annual report

भाकृअनुप
ICAR

वार्षिक प्रतिवेदन
1996-97

NRCWS

NATIONAL RESEARCH CENTRE FOR WEED SCIENCE
ADHARTAL, JABALPUR - 482 004. (M.P.) INDIA.

ANNUAL REPORT

1996-97

National Research Centre for Weed Science
(Indian Council of Agricultural Research)
Maharajpur, Adhartal, Jabalpur (MP) - 4

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FROM DIRECTOR'S DESK

The strategy for developing the Weed Science Research Programme in India got a push when All India Coordinated Programme on Weed Control was initiated in 1997-98 with 5 Centres. The Centres went on increasing because of the tremendous impact felt of the presence of weeds in crop fields and even in non-cropped situations. Today, we have 24 Centres which include 2 voluntary Centres spread in different Agro-Ecological Regions of the Country. These Centres provided guidance to the farmers by developing technologies for Weed Management and proved to be of big help in reducing the weed menace in crop fields. Later, it was felt that some of the problems which are of basic and of long term nature need to be probed for giving a sound base not only to the applied research programme but also to meet the long term needs in the Weed Science Research which is a multi-disciplinary programme. Considering this a need was felt to develop a National Research Centre for Weed Science which was started in 1989 and is engaged in research and development of technology for Weed Management. The work is also on the basic approaches for developing the technologies for Weed Management. The major programmes are based on Weed Management in field crops, Biological Weed Management Systems, Weed Physiology and Mechanical Methods of managing with the weeds. Rice, Wheat, Pulses and Oilseed form the major crop core of the crops in which the work is being done. Biological Control of weeds using pathogens and insects has been in progress and is further strengthen by the research projects from the International Institute of Biological Control, UK and also from the Department of Biotechnology and ICAR. During the year, the Centre has published 10 research papers and 7 papers were read in the Conferences at National and International level. Almost, all the Scientists of the Centre attended the various Symposiums, Seminars and the Workshops.

The infrastructural facilities are being provided in the form of research equipments, field implements and computers. A need base Library to strengthen the research programmes as well as well developed field experiment station has been established at the NRCWS. The main building of the Centre is under construction and is expected to be completed in the next year.

A training programme on Weed Management was conducted for Subject Matter Specialists and Officers of the different State Departments of Agriculture. The Centre had regular meetings of the Centre's Management Committee and Research Advisory Committee and their recommendations were implemented to improve the working of the Centre.

I take this opportunity to thank Dr R.S. Paroda, Director General; Dr G.B. Singh, Deputy Director General (SA&AF) and Dr P.C. Bhatia, Asstt.Director General (Agro), ICAR for their constant help in the working of this Centre. Scientists and other staff members of the NRCWS deserves appreciation in developing, executing and reporting of various researches done at this Centre which is still in the developing stage.

Our grateful thanks to the Secretary, DBT for financing the research project on Biological Weed Control using pathogens and also to the DG, ICAR for giving a project on Pest Potential of mexican beetle for biocontrol of parthenium plants.

Director

CONTENTS

List of Acronyms

ai	-	active ingradient
AM	-	Anti Meridian
CI	-	Cropping intensity
CD	-	Critical Difference
DAS	-	Days after sowing
DAT	-	Days after transplanting
FYM	-	Farm yard manure
LR	-	Leaf residue
NS	-	Non- Significant
OBLW	-	Other broad leaved weeds
PM	-	Post Meridian
PPI	-	Pre Plant Incorporation
PE	-	Pre Emergence
PO	-	Post Emergence
S	-	Significant
W/V	-	Weight per volume

EXECUTIVE SUMMARY

The National Research Centre for Weed Science is a centre under the Administrative control of Indian Council of Agricultural Research (ICAR). All the states of the country are served through 24 centres inclusive of two voluntary centres of AICRP-Weed Control with their headquarters at NRC-WS, Jabalpur.

The centre was set up in the year 1989 with the mandate of undertaking basic and applied research for developing strategies for efficient weed management in different agroecological zones, providing leadership role and coordinate the network research with SAUs for generating location specific technologies for weed management in different crops, cropping and farming systems, acting as a repository of information in weed science, acting as a centre for training in research methodologies in the area of weed science and management, collaborating with national and international agencies in achieving the above objectives and providing consultancy.

LOCATION AND WEATHER

The centre is located between 22.49^0 & 24.8^0 North Latitude, 78.21^0 & 80.58^0 East Longitude and at an Altitude of 411.78 metres above the Mean Sea Level. Jabalpur comes under the rice-wheat crop zone of the state. The average annual rainfall of this region is 1253.4 mm. The post rainy season (mid October through January), also known as the post-monsoon or *rabi* is dry and cool with short days. The hot dry summer season starts from February and lasts until rains begin again in June.

The soils of the centre are dark grayish brown with moderately alkaline AC horizon.

WEED MANAGEMENT

Weed Flora

Major Weed flora of the research farm were *Echinochloa colonum, Commelina communis, C. benghalensis, Brachiaria* sp, *Cyperus iria, Physalis minima, Euphorbia geniculata , Legacia molis* and *Alternanthera* sp during *kharif* season. While during *rabi* season, *Chenopodium* sp. , *Cichorium intybus, Medicago denticulata, Vicia sativa, Trifolium flagiferum* and *Phalaris minor* were the dominant weeds.

Cropping System

In soybean-wheat cropping system, presence of weeds caused 23 per cent reduction in grain yield of soybean and 28 per cent in wheat. Application of pendimethalin 1.25 kg/ha (PE) in soybean and isoproturon 1.0 kg/ha (PO) in wheat significantly reduced the weed population and its dry matter, and increased the grain yield of soybean and wheat by 8.18 and 18.62 per cent, respectively.

In maize-pea cropping system, application of atrazine 1.0 kg/ha in maize and pendimethalin 1.25 kg/ha in pea caused significant reduction in the weed population and its dry matter production and increased the yield by 19.13 and 15.57 per cent of maize and pea, respectively

In soybean based cropping intensity, application of pendimethalin 1.25 kg/ha PE in soybean and isoproturon 1.0 kg PO in wheat and mustard reduced the weed density and dry matter and increased the grain yield of crops.

The lowest weed population and weed dry matter were recorded with rice-wheat (200% CI) during *Kharif*. However, during winter season, it was noted with fallow-wheat (100% CI). The significantly highest grain yield was recorded with 100% cropping intensity. The application of butachlor 1.5 kg/ha PE in rice and isoproturon 1.0 kg PO in wheat and mustard reduced the weed population and weed dry matter and increased the grain yield by 18.18 and 36.80 per cent during *kharif* and *rabi* season, respectively.

A field experiment on integrated use of farm yard manure (FYM) and parthenium as green manure (GM) with and without fertilizer N in rice-wheat system was carried out in collaboration with IISS, Bhopal. The grain yield of rice increased significantly and successively with the increasing rates of fertilizer N upto 180. The per cent increase in grain over control was nearly 38, 115 and 144 per cent on application 45, 90 and 180 kg N ha^{-1}, respectively. Incorporation of manure (FYM and GM) with increasing rate also increased the grain yield of rice significantly and successively. There was significant increase in grain yield of wheat with increasing rates of fertiliser N from 45 to 90 and 180 kg/ha over control. The per cent increase in grain yield was 77, 136 and 165 per cent, respectively.

Soybean

Weeds caused 57 per cent reduction in grain yield of soybean. The application of Lactofen 0.2 kg/ha alone reduced the weed population and dry matter significantly over the sethoxydim 0.5 kg/ha. Among the herbicidal combinations, significantly the lowest weed population and its dry matter were recorded with lactofen 0.1 kg/ha combined with fluazifop-p- butyl and sethoxydim each at 0.25 kg/ha.

In an another experiment, the significantly lowest weed population and its dry matter production were recorded under fluazifop-p-butyl 0.25 kg/ha fb. one hand weeding at 25 days after spraying. Among the herbicidal combinations, significantly the lowest weed population and its dry matter and highest grain yield were recorded with fluazifop butyl (0.5 kg/ha) + sethoxydim (0.25 kg/ha).

From different trials, conducted to find out the suitable herbicides, chlorimuron @ 1.2 g/ha; metolachlor @ 1.0 kg/ha and MON 8435 at all the rates were found effective for controlling weeds.

Stale seed bed technique was quite effective in reducing the weed biomass to the greater extent and obtained higher grain yield followed by conventional tillage. Among the weed control method, fluchloralin @ 1 kg/ha , alachlor @ 2 kg/ha as PE (either to be applied as liquid or granules) proved effective for lesser number of weed count and dry weight. On the other hand , trifluralin @ 1.5 kg/ha resulted in the highest grain yield of soybean.

Direct seeded rice

In rice, anilofos applied @ 0.4 kg/ha coupled with one hand weeding at 30 DAS resulted in significant reduction of weed population. The highest grain yield was registered with the application of anilofos coupled with one hand weeding. The application of fenoxaprop 28 days after sowing was found to decrease the weed population and dry matter significantly and increase the grain yield of direct seeded rice

Wheat

- The weed intensity and weed dry weight were the lowest with metsulfuron 4 g/ha in combination with 2,4-D 500 g/ha.

The application of sulfosulfuron @ 25 g/ha at 1-3 leaf stage (25 DAS) ; fenoxaprop @ 90 g/ha ; metribuzin @ 300 g/ha and tralkoxydim at 30-35 DAS were found to decrease the weed population & dry matter of *Phalaris minor* significantly and increased grain yield.

The population of *P. minor* was effectively controlled at higher rate of clodinofop @ 50 + isoproturon @ 250 g/ha and the grain yield of wheat was the highest under the combination of cladinofop @ 50 g + isoproturon @ 750 g/ha.

In conservation tillage system, glyphosate application in zero tillage plot was effective for controlling weeds as compared to unweeded.

WEED PHYSIOLOGY

Herbicide protectant treated potato crop was not adversely affected by the 2,4-D application.

The experiment was conducted to assess the allelopathic potential of the extracts of *S.indicus* in different organic solvents on maize. It was observed that water extract was highly toxic followed by chloroform and 80% ethanol. Boiled water extract was less toxic. The chlorophyll content (mg/g fresh leaf) were 2.53; 3.23; 4.99; 2.57; 6.61; 7.05; 6.35 and 6.25 respectively with water; 80% ethanol, ether, chloroform; Hogland's solution; acetone; dichloroethane and boiled water. It was observed that allelopathic factor in *S.indicus* may be a volatile substance since there were contrasting results with boiled and cold water extracts.

The effect of *E. colonum* biomass both fresh and decomposed were studied on rice (*Oryza sativa*, Vr. Kranti) 1996 in plastic buckets. It was noted that the decomposed weed residues was extremely toxic to rice which completely suppressed tillering and fertile grain formation even in the case where N-fertiliser was used. In the case of fresh residue, the toxic effect was also severe which drastically reduced the growth and yield of rice. The fresh residue when combined with N-fertilizer however the effect on growth and yield was at par with control.

Glutamate dehydrogenase and glutamate synthetase enzymes played an important role in detoxifying 2,4-D in resistant *P. minima*. The sensitive tomato plants had but little activities of these enzymes which might not yield sufficient glutamic acid to form conjugates with 2,4-D to reduce its toxicity to a non toxic level.

BIOLOGICAL WEED MANAGEMENT SYSTEM

Survey was conducted during the period under report, for collecting the infested plant parts of important weeds with which plant pathogens were associated with *Parthenium hysterophorus*, *Cyperus rotundus*, *P minor*.

From infected samples of *Parthenium hysterophorus* fungi *Fusarium pallidoroseum, Colletotrichum gloeosporioides, Alternaria alternata, Sclerotium rolfsii* and *Sclerotinia sclerotiorum* were isolated. *Alternaria alternata* was found attacking the leaves, branches and flowers of *P. hysterophorus*. In *Cyperus rotundus*, *Fusarium* sp. and rust *Puccinia canaliculata* were found associated.

Application of Fungal suspension of *Sclerotium rolfsii, Trichoderma viride both* at 0-30 DAS and *S. sclerotiorum* from 0-15 DAS reduced plant height, number of branches/plant and number of flowers/plant of parthenium.

Experiment on effect of marigold on germinating parthenium revealed that profuse growth of marigold suppressed the growth and further development of parthenium at all the tested ratios.

Trichoderma viride treated wheat seeds could reduce seed germination of *P. minor* and also reduced root/shoot length by 22 and 17.41 percent, respectively. It indicates that seed treatment of wheat with *Trichoderma viride* can help in controlling the *Phalaris minor* weed.

Root (58.78 %) and shoot (20.41 %) growth of *Phalaris minor* was inhibited by the application of *Trichoderma viride* (200 g/m^2) grown on saw dust and neem oil cake, respectively.

Density of water hyacinth was gradually reduced in each ponds of Jabalpur surveyed but latter on population build up of water hyacinth occurred. In "Mahanada" pond other weeds viz., cattail (*Typha*) sp. and alligator weed (*Alternenthra philoxeroides*) replaced the weevil attacked water hyacinth.

During the survey made to Bangalore, in water hyacinth and Aligator weed infested lake, *Neochetina* spp. and *Cassida* sp. were found defoliating these weeds, respectively.

Survey made at in and around NRCWS farm, common aphids and termites were noted on *Phalaris minor*. On the other hand, *Cassia tora* seemed successfully replacing the parthenium in noncropped areas.

Mexican beetle defoliate parthenium in the patches corresponding to the build up of the population. In one instance, a thick patch of parthenium of about half kilometer in length along the roadside was identified as defoliated during the month of August. It was also noted that adult as well as 3rd-4th stage of larvae population were very high at one of the corner of the stand and there was complete defoliation of the parthenium stand at that particular site but near to this defoliated parthenium stand, there was high egg population and less adult beetles and full grown larvae. The damage on the plants was about 25% adjacent to complete defoliated stand .

MECHANICAL WEED MANAGEMENT

Twin wheel hoe operation performed at 15 and 25 days after sowing resulted in 80.7 per cent weed control efficiency in soybean and 81.9 per cent in maize, respectively.

TRANSFER OF TECHNOLOGY AND 'ON FARM RESEARCH

Training

Centre organised a short term training course programme on "**Weed Management : A tool for improving crop production**" of eight days schedule from 28-01-97 to 04-02-97. It was sponsored by Ministry of Agriculture (Deptt. of Agri. & Coopn.), Directorate of Extension, Krishi Vistar Bhawan, New Delhi. This training course programme was provided with a basic objective of imparting specialised training in the field of weed management to the subject matter specialist (SMS), officers of the State Deptt.of Agriculture and Training Associate of Krishi Vigyan Kendra of JNKVV. The participants were exposed to the advances in weed management technology and also through field visits around Jabalpur district for practical orientation and cultivation practices adopted by the farmers. Dr. V.P. Singh, Scientist, acted as Course Coordinator for the training programme.

1.0 GENERAL

1.1 INTRODUCTION

The National Research Centre for Weed Science (NRC-WS) was established by the Indian Council of Agricultural Research (ICAR) on April 22nd, 1989, at Jabalpur, (Madhya Pradesh). The centre is located adjoining to the campus of Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Krishi Nagar, Adhartal, Jabalpur, 482 004. The experimental farm is of 59.5 ha and is located at 9 km from the main Jabalpur railway station on national highway.

1.2 MANDATE

The mandate of the centre are :-

- To undertake basic and applied research for developing strategies for efficient weed management in different agro-ecological zones.
- To provide leadership role and coordinate the network research with State Agricultural Universities for generating location specific technologies for weed management in different crops, cropping and farming system.
- To act as repository of information in weed science.
- To act as a centre for training in research methodologies in area of weed science and management.
- To collaborate with National and International agencies in achieving the above objectives.
- To provide consultancy.

1.3 OBJECTIVES

The objectives of the centre are :-

- To undertake research work on biology, agro-ecology and physiology of weeds.
- To study aquatic and problem weeds and their control.
- Initial identification and evaluation of new herbicides and also development of bio-herbicides for problem weeds.
- Biochemistry of herbicides and its long-term effect on cropping system.
- To develop technology for biological and non-chemical methods of weed control and also development and testing of weed control equipments.
- To generate data on residue estimation and management of herbicides in soil, water and plants, cropped and noncropped situations and computer facility for data analysis and record making.

- To initiate research programme on integrated weed management.
- To conduct training programme in Weed Science.
- To conduct "on farm testing" and operational research projects regarding the use of recommended and newly developed weed management technology at farmers' fields.

The AICRP on Weed Control with its coordination unit at NRCWS and its 24 Centres inclusive of two voluntary centres located at various SAUs will work on applied research and on problems of their region to provide instant answer to the socioeconomic needs concerning to weed management of their areas.

1.4 AREA OF WORK OF VARIOUS SECTIONS AND UNITS

Weed Management :

I. Initial identification and evaluation of herbicides.
II. Weed Management in cropping system with emphasis on low land rainfed rice system.
III. Study of the long term effect of herbicides in important cropping systems.
IV. Designing and testing of weed control equipments (in association with Mechanical Weed Management Unit).

Weed Biology and Ecology :

I. Study of biology and ecology of important weed species.
II. Study of weed shifts in cropped and noncropped situations.
III. Weed management in non-cropped situations.

Biological Weed Management System :

I. Biological and non-chemical control of weeds.
II. Biology and control of aquatic, parasitic, perennial and problem weeds.
III. Weed management in non-cropped system.

Weed Physiology, Chemistry and Biotechnology :

I. Behaviour of weeds
II. Chemistry and mode of action of herbicides
III. Herbicide residue estimation and their management in soil- water-plant in cropped and non-cropped situations
IV. Identification and development of bio-herbicides.

Transfer of Technology and 'On Farm Research':

I. Training programmes for human resource development;
II. 'On farm trials' and demonstrations; and
III. Consultancy services.

Mechanical Weed Management :

Design, development and testing of weed control equipment, crop protection equipment and technologies related to crop production of food grains, oilseeds, pulses etc. To work on integrated weed management practices in crop production using mechanical, chemical and other methods of weed control. To generate energy requirements and economics of integrated weed management practices in cropping system.

Information, Statistics and Training

I. Planning, designing and development of softwares/systems in order to assist weed scientists in weed science;
II. Maintenance of existing systems and developing database;
III. Users training for different software packages; and
IV. Updating computer centre with latest technology.

1.5 INFRASTRUCTURAL FACILITIES

Experimental farm

The National Research Centre for Weed Science has a total area of 59.5 ha., out of which 20.1 ha area was covered under *kharif* crops and 41.8 ha under *rabi* crops. NRCWS farm provides facilities for field research and other field experimental activities.

Computer Unit

At present, LAN is being installed in the computer section with 4 terminals. Under ARIS 1 terminals & 1 Server (Pentium) have been provided. The Windows 3.11 workgroup, MS-Office & Visual C++ were also supplied by the council for office automation.

The centre has computer based data analysis and retrieval system to support scientists. Centre has five computers with VGA color monitor. Centre has recently installed the HP Colour Copy Jet Printer for taking colour transparency & DTP work.

There is a software package for paybill & account work (ARFIS 2.1 & 2.2). E-mail facility is being regularly utilized for sending and retrieving messages. The centre's computers has been further upgraded during the year under report. The computer cell provides analysis of the research data, transparency and slide works, library work, publications of the research papers, annual reports, Weednews, research articles, AICRP-WC reports, Technical reports preparation and conservation of various files, preparation of pay slips, monthly account and financial reports and its submission to ICAR H.Q. and providing of E-mail services.

Fig 1 : Computer Section of the Centre

Library

The library of the centre is being strengthened with the addition of 279 books during this year. At present the library is having a total of 931 books. The centre is equipped with good library facilities such as CABPEST CDROM (1973-97), Current Contents on Diskette CCOD 96-97 on biological sciences. The centre is also subscribing 54 Indian Journals and 09 Foreign Journals for the research support to the scientists. The library continued its activity on resource collections and rendering its services to the readers. One computer with HP Desk Jet printer has been installed recently for documentation services to the scientists and other users.

Reprographic and documentation eqiupments *viz.* Lamination and Spiral binding machines were added for better presentation of the centre's documents. To meet day-to-day needs of the office and research activities, two photocopiers (Xerox machine) have been provided in library and office.

In addition, bulletins, annual reports and newsletters are received on gratis/ exchange basis.

Laboratory Facilities

In the centre, there are four aircondition laboratories having modern research equipments such as spectrophotometer, BOD incubators, leaf area meters, pH meter, seed germinator, laminar air flow, universal research microscope with photomicrographic attachment, stereozoom research microscope, fine analytical balances, high speed refrigerated centrifuge, table top centrifuge, vacuum evaporator, hot air ovens, deep freezer, platform shakers, Gel electrophoresis, Millipore filter unit and electronic balances etc.

Estate & Works

Centre's offices and its laboratories are housed in five HIG buildings purchased from M.P. Housing Board Colony, Maharajpur adjoining the NRC WS Research Farm. For providing better environment of the buildings, they have been renovated to house computers, laboratories, office of scientists and other staff. Workshop cum garage shed and an implement shed have been constructed and handed over by the CPWD, besides the conference hall. Works related to construction of NRC-WS office cum laboratory building has been awarded to CPWD which is expected to be completed by March, 1998.

1.6 STAFF POSITION

The staff position during the period under report is given in **Table - 1**. The details are given in **Annexure - I**.

Table 1 : Staff Position as on 31.3.97

Category	Sanctioned	Filled	Vacant
Scientific	27*	13	14
Technical	30	23	07
Administrative	17	11	06
Supporting	25	25	-
Total	99	72	27

* Including one RMP Position of Director

1.7 RESEARCH COLLABORATION WITH OTHER INSTITUTES

The centre has collaborative projects with the following Institutions/ Organisations/ Private Sector which are given in **Table - 2.**

Table - 2 : Collaboration with other Institutes.

S. No.	Collaborative Instt./ Organisations/ Private Sector	Projects	Sections in Collaboration
1.	Indian Institute of Soil Science, Bhopal	Phosphate management in soybean -wheat cropping sequence and organic management in rice-wheat cropping sequence	Weed Management (Agro.)
2.	Department of Biotechnology, New Delhi	Biologicaal control of weeds using plant pathogens	Biological Weed Management
3.	ICAR	Studies on the pest potential of the Mexican beetle *Zygogramma bicolorata* introduced for biocontrol *Parthenium hysterophorus*.	Biological Weed Management
4.	Pesticide Industries	Screening and development of new herbicides	Weed Management (Agro.)

1.8 BUDGET

The centre has a total budget of Rs. 1,15,00,000 during the year out of which Rs. 94,00,000 lakhs was utilised in plan and Rs. 21,00,000 lakhs in non-plan. (for details, see **Annexure - II**).

1.9 HUMAN RESOURCE DEVELOPMENT

Participation in seminar, symposia, conference, meeting etc. and honours and awards (for details, see **Annexure - III**).

2.0 AGROCLIMATE

2.1 LOCATION

The centre is located between 22.49° and 24.8° North latitude, 78.21° and 80.58° East longitude and at an altitude of 411.78 metres above the Mean Sea Level. Jabalpur comes under the agroclimatic region of Kymore plateau and Satpura hills and lies in the rice-wheat crop zone of the state. The climate of Jabalpur region is typically sub-humid and subtropical.

2.2 SOIL AND WEATHER

The soils of the farm belong to Kheri series. The Kheri series is a member of the very fine, montmorillonitic, hyperthermic family of Typic Chromusterts. Kheri soils have dark greyish brown moderately alkaline AC horizons. They have developed in basaltic alluvium on level to very gently sloping Piedmont plains in Jabalpur and Narsinghpur districts of Madhya Pradesh at an elevation of 375 to 400 metre above MSL. The principal associated soil is Adhartal series, a Vertic Ustochrept.

For the period under report the meteorological data of Jabalpur is given in **Table - 3.**

Table - 3 : Meteorological data for the year 1996-97.

Month	Temperature -------°C ------		Humidity ---- % -----		Rainfall	Wind Velocity	Sun shine	Vapour Pressure (mm)	
	Max.	Min.	7.11 Hrs	14.11 Hrs	(mm)	(km/hr)	(hrs/day)	7.11 Hrs	14.11 Hrs
April, 1996	38.2	20.2	55	22	7.7	3.9	8.6	12.0	10.6
May	42.0	26.0	42	18	0.0	5.2	9.1	12.3	10.6
June	39.9	28.2	51	29	5.9	6.7	6.3	16.1	14.0
July	32.7	25.0	82	66	265.4	4.7	3.1	20.4	20.7
August	29.1	23.8	93	81	324.4	4.0	2.5	21.6	22.7
September	31.9	23.5	90	66	63.0	2.0	6.1	21.0	21.1
October	30.5	19.0	92	54	117.0	1.5	7.3	16.5	16.3
November	29.6	11.1	88	31	0.0	0.7	8.7	9.6	9.1
December	25.5	6.1	86	24	0.0	1.0	8.1	6.4	5.4
January, 97	23.4	7.5	87	35	25.4	0.9	7.4	7.2	7.3
February	26.9	9.3	74	24	0.0	1.7	9.4	7.0	6.4
March, 97	32.9	15.4	66	23	0.0	2.0	8.0	9.6	8.1
					* 808.8				

* Total Rainfall (mm)

3.0 RESEARCH HIGHLIGHTS

3.1 WEED MANAGEMENT

WM-6-a : Effect of animal manure input system on the emergence of weeds and their management in diverse rotation of legume and cereal.

V.P. Singh and V.M. Bhan

An experiment was laidout by keeping in view the evaluation of the long term effect of animal system using manures on the intensity and diversity of weed flora in diverse rotation of legumes and cereals. The treatments consisted of T_1 (low input animal system using manure i.e. 50% of recommended close of nutrients supplied through FYM only), T_2 (low input animal system using manure i.e 25% of recommended NPK supplied through FYM and 25% through inorganic fertilizers), T_3 (recommended NPK supplied through inorganic fertilizers), and T_4 (recommended NPK supplied through FYM only), alongwith sub-treatments weedy, weed free and herbicides as per crops.

In soybean-wheat cropping system, *Echinochloa colonum, Commelina communis, C. benghalensis, Brachiaria* sp, *and Alternanthera* sp. were the dominant weed flora in soybean and *Chenopodium* spp., *Medicago denticulata* , *Cichorium intybus*, *Vicia sativa* and *Phalaris minor* were dominant in wheat. The weed population, weed dry matter and grain yield of crops were significantly influenced with the treatments. The weed population and its dry matter recorded with T_4 and weed dry matter with T_3 recorded were significantly higher over T_1 and T_2 in soybean,whereas in wheat the highest weed population and its dry matter were recorded with T_3 which were significantly higher over T_1 and T_2.

Weed caused 22.93 per cent reduction in grain yield of soybean and 27.73 per cent in wheat. Application of pendimethalin 1.25 kg/ha in soybean and isoproturon 1.0 kg/ha in wheat significantly reduced the weed population and its dry matter, and increased the grain yield of soybean and wheat by 8.18 and 18.62 per cent, respectively.

In maize-pea cropping system, *Echinochloa colonum, Commelina* sp., and *Cyperus iria* in maize and *Chenopodium* sp. and *Cichorium intybus*, *Medicago denticulata* and *Vicia sativa* were major weeds in pea. The weed population and its dry matter recorded were significantly higher with T_4 over T_1 and T_2 in both the crops. The highest grain yield was recorded with T_3 which was significantly higher over rest of the treatments.

Application of atrazine 1.0 kg/ha in maize and pendimethalin 1.25 kg/ha in pea caused significant reduction in the weed population and its dry matter production and increased the yield by 19.13 and 15.57 per cent of maize and pea, respectively (**Table - 4**).

Table - 4 : Weed population,weed dry matter and yield of crops as influenced by animal system using manuers in soybean - wheat and maize-pea diverse rotations.

