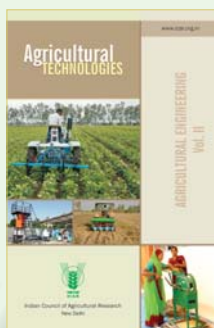
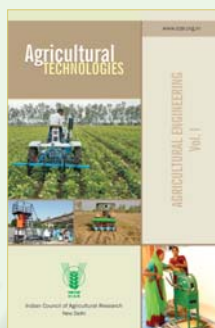
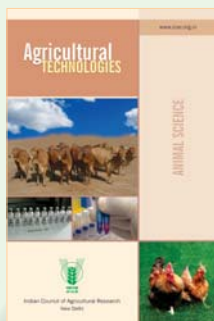


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Indian Council of Agricultural Research
New Delhi



Agricultural Technologies

Commercialized/Ready for Commercialization

CROP SCIENCES



Indian Council of Agricultural Research
New Delhi

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शरद पवार
SHARAD PAWAR



कृषि एवं खाद्य प्रसंस्करण उद्योग मंत्री
भारत सरकार
Minister of Agriculture &
Food Processing Industries
Government of India

Message



Indian agriculture has overcome several challenges in the past and achieved phenomenal success ensuring self-sufficiency in food production. The technologies generated within the National Agricultural Research System (NARS) have significantly contributed to the transformation of Indian agriculture and ushering in Rainbow Revolution, representing Green, White, Golden, Brown and Blue revolutions, defining outstanding technology-led performance in foodgrains, milk, oilseeds and pulses, horticulture and fisheries sectors. Agriculture along with other primary sectors is a major source of strength for the Indian economy. However, burgeoning population, increasing demand for food, feed and fodder, decreasing land availability, natural resource degradation, decreasing factor productivity, climate change, slow growth in farm income and new global trade regulations have put new challenges threatening food, nutritional and livelihood security.

Technological interventions by the NARS have led to spectacular accomplishments relating to input-use efficiency, climate resilience, mechanization and secondary agriculture, leading to economic transformation. These coupled with the application of information and communication technology will play a critical role in our future endeavours to accelerate agricultural growth in the country. I am glad that the Subject Matter Divisions of the Indian Council of Agricultural Research (ICAR) have synthesized and compiled practical and useful technologies in this series of publications on Agricultural Technologies in a user-friendly mode. I am sure this information will be useful to farming community, extension agencies, entrepreneurs and agro-industries in their efforts to make Indian agriculture economically viable and ecologically secure.

Krishi Bhavan
New Delhi 110 001



(Sharad Pawar)

Foreword

Agriculture is the cornerstone of Indian economy. About 70% of India's 1.27 billion population live in rural areas with small and marginal land holdings. India with a geographical area of over 328 million hectares is endowed with diversity of climate, soil and vegetation. This rich resource endowment is, however, threatened with ever increasing population, vagaries of nature and climate change. The National Agricultural Research System (NARS) comprising the Indian Council of Agricultural Research (ICAR), 55 State Agricultural Universities, five Deemed Universities, four Central Universities with agriculture faculty, one Central Agricultural University and 637 Krishi Vigyan Kendras has attained excellence in several frontier areas of agricultural sciences and technology, contributing significantly towards spectacular growth of Indian agriculture during the past 60 years.

Initiatives by the NARS in the country have led to notable accomplishments resulting in the socio-economic transformation of farmers. The agriculture sector is, however, witnessing radical changes and challenges both at national and global levels. The emerging challenges and opportunities necessitate wider and faster adoption of improved technologies by all the stakeholders right from production to consumption in a food chain. In an effort to achieve this, the divisions of crop science, horticulture, animal science, natural resource management, fisheries and agricultural engineering in the ICAR have compiled the technologies already commercialized and the technologies ready for commercialization. This series of publications bring out the salient features of the technologies with details on potential users and contact details of the developers for ready and ease access. It will be our endeavour to periodically update this Technology Series. I hope that this publication would be useful to the farming community, extension agencies, entrepreneurs and industry. I greatly appreciate the efforts put in by my colleagues in the Council, Research Institutes and State Agricultural Universities (SAUs) in bringing out this compilation.



