# वार्षिक प्रतिवेदन

# ANNUAL REPORT

## 2013-14

**DIRECTORATE OF MUSHROOM RESEARCH**
**(Indian Council of Agricultural Research)**
**Chambaghat, Solan - 173 213 (H.P.), India**

# वार्षिक प्रतिवेदन

# ANNUAL REPORT 2013-14

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***Photos on back cover (Left to right)*** **:**

Wild *Lentinus* sp. Wild *Lentinula* sp. Crop of DMR-button-03 Crop of OE-388 Crop of DMR-Milky-334 Fruit bodies of *Volvariella bombaciana*

Flowering of *Primula melacoides* using SMS Pea crop using SMS

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# PREFACE

Malnutrition is acute in many agriculture dependant countries like India where more than half of the population is engaged in food production. Deficient intake of protein, particularly good quality protein is the main dietary defect. Mushrooms due to very high productivity per unit area and time, conversion of worthless agro waste into good quality protein as well as good organic compost for field crops and above all pleasant aroma and taste, can be an important food source contributing to the protein requirement.

Use of mushrooms as food and medicine has been known since time immemorial and probably predates any historical account. Their description and use can be seen in various ancient treatises like Vedas and Bible. The early civilizations like Greeks, Egyptians, Romans, Chinese and Mexicans appreciated mushrooms as delicacy and therapeutic agents and were used in the religious ceremonies considering them divine. Where Greeks regarded them as strength food for warriors, Romans considered them as food of gods, Chinese called them as “Elixir of Life”. The much-referred “Somrus” in ancient Indian literature is considered to be decoction of mushrooms. The high esteem in which mushrooms were held is also indicated by the restriction of use of many species for rulers only.

India is blessed with a varied agro-climate, abundance of agricultural waste and manpower making it suitable for cultivation of all types of temperate, tropical and sub-tropical mushrooms. It is estimated that India is generating about 700 million MT of agricultural waste besides fruit and vegetable residue, coir dust, husk, dried leaves, prunnings, coffee husk, tea waste, etc. A large amount of the agricultural wastes are burnt or left in the field for composting and incorporation in the soil for fertility. In this process a large amount of potent source of organic carbon and nutrients are lost, which otherwise could be recycled back to the field.

Problems of unemployment, poverty and malnutrition are inextricably linked and are acute in the vulnerable sections of the society. Obviously, these cannot be solved by conventional land based agriculture. Creation of opportunities for enhancement of income of small farmers, landless labourers and unemployed youths by diversification of opportunities of income generation through subsidiary occupation are the new challenges. Mushroom production is an indoor activity and land is of little or no importance. It is labour intensive and a high profit venture for gainful employment of the poor people. It would also provide good quality protein to bridge the protein gap. Therefore, mushroom cultivation may go a long way in contributing significantly to the solution of the twin problem of poverty and malnutrition in developing countries in general and India in particular. The Directorate of Mushroom Research has not only collected mushroom diversity, but has also developed high yielding varieties and cultivation protocols for number of mushrooms. The rapid growth of mushroom industry in last few years and diversification in mushroom cultivation are promising signals for increased production and consumption of this important commodity.

**(Manjit Singh)**
**Director**

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# EXECUTIVE SUMMARY

The Directorate of Mushroom Research has made significant progress in research, transfer of technology and human resource development during 2013-14. The achievements in the area of Crop Improvement, Crop Production, Crop Protection, Post Harvest Technology, Spent Mushroom Substrate, Transfer of Technology, Trainings and Publications are summarized here.

Fungal forays were undertaken in the forest areas of Himachal Pradesh, Mizoram, Arunachal Pradesh and Gujrat. A total number of 211 specimens were collected and 195 specimens identified upto genus level. Further, pure tissue cultures were obtained and deposited in the Gene Bank of DMR, Solan.

Released eight varieties of five mushroom species viz., DMR-Button-03 and DMR-Button-06 of button mushroom; DMRO-247 and DMRO-484 of paddy straw mushroom; DMR-Shiitake-38 and DMR-Shitake-338 of shiitake mushroom; DMR-Milky-334 of milky mushroom and DMR-Macrocybe-01 of Macrocybe mushroom. The white variety of button mushroom is successfully performing at commercial mushroom farm with an average yield of 20 kg per 100 kg compost. Another variety (U3-54) has been put for commercial level trial and is performing excellent at commercial mushroom unit. The production level reported so far is 22 kg per 100 kg compost in two flush. In all 349 hybrids of button mushroom were made using non-fertile isolates from 7 strains and subjected to evaluation trial. A total of 160 putative hydrids have shown different yield levels and confirmed hybrid status. The yield and quality parameters of the hybrids were noted and forty-one of them showed high degree of bruise resistance. The mushroom fruit body did not show any browning even after 2 hours of mechanical bruising. A total of five bruise resistance hybrids have been chosen for AICRP trials as IVT during the year 2013-14.

Identified a number of retroelement based markers linked with fertility in *Agaricus*, strain specific markers in different strains of *Agaricus* and also genus and species specific markers in different mushrooms. Presence of WRKY type transcription factor has been confirmed in *Agaricus* mushroom and this has opened a new area of study of evolutionary.

It was observed that there is gradual reduction in yield and linear growth in button mushroom with spawn to spawn multiplication. About 20 % reduction in yield was recorded in the sixth generation spawn. Enzyme activity of laccase, PPO and cellulases (CMCase, Fpase and xylanase) also lowered down in successive generations. Seven wheat varieties namely DWR 16, PBW 550, DWR 39, DBW 17, DPW 621-50, DBW 14 and HD 2967 were evaluated for their suitability for spawn production of oyster, paddy straw, milky and shiitake mushrooms. DPW 621-50 was the best for oyster mushroom, PBW-550 for paddy straw and shiitake mushrooms, and DWR-16 and DBW-14 for Milky mushroom

Liquid spawn of Shiitake (OE-388) was successfully prepared in Potato dextrose broth medium in alternate day shaking treatment after 25 days. Liquid spawn of Oyster (P-1) successfully prepared in Potato dextrose broth medium in 150 ml flask in daily shaking treatment after 20 days.

Spawn was successfully prepared in 300g and 500g bags for button (U3), oyster (P1) and milky mushrooms in sealed bags (i.e. bags without cotton plugs). However there was some moisture problem in 1000g bags in all the mushrooms. Spawn of button mushroom (U3) was successfully prepared using 0.25, 0.5, 1.0 and 1.5 inch diameter cotton plug. Solid state master spawn of oyster and button mushrooms can be successfully prepared in 9 and 13 days by using liquid inoculumn in comparison to 12 and 20 days, respectively by traditional method.

Trial on compression of compost after spawning in button mushroom helped in early first harvest of mushrooms compared with non-compressed bag. However higher yield was obtained from the non-compressed bags along with perforation. The inoculation of *Alcaligenes*

*faecalis* in casing enhanced the yield of button mushroom significantly. Spent mushroom substrate was used for compost production for button mushroom. The spent mushroom substrate substitution beyond 50 % in compost resulted in lesser yield compared to yield from chicken manure based compost.

*Volvariella bombycina*, a new paddy straw mushroom species successfully domesticated. The culture viability, genetic characterization and yield potentials were obtained. The shelf life studies showed that this mushroom can be stored under refrigerated conditions for more than one week while retaining same quality as equivalent to fresh fruit bodies.

Six strains (CI-13-1, CI-13-2, CI-13-3, CI-13- 4, CI-13-5 and CI-13-6) of *Calocybe indica* evaluated on wheat straw. CI-13-6 gave the highest yield followed by CI-13-1 and CI-13-2. Rest of the three strains did not produce any fruit body.

Compost was prepared for shiitake cultivation using wheat straw and calcium nitrate and ammonium nitrate. Shiitake was successfully grown at experimental scale in this compost consecutively pasteurized at 65°C for 12h for two days.

Wheat straw compost was prepared for shiitake cultivation using two thermophilic fungi (*Humicola insolens*, *Scytlidium thermophillum* @0.1%) and one bacterium, *Bacillus subtilus.* Compost was supplemented with 1 per cent $CaCO_3$ of the compost was successful for shiitake cultivation. Initially spawn started colonizing the substrate but after few days it gets restricted only in that patch.

Zero energy poly tunnel was evaluated for the substrate preparation of milky and oyster mushroom. The compost/substrate became ready in five days. Spawn run was little slow in milky mushroom but the yield obtained were comparable to CST for both milky and oyster mushroom.

Different substrates viz. wheat straw, paddy straw, cotton waste and saw dust were attempting for the cultivation of *Phellorina*. After the spawn run bump type structure resembling primordia developed in all the substrates after removing the PP bag. But no further differentiation took place. Winter mushroom (*Flammulina velutipes*) cultivated successfully on coir pith based substrate formulation but with lesser yield compared to saw dust based substrate formulation.

Two bacterial isolates B-9 (*Bacillus*) and B- 18 (*Alcaligene*) proved to be very promising bio control agents for the management of wet bubble disease both under laboratory and mushroom house conditions. Commercial formulations are being developed.

Out of five fungicides and two other chemicals tried, carbendazim proved most effective in managing wet bubble disease among all the fungicides/ chemical tested.

Pre spawning of casing soil with button mushroom strain 5-20 days prior to pasteurization resulted in reduced incidence of wet bubble disease.

Lower moisture contents of casing soil at the time of pasteurization favoured the survival of *Mycogone perniciosa. Mycogone* failed to survive in casing soil having moisture contents 60% or more at 60°C or above temperature.

Spent mushroom substrate based growing medium developed for *Primula melacoides* Franch (temperate flowering pot plant). SMS based soilless medium was also evaluated for rooftop cultivation of pea. In both experiments, well-decomposed SMS in combination with inorganic fertilizers supported better growth and enhanced yield significantly. Runoff water collected and characterized from SMS site revealed that runoff from fresh SMS dumped site was rich in organic as well as nutrients compared to runoff collected from sites which are free from SMS dumping.