Treatments	Weed population/m^2 at 60 DAS				Weed dry matter (g/m^2) at 60 DAS				Grain yield (kg/ha)			
	Soybean	**Wheat**	**Maize**	**Pea**	**Soybean**	**Wheat**	**Maize**	**Pea**	**Soybean**	**Wheat**	**Maize**	**Pea**
Farming system												
T_1	14.22*	7.68	13.12	8.37	17.13	3.30	8.69	7.87	1455.22	2775.08	1950.78	1217.83
T_2	13.85	8.02	13.16	8.66	17.26	3.93	8.96	8.35	1465.78	3350.99	2352.89	1254.10
T_3	13.25	9.22	14.98	9.78	19.23	5.07	9.50	8.85	1611.11	4507.79	3367.67	1736.13
T_4	15.71	9.23	15.84	10.15	17.92	5.01	11.16	8.77	1530.67	3224.32	3073.00	1478.70
CD at 5%	**1.46**	**0.64**	**1.44**	**0.80**	**2.16**	**0.57**	**1.55**	**0.67**	**101.99**	**203.74**	**178.08**	**104.13**
Weed management												
Weedy	16.59	10.19	16.14	10.15	19.49	5.94	12.92	9.49	1342.67	2877.43	2272.08	1127.51
Weedfree	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	1742.08	3981.57	2976.67	1802.17
Herbicide	11.93	6.88	12.41	8.33	16.27	2.72	6.24	7.43	1462.33	3535.33	2809.50	1335.40
CD at 5%	**1.04**	**0.46**	**1.02**	**0.57**	**1.53**	**0.40**	**1.09**	**0.48**	**88.32**	**176.44**	**154.22**	**90.18**

* Transformed valued by _/(X+0.5) and DAS- Days after sowing

WM-5-b : Study on the effect of soybean based cropping intensity on the distribution of weed flora

V.P. Singh and V.M. Bhan

This experiment was laidout to find out the influence of soybean based cropping intensity on the distribution of weed flora. The experiment consisted of 4 cropping intensity along with weedy, weed free and herbicide as per crop (**Table 5 & 6**) and replicated thrice in split plot design.

Echinochloa colonum, *Commelina communis*, *Brachiaria* sp. *Physalis minima*, *Euphorbia geniculata* and *Legacia molis*, during *rainy* and *Chenopodium sp.*, *Phalaris minor* and *Medicago denticulata*, during *winter* season were main dominant weed flora. The weed population and weed dry matter production were significantly influenced by cropping system. The lowest weed count, its dry

matter production and highest grain yield were recorded with soybean-mustard-moong (300% CI) which were significantly higher over 200% CI during rainy season, whereas the similar trend was also recorded with fallow-wheat (100% CI) during winter season. Application of pendimethalin 1.25 kg/ha PE in soybean and isoproturon 1.0 kg PO in wheat and mustard reduced the weed density and dry matter and increased the grain yield of crops during both the season.

Table - 5 : Effect of soybean based cropping intensity on rainy weeds and grain yield of soybean

Treatments	Weed population/m^2		Weed dry matter(g/m^2)		Grain yield
	30 DAS	60 DAS	30 DAS	60 DAS	(kg/ha)
Cropping intensity					
Soybean-Wheat (200%)	24.58*	19.19	10.97	14.28	1381.33
Soybean-Mustard-Moong (300%)	17.06	14.91	9.59	13.14	1473.38
Soybean-Fallow (100%)	18.73	15.80	9.90	13.74	1321.45
Fallow-Wheat (100%)	-	-	-	-	-
CD at 5%	**2.58**	**2.67**	**1.30**	**3.80**	**234.09**
Weed Control					
Weedy	21.58	17.97	11.45	15.03	968.16
Weed free	0.71	0.71	0.71	0.71	1986.55
Pendimethalin (PE) 1.25 kg/ha	18.66	15.30	8.85	12.41	1221.45
CD at 5%	**1.40**	**1.37**	**1.25**	**1.01**	**92.26**

*Values transformed by /(X+0.5) and DAS- Days after sowing

Table -6 : Effect of soybean based cropping intensity on winter weeds and soybean equivalent yield

Treatments	Weed population/m^2		Weed dry matter(g/m^2)		Grain yield
	30 DAS	60 DAS	30 DAS	60 DAS	(kg/ha)
Cropping intensity					
Soybean-Wheat (200%)	13.03*	13.10	3.38	5.96	2098.52
Soybean-Mustard-Moong (300%)	13.77	13.93	3.64	6.43	1385.86
Soybean-Fallow (100%)	-	-	-	-	-
Fallow-Wheat (100%)	11.86	11.76	3.29	5.44	1993.83
CD at 5%	**1.71**	**1.96**	**0.61**	**0.99**	**255.85**
Weed Control					
Weedy	14.94	15.60	3.98	7.12	1344.56
Weed free	0.71	0.71	0.71	0.71	2300.91
Isoproturon 1.0 kg/ha (PO)	10.84	10.27	2.89	4.77	1832.74
CD at 5%	**0.50**	**0.59**	**0.24**	**0.26**	**77.00**

*Values transformed by /(X+0.5) and DAS- Days after sowing

WM-5-a : Influence of rice based cropping intensity on the distribution of weed flora and its control

V.P. Singh and V.M. Bhan

Echinochloa spp. and *Commelina communis* during rainy season and *Chenopodium* spp., *Phalaris minor*, *Cichorium* sp.and *Trifolium flagiferum* during *winter* season were main dominant weed flora in the experiment.

The lowest weed population and weed dry matter were recorded with rice-wheat (200% CI) which were at par with rice-fallow (100% CI) and significantly lower over rice-mustard-moong (300% CI) during rainy season. However, during winter season, the lowest weed population and weed dry matter production were observed with fallow-wheat (100% CI) which were significantly lower over 200 and 300% cropping intensity. So far grain yield of crops are concerned, the significantly highest grain yield was recorded with 100% cropping intensity during both the seasons (**Table 7 & 8**).

The application of butachlor 1.5 kg/ha PE in rice and isoproturon 1.0 kg PO in wheat and mustard reduced the weed population and weed dry matter and increased the grain yield by 18.18 and 36.80 per cent during *kharif* and *rabi* season, respectively.

Table - 7 : Effect of rice based cropping intensity on rainy weed population, weed dry matter and grain yield of rice

Treatments	Weed population/m^2		Weed dry matter(g/m^2)		Grain yield (kg/ha)
	30 DAS	60 DAS	30 DAS	60 DAS	
Cropping intensity					
Rice-Wheat (200%)	4.66*	5.46	8.03	10.52	4451.71
Rice-Mustard-Moong (300%)	5.42	6.15	9.33	12.09	4414.93
Rice-Fallow (100%)	4.50	5.41	8.92	10.93	4700.80
Fallow-Wheat (100%)	-	-	-	-	-
CD at 5%	**0.58**	**0.56**	**1.14**	**0.97**	**306.43**
Weed Control					
Weedy	6.16	7.14	10.68	13.63	3874.60
Weed free	0.71	0.71	0.71	0.71	5262.29
Butachlor 1.50 kg/ha (PE)	3.56	4.20	6.84	8.72	4527.55
CD at 5%	**0.20**	**0.44**	**0.72**	**0.40**	**220.90**

* Values transformed by _/(X+0.5) and DAS- Days after sowing

Table - 8 : Effect of rice based cropping intensity on winter weed population, weed dry matter and equivalent grain yield of rice

Treatments	Weed population/m^2		Weed dry matter(g/m^2)		Grain yield
	30 DAS	60 DAS	30 DAS	60 DAS	(kg/ha)
Cropping intensity					
Rice-Wheat (200%)	13.75 *	12.61	2.69	4.58	5247.72
Rice-Mustard-Moong (300%)	14.76	13.38	3.05	5.08	3742.02
Rice-Fallow (100%)	-	-	-	-	-
Fallow-Wheat (100%)	12.84	11.39	2.54	3.94	5263.18
CD at 5%	**1.58**	**1.22**	**0.38**	**0.69**	**424.42**
Weed Control					
Weedy	18.29	17.25	3.40	5.93	3605.59
Weed free	0.71	0.71	0.71	0.71	5763.43
Isoproturon 1.00 kg/ha (PO)	9.28	7.67	2.12	3.14	4883.90
CD at 5%	**0.81**	**0.99**	**0.21**	**0.55**	**182.07**

*Values transformed by _/(X+0.5) and DAS- Days after sowing

WM-11-C : Influence of post em. herbicides alone and in combination on weeds and grain yield of soybean

V.P. Singh, Anil Dixit and V.M. Bhan

This experiment consisted of eleven treatments (**Table-9**) designed in randomized block design with three replications with objectives to see the response of post emergence herbicides applying alone and in combination on weed growth and grain yield of soybean.

The experimental field was severely infested with *Commelina communis, Echinochloa colonum, Physalis minima* at early stages. *Euphorbia geniculata* and *Phyllanthus niruri* appeared at later stages. It is obvious from table-1 that the combination of post emergence herbicides has proved better than the herbicides applied alone in reducing the weed population and its dry matter production. The application of Lactofen 0.2 kg/ha alone being at par with fluazifop butyle (0.5 kg/ha) reduced the weed population and dry matter significantly over the sethoxydim 0.5 kg/ha. Among the herbicidal combinations, significantly the lowest weed population and its dry matter were recorded with lactofen 0.1 kg/ha combined with fluazifop butyl and sethoxydim each at 0.25 kg/ha over rest of the treatments. Weed caused 57.43 per cent reduction in grain yield of soybean. The herbicidal combinations gave significantly higher grain yield of soybean over herbicides applied alone. The significantly highest grain yield of soybean was obtained under lactofen 0.1 kg/ha combined withfluazifop butyl and sethoxydim each at 0.25 kg/ha which wae at par with combination of fluazifop butyl and sethoxydim each at 0.25 kg/ha.

Table - 9 : Influence of post em. herbicides alone and in combination on weeds and grain yield of soybean.

Treatments	Dose	Weed population/m^2		Weed dry matter(g/m^2)		Grain yield (kg/ha)
		40 DAS	60 DAS	40 DAS	60 DAS	
T1 Lactofen	0.2 kg/ha (PO)	16.34*	15.40	11.51	9.12	1142.96
T2 Fusilade	0.5 kg/ha (PO)	17.78	15.42	12.54	10.21	1226.30
T3 Sethoxydim	0.5 kg/ha (PO)	20.72	17.75	14.12	10.30	1185.78
T4 T1 + T2	0.2+0.125 kg/ha	15.29	15.40	11.22	8.40	1333.34
T5 T1 + T2	0.2+0.25 kg/ha	13.71	13.86	8.17	6.13	1517.60
T6 T1 + T3	0.2+0.125 kg/ha	18.19	15.76	12.52	9.09	1300.93
T7 T1 + T3	0.2+0.25 kg/ha	14.08	13.77	11.14	8.27	1434.26
T8 T2+T3	0.25+0.25 kg/ha	14.49	13.56	8.72	6.06	1808.33
T9 T1+T2+T3	0.10+0.25+0.25 kg/ha	10.37	11.39	6.01	4.88	1961.11
T10 Weed free		0.71	0.71	0.71	0.71	2163.89
T11 Weedy		25.33	20.17	15.25	17.07	920.37
CD at 5%		**5.19**	**1.47**	**1.56**	**1.06**	**228.26**

*Values transformed by _/(X+0.5) and DAS- Days after sowing

WM-11-d : Integrated weed management in soybean

V.P. Singh and V.M. Bhan

An experiment was carried out to find out the suitable integrated weed management practices which includes the herbicidal application alone, their mixture and in combination with hand weeding in soybean. The experiment was designed in randomized block design with ten treatments replicated thrice (**Table-10**).

Echinochloa colonum, Commelina communis, Alternanthera sessilis and *Cyperus iria* were dominant weed flora in the field. The weed population and weed dry matter were significantly influenced by combined application of post em. herbicides and their combination with hand weeding. At early crop growth stages significantly lowest weed population and dry matter were noted with one hand weeding at 25 DAS. But at later crop growth stages, the significantly lowest weed population and its dry matter production were recorded under fluazifop butyl 0.25 kg/ha fb. one hand weeding at 25 days after spraying,which were at par with sethoxydim 0.25 kg/ha fb. 1 HW at at 25 DAS**. Among the herbicidal combinations, sigmificantlythe lowest weed population and its dry matter were recorded with fluazifop butyl (0.5 kg/ha) + sethoxydim (0.25 kg/ha) as comparison to other herbicidal combinations and their alone application.

Presence of weed throughout the cropping season caused 54.91 per cent reduction in grain yield of soybean. The highest grain yield of soybean was recorded with fluazifop butyl (0.5 kg/ha) + sethoxydim (0.25 kg/ha) mixture which was at par with application of fluazifop butyl and sethoxydim each at 0.25 ka/ha followed by one hand weeding at 25 days after spraying.

Table -10 : Effect of fluazifop butyl and sethoxydim alone and in combination with hand weeding on weeds and grain yield soybean

Treatments	Weed population/m^2		Weed dry matter(g/m^2)		Grain yield (kg/ha)
	40 DAS	60 DAS	40 DAS	60 DAS	
T1 Fluazifop-butyl 0.5kg/ha (PO)	15.54*	13.44	8.41	7.35	1489.78
T2 Sethoxydim 0.5 kg/ha (PO)	17.96	15.27	9.68	9.31	1365.00
T3 T1 + T2 0.5+0.25 kg/ha	12.97	9.89	6.45	6.68	1867.97
T4 T1 + T2 0.25+0.5 kg/ha	14.24	12.32	8.59	8.37	1722.22
T5 T1 + T2 0.25+0.25 kg/ha	17.20	14.96	9.73	9.43	1443.78
T6 1 HW at 25 DAS	10.41	14.37	3.80	8.84	1613.89
T7 Fluazifop 0.25 kg/ha fb. 1 HW at 25 DAS**	17.50	8.96	10.15	4.27	1867.97
T8 Sethoxydim 0.25kg/ha fb. 1 HW at 25 DAS**	19.23	9.31	10.29	4.46	1811.12
T9 Weed free	0.71	0.71	0.71	0.71	2166.67
T10 Weedy	22.87	17.67	13.76	14.61	976.87
CD at 5%	**2.98**	**4.85**	**1.64**	**1.32**	**260.82**

* Values transformed by _/(X+0.5) and **DAS - Days after sowing

Integrated N management through urea and organic manures for sustainable productivity of rice-wheat in Vertisols

Muneshwar Singh, V.P. Singh, P.N. Takkar and V.M. Bhan

A field experiment on integrated use of farm yard manure (FYM) and parthenium as green manure (GM) with and without fertilizer N was conducted in collaboration with NRCWS, Jabalpur on rice-wheat system in Vertisols. Fourteen treatments comprising of urea N, FYM and GM with and without N were laid out in randomized block design. The details of treatments are given in **Table - 11**. After puddling the plot, required amount of FYM and GM (10-15 cm long pieces) were incorporated into the soil manually, Nitrogen through urea was applied into equal splits at transplanting and maximum tillering stage. All the rtreatments received 60 kg P_2O_5, 40 kg K_2O and 5 kg Zn ha^{-1} as basal dose in both the crops through SSP, MOP and $ZnSO_4$ respectively. After harvesting rice, wheat was sown with same treatment in the same plot except FYM and GM which were added to rice only. Post harvest surface soil samples were collected after both the crops. The results obtained summarized as below.

Grain and straw yield rice and wheat

The grain and straw yield of rice (1995) and wheat (1995-96) is presented in **Table - 11**. The grain yield of rice increased significantly and successively with the increasing rates of fertilizer N upto 180. The per cent increase in grain yield over control was nearly 38, 115 and 144 per cent on application 45, 90 and 180 kg N ha^{-1}, respectively. Incroporation of manure (FYM and GM) with increasing rate also increased the grain yield of rice significantly and successively. The grain yield followed the quadratic relationship with fertilizer and optimum dose of N was found to be 138 kg N ha^{-1}.

Rice grain, t ha^{-1} (Y) = $1.944 + 0.034x - 0.98 \times 10^{-4}x^2$ (R=0.99)

Also there was significant increase in grain yield of wheat with the incresing rates of fertilizer N over control. The percent increase in grain yield was 77, 136 and 165 per cent, respectively, on application of 45, 90 and 180 kg N ha^{-1}. The grain yield of wheat followed quadratic response and the optimum dose of N was found to be 128 kg N ha^{-1}

Wheat grain t ha^{-1}(Y) = 1.73 + 0.036 x - 0.112 x 10^{-3} x^2 (R=0.99)

Organic manures (FYM & GM) were applied in conjuction with fertilizer N. After harvest of wheat, appreciable reduction in amino acid, amino sugar and hydrolyzable fractions was noted as compared at rice harvest and the maximum reduction was observed in amino sugar followed by aminoacid and hydrayzable N fractions which suggest that these forms of N have contributed towheat yield. Which is also reflected by the higher correlation values with grain yield (**Table - 11**).

Table - 11 : Grain and straw yields (t ha^{-1}) and N uptake of rice and wheat as influenced by integrated use of fertilizer N, FYM and green manure (**parthenium**).

Treatment	RICE 95		WHEAT 95-96		N Uptake kg/ha	
	Grain	Straw	Grain	Straw	Grain	Straw
Control	1.97	5.53	1.75	2.89	47.1	40.7
Fertilizer N (kg/ha)						
45	3.19	7.97	3.10	5.26	68.5	62.4
90	4.23	1.07	4.14	6.54	87.4	76.8
180	4.81	1.24	4.65	7.44	104.1	98.6
Organic (t/ha)						
FYM 5	2.99	7.55	3.14	4.97	62.4	59.4
FYM 10	3.65	9.52	3.45	5.98	85.1	75.8
FYM 15	3.84	9.41	3.85	6.12	84.2	83.8
GM* 3	2.36	6.07	3.25	5.17	55.8	61.0
GM 6	3.08	7.46	3.56	5.54	73.0	77.5
GM 9	3.33	8.59	3.73	5.90	79.2	82.3
Fertilizer N + Organic						
N 45 + FYM 5	3.59	9.26	3.86	6.09	86.4	85.0
N90 + FYM 5	4.75	1.22	4.72	7.56	107.3	102.0
N45 + GM 3	3.39	8.81	3.54	5.59	79.5	85.6
N90 + GM 3	4.29	9.78	4.32	6.82	98.6	99.7
CD at 5%	**0.12**	**0.24**	**0.14**	**0.21**	-	-

Correlation with yield

Simple linear regression equations were filted to establsih the relationship between grain yield of rice and wheat with various fractions of nitrogen. Highest correlation of rice grain yield was observed with inorganic fractions folowed by hydrolyzable ammonia total hydrolyzable, amino sugar and amino acid fractionsl. However, in wheat strongest relationship was noted with haxose amine followed by amino acid, inorganic N and hydrolyzable N. The higher value of r with haxose amine and amino acid indicate that these fractions have contributed more to grain yield of wheat. A negative correlation was observed with hydrolyzable in identified fraction of N in both the crops.

Incorporation of both FYM and GM increased to seed yield of both rice and wheat significantly upto 15 T FYM and 9 t GM ha^{-1}. The extent of influence of 15 t FYM and 9 t GM was significantly higher than that of 45 kg N ha^{-1}. Application of 5 t FYM in conjuction with 90 kg N ha^{-1} produced similar quality of rice grain yield, statistically at par with the grain yield, obtained on application of 180 kg N ha^{-1}. Tha data presented in **Table-11** indicate that the combined grain yield of both rice+wheat obtained on application of 10 t FYM and 6 t GM to rice was larger than the grain obtained on application of 45 kg N ha^{-1} to both the crops. The combined grain of rice+wheat recorded on incorporation of 5 t FYM though was lower than the grain yield obtained on application of 45 kg N but statistically both are at par. A similar effect of FYM, N and GM was also recorded on N uptake and straw yield of both rice and wheat.

WM-2 (vii) : Effect of metsulfuron methyl and 2,4-D in combination and alone on broadleaved weeds in wheat.

Anil Dixit and V.M. Bhan

An experiment was carried out with 11 treatments which were alloted randomly in randomised block design with three replications. The experimental field was mainly dominated with *Chenopodium album*, *Medicago sp*, *Cichorium intybus* and *P. minor*. Data revealed that from the **Table-12,** the weed intensity and weed dry weight was the lowest with metsulfuron 4 g/ha in combination with 2,4-D 500 g/ha.

Table -12 : Effect of metsulfuron and 2,4-D in combination and alone of broad leaved weeds in wheat

Treatments (g/ha)	Weed count/m^2		Dry wt. g/m^2		Grain yield (kg/ha)
	40DAS	80 DAS	40 DAS	80 DAS	
MET 2+ Surfactant 2%	13.07	11.33	5.58	7.05	4423
MET 4	11.06	9.31	5.20	6.25	4450
MET 2 + 2,4-D 250 (2%)	9.61	8.89	5.08	5.92	4516
MET 4 +2,4-D 250	9.18	8.58	4.81	5.92	4543
MET 2 +2,4-D 500	8.89	8.19	4.37	5.45	4733
MET 4 +2,4-D 500	7.93	6.34	3.71	4.93	4920
2,4-D 250(EE) + Surfactant 2%	10.91	8.71	5.45	6.46	4620
2,4-D 500 (EE)	8.40	7.77	4.17	5.07	4786
2,4-D (NA Salt) 500	10.60	8.96	5.45	6.46	4761
Weedy	20.27	17.64	7.70	8.43	2886
Weed free	0.71	0.71	0.71	0.71	5363
CD 5%	**0.93**	**0.87**	**0.42**	**0.39**	**63.0**

* MET- Metsulfuron and EE- ethyl ester

WM-2 (viii) : Effect of metsulfuron methyl in combination with isoproturon and alone on *P. minor.*

Anil Dixit and V.M. Bhan

This experiment was conducted with the objective to find out the efficacy of metsulfuron methyl alone and in combination with isoproturon for the control of weeds. The experiment consisted of 14 treatments. It was found that weed intensity and weed biomass reduced to a significant level when 2,4-D 500 g in combination with isoproturon 750 g/ha were applied followed by metsulfuron 4 g with isoproturon 1 kg/ha. As regard to grain yield the treatments consisted of metsulfuron and 2,4-D with isoproturon obtained higher grain yield of wheat and were comparable to each other.

Table - 13 : Effect of metsulfuron and IPU in combination and alone on mixed weed flora

Treatments	Weed count/m^2		Dry wt. g/m^2		Grain yield
	40DAS	80 DAS	40 DAS	80 DAS	(kg/ha)
MET 2 g + IPU 500 g/ha	10.07	8.97	5.20	6.76	4746
MET 2 g + IPU 750 g/ha	7.51	6.76	4.21	5.45	4946
MET 2 g + IPU 1000 g/ha	6.03	4.51	3.32	4.81	5236
MET 4 g + IPU 500 g/ha	9.40	8.10	5.07	6.24	4910
MET 4 g + IPU 750 g/ha	7.14	5.32	4.21	5.40	5240
MET 4 g + IPU 1000 g/ha	5.91	4.51	3.12	4.81	5400
2,4-D 500 g + IPU 750 g/ha	6.76	4.12	2.98	4.21	5470
2,4-D 750 g + MET 2g + IPU 500 g/ha	9.73	7.81	5.58	7.15	5463
MET 4 g/ha	11.29	9.40	5.81	7.42	4853
IPU 500 g/ha	11.73	10.12	5.20	6.46	4780
IPU 750 g/ha	10.09	7.33	5.08	6.25	4858
IPU 1000 g/ha	9.26	6.55	4.66	5.92	5053
Weedy	19.33	15.71	7.14	8.89	3110
Weed free	0.71	0.71	0.71	0.71	5720
CD at 5%	**0.85**	**0.47**	**0.40**	**0.46**	**85**

* MET- Metsulfuron and IPU - Isoproturon

WM-14 (f) : Influence of herbicide application in rice and its effect on succeeding crop of wheat.

Anil Dixit and V.M. Bhan

An experiment was conducted to find out efficient weed management in rice-wheat sequence and the effect of treatments applied in kharif were studied for their carry over effect in succeeding crop. Six treatment were replicated three times in randomized block design as indicated in **Table-14** applied to rice in RBD with 3 replications. During the winter season the experiment was laid out in split plot design keeping rice field comprised of *Echinocloa colonum*, *E.glabrescence*, *E. crusgalli*, *Caesulia auxillaris*, *Cyperus iria*, *Alternanthera* sp. and *Commelina communis*. Weed species that dominated the

wheat crop grown after rice included *Phalaris minor, Chenopodium album, Avena fatua, Vicia sativa, Cichorium intybus* and *Medicago denticulata.*

Herbicide checks did not differ significantly among them in reducing weed population and weed dry weight. Anilofos applied @ 0.4 kg/ha coupled with one hand weeding at 30 DAS resulted in significant reduction of weed population.

Grain yield obtained from the plot treated with anilofos was statistically similar to that obtained from butachlor. The highest grain yield was registered with the application of anilofos coupled with one hand weeding. There was no significant effect of treatments applied to rice on weed population and weed dry matter in wheat crop. The interaction between the treatments applied in rice and wheat was also non-significant indicating that the herbicide applied in rice degraded to safe limits by the sowing time of wheat.

Table - 14 : Influence of herbicide application in rice and its effect on succeeding crop of wheat

Treatment	**Weed count/m^2**		**Dry Weight g/ha**		Grain Yield
	40 DAS	80 DAS	40 DAS	80 DAS	(kg/ha)
Rice					
Butachlor 2 kg/ha	8.66	6.96	6.85	8.82	4989
Butachlor + HW at 30 DAS	7.04	5.49	6.03	8.11	5381
Anilofos 0.4 kg/ha	7.33	5.32	6.86	8.89	5032
Anilofos 0.4 kg/ha + HW at 30 DAS	6.03	4.69	5.58	7.60	5620
Weed free	0.71	0.71	0.71	0.71	5991
Weedy check	12.72	10.97	9.40	11.90	3398
CD at 5%	**0.71**	**0.55**	**0.60**	**0.51**	**189**
Wheat					
Isoproturon 1.5 kg/ha	5.61	5.38	4.10	5.68	3879
HW at 15,30 & 45 DAS	4.63	4.00	4.34	5.81	3816
Weedy	11.32	8.96	8.14	10.33	2600
CD at 5%	**0.46**	**0.31**	**0.20**	**0.40**	**91**

WM-14 (g-i) : Effect of tralkoxydim and anilofos on weed intensity and weed biomass in wheat.

Anil Dixit and V.M. Bhan

An experiment was conducted to evaluate tralkoxydim and anilofos against weeds in wheat. The experimental field was infested mainly with *Phalaris minor, Chenopodium album and Medicago sp.* It is evident from the table that isoproturon in combination with anilofos resulted in reduction of weed biomass and dry weight. The yield data (**Table - 15**) also revealed that higher grain yield recorded under the said treatment.

Table - 15 : Effect of tralkoxydim and anilofos on weed intensity and dry weight of weeds at 60 DAS in wheat.

Treatment (Kg/ha)	Weed count/m^2 *P. minor*	BLW	Total	Dry weight (g/m^2)	Grain yield (kg/ha)
Tralkoxydim 0.2	6.03	16.08	17.17	7.24	4876
Tralkoxydim 0.3	4.93	14.61	15.41	5.92	4990
Tralkoxydim 0.4	3.12	12.06	12.44	4.80	5050
Anilofos 0.2	7.85	16.50	18.26	8.02	4526
Anilofos 0.3	6.76	16.05	17.41	7.05	4656
Anilofos 0.4	5.18	14.83	15.50	6.03	4723
Isoproturon 0.75+ Anilofos 0.3	1.18	11.09	11.15	4.51	5240
Isoproturon 0.75	3.44	12.45	12.55	5.19	4973
Weed free	0.71	0.71	0.71	0.71	5420
Weedy	10.97	17.97	21.05	9.19	3233
CD at 5%	**1.04**	**1.00**	**0.71**	**0.54**	**35**

WM-2 (xi) : Effect of chlorimuron against weeds in soybean.

Anil Dixit and V.M. Bhan

The experiment was conducted during *kharif* 1996-97 at NRCWS, Jabalpur. The objective of study was to evaluate sulfonyl urea compound against weeds in soybean.