(S. Ayyappan)
Secretary

Department of Agricultural Research and Education
and

Director General

Indian Council of Agricultural Research
New Delhi

January 2014
New Delhi 110 001

Preface

The publication entitled 'Agricultural Technologies: Crop Science' has covered crop technologies already commercialized and ready for commercialization from the ICAR-SAU system with salient features and contact details of the institutions, which developed them, for further information.

In the first section, the prominent commercialized technologies related to crop-protection aspects embody pesticide and high temperature -tolerant strains of egg parasitoid (*Trichogramma chilonis*); pesticide- tolerant strain of an important predator (*Chrysoperla zastrowi sillemi*) of sucking pests; wettable powder (WP) formulations of entomopathogenic nematode and bio-nematicide (*Pochonia chlamydosporia*); and WP and suspension concentrate of *Bacillus thuringiensis*, a well-recognized biological control agent of larval stages of insect-pests and suspension concentrate of *Beauveria bassiana*, effective against gram pod borer and capitulum borer. Along with, the section covers devices that help not only in the management of insect-pests but also in protecting beneficial insects; such as light trap safer to beneficial insects, moth- egg cleaning device, aerial insect trap, white grub beetle trap, devices for on-farm / *in-situ* multiplication of parasitoids of crop- pests and burrow fumigator.

A few kits based on biotechnological approach include a simple immunological test that can be used directly in the field for rapid detection of *Bt*-Cry1Ac toxin. The popular test by 'Bt-Express Kit' takes hardly five-to-ten minutes to give clear-cut results in detecting presence/absence of *Bt*-toxin (Cry1Ac) in the tissues of *Bt*-cotton plant. Besides, an enzyme-linked immunosorbent assay (ELISA) kit commercialized can be used for quantification of Cry1Ac, Cry1Ab, Cry1F and Cry2Ab in *Bt*-cotton transgenic-plants. Another kit 'Bollgard-II-Seed-Detection Kit' was designed to detect glucuronidase (*GUS*) marker expression in transgenic-plants. PCR-based detection assays and protocols for ten genetically modified (GM) crops, particularly for the initial screening to check their GM status, hold promise. The process for preparation of sugarcane juice powder has been developed for safely storing and for use as per convenience.

Technologies that are ready for commercialization are in the second section, and includes technologies for biological control of pests and diseases. A potential obstacle to the adoption of biological control measures, however, is the cultivators' penchant for using familiar pesticides. Wettable powder formulation of *Bt* would be a matter of past after the arrival of liquid formulation of *Bt* alone and also its combination with *Beauveria bassiana*. Bioformulations of salinity and carbendazim-tolerant isolates of *Trichoderma harzianum* with biocontrol potential are available

for commercialization. Another technology, a novel mycelial formulation of *Hirsutella thompsonii* to enhance myco-parasitism of mite- pests in crops, is ready to be commercialized. Availability of powder-based formulation of *Bacillus megaterium* for promoting growth and managing bacterial wilt disease and that of *Pseudomonas fluorescens* for rainfed and stressed agricultural soils will give impetus to sustainable agriculture.

Enzyme-linked immunosorbent assay (ELISA) kits developed for detection of natural infection of a number of viruses such as tospovirus, Groundnut Bud Necrosis Virus, Watermelon Bud Necrosis Virus, Capsicum Chlorosis Virus, Papaya Ring Spot Virus, Potato Virus Y, Zucchini Yellow Mosaic Virus, Bean Common Mosaic Virus, Onion Yellow Dwarf Virus And Chilli Veinal Mottle Virus affecting various crops are ready for commercialization.

Some gene constructs are also ready for commercialization to be used for induction of transgenic male sterility and fertility restoration for exploitation of hybrid vigour in crops, especially those which don't have good pollination control mechanism. Solar-powered knapsack sprayer with desired inclination of solar panel to catch maximum incident sun rays has been developed. Processes to recover pure solanesol and nicotine from tobacco; bud- chips for rapid seed multiplication of sugarcane and microbial retting consortium for jute/mesta are other technologies ready for marketing.

