Biofertilizer Technology For Apple

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Background

Biofertilizer has potential to improve agriculture in a sustainable manner. ICAR All India Network Project on Soil Biodiversity Biofertilizer (AINP SBB) has developed a biofertilizer technology for apple. The biofertilizer was formulated at the AINP SBB center Dr Y S Parmar University of Horticulture and Forestry (YSPUHF), Solan. A bacterial endophyte *Bacillus licheniformis* CKA1 was isolated from roots of apple (*Malus domestica Borkh*). The strain exhibits multifarious plant growth promoting (PGP) traits including P-solubilization, ability to grow in nitrogen free medium, iron chelating ability, phyto-hormone production, siderophore production, chitinase and protease enzyme production. The strain exhibits antifungal activity against soil borne pathogens such as *Phytophthora sp., Fusarium oxysporum, Pythium aphanidermatum* and *Dematophora necatrix)*. Therefore, the *Bacillus licheniformis* CKA1acts as biofertilizer, biostimulant and protectant. The strain CKA1 found to control fungal diseases, enhanced plant health and maximized profitability. The product is applicable to most of the apple varieties like Red Chief, Top Red, Super chief, Royal delicious and Starkling delicious etc. It increases yield from 14 % to 88%. Besides, the product controls ~ 80% white root rot disease caused by *Dematophora necatrix* at field conditions. During the last five years more than 250 apple farmers of Himachal Pradesh have been benefitted by using the product. The developed technology has been accepted and recommended by the State package and practices committee for the apple growers. The technology is included in the Package of Practices of Fruit Crop published by Directorate of Extension Education department of the university.

Characteristics of selected *Bacillus licheniformis strain-CKA1*

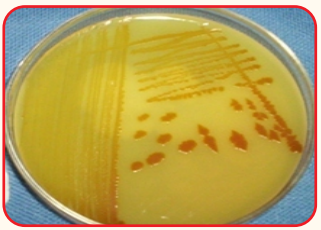
- Naturally occurring indigenous endophytic strain of *Bacillus licheniformis-CKA1*
- High P-solubilization efficiency
- High tolerance to carbendazim (1000μg/ml)
- Produces plant growth regulators (IAA-21.6 μg/ml)
- Produce iron sequesters siderophore & Multiple antifungal activity (particularly 100 per cent inhibition against *Dematophora necatrix*)
- Cost effective (1:4)

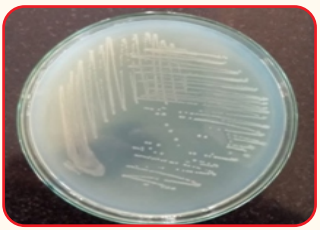
A. Method of Preparation of charcoal and liquid based formulation.

METHOD OF PREPARATION	MODE OF APPLICATION
Charcoal based Biofertilizer : 200g autoclaved charcoal+200 ml cell suspension of 1.5 OD at 540 nm. **The optimum ratio :**Jaggery (20% w/v) 500 ml + Charcoal based inoculant 200 g + Apple seeds 1 Kg This preparation resulted in coating of $3x10^{11}$ cfu /seed	Treat 1 kg apple seed with 200g charcoal based bacterial formulation after stratification before sowing.
Liquid based Biofertilizer : 1000 ml liquid formulation in nutrient broth having $1.7x10^{11}$ cfu /ml resulted in coating of $1.9x10^{11}$ cfu /seed **Suitability:** The developed technology is suitable for quality apple nursery production in the state. **Cost Benefit ratio:** The application of liquid bacterial inoculum costs Rs. 60/litre {2.5 l inoculum required for 1kg seed i.e. Rs 150 per kg seed; producing about 7500 seedlings (1500 more seedlings over un-inoculated)}.	Treat 100 g apple seed with 250 ml liquid bacterial formulation after stratification before sowing, drench left over culture in the bed. **Benefit:** · Increases root shoot length and biomass by 20 %. 100% control of white-root rot caused by *Dematophora necatrix*

BIOFERTILIZER PRODUCTION

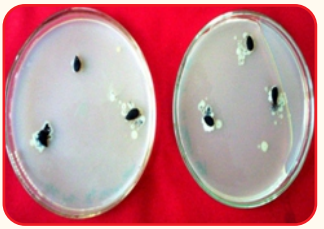
Step 1. Isolation, purification and preparation of mother culture.