# 1. INTRODUCTION

The ever-increasing population, shrinking of agricultural land, environmental issues, water availability and quality food demands are going to be burning issues during coming decades. To meet these challenges, diversification in food portfolio in areas like horticulture is of paramount importance. Conservation of natural resources with increased productivity through recycling of agro-wastes is important to develop sustainable systems. Utilising these wastes for growing mushrooms can enhance income and impart higher level of sustainability.

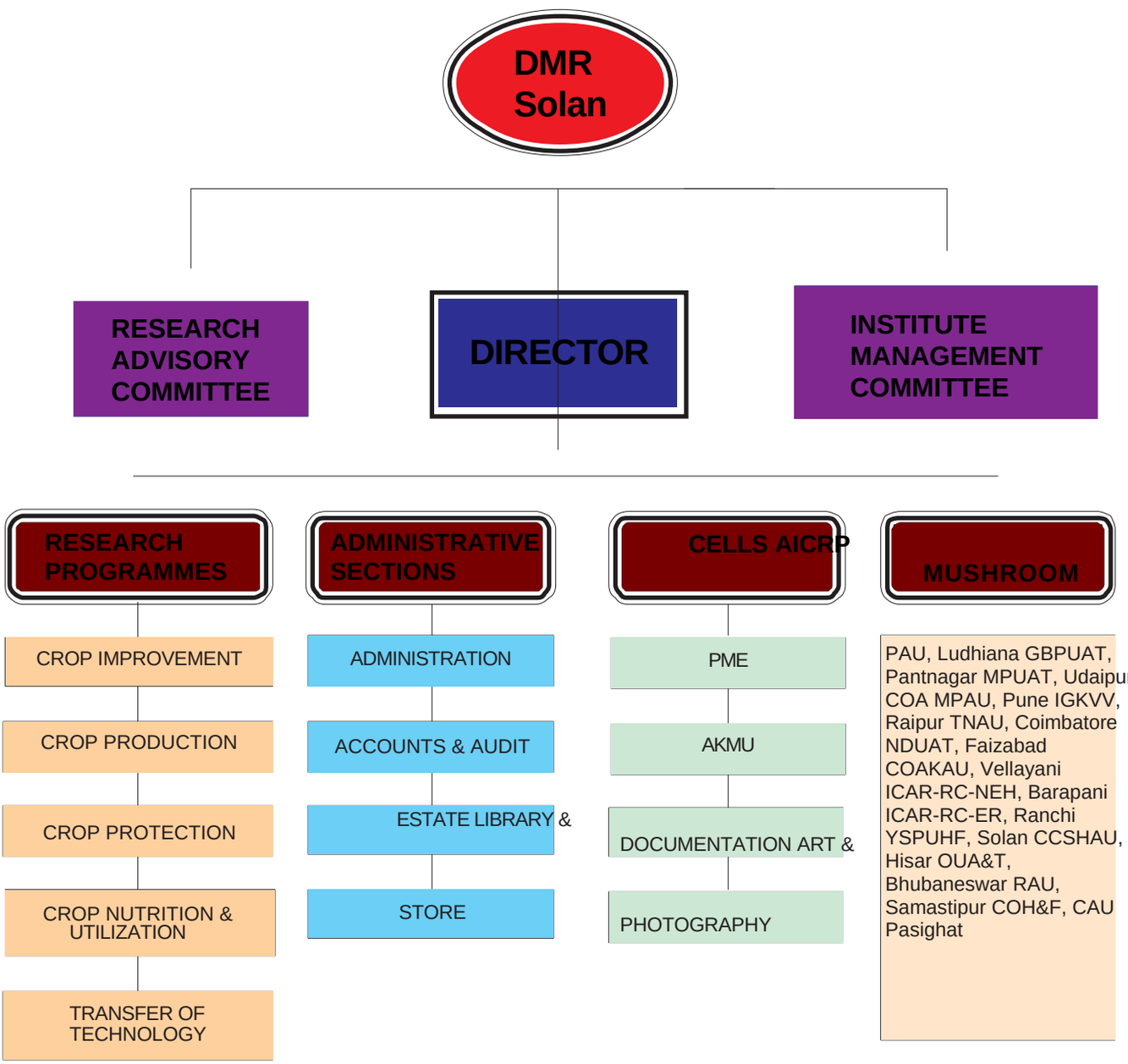
India produces about 700 million tonnes of agricultural waste per annum and a part of it is left out to decompose naturally or burnt in situ. By just diverting 1% of agro-wastes towards mushroom production, India can produce 3-4 million tonnes of mushroom and about 15-20 million tonnes of compost. At present, the per capita consumption of mushroom in India is a dismal 40-50 g as compared to 2-3 kg in USA and Europe. India itself is a big market and increase of per capita consumption even up to 100 g from present figure will help growers to market over 1.00 lakh ton mushroom within the country.

National Centre for Mushroom Research and Training (NCMRT), now referred as Directorate of Mushroom Research, was established in 1983 under the aegis of Indian Council of Agricultural Research. This Directorate is the only institute exclusively dedicated to mushroom research and development in the country. The Directorate has developed array of technologies for cultivation of different mushrooms in various agro-climatic regions of the country and is also the headquarter of All India Coordinated Research Project (AICRP) on Mushroom with 14 Coordinating and 2 Cooperating Centres located in fifteen states.

During the year under report, germplasm collection activities were continued and 211 specimens were collected, 195 identified and 109 were cultured and added to DMR Gene Bank. The emphasis on genetic improvement resulted in development and release of two button mushroom varieties (one each of white and brown strain) that showed outstanding performance at commercial levels. Besides, three button mushroom hybrids with high yield and high bruise resistance were also developed, which are under commercial level trials. Promising varieties of shiitake (2), paddy straw (2), Milky (1) and *Macrocybe* mushroom have also been released. Under spawn production technology, significant reduction in mushroom yield was noticed when spawn was multiplied for more than five generations. Liquid spawn technology for oyster and shiitake mushroom was standardized. Zero energy poly tunnel technique was successfully employed for cultivation of milky and oyster mushrooms. Spent mushroom substrate was evaluated as one of the ingredient in compost production for button mushroom, which showed that substitution beyond 50% resulted in lesser yield compared to yield from chicken manure based compost. SMS based soilless medium of well-decomposed SMS in combination with inorganic fertilizers gave good yields of pea. Two biological controls for wet bubble disease were identified.

Like earlier years, the Directorate was dedicated towards imparting on- and off-campus trainings to farmers, entreprenuers and scientists. The good work done is reflected in the research publication.

# ORGANOGRAM OF DMR, SOLAN



# 2. RESEARCH ACHIEVEMENTS A.

## C ROP IMPROVEMENT

### I. Mushroom Genetic Resources Germplasm

#### collection and identification of wild fleshy fungi

Fungal forays were undertaken in the forest areas of Himachal Pradesh, Mizoram, Arunachal Pradesh and Gujrat. A total of 211 specimens were collected and 195 specimens identified upto genus level. All the specimens have been preserved in the Herbarium of DMR, Solan. The specimens were examined for their macroscopic features in the field along with their field photographs (Fig 2.1). Pure tissue cultures of 109 specimens were obtained and deposited in the Gene Bank of DMR, Solan.

We have collected an interesting green lamellate *Chlorolepiota* sp and *Flammulina* sp growing on dried log for the first time from from Mizoram. The specimen and cultures have been deposited in the Gene Bank and Herbarium of DMR, Solan.

Several interesting specimens of *Leucopaxillus* sp (edible mushroom), *Pleurotus* spp (15 spp.), *Lentinus connatus, L. squarrosulus*, 18 unidentified Lignicolous *Lentinus* spp., 5 specimens of *Schizophyllum* spp., *Lentinula lateritia* from Arunachal Pradesh and Mizoram. *Tremella* spp. (2 spp.), 5 different specimens of *Auricularia* spp, *Laccaria* spp., 9 specimens of *Collybia* spp., *Inocybe* sp (3 spp.), *Cantharellus* spp. (2 spp.) 3 specimens of *Clitocybe*, *Amanita* spp. (4 spp.), *Leucocoprinus* sp (2 spp) from *Ficus benghalensis*, *Hebeloma* sp., *Macrotyphula* sp., *Stereum* sp., *Lacrymaria* sp., *Omphalina* sp., *Gymnopilus* sp., *Geoglossum* sp., *Tricholoma auranticum*, *Xylaria* sp (giant sized) and a *Cordyceps* sp.