The Crop Science Division of the ICAR has also been administering research programmes on the crop improvement, primarily for the development of high-yielding and stress- tolerant varieties/hybrids suitable for different agroclimatic conditions of the country in collaboration with the State Agricultural Universities (SAUs). State- wise recommended (released from the ICAR-SAU System) varieties/hybrids of cereals, millets, pulses, oilseeds, sugarcane, fibre crops, forages and grasses along with their year of notification, recommended niche, salient features and reaction to biotic and abiotic stresses and quality traits, breeder seed details have been covered to harness their potentiality. All readers would also find detailed information about the Project Directors/ Project Coordinators for any kind of query regarding crop varieties/hybrids and related additional information.

I take this opportunity to congratulate all the Directors, Project Coordinators and Scientists of the Crop Science institutes/projects, who have developed these technologies, and also thank them for providing information for this valuable document. I would also like to appreciate the painstaking efforts made by Dr B. B. Singh, ADG (O&P); Dr T. P. Rajendran, Ex-ADG (PP) and OSD (NIBSM, Raipur); Dr N. Gopalakrishnan, ADG (CC); Dr R. P. Dua, ADG (FFC) and Dr S. K. Jha, Principal Scientist (O&P) of my Division, who have compiled and edited the bulletin. Though the bulletin is not exhaustive in respect of varieties and technologies, I do hope that it would benefit all stakeholders, including promising agri-entrepreneurs, extension-workers and farmers in their endeavour for practising scientific agriculture.

Swapan Kumar Datta
Deputy Director General (Crop Science)
ICAR, New Delhi

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1. Commercialized

Endogram: Endosulphan -tolerant strain of egg parasitoid, *Trichogramma chilonis*

Salient features

- Endosulphan-tolerant strain, endogram, can parasitize >90% eggs and its mean survival is 3.6 days, compared to <20% parasitization by the susceptible laboratory strain with mean survival of 1.6 days.
- Parasitism enhances significantly with dosage of 100-500 thousand parasitoids per hectare.
- The strain was released in a total of 11,880 hectares of vegetable crops and cotton.
- The product is exempted from the biosafety clearance of the Central Insecticides Board and Registration Committee.
- This product is being utilized for biocontrol of vegetable crops, cotton and rice since 2010.

Manufacturer

- Excel Crop Care, 184/87, S.V. Road, Jogeshwari West, Mumbai (Maharashtra) 400 102; Telephone: 022-66464200

Contact

Dr S.K. Jalali

Principal Scientist, Division of Insect Systematics

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Telephone: 080-23411961, 3531627, 23511982

E-mail: jalalisk@yahoo.co.in

Multiple insecticides tolerant strain of egg parasitoid, *Trichogramma chilonis*

Salient features

- *Trichogramma chilonis* is resistant to multiple insecticides with a high resistance factor.
- In Saharanpur (Uttar Pradesh), according to farmer Shri Madan, fields of brinjal and chilli were freed of pests after the use of this strain.
- According to another farmer Shri Sanjay Kumar, its use in the pest-management programme resulted in saving of thousands of rupees; being spent on insecticides for crop protection.



- The product is exempted from the biosafety clearance of the Central Insecticides Board and Registration Committee.
- Its license is non-exclusive.

Performance results

- Rangel village in Saharanpur became aware of the use of this beneficial parasitoid, *Trichogramma chilonis*.
- Large-scale validation trials were conducted on rice, sugarcane, tomato and brinjal during 2011-12 and rabi 2012.

Manufacturer

- Excel Crop Care, 184/87, S.V. Road, Jogeshwari West, Mumbai (Maharashtra) 400 102; Telephone: 022-66464200

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High temperature- tolerant strain of egg parasitoid, *Trichogramma chilonis*

Salient features

- This strain of *Trichogramma chilonis* is tolerant to temperature, up to 40°C; pest-infested fields in hot climatic regions can be effectively managed.
- In high-temperature-affected fields, mainly of vegetable-paddy-based ecosystems, farmers can use this strain to control wide range of lepidopteran and other pests effectively.
- The product is exempted from the biosafety clearance of the Central Insecticides Board and Registration Committee.
- Its license is non-exclusive.



Performance results

- Large- scale validation trials were conducted on rice, sugarcane, tomato and brinjal during 2011-12 and *rabi* 2012.