The study revealed that Chlorimuron @ 1.2 g/ha found effective against weed for reducing the weed biomass and obtained higher grain yield to the tune of 11.65 kg/ha.

Table - 16 : Effect of chlorimuron against weeds in soybean

Treatment	Weed count/m^2 60 DAS	Dry weight (g/m^2) 60 DAS	Grain yield (kg/ha)
Chlorimuron 6 g/ha	11.73	9.28	866
Chlorimuron 9 g/ha	10.28	7.42	977
Chlorimuron 12 g/ha	8.02	7.42	1165
Metolachlor 1 kg/ha	11.73	8.96	944
Weed Free	0.71	0.71	1459
Weedy	15.90	12.84	610
CD at 5%	**0.90**	**0.64**	**119**

WM-13 (a-i) : Performance of tillage in relation to chemical method of weed management in soybean.

Anil Dixit and V.M. Bhan

The experiment was conducted during *kharif* 1996-97 at NRCWS, Jabalpur. The objective of the experiment was to see the effect of tillage in relation to chemical weed management in soybean. The study revealed that stale seed bed technique was quite effective in reducing the weed biomass to the greater extent and obtained higher grain yield followed by conventional tillage. Among the weed control method fluchloralin @ 1 kg/ha proved effective for lesser number of weed count and dry weight.

Table - 17 : Performance of tillage in relation to chemical method of weed management in soybean

Treatment	Weed count/m^2		Dry Weight g/ha		Grain Yield (kg/ha)
	40 DAS	80 DAS	40 DAS	80 DAS	
Main Plot					
Stale seed bed	11.76	9.19	6.88	9.64	929
Conventional	13.23	10.59	7.33	10.25	855
Minimumm tillage	14.37	11.37	8.10	10.36	851
CD at 5%	**0.33**	**0.57**	**0.69**	**0.45**	**49**
Sub Plot					
Fluchloralin	15.77	12.48	9.77	13.21	886
Weed free	0.71	0.71	0.71	0.71	1333
Weedy	22.88	17.98	11.86	16.53	437
CD at 5%	**0.29**	**0.38**	**0.27**	**0.32**	**48**

WM-13 (a-ii) : Evaluation of glyphosate in conservation tillage system.

Anil Dixit and V.M. Bhan

Glyphosate is well know non-selective herbicide for controlling almost all types of weed in arable crop land. An experiment was conducted at NRCWS, Jabalpur with the objective to see the effect of glyphosate in zero tillage system. The experiment consisted of 8 treatments laid out in RBD. glyphosate @ 1.5, 2.0 & 2.5 Kg/ha was applied just one day before the drilling of wheat crop.

The study revealed that glyphosate application in zero tillage plot was effective for controlling weeds as compared to unweeded. On the other hand, conventional tillage followed by isoproturon @ 1 kg/ha proved quite effective for reducing the weed biomass and obtained the highest grain yield of wheat followed by minimum tillage.

Table - 18 : Evaluation of glyphosate in conservation tillage system.

Treatment (l/ha)	Weed count/m^2			Dry weight (g/m^2)	Grain yield (kg/ha)
	Grassy	BLW	Total		
Zero tillage (No treatment)	14.53	17.60	22.81	9.40	2856
Zero tillage + glyphosate 1.5	12.66	13.33	18.37	8.43	3266
Zero tillage + glyphosate 2.0	11.38	12.60	16.98	7.86	3366
Zero tillage + glyphosate 2.5	9.46	12.05	15.33	7.51	3490
Zero tillage + Isoproturon 1.0	7.66	14.89	16.74	7.94	3500
Minimum tillage + glyphosate 2.0	6.34	10.97	12.66	5.80	3553
Minimum tillage + Isoproturon 1.0	4.78	13.32	14.15	5.20	3640
Conventional tillage + Isoproturon 1.0	4.04	11.25	11.95	4.51	3973
CD at 5%	**0.94**	**1.14**	**0.66**	**0.45**	**70**

Fig. 2 : Crop growing with zero tillage

WM-13 (b) : Effect of method of application of alachlor in soybean.

Anil Dixit, V.P. Singh and V.M. Bhan

The investigation was carried out at NRCWS, Jabalpur during *kharif* 1996-97. The results revealed that alachlor @ 2 kg/ha as pre-emergence either to be applied as liquid or granules found to be effective for control of grassy weeds in soybean.

Table - 19 : Effect of method of application of alachlor in soybean

Treatment	Weed count/m^2		Dry Weight g/m^2		Grain Yield
	40 DAS	80 DAS	40 DAS	80 DAS	(q/ha)
Alachlor 1.0 kg/ka (PE)	12.91	12.06	9.40	12.18	10.77
Alachlor 1.5 kg/ka (PE)	11.72	10.66	8.50	11.56	11.80
Alachlor 2.0 kg/ka (PE)	15.01	12.61	10.22	13.87	8.16
Alachlor 1.0 kg/ka (PPI)	13.86	11.27	9.61	12.98	9.17
Alachlor 1.5 kg/ka (PPI)	13.12	10.34	8.74	12.07	10.47
Alachlor 2.0 kg/ka (PPI)	10.99	9.19	7.51	10.60	13.70
Alachlor 1.0 kg/ka (PO)	16.17	13.02	10.97	14.44	8.00
Alachlor 1.5 kg/ka (PO)	15.42	12.29	10.02	13.63	9.77
Alachlor 2.0 kg/ka (PO)	13.22	10.60	8.50	12.34	11.00
Alachlor 1.0 kg/ka (G)	13.82	12.29	10.02	12.18	8.74
Alachlor 1.5 kg/ka (G)	12.29	10.66	8.96	11.56	9.88
Alachlor 2.0 kg/ka (G)	11.55	9.40	7.85	10.60	11.18
Weed free	0.71	0.71	0.71	0.71	14.73
Weedy	19.26	15.50	13.03	17.64	5.19
CD AT 5%	**1.06**	**0.65**	**0.48**	**0.46**	**5.1**

WM-13 (c) : Evaluation of herbicidal application in soybean.

Anil Dixit and V.M. Bhan

The area of soybean is increasing due to its wider adaptability during *kharif* in Madhya Pradesh. The spectrum of weed species in soybean has also widened due to variation in agroecological situation. Therefore, it is essential to find out some broad spectrum, selective and effective herbicide for weed control in soybean to be used either as pre-emergence or post-emergence.

In the present investigation six herbicides were evaluated and compared with weed free and weedy check (**Table-20**) in randomized block design in three replications on clay loam soils at NRCWS, Jabalpur during 1996-97. Soybean variety JS 75-46 was sown @ 100 kg/ha at 22.5 cm row spacing. The major weed species were *Euphorbia hyssopifolia*, *Echinocloa crusgalli*, *Commelina communis* and *Cyperus rotundus*. Amongst the herbicidal control trifluralin @ 1.5 kg/ha resulted in the highest grain yield which was at par with fluchloralin. The lowest intensity & biomass was observed with the same treatment.

Table - 20 : Evaluation of herbicide application in soybean

Treatment	Weed count/m^2		Dry Weight g/m^2		Grain Yield
	40 DAS	80 DAS	40 DAS	80 DAS	(q/ha)
Oxyfluorfen 2.0 kg/ha	14.01	12.12	11.44	14.97	8.66
Pendimethalin 1.25 kg/ha	14.88	12.97	11.90	15.50	7.99
Chlomazone 1.0 kg/ha	16.74	13.91	13.43	16.50	6.88
Fluchloralin 1.5 kg/ha	12.39	9.87	8.50	12.00	11.74
Trifluralin 1.0 kg/ha	13.72	12.11	9.46	13.18	11.33
Trifluralin 1.5 kg/ha	10.07	7.39	7.77	10.13	12.40
Sethoxydim 0.5 kg/ha	14.89	13.72	11.08	15.06	8.88
Weed free	0.71	0.71	0.71	0.71	13.99
Weedy	22.72	17.90	14.61	20.43	5.55
CD at 5%	1.68	0.94	0.81	0.87	0.62

WM-2 (xii) : Efficacy of metribuzin for the control of weeds in wheat

Anil Dixit and V.M. Bhan

The objective of the experiment was to find out the efficacy of metribuzin against associated weeds in wheat. WH-147, a dwarf variety was drilled on 30th Nov. 1996. The seed rate was @ 120 kg/ha. The fertility level of the fields were maintained at N 120 kg/ha, P_2O_5 & K_2O @ 60-80 kg & 40 kg respectively. Half of the N & full dose of P&K were applied at the time of sowing. The soil of the experimental field was rich in organic matter. The experiment with seven treatments was replicated 3 times in randomized block design. The metribuzin was applied at 4 doses i.e. 150, 200, 250 & 300 g/ha compared with isoproturon 1000 gm at 35 days after sowing. The herbicide was sprayed by dissolving in water applied @ 500 l/ha. The observations were recorded on weed population/m^2 and weed dry matter/m^2 at 60 DAS. The data on weed population and dry matter is subjected to square root transformation.

The experimental field was infestd with *Phalaris minor, Chenopodium album* and *Medicago sp* The application of metribuzin at 35 days after sowing was found to decrease the weed population & weed biomass significantly when compared with weedy check. The application of metribuzin @ 300 g/ha resulted in lowest weed population and weed dry wt. at 60 DAS and was at par with isoproturon at 1 kg/ha. The grain yield was also obtained higher in metribuzin treated plot @ 300 g/ha.

The aforesaid study revealed that metribuzin in heavy soil can be applied @ 250-300 g/ha for the control of grassy & broadleaved weeds effetively. It was observed that metribuzin acts fast & reveals the results with in 3-4 days after application of treatment. The mechanism of action of the metribuzin in higher plants is a blockageof photosynthesis. Initial biomass phytotoxic effect on wheat crop was observed at higher dose but recovered in later stage of crop growth.

Table - 21 : Influence of treatments on weed population,weed biomass and grain yield.

Treatrment Dose (g/ha)	Weed Population m^2 at 60 DAS Grassy	Braodleaved	Total	Weed Biomass g/m^2 at 60 DAS	Grain yield (kg/ha)
Metribuzin 150	9.54	11.32	14.79	6.15	4209.0
Metribuzin 200	7.93	10.91	13.47	5.76	4343.0
Metribuzin 250	7.28	8.80	11.44	5.33	4443.0
Metribuzin 300	5.44	8.17	9.82	4.30	4670.0
Isoproturon 1000	4.64	8.88	10.01	4.74	4633.0
Weed free	0.71	0.71	0.71	0.71	5093.0
Weedy check	11.95	11.84	16.82	8.96	3176.0
CD at 5%	**0.84**	**1.04**	**0.96**	**0.44**	**85**

Weed count and weed biomass values are subjected to square root transformation.

WM-2 (ix) : Evaluation of fenoxaprop against *Phalaris minor* in wheat.

Anil Dixit and V.M. Bhan

The objective of this experiment was to find out the effect doses of fenoxaprop at different on the yield of wheat and associated weeds. *WH-147*, a dwarf variety was drilled @ 120 kg/ha on 30th Nov. 1996. The fertility level of the fields were maintained at N 120 kg/ha, P_2O_5&K_2O @ 60-80 kg & 40 kg respectively. Half of the N and full dose of P_2O_5 K_2O were applied at the time of sowing. The soil of the experimental field was rich in clay content. Seven treatments were replicated 3 times in randomized block design. The fenoxaprop-p-ethyl was applied at 4 doses *i.e* . 40, 60, 80 & 90 g/ha compared with isoproturon 1000 g/ha at 35 DAS. These herbicides were sprayed by dissolving in water @ 500 l/ha.

The observations were recorded on weed population/m^2 and weed dry matter/m^2 at 60 DAS. Grain yield of wheat was taken from net plot of 22.5 m^2 and converted per hectare. The data on weed population & dry matter is subjected to square root transformation.

The major weed population of experimental plot conisted of *Phalaris minor*, *Chenopodium album* & *Medicago* sp. Other weed species of minor infestation were *Rumex dentata Convolvulus arvensis* and *Vicia sativa.*

The application of fenoxaprop at 35 DAS was found to decrease weed population & weed biomass @ 90 g/ha. However, the isoproturon application @ 1 kg/ha was also at par with fenoxaprop @ 90 g/ha to reduce the population of *Phalaris minor* & dry wt. The grain yield was the highest under isoproturon @ 1 kg/ha and comparable with fenoxaprop @ 90 g/ha.

The aforesaid study revealed the fenoxaprop-p-ethyl can be substitute of isoproturon for the control of *Phalaris minor* to a greater extent.

It was observed that fenoxaprop acts fast & reveals the results within 2-3 days after application of treatment. The weeds stop growing & necrosis was observed at the base of tillers this was accompanied by

chlorosis to the leaf ultimately leading to necrosis the plants die generally within 20-25 days after treatment application.

Table - 22 : Effect of fenoxaprop on weeds in wheat

Treatment	**Weed population/m^2** (*P. minor*)	**Weed Dry wt.** (g/m^2)	GrainYield (kg/ha)
Fenoxaprop 40 g/ha	9.68	9.19	3903
Fenoxaprop 60 g/ha	9.11	8.51	4073
Fenoxaprop 80 g/ha	8.50	7.51	4166
Fenoxaprop 90 g/ha	7.51	6.03	4456
Isoproturon 1000 g/ha	5.19	6.66	4476
Weed Free	0.71	0.71	4893
Weedy Check	13.48	10.08	2983
CD at 5%	**0.60**	**0.46**	**76**

Weed count and weed dry wt. values are subjected to square root transformation

WM-2 (xiii) : Evaluation of sulfosulfuron against *Phalaris minor* in wheat

Anil Dixit and V.M. Bhan

The objective of this experiment was to find out the efficacy of sulfosulfuron for the control of *Phalaris minor* in wheat. WH-147, a dwarf variety was drilled on 30 Nov. 1996. The seed rate was @ 120 kg/ha. The experiment with 10 treatments was replicated 3 times in randomized block design. The sulfosulfuron was applied at 4 doses i.e. 20, 25, 30 & 45 g/ha at two different time of application *i.e.* 1-3 leaf stage (25 DAS) & 4-6 leaf stage (35 DAS). The herbicide was sprayed by dissolving in water @ 500 l/ha. The observation were recorded on weed population/m^2 and dry matter/m^2 at 60 DAS. Grain yield of wheat was taken from net plot of 22.5 m^2 and converted per hectare. The data on weed population & dry matter is subjected to square root transformation.

The major weed population of experimental plot conisted of *Phalaris minor*, *Chenopodium album* & *Medicago* sp. Other weed species of minor infestation were *Rumex dentata* *Convolvulus arvensis* and *Vicia sativa*.

The application of sulfosulfuron @ 45 g/ha at 1-3 leaf stage (25 DAS) was found to decrease the weed population & dry matter of *Phalaris minor* significantly when compared to other combination of treatments. Grain yield was also observed maximum at higher dose of sulfosulfuron i.e 45 g/ha applied at 25 DAS.

The aforesaid study revealed that control of *Phalaris minor* was effective when the weeds were 3 leaf stage and the control of the weeds both grassy & broadleaved significantly improved the grain yield of wheat. It was observed that sulfosulfuron translocated within the plant. After inhibitionof plant growth, chlorotic patches develop. The action of the product reaches its conclusion about 3-4 weeks. No phytotoxicity was observed on wheat.

Table-23 : Evaluation of sulfosulfuron against *Phalaris minor*

Treatment	Dose g/ha	Time of application	Population of *P. minor* (60 DAS)	Dry wt. g/m^2	Grain yield (kg/ha)
Sulfosulfuron	20	1-2 leaf	8.11	6.94	4586
Sulfosulfuron	25	1-2 leaf	7.48	6.25	4713
Sulfosulfuron	30	1-2 leaf	6.66	5.81	5026
Sulfosulfuron	45	1-2 leaf	4.51	5.08	5363
Sulfosulfuron	20	2-4 leaf	9.97	8.96	4400
Sulfosulfuron	25	2-4 leaf	9.75	8.11	4546
Sulfosulfuron	30	2-4 leaf	8.89	7.51	4643
Sulfosulfuron	45	2-4 leaf	6.95	6.34	4780
Isoproturon	1000	2-4 leaf	5.64	5.20	5336
Weedy			13.81	10.21	3106
CD at 5%			**1.53**	**0.66**	**94**

Weed count and weed dry wt. values are subjected to square root transformation

WM-2 (xiv) : Studies on the efficacy of clodinofop against *Phalaris minor* in wheat

Anil Dixit and V.M. Bhan

The objective of this experiment was to evaluate the efficacy of clodinofop against *P. minor* in wheat. The experiment was carried out at NRCWS, Jabalpur during *rabi* 1996-97. Wheat variety WH-147 was sown @ 120 kg/ha on 30 Nov., 1996. Eight weed control treatments comprised of clodinofop 40, 50 & 60 g/ha and isoproturon @ 1 kg/ha alone and combination of clodinofop + isoproturon were also included. The treatments were replicated thrice in randomized block design. The clodinofop was applied immediately after first irrigation. The herbicides were applied in 500 l of water/ha using flat fan nozzle. The data were noted for weed population by quadrates randomly at 60 DAS. The weed biomass was also recorded by 60 DAS. Grain yield of wheat was taken from net plot of 22.5 m^2 and converted per hectare. The data on weed population & dry matter is subjected to square root transformation.

The major weed population of experimental plot conisted of *Phalaris minor*, *Chenopodium album* & *Medicago* sp. Other weed species of minor infestation were *Rumex dentata* *Convolvulus arvensis* and *Vicia sativa.*

The weed population recorded at 60 DAS that the clodinofop application at all the rates reduced the population of *Phalaris minor* & other grassy weeds. Whereas, the population of *P. minor* was effectively controlled at higher rate of clodinofop @ 50 + isoproturon @ 250 g/ha (Table-1). As regard to weed biomass, the lowest weed biomass was also recorded under the combination of clodinofop @ 50g + isoproturon 750 g/ha. The application of clodinofop alone at different rates i.e. 40, 50 & 60 g/ha was also found superior to isoproturon application alone in reduction. The weed biomass even the lower dose of clodinofop @ 40 g/ha found superior to isoproturon. The grain yield of wheat was the highest under the combination of cladinofop @ 50 g + isoproturon @ 750 g/ha.

The aforesaid study revealed that the control of *Phalaris minor* was effectiven when clodinofop was effective when clodinofop was applied alongwith isoproturon. In general, clodinofop alone was better

to isoproturon for controlling *Phalaris minor* in wheat. There was not phytotoxicity on wheat crop when clodinofop was applied.

Table - 24 : Evaluation of clodinofop for the control of *P. minor* in wheat

Treatment	**Weed population/m^2** (*P. minor*)	**Dry wt.** (g/m^2)	Grain yield (kg/ha)
1. IPU 1 kg/ha	3.66	6.96	4630
2. Clodinofop 40 g/ha	6.86	6.25	4733
3. Clodinofop 50 g/ha	5.08	5.58	4866
4. Clodinofop 60 g/ha	1.91	5.08	4956
5. IPU + Clodinofop 750 + 40 g/ha	1.44	4.84	5160
6. IPU + Clodinofop 750 + 50 g/ha	1.38	4.72	5216
7. Weed Free	0.71	0.71	5460
8. Weed Check	9.88	9.40	3136
CD at 5%	**1.31**	**0.47**	**52**

Weed count and weed dry wt. values are subjected to square root transformation

WM-2 (xv) : Evaluation of tralkoxydim against annual grassy weeds in wheat

Anil Dixit and V.M. Bhan

The objective of this experiment was to find out the effect of tralkoxydim at different doses & time of application on the yield of wheat and associated weeds. The experiment with 14 treatments was replicated three times in randomized block design. The tralkoxydim was applied at 3 doses *i.e.* 200, 300 & 400 g/ha at 4 different time of application *i.e.* pre-em., 25 DAS, 30 DAS & 35 DAS. The herbicide was sprayed by dissolving in water applied @ 500 l/ha. The observation were recorded on weed population/m^2 and dry matter/m^2 at 60 DAS. Grain yield of wheat was taken from net plot of 22.5 m^2 and converted per hectare.

The major weed population of experimental plot conisted of *Phalaris minor*, *Chenopodium album* & *Medicago* sp. Other weed species of minor infestation were *Rumex dentata* *Convolvulus arvensis* and *Vicia sativa.*

The application of tralkoxydim as post em. was found to decrease the weed population and dry matter of weeds significantly when compared with its pre-em. applicaion.The lowest weed population and weed biomass was recorded under tralkoxydim @ 400 g/ha applied at 35 DAS. With regard to time of application definitely post em. application proved superior over pre-em. application. There was not much difference between 30 & 35 DAS.

The aforesaid study revealed that control of annual grassy weeds was effective when the weeds were 3-4 leaf stage (30-35 DAS) and contorl of weeds significantly improved the grain yield of wheat. It was observed that tralkoxydim enters the foliage and moves rapidly in the phloem tissue to the growing sprouts. Weeds die within 15-20 days after spray. The tralkoxydim did not show any phytotoxic effect on wheat crop upto 400 g/ha.

Table - 25 : Response of tralkoxydim to time and doses of application at 60 DAS in wheat (1995-96).

Treatment	Dose kg/ha	Time	Weed count/m^2 *P. minor*	Weed count/m^2 Total	Dry wt. (g/m^2)	Yield kg/ha
T1- Tralkoxydim	0.2	PE	6.17	9.80	9.68	3293
T2 -Tralkoxydim	0.3	PE	5.87	9.35	9.28	3483
T3- Tralkoxydim	0.4	PE	5.33	8.85	8.62	3563
T4- Tralkoxydim	0.2	25 das	5.70	8.89	8.70	3675
T5- Tralkoxydim	0.3	25 das	5.33	8.23	8.39	3817
T6- Tralkoxydim	0.4	25 das	4.74	7.46	8.02	3952
T7- Tralkoxydim	0.2	30 das	4.91	8.25	8.11	3680
T8- Tralkoxydim	0.3	30 das	4.21	7.44	7.84	4079
T9- Tralkoxydim	0.4	30 das	3.23	5.48	7.05	4212
T10-Tralkoxydim	0.2	35 das	4.25	7.10	7.55	3925
T11- Tralkoxydim	0.3	35 das	3.00	5.89	6.85	4045
T12- Tralkoxydim	0.4	35 das	2.33	4.81	6.14	4221
T13- Weed free			0.71	0.71	0.71	4483
T14- Weedy check			7.46	12.28	10.64	2527
CD at 5%			**0.43**	**0.36**	**0.34**	**231**

Table -26 : Response of tralkoxydim to time and doses of application at 60 DAS in wheat (1996-97)

Treatment	Dose kg/ha	Time	**Weed count/m^2** *P. minor*	Total	Dry wt. (g/m^2)	Yield kg/ha
T1- Tralkoxydim	0.2	PE	11.62	19.81	8.74	4440
T2 -Tralkoxydim	0.3	PE	10.66	18.52	8.11	4553
T3- Tralkoxydim	0.4	PE	9.75	16.74	7.51	4653
T4- Tralkoxydim	0.2	25 das	10.60	18.39	8.10	4566
T5- Tralkoxydim	0.3	25 das	9.40	17.90	7.60	4680
T6- Tralkoxydim	0.4	25 das	8.18	16.50	6.66	4840
T7- Tralkoxydim	0.2	30 das	7.77	18.37	7.85	4870
T8- Tralkoxydim	0.3	30 das	6.34	16.42	7.24	4990
T9- Tralkoxydim	0.4	30 das	4.78	14.43	6.14	5130
T10-Tralkoxydim	0.2	35 das	6.34	14.93	5.20	4876
T11- Tralkoxydim	0.3	35 das	4.51	13.07	4.04	5060
T12- Tralkoxydim	0.4	35 das	2.38	10.60	3.32	5276
T13- Weed free			0.71	0.71	0.71	5310
T14- Weedy check			15.89	27.93	11.51	3296
CD at 5%			**0.85**	**0.91**	**0.47**	**72**

Weed count and weed dry wt. values are subjected to square root transformation

WM-2 (iii) : Studies on the performance of fenoxaprop on grain yield of direct seeded rice and associated weeds.

Anil Dixit and V.M. Bhan

The objective of this experiment was to find out the effect of fenoxaprop at different doses and time of application on the yield of direct seeded drilled rice and associated weeds. 'Kranti' a high yields variety was drilled on June 1996. The seed rate was at 100 kg/ha. The crop with 11 treatments was replicated 3 times in randomized block design. The fenoxaprop was sprayed @ 45, 60 & 75 g/ha at 14, 21 & 28 days after sowing.

The experimental fields were infeted with following weeds - *Echinochloa colonum, E. crusgalli* & *Alternanthera* sp. etc. The application of fenoxaprop 28 days after sowing was found to decrease the weed population and dry matter significantly when compared to 14 & 21 days after sowing.

Grain yield was also observed maximum at 28 days after sowin when compared with 14 & 21 days after sowing. Application of fenoxaprop at 75 g/ha has significantly reduced the weed population and dry matter when compared with 45 & 60 g/ha. Similarly the grain yield was maximum a 75 g/ha when compared with that of 45 & 60 g/ha. The interacion studies revealed that the population and dry matter was markedly low and the grain yield was maximum when fenoxaprop was applied at 28 DAS @ 75 kg/ha.

Table- 27 : Effect of fenoxaprop at different doses and time of application in direct seeded rice

Treatment g/ha	Weed population/m^2 60 DAS	Weed dry wt. g/m^2	Grain yield kg/ha
Fenoxaprop 45 at 14 DAS	14.43	11.38	2284
Fenoxaprop 60 at 14DAS	13.72	10.35	2369
Fenoxaprop 75 at 14 DAS	12.62	9.40	2406
Fenoxaprop 45 at 21 DAS	11.16	8.27	2475
Fenoxaprop 60 at 21 DAS	10.54	7.77	2532
Fenoxaprop 75 at 21 DAS	9.05	7.05	2592
Fenoxaprop 45 at 28 DAS	8.10	6.25	2683
Fenoxaprop 60 at 28 DAS	7.05	5.06	2843
Fenoxaprop 75 at 28 DAS	6.25	4.04	3013
Weed Free	0.71	0.71	3263
Weedy Check	16.26	12.92	1862
CD at 5%	**0.75**	**0.70**	**58**

Weed count and weed dry wt. values are subjected to square root transformation

WM-2 (x) : Weed control efficacy of acetochlor (MON 8435) in soybean

Anil Dixit and V.M. Bhan

The objective of this experiment was to evaluate the efficacy of acetolachlor against various annual grasses and some broadleaved weeds in soybean. Eight treatments comprised of acetochlor @ 0.9, 1.35, 1.80 & 3.6 kg/ha as pre em. and alachlor 2.0 kg/ha compared with metolachlor @ 1 kg/ha, weed free and weedy check were treated in a randomized block design. All the herbicidal treatments were applied as pre em. two days after sowing.

The experimental field was infested with *Echinocloa colonum, E. crusgalli, Alternanthera sp., Commelina communis, Cichorium intybus, Cyperus rotundus, Corchorus olitorius, Ageratum conyzoides.* The weed population recorded at 60 days after sowing revealed that the pre emergence application of MON 8435 at all the rates tested reduced the population of weeds. Metolachlor @ 1 kg/ha was also effective to control these weeds. The effectivity of metolachlor & MON 8435 was almost similar. The weed biomass recorded at 60 DAS revealed that MON 8435 @ 3.6 kg/ha restricted the weed growth to a significant levels and the highest weed control efficiency was obsered under MON 8435 at higher rate.

The highest grain yield under the herbicidal application was observed in MON 843 at higher rates *i.e.* 3.6 kg/ha followed by metolachlor @ 1.0 kg/ha. The pre em. application of MON 8435, alachlor and metolachlor did not show any phytotoxic effect on crop. Application of MON 8435 upto 3.6 kg/ha did not show any abnormaliy on plant growth of soybean under pre emergence.

The aforesaid study revealed that the control of *Echinochloa colonum, E. crusgalli & Commelina sp.* were effective when MON 8435 was applied as pre-em.