*(DMR-01-Germplasm collection and identification of wild fleshy fungi)*

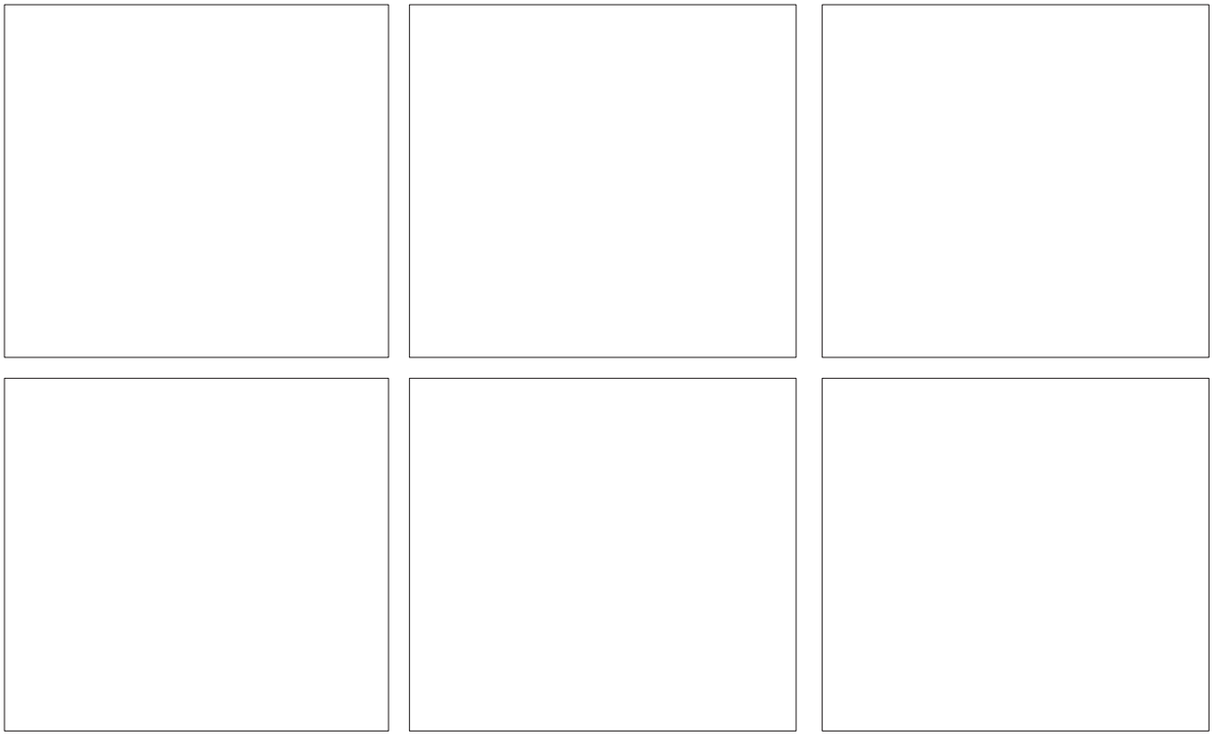


**Fig. 2.1. Wild collection during the year 2013-14**

## 2. Genetic Improvement (a)

### *Agaricus bisporus*

### i) Identification of Retroelement based markers for fertility and strain identification

To develop retroelement based DNA markers for Marker Assisted Selection and varietal/clone/ species identification, identification of non-fertile isolates in *Agaricus bisporus*, ten strains of *Agaricus*, and 10 of each from fertile and non-fertile lines and also strains of *Agaricus*, *Lentinula* and *Pleurotus* collected from the market were used (Fig. 2.2).

First of all, searched for the retroelement motifs in the *Agaricus* genome. Located and got the sequences of retroelement motifs. Checked TAFLHG and YVDDML against *Agaricus* genbank accessions and found many occurrences of these sequences in the database. Two types of retroelement motifs could be found in the *Agaricus* genome i.e. Ty-1 Gypsy type and Ty-3 Copia type elements. Searched for LINE and SINE type of retroelements and could find somewhat similar sequence motifs in the *Agaricus* genome. However, the retroelement motifs in *Agaricus* differed from the motifs found in the plants hence used some degenerate primers. The primers were

#### For Gypsy Type elements

1. GYRT-1- "MRNATGTGYGTNGAYTAYMG" and GYRT-4 – "RCAYTTNSWNARYTTNGCR"

2. GYP-1 F- "GTTTAWYKTIGAYGAYRTIYTIRT" and GYP-2R-"TCKYTCISWYTGICRT CISTYTGTGG"

#### For Copia type elements

1. TY-1-1- "ACNGCNTTYYTNCAYGG" and Ty-1-2- "ARCATRTCRTCNACRTA"

#### For LINE type of element

1. BEL1MF- "RVNRANTTYCGNCCNATHAG" and BEL2MR- "GACARRGGRTCCCCC TGNCK"

2. BE41- "RVNRANTTYCGNCCNATNTC" and BE-42 - "TGYGTCCCCTRGGRRACAC"

#### For SINE type of element

1. MESINE-1-"TTTCTTGTTATAGCCCACCA CAC" and 2.

MESINE-2 – "TTTGATTAATAAGGTGTTGAT"

Optimized annealing temperature for all the primers for retroelement primers using gradient

**Fig 2.2. Collection of mushroom specimens from UK**

PCR (Table 2.1). Amplified Copia, Gypsy, LINE and SINE type elements. The results showed that Gypsy and Copia type elements were present in multiple copy number but LINE and SINE type elements could not be amplified well (Fig. 2.3). Further amplified the Gypsy and Copia elements

**Fig. 2.3. Gradient PCR with primers fro Gypsy, Copia, Lines and SINE elements at different temperatures (Lane 1 & 2 – Gypsy type elements; 3 – Copia type elements; 4 – LINE element and 5 – SINE element)**

in all the six mushroom species/strain (Le-1, Le-2, Le-3, Le-4, Le-5 and Le-6) with the optimized annealing temperature of the primers to see intra- and inter-specific variation. Amplicon size in different species varied from each other and species specific markers could be found (Fig 2.4). The markers were eluted and kept for sequencing.

Further, Gypsy and Copia type elements were amplified in five each of non-fertile, fertile isolates and commercial strains of *A. bisporus* to see the intra-specific diversity and identification of markers for fertility but no fertility markers could be observed, although, some strain specific markers could be amplified in Gypsy type element (Fig 2.5).

After successful amplifications of retroelement motifs, the IRAPs primers already used for plants for amplifications of these domains were used to see the intra-specific polymorphisms in the *Agaricus* and inter-generic and inter-specific variations in different mushrooms. First of all, thirteen outward facing IRAP primers were used to see their annealing in *Agaricus* genome. These primers were LTR 6149, LTR 6150, 5'LTR, 3'LTR, Nikita, Sukkula, RTY-1, IRAP Croc Nikita, IRAP Croc Sukkula, 5'LTR-1, Sukkula LTR, RTY-2, IRAP Croc 5'LTR. Out of them 8 primers worked with *Agaricus* genome but only four could produce high number of bands (Fig 2.6).

Out of thirteen IRAP primers tested five i.e. 3'LTR, Sukkula, RTY-1, Nikita and LTR-6150, were individually tested with all the six mushroom specimens collected (Le-1 to Le-6). The results showed some species specific marker bands, which could be used to identify the mushroom species (Fig 2.7).

After identifying the working IRAP primers with *Agaricus* DNA, outward facing IRAPs primer were

**Fig 2.4. Amplification of all the six specimens Le-1 to Le-6 with retroelement primers (1- Gyp-1F+Gyp-2R; 2- GYRT-1 + GYRT-4; 3 – TY-1-1 + TY-1-2; 4 - Bel-1MF + Bel2MR). Species specific marker bands are indicated using arrows and circles**

**Fig 2.5. Amplification of Gypsy type elements in 5 non-fertile, 5 fertile and 5 commercial strains of *A. bisporus* showing strains specific marker bands in GYRT-1+GYRT-4 amplification**

**Fig 2.6. Amplification of different retroelement motifs with *Agaricus* DNA to identify presence of those motifs and to optimize annealing temperature of the primers**

**Fig 2.7. Species specific bands amplified in 3'LTR and Sukkula retroelement motifs**

used in combinations to amplify the region between two retroelement motifs. Nine combinations of outward facing IRAP primer combinations were used to amplify all six collected mushroom specimens (Le-1 to Le-6).

The amplifications showed highly specific bands for different species (Fig 2.8). The combinations used were Sukkula + 5'LTR-1; Sukkula + 3'LTR; Nikita + 3'LTR; LTR-6150 + Sukkula; LTR-6150 + 3'LTR; LTR-6149 + Nikita; LTR-6149 + RTY-1; LTR-6150 + RTY-2; Nikita + 5'LTR-1.

Further, five IRAP primers combinations were tested against non-fertile, fertile isolates and strains of *Agaricus bisporus* and the results obtained showed strain specific bands as well as marker bands in fertile isolates (Fig 2.9).

A total of 24 mushroom specific primers were designed and synthesized to see Inter Retroelement Amplified Polymorphism in non-fertile, fertile isolates and strains of *Agaricus bisporus*. A total of 30 outward facing IRAP primer combinations were tested to identify fertility specific markers. The results showed some clear strain specific markers and also some markers linked with fertility could be identified (Fig 2.10).

**Fig. 2.8. Species specific bands obtained in different IRAP profiles (indicated with arrows)**

**Fig. 2.9. IRAP profiles of 5 each of non-fertile, fertile and strains of *A. bisporus* showing specific marker bands in fertile isolates and strain specific marker bands**

**Fig. 2.10. IRAP profile of 3 non-fertile, 3 fertile and 2 strains of *Agaricus bisporus* showing some strain specific bands (shown with arrows) and fertility linked markers (shown with boxes)**

The list of primers used in the study and their sequence is given in table 2.1. All the strain specific and fertility specific marker bands were eluted from the gel and were sent for sequencing. The sequences are yet to be received.

Besides IRAP studies, Retroelement Microsatellite Amplified Polymorphism (REMAP) was also used to identify fertility markers in *Agaricus bisporus* using successful IRAP primers and some microsatellite primers. A total of 10 IRAP primers in combination with 3 microsatellite primers were used to differentiate between non-fertile and fertile isolates of different strains. Unique marker bands linked with fertility could be found in two combinations (Fig 2.11).

WRKY transcription factors are a class of sequence-specific DNA binding transcription factors found almost exclusively in plants. WRKY proteins are thought to play an important role in plant defense responses, plant hormone signaling, secondary metabolism, seed germination, cell senescence and plant responses to abiotic stress. In a few WRKY proteins, the WRKY amino acid sequences have been reported to be replaced by WRRY, WSKY, WKRY, WVKY or WKKY. We have searched for WRKY domain in silico in the genome sequence of *A. bisporus* and also the priming sites were searched. On the basis of results, we have tried two WRKY and one Nucleotide Binding Site primers to see the amplification of these domains. Surprisingly, *Agaricus* genome showed the presence of WRKY domain at multiple sites and also different type of WRKY domains could be identified in the genome (Fig 2.12). Out of two WRKY primers tested, A7G1 primer have amplified a number of fragments in *Agaricus*, which shows that a number of WRKY priming sites are available in the genome of the mushroom. Also the Nucleotide Binding Site (associated with WRKY domain) primer for disease resistance gene amplified fragment in the mushroom showing the presence of disease resistance gene.

