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Popularization of biocontrol agents, botanicals and PSB for seed spices and other horticultural crops in Rajasthan

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Abstract

A modern biological control laboratory for mass production of different bio agents was established during 2009 at ICAR: National Research Centre on Seed Spices, Ajmer. This laboratory was financially supported by DASD under National Horticulture Mission (NHM), Govt of India. The major objective was to reduce the indiscriminate use of pesticide and promotion of organic and eco friendly management of pests, diseases and nutrients. During the year 2017 total nine different Bioagents including bio fertilizer were produced and distributed among the farmers in different districts of Rajasthan. The coverage and extent of bioagents utilization was calculated based on the distribution record of farmers, who procured the NRCSS bio agents for use in their different crops as per their need of diseases and pests problem and organic cultivation. Almost all the farmers who participated in this study were voluntarily chosen the different products to manage their crop problems. A total of 1565.5 kg of different bioagents were produced for distribution to seed spice and other horticultural crops including protected cultivation during 2017. The maximum utilization of Bioagents was recorded in protected cultivation followed by seed spices and cole crops. Among the districts covered for bio agents the highest was observed in Ajmer followed by Kota and Bharatpur.

Key words : Bio-gents, botanical, horticultural crops, PSB and seed spices.

Introduction

Modern agriculture is largely based on the use of synthetic chemicals as fertilizers and pesticides. Heavy dependence on the chemicals in agriculture led to many disadvantageous outcomes related to undecomposed residue of chemicals present in agricultural food for human and animal. Ecological balance of pest and beneficial organism is deteriorated considerably lead to development of newer pests which never heard of earlier. Application of biological control agents for management of pest and diseases has proven the most sustainable and effective approaches to pest control. Pest and disease management using various bioagents has been adopted across the world. However, various records of success, cost effectiveness and sustainability, large scale adoption has not been done in agriculture production. (Huffaker and Messenger 1976; Moran and Hoffmann 2015 ; Heimpel and Mills 2017 ; Barratt *et al.,* 2018).

Many potential biocontrol organisms have been identified for various disease and pests over last few decades. The technologies for mass production and commercialization has also been standardized (Shali *et al.,* 2010). *Trichoderma* spp. is proven as potential biocontrol for wilt and root rot diseases in many crops (Verma *et al.,* 2007). *Trichoderma* populations can be established relatively easily in different types of soil and can continue to persist at detectable levels for months. *Trichoderma* is known to produce different kinds of enzymes which have a significant role in biocontrol activity like cell wall degradation, biotic and abiotic stress tolerance, hyphal growth, antagonistic activity against plant pathogens. *Trichoderma harzianum and Trichoderma viride are the* widely used species and have been exploited on about 87 different crops and about 70 soil borne and 18 foliar pathogens, (Sharma *et al.,* 2014). *Pseudomonas fluorescens* is a gram-negative bacterium found in soil and water that harbours multiple flagella and secretes the fluorescent pigment pyoverdin. It also produces the antibiotic mupirocin and protects some plant roots from parasitic fungi or nematodes. It has been showed significantly management of fungal, bacterial and nematode diseases in many agricultural and horticultural crops. In many crop it proved better in controlling diseases than with fungicides. However, the bacterial antagonism in combination with fungicides sometimes improved efficacy in controlling diseases besides disease control,

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treatment (Ganesan and Kumar, 2005).

Entomopathogenic fungi (EPF) as bio pesticides play a vital role in control of insect pests which have developed resistance to phased out agrochemicals. EPF generally classified into two groups namely Entomophthorales and Hypocreales. The fungal evolution, taxonomy and ecology of EPF in relation to biocontrol have been quite extensively studied (Blackwell, 2010; Roy *et al*., 2010). The EPF have great prospective for commercial use as they possess several merits which make them interesting candidates of biological control within integrated pest management (IPM). They are generally non toxic to humans, animals and non target beneficial insects when compared to chemical pesticides as they have specific and unique mode of action towards host. Entomopathogenic fungi includes, *Beauveria bassiana*, *Metarhizium anisopliae*, *Verticillium lecanii*, *Nomuraea rileyi* and *B. brongniartii* are the most common among the EPF registered for commercial use as insect control agents from among the approximately 750 entomogenous fungi distributed in about100 genera (Inglis *et al.,* 2001).