Table- 28 : Performance of acetolachlor in soybean

Treatment (kg/ha)	Weed count/m^2 60 DAS	Weed Dry wt. (g/m^2)	Grain yield (kg/ha)
Acetochlor 0.9	15.76	12.40	680
Acetochlor 1.35	14.74	11.90	733
Acetochlor 1.80	14.34	11.15	851
Acetochlor 3.60	13.16	9.60	1222
Alachlor 2.00	15.59	11.68	858
Metolachlor 1.00	13.57	10.22	936
Weedy Check	18.74	13.91	555
Weed Free	0 .71	0.71	1399
CD at 5%	**0.84**	**0.56**	**68**

Weed count and weed dry wt. values are subjected to square root transformation

WM-2 (v) : Studies on the evaluation of ethoxysulfuron in combination with fenoxaprop on grain yield of direct seeded rice and associated weeds

Anil Dixit and V.M. Bhan

The objective of this experiment was to find out the effect of ethoxysulfuron at different doses in combination with fenoxaprop on the yield of direct seeded drilled rice and associated weeds.

'Kranti' a high yielding variety was drilled @ 100 kg/ha. The experiment with 14 treatments was replicated 3 times in randomized block design. The ethoxysulfuron was applied at 3 doses i.e. 10, 15 & 20 g/ha at 21 DAS. Anilofos was also applied alone @ 400 g/ha. The herbicide was sprayed by dissolving in water applied @ 500 l/ha. The observation were recorded on weed population/m^2 at 60 DAS. Grain yield of rice was taken from net plot of 22.5 m^2 and converted per hectare.

The experimental fields were infested with *Echinochloa colonum, Echinocloa crusgalli, Alternanthera sp., Phyllanthus niruri & Cyperus sp.* The application of ethoxysulfuron @ 20 g/ha alongwith fenoxaprop @ 60 g//ha at 21 DAS was found to decrease the weed population and dry matter significantly when compared to other combination of ethoxysulfuron and fenoxaprop. Ethoxysulfuron alone also found better when compared with fenoxaprop alone. Grain yield was also observed maximum at higher combination of ethoxysulfuron and fenaxoprop when compared with other treatments.

Table- 29 : Evaluation of ethoxysulfuron in combination with fenoxaprop in direct seeded rice

Treatments	**Weed population/m^2** 60 DAS	**Weed Dry wt.** g/m^2	Grain yield (kg/ha)
Ethoxy 10 g/ha	10.10	9.47	2273
Ethoxy 15 g/ha	9.19	8.50	2363
Ethoxy 20 g/ha	8.11	7.24	2543
Fenoxaprop 45 g/ha	10.47	10.97	2196
Fenoxaprop 60 g/ha	8.96	9.75	2413
E+F 10 + 45 g/ha	8.97	8.96	2686
E+F 15+45 g/ha	8.51	8.27	2750
E+F 20+45 g/ha	8.10	7.59	2870
E+F 10+ 60 g/ha	7.77	7.76	2893
E+F 15+60 g/ha	6.93	6.03	2980
E+F 20+60 g/ha	6.23	4.51	3176
Anilofos 400g/ha	9.65	8.85	2513
Weed Free	0.71	0.71	3283
WC	14.52	13.03	1886
CD at 5%	**2.15**	**0.58**	**73**

Weed count and weed dry wt. values are subjected to square root transformation

The aforesaid study revealed that control was effective when the weeds were 4-6 leaf stage and the control of the weeds significantly improved the grain yield of rice when ethoxysulfuron was applied in combination with fenoxaprop.

It was observed that ethoxysulfuron translocated within the plants. After inhibition of plant growth. clorotic patches develop and spread at first acropetally then basipetally. The action of the product reaches its conclusion about 3-4 weeks. Ethoxysulfuron acts by inhibition of the acetolachtate synthetase.

WM-2 (xvi) : Bioefficacy studies on chlorsulfuron and metsulfuron combination in wheat.

Anil Dixit and V.M. Bhan

The introduction of short stature high yielding wheat varieties though gave a boost to the productivity of this cropbut also brought in wake the problem of canary grass (*P. minor*). Moreover, the change in the ecological conditions induced by the adoption of rice-wheat cropping system on a large scale also favoured *P. minor* infestation in wheat. At present isoproturon, the aly available herbicide, is very widely used for the control of *P. minor* in wheat. In this experiment possibility has been explored to evaluate the new sulfonylurea compound viz. chlorosulfuron in wheat.

Table - 30 : Effect of chlorosulfuron alone & in combination with on weeds in wheat

Treatment (g/ha)	Weed count/m^2 at 60 DAS			Dry weight (g/m^2)	Grain yield (kg/ha)
	Grassy	BLW	Total		
IPU 750	11.03	2.91	17.40	8.74	4300
IPU 1000	8.42	14.05	16.38	7.77	4433
IPU 1500	5.56	14.48	15.51	5.67	4543
CHLORO 10 + IPU 750	8.88	14.98	16.97	8.02	4456
CHLORO 15 + IPU 1000	7.50	14.23	16.09	7.24	4533
CHLORO 30 + IPU 1500	4.51	11.94	12.77	5.84	4743
CHLORO 10 + MET	8.19	8.10	11.50	5.66	4853
CHLORO 15 + MET 4	7.42	8.10	10.97	5.20	4946
CHLORO 30 + MET 6	6.24	6.45	8.96	4.51	5056
WEED FREE	0.71	0.71	0.71	0.71	5263
WEEDY	18.63	18.15	26.00	10.35	3123
CD AT 5%	**0.80**	**1.21**	**0.89**	**0.62**	**86**

A field trial was conducted in the experimental area of NRCWS Jabalpur during *rabi* 1996-97 on a infeseted field of *P. minor* trial laid out in randomized block design with 11 treatments and three replications. Chlorosulfuron @ 10, 15 & 30 g/ha was applied alone and in combination with isoproturon or metsulfuron recorded the lowest weed biomass. Similar trend was also observed for final weed count. Minimum weed intensity of fray & broad leaved weeds was recorded in all the treatments of chlorosulfuron in combination with IPU & metsulfuron. Thereby the effectiveness against *P. minor*. all the weed control

treatments produced significantly more grain yield than unweeded crop. All the treatments of chlorosulfuron irrespective of their dose and combination with isoproturon or metsulfuron methyl produced higher grain yield compared to isoproturon alone.

The aforesaid study revealed that the control of *P. minor* was effective when chlorosulfuron was applied alongwith metsulfuron or isoproturon. In general, chlorosulfuron in combination with metsulfuron and isoproturon found better to isoproturon alone for controlling *P. minor* in wheat. There was no phytotoxic effect of chlorsulfuron in combination with metsulfuron & isoproturon on wheat.

Fig. - 3 : Multicrop herbicide testing

3.2 WEED PHYSIOLOGY, CHEMISTRY AND BIOTECHNOLOGY

WP-4.b(iii) : Studies on the effect of 2,4-D and its protectants on potato.

D. Swain and V.M. Bhan

Potato (*Solanum tuberosum* L. vr. Kufri Sinduri) was grown following the standard agronomic practices. 2,4-D protectants like aspartic acid, glutamic acid, Sodium glutamate, dextrose (all 100 ppm solution) and *P.minima* root extract (2.5%) were applied to potato crop and after 3 days, 2,4-D at 0.5 kg/ha was applied in between rows. Various observations like total chlorophyll at flowering and yield was taken into consideration.

It was observed that, the tomato crop was not adversely affected by 2,4-D when applied 3 days after the application of herbicide protectants, which is otherwise highly sensitive to 2,4-D. The best potection was offered by dextrose which was at par with control (without 2,4-D) and the yield values were 2.76 kg/m^2 and 2.86 kg/m^2 ,respectively.

Table -31 : Effect of 2,4-D and different herbicide protectants on potato.

Herbicide protectants	**Total chlorophyll (mg/g fresh weight) at flowering**	**Yield / m^2**	
		20 DAE	**35 DAE**
Aspartic acid	6.16	2.15	1.58
Dextrose	6.45	2.76	1.66
Glutamic acid	7.68	2.10	1.90
Glutathione	7.14	1.60	2.46
Sod. glutamate	13.99	2.50	1.86
P. minima root extract	9.98	2.50	2.36
Sole 2,4-D	8.17	2.16	2.40
Weedy	9.41	2.56	1.66
Weed free	8.70	2.33	2.10
Commercial	10.44	2.86	2.66
CD at 5%	-	**1.05**	**0.76**

WP-4-b (iv) : Studies on the sensitivity of potato crop to various doses of 2,4-D.

D. Swain and V.M. Bhan

Potato plants (vr. Kufri Sinduri) 35 DAS were treated with various doses viz. 0.5, 1.0 & 1.5 kg/ha of 2,4-D as post emergence and observations on the 2,4-D toxicity to the crop and its yield were taken into consideration. It was observed that potato plants were highly tolerant to 2,4-D. The plant morphology did not exhibit the usual symptoms of 2,4-D toxicity and was found normal in stand and growth. The yield was not significantly affected by 2,4-D application even in higher doses. This is for the first time, the tolerant nature of potato vr. Kufri Sinduri to high concentration of 2,4-D was observed and reported here.

WP-11-b : Studies on the allelopathic effect of *Sphaeranthus indicus* on Maize (*Zea mays* L. Vr. G-5).

D. Swain and V.M. Bhan

The experiment was conducted to assess the allelopathic potential of the extracts of *S.indicus* in different organic solvents on maize. The plants were grown in Hogland's nutrient solution (1:10 diluted with water). The solvents used for extraction were (i) 80% ethanol, (ii) ether, (iii) acetone, (iv) dichloroethane, (v) boiled in water, (vi) water at room temperature (water). O.5 g of the whole plant powder of *S. indicus* were soaked with 100 ml of solvent for over night, filtered, evaporated in a water bath at 55^0C and the residue redissolved in Hogland's nutrient solution. 4-5 days old maize seedlings (germinated on moist filter paper in petridish in seed germinator at 25^0C) were wraped at the base with non-absorbant cotton plug and fitted to the mouth of a conical flask containing the extract in Hogland's solution. The plants were allowed to grow under artificial light (5000 lux) for one weak and various growth parameters like primary and secondary root growth, shoot growth, chlorophyll content and development of anthocyanine pigment were taken into consideration. The injury to maize plant was noticed in the form of inhibition of root/shoot growth,reduction of chlorophyll and development of anthocyanine pigmentation in the stem (coleoptile) and leaf.

It was observed that water extract was highly toxic followed by chloroform and 80% ethanol. Boiled water extract was less toxic. The chlorophyll content (mg/g fresh leaf) were 2.53; 3.23; 4.99; 2.57; 6.61; 7.05; 6.35 and 6.25 respectively with water; 80% ethanol, ether, chloroform; Hogland's solution; acetone; dichloroethane and boiled water. It was observed that allelopathic factor in *S.indicus* may be a volatile substance since there were contrasting results with boiled and cold water extracts.

WP-4-d(ii) : Studies on the effect of atrazine on germination and growth of wheat (*Triticum aestivum* L. vr. WH-147) and *Phalaris minor*.

D. Swain and V.M. Bhan

The experiment was conducted in earthen pots to see the effect of different doses of atrazine from 0-5 kg/ha (at 0.5 kg/ha intervals) on germination and growth of wheat and *P.minor*. Various observation like number of plants/pot at 15 & 30 DAS, height of the plant at 15 DAS were taken into consideration. It was observed that germination of wheat was almost at par with control (0-atrazine) upto 1 kg/ha followed by slight decrease upto 5 kg/ha. However, the mortality of wheat was very less upto 1 kg/ha but became lethal in subsequent doses after 30 DAS. A similar result was also obtained with *P.minor*. The germination and mortality of *P.minor* was not affected by atrazine upto 0.5 kg/ha but significantly affected at 1 kg/ha. Therefore, atrazine at 1 kg/ha has a selective advantage for wheat against *P.minor*.

WP-4-d(i) : Studies on the effect of diuron on the germination and growth of wheat and *Phalaris minor*.

D. Swain and V.M. Bhan

The experiment was conducted in earthen pots to see the relative sensitivity of wheat and *P.minor* to different concentrations (0-5 kg/ha, at increment of 0.5 kg/ha) of diuron. Various observations like number of plants/pot at 30 & 60 DAS and plant height at 15 DAS were taken into consideration.

It was observed that the germination of wheat and its growth was not affected upto 1.5 kg/ha of Diuron. The doses from 2 kg/ha to 3.5 kg/ha were moderately toxic and above 3.5 kg/ha, it was highly toxic to wheat. *P.minor* was found to be relatively more tolerant to Diuron even in 5 kg/ha doses, as the height of the plant remained more or less same as that of control. It was, therefore, revealed that diuron was relatively more toxic to wheat than to *P.minor*.

WP-4-a : Studies on the allelopathic effect of *Echinochloa colonum* (l.) Link residue on paddy

D. Swain and V.M. Bhan

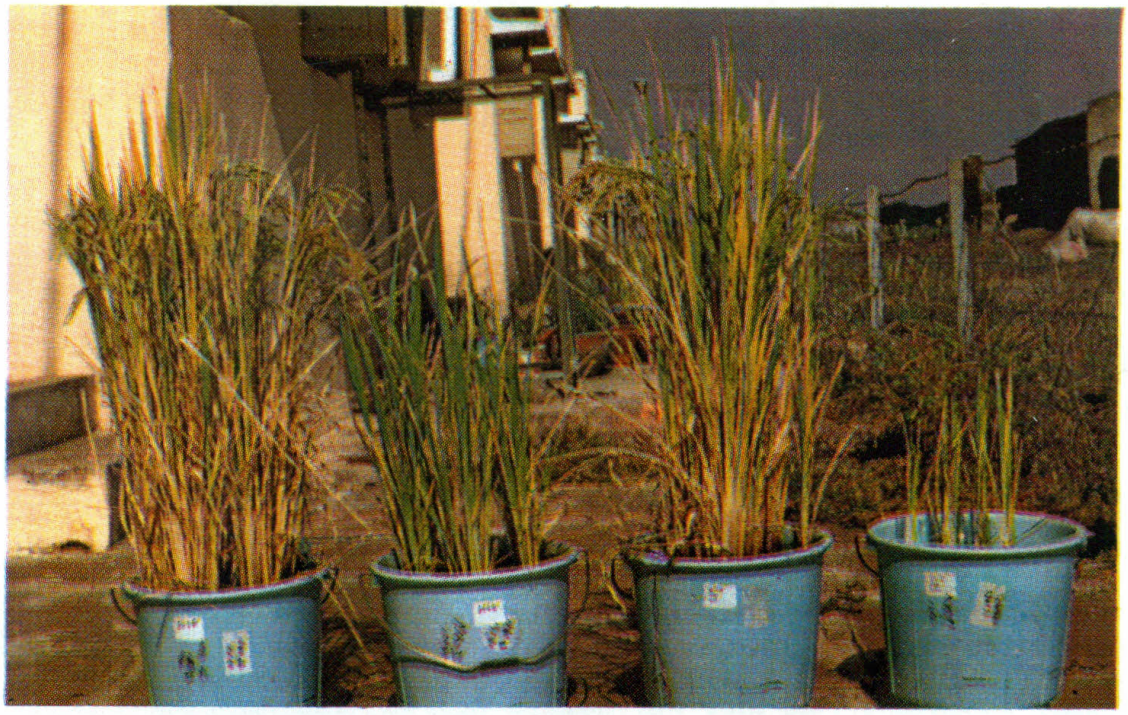
The effect of *E. colonum* biomass both fresh and decomposed were studied on rice (*Oryza sativa*, Vr. Kranti) during *kharif*, 1996 in plastic buckets. Healthy *E. colonum* plants with panicles were collected from the rice field and incorporated into soil in the proportion of 1:20 in plastic buckets. In one set of experiments, 20 days old rice nursury (dapog) were transplanted into pots containing fresh *E. colona* biomass. In another set up, first *E. colonum* biomass was allowed to decompose in the soil and then transplanting was done. Treatments of both fresh and decomposed weed residue with and without N-fertilizer were used. Checks with and without fertilizer were aso maintained. Various observations like plant height, tillars/plant at 30 & 60 DAT numbers of effective tiller/hill, length of panicle, no. of sterile/fertile grains/panicle and grain test weight were taken into consideration.

It was observed that the decomposed weed residue was extremely toxic to rice which completely suppressed tillering and fertile grain formation even in the case with N-fertiliser. In the case of fresh residue the toxic effect was also severe which drastically reduced the growth and yield of rice. The fresh residue when combined with N-fertilizer, however, the effect on growth and yield was at par with control. The expeiment showed that *E. colonum* residue was highly toxic to rice which could be averted when supplemented with N-fertilizer. The *E. colonum* residue has no green manuring effect on rice as generally thought (**Table-32**).

Table - 32 : Effect of fresh and decomposed *Echinochloa colonum* residue on rice

Treatment	Plant height (cm)		No. of tillers/hill		Grains/panicle		Total	Grain test weight (g)
	30 DAT	60 DAT	30 DAT	60 DAT	Fertile	Sterile		
O+O	32.46	33.85	-	-	0.0	8 .00	8.00	-
O+F	48.23	64.08	3.50	6.0	69.0	91.32	160.32	26.20
FEC+O	11.90	36.92	-	1.33	0.0	59.00	59.00	-
FEC+F	45.30	61.08	3.5	9.71	98.33	65.33	163.66	24.20
DEC+O	9.80	21.65	0.0	0.0	-	-	-	-
DEC+F	43..04	59.32	2.15	4.23	0.0	148.00	148.0	-

F - Standard dose of fertiliser; FEC - Fresh *Echinochloa colonum* residue
DEC - Decomposed *Echinochloa colonum* residue



(a) Zero fertilizer (sterile soil) (b) Standard dose of fertilizer [SDF]
(c) Fresh residue (d) Fresh residue + SDF

(e) Decomposed residue + SDF (f) Decomposed residue

Fig - 4 : Allelopathic effect of *Echinochloa colonum* (l.) Link residue on the growth and yield of rice.

WP-4-c : Studies on the effect of different herbicide protectants on tomato against 2,4-D injury

D. Swain and V.M. Bhan

Tomato vr. Sutton's Pusa ruby was sown in lines by hand (seed:sand mixture 1:50) and subsequently grown following the standard agricultural practice. Gapfilling was done after 10 DAS and thinning at 20 DAS. One month old plants were treated with (sprayed) herbicide protectants (HPS) like *Physalis minima* root extract (2.5%) dextrose (100 ppm) glutamic acid (10 ppm), aspartic acid (100 ppm) glutathione reduced (100 ppm), sodium glutamate (100 ppm).

The HPS were sprayed on tomato plants (fully drenched) 3 days before the application of 2,4-D.

Various parameters like number of plants/m^2, chlorophyll content at flowering, weight/fruit, dry weight of plant at harvest, yield of tomato and weed dry matter/m^2 were taken into consideration. It was observed that the plant population, which was highly susceptible to 2,4-D remained unaffected when 2,4-D was applied in between rows of tomato (0.5 kg/ha) after the application of HPS. The highest population was encountrered in case of glutamic acid treatment and the lowest in the case of sole 2,4-D followed by

glutathione. The heighest chlorophyll content was obtained with glutamic acid and that of weight/fruit with *Physalis minima* root extract. The highest yield was noted with dextrose treatment the highest dry weight/crop plant was noted with aspartic acid and the lowest weed dry matter with dextrose treatment. It was interesting to note that these herbicide protectants could protect tomato against 2,4-D injury very effectively without adversely affecting stand and yield (**Table - 33**).

Table - 33 : Effect of 2,4-D and its protectants on growth and yield of Tomato

Treatment	No. of plants /m^2 at 60 DAS	Chlorophyll mg/g fresh wt.	Wt./fruit (g)	Yield/m^2 (kg)	Dry wt./plant (g)	Weed dry wt/m^2 (g)
Asparfic acid	26.66	7.23	38.29	8.98	72.69	14.31
Dextrose	27.33	9.00	41.67	10.50	40.76	11.79
Glutamic acid	29.33	11.11	44.59	9.90	37.39	21.05
Glutathione	21.45	8.25	41.14	6.85	38.80	45.71
Sodiglutamate	26.38	8.07	45.61	5.43	58.17	35.26
P. minima root extract	26.00	7.50	51.28	5.30	34.60	34.06
2,4-D	3.00	8.06	15.08	0.36	12.13	56.43
Weedy	29.66	6.98	35.31	2.18	31.11	190.51
Hand weeding	27.0	7.5	45.03	6.45	38.27	26.44
Commercial	21.0	8.64	39.25	7.0	39.13	46.55
CD at 5%	**21.33**	-	**13.0**	**2.23**	**30.69**	**40.57**

WP-4-b : Study of occurrence and distribution of glutamate dehydrogenase and glutamate synthetase in *Physalis minima* and *Lycopersicon esculentum* Mil. and their role in *in situ* 2,4-D detoxification.

D. Swain and V.M. Bhan

The activitiy of glutamte dehydrogenase (L-glutamate : NAD $^+$ oxidoreductase - EC 1.4.1.2, "GDH" and glutamate synthetase (glutamate : $NADP^+/NAD^+$ oxidoreductase - EC 1.4.1.13", GS") enzymes which contribute to the glutamic acid pool of the plant (glutamic acid being a 2,4-D protectant by formation of weakly irreversible conjugates) were measured in the leaf, stem and root tissues of 2,4-D resistant and sensitive plants. *P.minima* and *L. esculentum* respectively, before and 1 & 24 hour after 2,4-D application. A high GDH activity was noted in roots of L. *esutentum* (13 X 10^3 nanomole/min/mg protein) and *P. minima* (6.7 x 10^3) control plants. After 2,4-D application, reduction in GDH activity was noted except in roots of *P. minima*. The GS activity had increased in all tissues of *P. minima* after 2,4-D application unlike tomato.

It was noted that both the enzymes play an important role in detoxifying 2,4-D in resistant *P. minima* The sensitive tomato plants had but little activities of these enzymes which might not yield sufficient glutamic acid to form conjugates with 2,4-D to reduce its toxicity to a non toxic level.

3.3 BIOLOGICAL WEED MANAGEMENT SYSTEM

PLANT PATHOLOGY

BWM-1-A : Biological control of weeds using plant pathogens.

L.P. Kauraw and V.M. Bhan

Surveys were conducted for collecting the palnt parts with which plant pathogens were associated with *Parthenium hysterophorus*, *Cyperus rotundus*, *Phalaris* from April 1996 to March 1997. The areas surveyed were around Jabalpur, Katni and Chargawa. Some of the samples exhibited leaf spots and wilting of Parthenium plants and deep brown spots on *Cyperus rotundus*. No clear disease symptoms on *Phalaris minor* could be observed.

BWM-1-A-b : Isolation of pathogens :

From infected samples of *P. hysterophorus* L.,fungi *Fusarium pallidoroseum, Colletotrichum gloeosporioides, Alternaria alternata, Sclerotium rolfsii* and *Sclerotinia sclerotiorum were* isolated from Katni, Seoni, Chargawa Road, Gadarwara, Mandla, Ludhiana, Karnal, NRC-WS Farm and around Jabalpur city. In the NRCWS farm *A. alternata* was found attacking the leaves, branches and flowers of *P. hysterophorus*. This fungus seems to be very effective in killing *P. hysterophorus* flowers. No pathogen could be isolated from *P. minor*. In *Cyperus rotundus*, *Fusarium* sp. from Katni area and rust *Puccinia canaliculata* from Karnal and Ludhiana were found associated.

BWM-1-A-g : Effect of spray of fungul suspension of *Sclerotium rolfsii* for the control of *Parthenium hysterophorus.*

L.P. Kauraw, A. Chile and V.M. Bhan

In this investigation, the effect of *Sclerotium rolfsii* at different growth stages of *Parthenium hysterophorus* showed that the spray of the fungus from 0 DAS to 75 DAS could reduce plant height, number of branches/plant and number of flowers/plant. Maximum reduction in height, number of branches/plant and no. of flowers/plant was obtained in spraying of the fungal suspension 0-30 DAS.

BWM-1-A-g : Effect of spray of *Sclerotinia sclerotiorum* mycelium suspension in the control of *Parthenium hysterophorus.*

L.P. Kauraw, A. Chile and V.M. Bhan

This experiment was framed to observe the effect of spray of *S. sclerotiorum* suspension on the *P. hysterophorus*. It was observed that the spray of *Sclerotinia sclerotiorum* fungus suspension from 0 DAS to 15 DAS could cause maximum reduction in height/plant, number of branches/plant and number of flower/plant.

BWM-1-A-g : Effect of *Trichoderma viride* mycelial and spore suspension spray on the control of *Parthenium hysterophorus*.

L.P. Kauraw, A. Chile and V.M. Bhan

This experiment was conducted to find out the suitable time of spray of *T. viride* susspension. It was observed that the spray of the fungus suspension from 0 DAS to 75 DAS could reduce plant height, number of branches/plant and number of flowers/plant. Maximum reduction in height, number of branches/plants and number of flowers/plant was obtained in plots sprayed from 0-30 DAS and least when sprayed at 60-75 DAS.

BWM-1-A-i : Effect of marigold population on the growth and survival of *Parthenium hysterophorus* .

L.P. Kauraw, A. Chile and V.M. Bhan

This experiment was designed to observe the smothering effect of marigold on parthenium stand at different ratios. Results revealed that Marigold suppressed Parthenium in all the tested ratio. It was observed that during first 35 days Parthenium grows very slow and marigold plant grows very fast. It is assumed that due to fast growth of marigold in its early growth, parthenium get suppressed and later on the whole area is covered by marigold plant and the suppressed plants of parthenium becomes unable to compete with them. There was reduction in growth parameters of parthenium such as the height, no. of branches and flowers/plant. Marigold flowering plant is found to suppress the growth of parthenium and could successfully replace it. In these plots, second generation of parthenium could not get re-established and very few plants which could come up were not normal, their root system was damaged and the plant could not develop further. The recycling of parthenium could be stopped for 2-3 years. It seems that chemical compound released by the roots of marigold plant inhibits the establishment of parthenium .

Table-34 : Effect of Marigold population on the *Parthenium hysterophorus* (1995-96)

Treatment Number of plant*	P : M Ratios	Parthenium height / plant (cm)	No. of branches per plant	No. of flowers per plant	No. of plant regerminated
50 25	(1 :.5)	118.33	3.86	668.33	4.00
50 50	(1: 1)	102.40	3.00	392.73	2.33
50 75	(1:1.5)	109.46	2.80	314.53	0.33
50 100	(1:2)	106.00	1.86	319.06	4.00
50 125	(1: 2.5)	91.60	2.10	162.86	0.66
50 150	(1:3)	103.20	2.60	246.26	0.33
50 175	(1:3.5)	101.73	2.26	238.66	0.66
50 200	(1:4)	93.46	1.80	177.33	0.00
Control		125.06	5.60	985.66	28.33

* Number of plants of Parthenium and marigold sown in 3x2 sq.m. plot area

P - Parthenium **M** - Marigold

BWM-1-A-m : Effect of seed treatment and different concentrations of culture filterate of *Fusarium pallidoroseum* on the *Phalaris minor* seed germination by seed dip treatment (filter paper).

L.P. Kauraw, A. Chile and V.M. Bhan

Culture filterate of *Fusarium pallidoroseum* at different concentrations i.e. 25, 50, 75 and 100 percent was tested against *P. minor* for its germination. The results indicated that seeds were colonised by the fungus and inhibited seed germination by 84%. Fungus filtrate (100 percent) could reduce the seed germination 48 percent whereas lowest reduction of seed germination (12%) was obtained in 25% filterate as 100% in compared to control. It indicates that with increasing concentration of the culture filterate there was increase in the reduction of germination of *Phalaris minor* seeds .

BWM-1-A-m : Effect of seed treatment with *Trichoderma viride* on *Phalaris minor* seed germination and root/shoot length (test tube agar method).

L.P. Kauraw, A. Chile and V.M. Bhan

The seeds of *P. minor* were treated with *T. viride* and tested by test tube agar method. This study showed that *Trichoderma viride* delayed *Phalaris minor* seed germination by 2-3 days as compared to control. In *Phalaris minor* seedlings root and shoot length was reduced by 31 and 70 per cent, respectively.