The WRKY primers have also been tried in non-fertile & fertile isolates and also in mushroom specimens Le-1 to Le-6 (Fig 2.13). Some fragments were also sequenced and the blast

**Table 2.1.** Primers used in the study and their sequences

| Primer name Sequence |
|---|
| Sukkula GATAGGGTCGCATC#TTGGGCG TGAC |
| IRAPCrocusSuk AAC AGA AGT AGT GGC AGC TTG AGA G |
| Nikita CGCATTTGTTCAAGCCTAAACC IRAPCrocusNik CAG TTT TGA TCA AGT CAT AAC C LTR6149 ACTACATCAACCGCGTTTATT LTR6149_TEO CTCGCTCGCCCACTACATCAA |
| CCGCGTTTATT LTR6150 ATGTCTATGTATCCACACATGTA ShortLTR6150 CCA TGT CTA TGT ATC CAC ACA |
| TGT A ReverseTy1 CCYTGNAYYAANGCNGT Reverse TY2 TRGTARAGRAGNTGRAT IRAPCrocus 5'LTR AAC AGA AGT AGT GGC AGC TTG |
| AGA G 5'LTR1 TTG CCT CTA GGG CAT ATT TCC |
| AAC A 3'LTR TGTTTCCCATGCGACGTTCCCC |
| AACA marY1-LTR-L GAA GGA AAT GAG GTG GGG AA-3' marY1-LTR-R TTT TTA GGT TAT ATT TGA TTT TTG |
| TCG TCT T-3' LTR1L AAAGTACGCAGCCCCTATCA-3' LTR1R GAAGTGGCGGAACCAATAGA-3' LTR2L TATAGCCAACCCTCCACAGC-3' LTR2R AACTGGACAAGGCAACAAGG-3' MarY1L GTGCCCTGTGTGTTTTTCCT-3' MarY1R 5' AAGGGGTACTCCGCCTCTAA-3' RTE-L 5' CACCGTTGCCTTTTCTGTCT-3' RTE-R AGTAAACGAGGGTGGTCACG-3' UBC807 A GA GA GA GA GA GA GA GT-3' UBC818 C AC AC AC AC AC AC AC AG-3' CPLTR1/R GTGCAAGCGACACACAAACT-3' CPLTR2/R GCAGTGTTTCTACAGCGAAG-3' CPLTR1/F CTCGCTTCTTCAGCTTGACC-3' CPLTR1/R GTGCAAGCGACACACAAACT-3' CPLTR2/R GCAGTGTTTCTACAGCGAAG-3' MS1 GGCGGCGGCGGCGGCGGCGG |
| CT-3' MS2 ATGATGATGATGATGATGATGG-3' MS4 CACACACACACACACACACAG-3' Ps 48 GAGGTGGGGAAAAATATGGGACG |
| AAC-3' Pl281 CTTCACATATACTGGGCATCAGC |
| AAGGG-3' PDGSL313-1 CGATGTATGTGGCTGTGCCAGTA |
| CCAT-3' PDGSL719-2 TGGGCCGCCCTTGATGGCTCA |
| TATT-3' |

**Fig. 2.11. REMAP profile of 3 Non-fertile, 3 fertile isolates and 2 strains of *A. bisporus* showing unique bands in fertile and non-fertile isolates**

**Fig. 2.12. Amplification of WRKY and NBS domain in the *Agaricus bisporus* genome**

showed that the WRKY domain is present in the *Agaricus* genome (Fig 2.14) but it has different organization. This is a first report of presence of WRKY domain (specific to plants) in mushroom genome. We have also sequenced the WRKY domain in *Agaricus* and it was found that these domains are found in high copy numbers in *Agaricus* genome. Also different types of WRKY domains could be found in the *Agaricus*.

Fluorescent In Situ Hybridization technique (FISH) was tested on wheat chromosomes (Fig 2.15) and also tried on mushroom with labeling of microsatellite DNA of *Agaricus*. We were not successful as the chromosomes of the mushroom were very small and can only be separated by pulse field gel electrophoresis.

The results of the study showed that retroelement based DNA markers can be highly useful in species identifications, developing strain specific markers and also the markers linked with the traits in *Agaricus* species particularly for fertility.

**Fig. 2.13. Amplification of WRKY and NBS domain in different species of mushroom and fertile and non-fertile isolates of *A. bisporus***

**Fig. 2.14. Presence of WRKY Domain in *Agaricus* genome**

### ii) Release of two high yielding varities of button mushroom

a. DMR-Button-03 (White) b.

DMR-Button-06 (Brown)

The white variety is successfully performing at a commercial button mushroom farm Balaji Mushroom with an average yield of 20 kg per 100 kg compost (Fig 2.16).

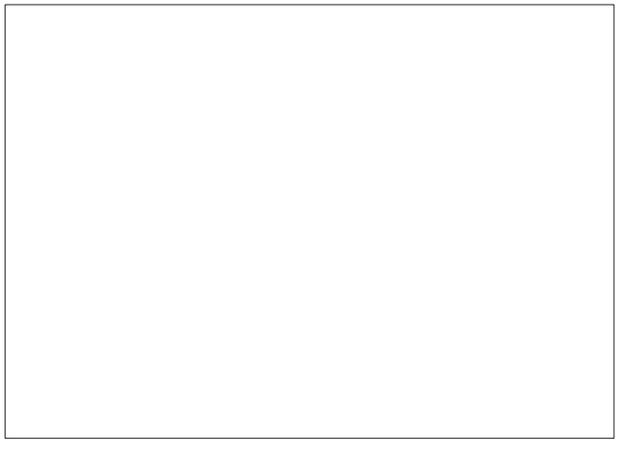
### iii) New variety under commercial trial

Another variety (U3-54) has been put for commercial level trial and is performing excellent. The production level reported so far is 22 kg per 100 kg compost in two flushes (Fig 2.17).

### iv) Testing of 41 bruise resistance hybrids on large scale for yield

Of 349 hybrids tested for fruiting trials, 41 hybrids have shown different degrees of bruise resistance and yield. Five hybrids were selected for AICRP and commercial trials on the basis of high yield along with high bruise resistance and

**Fig. 2.15. FISH in wheat chromosomes with biotin and dioxigenin labeled 5s and 45s rDNA**



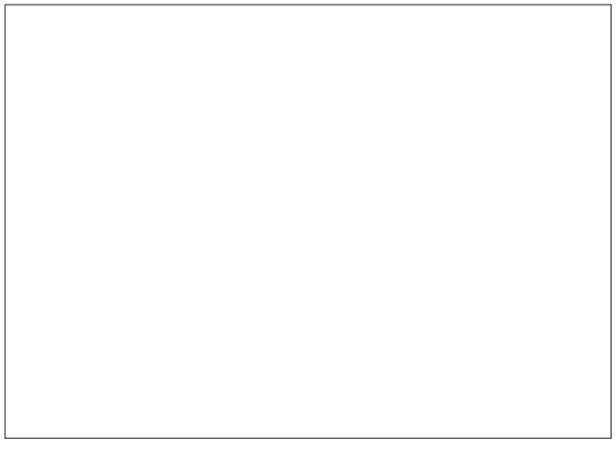


**Fig. 2.16. Yield performance of DMR-button-03 at DMR, Solan (Left) and at a commercial unit (right)**

**Fig. 2.17. Commercial trial of New variety of button mushroom U-3-54** **Table 2.2. Mushroom yield of the strain**

**DMR-Button-03 against its control at five different locations under AICRP mushroom in the year 2011-12 and 2012-13**

| ***A. bisporus*** **strain** | **Mushroom yield (kg/100kg compost) at different centres** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Murthal** | | **Pantnagar** | | **Pune** | | **Solan** | | **Average** | |
| | **2011-12** | **2012-13** | **2011-12** | **2012-13** | **2011-12** | **2012-13** | **2011-12** | **2012-13** | **2011-12** | **2012-13** |
| U-3-58 | 22.8 | — | 22.65 | 19.21 | 13.44 | 17.52 | 18.50 | 18.50 | 19.0 | 18.17 |
| U-3 (Control) | 7.3 | — | 16.57 | 13.70 | 14.22 | 11.77 | 14.00 | 11.75 | 13.02 | 12.81 |
| **CD (0.05)** | 2.48 | — | 2.30 | 1.08 | 1.92 | 0.82 | 2.62 | 1.18 | — | 1.22 |

quality. The five bruise resistant hybrids (NBS-1 to NBS-5) were tested at our Directorate as well as at two commercial farms Tirupati Balaji Agro-products, Baramati and Weikfield Mushroom, Pune along with one control strain which these units were using (Fig 2.18, 2.19, 2.20 and 2.21). The results showed very good yields and the productivity were found to be at least 10-15 per cent higher than the imported strains. The results from the two farms are given in Table 2.3 and 2.4.