Insect mortality due to entomopathogenic fungi occurs due to nutritional deficiency, destruction of tissues and by release of toxins. Cuticular degrading enzymes of entomofungal pathogens like chitinase, protease and lipase play an important role in the pathogenicity of these organisms on insects in the breakdown of insect cuticle for penetration of fungal germ tube into the insect body. The entomopathogenic fungi facilate its entry through the insect cuticle is considered to occur by a combination of mechanical pressure and enzymatic degradation. Several mycotoxins like, Beauvericin, Beauverolides Bassianolide (by *B. bassiana, V. lecanii, Paecilomyces* spp.) and Destruxins (by *M. anisopliae*) are produced during pathogenesis and these act like poisons for the insects. (Tanada and Kaya,1993). *Hirsutella thompsonii*, a moniliaceous fungus pathogenic to mites. Approximately 80 species of fungi were found belonging to the genus Hirsutella. Some of them were found to be pathogens of Acari, eriophyids in particular, Hirsutella thompsonii. found very effective in controlling of mites pests of agricultural and horticultural crops.

Material and methods

Multiplication and production of bio agents *viz*., soil antagonists, entomopathogens, nematopathogen, acaripathogen, botanical insecticide soap and Phosphate solubilising bacteria were done as per standard protocol developed for quality production. Fungal formulation of different entomopathogens *Verticillium lecanii*, *Beauvaria bassiana* and *Metarhizium anisopliae* has been developed for control of various insect pests of seed spices. The technology for growth of fungal consortia and large scale production on modified growth medium has been standardized. The fungal consortia have been produced in 1000 ml Erlenmeyer flasks on rotary shaker at 100 rpm and 28±2 C temperature. The consortia after growth of 7 days was formulated in talc powder based biocontrol product. It has been assayed for fungal count and efficacy against aphids under laboratory conditions as per the methods (Yeo *et al*., 2003). Potato Dextrose broth was used for stimulating sporulation, because potato infusion and dextrose promote luxuriant fungal growth. The native isolates of entomopathogenic fungi were obtained from NBAII, Bengaluru, India. Unlesss stated otherwise all chemicals and other ingredients were of analytical grade procured from Himedia Laboratories Pvt. Ltd., Mumbai, India. Similar methodology was used for mass production of *Trichoderma viride*, *Trichoderma asperlum, Hirsutella thompsonii and Paecilomyces lilacinus.* All these fungal bio formulations were manually mixed with a pre-sterilized talc powder and CMC under aseptic conditions in a ratio of 1:3 and sealed packed in polyethylene pouches and stored for further sale and distribution among the farmers. Botanical insecticide soap was developed at the Institute based on seed oil and plant derivatives of known insecticidal value.

The bacterial culture of B*. subtilis* strain NRCSS-I suspension in nutrient broth media (Hi-media, India) was prepared in a BOD incubator cum shaker at 28±1 ^{0}C with continuous shaking at 100 rpm for 72 h. The bacterial culture broth was mixed with pre-sterilized talc powder along with carboxy methyl cellulose (CMC) in a 1:3 ratio and after thorough mixing the PSB formulation was seal packed in poyethylelne puches with 200 gram material in each. For *Pseudomonas* sp. the protocol as described for PSB mass multiplication was used and bio formulations were stored in a cool room till their distribution to farmers involved under the investigations. All bio control formulation maintained were containing and at least $1x10^8$ CFU g^{-1}.

Results and discussion

Mass production of different bio agents and bio fertilizers were produced at Biological Control Laboratory of NRCSS. The laboratory established during the year 2009 with financially help from by Directorate of Spice and Arecanut Development Board (DASD) under National Horticulture Mission (NHM), Govt of India. Total ten types of different bio agents/botanicals/bio fertilizer were multiplied and

Table 1. Bioagents produced during 2017.

S.No.	Catagory	Bioagent	Target pest/nutrient
1	Entomopathogen	*Verticilium lecanii*	Aphids, Thrips, Jassids, White fly
		Metarhizium anisopilae	cutworm, white grub
		Beaubaria bassiana	bores and defoliators
2	Soil antagonist	*Trichoderma viridi*	wilt and root rot
		Trichoderma harzanium	wilt and root rot
		Pseudomonas fluorescens	Soil born diseases, Nematodes
3	Nematopathogen	*Paecilomyces lilacinus*	Nematodes
4	Acaripathogen	*Hirsutella thompsonii*	Mites
5	Botanicals	Botanical Insecticide Soap	control of sucking /defoliators/leaf miner
6	Bio fertilizer	Phosphorus solubilising bacteria (PSB).	Phosphorus