BWM-1-A-k : Effect of seed treatment of wheat with *Trichoderma viride* and its effect on germination of *Phalaris minor* and wheat .

L.P. Kauraw, A. Chile and V.M. Bhan

For knowing the effect of wheat seed treatment with *Trichoderma viride* and its effect on *Phalaris minor* seed germination (untreated), the treated seeds of wheat and untreated seeds of *Phalaris minor* were sown in soil having alternate rows of wheat and *Phalaris minor.*

Results revealed that *Trichoderma viride* treated wheat seed could reduce seed germination of *P. minor* and also reduced root/shoot length by 22 and 17.41 per cent respectively. It indicates that seed treatment of wheat with *Trichoderma viride* can help in controlling the *Phalaris minor* weed.

BWM-1-A-m : Effect of seed treatment with *Trichoderma viride* on *Phalaris minor* and wheat seed germination on filter paper.

L.P. Kauraw, A. Chile and V.M. Bhan

Seeds of both wheat and *Phalaris minor* were treated with *Trichoderma viride* and tested by blotter method. Results showed that *Trichoderma viride* inhibited seed germination of *Phalaris minor* by 74 % whereas wheat seed germination was 100 percent. *Trichoderma viride* enhanced seed germination of wheat by one day and delayed *Phalaris minor* seed germination by 2-3 days. The root and shoot length was

better in wheat as compared to control whereas *Phalaris minor* root and shoot length was reduced by 5 and 24 per cent, respectively.

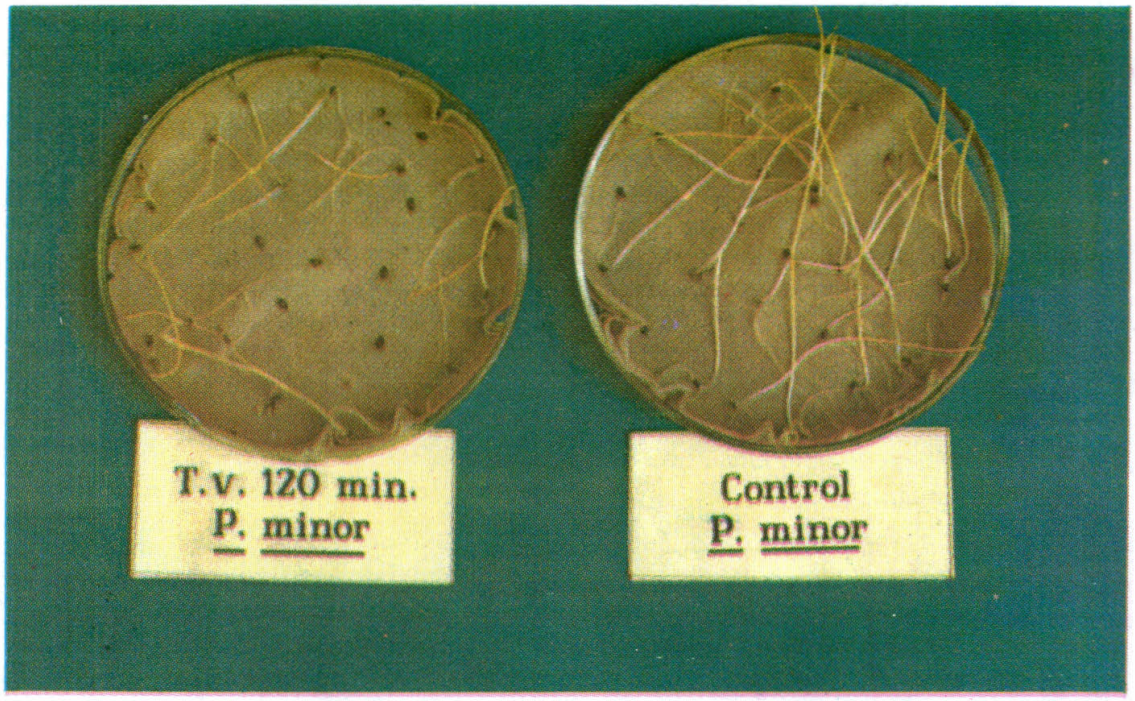


Fig.-5 : Seed treatment of *Phalaris minor* with *Trichoderma viride*

BWM-1-A-k : Effect of soil amendment with *Trichoderma viride,* neem oil cake and saw dust on germination of wheat and *Phalaris minor* seed.

L.P. Kauraw, A. Chile and V.M. Bhan

Study was conducted to observe the effect of soil infestation of *Trichoderma viride* grown on neem oil cake and saw dust applied at the rate of 100, 150 and 200 g/m^2 . Study revealed that *Phalaris minor* seed germination was reduced 34-50%, in all the treatments as compared to control (100%) in control. Maximum inhibition of seed germination was in the treatment 200 g/m^2 **(Table-33).**

Trichoderma viride grown on saw dust, neem oil cake and saw dust applied at the rate of 100, 150 and 200 g/m^2 could also reduce root length and shoot length of *Phalaris minor.* Maximum root length (58.78) of *Phalaris minor* was inhibited at 200 g/m^2 *Trichoderma* viride grown on saw dust as compared to neem oil cake. Maximum shoot length (20.41 %) was inhibited in the treatment 200 g/m^2 of *Trichoderma* grown on neem oil cake as compared to grown on saw dust.

Table-35 : Effect of soil infestation of *Trichoderma viride*, Neem oil cake and saw dust on wheat and *Phalaris minor* seed germination (1996-97)

Sl. No.	Treatment	No. of sown seeds		No. of germinated seeds	% inhibition of germination	Root length (cm)	Shoot length (cm)	*P. minor* % inhibition		Wheat	
		P. minor	Wheat	*P. minor*				RL	SL	Root length	Plant height
1.	**Saw dust**										
	100 g/m^2	100	80	95	0.04	6.48	7.27	1.81	6.43	14.38	20.00
	150 g/m^2	100	78	96	10.34	5.88	7.61	10.90	2.05	18.97	21.13
	200g/m^2	100	79	96	9.19	6.46	7.48	2.12	3.73	14.22	20.88
2.	**Neem oil cake**										
	100 g/m^2	100	57	92	34.48	6.23	7.60	5.60	2.18	18.49	19.57
	150 g/m^2	100	57	97	34.48	5.33	7.11	19.24	8.49	19.35	21.21
	200 g/m^2	100	50	97	42.52	4.97	6.22	24.69	19.94	17.67	21.31
3.	***Trichoderma viride*** (Sd)										
	100 g/m^2	100	57	100	34.48	3.37	7.02	48.93	9.65	17.12	21.22
	150 g/m^2	100	54	100	37.93	2.67	7.61	59.54	2.05	13.04	20.68
	200 g/m^2	100	43	100	50.57	2.72	7.30	58.78	6.04	14.90	19.12
4.	***Trichoderma viride (NC)***										
	100 g/m^2	100	59	100	32.18	3 62	6.21	14.48	20.07	13.71	20.77
	150 g/m^2	100	53	100	39.08	5.30	7.30	19.69	6.04	20.23	21.55
	200 g/m^2	100	52	100	40.22	4.92	6.15	34.14	20.48	17.92	21.04
5.	**Control**	100	87	100	-	6.60	7.77	-	-	14.78	20.81

BWM-1-A Effect of seed treatment with *Gliocladium virens* on *Phalaris minor* seed germination and root, shoot length (test tube agar method)

L.P. Kauraw, A. Chile and V.M. Bhan

Results revealed that *Gliocladium virens* could inhibit seed germination of *Phalaris minor* in agar media by 90 per cent as compared to control (100%) and in germinated seedlings, root/shoot length was reduced by 100 and 84 per cent, respectively .

BWM-1-A : Effect of *Gliocladium virens* on *Phalaris minor* and wheat seed germination (filter paper)

L.P. Kauraw, A. Chile and V.M. Bhan

It is observed that *Gliocladium virens* could reduce seed germination of *Phalaris minor* up to 84% as compared to the control (100%). There was no adverse effect on the wheat seed treated with *Gliocladium virens*. *G. virens* delayed *Phalaris minor* seed germination by 2-3 days. The root (15.90) and shoot (18.51) length was better in treated wheat as compared to control (root length 10.91 and shoot 16.52) whereas in case of *Phalaris minor* root and shoot length was reduced by 55 and 67 per cent ,respectively.

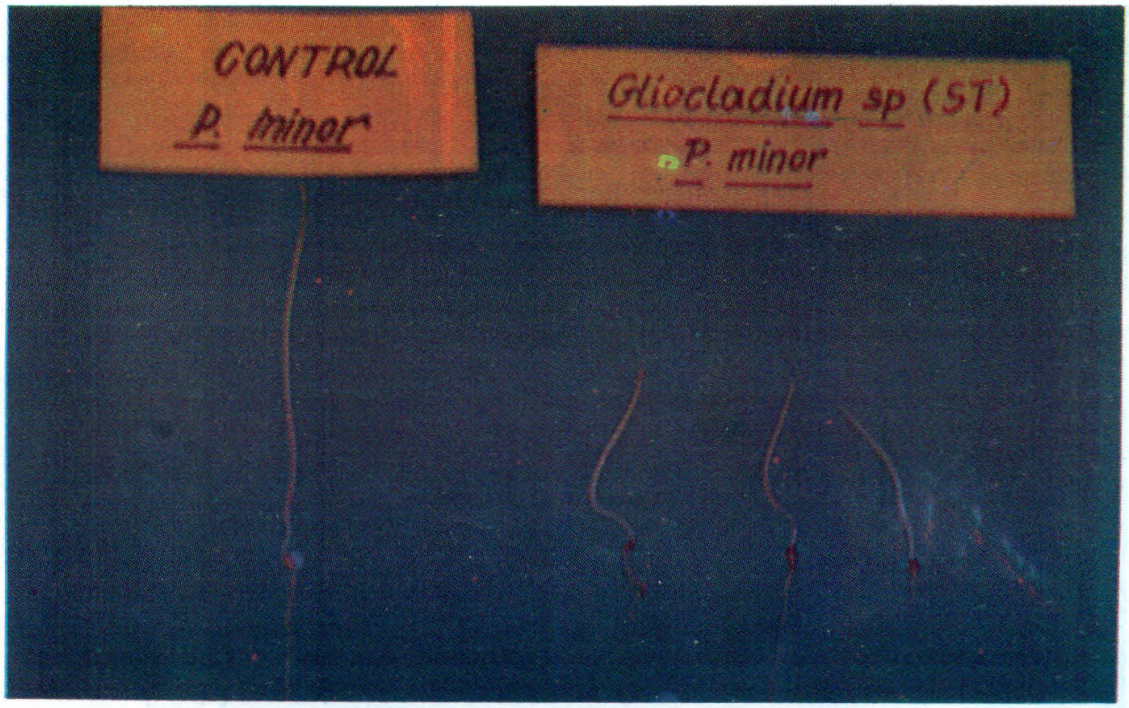


Fig. - 6 : *Gliocladium virens* inhibits the growth and developments of *Phalaris minor*

ENTOMOLOGY

BWM-2.a : Biological control of Water hyacinth by insects

Sushilkumar and V.M. Bhan

Monthly surveys were made in different three ponds of Jabalpur initially selected after overall survey. From each pond, samples were collected and each plant was searched for adult weevils, grubs and pupae and total population was counted and pooled. It was found that maximum population occurred in "Man Singh' pond followed by "Rani Tal" and Mahanadapond. Total density of water hyacinth was gradually reduced in each pond but latter on population build up of water hyacinth occurred. In "Mahanada" pond other weeds *viz.*, cattail (*Typha*) sp. and alligator weed (*Alternenthra philoxeroides*) took the niche vacated by the action of weevil. During rainyn season, the population of water hyacinth again incresed in the pond.

It is interested to note that the trend of population of *Neochetina* spp. is some what differfent than the previous year. This year, there was increase in the poulation in the "Ranital" pond after rainy season but in coming months, population densityy declined due to the action of weewil. Over all population of beetles in Jabalpur when pooled togater remained high during August to December and gradually declined with the dry season corresponding to the decline of water hyacinth density.

The reason of less effectiveness of weevils in the Man Singh's pond may be its rapid drying during summer season due to which heavily infested population of water hyacinth dried and simultaneously the weevil population also died. Due to less water on the bank side where generally water hyacinth population come from the high water level side due to floating action, stayed and naturally died but released a lot of seeds before death to germinate in the forthcoming suitable time.

The reasons for non-effectiveness of the weevil in Mahanada pond may be adding of rich nutrients from the adjoining areas with the water from the houses due to which weed grow rapidly in comparison of pupulation build up of bioagent. In "Ranital", overall population of water hyacinth was found high and it seems that in spite of appreciable infestation of water hyacinth, no complete releife is likely to be occured from the water hyacinth.

This year too water hyacinth was also found infested by the aphid but attack was negligible. This year so far, the attack of lepidopteran larvae *Diacrasia obliqua*, a polyphagous pest, was not found. Tried were also made to search natural enemies of *Neochetina* weevils but no parasite and predator was recorded on them.

This year, another pond in the Jabalpur named "Hanumantal" was infested badly by the water hyacinth. About 4o per cent of the pond area was covered by this weed. This alarming situation was brought to the kind notice of the local administrration and manual removal of weed was suggested. The action was taken by the Jabalpur Municipility and weed was checked in time. During survey, it was observed that *Neochetina* spp. were present in the pond but the population of weevile was very less. The pond is under surveilance for further outbreak of the weed. It is interesting to note that the niche vacated by the water hyacinth is being taken by another aquatic weed *Alternanthra philoxeroides*. This weed also has enormous capacity to spread rapidly.

Fig.-7 : A pond badly infested by Water hyacinth indicating the brown patches resulted from the attack of exotic weevil (*Neochetina sp.*)

Fig.-8 : A pond view where Alligator weed covering niche vacated by Water hyacinth

areas where it was found to suppress parthenium. Suppression and subsequent replacement of parthenium by *Cassia sericea* in Karnataka has already been recorded and its deliberate use to manage parthenium has been demonstrated and advocated . Interference in the form of allelopathic effect or by competition have been found to influence succession of vegetation in many plant communities The interference role of *Cassia tora* has also been noticed in South India but there *C. sericea* is more prevalent than *C. tora* and has high capacity to suppress parthenium than other competitive species .As the growth and spread of carrot grass parthenium remained unchecked in spite of several control methods, here an attempt has been made to find the role of *C. tora* in parthenium suppression in Jabalpur.

To know the actual species of Cassia prevalent in the area a survey was made and samples of *Cassia* species were collected and got identified. To get an idea about the peoples awareness about the parthenium and role of *Cassia tora* in suppression of parthenium, interviews were taken from the people inhabiting urban, semi-urban and rural areas of Jabalpur and adjoining areas.

To see the actual effect of *C. tora* on parthenium in the natural conditions of the Jabalpur . Three locations were marked, one with a pure stand of parthenium and other two with pure stand of *C. tora* in September 1995. Out of these, *C. tora* dominated locations, *C. tora* was removed from one location in second fortnight of September while at the other location , *C. tora* was allowed to grow uninterrupted naturally to complete its life cycle. In September 1996, population of parthenium was recorded in one metre2 area by taking 5 samples from each locations.

Ten gram dried seeds of *C. tora* were washed and soaked in 100 ml of distilled water at 26$\pm$ 2^{0}C for 12 hours. The leachates were filtered through triple layer of muslin cloth. 25 parthenium seeds were placed on a filter paper in 9.0 cm diameter Petri dish and incubated at 25$\pm$2^{0}C (which is supposed to be optimum temperature for the germination of parthenium seeds). The seeds were kept moist by 5% of leachates of *C. tora* as and when required. In control, only double distilled water was used. The observations for germination inhibition was taken after 14 days (which is considered to be optimum period for germination of parthenium).

Survey and awareness of people :

Survey revealed that three species namely *Cassia tora* L., *C. obtusifolia* L. and *C. occidentalis*, locally called Chakora, Puar and Ciritha, respectively, are found in Jabalpur and adjoining area. Among these, *C. tora* was most dominated weed in wastelands and along the roadside. Some times these species were also found infesting agricultural fields adjoining the road side but the occurrence in agricultural fields was very low. Interviews with local inhabitants revealed that all most all were aware about the ill effects of parthenium in context to irritation of skin and around the eyes but non revealed any ill effect of *C. tora*. About 5% interviewees revealed that seeds of *C. tora* and *C. obtisifolia* are used as purgative and useful in curing cough, whooping cough and skin disease. Ten per cent interviewees mainly from rural areas told that seeds of *C. tora* are mixed in the cattle feed after drying them about 15 days. Ninty per cent interviewees of the opinion that the dominance of the *C. tora* at the places of parthenium locations was a recent phenomenon being observed about the year 1990.

Effect of *C. tora* on the germination of parthenium in natural conditions. Our field observations showed that in pure parthenium stand, mean parthenium density was 30.2/m2 while it was

Fig.-9 : Dominance of *Cassia tora* over Parthenium but early germinated Parthenium Plant are able to survive amidst the *Cassia tora*

Fig.-10: A suppressed Parthenium plant amidst the *Cassia tora* in a waste land.

only 8.8/m^2 in the *C. tora* dominated locations. Where pure patches of *C. tora* were removed in the second fortnight of September last year, the mean density was recorded about 28.6/m^2. It was observed that in pure patches of *C. tora*, parthenium had to struggle hard to survive

Effect of *C. tora* leachates on parthenium germination:

In laboratory conditions, only 63.45% (mean of 5 replication) germination of parthenium seeds was observed when treated with 5% of leacheates while at 10% leachates only about 11% germination was observed while it was about 88% in case of control treated with distilled water. ne of the important factors of parthenium rapid spread throughout the contrary is attributed to its allelopathic properties which inhibit other plant species germination. Our study clearly conforms with the earlier work carried out on the role of an another species C. sericea in the Karnataka state of India by many workers. In Jabalpur, instead of *C. sericea*, *C. tora* is one of the dominated species replacing parthenium pure stands naturally. In fact, after initial rains in June-July in Jabalpur, both parthenium and *C. tora* start to germinate but the young seedlings of *C. tora* are larger than parthenium due to which *C. tora* grows fast and take over the parthenium. Due to shade competition effects, parthenium remains suppressed amidst the *C. tora* stand. However, those parthenium plants which germinate early than *C. tora* are able to take over late germinated *C. tora* seedlings and are able to survive and produce viable seeds. Under this situations, *C. tora* may grow well but remains below the parthenium canopy without being affected. This initial superiority of *C. tora* was found one of the important factors which helps the *C. tora* in suppressing parthenium leading to low biomass production besides the allelopathic effects.

BWM-2-C : Studies on the pest potential by the Mexican beetle, *Zygogramma bicolorata* introduced for biocontrol of parthenium.

Sushilkuamr and V.M. Bhan

2.C.1 Spread of Mexican Beetle at Vindhyanagar:

Monthly survey was made at Vindhyanagar (where the beetle *Zygogramma bicolorata* was released in `1991) throughout the year in question from April 1996 to March 1997. Survey revealed that beetle has spread maximum up to about 14-28 km far towards from the released point in all the direction except towards in one side which is blocked by a large reservoir of water. Since last year, about 8 km more spread of *Z. bicolorata* has been observed towards east and north east side, about 5 km more towards north side and about 8 km towards the west side.

2.C.2. Field Monitoring of the *Zygogramma bicolorata* at Vindhyanagar

(I). Seasonal abundance of Mexican beetle:

The population density trend of the beetle was almost same as was noticed in the previous year. Population was recorded even in the hottest months of May and June when temperature touched about 45^{0}C during day time but during this period mostly adult beetles were seen. Beetles were found even in the hottest mid day on the plants when it was very torturous to stand in the direct sunlight in the open field. In May and June, eggs were also observed but it was seen that most of the eggs which were not laid at the sites of sufficient moisture and cool were desiccated in the heat but those eggs which were laid at the proper sites

were able to develop larvae and subsequently adults. Like previous year, in August 96, population density of beetles was high but at the end of September, population declined drastically. By the end of October 96, it was hard to locate the beetles on the parthenium plants except in stray cases. By the end of October, temperature of the region began to decline which is correlated with the decline of parthenium population drastically. However, a fraction of population, although in very low frequency, always occurred in the area, particularly near the places of water sources where parthenium plants got opportunity to grow. During March 97, all the stages of *Z. bicolorata* were recorded with 4th mature stage of larvae near to pupation indicating that *Z. bicolorata* began to build up its population from the March when temperature began to arise and gave opportunity to diapausing adult to emerge and start development. After March, again temperature started to rise corresponding to decline in humidity resulting sharp decline of the population which was built during the mild temperature of March. During lean season that is November to April, beetles were found only on succulent small plants having rich green foliage and were devoid of infloroscence. During this period, it was seen that adult beetles even did not like to sit on the older plants having tough texture of the leaves. It was seen that adult beetles also hide themselves amidst the curly bunch of the old leaves of the plants during day time in May and June.

(ii) Damage intensity of Mexican beetle

Damage potential of parthenium beetle was more or less same as observed in the previous year. It was observed that Mexican beetle defoliate parthenium in the patches corresponding to the build up of the population. In one instance, a thick patch of parthenium of about half kilometer in length along the roadside was identified to see the defoliation pattern and intensity in August 1996. It was found that adult as well as 3rd-4th stage of larvae population were very high at one of the corner of the stand and there was complete defoliation of the parthenium stand at that particular site but near to this defoliated parthenium stand, there was high egg population and less adult beetles and full grown larvae. The damage on the plants was about 25% adjacent to complete defoliated stand . On the extreme corner of the patch, over all population was low corresponding to the damage intensity. There was clear demarcation between the complete defoliated patch and green patch. Next month survey revealed that the whole half km parthenium patch was completely defoliated by the beetle. Only parthenium stems devoid of any leaves and infloroscence were standing indicating that if sufficient population buildup occur, even full grown parthenium can be destroyed completely by the beetle.

2.C.3. Mexican beetle interaction with sunflower

It is pertinent to bring in the notice that Vindhyanagar and adjacent area is not a sunflower growing area in the region.

(i) Feeding initiation on sunflower

Freshly emerged "0' day beetle showed varied response in their feeding initiation on sunflower. It was 4 hours to 7 days in case of sunflower but in majority of cases the feeding initiate was observed between 24 to 30 hours.

In field conditions:

In July and August 1996 , sunflower plants at various places amidst severe infestation of parthenium in Vindhyanagar campus and Shaktinagar campus wer grown to see the effect of beetles on the sunflower plants. Beetle nibblings were observed only in a few plants in the experimental plots. During this period, large population (about 1000 in no.) was collected from the field and released in the sunflower plots but it was observed that within 3-4 days, most of the adults fly away from the plots and settled on the nearby area where parthenium plants were in sufficient number. In another experiment, sunflower variety Arun was grown and between two lines of sunflower, one line of parthenium was grown and large population of adult beetles (1000 in No.) collected from other high infested area were released on the site. It was observed that most of the beetles settled on the parthenium plants and only a few (23) were observed sitting on the sunflower plants and nibbling the leaves of 25 days old sunflower. In another Experiment variety Arun, Cargil, Morden and PAC were grown in an area of 10x10 m at randomly to see the preference pattern of the beetle and field collected beetles(1000 in No.) were released in the plot mid point. Next day observation revealed that most of the beetles fly away from the plot and only 96 beetles were observed sitting on the sunflower plants and amongst these, 45 beetles were recorded on the variety Arun, 30 on the Cargil, 21 on the Morden and remaining on the PAC. Careful inspection of the beetles revealed that most of the beetles were 2-5 days old. On third day beetles population declined to 20 only mainly on Arun and Cargil. Observation revealed that a good fraction of released beetles settled on the nearby plants of parthenium as on third day population of adult beetles on the plants around 10 metres of the sunflower plot increased. From these experiment, it was clear that at Vindhyanagar, in field conditions beetle do not prefer sunflower. Beetles from Vindhyanagar were brought in the laboratory in our Jabalpur institute and life cycle studies in laboratory conditions and caged conditions on different available variety of sunflower was carried out. The leaves of these variety were provided to different stages of Mexican beetle larvae and adult stages.

(ii) Sunflower and *Mexican beetle* interaction in Net-House conditions

Sunflower variety, Cargil, Arun, Morden, KBSH, MSF, Jwalamukhi and PAC were grown at randomly and parthenium plants were also grown amidst them to see the preference as well as development of the beetle on sunflower. In mid June 1996 about 500 beetles collected from Vindhyanagar and reared in the laboratory were released in the wire net house of 8x6 m size situated in the farm area of NRC Weed Science, at Jabalpur on the 20 days old sunflower plant. Next day, only 30% beetles were found sitting on the sunflower plants and amongst them mostly on Arun, Cargil, and Modern. On PAC least number of beetles were observed. Rest of the beetles were shifted on the adjoining parthenium plants. By the 7th day of release, only 5% beetles were observed sitting on the sunflower plants. By the end of June most of the parthenium plants were totally defoliated and we had to plant fresh parthenium plant for beetles survival. Eggs of the beetles were recorded both on the parthenium and sunflower but in less number on the latter. First instar larvae were also recorded on the sunflower plants in the end of the June however up to 3rd instar larvae on the parthenium plants. By this time, attack of black ant was recorded in the net house which prayed on eggs and reduced the egg population drastically. Adult beetle population reduced due to weather conditions and many of them went under diapause. In spite of all these adverse conditions, many 4th instar larvae were seen on the parthenium plant which gave adults in July. In July only a fraction of population was seen mostly sitting on parthenium but a few were always found on sunflower. With the onset of monsoon in the end of July, beetle number began to increase indicating their emergence from diapause conditions. Every fortnight fresh sowing of sunflower cultivars was done in between the older plants so that to make available 20-30 days old sunflower plants to larvae and beetles to enable them to lay

eggs and to complete life-cycle on the desired host. By the end of August 3rd instar larvae were observed on the parthenium plants while only first instar larvae on the sunflower plants. In the first fortnight of September many '0' day beetles were seen indicating completion of one generation on the parthenium plants. Some of these '0' day beetles chewed sunflower plants and laid eggs. From these eggs always larvae hatched but most of them were found disappeared from those plants where they were recorded in previous week. By the end of September population of beetle in the nest house increased up to 300 and defoliated parthenium plant badly which had to be replaced regularly by fresh plants taken from out side. In the September last week a few 4th instar larvae near to pupation were observed on the variety Arun and Cargil indicating their development on the sunflower.

Fig.-11 : Sunflower varity Arun badly defoliated by *Maxican beetle*

After the second fortnight of October 96 Sharp decline on the population of beetles was noticed. In November, December, January and February only a few beetles were recoded in the net house indicating their fresh emergence as well as egg laying on parthenium. Stay occurrence of '0' day beetles were observed on sunflower plants but no egg laying. Larval population could not survive even on parthenium in the net house during winter season. However, a few adults were always seen sitting and feeding on parthenium and sunflower.

In the March 1997, with the increase of temperature, population of beetles begain to increase indicating their emergence from the diapause. '0' day beetle occurrence indicated that they might have

developed from the larvae which pupated during October and went in the diapause. These beetles laid eggs and from these again larvae developed and pupated mostly on parthenium and a few on sunflower. Mostly '0' day beetles badly attacked sunflower plants.

From net house study it was clearly demonstrated that field collected beetles do not prefer sunflower plants amidst the parthenium plant but ' 0' day beetles were able to defoliate and continue their life-cycle on sunflower. It was also observed that mostly beetles prefer 20-30 days old sunflower plants but they can feed the upper leaves near the growing point of 70-90 days old plants of sunflower.

2.C.4. Mexican beetle interaction with *X. strumarium*

Last year complete life-cycle development of Mexican beetle was achieved on the Xanthium in the laboratory conditions. This year, to see whether *Z. bicolorata* is able to complete the development on Xanthium in out side conditions, Xanthium plants were grown in the cages of 1x 0.5x 0.5 m (w x l x h) and in each cage, one pair of '0' day beetle was released. In another set parthenium plants were transplanted from outside in the cages and '0' day beetles were released. The experiment was done in triplicate. The complete life-cycle was observed in August 96 in the Xanthium plants confirming our earlier results of laboratory rearing. The development of larvae was more or less similar as on parthenium except delayed egg laying by the '0' day beetles in the cages of Xanthium.