**Fig. 2.18. Crop of NBS-1 (Left) and NBS-2 (right) during commercial scale trial**

NBS-1 NBS-2 NBS-5 Italian strain

Fig. 2.19. Quality of fruit bodies after 48 hrs of storage at room temp

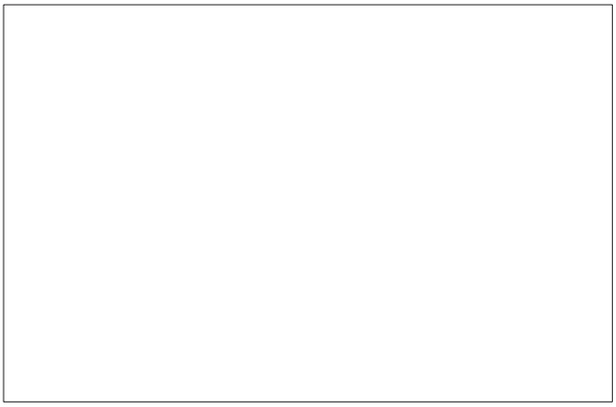


Fig. 2.20. Crop of NBS-5 (Left) and Control Italian strain(right) during commercial scale trial

NBS-1 NBS-2 NBS-3

NBS-4 NBS-5 A-15

Fig. 2.21. Bruising test of fruit bodies at a commercial unit in Baramati

**Table 2.3. Yield of Non-bruising hybrids at a commercial unit in Baramati**

| Strains Average Fruit body Yield (kg/ wt (g) 100kg compost) |
|---|
| NBS-1 14.0 25.19 NBS-2 13.8 23.34 NBS-3 15.8 21.21 NBS-4 14.1 20.31 NBS-5 13.8 24.16 Control (Italian strain) 14.3 22.95 |
| **CD (0.05) 2.20** |

Days taken to spawn run - 12 days Days taken to first harvest (after casing) - 19 days

**Table 2.4. Yield of Non-bruising hybrids at a commercial unit in Pune**

| Strains Average Fruit body Yield (kg/ wt (g) 100kg compost) |
|---|
| NBS-1 13.6 21.26 NBS-2 13.2 19.44 NBS-3 16.0 15.13 NBS-4 12.6 11.56 NBS-5 12.4 23.06 Control (A-15) 11.26 18.73 CD (0.05) 1.66 |

Days taken to spawn run - 12 days Days taken to first harvest (after casing) - 19 days in NBS- 1 and 21 days in others

### v) Development of new hybrids using newly identified non-fruiting SSIs of wild strain with U-3 and A-94

A total of 150 putative hybrids were developed by crossing non-fertile SSIs of five different strains.

### vi) Initial Varietal Trial on white button mushroom

Six newly developed hybrids along with one control are under trial as IVT at AICRP centres along with the headquarter Solan. Very good yields have been obtained with a highest of 18.19% BE (Table 2.5 Fig 2.22).

**Fig. 2.22. Initial Varietal Trial at DMR, Solan** **Table 2.5. Yield of strains of button mushroom on short method compost in four weeks cropping in Solan**

| ***A. bisporus*** **strain Mushroom yield (kg/100kg compost) in 30 days cropping period** |
|---|
| IVT-13-01 14.64 IVT-13-02 15.50 IVT-13-03 10.65 IVT-13-04 11.34 IVT-13-05 15.14 IVT-13-06 17.06 IVT-13-07 18.19 |

## (b) *Pleurotus* spp. i) Mating studies on *Pleurotus sajor caju*

Four wild cultures *Pleurotus sajor caju viz.,* DMRP 112, 214, 233, and 255 were cultivated on wheat straw for obtaining spore prints, and morphological and anatomical characterization. The basidiospores of three parent strains are similar while one parent strain has smaller basidiospores and number of basidia are very less in number as compared to the other three strains. Spore prints were obtained on sterile plates for isolating single spore cultures. Forty single spores were isolated on fresh medium plates and used for developing hybrid strains.

## ii) Evaluation of hybrid strains in *Pleurotus* spp.

To evaluate stability of hybrid strain of *Pleurotus florida* and *Pleurotus sajor caju*, five hybrid strains each of *Pleurotus sajor-caju* and *P. florida* developed earlier (referred as old) were compared with fresh hybrid strain prepared by mating same parent single spores (referred as new). Pasteurized wheat straw was used for spawning with six replications per treatment. Hybrid strain P-9 and P-21 of *Pleurotus sajor caju* gave significantly higher yield from the parent strain (table 2.6). However no much variation was observed in old and new same hybrid strain. Among *Pleurotus florida* strain no. P1H25 and H-38 gave higher yield from the parent strain. The yield data are present in table 2.7.

**Table 2.6. Yield of *Pleurotus sajor caju* hybrid strain (old and fresh) on pasteurized wheat straw**

| **S. No. Hybrid strain BE% New Old** |
|---|
| 1. PSC H-8 26.6 18.4 2. PSC H-9 58.4 51.2 3. PSC H-21 59.0 44.8 4. PSC H-27 35.2 36.0 5. PSC H-31 27.2 44.2 6. P.SC. (parent) 23.2 CD at 5% 11.8 |

**Table 2.7. Yield of hybrid strain *Pleurotus florida* (old and fresh) on pasteurized wheat straw**

| S. No. | Hybrid strain | BE% | New | Old |
|---|---|---|---|---|
| 1. | P1 H4 | 35.0 | 44.0 | |
| 2. | P1 H8 | 38.9 | 45.0 | |
| 3. | P1 H25 | 58.5 | 66.1 | |
| 4. | P1 H35 | 48.0 | 23.0 | |
| 5. | P1 H38 | 22.0 | 29.0 | |
| 6. | P1 Control | | 24.8 | |
| CD at 5% | | | 12.54 | |

### iii) Evaluation of intra-strainal hybrid strains of *Pleurotus fossulatus*

Two parent strains of *Pleurotus fossulatus* named DMRP-120 (Indian strain) and DMRP-278 (Afghanistan strain) were used to obtain spore print on sterile plates. Spore prints were used for isolating single spores. Individual single spores were marked and plated on fresh medium. Forty single spores from both strains were mated in different combinations.

The mycelia from fused zone were examined for clamp connections. Successful mating was observed in seven combinations and they were used for spawn preparation and cultivation. Hybrid strain no. 5 and 6 showed very fast grown but no fruiting was observed due to heavy contamination of green mould.

## (c) Paddy straw mushroom i) Genetic characterization of *Volvariella bombycina* strain

The pure culture from wild mushroom fruit body collected from Vadodara, Gujarat, India was raised using tissue culture raising technique on Malt Extract Agar (MEA) medium at 32±2 °C. The mycelial culture was molecularly as *V. bombycina* by amplification of the ITS regions of 5.8S rRNA using PCR, followed by sequencing and blasting of the PCR amplified amplicon. The improved consensus sequence was blasted using BLASTn tool of NCBI for conformity of the species. The consensus sequence was also submitted to NCBI database with accession number KC142120.

The improved consensus sequence of the ITS region of 5.8S rRNA gene of the test fungus along with five closely hit sequences from NCBI databank (HM562212.1, EU920673.1, EF566874.1, EU679364.1 and EU676242.1) were studied for variability using ClustalW2 tool of European Bioinformatics Institute (EBI). Phylogenetic and molecular evolutionary analyses were conducted using MEGA version 5.0. The evolutionary history was inferred using the Neighbor-Joining method. The evolutionary distances were computed using the Maximum Composite Likelihood method and were in the units of the number of base substitutions per site.

The blasting of the improved consensus sequence using BLASTn tool of NCBI revealed its 100% identity against *V. bombycina* strain voucher AJ244 (NCBI accession No. HM562212.1), followed by *V. bombycina* strains with accession Nos. EU920673.1 and EF566874.1. The evolutionary relationship amongst the strain we isolated and the five closely hit strains during blast, deduced by using Neighbor-Joining method revealed that our strain of *V. bombycina* (DMRO-481) showed bootstrap value of 100 against *V. bombycina* strain with accession No. HM562212.1 (Justo et al. 2011). Similarly two other strains with accession Nos. EU679364.1 and EU676242.1, respectively both reported from India exhibited a bootstrap value of 100. These two strains exhibited the bootstrap value of 67 against one another strain (EU920673.1) reported from Brazil. The strain with accession No. EF566874.1 reported from Thialand formed clade with our strain (DMRO-481) and strain with accession No. HM562212.1, while the rest three strains, two reported from India and one from Thialand formed separate clade (Fig 2.23).

### ii) Release of varieties of paddy straw mushroom

Two selections of paddy straw mushroom DMRO – 247 and DMRO- 484 were released during the year. The average yield of DMRO-247 was found to be in the range of 12-38 kg /100kg

**Fig. 2.23. Phylogenetic tree derived from the sequences of the ITS region of 5.8S rRNA gene of *V. bombycina* (one isolated and rest five closely hit sequences from NCBI database). The NJ-tree was constructed using neighbors joining algorithm in MEGA 5.0 software. Numbers at nodes indicate percent bootstrap values.**

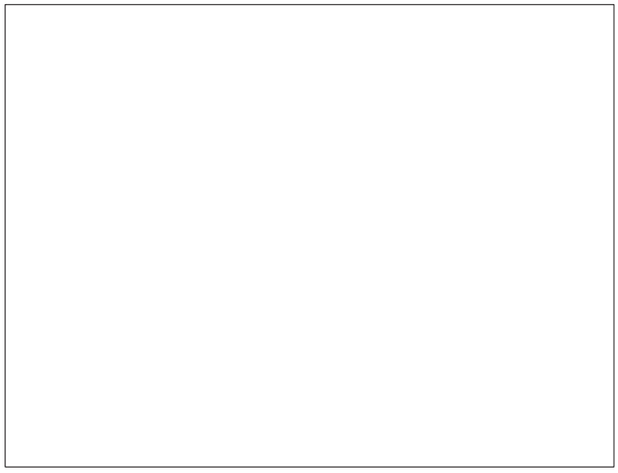
dry compost/different substrates with average fruit body size ranging 5-7 cm long × 4-5 cm wide, average Fruit body weight 14-18 g and Light brown Fruit body colour (Fig 2.24) while average yield of DMRO-484 was found to be 14-40 kg/100kg dry compost/different substrates with Fruit body size 5-7 cm long ×3-5 cm wide, Fruit body weight 14-20 g and Fruit body colour White to grey (Fig 2.25).