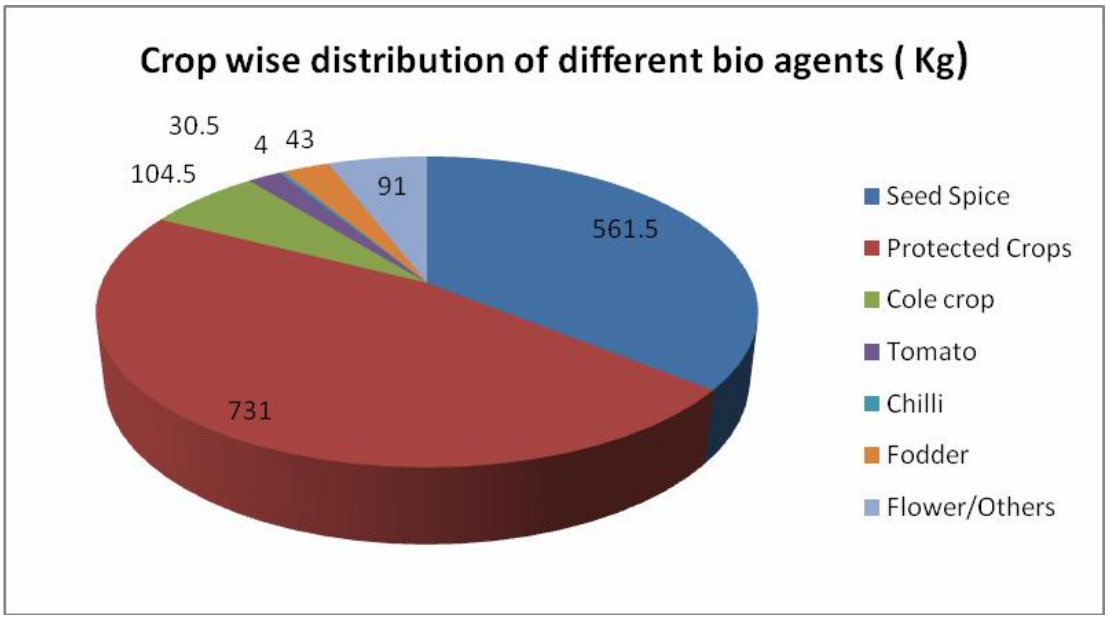

Fig. 1. Distribution of bio agents in different crop.

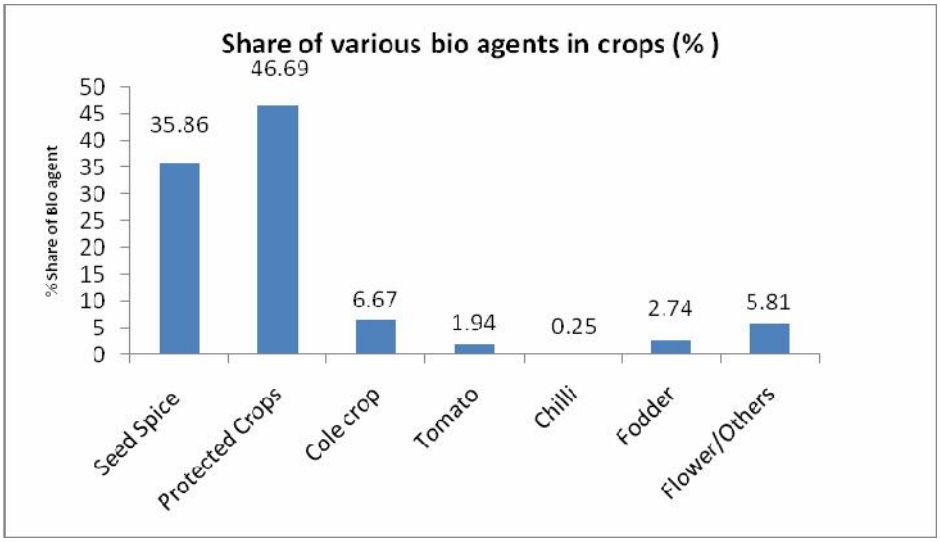

Fig. 2. Percent share of various bio agents.

produced during the year 2017 for field application on various crops (Table 1). Bio control agents produced against different pests/diseases during the study include soil antagonists *Trichoderma viridi, Trichoderma harzanium and Pseudomonas fluorescens,* Entomopathogens *Verticilium lecanii, Metarhizium anisopilae and Beaubaria bassiana,* Nematopathogen *Paecilomyces lilacinus* , Acaripathogen *Hirsutella Thompsonii,* Botanical insecticide soap, and bio fertilizer Phosphorus solubilising bacteria (PSB). Bio control agents was popularized among farmers based on work of a DBT funded project on popularization of bio agents in seed spice farmers, farmers visit at different districts, FLD, Kisan Mela and Kisan gosti organized at Institute and at farmers villages. Total bio agents produced in the laboratory was 1565.5 kg. The produced bio agents were used for sale to the farmers, field demonstration and for use in the Institute farm against pests and diseases. The quantity of various bio agents was produced as per the need of farmers for their crop.