At Vindhyanagar in the District Sidhi of Madhya Pradesh, *Z. bicolorata* was released in 1991 and it has been established in that region in about 25 km area from the releasing point. This region face extreme summer (45^0C) and winter temperature (up to 100^0C). The beetles remain most active during July to September. In field conditions, beetles and larvae were observed to defoliate *X. strumarium* plants during July to second week of September. Eggs were also seen. Defoliation of *X. strumarium* was observed only at those places where *Z. bicolorata* devoured parthenium population completely. At those places where parthenium population was sufficient, attack on xanthium was not noticed. Extensive survey for last two years did not reveal Mexican beetle feeding extensively on *X. strumarium* but it is confirmed that in scarcity of parthenium food, Mexican beetle can use *X. strumarium* as an alternate host for its survival.

Experiment were also conducted to see the development of *Z. bicolorata* on *X. strumarium* in the laboratory. Unequivocally, *Z. bicolorata* is able to complete its life cycle on *X. strumarium*. The time taken to complete development on xanthium was somewhat higher than parthenium. The development of the beetle on xanthium has been reported elsewhere. Eggs are of light reddish in colour instead of yellow as were observed in the parthenium fed eggs. In xanthium reared adults, egg laying begin to start somewhat late (13-26 days) while in parthenium reared beetle it started earlier (8-13 days). The total eggs laid during female life span were about 730.20/female in comparison to parthenium reared adults (mean 2520.90)7.

In another experiment, 2nd, 3rd and 4th instar larvae of *Z. bicolorata* reared on parthenium were released on the Xanthium and vice versa to see whether they are able to complete the development. It was observed that larvae of 1st, 2nd, 3rd and 4th are able to complete their development on xanthium and parthenium vis-versa in the caged conditions kept out side of the room in natural conditions. The mortality rate of 2nd instar larva was somewhat higher in case of xanthium when transferred from parthenium. This also indicates that xanthium may act as an alternate host for the Mexican beetle *Z. bicolorata*.

Preliminary study conducted on the survival rate of the eggs of parthenium fed beetle on parthenium, xanthium and sunflower revealed highest adult emergence in parthenium followed by xanthium and sunflower corresponding to the negative intensity of care taken to rear them. These results indicate that although *Z. bicolorata* may develop on xanthium in field conditions but their chances to defoliate xanthium extensively like parthenium are remote and beetle may use xanthium only as host in scarcity of food.

2.C.5. Comparative rearing of *Z. bicolorata* in laboratory condition on parthenium, sunflower and xanthium

Study was carried out to rear Mexican beetle in the laboratory conditions in plastic containers with fine brass wire mesh windows on the side and on the lids for good aeration in BOD having temperature $27\pm^{0}$ C and humidity 70±5 RH. A pair of adult '0' day beetle was released in the cages of each host and for each host (parthenium, sunflower and xanthium) the study was undertaken for three pairs. In case during study, if male died it was replaced by the fresh male reared on the respective host. But if female died, the experiment or replication was discarded. In each replication, sufficient number of eggs laid on the same date were taken for the study. Adults emerged from these eggs were the indication of completion of first generation and these were considered as pure stock and designated as PP, PX, PS, developed absolutely on parthenium, xanthium and sunflower, respectively. Here, first letter indicate their parental status from where the '0' day beetle was taken for study. For example, PS means '0' day beetle developed from the larvae fed on parthenium were kept on sunflower for development while SS indicate that '0' day beetles developed from the larvae fed on sunflower were kept again on sunflower and will be the indication of completion of 2nd generation on the sunflower. Likewise SSS will indicate completion of third generation on sunflower. This designation will facilitate to consider even pureness of the generation taking in to consideration of genetic characters. Following parameters were recorded during the rearing: first and last mating date, hatching period, hatching %, larval period, pupal period, longevity of male and females, fecundity and fecundity period and sex ratio. The study was carried out up to 4th generation taking rearing of parthenium as standard.

In another experiment, parthenium, sunflower and xanthium plants were grown out side the room in the wire mesh cages of 1x 0.5x 0.5 m (w x l x h) having sufficient layer of soil on the perforated base to support the growing of the plants and in each cages one pair of '0' day beetle was released and development of future generation was observed. In this experiment only first egg laying date, hatching date, larval and pupal period were observed. Fecundity was not studied in the outside cages. As and when, plants inside were completely defoliated, they were replaced by fresh one. Sometimes, in necessity, bouquets of concerned hosts were also provided which were kept in a plastic vilas having water inside. These vials were buried in the cage soil in such a manner so that bouquets were in touch of soil as they were grown naturally.

2.C.6. Development of beetle reared on sunflower leaves sprayed with parthenium leaves extract:

In one set of experiment, sunflower leaves of 20-30 days old plants were sprayed with 10% parthenium leaf extract solution and provided to the pair of '0' day PS beetle and reared continuously to observe any effect of parthenium leaves extract on the overall survival rate of larvae.

Results indicate that overall adult emergence was higher in parthenium (PP) reared larvae (78.10%) followed by xanthium (PX, 75.41) and sunflower (SS,7.38).When the '0' day beetle absolutely reared on sunflower were kept on xanthium (designated as SX), the adult emergence increased up to 13.33% while it was 80% in case of parthenium(SP). It clearly indicates that although survival rate of larvae on the sunflower (PS) was very low (7.38%) but when the egg laying occurred on the parthenium by the beetle of PS, survival rate increased tremendously comparable to parthenium (PP) while it could be increased up to 13.33 in case of SX ('o' day beetle reared on sunflower kept on xanthium for egg laying).

When longevity and fecundity data of first generation reared on different host was compared, the longevity of females varied when reared on different hosts. Mean of three beetles kept for development study showed that maximum longevity was in case of parthenium fed followed by xanthium and sunflower, however, range variation was high in all the cases. In case of XS longevity was even low. Likewise fecundity was also observed highest in parthenium fed beetle followed by sunflower and xanthium. In fecundity case too, high variation in female to female was observed in total egg laying. In general, fecundity rate is highest in parthenium fed beetle followed by xanthium and sunflower. In case of XS, the fecundity rate was observed very low. In 2nd generation (SS) the fecundity was observed approximately 50% while longevity was about 68.66 days (mean of three females). In case of 2nd generation of sunflower fed beetle whose parents were of xanthium fed (XSS) generation laid very less eggs in spite of the high rate of longevity of females in question and in third generation no egg laying was observed in spite of high rate of longevity.

Body weight of male and female was also found highest in parthenium fed beetles followed by xanthium and sunflower The whole study was carried out from September 1996 to May 97 in the laboratory in BOD. In general, on parthenium (PP) and xanthium (PX) group up to 4th generations were completed. In case of sunflower group (PS), third generation could not be completed while in case of XS group, third generation beetle were developed but they could not lay eggs. This study showed that unequivocally, parthenium is the most suitable and preferred host for the Mexican beetle *Z. bicolorata* followed by xanthium and sunflower. Although in sunflower fed beetles, good fecundity was observed in 1st and 2nd generation but the survival rate was very poor in comparison to parthenium and xanthium fed beetles.

It was also interesting to note that in spite of utmost care taken in rearing of sunflower fed larvae, survival rate was minimum while it was maximum in parthenium fed larvae corresponding to the care taken minimum in handling the culture followed by xanthium.

In case of the 10% parthenium leave extract sprayed on sunflower leaves, the survival rate increased up to 15.15% in comparison to non-sprayed (7.38%).

2.C.7. Leaf Area Study:

Aqueous extract of 5, 8 and 10% concentration of parthenium leaves was made and sprayed on the sunflower leaves. Adult beetles (male and female separately) were kept starved for 24 hours and than released on the pre measured leaves of sunflower sprayed with parthenium extract at different concentrations. In control, water was sprayed. Different variety were tested for leave area study. In reverse ,sunflower and xanthium leaf extracts were also sprayed on parthenium to see any effect on feeding. For each variety, 5 replications were made and in each replication , leaves were measured three times by the laser based leave area metre to minimize the error and data were pooled.

Spraying of aqueous extract gave mixed results. In KBSH, highest feeding was recorded at 10 % concentration while it was more or less same in all the concentration in MSH. Response of Cargil variety to the beetle was more or less same in all the concentrations and was not significant in comparison to control. Arun was found most preferred and PAC was most resistant variety. In PAC somewhat increase in consumption was noticed at all the concentrations than control and at 10%, it was about 1.5 fold more than the control. When parthenium leaf extract was sprayed on xanthium leaves and given for feeding to beetle, no significant consumption was noticed.

Spraying of xanthium and parthenium extract did not affect the feeding except at 5% in case of sunflower and 10% in case of xanthium extract. Spraying of 10% aqueous extract of parthenium leaves on the different variety of sunflower showed significant increase in consumption in treated leaves than untreated leaves but consumption of parthenium was reasonably high from both the treated and untreated leaves.

From these experiments, it was clear that response of adult beetles may be different in different days and it is dependable on age and sex of the beetle. Some beetles earlier fed on parthenium when exposed to sunflower, did not even nibbles while on the other hand some beetles ate sunflower leaves significantly higher.

Repeated experiments are needed for further authentication of the response of adult (male and female) beetles on sunflower.

2.C.8. Biochemical studies

2.C.8.a. Host preference on the basis of biochemical profiles of the grubs of Mexican beetle *Zygogramma bicolorata* Pallister

Sushilkumar, B. Dalal and V.M.Bhan

Host preference of Mexican beetle *Zygogramma bicolorata*, a biocontrol agent of parthenium was studied using biochemical parameters.

Laboratory culture of *Z. bicolorata* was reared separately on parthenium and xanthium hosts. Larvae of different stages were washed chilled and homogenized in 0.25(M) sucrose containing 1 mm EDTA (at $\pm 4^0$C) in glass teflon homogenizer followed by centrifugation at 800 x 9 for 20 minutes in centrifuge to remove debris. The supernatant was appropriately diluted and used for assay purpose for various parameters. Estimation of protein was carried out by the method of Lowry et al., (1951) using Bovine serum albumin as standard . DNA and RNA were estimated by the method of Scheider (1957)

using yeast DNA and RNA standards. Total carbohydrate content was measured by the method of Phenol-H2So4 (Dubois, 1956). Free amino acid was measured by treating supernatant with 20% TCA with ratio 2:1 at 0^0C to precipitate proteins. To 1 ml of the supernatant, 1 ml of Folin reagent was added followed by addition of 2 ml of 1.4(M) Na_2CO_3 and the reaction mixture was heated at 60^0C for 1. minutes. The coloured developed was monitored at 650 nm using tyrosine as standard. Data were collected from 4-5 larvae in each set and each experiment was done in triplicate.

An increase was seen in various biochemical profiles in the parthenium fed larvae than xanthium fed larvae. Low amount of proteins in xanthium fed larvae was probably because of increased proteolysis which may also be explained in the high level of transferease enzymes to maintain amino acid metabolism. Gradual increase in DNA of larvae fed on parthenium leaves showed steady increase in cell number due to cell multiplication than xanthium fed larvae. It may be one of the probable reasons of less reproductive capacity in xanthium fed larvae. The high amount of RNA in various stages of larvae fed on parthenium also supports more protein synthesis than maintained on xanthium.

Biochemical analysis of Xanthium and parthenium leaves showed higher amount of carbohydrate, protein and free amino acids while lower amount of phenol content.

The nutritional quality of host plant tends to influence the growth and development of insect but the combined effect of semiochemicals and nutritional quality is responsible for host preference of forage chewers (Gogoi et. al., 1975). This preliminary study clearly indicates that parthenium is certainly a preferred host for Mexican beetle than the xanthium.

Table 36 : Biochemical profiles of larval stages of *Z. bicolorata* fed on parthenium and xanthium (weight in mg/g leave).

Host	Developmental stages	Larval weight	Moisture %	Total protein	DNA	RNA	Free amino acid
Parthenium	1st & 2nd	0.40	85	10.50+0.40	2.70+0.20	24.60+0.60	1.40+0.20
	3rd	4.80	84	17.20+0.60	2.50+0.10	25.00+0.60	1.10+0.01
	4th	21.00	87	25.00+0.40	5.80+0.10	55.60+0.30	2.70+0.20
Xanthium	1st & 2nd	0.40	84	9.50+0.30	2.30+0.40	20.10+0.10	1.10+0.05
	3rd	4.60	84	14.80+0.70	2.10+0.10	24.30+0.70	0.80+0.03
	4th	18.40	88	21.20+0.50	2.90+0.10	50.80+0.12	1.90+0.05

Table- 37 : Effect of food plant (Parthenium) on various biochemical parameters of *Z. bicolorata* larvae.

Parameters	1st & 2nd	3rd*	4th*	Adult
Wt. of larva (mg/larva)	0.40	4.80	21.40	30
% of moisture	85.00	89.00	88.00	80
DNA (mf/larva)	6.75	62.50	140.00	-
RNA (mg/larva)	61.50	625.00	1390.00	-
Proteins (mg/larva)	27.62	180.00	125.00	-
Free amino acid (mg/larva)	3.50	27.50	70.00	-

2.C.8.b. Effect of defoliation on the natural content of phenols and sugars in sunflower and parthenium by Zygogramma bicolorata

Sushilkumar, B. Dalal and V.M. Bhan

To see the localised effect of defoliation on phenols and carbohydrate parameters, in one set of the experiment, 'O' day beetles of *Z. bicolorata* were released in the caged conditions having 20 days old variety of Arun, MSF and PAC and parthenium. On achieving 30 and 50% damage in the particular leaves, they were plucked from the plants. Like wise 30 and 50% leaves were damaged artificially and removed after 48 hours of their damage. Leaves were analyzed for total phenols and carbohydrates.

For estimation of total phenols, leave or whole plants were washed thoroughly with glass distilled water, dried on blotting paper, weighed and finally homogenized with 80% ethanol. The homogenate was centrifuged and the supernatant was used for analysis. For estimation of sugars, samples were homogenized with 20% TCA and the supernatant was analysed by the method of Dubois et al., (1956).

Table- 38 : Effect of local damage on sugars and phenolics

Plant	Percent damage	Sugar (mg/gm leaves)	Phenolics (ug/gm leaves)
Parthanium	Control	32.00	71.60
	30	9.67	7.73
	50	3.27	14.46
Arun	Control	14.27	40.20
	30	11.66	31.20
	50	2.21	31.90

*10 larvae

3.4 MECHANICAL WEED MANAGEMENT

MWM-1 : Performance evaluation of improved mechanical weeder for weed control in *Kharif* crops.

H.S. Bisen and V. M. Bhan

To evaluate the performance of improved mechanical weeder i.e. twin wheel hoe, and wheel hoe (Big), field experiment was carried out during *Kharif* 1996 in soybean and maize crops. The crops were raised by following the conventional cultivation practices. The weed control operations were carried out as per seven treatments framed in the experimental design to find out their influence in crop growth and yield.

Results revealed that the higher weeding efficiency of 80.7 and 81.9 was achieved in operation of the twin wheel hoe at 15 DAS and 25 DAS, respectively. But at later stage, weed left over were again established therefore operation at second weeding stage at 30 and 40 DAS gave higher grain yield. When the plot was kept weed free by operation of weeder at 15, 30 and 50 DAS gave highest yield. The treatment T-3 has shown best results when the weeder was operated at 15 DAS and 30 DAS followed by treatment T-4 by operation of the weeding tool at 25 DAS and 40 DAS. Similarly in maize crop also operation of the wheel hoe has given best yield in treatment T-3 when the weeder was operated at 15 DAS and 30 DAS.followed by treatment T-4 . Highest yield was recorded in weed free plots of maize crop by operation of the weeding tool thrice at 15 DAS, 30 DAS and 50 DAS. The weed control efficiency and yield of soybean and maize crops were found significant in treatment compared to control plots.

The results of field evaluation carried out for 3 years also revealed that two operations of the weeding tools are required preferably at 15 DAS and 30 DAS in soybean and maize crops.

MWM-2 : Development of manually operated weedicide applicator using wetting element (wick).

H.S. Bisen

The concieved design of wick applicator was fabricated completely during the year and it was preliminarily operated during *Kharif* 1996. The different parts were suitably improvised keeping in view the difficulties being experienced during its operation. The unit was fully operational and first prototype of wick applicator was found functional. The design details of components was prepared and their drawings were made. The developed wick applicator was put in its field trial during *Rabi* 1996-97 season on mustared crop. The crops was raised following the conventional cultivation practices. Six treatments were planned and replicated in 4 plots in RBD. The operation of the wick applicator was performed after different DAS of crop in order to evaluate its performance on different growth stages of weeds are as T-1 as operation of wick aplicator at 25 DAS for the herbicide; T-2 as operation of wick applicator at 35 DAS for the herbicide; T-3 as operation of wick applicator at 45 DAS for the herbicide ; T-4 as application of herbicide by knapsacksprayer ; T-5 as no weed control measure ; T-6 as weed free plot control.

Sticking of soil was a problem experienced in operation of the wick applicator at the small weed situation in begining of crop season on rotor of the unit. But at 25 DAS of crop, the contact of rotor with soil is reduced. The weed control efficiencies achieved from the weed count data indicate that 26.3% control of weed was achieved at 25 DAS compared to 53.3 and 60.75 per cent at 35 DAS and 45 DAS of crop due to increased weedd growth at later stages of crop. Application of herbicide by knapsack sprayer resulted in 68.8% control. Keeping these data in view, it is concluded that the efficiency of wick applicator in control of weeds was comparable to knapsack sprayer after 30 DAS of crop. The operation of the wick applicator is easier and lighter as compared to knapsack sprayer. The field capacity of the developed applicator is 0.309 ha/hr. Similary the yield of mustard crop shows that comparable yield has been obtained in experimental plots when the herbicide sethoxidin was applied either by wick applicaton or by knapsack sprayer. The weed control efficiency data and yield data were analysed statistically and were found varying significantly.

Fig. -12 : Operation of Wick applicator being demonstrated to Management committee

3.5 TRANSFER OF TECHNOLOGY AND 'ON FARM RESEARCH'

TT-1 : Field demonstration of chemical and mechanical methods of weed control in *Kharif* and *Rabi* crops in village adoption Programme.

H.S. Bisen

The team consisting of scientists Er. H.S. Bisen Sr. Sci. (AE), Dr. Anil Dixit (Agro), Shri G.S. Vishwakarma, Field Assistant worked in adoption of suitable village for showing field demonstrations of weed control technologies in farmers field. The work started in June 96. Farmers were contacted and finally village 'Khamond" was adopted for this programme on Jabalpur Damoh road via Patan. With the help of village progresive farmer Shri Anand Patel five demonstrations on paddy and soybean were carried out by the team of NRC-WS. The demonstration were laid in fields of Shri Anand Patel, Shri Shiv Kumar Jaria, Shri Delan Singh Patel and Shri Govind Patel. In paddy, dry seedling, trifluralin in soybean, Lasso granules were demonstrated in farmers' field. The chemical were applied and demonstrated in field. In soybean, 50 to 60% control was achieved in weed population. Similarly, trifluralin also checked the emergence of weeds (annual both mono cotyledenous and dicot) in order to establish the crop initially in the *Kharif* season. The rains were late during July, 1996 and therefore more demonstration could not be The scientist also visited during the *Kharif* season for any help in weed control problems and other crop production problems. The farmers adopted and others were convinced with the use of herbicides in weed control for taking higher crop productivity. During the visits farmers were also adviced for agricultural implements, machniery and weed control tools such as wheel hoes, grubber *etc.* for usage.

Training

Centre organised a short term training course programme on "Weed Management : A tool for improving crop production" of eight days schedule from 28.01.97 to 04.02.97. It was sponsored by Ministry of Agriculture (Deptt. of Agri. & Coopn.), Directorate of Extension, Krishi Vistar Bhawan, New Delhi. This training course programme was provided with a basic objective of imparting specialised training in the field of weed management to the subject matter specialist (SMS), officers of the State Deptt.of Agriculture and Training Associate of Krishi Vigyan Kendra of JNKVV. The participants were exposed to the advances in weed management technology and also through field visits around Jabalpur district for practical orientation and cultivation practices adopted by the farmers. Dr. V.P. Singh, Scientist, acted as Course Coordinator for the training programme.

4.0 ACHIEVEMENTS OF AICRP-WEED CONTROL (1996)

The AICRP-WC started functioning since 1977-78 with 5 centres. The utility and the work done in the project found to be of immense support among farmer's community and therefore, ICAR went on increasing centres and at present, there are 22 centres located in different SAUs with 2 volunteer centres located at ICAR NEH Complex, Barapani and IIHR, Bangalore. The work done at these centres has been of immense value in the area of their jurisdiction. Most of the centres have scientists in position and are effectively working for finding out the solutions of various weed problems pertaining to their areas. Many of the centres have sent their report for the year 1996 which has been compiled in the following pages. This report provides a broad base condensation of the individual annual report so that the work done at each centre may be seen at a glance.

The work done in the Project at different coordinating centres consisted of weed survey, crop weed competition, weed management in different crops and cropping system , biology and control of problem weeds, weed physiology, herbicide residue, evaluation of weed control tools and implements and on farm trials during the year 1996.

Weed survey

Twelve centres have reported the work done on survey of weed flora in different areas in the area of their jurisdiction. Madhya Pradesh reported the observations of 55 weed species in soybean crop alone and the dominance was located in Dewas and Ujjain. *Euphorbia geniculata* was observed as a problem weed in the hill areas of Himachal Pradesh. *Ageratum conyzoides* was an important weed and in the lower hills, *Echinochloa crusgalli, Mollugo* sp., *Commelina benghalensis* have been reported in major *kharif* crops which include moong and soybean. *Cynodon dactylon* was reported alongwith other grasses as a major *kharif* weed. In redgram, *Trianthema monogyna* was observed in high intensity. Wheat crop had predominance of *Avena fatua, Lolium temulentum, Phalaris minor, Polypogon monsplensis* in Vaishali and Munger districts of Bihar State. In Gujarat, *Cyperus rotundus, Trianthema monogyna* were the major weeds in *kharif* crops including summer groundnut. In *kharif* oilseeds and pulses, *Echinochloa colonum, Aeschyum* sp., *Cynodon dactylon, Cyperus rotundus, C. digitaria, Phyllanthus niruri* were major weeds. In winter season, *Phalaris minor* remained major grassy weed of the wheat crop in the north and north-eastern regions comprising of Punjab, Haryana, northern Uttar Pradesh, northern Bihar and West Bengal and parts of Assam in rice-wheat cropping system.

Survey of farmer's method of weed management

Four coordinating centres viz. GAU, Anand; JNKVV, Jabalpur; RAU, Pusa and KKV, Dapoli conducted survey of farmer's field where weed management practices are being adopted. Most of the farmers surveyed, generally use one or two hand weeding followed by hoeing during peak competition period. In the beginning of the season, the weeds are either managed by ploughing the field 2-3 times or damaged in first or second flushes. In areas of Dapoli in rice nursary, pre burning is followed after which seeds are broadcasted or sown in lines. Some of the well advanced farmers are using latest weed management technologies by using herbicides.

Biology and control of problem weeds

At UAS, Bangalore, combination of sethoxydim with glyphosate enhanced the uptake of glyphosate in *Cyperus rotundus* and *Oxalis latifolia* by 1.5 times. At JNKVV, Jabalpur, application of dichlofop-methyl (1.0 kg/ha), triallate (1.25 kg/ha) and isoproturon (1.0 kg/ha) reduced the growth of *Asphodelus tenufolius* and enhanced the grain yield of wheat crop. In mustard, application of butachlor (2.0 kg/ha), alachlor (2.0 kg/ha) and oxyfluorfen (0.2 kg/ha) as PE also inhibited the growth of this weed. In soybean, application of sethoxydim 0.25 kg/ha fb fluazifopbutyl 0.375 kg/ha controlled *Cynodon dactylon*. At HPKVV Palampur in maize crop, application of glyphosate (1.25 kg/ha) alone or in combination with 2,4-D (Na) 0.5 kg/ha, ammonium sulphate 0.5% (PPI) fb atrazine 1.0 kg/ha (PE) effectively controlled *C. rotundus*. At KAU, Trichur, temporary control of perennial weed *Pennisetum polystachyon* was noted by tillage operations during which plants may be broken into various pieces. At OUA&T, Bhubaneshwar, *Eichhornia crassipes, Scirpus gressus* and *Cyper plagstylis* were controlled by tank mixing of 2,4-D (Na) with paraquat or glyphosate.

Crop-weed competition

At IIHR Bangalore, allowing weeds to grow upto harvest resulted 48 per cent reduction in cabbage yield. Hand weeding 20 DAT was found effective but keeping weedy upto 60 days reduced yield. At MAU Parbhani, in pigeonpea, weeds caused 57 per cent yield reduction. At CSAUA&T Kanpur, weed free period of 15-60 days after trasnplanting of chilli was rewquired to obtain economic yield. Competition of 5 and 10 plants/m^2 of *Commelina benghalensis* with groundnut caused 21.73 and 26.73 per cent reductions in groundnut yield.

Physiological studies

Studies conducted at PAU, Ludhiana revealed that there was partial herbicide resistance in *Phalaris minor* even at high dose of isoproturon. Application of 2,4-D and glyphosate reduced the gropwth of *C. rotundus* during May to August. Growing *Parthenium* in association with *Cassia sericea* exhibited suppressed growth of parthenium which later on did not regenerate. Studies conducted at GBPUA&T, Pantnagar revealed that residues of *Ageratum conizoides, Chenopodium album* and *Melilotus indica* inhibited the growth and development of soybean. It was added that population of wheat was reduced due to incorporation of parthenium biomass at 500 g/m^2 . Four hundred millilitre aquous extract of *Imparata cylindrica* and *Polygonum hydropripes* inhibited the emergence of rapeseed resulting prolonged flower:fruit ratio. The aquous extracts of *Penisatum purpurium, Bidens pilosa* and *Convolvulus arvensis* were effective in restricting growth of *Rhizortonia solanii.*

Weed management research

In rice nursery, pretilachlor 0.5 kg/ha + safeners (Sofit 35 EC) mixed with sand; butachlor 1.5 kg/ha (3 DAS), pendimethalin 1-1.5 kg/ha (3-6 DAS); oxadiazon 0.5 kg/ha and rabbing method were significantly effective against weed menace with higher weed control efficiency. In transplanted rice, application of butachlor 1.5 kg/ha, pretilachlor 0.5 kg/ha and combination of ethoxysulfuron 10 g/ha + fenoxaprop-p-butyl 45 g/ha (10 DAP) resulted significantly higher yield. While alone application of fenoxaprop-p-butyl 75 and 90 g/ha at 15 DAS was also quite effective in controlling weeds . Studies revealed that application of metsulfuron methyl (4-8 g/ha) alone and in combination with anilophos (300-

400 g/ha) fb tribenuron methyl (15 and 30 g/ha) provided good control of weeds especially barnyard grass resulting in higher yield of rice while early application of almix effectively conrolled barnyard grass at 2-4 leaf stage. In soybean, weed density was significantly reduced under pre emergence application of metolachlor at 1.5 and 2.0 kg/ha, pendimethalin 1.0 kg/ha and fluazifop-p-butyl and sexthoxydim as postemergence. Efficacy of fenoxaprop-pmethyl increased with increase in dose over *Echinochloa colonum* weed but it was very effective when applied at 14 DAS rather than 21 DAS. Application of fluchloralin, alachlor, anilofos, pendimethalin/butachlor either applied as liquid or granule performed equally well. While in Sunflower , application of herbicides like linuron 0.5 kg/ha, butachlor 1.0 kg/ha, oxyfluorfen 0.08 kg/ha, metolachlor 1.0 kg/ha (all PE), fluazifop-butyl 0.125 kg/ha (15 DAS) fb hand weeding (35 DAS) gave more seed yield comparable to the hand weeding performed twice. In case of safflower, the application of trifluralin and fluchloralin both at 0.75 and 1.0 kg/ha, respectively applied as PPI was very effective. In green gram, application of fluchloralin (1.5 kg/ha) and alachlor (1.0 kg/ha) and in gram, application of metolachlor 1.5 kg/ha (PE) integrated with 1 HW resulted highest grain yield. On the other hand, pendimethalin applied 1.0 kg/ha (PE) has enhanced the yield of gram. In pea, pre em. application of linuron 0.5-0.625 kg/ha, pendimethalin 0.75-1.5 kg/ha produced higher seed yield. Under varietal trial of pea, KPMR-171 variety showed effective smothering significant effect over growth and development of germinating weeds. In cowpea, preplant incorporation of fluchloralin (0.75 kg/ha) and pre em. application of pendimethalin 1.0 kg/ha produced significantly 83 & 81 per cent higher seed yield of cowpea over control. In fingermillet, highest seed yield was resulted under the treatment of hand weeding performed twice. In potato, application of pendimethalin (0.75 kg/ha PE); metribuzin at (0.7 kg/ha PE 3 DAP); oxyflurfen (0.1 kg/ha) and linuron (0.635 kg/ha) resulted in effective weed management.