### (d) Shiitake mushroom i) Release of varieties of shiitake mushroom

Two selections of Shiitake mushroom DMR-shiitake-38 and DMR-shiitake-388 were released during the year. The average yield of DMR-shiitake-38 was found to be in the range of 31-40 kg/100 kg saw dust with average fruit body weight 40-45g and Fruit body colour (centre dark brown and outer light brown with white scars) (Fig 2.26) while average yield of DMR-shiitake-388 was found to be 22.3-43.9kg/100kg wheat straw with fruit body cap size 6-7 cm, fruit body weight 35- 39 g, fruit body colour light brown and ring of white scars on the cap (Fig 2.27).

### (e) Milky Mushroom i) Release of variety of milky mushroom

One selections of Milky mushroom DMR-Milky-334 was released during the year. The average yield of DMR-Milky-334 was found to be in the range of 74-82 kg/100 kg of dry wheat / paddy straw with average cap size 7-8 cm, fruit body weight 33-38 g and fruit body colour white (Fig 2.28).



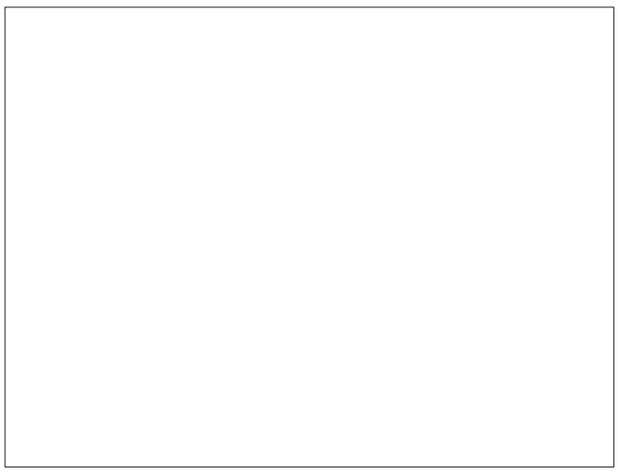
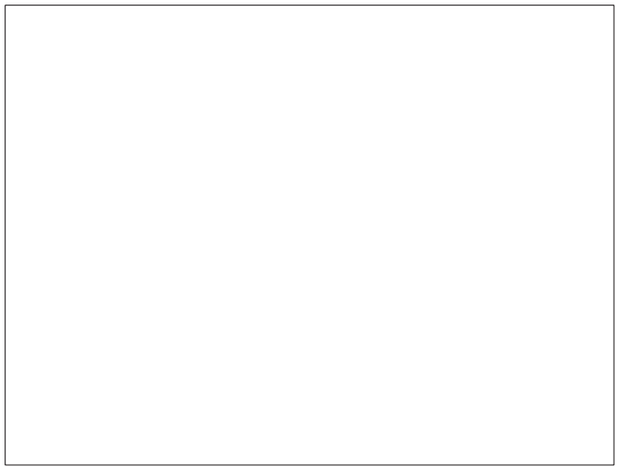


**Fig. 2.24. Crop of DMRO-247 Fig. 2.25. Crop of DMRO-484**



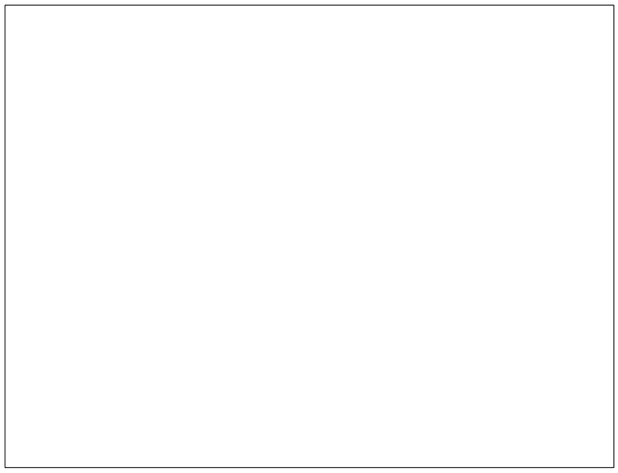
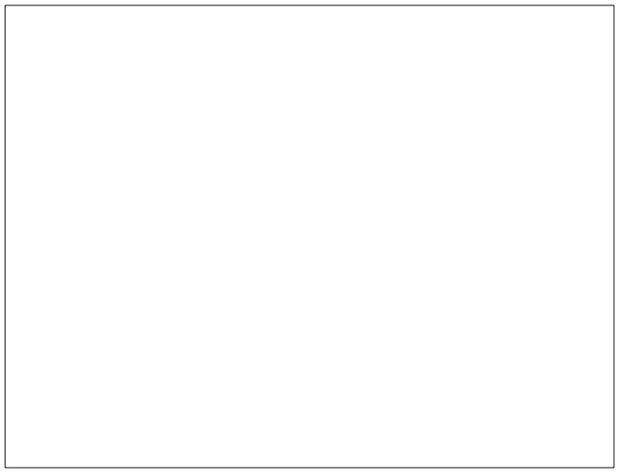


**Fig. 2.26. Crop of DMR-shiitake-38 Fig. 2.27. Crop of DMR-shiitake-388**

### (f) Macrocybe Mushroom i) Release of variety of *Macrocybe* mushroom

One selection of *Macrocybe* mushroom DMR-*Macrocybe*-01 was released during the year for cultivation. The average yield of DMR-*Macrocybe*-01 was found to be in the range of 40-70 kg/100 kg of dry wheat /paddy straw with average fruit body weight 20-40g and fruit body colour white (Fig 2.29).

*(DMR-02-Genetic Improvement of button, oyster and paddy straw mushroom)*



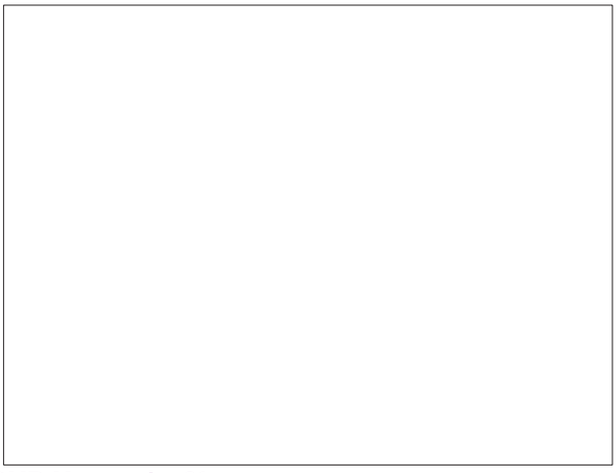


**Fig. 2.28. Crop of DMR-milky-334 Fig. 2.29. Crop of DMR-Macrocybe-01**

# B. Crop Production

### a) Spawn i) Effect of spawn to spawn multiplication on button mushroom productivity

There was gradual reduction in yield and linear growth with spawn to spawn multiplication. Downward linear growth was 87.0, 83.6, 83.3, 82.6, 80.6 and 79.3 mm after 19 days of incubation in I, II, III, IV, V and VI generation, respectively (Fig 2.30). The mushroom yield in different generations (I-VI) was 16.6, 16.4, 15.0, 14.7, 14.0 and 13.2 kg/100 kg compost. About 20 % reduction in yield was recorded in the sixth generation spawn.

### ii) Extracellular ligninocellulolytic enzymes

*Agaricus bisporus* belongs to basidiomycetes class of fungi and also secretes enough extracellular ligninocellulolytic enzymes for the biodegradation of lignocellulolytic materials. Among ligninolytic enzymes, Laccase, Polyphenol oxidase and cellulases (CMCase, Fpase and xylanase) activity (Fig 2.31) decline in successive generations of spawn. Whereas in case of spawn of first generation which was considered as control for subsequent generations showed highest activity of Laccase, CMCase, FPA and xylanase. No xylanase activity was recorded in third generation onwards which indicates their non-stability for longer duration.

### iii) Evaluation of wheat varieties for spawn production of different mushrooms

Seven wheat varieties namely DWR 16, PBW 550, DWR 39, DBW 17, DPW 621-50, DBW 14 and HD 2967 were evaluated for oyster, paddy straw, milky and shiitake mushrooms. These

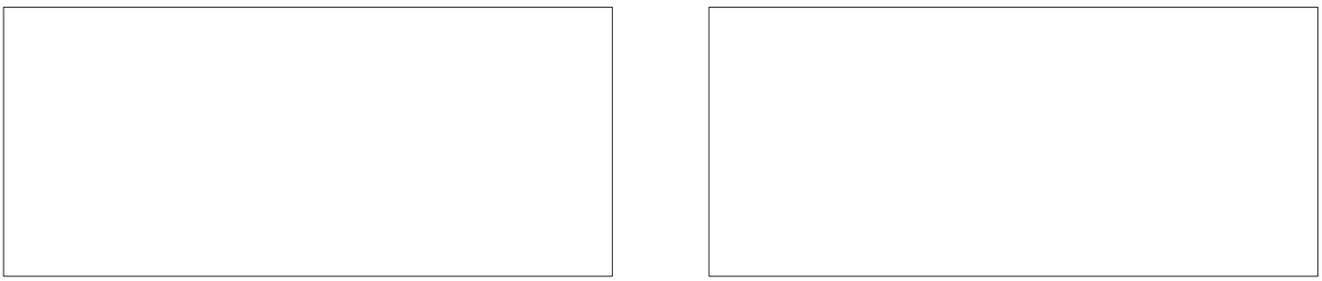


**Fig. 2.30. Comparison of (a) downward linear mycelia growth (b) yield attributes of six generation spawn of *A. bisporus***