From the perusal of figure 1 it is evident that under crops of protected cultivation the maximum use of different bio agents occurred (731.0 Kg) followed by seed spice crops (561.5 kg) and the minimum was used by chilli growers. Farmers engaged in protected cultivation of vegetables (cucumber, capsicum and tomato) were highest consumers of bio agents. The demand of bio agents in protected cultivation was mainly for management of wilt/ root rot, nematode, white fly and mites. The utilization of bio agents in seed spice was mainly in wilt/root rot, aphids, thrips, white fly and leaf miners. In cole crops, tomato ,chilli flowers target pests was Diamond Back Moth, fruit borer, mites, thrips and nematodes. Percent of share of different bioagents showed that in protected cultivation contribute 46.69% of total bio agents consumption followed by Seed Spice Crops 35.86% . (Fig.2)

Data of bio agents distribution in different district of Rajasthan showed that total fifteen districts were covered for supply of various bio products (fig.3). Ajmer district was accounted that maximum share (594 kg) followed by Bharatpur (175 kg) and Nagour (171.5 kg) district. Where as Barmer and Churu district accounted for lowest (6 kg each) use of different bio agents. Share of total bio agents distributed among farmers showed that *T.viride* contribute maximum (698.5 kg) followed by *P. lilacinus* (247 kg), *T. harzanium* (235 kg) utilized for management of diseases and nematodes. Among entomopathogens *Verticilium lecani* (73 kg) and *Metarhizium anisopilae* (45 kg) distributed for management of sucking and soil pests. Acaripathogen *H. Thompsonii* (24 kg) was utilized mainly for mites control in chilli,tomato and capsicum (fig.4).