In transplanted rice, application of butachlor 0.5 kg/ha or anilophos 0.2 kg/ha in closely spaced rows reduced significantly the weed density and its dry matter at 45 DAS. The results indicated that mechanical hoeing alongwith hand weeding recorded the minimum weed dry weight. In direct seeded rice, the results revealed that all the cultivation practices produced significantly higher grain yield over conventional method of rice cultivation. Maximum grain yield was recorded under pre sowing dessication of weeds with glyphosate followed by paraquat and summer ploughing. There was significant increase in grain yield of rice with application of oxyfluorfen 0.15 kg/ha. Application of anilofos 0.4 kg/ha; butachlor 1.5 kg/ha or thiobencarb 1.0 kg/ha alone or in combination with 2,4-D 0.533 kg/ha, cyhalofop 0.09 kg/ha or HW were effective. In wheat, isoproturon application as BFI followed by 2,4-D at 35 DAS provided better weed control. Metsulfuron methyl at 2.0 g/ha + surfactant 0.2% was as effective as metsulfuron methyl at 4.0 g/ha applied alone in controlling weeds and produced more yield. The population of grassy weeds decreased with increase in the rates of isoproturon whether applied alone or in combination with metsulfuron methyl or 2,4-D. While isoproturon 1.5 kg/ha + surfactant 0.5% applied at 20 DAS being statistically at par with dichlofop methyl 0.75 kg/ha (20 DAS), triallate 1.0 kg/ha (pre) fb isoproturon 1.5 kg/ha + surfactant (20 DAS) were effective in controlling wild oat and rye grass and increasing grain yield of wheat. Preplant incorporation of triallate 1.5 kg/ha alone or fb isoproturon caused toxicity to wheat seedlings. Stale seed bed in integration with dichlofop-methyl 0.5 kg/ha + surfactant/isoproturon 1.0 kg/ha + surfactant (0.5%) was most effective in controlling all the grassy weeds and increasing grain yield of wheat.

In maize, integrating 1 HW on 35-40 DAS alongwith pre-em. herbicides (all applied at 3 DAS) atrazine 0.75 kg/ha (5112 kg/ha), fluchloralin (0.68 kg/ha) (5512 kg/ha) and oxyfluorfen 0.08 kg/ha (5512 kg/ha) resulted in seed yields quite comparable to 2HW (15-20 & 35-40 DAS) (5034 kg/ha). In pigeonpea, double line sowing (pure crop) was at par with double line sown crop intercropped with urd bean. Highest seed yield was recorded in double line (20:40:20 cm) intercropped treatment. In green gram , results

revealed that application of fluchloralin, oxadiazon and pendimethalin at their recommended rates reduced the dry weed biomass significantly to 103-803 kg/ha as against 1450 kg/ha in weedy check. All the treatments significantly increased the grain yield of greengram over weedy check and at par among themselves except one hoeing done at 20 DAS. Maximum grain yield was recorded in plots treated with pendimethalin 0.50 kg/ha + hoeing closely fb weed free check. In chickpea, pre-em. application of pendimethlin 1.0 kg/ha + HW at 45 DAS was found most effective to control the weeds. Results also revealed that maximum yield was recorded under weed free check . Row spacing of 30 cm recorded significantly higher grain yield than 20 cm. In soybean, results indicated that amongst various mulches used, the weed control efficiency of soybean mulch @ 2.5 t/ha was 97% while wheat straw mulch @ 5.0 t/ha was 95%. The seed yield was significantly higher under soybean mulch (1250 kg) . Application of fluchloralin, alachlor, metolachlor, metribuzin, pendimethalin each supplemented with 1 HW at 35 DAS produced significantly higher seed yield than application of these herbicides alone. There was reduction in seed yield to the tune of 54.2% due to non removal of weeds. Application of oxyfluorfen 0.15 kg/ha, alachlor 1.0 kg/ha, fluchloralin 1.0 kg/ha each followed by one intercultivation resulted in higher soybean seed yield (1680 - 1807 kg/ha). In groundnut, results revealed that the weed population/m^2 at 20 DAS was sufficiently low in the butachlor applied plot at 1.25 kg/ha of ICGS variety. Application of pendimethalin 1.0 kg/ha as pre em.+ 1 HW produced significantly higher pod yield of groundnut (6.0 q/ha) and shelling (67.25%) than weedy check. In sesamum, the best weed control was recorded by the PPI of metolachlor followed by alachlor. Higher dose of pendimethalin exhibited phytotoxic effect on mustard seedlings. In onion, oxyfluorfen 0.15 kg/ha (PE) fb 1 HW was significantly superior in reducing the dry matter of weeds and increasing bulb yield. Integrated treatments viz., oxadiazon 0.5 kg/ha + HW and pendimethalin 1.0 kg/ha + HW gave significantly higher yield as compared to other treatments except oxadiazon 0.5 kg/ha alone. Application of FYM 10 t/ha and 20 t/ha being at par produced significantly higher bulb yield than no application. In chillies, the results showed that significantly highest green fruit yield of chilli was obtained with traditional practice (3 Intercultivation + 3 HW). In cotton, pendimethalin/trifluralin both at 1.0 kg/ha as pre-em. and ppi respectively fb directed application of glyphosate 1.0 kg/ha or paraquat 0.3 kg/ha at 6 and 8 WAS provided effective weed control. Glyphosate had an edge over paraquat as it also controlled perennial weeds like *Cyperus rotundus* and *Sorghum halepense*. Application of alachlor 1.0 kg/ha fb 2 IC at 30 & 50 DAS resulted significantly higher kapas yield (1332 kg/ha) In chikory, the results revealed that either fluchloralin or trifluralin at 0.5 kg/ha alongwith 1 HW at 45 DAS was as good as 2 HW at 25 & 50 DAS in controlling weeds and producing higher yield of chicory.

In rice - wheat cropping system, isoproturon + 2,4-D gave better control of broadleaf weeds alongwith grass weeds but failed to control *Anagalis arvensis and Medicago denticulata.* Butachlor treated plots had a heavy population of *Ischaemum rugosum* and where anilofos was used, there was build up of *C. iria.* In sunflower (summer)-soybean system, pre-em. application of alachlor 1.0 kg/ha (1808 kg/ha) and metolachlor 1.0 kg/ha (1632 kg/ha) produced seed yield comparable to 2 HW (15-20 & 35-40 DAS) (1862 kg/ha). Unweeded control lowered the seed yield by 43-67 % due to severe competition of grasses and broadleaf weeds. In rice-niger system, results revealed that anilophos 0.4 kg/ha resulted in highest yield (3.19 q/ha) of niger. In rice-mustard system, application of butachlor 1.5 kg/.ha and pendimethalin 1.0 kg/ha proved better in controlling weeds over other herbicides yielding 49.4 and 47.8 q/ha respectively. In groundnut+ redgram system, integrating one late HW (35-40 DAS) alongwith pre-em. herbicides (all applied 3 DAS) metolachlor 1.0 kg/ha (1407 kg/ha0, pendimethalin 0.75 kg/ha (1389 kg/ha), butachlor 1.0 kg/ha (1611 kg/ha), oxyfluorfen 0.08 kg/ha (1482 kg/ha), clomazone 0.08 kg/ha (1482 kg/ha), post-em. herbicides (15 DAS) fluazifop-p-butyl 0.125 kg/ha (1204 kg/ha) and chlorimuron ethyl 6 g/ha (1463 kg/ha) gave pod yields. Among the different intercropping systems tried, the system *Setaria* + Pea (1:1) recorded the lowest weed population other than *Ageratum* spp. and was statistically at par with the

systems like oat + pea (F), oat (F) + rapeseed, Potato + lentil, Potato + niger, sugarcane + potato, sugarcane + lentil, sugarcane + niger, sugarcane + rapeseed etc. In sorghum+pigeonpea system, results revealed that lower weed dry weight was recorded with HW twice followed by metolachlor or alachlor or pendimethalin alongwith one HW. Diclofopmethyl and pendimethalin caused stand reduction of sorghum, while metsulfuronmethyl and butachlor were phytotoxic to pigeonpea. Both sorghum and pigeonpea yields were maximum with HW twice and alachlor 1.0 kg. In greengram+ sunflower system, application of pendimethalin (1.0 kg/ha) at second day after sowing and fluazifop-p-butyl (0.375 kg/ha) at 15-30 DAS under sequential application demonstrated satisfactory control of *T. monogyna and Sorghum halepense.* In chilli + cotton mixed cropping system significantly highest kapas yield of 521 kg was recorded with diuron 1.25 kg/ha coupled with two intercultivations at 20 & 45 DAS and 1 HW at 50 DAS.

Herbicide residue/bioassay studies

In rice nursery, bioassay studies revealed that pretilachlor degraded to safe level by 20 days after spray at 0.3 and 0.5 kg/ha dose and by 30 days of application at higher does (0.75 kg/ha). In another experiment bioassay studies indicated that anilofos (0.4 kg/ha), butachlor (1.5 kg/ha) and pretilachlor (0.75 kg/ha) applied pre-em. in transplanted rice exerted significant adverse effect on shoot height and dry matter accumulation of indicator plant (muskmelon and cucumber) upto 40 days and 2,4-D (0.5 and 0.765 kg/ha) upto 20 days. It can be concluded that anilofos, butachlor and pretilachlor persisted in soil upto 40 days and 2,4-D at both rates upto 20 days after their application. In sunflower-soybean system, pendimethalin residue was detected using gas choromatography with ECD at column temperature of 210 C, injector-250 C, detector-290 C, gas flow of 40 ml/min. In transplanted fingermillet - groundnut system, the residues of butachlor could be detected only upto 20 DAS herbicide in 0-30 cm soil depth, the movement of butachlor was noticed in 15-30 cm on 5 DAS. After 30 DAS residue of butachlor could not be detected. In chicory crop, the fluchloralin residues were present on 50 and 100th day in a treatment involving application of fluchloralin @ 1.0 kg/ha.

Weed shift

In transplanted rice, all weeds except *Panicum* sp., *Monochoria vaginalis* and *Commelina benghalensis* were controlled effectively with continuous use of butachlor. Maximum change was recorded with 75% NPK application in summer and 75% NPK applied in *kharif* fb 25% N through *Azolla*, where, *Alternanthera sessilis*, annual *Cyperus & Fimbristylis* species, and *Echinochloa crusgalli* were found to be absent, while, *Ageratum* spp., *Commelina-Murdania* complex, *Cuphea balsamona, Leersia hexandra, Paspalum conjugatum, rotala spp., Saccolepis interupta* and *Spilanthes paniculata* were noted.

Fertilizer use economy through weed control

Result revealed that increasing doses of nitrogen showed decreasing trend in garlic bulb yield in presence of weeds. However, linear increase in bulb yield was registered in absence of weed competition created either manually or chemically. The pre em. application of pendimethalin (1.0 kg/ha) fb one hand weeding increased bulb yield appreciably.

Evaluation of weed control tools and implements

Application of atrazine at 1.0 kg//ha (6090 kg/ha) and HW twice at 20 & 40 DAS (5878 kg/ha) resulted similar grain yield and was significantly superior to intercultivation (IC) with three tyned cultivator fb star weeder (3454 kg/ha) or blade harrow fb star weeder (4652 kg/ha). Application of atrazine 1.0 kg/ha and HW gave 86 & 84% of weed control efficiency respectively, while it was 60 & 69% in intercultivation with three tyned cultivator fb star weeder and blade harrow fb star weeder respectively. In groundnut hand weeding twice at 20 & 40 DAS (817 kg/ha), oxyfluorfen 0.15 (667 kg/ha) or 0.20 kg/ha (650 kg/ha) fb IC with three tyned cultivator at 25 DAS and IC with star weeder (683 kg/ha) resulted in similar pod yield. The weed control efficiency among these treatments varied between 72-80%.

On farm trials

Evaluation of pre-em. application of metolachlor 1.0 kg/ha (Dual 50 EC) and post em. application of fluazifop-p-butyl 0.125 kg/ha (Fusilade Super 2000 12.5 EC) for weed management in irrigated/rainfed groundnut and evaluation of butachlor 0.75 kg/ha as pre-em. for weed management in transplanted fingermillet were laid out through Agric. Deptt. staff & Extension Units of UAS(B) in Shimoga, Tumkur, Kolar, Mandya, Hassan , Mysore, Bangalore (rural & urban) districts. Thirty five 'on farm trials' were conducted for controlling *Lantana* in pasture lands, *Ageratum* in maize, orchards, grasslands and wastelands, control of weeds in wheat, maize and rice. Farmers' method of weed control was surveyed in direct seeded summer rice, transplanted summer rice. *Kharif* rice, oilseeds, pulses and vegetables commonly grown in the different agro climatic regions of the State. In upland broadcasted summer rice, the farmers commonly used "Bindha" - a traditional type of bullock drawn implement used at 15-20 DAE of the crop. In some areas dryland weeders are also used manually 20-25 DAS & 40-45 DAS. In transplanted summer rice, paddy rottery weeder twice at 20-25 and 40-45 DAT, in jute, "Bindha" and traditional implements "Jaboka" and "Jengkur" are also used in row sown crops. In pulses and oilseeds generally hand weeding is practiced. In row sown crop mechanical weeding with grubber and peg type dryland weeders are also used. Mulching with water hyacinth and rice straw are also practiced in vegetables and *rabi* crops.

A field trial was conducted at Trichur to control the *Cyperus rotundus* in jasmine. Application of paraquot at the arte of 6 ml commercial product per litre of water resulted in drying of foliage of *Cyperus rotundus* but it was regerminated, however, glyphosate application resulted in gradual yellowing and drying of *Cyperus rotundus* .

During the year 1996-97, demonstations involving herbicide vs. no herbicide were laid out on cultivators field of village Biribandha in Jagatsinghpur distt. Cultivars of the village, grow upland paddy locally known as 'Biali' at the onset of monsoon. Butachlor (Machete 50% EC, Hitlachlor) 1.25 kg/ha, anilophos 0.3 kg/ha, pendimethalin 0.75 kg/ha were sprayed just 1-2 DAS. Application of butachlor enhanced the grain yield over weedy check and controlled weeds most effectively.

5.0 EXPERIMENTAL FARM

The centre is equipped with a research farm having 59.5 ha land handed over by JNKVV, Jabalpur in 1990. The farm has two tractors and different farm implements. At present, most of the area of experimental farm is irrigated with three tubewells. The land is cultivated by growing various crops each year. The farm has an information centre cum conference room, temporary shed for office and field laboratories and garages for tractors, workshop cum garage shed and implement shed.

During *kharif* season, 20.10 ha was covered under cultivation and crops grown were soybean, paddy, maize, dhaincha, multicrop trial. Dry spell prevailed during kharif season which adversely affected the crops. In *rabi* season, 41.8 ha area was covered under wheat, gram, pea, rajmash, linseed, mustard and vegetable crops.

Table - 39 : Area and production of *Kharif* and *Rabi* crops.

Kharif Crops	Area (ha)	Production (Qtl.)	Rabi Crops	Area (ha)	Production (Qtl.)
Paddy			**Wheat**		
a. Kranti	9.3	360.86	a.WH-147	11.2	421.23
b. JR-370	2.2	55.56	b.C-306	2.8	88.01
Paddy Nursery	0.8	-	c.Sujata	4.0	112.43
Soybean			Linseed (JL-17)	7.6	79.00
a. JS 75-46	4.8	17.34	Mustard (Pusa bold)	5.3	31.02
b. JS 80-21		11.57	Pea (JP-885)	3.9	70.00
			Gram (JG-315)	4.0	86.58
Maize			**Vegetable trial**	1.00	
Ganga-5	0.6	14.57	Potato		8.95
			Tomato		2.98
			Rajmash contender	0.2	0.23
Dhaincha	1.0	9.47	Sunflower	0.7	-
Multicrop/	1.4	-	Multicrop trial	0.3	-
Parthenium control *etc.*	-	-	Marigold trial	0.8	-

6.0 PUBLICATIONS

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7.0 VARIOUS COMMITTEES

- **MANAGEMENT COMMITTEE**

The VIth meeting of the management committee was held on 04.03.97 under the chairmanship of Dr. V.M. Bhan, Director of the centre and other members present were Dr. P.C. Bhatia, ADG (Agro); Dr. R.S. Tripathi, Prof. & Head, Deptt. of Agronomy, IGKVV, Raipur; Sh. Pradeep Kumar, Non-official member; Dr. S.K. Mukhopadhyay, Ex-Dean, College of Agriculture, Shantiniketan (Special invitee); Dr. N.T. Yaduraju, Sr. Scientist, Div. of Agro., IARI, New Delhi; Dr. S.K. Handa, Prof. & Head, Agrochemicals, IARI, New Delhi; Dr. L.P. Kaurav, Sr. Scientist ,NRCWS; Sh. H.S. Bisen, Sr. Scientist, NRCWS; Sh . S.C. Sharma, Suptd.(A&A) member of IJSC and Sh. B. Rai, AAO & member secretary. The committee discussed on the issues of provision of additional funds under works during revised estimate and next five year plan; Construction of scooter/cycle stand/tiffin shade for the institutes labourers; Hiring building for the institutes guest house; Review of audit para and proceeding of IJSC; Progress of civil works; Income generation by consultancy, sale of farm produce; Summary of RAC recommendations and progress of the research.

Fig.-13: Centre's Management Committee surveying the progress of building construction.

RESEARCH ADVISORY COMMITTEE

Meeting of Research Advisory Committee was convened at NRC-Weed Science , Jabalpur on April,18-19, .1996. The committee formulated the research guidelines and direction to the research policies of the centre under the chairmanship of Dr. Ambika Singh (Ex-ADG); Dr. O.P. Gupta (Ex-DR, RAU); P.C. Bhatia (ADG, Agro); Dr. S.K. Mukhopadhyay (Prof., Agro., V.B.); Dr. Y.P. Abrol (Ex-Head, Pl. Physiol.,IARI) and Dr. V.M. Bhan, Director of NRC-WS and Member Secretary. The second meeting of the RAC was convened on 5-6 March,1997 under the chaimanship of Dr. Ambika Singh (Ex-ADG).

Fig. - 14 : Research Advisory Committee visiting the centre's laboratories.

- **STAFF RESEARCH COUNCIL**

Meeting of Staff Research Council (SRC) was held on 18th and 19th June, 1996 under the Chairmanship of Dr. V.M. Bhan, Director. Progress of research work during April 1st to March, 31st, 1997 and new project proposals for the 1996-97 were discussed and programme of work for the year 1996-97 was also finalised.

- **QUINQUENNIAL REVIEW TEAM (QRT)**

Meeting of Quinquennial review team was held to review the performance of the centre with regard to achievement of its objectives in the last five years. It examined the objectives, scope and relevance of the research programmes for the next five years in relation to the overall national plans, policies and long-term and short-term priorities. The team comprised of the members are Dr. R.P. Singh, Ex-Director, CRIDA, Hyderabad as Chairman and Dr. H.K. Pandey, Ex-Director, CRRI, Cuttack; Dr.

Vikram Singh, Ex-DRS, GBPAU & T, Pantnagar; Dr. S.K. Mukhopadhyay, Sr. Professor, Vishva Bharti, Sriniketan; Dr. R.K. Malik, Professor Weed Science, CCSHAU, Hisar all as members and Dr. V.M. Bhan, Director, NRCWS, as Member Secretary. The first meeting was held on April 14-16, 1996 at the centre and second meeting , held on July 10, 1996 at IARI, New Delhi.

Fig. -15 : Interaction of QRT team with scientists of the centre

To assist day-to-day working of the centre, the following committees are also functioning:

- Farm Advisory Committee;
- Purchase Committee;
- Price Fixation Committee; and
- Yield Estimation Committee.

8.0 MISCELLANIOUS ACTIVITIES

- **DISTINGUISHED VISITORS**

National

1. Dr. Ambika Singh, Ex-ADG, visited the centre on 19.04.96.

2. Dr. V.L. Chopra, Former Director General, visited the centre on 30.08.96.

3. Dr. B.L. Jalali, CCSHAU, Hisar visited the centre on 12.09.96.

4. Dr. A.N. Mukhopadhyay, Dean, G.B. Pant Univ. of Agril. and Technology visited the centre to review the DBT project of the centre.

- **PROGRAMMES**

Cultural programmes were organised by the office staff on the eve of Annual Day. The programmes offered the opportunity to staff to display their cultural talents such as singing, dancing, etc.

Republic Day

The Republic Day was celebrated by the centre and the flag hoisting was done by the Director of the centre. During celebration, children events were organised and prizes for the same were also distributed.

Foundation Day

The foundation day which falls on April, 22 ,1989 every year was celebrated in 1996-97. During the celebration, various cultural programmes were arranged. Staff and their children participated in the cultural events.

Independence Day

The centre celebrated the 49th independance day on 15th of August,1997. The flag hoisting was done by the Director of the centre.

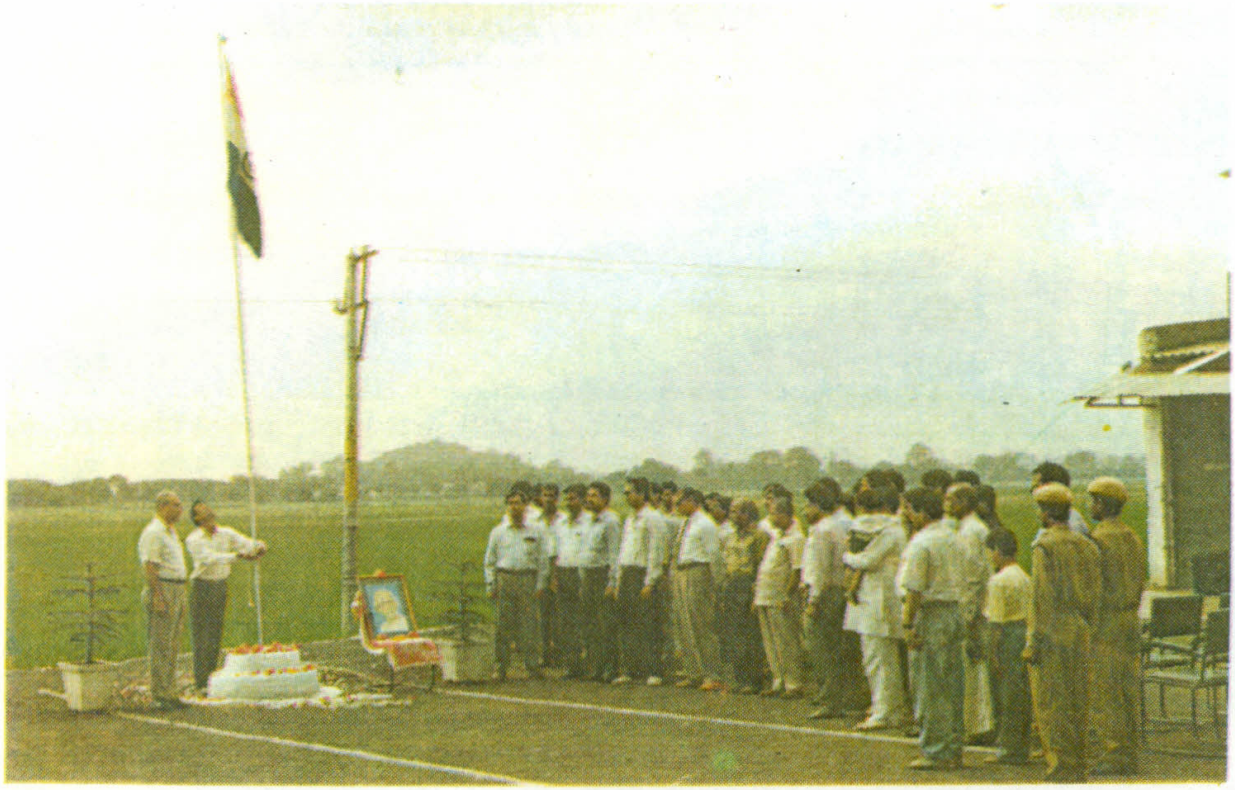

Fig - 16 : Flag hoisting by the Director of the centre on the occasion of **Independence day**

Fig.-17 : Foundation day being inaugrated by the Hon'ble Vice Chancellor Dr. Panjab Singh of the JNKVV, Jabalpur

9, 0 सारांश

राष्ट्रीय खरपतवार विज्ञान अनुसंधान केन्द्र, । भारतीय कृषि अनुसंधान परिषद् । के प्रशासनिक नियंत्रण के अंतर्गत आता है । खरपतवार नियंत्रण की अ.भ.स.अनु. परियोजना का मुख्यालय भी इस केन्द्र में होने के साथ–साथ 22 केन्द्रों एवं 2 स्वैच्छिक केन्द्रों के साथ कार्यरत है ।

यह केन्द्र वर्ष 1989 में प्रतिकूल जलवायु वाले क्षेत्रों में प्रभावी खरपतवार प्रबंधन की प्राथमिक एवं व्यवहारिक अनुसंधानों का निश्चित विकसित करने का उत्तरदायित्व, राज्यों के कृषि विश्वविद्यालयों के स्थानीय क्षेत्रों के लिये विशेष तकनीकी प्रदान करने हेतु उचित नेतृत्व अनुसंधान तंत्रों के बीच उचित समन्वयः खरपतवार विज्ञान से संबंधित समस्त जानकारियों का कार्य विवरण खरपतवार विज्ञान एवं प्रबंधन के क्षेत्र में अनुसंधान प्रणाली हेतु प्रशिक्षण प्रदान करना, राष्ट्रीय एवं अंतर्राष्ट्रीय माध्यमों के द्वारा उपरोक्त उद्धेश्यों की प्राप्ति एवं खरपतवार विज्ञान हेतु परामर्श आदि अधिदेशों के तहत् स्थापित किया गया ।

स्थिति एवं ऋतु –

केन्द्र समुद्री सतह से 411.78 मीटर की उंचाई तथा 22.49 24.8 अंश उत्तरी अक्षांश और 78.21 अंश से 80.59 पूर्वी देशांतर रेखा के बीच स्थित है । यह राज्य के चांवल–गेहूं पैदा करने वाला क्षेत्र है । जबलपुर की जलवायु अर्द्ध–आर्द्र और उपोषणी है । यहां की औसत वर्षा 1253 मि.मी. है । साधारणतः यह 15 जून से अक्टूबर के प्रारंभ तक रहतीी है । इसका 80 प्रतिशत भाग खरीफ फसलों की वृद्धि के समय होता है । जाड़े के समय होने वाली वर्षा, प्रारंभ होने तक रहता है ।

भूमि –

इस केन्द्र के प्रक्षेत्र के खेतों की मिट्टी सामान्य क्षारीय ए.सी. क्षितिज वाली गहरे धूसरे भूरे रंग की है