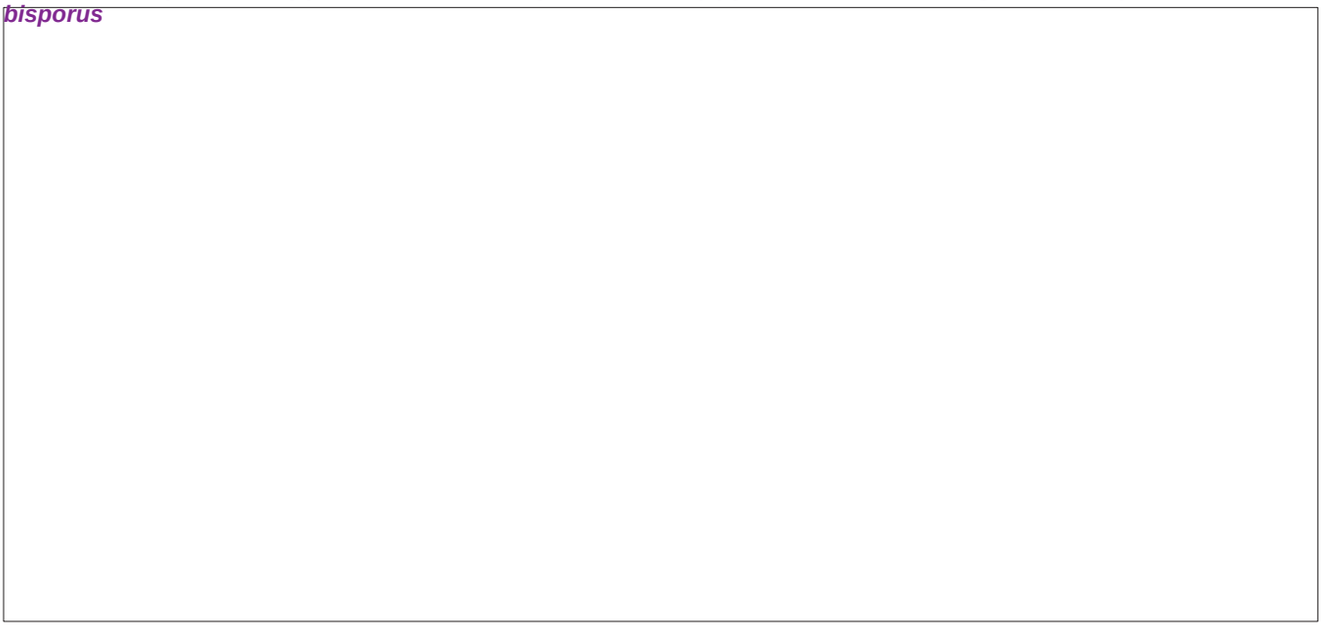


**Fig. 2.31. Comparison of extracellular lignocellulolytic enzyme activities of *A. bisporus* at different multiplication stage**

**Table 2.8. Various quality parameters of wheat varieties (Source: DWR, Karnal) SNo. QualityParameters Name of wheat variety DWR 16 PBW 550 DWR 39 DBW 17 DPW 621-50 DBW 14 HD 2967 1** Test Weight (kg/hl) 79.1 78.6 78.6 78.2 80.1 77.2 77.8

**2** Protein Content (%) 11.7 12.0 11.8 12.6 12.6 11.9 12.2

**3** Moisture Content (%) 9.2 9.6 9.3 8.9 9.4 8.8 9.1

**4** Grain Hardness Index 73 80 81 77 80 78 76

**5** Sedimentation Value (ml) 42 47 40 39 56 42 52

**6** Wet Gluten (%) 29.3 31.3 30.2 32.5 33.1 30.6 31.2

**7** Dry Gluten (%) 9.3 10.1 9.6 10.5 10.7 9.8 10.1

**8** Yellow Pigment (ppm) 2.43 3.07 4.11 4.10 3.15 3.48 3.52

**9** Iron Content (ppm) 39.6 31.6 38.5 35.8 32.8 42.5 37.1

**10** Zinc Content (ppm) 36.5 30.8 40.6 38.2 36.8 35.5 39.8

**11** Copper Content (ppm) 5.28 4.79 5.77 4.91 4.82 5.63 5.18

**12** Manganese Content (ppm) 37.5 33.3 41.3 34.6 34.8 43.1 36.8

varieties were procured from Directorate of Wheat Research, Karnal (Table 2.8). DPW 621-50 was the best for oyster mushroom, PBW-550 for paddy straw and shiitake mushrooms, and DWR-16 and DBW-14 for Milky mushroom

All wheat varieties were optimized for quality spawn production. Downward linear mycelial growth of four mushrooms namely milky (*Calocybe indica,* strain OE-334), paddy straw (*Volvariella volvacea,* strain OE-274), oyster (*Pleurotus sajor caju,* strain PL-112) and shiitake (*Lentinula edodes,* strain OE-38) were evaluated on all the wheat varieties.

Among the tested wheat varieties, DPW 621- 50 showed highest mycelial growth (68.6 mm) with *Pleurotus* (PL-112) whereas PBW-550 showed highest mycelial growth (72.3 mm) with paddy (OE-274) and (72.6 mm) shiitake (OE- 38) mushroom (Fig 2.32a & b). Wheat varieties DWR-16 and DBW-14 showed highest mycelial growth (66.0 mm) with milky mushroom (OE-334) after 22 days of incubation at 28 C (Table 2.9).

**Fig. 2.32a. Downward mycelial growth of mushroom on different wheat varieties**

**Fig. 2.32b. Downward mycelial growth of mushroom on different wheat varieties**

**Table 2.9. Linear growth of different mushrooms on various wheat varieties S.No Wheat Downward Linear Mycelial**

| Growth (mm) variety Milky mushroom - OE-334 (22 Days) | Paddy straw mushroom - OE-274 (7 Days) | Oyster mushroom - PL-112 (9 Days) | Shiitake mushroom - OE-38 (25 Days) |
|---|---|---|---|
| 1 DWR-16 66.0 | 72 | 64.6 | 58.6 |
| 2 PBW-550 54.3 | 72.3 | 67.6 | 72.6 |
| 3 DWR-39 49.3 | 61.3 | 67.6 | 61.3 |
| 4 DBW-17 58.0 | 66 | 67.3 | 68 |
| 5 DPW 621-50 62.0 | 70.6 | 68.6 | 69.6 |
| 6 DBW-14 66.0 | 60 | 61.3 | 56 |
| 7 HD-2967 61.3 | 70 | 63.3 | 58.6 |

### iv) Preparation of liquid spawn of Shiitake and Oyster mushroom

Liquid spawn of Shiitake (OE-388) was successfully prepared in Potato dextrose broth medium in alternate day shaking treatment after 25 days. Liquid spawn of Oyster (P-1) successfully prepared in Potato dextrose broth medium in 150 ml flask in daily shaking treatment after 20 days. In *L. edodes* maximum biomass (7.44 mg ml$^{-1}$) was obtained after 25 days in alternate day shaking and in *P. florida* maximum biomass (0.82 mg ml$^{-1}$) was obtained after 20 days in daily shaking basis (fig 2.33).

**Fig. 2.33. Biomass production by P. florida in liquid spawn**

### v) Preparation of master spawn using liquid spawn inoculumn

Solid state master spawn of oyster and button mushrooms can be successfully prepared in 9 and 13 days by using liquid inoculumn in comparison to 12 and 20 days, respectively by traditional method on inoculating with wheat grain spawn.

### vi) Effect of aeration on spawn quality in sealed bags

The commercial spawn bags containing different quantities of wheat grains (1000 g, 500 g and 300 g) were inoculated and sealed (Fig 2.34). Growth of mycelium was measured and numbers of days taken for colonisation of the wheat grains in the bags were tabulated for three different mushrooms *viz.,* button (*A. bisporus* strain U-3),

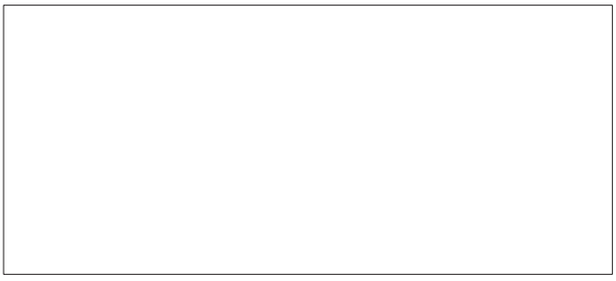


**Fig. 2.34. Mycelial growth in sealed bags of different weight**

milky (*Calocybe indica* strain OE-334) and oyster (*Pleurotus sajor caju* strain PL-112) mushrooms.

Spawn was prepared successfully in sealed bags containing 300 g wheat grains. Though number of days taken for complete colonization of wheat grains were more in sealed bags than in control (Table 2.10). Bags containing 300 g wheat grains were colonized successfully in all strains. 500 g bags were colonized in 12 days in case of P-1 but growth was patchy and stagnant in 1000 g bags in all strains and bags could not be colonized fully. Spawn of button mushroom (U3) was successfully prepared using 0.25, 0.5, 1.0 and 1.5 inch dia cotton plug.

## (b) Button Mushroom i) Effect of different compression and perforation treatments on yield of *Agaricus bisporus*

Two trials were conducted during the period under report by involving four levels of compression both with and without perforation in compost filled polybags. In trial 1, compression as such helped in early first harvest of mushrooms compared with control. However, perforation in compost filled polybags gave slight advantage also in bags filled up to standard height (12") and bags compressed up to 9" compost depth. Mushroom yield enhancement was nearly 15 % on making perforation in bags filled up to standard height, while it was 13.77 % in bags compressed to 7" compost height with perforation in compost filled polybags and only 8.21 % in bags compressed to 7" compost height without perforation in compost filled polybags (Table 2.11). The mean fruit body weight was slightly higher in almost all perforated treatment compared to their respective controls.