There are nearly 171 products registered in the world for

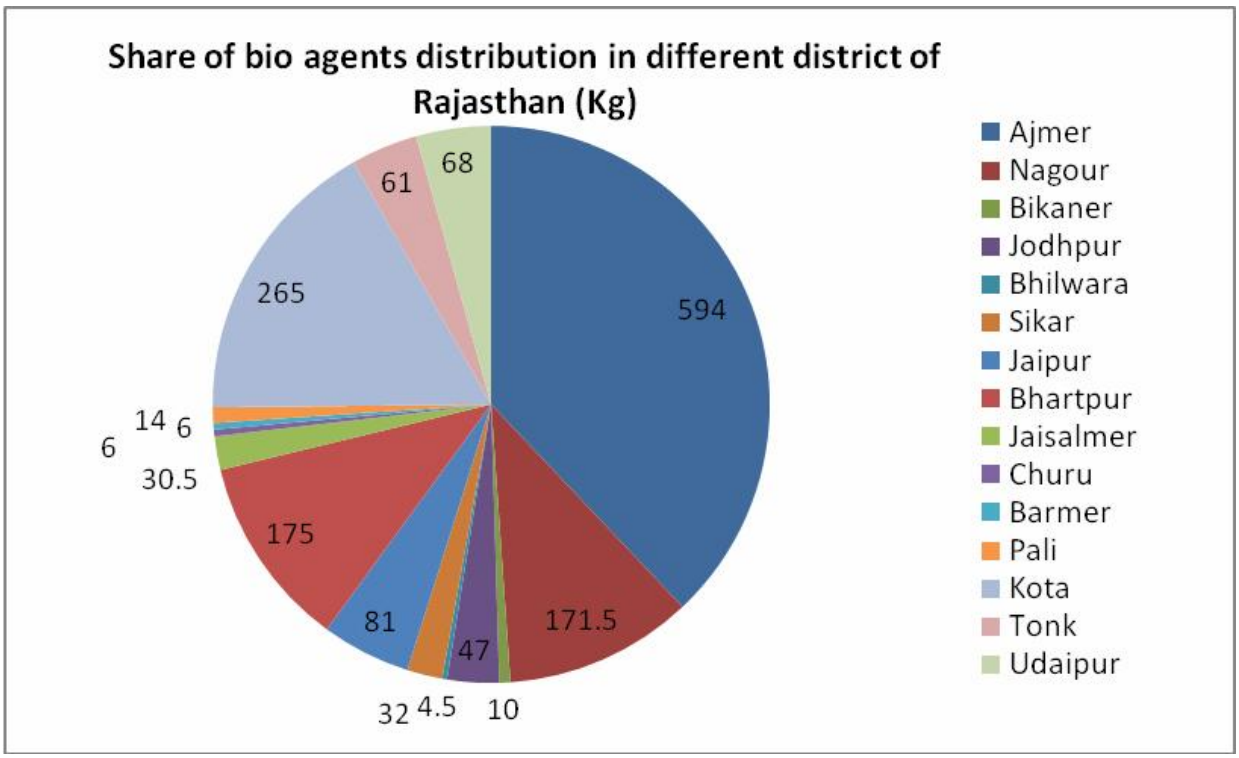

Fig. 3. District wise share of different bio agents

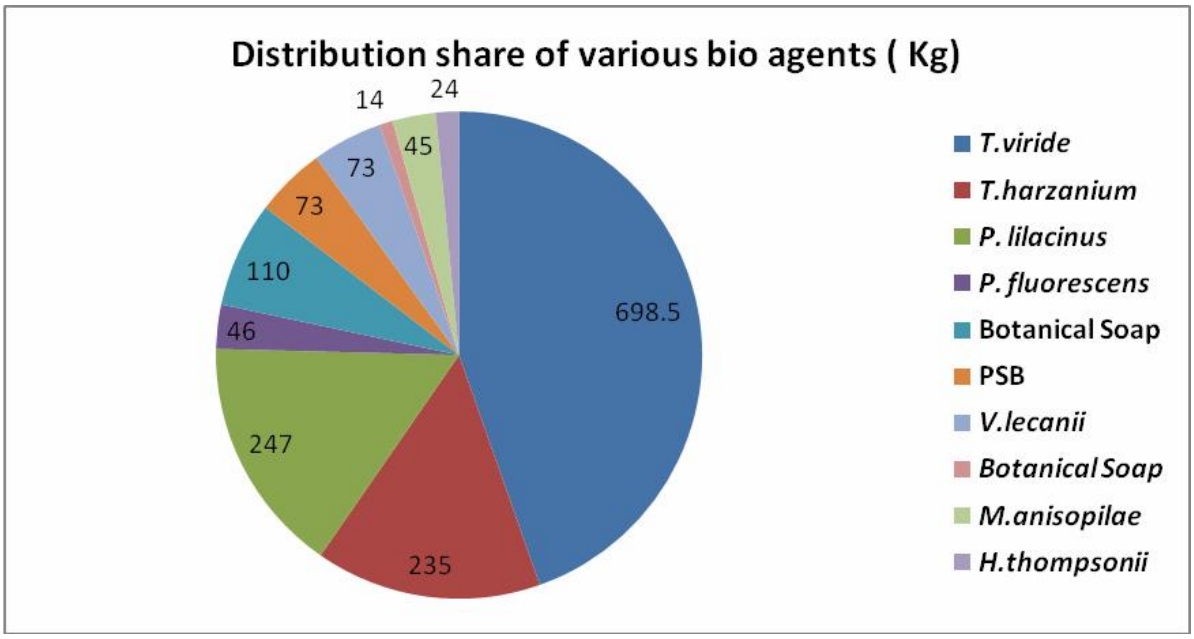

Fig. 2. Distribution share of various bio agents.

commercial use. All major groups of crop and forest pests are attacked by entomopathogens. The use entomopathogenic fungi, have been investigated for the control of a wide range of orchard and field crop pests. Many have been formulated into products that are commercially available for use in controlling insects of economic importance. Current commercial entomopathogenic products in the markets being used to control a number of insects worldwide (Maina *et al.,* 2018). Presently, the largest microbial control program involves the use of *M. anisopliae* for control of spittlebugs (Cercopidae) in South American sugarcane and pastures (Zengzhi *et al.,* 2010). The application of *B. bassiana* for the control of the pine moth *Dendrolimus* spp. in China probably represents one of the largest uses of a biocontrol agent over one million hectares of pine forest (Lord, J.C., 2005). *B. bassiana* strain Bb-147 is registered on maize in Europe for control of the European corn borer, *Ostrinia nubilalis* and the Asiatic corn borer, *Ostrinia furnacalis.* Total PSB distribution accounted for 73 kg in different crop during the study. Many farmers are also aware about application of bio fertilizers beside bio control agents under protected cultivation crops and seed spices.

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