Manufacturer

- Sun Agrobiotech Research Centre, 3/340 Main Road Madanandapuram, Porur, Chennai (Tamil Nadu) 600 116; Telephone: 044-24827652; Fax: 044-42114282

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E-mail: jalalisk@yahoo.co.in

Pesticide-tolerant strain of aphid lion, *Chrysoperla zastrowi sillemi*

Salient features

- PTS 8, a strain of *Chrysoperla zastrowi sillemi*, is tolerant to different groups of pesticides —organophosphate, organochlorine and synthetic pyrethroid.
- This strain recorded high resistance factor for acephate, fenvalerate and endosulphan as compared to susceptible population (CZS 10).
- Biochemical assays revealed higher detoxifying enzymes in PTS 8 as compared to the susceptible population.
- Validation of this strain under vegetable ecosystem for suppression of insect- pests was found effective in Saharanpur (Uttar Pradesh).
- The strain can be used by farmers in insecticide- stressed farm conditions of cotton- based and vegetable-based ecosystems to control pests efficiently.
- *C. zastrowi sillemi* can feed on sucking pests and eggs and early instar larvae under pesticide- stressed farm conditions.
- Its license is non-exclusive.
- The product is exempted from the biosafety clearance of the Central Insecticides Board and Registration Committee.



Performance results

- Large- scale validation trials were conducted on tomato and brinjal during 2011-12 and *rabi* 2012.

Manufacturer

- Excel Crop Care, 184/87, S.V. Road, Jogeshwari West, Mumbai (Maharashtra) 400 102; Telephone: 022-66464200

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Wettable powder formulation of entomopathogenic nematode, *Heterorhabditis indica* strain NBAII Hi1

Salient features

- Wettable powder formulation contains active entomopathogenic nematode strain NBAII Hi1 of *Heterorhabditis indica*.
- This WP formulation has a shelf-life of 8-10 months.
- This nematode usually enters insects through their breathing hole, mouth or anus and kill them in 48-96 hours. It is also capable of penetrating through insect cuticle. Insect cadavers are utilized as food by nematodes for their multiplication and recycling.
- *In-vivo* production is in *Galleria mellonella* partitioned protocols, which clearly demarcate insect-nematode production stages, facilitating scale-up of production, mechanization, down-stream processing and developing formulations.
- Physical parameters of formulation have been identified and defined for better shelf-life with better biological activity.
- The formulation is easy- to- apply with conventional equipment, and does not require special application gear.
- The infective juveniles are tolerant to most agrochemicals, including herbicides, fungicides and insecticides.
- The product is exempted from the biosafety clearance of the Central Insecticides Board and Registration Committee.



Impact and benefits

- Entomopathogenic nematodes have been commercialized for the management of pests, as an alternative to the use of chemicals; being safe biological control agent.
- This biologically active and beneficial product is a broad spectrum biological insecticide; effective against several cryptic pests, including scarabeid, curculionid, cerambicid grubs, cutworms, other soil insect pests etc., associated with arecanut, sugarcane, banana, cardamom, groundnut, potato, corn, turf-grass, tuber crops etc.

- The nematodes are specific to insects and are not a threat to environment, unlike chemical insecticides.
- Its license is non-exclusive.

Manufacturers

- Multiplex Bio-Tech Pvt Ltd #180, 1st Main Road, Mahalakshmi Layout, Bengaluru (Karnataka) 560 086; Telephone: 080-23490647; E-mail: multiplex@multiplexgroup.com
- Camson Biotechnologies Limited, C-7, 7th Floor, Corporation Block, Golden Enclave, Old Airport Road, Bengaluru(Karnataka) 560 017; Telephone: 080-40768900; E-mail: research@camsonbiotechnologies.com
- Sri Biotech Laboratories India Ltd, “Biosphere”, Plot No. 21, Sagar Society, Road No.2, Banjara Hills, Hyderabad(Andhra Pradesh) 500 034; Telephone: 040-32580685; E-mail: sribio@gmail.com
- Sri Venkateshwara Chemicals, No.125, Annam Gardens, Kavadiguda, Secunderabad (Andhra Pradesh) 500 380; Telephone: 040-23045337; E-mail: knbiolabs@gmail.com
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Wettable powder formulation of *Pochonia chlamydosporia* var. *chlamydosporia* (MTCC No. 5583, NAIMCC Acc. No. F-02519)