Pure culture of *Bacillus licheniformis-CKA1* on Nutrient Agar and Pikovskaya's medium

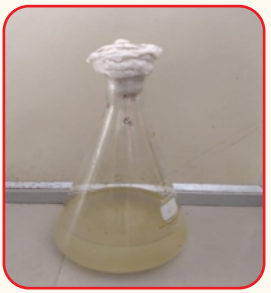
Step 2. Bacterization of seeds with inoculum and screening in pot culture.



SURFACE STERILIZED SEEDS

BACTERIZATION OF SEEDS

Mother Culture and Small Scale Liquid Inoculum Production



Step 3. Inoculation with charcoal and liquid culture in pot experiment

LEFT-LIQUID FORMULATION
MIDDLE-CHARCOAL FORMULATION
RIGHT- CONTROL

POT CULTURE EXPERIMENT

Step 4.The *Bacillus licheniformis* strain CKA1 liquid formulation produced quality apple seedlings in pot experiment used for large scale nursery production @ 1 litre per m^2

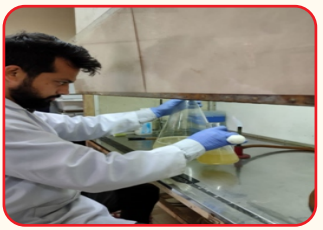
TREATED APPLE SEEDLINGS

B. Biofertilizer Technology for higher yield & quality of apple.

METHOD OF PREPARATION	MODE OF APPLICATION	SUITABILITY	BENEFITS	COST
1000ml liquid formulation in nutrient broth having $1.7x10^{11}$ cfu /ml	Soil drenching of apple plant basin with One liter of liquid formulation diluted to 4 liters in the month of February/ March.	Suitable for different apple growing regions of the state and compatible with commonly used fungicides for soil drenching.	Inoculation of B. *licheniformis CKA*1 increases yield of apple up to 15% over un-inoculated control.	Cost of biofertilizer = Rs 60 plant Additional net income = Rs. 240 per plant over un-inoculated control (Based on average price of apple= Rs. 1000 per box)

BIOFERTILIZER APPLICATION STRATEGIES FOR APPLE :

Step1. The steps involved in production of mother culture of liquid biofertilizerare same as for preparation of quality nursery production.



PREPARATION OF MOTHER CULTURE

Step 2.Soil drenching of apple plant basin with one litre of liquid formulation diluted to four litre (should be done in the month of February/March).

DRENCHING OF LIQUID BIOFERTILIZER IN FIELD

APPLICATION OF BIOFERTILIZER AT DIFFERENT ORCHARD SITES OF SHIMLA DISTRICT OF HIMACHAL PRADESH

LIQUID BIOFERTILIZER TREATMENT AT RHRS MASHOBRA

FARMER'S ORCHARD AT MATIANA, SHIMLA

EFFECT OF LIQUID BIOFERTILIZER ON THE GROWTH AND YIELD OF APPLE AT KVK ROHRU

Trainings / Package of Practices / Stakeholders (2012-20)

BENEFICIARIES

FARMERS BENEFITTED — 250 APPLE ORCHARDISTS OF THE STATE WERE BENEFITTED

PROGRESSIVE APPLE ORCHARDISTS

1. Sh. Maninder Chauhan,Village Jole P.O. Kyari Tehsil Kotkhai District Shimla, 8988124673
2. Madam Vidya Stokes, Madhuban Orchards on Shathala road, Thanedar, Himachal Pradesh 172030, 098164 20213
3. Sh. D R Diwan, Village Jadon, P.O Bhalaog, Tehsil Kumarsen District

Shimla, 9418023047.

4. Sh Bali Ram Chandel, Village Khalju, PO Matiana, Tehsil Theog, District- Shimla, 9418228080.
5. Sh Kailash Thakur, Village Jongle Kalari, Post BPO, Sarion Tehsil Theog District Shimla, 9418020552.
6. Sh. Diwan Chandel, Village Sablog, PO Shari, Matiana, Tehsil, Theog, District Shimla, 9418310601.
7. Sh. N S Chauhan, Village Jole P.O. Kyari Teh. Kotkhai District Shimla, 9816404513.
8. Sh. Rohit Chandel, Village Batara, PO Shari Matiana, Tehsil-Theog, District-Shimla, 9816303568.
9. Smt. Chander Shukla Dogra, Dogra Farmhouse, Dahan Road, Thanedhar, Rajgarh, 7986937726.
10. Dr J S Chandel, PO Matiana, Tehsil Theog, District-Shimla,9418117454
11. Dr C K Shirkot , Galang,kotho, District Solan, 9418117399.