खरपतवार प्रबंधन –

अनुसंधान क्षेत्र में पाये जाने वाले मुख्य खरपतवारों में इकाईनोक्लोवा कोलोनम, कॉमीलीना कम्युनिस, कॉमीलीना बेंगालेनसिस, ब्रेचेरिया, स्पी., साईप्रस स्पी. फाइसेलिस मिनीमा, यूफोरबिया जेनिकुलाटा, लिगेसिया मोलिस, आल्टरनेनथेरा सिसलिस आदि खरीफ मौसम में तथा चिनोपोडियम अल्बम, सिचोरियम इनटाइबस, मेडिकॉगो डेन्टीकुलाटा, विसिया सताईवा, ट्राइफोलियम फलेजिफेरम एवं फैलेरिस माइनर आदि रबी मौसम में दर्ज किये गये ।

सस्यन प्रणाली –

सोयाबीन – गेहूं सस्यन प्रणाली में खरपतवारों की उपस्थिति से सोयाबीन बी उपज में 23 प्रशित की कमी आंकी गई । वही गेहूं की उपज में 28 प्रतिशत की कमी दर्ज की गई । खरपतवार की रोकथाम हेतु सोयाबीन की फसल में पेन्डीमिथालिन 1.25 कि.ग्रा. /हेक्ट. अंकुरण पूर्व एवं गेहूं में आइसोप्रोटूरान 1 कि. ग्रा./हेक्ट. अंकुरण पश्चात् के छिड़काव से खरपतवारों की संख्या एवं उनके शुष्क पदार्थ में प्रभावपूर्ण कमी दर्ज की गई साथ ही साथ उनकी उपज में क्रमशः 8 एवं 18 प्रतिशत की वृद्धि दर्ज की गई ।

मक्का : मटर सस्यन प्रणाली में खरपतवारों से निपटने के लिये मक्के की फसल में एट्राजीन 1 कि.ग्रा. /हेक्ट. एवं मटर में पेन्डीमेथालिन 1.25 कि.ग्रा./हेक्ट. ।अंकुरण पूर्व। नामक शाकनासियों के छिड़कने से खरपतवारों की संख्या एवं उनके शुष्क पदार्थ में अर्थपूर्ण कमी आयी तथा वही उनकी उपज में क्रमशः 19 एवं 15 प्रतिशत की बढ़ोत्तरी भी दर्ज की गई ।

सोयाबीन पर आधारित सस्यन तीव्रता वाले एक अन्य परीक्षण में सोयाबीन के बाद सरसौं एवं मूंग को एक ही खेत में लगाने से ।300 प्रतिशत फसलीय तीव्रता। तथा फैलो – गेंहूं ।100 प्रतिशत फसलीय तीव्रता। में सबसे कम खरपतवार दर्ज किये गये एवं सबसे जयादा उपज प्राप्त हुई । इन्हीं फसलों में खरपतवारों की रोकथाम हेतु शाकनासियों का छिड़काव भी किया गया । सोयाबीन में पेन्डीमेथालिन 1.25 कि.ग्रा. /हेक्ट. तथा गेंहूं और सरसौ। में आइसोप्रोटूरान 1ण्0 कि.ग्रा./हेक्ट. की दर से छिड़काव करने से खरपतवारों कीसंख्या में कमी दर्ज की गई ।

एक अन्य फसलीय तीव्रता वाले परीक्षण में धान–गेहूं तीव्रता ।200 प्रतिशत। तथा फैलो–गेहूं ।100 प्रतिशत। में सबसे कम खरपतवार दर्ज किये गये । फलस्वरूप उनके शुष्क पदार्थ में भी भारी कमी आयी । धान की फसल में ब्यूटाक्लोर 1ण्5 कि.ग्रा./हेक्ट. तथा गेहूं में आइसोप्रोटूरान 1.0 कि.ग्रा./हेक्ट. की दर से छिड़काव करने से खरपतवारों की कमी के साथ–साथ इनकी उपज में क्रमशः 18 एवं 36 प्रतिशत की बढ़ोत्तरी दर्ज की गई ।

भारतीय मृदा विज्ञान संस्थान, भोपाल के साथ किये गये परीक्षण से यह पता चलता है कि गोबर की खाद एवं हरी खाद ।पारथेनियम। को नत्रजन उर्वरक के बढ़ते क्रम 45.90 एवं 180 कि.ग्रा. के साथ उपयोग करने से धान की उपज में क्रमशः 38,115 एवं 144 प्रतिशत की बढ़ोत्तरी होती है । वही गेहूं की उपज में क्रमशः 77,136 एवं 165 प्रतिशत का लाभ होता है ।

सोयाबीन – सोयाबीन की उपज में खरपतवारों की उपस्थिति से 57 प्रतिशत की कमी दर्ज की गई । खरपतवारों की संख्या को कम करने के लिये सोयाबीन मे लेक्टोफेन ।0.2 कि.ग्रा./हेक्ट.। नामक शाकनासी को अकेले एवं फलूजीफाप ब्यूटाइल तथा सिथाक्सीडिम ।दोनों 0.25 कि.ग्रा./हेक्ट. की दर से। छिड़काव करने से खरपतवार नियंत्रण में सफलता प्राप्त होती है । एक अन्य परीक्षण में सोयाबीन में एकीकृत खरपतवार प्रबंधन में, फलूजीफाप ब्यूटाइल ।0.25 कि.ग्रा./हेक्ट. के साथ की दर से। छिड़कने पर खरपतवारों पर विजय प्राप्त होती है । विभिन्न शाकनासियों के परीक्षणों में, क्लोरीमुरान ।1.2 कि.ग्रा. /हेक्ट. ।मेटालाक्लोर ।1.0 कि.ग्रा./हेक्ट.। तथा एम.ओ.एन. 8453 खरपतवारों के विरूद्ध प्रभावी पाये गये

स्टेलसीड बेड ।जीर्ण खेत। नामक पद्धति से खरपतवारों के शुष्क पदार्थ में भारी कमी दर्ज की गई । तथा सोयाबीन की लौलिक जुताई पद्धति के बराबर उपज प्राप्त हुई । खरपतवार नियंत्रण उपचारों में फलूक्लोरालिन ।1.0 कि.ग्रा./हेक्ट. तथा एलाक्लोर 2.0 कि.ग्रा./हेक्ट. की दर से उपयोग करने पर खरपतवारों को नियंत्रण में रखने हेतु काफी प्रभावपूर्ण सिद्ध हुए ।

धान – धान की फसल में एनीलोफास ।0.4 ।कि.ग्रा./हेक्ट.। के उपचार से खरपतवारों की वृद्धि एवं विकास में कमी आयी ।

गेहूं – गेहूं की फसल में चिरैया, बाजरा के बढ़ते प्रकोप को देखते हुए विभिन्न शाकनासियों की प्रारंभिक जांच की गई जिसके तहत् मेट्रीब्यूजीन (4 ग्रा./हेक्ट.) सल्फोसल्फयशूरान (300 ग्रा./हेक्ट.) फिनाक्साप्राप (90 ग्रा./हेक्ट.) ट्रल कॉकसीडिम को 30 से 35 दिन के बीच प्रयोग करने से चिरैया बाजरा की एवं अन्य खरपतवारों की संख्या में कमी आयी । अन्य शाकनासियों में क्लोडिनोफॉप (50 ग्रा./हेक्ट. की दर से) चिरैया बाजरा एवं अन्य खरपतवारों के शुष्क पदार्थ एवं उनकी संख्या में कमी आती है ।

खरपतवार कार्यिकी –

शाकनासी रक्षक से उपचारित आलू के पौध पर 2,4–डी नामक शाकनासी का कोई प्रभाव नहीं पड़ता है । मक्के पर स्पेरेन्थस इंडीकस के अर्को के एलीलोपैथिक विभव जानने हेतु एक परीक्षण किया गया । अर्को को विभिन्न कार्बनिक घोलों में धोलकर अर्को का असर मक्के पर देखा गया । परीक्षण से यह ज्ञज्ञत हुआ कि पानी वाले अर्क का प्रभाव लगभग क्लोरोफार्म एवं 80 प्रतिशत वाले इथेनॉल जैसा रहा । गर्म एवं ठण्डे पानी के अर्को के प्रभाव को देखकर ऐसा विदित होता है कि स्पेरेन्थस इंडिकम में कोई वाष्पिकृत वानस्पितक घटक विद्यमान है ।

धान की फसल में सवॉ के ताजे एवं सड़े हुए अवशेषों का प्रभाव देखा गया । इस परीक्षण से यह ज्ञात हुआ कि सड़े हुए वॉ के अवशेषों का धान की फसल परद जहरीला असर होता है । फलस्वरूप पौधें के उपर से आने वाली जड़ों (टीलरस) एवं दाने के बनने पर प्रतिकूल असर देखा गया है । वही दूसरी तरफ ताजे अवशेषों के उपयोग का भी प्रतिकूल असर देखा गया । जिसके फलस्वरूप धान की वृद्धि एवं विकास पर विपरीत असर हुआ ।

एक अन्य परीक्षण में प्रतिरोधक फाईसेलिस मिनिमा नामक खरपतवार में निहित ग्लूटामेट डीहाईड्रोजिनेज एवं ग्लूटामेट सिन्थेटेस पदार्थो के बहुत ही कम मात्रा में निहितता पायी गई जो कि अग्रिम क्रियाओं से उतना ग्लूटामिक अम्ल उत्पन्न नहीं करते है जो कि 2,4–डी के असर को खत्म कर सके ।

जैविक खरपतवार प्रबंधन –

अप्रैल, 1996 से मार्च 1997 वर्ष में, एक सर्वेक्षण के दौरान रोगयुक्त कुछ मुख्य खरपतवारों के पौधों को प्रयोगशाला में लाकर उनसे निहित रोगों के उतपत्ति करने वाले मूलकों को अलग किया गया । प्रयोगशाला में पृथक किये गये रोगों के मूलकों के पार्थेनियम ।गाजरघास। पर छिड़काव किया गया । स्केलोरोशियम रोल्फशाई, ट्राईकोडर्मा विरिडी दोनों को 0.30 दिन पर एवं स्केलोरोशियम स्केलेरोटियोरम के 0–15 दिन पर इनका घोल बनाकर छिड़काव करने से गाजरघास की उंचाई, शाखाओं एवं उसके फूलों में काफी हद तक कमी आती है ।

एक अन्य परीक्षण में यह देखा गया है कि घने रूप में उगी गेंदे के पौधों में से उगने वाली गाजरधास की वृद्धि एवं विकास पर प्रतिकूल असर देखा गया ।

ट्राइकोडर्मा विरिडी से उपचारित गेहूं के बीजों को बोने से भूमि में निहित फेलेरिस माइनर के बीजों के अंकुरण पश्चात् तने व जड़ों की लंबाई में 17.4 एवं 22 प्रतिशत तक की कमी आती है । इससे यह विदित होता है कि फंफूद चिरैया बाजरा नामक खरपतवार को नियंत्रण मे रखने हेतु काफी हद तक सहायक सिद्ध होती है ।

सर्वेक्षण के दौरान बैंगलोर शहर की एक झील जिसमें नियोकेटिना स्पी. एवं केसीडां स्पी. नामक दो कीटों को दो खरपतवारों कमशः जलकुंभी एवं ऐलीगेटर खरपतवार को पत्ती रहित करते देखे गये । एक अन्य सर्वेक्षण जो कि केन्द्र के प्रक्षेत्र एवं आसपास के इलाकों में किया गया में चिरैया बाजरा जो कि गेहूं की फसल को मुख्य खरपतवार है पर मांहू एवं दीमक नामक दो कीट देखे गये । वही दूसरी तरफ एक गैर फसलीय क्षेत्र में सर्वेक्षण के दौरान यह पाया गया कि घनी संख्या में पाये जाने वाले चकौड़े के क्षेत्र में उगने वाली गाजरघास की वृद्धि एवं विकास में भारी कमी आती है ।

जैविक खरपतवार प्रबंधक के अंतर्गत गाजरघास का कीड़ों द्वारा नियंत्रण पर एक परीक्षण किया गया । जिसमें यह ज्ञात हुआ कि जायगोग्रामा बाईकोलोराटा नामक कीटल गाजरघास की पत्तियों को भोजन समझकर उस पर अपना जीवन निर्वाह करता है । सर्वेक्षण के दौरान यह भी ज्ञात हुआ कि लगभग आधा किलोमीटर के क्षेत्र में गाजरघास पूरी तरह पत्तियां रहित पायी गई । विश्लेषण पश्चात् यह ज्ञात हुआ कि इस प्रकार का आकमण उपर दिये गये कीड़े द्वारा ही किया जाता है ।

यांत्रिकीय खरपतवार प्रबंधन –

सोयाबीन एवं मक्के की फसल में दो चको वाले हाथ से चलित 'हो' को फसल की बुआई के 15 एवं 25 दिन बाद चलाने से खरपतवार नियंत्रण क्षमता कमशः 80 एवं 81 प्रतिशत प्राप्त होती है ।

प्रशिक्षण –

केन्द्र में कृषि मंत्रालय के सौजन्य से कृषि विभाग के विषयवस्तु विशेषज्ञों एवं अधिकारियों को तकनीकी हस्तातंरण हेतु खरपतवार प्रबंधन पर 8 दिन के ।28.01.97 से 04.02.97। का प्रशिक्षण दिया गया । इस प्रशिक्षण का मुख्य विषय खरपतवार प्रबंधनः एक उपज बढ़ाने का तरीका था । जिसमें तहत् विभिन्न फसलों में खरपतवार नियंत्रण की नई तकनीकियों का ब्यौरा दिया गया साथ ही साथ उन्हें अनुसंधान प्रक्षेत्रों से भी रूबरू कराया गया ।

ANNEXURE - I

Total strength of the staff in the centre is 72 (Scientist-13, Technical-23, Administrative-11, and Supporting staff-25) A list of staff position is given below.

STAFF IN POSITION (as on 31.03.97)

Sl.	Designation	Name	Joining	Remarks
RESEARCH MANAGEMENT PERSONNEL				
1.	Director	Dr. V.M. Bhan	22.04.89	
SCIENTIFIC PERSONNEL				
2.	Sr. Scientist (Pl.Patho)	Dr. L.P. Kauraw	10.07.91	
3.	Sr. Scientist (Ag. Engg)	Sh. H.S. Bisen	01.01.92	
4.	Scientist (Pl. Physiol)	Dr. D. Swain	25.02.91	
5.	Scientist (Pl. Physiol)	Sh. D.K. Pandey	29.11.91	On Study Leave
6.	Scientist (Agronomy)	Dr. S. Singh	20.11.90	
7.	Scientist (Agronomy)	Dr. A.N. Singh	01.04.91	On lien
8.	Scientist (Agronomy)	Dr. V.P. Singh	28.05.92	
9.	Scientist (Agronomy)	Sh. J.S. Mishra	24.07.92	On Study Leave
10.	Scientist (Entomo.)	Dr. Sushilkumar	11.04.94	
11.	Scientist (Agro.)	Dr. Anil Dixit	11.08.94	
12.	Scientist (Soil Sci.)	Dr. M.B.B Prasad Babu	18.12.96	
13.	Scientist (Soil Sci.)	Dr. P.J. Khankhane	14.08.96	
TECHNICAL PERSONNEL				
14.	T-5 (Technical Officer)	Dr. M.S. Raghuwanshi	24.08.92	
15.	T-5 (Farm Manager)	Sh. R.S. Upadhyay	17.03.90	
16..	T-5 (Artist)	Sh. M.K. Bhatt	10.07.96	
17.	T-5 (Librarian)	Sh. M.N. Jadhav	08.07.91	Promoted
18.	T-4 (Sr. Photographer)	Sh. Basant Mishra	19.12.91	
19.	T-4 (Tech. Asstt.)	Sh. Sandeep Dhagat	05.11.90	
20.	T-4 (Artist)	Sh. V.K.S. Meshram	05.11.90	
21.	T-4 (Draftsman)	Sh. G.R. Dongre	19.09.91	Promoted
22.	T-II-3 (Tech. Asstt.)	Sh. O.N. Tiwari	01.02.94	
23.	T-II-3 (Farm Mechanic)	Sh. M.P. Tiwari	21.05.92	
24.	T-2 (Field Assistant)	Sh. J.N. Sen	13.03.90	On Study Leave
25.	T-2 (Field Assistant)	Sh. S.K. Parey	15.03.90	

Sl.	Designation	Name	Joining	Remarks
26.	T-2 (Field Assistant)	Sh. K.K. Tiwari	14.21.92	
27.	T-2 (Field Assistant)	Sh. S.K. Tiwari	14.01.92	Promoted
28.	T-2 (Field Assistant)	Sh. Somitra Bose	14.01.92	
29.	T-2 (Field Assistant)	Sh. G. Vishwakarma	28.03.92	
30.	T-2 (Field Assistant)	Sh. Ajay Pal Singh	28.03.92	
31.	T-1 (Field Assistant)	Sh. R.K. Meena	11.02.94	
32.	T-1 (Field Assistant)	Sh. Mukesh Meena	22.02.94	
33.	T-1 (Field Assistant)	Sh. V.S. Raikwar	26.05.95	
34.	T-1 (Driver)	Sh. Prem Lal	23.03.90	
35.	T-1 (Driver)	Sh. D.K. Sahu	23.03.90	Promoted
36.	T-1 (Tractor Driver)	Sh. Bhagunte Prasad	15.05.90	
ADMINISTRATIVE				
37.	Asstt. Admn. Officer	Sh. Balwant Rai	21.08.89	
38.	Suprintendent (A&A)	Sh. S.C. Sharma	19.03.90	
39.	Sr. Clerk	Sh. S.K. Sharma	02.12.89	
40.	Stenographer	Smt. Nidhi Sharma	28.11.89	Promoted
41.	Jr. Stenographer	Sh. Ajay Bhowal	24.10.92	
42.	Jr. Stenographer	Sh. Manoj Gupta	05.05.95	
43.	Jr. Clerk	Sh. J.P. Kori	21.05.90	
44.	Jr. Clerk	Sh. R.K. Hadge	26.11.90	
45.	Jr. Clerk	Sh. T. Lakhera	26.11.90	
46.	Jr. Clerk	Sh. Sunil Gupta	17.02.90	
47.	Jr. Clerk	Sh. B.P. Uriya	25.03.92	
SUPPORTING				
48.	Messenger (SSG-II)	Sh. Francis Xavier	17.02.90	
50.	Messenger (SSG-II)	Sh. Veer Singh	02.03.90	
51.	Messenger (SSG-I)	Sh. A.K. Tiwari	31.03.92	
52.	Messenger (SSG-I)	Sh. Shiv K. Patel	28.03.92	
53.	Messenger (SSG-I)	Sh. Pyare Lal	31.03.92	
54.	Messenger (SSG-I)	Sh. Sukha Singh	03.04.92	
55.	Lab. Attendant (SSG-I)	Sh. Sebasten	28.03.92	
56.	Lab. Attendant (SSG-I)	Sh. S.L. Koshta	28.03.92	
57.	Lab. Attendant (SSG-I)	Sh. J.P. Dahiya	31.03.92	
58.	Lab. Attendant (SSG-I)	Sh. Madan Sharma	31.03.92	
59.	Lab. Attendant (SSG-I)	Sh. J. Vishwakarma	08.04.92	
60.	Farm Mazdoor (SSG-II)	Sh. Raju Prasad	19.03.90	
61.	Farm Mazdoor (SSG-II)	Sh. Jagoli Prasad	21.03.90	
62.	Farm Mazdoor (SSG-II)	Sh. Jagat Singh	23.03.90	
63.	Farm Mazdoor (SSG-II)	Sh. C.L. Yadav	30.03.90	

Sl.	Designation	Name	Joining	Remarks
64.	Farm Mazdoor (SSG-I)	Sh. Anil Sharma	23.04.91	
65.	Farm Mazdoor (SSG-I)	Sh. Ram Kumar	10.05.91	
66.	Farm Mazdoor (SSG-I)	Sh. Naresh Singh	10.05.91	
67.	Farm Mazdoor (SSG-I)	Sh. Gajjulal	26.10.93	
68.	Farm Mazdoor (SSG-I)	Sh. S.C. Rajak	09.02.96	
69.	Security Gaurd (SSG-I)	Sh. Rajesh	23.05.95	
70.	Security Gaurd (SSG-I)	Sh. Gangaram	23.05.95	
71.	Security Gaurd (SSG-I)	Sh. Santosh Kumar	12.02.96	
72.	Security Gaurd (SSG-I)	Sh. Santlal	13.02.96	
73.	Security Gaurd (SSG-I)	Sh. M. Patel	24.02.96	

ANNEXURE - II

The expenditure (In rupees) for the year 1996-97 under different heads is as follows:

Statement of expenditure during the year 1996-97 (In Rs.)

SL. NO.	NAME OF HEADS	PLAN	NON-PLAN	TOTAL
1.	a. Establishment charge	30,60,000	8,75,000	39,35,000
	b. Wages	9,00,000	2,00,000	11,00,000
2.	Travelling Expenses	1,10,000	16,000	1,26,000
3.	Building & other original works	23,30,000	24,000	23,54,000
4.	Other charges	26,00,000	9,85,000	35,85,000
	TOTAL	90,00,000	21,00,000	1,11,00,000
5.	Additional expenditure a. P-Loans	4,00,000	-	4,00,000
	GRAND TOTAL	94,00,000	21,00,000	1,15,00,000

ANNEXURE-III

- **VISITS IN SYMPOSIUM/SEMINAR/CONFERENCE/MEETING/WORKSHOP ETC.**

Dr. V.M. Bhan, Director,

⇒ participated the XIIth AICRP-WC Workshop held at CSAUA&T, Kanpur from 4-6.4.96.

⇒ attended First meeting of National Steering Committee of Rice-Wheat cropping system Indogangatic plains held at ICAR, Krishi Bhawan, New Delhi on 16.5.96.

⇒ attended the workshop on Aquatic weeds - Problems and Management organised by Central Board of Power and Irrigation, Bangalore from 5-7.6.96.

⇒ attended the QRT meeting of the centre held at IARI, PUSA, New Delhi on 10.7.96.

⇒ attended the Iind International Crop Science Congress at Vigyan Bhawan, New Delhi from 17-24.11.96.

⇒ attended the Biennial Conference of ISWS, held at PAU, Ludhiana from 19-23.02.97.

⇒ attended the Management Committee of Directorate of Wheat Research, Karnal on 20.3.97.

Dr. D. Swain, Scientist (Pl. Physiol.)

⇒ attended the Biennial Conference of ISWS, held at PAU, Ludhiana from 19-23.02.97.

Dr. V.P. Singh, Scientist (Agronomy)

⇒participated the XIIth AICRP-WC Workshop held at CSAUA&T, Kanpur from 4-6.4.96.

⇒attended the IInd International Crop Science Congress at Vigyan Bhawan, New Delhi from 17-24.11.96.

⇒attended the Biennial Conference of ISWS, held at PAU, Ludhiana from 19-23.02.97.

Sr. Sushilkumar, Scientist (Entomology)

⇒ participated the XIIth AICRP-WC Workshop held at CSAUA&T, Kanpur from 4-6.4.96.

⇒ attended the Biennial Conference of ISWS, held at PAU, Ludhiana from 19-23.02.97.

Dr. Anil Dixit, Scientist (Agronomy)

⇒ participated the XIIth AICRP-WC Workshop held at CSAUA&T, Kanpur from 4-6.4.96.

⇒ attended the Iind International Crop Science Congress at Vigyan Bhawan, New Delhi from 17-24.11.96.

⇒ attended the Biennial Conference of ISWS, held at PAU, Ludhiana from 19-23.02.97.

Sh. S.C. Sharma, Suptd. (A&A),

⇒ attended HINDI KARYASHALA at GCF, Ministry of Defence, Govt. of India, Jabalpur from January, 28-30,1997.

Sh. Manoj Gupta, Jr. Steno (Hindi)

⇒ attended HINDI KARYASHALA at GCF, Ministry of Defence, Govt. of India, Jabalpur from January, 28-30,1997.

- **HUMAN RESOURCE DEVELOPMENT**

Dr. Sushilkumar, Scientist (Entomology)

⇒ attended training programme on Software Statistical Analysis at NAARM, Hyderabad from 19-29.11.96.

Dr. M.B.B. Prasad Babu, Scientist (Soil Sci.)

⇒ has undergone 56th foundation course for Agril. Research Service at NAARM, Hyderabad from July 5th -Dec. , 1996.

Dr. P. J. Khankhane, Scientist (Soil Sci.)

⇒ has undergone 59th foundation course for Agril. Research Service at NAARM, Hyderabad from March 4th- July, 1997.

Dr. M.S. Raghuwanshi, Technical Officer

⇒ attended the training course programme on " EDUCATIONAL VIDEO PRODUCTION" at NAARM, Hyderabad from April 21st to May 4th 1996.

Sh. M.N.Jadhav, Librarian

⇒ attended the UNESCO CDS/ICSS Library training at NAARM, Hyderabad from 20.9.96 to 1.10.96.

⇒ attended the training " IN CREATION AND ACCESSING BIBLIOGRAPHIC DATA BASE" at DESIDOC, New Delhi from 11-22.3.96 .

Sh. Basant Mishra, Photographer,

⇒ attended the training course programme on " EDUCATIONAL VIDEO PRODUCTION" at NAARM, Hyderabad from April 21st to May 4th 1996.

Sh. Sandeep Dhagat, Tech. Asstt., (Computer Section)

⇒ attended training cum workshop on Agricultural Research Financial Inf. Sys. at NAARM, Hyderabad from 21.04.96 to 23.04.96.

⇒ attended training programme on Office Automation Payroll/ GPF Package at NAARM, Hyderabad from 09.09.96 to 13.09.96.

⇒ attended training cum workshop on Agricultural Research Financial Inf. Sys. (ARFIS) at CIFE, Mumbai from 08.10.96 to 09.10.96.

Sh. O.N. Tiwari, Tech. Asstt.,.

⇒ attended the training programme on Intensive course on Computer application held at Directorate of Instrumentation, JNKVV, Jabalpur on December 4-12, 1995.

⇒ participated the XIIth AICRP-WC Workshop held at CSAUA&T, Kanpur from 4-6.4.96.

Sh. Balwant Rai, AF & AO

⇒ attended Regional training cum workshop on the ARFIS at CRIJAF, Barrackpore from 14.11.96 to 15.11.96.

Sh. S.C. Sharma, Supdt. (A&A)

⇒ attended training cum workshop on Agricultural Research Financial Inf. Sys. at NAARM, Hyderabad from 21.04.96 to 23.04.96.

Sh. Sunil Gupta, Jr. Clerk (A&A)

⇒ attended training cum workshop on Agricultural Research Financial Inf. Sys. at NAARM, Hyderabad from 21.04.96 to 23.04.96.

⇒ attended training programme on Office Automation Payroll/ GPF Package at NAARM, Hyderabad from 09.09.96 to 13.09.96.

⇒ attended Regional training cum workshop on the ARFIS at CRIJAF, Barrackpore from 14.11.96 to 15.11.96.

AWARDS

Dr. V.M. Bhan, Director was awarded the GOLD MEDAL of the Indian Society of Weed Science (ISWS) during the Biennial Conference of ISWS held at PAU, Ludhiana from Feb. 19-23, 1997.

ACKNOWLEDGEMENT

The thanks are due to Dr. R.S. Paroda, DG: Dr. G.B. Singh, DDG (SA&AF) Dr. P.C. Bhatia, ADG (Agro) for their constant encouragement in carrying out the various programmes; Shri N. Parthsarthy, Financial Advisor, Shri B.K. Chauhan, IAS, Secretary, ICAR, Director (Finance): Capt. R.K. Marwaha Director (Personnel) and their team of persons who helped in various matters pertaining to NRC-WS. Under Secretary of the IA II Sectionalso deserve thanks for assisting in day to day activities.

The Director acknowledges with thanks to Vice Chancellor, Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur for providing the assistance of staff members in various selection committee, purchase committees and other advisory committees.

The help rendered by the scientists, officers and staff members of the NRC-WS is also gratefully acknowledged.