Salient features

- Nematodes have become the major constraint in the intensive cultivation systems, polyhouses, monocropped cereals and perennials; especially, root-knot nematodes in rice-wheat, citrus, pomegranate, vegetables, etc.; and cyst nematodes in pulses, etc.
- The technology developed encompasses novel and economically viable scale-up processes for production, down-stream processing and development of formulation of beneficial fungus, *Pochonia chlamydosporia* (MTCC No. 5583; NAIMCC Acc. No. F-02519), for biological control of root-knot, cyst and reniform nematodes in polyhouse crops— vegetables, gherkins, potatoes, oilseeds and pulses.
- It comprises validated maximized productivity of 10^9 - 10^{10} spores/g, and shortened production cycle (14-16 day); Easy down-stream processing and automation.
- Formulation shelf-life is 18 months.
- Biosafety data: Biosafety (Toxicology data) and field efficacy data have been generated and are available for 9 (3b) and 9 (3) Central Insecticides Board and Registration Committee.
- Its license is non-exclusive.



Impact and benefits

- Among various beneficial fungi, *Pochonia chlamydosporia* var. *chlamydosporia* is unique in its ability to parasitize eggs, females and cysts of nematodes and in tolerance to abiotic stresses (temperature, desiccation, fungicide tolerance, long persistence in the treated soils), and is biologically safe to humans, non-target organisms etc., thus is most prospective candidate for biological control of root-knot, reniform and cyst nematodes.

Manufacturer

- Mr Ramji Mangukia, Agriland Biotech Ltd, Prience Industrial Estate, Mota Moti Pura, Kareli Baug, Kareli Baug, Vadodara(Gujarat) 390 018; Telephone: 0265-2541193

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Liquid formulation of *Bacillus thuringiensis* (NBAIL-BT1)

Salient features

- *Bacillus thuringiensis* (NBAIL-BT1) is a strain that infects caterpillar-pests of pulses and vegetables.
- **Biosafety:** Toxicology data are to be generated.
- **Label claims:** Against lepidopteran insects of pulses and vegetables. Multi-location trials have been completed.
- **Host range:** Lepidopteran pests of pulses and vegetables
- Its license is non-exclusive.



Impact and benefits

- Lab and field evaluations of liquid formulation of *Bt* against *Helicoverpa armigera* in pulses and *Plutella xylostella* in vegetables under the AICRP trials were very effective against these pests.

Manufacturer

- Agro Bio-tech Research Centre Limited, Registered Office: Industrial Area, Poovanthuruthu, Kottayam (Kerala) 686 012; Mobile: 09447047719

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E-mail: rangeshw@rediffmail.com

Light trap safer for beneficial insects

Salient features

- Light trap is to monitor and mass-trap, as the case may be, based on the biology of the pest stage in crops.
- Use of light traps for such purposes has been well-catalogued in the last century's pest management manuals and recommendations.
- The perceived constraint of trapping also beneficial insects / other non-target organisms was the limitation of the old designs. However, the new design developed by the National Centre for Integrated Pest Management has made it safe for beneficial insects (parasitoids) and non-targeted insects having small body size.
- Design has been patented for light trap with durability of 4-5 years.



Manufacturer

- M/s Fine Traps (India), 6 Sawarkar Market Datta Chowk, Yavatmal (Maharashtra) 445 001; Telephone: 07232-244282; Mobile: 09422166867; Website: www.lightrap.in

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Telephone: 011-25740951-52, 25843985, 25843935-36; Fax: 011-25841472

E-mail: ipmnet@bol.net.in

Moth-egg cleaning device

Salient features

- It is a mechanically operated gadget for cleaning *Corcyra cephalonica* eggs from insect scales in the insect biocontrol labs.
- It is environment friendly and is cost- effective.
- Design is patented with durability of 5-6 years.

Manufacturer

M/s Rescholar Equipment 85, HSIDC, Industrial Estate, Ambala Cantt, Haryana

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Aerial Insect Trap

Salient features

- Aerial Insect Trap has been designed, fabricated and standardized for Indian conditions.
- The trap is effective in sampling air and trapping air-borne insects.
- It is a zero- energy based trap; natural wind energy rotates it.
- Durability of the trap is 6-7 years.
- Since it is a zero-energy based device, it is cost-effective and is important IPM tool for sustainable insect control.



Manufacturer

M/s Rescholar Equipment 85, HSIDC, Industrial Estate, Ambala Cantt, Haryana

Contact

Director

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