR-50 (herbicide concentration to inhibit plant growth by 50%) have been calculated.

Aquatic weed control. Examples of recent successes with the classical approach of biological weed control in India are the use of the weevils *Neochetina bruchi* and *N. eichhorniae* to control water hyacinth, the use of *Cyrtobagous salvinae* to control salvinia, and the use of grass carp (*Ctenopharyngodon idella*) to control submerged aquatic weeds.

Designing and developing weed control tools and implements. At IIT Kharagpur a low cost herbicide applicator with weed attachment (ITTWAM-82) has been developed. The different weed tools that can be attached to this machine include flat blades, flat blades with serrated edges, fine line blades and double blades of improved Aspee make and Philippines design. A power operated aquatic weeder for ponds, canals and larger aquatic bodies has been designed, developed and fabricated for cutting, clearing, and disposing of free floating and submerged aquatic weeds.

## FUTURE THOUGHTS ON WEED RESEARCH IN INDIA

Emerging problems in weed management. The repeated use of some herbicides year after year in the same area leads to a shift in weed flora and the appearance of resistant weeds which were hitherto of relatively minor importance (Table 3).

New weed species have come up in different parts of India, and are posing great problems (Table 4).

Herbicides which persist much longer than the desired periods pose several potential environmental problems. Agriculturally they may cause injury to succeeding crop production (particularly in multiple cropping systems), and possibly cause adverse effects on soil microflora and fauna. Residue problems are not only agricultural in scope. Within the last decade the public has become increasingly aware of the potential danger from pesticide residues in the environment. The accumulation of residues in grain, vegetables, fruits and other plant parts, soil and water sources present potential health problems.

Table 3. Shifts in weed flora in India

| Crop | Original weed flora | New weed flora |
|---|---|---|
| Wheat (first phase) | *Chenopodium* spp., *Spergula arvensis*, *Anagallis arvensis* | *Phalaris minor*, *Avena fatua*, *Lolium temulentum* |
| Wheat (second phase) | *Phalaris minor*, *Avena fatua* | *Lathyrus aphaca*, *Convolvulus arvensis*, *Medicago* sp., *Cirsium arvense* |
| Rice (transplanted) | *Echinochloa* sp. | *Cyperus iria*, *Fimbistylis miliacea*, *Sphenoclea zeylanica* |
| Sugarcane | Broadleaved weeds | Grassy weeds |

Table 4. New weed species becoming apparent in India

| Region/Crop | New weeds |
|---|---|
| Waste lands all over India | *Parthenium hysterophorus* |
| Up hills and N.E. hills region | *Oxalis corniculata* |
| Rabi crop fields of North Bengal | *Polygonum* spp. |
| Tamil Nadu (Periyar and Coimbatore district) | *Solanum elaeagnifolium* |
| Roadsides, waste land, terai hills | *Lantana camara*<br>*Ageratum conyzoides*<br>*Eupatorium* sp.<br>*Parthenium hysterophorus* |
| Tea gardens | *Imperata* sp.<br>*Mikania* sp. |
| Tobacco, brinjal | *Orobanche* sp. |
| Sugarcane | *Striga* sp. |
| Fencing shrubs, roadside trees, niger crops in Orissa | *Cuscuta* sp. |
| Water bodies | *Eichhornia crassipes* |

Approaches to integrated weed management with stress on non-chemical methods of weed control. Investigations carried out in India over the last two decades have helped identify herbicides for a wide range of crops under different agro-ecosystems to supplement traditional practices of hand weeding and economise on production costs. Considering the diversity of weed problems, no single method of control can reach the desired level of efficiency under all situations, though the effectiveness of herbicides is more pronounced under assured irrigation. This calls for a holistic approach to produce Integrated Weed Management (IWM) packages for cropping systems as a whole. Major components of IWM systems have been identified as non-chemical methods with low cost input, including stale seed beds, minimal cultivation, nitrogen

management, higher crop stand by slightly increasing seed rate and close spacing, intercropping, use of competitive crop cultivars, and supplemental use of herbicides at as low rates as possible (5).

To avoid the possible hazards of chemical weed control, emphasis is being given to biological methods to combat weed problems.

Basic research. Basic research on weed biology and microbiology and the selectivity, absorption, translocation and degradation of herbicides have been going on in one or two centres. These studies need to be intensified.

Utilisation of weeds for useful purposes. Large scale programs for the utilisation of water hyacinth for compost, animal feed, production of paper, hormone and leaf protein, fish food, biogas and water pollution control should be initiated. Many common weeds are used for vegetables and medicinal purposes, whilst other uses of certain weeds include animal fodder, fibres, oil, dyes and tannins.

Problem weeds and their control. Knowledge of problematic and perennial weeds including *Lantana camara, Eupatorium* sp., *Imperata cylindrica, Cyperus rotundus, Saccharum spontaneum, Ischaemum pilosum, Striga* sp. and *Parthenium hysterophorus* which cause serious damage to crops and farm lands is not sufficient to enable the development of adequate control methods, and the biology and ecology of these weeds should be studied in greater detail. Research should be further concentrated on the control of these weeds.

Development and application of biotechnology in weed management. Four areas within the field of integrated weed management offer attractive opportunities for the application of biotechnology. These are the development and use of bioherbicides, the discovery and use of naturally occurring herbicides, genetic manipulation of crop tolerance to herbicides, and use of genetically engineered micro-organisms for the biodegradation of herbicides in soil and water and as herbicide safeners for increasing the selectivity of herbicides. Research in these fields should be initiated (6).

Weed science education. Weed science is currently a component of agronomy in many universities, but the education program is quite weak. The number of students specialising in weed management at post graduate level is very limited. Similarly the number of full time scientists in weed science research is extremely limited.

At present a core course on weed control of 2-3 credits is offered out of 20-25 credits allocated to agronomy at undergraduate classes in some universities. At postgraduate level the situation is slightly better, as one or two separate courses with 3-5 credits are offered. Looking into the importance of weed science and its relevance to crop production it is necessary that students should specialise in weed science as a distinct sub-discipline of agronomy, as is done with crop husbandry and soil and water management (8). Modern weed science is a multi-disciplinary subject encompassing agronomy, botany, soil science, plant physiology, biochemistry, organic chemistry, residue chemistry, toxicology and ecology, and needs to be developed into a separate discipline.

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