REVENUE GENERATED (2018-20)

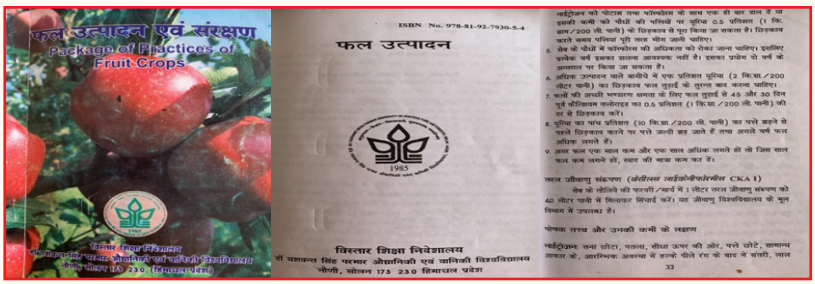
Revenue Earned (2018-2020)

Total: Rs.50,000
Rs. 40,000 (2018-2019)
Rs. 10,000 (2019-2020)

STATE GOVT RECOMMENDATION

Package Of Practices

The developed technology was accepted and recommended by the State package and practices committee for the apple growers. The technology is included in the Package of Practices of Fruit Crop published by Directorate of Extension Education Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) in the year 2014 page 33.



Package of Practices of Fruit Crop published by Directorate of Extension Education YSPUHF, Nauni, Solan (H.P.) 2014.

EFFECT OF LIQUID BIOFERTILIZER ON FRUIT YIELD & QUALITY

Yield (Kg/tree)					
Treatment	RHRS Mashobra	Farmer's field Matiana (Nanni)	Farmer's field Matiana (Sabloab)	Farmer's field Thanedar (Shatla)	Farmer's field Koatkhai (Kyari)
Un-inoculated Control	17.8	11.6	80	83.3	51.1
CKA1 inoculated	20.2 (13.6)	16.7 (43.3)	103.8 (29.7)	157.1 (88.5)	66.3 (29.8)*

*% Increase in yield over control

UNTREATED

TREATED

Drenching of liquid biofertilizer in apple orchard

The information given in the document is based on the experiments carried out at the Department of Soil Science and Water Management, Dr. YSP-UHF, Nauni, Solan -173230, Himachal Pradesh. For training, demonstration and other enquiries please contact the department.

Published by : ICAR All India Network Project on Soil Biodiversity Biofertilizer (AINP SBB), Department of Soil Science and Water Management, Dr. YSP-UHF, Nauni, Solan -173230, Himachal Pradesh.

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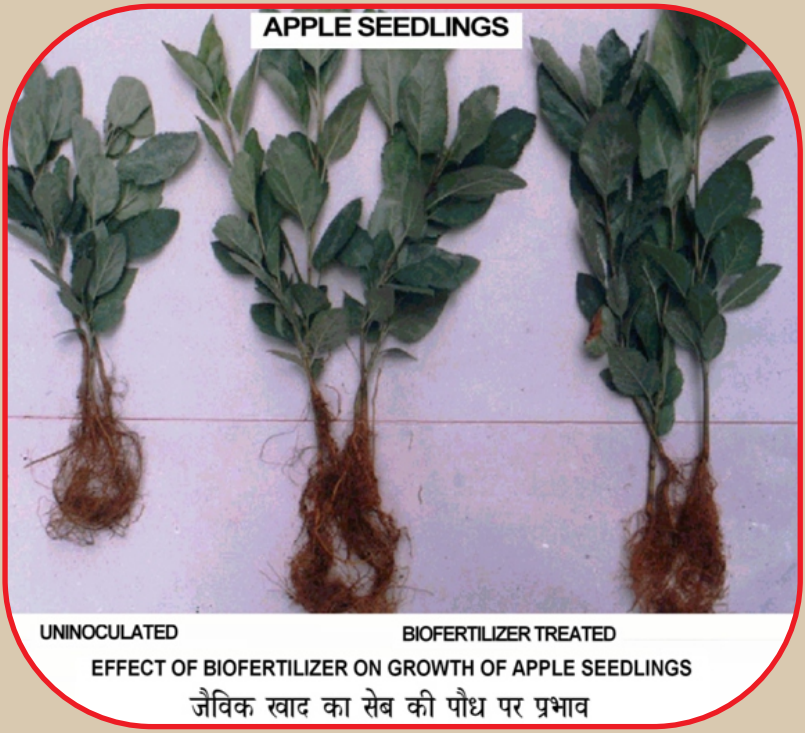

EFFECT OF BIOFERTILIZER ON GROWTH OF APPLE SEEDLINGS

जैविक खाद का सेब की पौध पर प्रभाव

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