**Table 2.10. Effect of aeration on spawn quality in sealed bags Strain Mycelial growth in days 300 g 500 g 1000 g Control Sealed Control Sealed Control Sealed**

| |
|---|
| U-3 12 15 12 PSG* 16 PSG P-1 9 9 9 12 11 PSG OE-334 6 8 8 PSG 14 PSG *PSG - Patchy stagnant growth |

**Table 2.11. Effect of different level of compression and perforation in compost filled bags on the yield of button mushroom (*A. bisporus*) – Trial 1**

| **Compression First harvest (days post-casing) Mushroom yield (kg/q compost) With perforation Without perforation With perforation Without perforation** |
|---|
| 7" 18.08 ± 0.26 17.33 ± 0.33 14.13 (+13.77%) 13.44 (+8.21%) 9" 17.58 ± 0.34 18.17 ± 0.27 13.41 (+7.97%) 13.63 (+9.75%) 11" 18.25 ± 0.30 18.25 ± 0.25 13.49 (+8.62%) 12.24 (-1.45%) No compression 18.67 ± 0.14 19.25 ± 0.22 14.26 (+14.81%) 12.42 (0.00%) *Figure in parentheses indicate % increase over control |

**Table 2.12.Effect of different level of compression, perforation and bacterial inoculation treatments on yield of button mushroom (*A. bisporus*) – Trial 2**

| Compression First harvest (days post-casing) Mushroom yield (kg/q compost) With perforation Without perforation With perforation Without perforation |
|---|
| 7" 17.12 ± 0.18 18.36 ± 0.59 14.53 (+5.55%) 14.14 (+6.58%) 9" 17.80 ± 0.19 17.44 ± 0.22 13.78 (+4.31%) 14.39 (+3.95%) 11" 17.44 ± 0.18 17.52 ± 0.22 13.48 (+2.04%) 13.55 (+2.50%) No compression 17.36 ± 0.33 18.52 ± 0.54 15.93 (+20.55%) 13.21 (0.00) |
| *A. faecalis* inoculation 18.54 ± 0.61 - 15.88 (+20.21%) - |
| *B. subtilis*-III inoculation 18.21 ± 0.27 - 14.19 (+7.42) - |
| *B. subtilis*-IV inoculation 17.63 ± 0.32 - 14.84 (+12.34%) - *Figure in parentheses indicate % increase over control |

In trial 2 perforation as such again helped in harvesting mushrooms at an early stage than the imperforated bags. Enhancement in mushroom yield was recorded in bags with perforation but with standard height and enhancement was above 20 % compared to control bags without any perforation (Table 2.12). In this trial, all compressed bags gave higher mushroom yield than control however, the enhancement varied in different treatments from 2.04 to 20.59 %. Invariably the mean wt. of fruit bodies in perforated treatments was higher than imperforated bags compressed with same level. The inoculation of *Alcaligenes faecalis* in casing soil also resulted in above 20 % yield enhancement over control. The rest of the yield parameters like time taken for first harvest and mean wt. of fruit bodies were at par with the control treatment.

The relationship between residual nitrogen content and the fruit body yield as well as fruit body weight was derived in which the bags with standard compost height along with perforation in compost filled bags exhibited highest nitrogen content along with highest fruit body yield. Similarly the treatment with 7" compost height without perforation in compost filled polybags exhibited lowest nitrogen content in SMS along with lowest fruit body yield (kg/100 kg compost (Fig 2.35). No correlation could be derived for the residual nitrogen contents of SMS and the fruit body weight in different treatments.

**Fig 2.35. Comparative fruit body yield, fruit body weight and nitrogen (%) in SMS, of different compost compression and perforations treatments**

### ii) Effect of bacterial broth mixing in different casing materials/compost on yield of *Agaricus bisporus*

The experiment was conducted by involving twelve different treatments. The first two treatments involved mixing of bacterial broth of two different strains of *B. subtilis* in compost at the time of spawning, while the rest eight treatments were on inoculation of *Alcaligenes faecalis* in four different casing materials at the time of casing soil application. In majority of the cases the time taken for first harvest was slightly more in bacterial broth mixed casing materials than their respective controls. The mushroom yield was higher in *Alcaligenes faecalis* inoculated treatments of FYM + spent compost and spent compost alone based casing materials treatments (Table 2.13). The inoculation of two different strains of *Bacillus subtilis* also gave higher fruit body yield compared to the control (FYM + Spent compost based casing). In other casing material treatments, the mushroom yield

**Table 2.13. Effect of bacterial inoculants mixed in compost at spawning and in different casing materials at casing on yield parameters of *A. bisporus***

| Treatment Yield parameters of *A. bisporus* | First harvest Mushroom yield No. fruitbodies/ Av fruit body (days post-casing) (kg/q compost) q compost wt. (g) |
|---|---|
| *B. subtilis* (S-III)in compost at spawning 17.83 ± 0.32 12.91 1004 12.86 | |
| *B. subtilis* (S-IV) in compost at spawning 18.25 ± 0.30 13.24 1063 12.45 | |
| *A. faecalis* in FYM + Spent compost casing 18.25 ± 0.33 17.07 1299 13.14 FYM + Spent compost based casing 17.66 ± 0.26 15.34 1166 13.16 | |
| *A. faecalis* in Spent compost based casing 19.17 ± 0.37 12.16 896 13.57 Spent compost based casing 20.00 ± 0.58 9.62 744 12.93 | |
| *A. faecalis* in FYM + Coir pith based casing 19.75 ± 0.28 15.49 1193 12.98 FYM + Coir pith based casing 19.00 ± 0.28 16.12 1183 13.63 | |
| *A. faecalis* in Coir pith based casing 21.17 ± 0.27 17.12 1244 13.76 Coir pith based casing 20.92 ± 0.42 17.14 1291 13.27 | |
| *B. subtilis* (S-III) in casing at casing 19.75 ± 0.25 13.75 1030 13.35 | |
| *B. subtilis* (S-IV) in casing at casing 18.92 ± 0.34 16.18 (+5.48 %) 1273 12.70 | |

was at par in bacterial broth mixed and their control treatments. The mean wt. of fruit bodies exhibited no specific trend in different treatments.

A relationship between fruit body yield and the bacterial/fungal population in different treatments was drawn in which the bacteria inoculated treatment was found to harbor higher population of bacteria and fungi, and these treatments were also recorded to gave higher mushroom yield than bacteria un-inoculated treatments.

### iii) Effect of different watering regimes on mushroom beds after casing on yield of *Agaricus bisporus*

The trial was performed by using four different watering schedules. The regime of light water spray for first four days followed by regular spray yielded mushrooms in the shortest possible time (18.17 days), followed by regime of routine spray of water. Highest time was taken in coir pith + Burnt Rice Husk (BRH) based casing supported by volume raising to five times. All watering regimes including heavy spray of water on 0, 4 and $7_{th}$ day after casing, light spray for first four days, followed by regular spray and through wetting of coir pith + BRH based casing before casing gave higher mushroom yield than control (Table 2.14). Mean wt. of fruit bodies was highest in heavy water spray treatment on 0, 4 and 7 days after casing.

The subsequent trial was conducted to evaluate the role of liquid content in casing material at the time of casing or the bacterial inoculum inoculated along with nutrient broth in yield enhancement of button mushroom. Five different treatments were evaluated including mixing of plain water in casing at the time of casing, mixing of nutrient broth and mixing of broth cultures of *A. faecalis* and *B. subtilis* separately along with control treatment. Lowest time for first harvest (17.75 days) was in plain water mixed casing soil treatment, while highest (19.83 days) in nutrient broth mixed casing soil treatment (Table 2.15). Mushroom yield was higher in all treatments than control, while it was highest in *A. faecalis* mixed treatment, followed by nutrient broth and water mixed treatments (Fig. 3). Mean wt. of fruit bodies was lowest in control treatment (11.64 g), while it was higher in rest all treatments.

**Table 2.14. Effect of watering regimes on yield parameters of *A. bisporus***

| Treatment Yield parameters of *A. bisporus* | First harvest Mushroom yield No. fruitbodies/ Av fruit body (days post-casing) (kg/q compost) q compost wt. (g) |
|---|---|
| Coir pith + BRH based casing with through 22.92 ± 1.06 14.36 1083 13.26 wetting before casing (+9.04 %) | |
| FYM + SC based casing, heavy spray at 0, 19.33 ± 1.05 14.22 1044 13.62 4 & 7 day,[th]followed by normal spray (+7.97 %) FYM + SC based casing, light spray for first 18.17 ± 0.34 14.76 1169 12.62 | |
| 4 days, followed by routine spray (+12.07 %) FYM + SC based casing, regular routine spray 18.42 ± 0.42 13.17 994 13.25 | |
| (±0.0 %) | |

**Table 2.15.** Effect of watering regimes and other additives on yield parameters of *A. bisporus*

| Treatment Yield parameters of *A. bisporus* | First harvest Mushroom yield No. fruitbodies/ Av fruit body (days post-casing) (kg/q compost) q compost wt. (g) |
|---|---|
| FYM + SC based casing + water @ 80 ml/bag 17.75 ± 0.33 15.21 (+11.76 %) 1208 12.59 FYM + SC based casing + nutrient broth @ 19.83 ± 0.49 15.31 (+ 12.49 %) 1206 12.70 | |
| 80 ml/bag FYM + SC based casing + bacterial broth @ 18.67 ± 0.28 15.67 (+15.14 %) 1196 13.10 | |
| 80 ml/bag (*A. faecalis*) FYM + SC based casing + bacterial broth @ 18.33 ± 0.28 14.02 (+3.01 %) 1050 13.35 | |
| 80 ml/bag (*B. subtilis*) Control (FYM + SC based casing + routine 18.42 ± 0.53 13.61 (±0.0 %) 1169 11.64 | |
| water spray) | |

### iv) Effect of different cultural practices on yield of *Agaricus bisporus*

The trial was laid out by involving eleven different treatments. Lowest time taken for first harvest (16.19 days) was in Phosphotika biofertilizer mixed treatment, while highest in Veradix-2 spray treatment (17.19 days). Compared to control almost all treatments gave higher mushroom yield, however, highest enhancement (23.46 %) in mushroom yield was recorded in *A. faecalis* inoculated treatment, and its combination with Phosphotika mixing (23.57 %). Amongst physical practices, perforation in compost filled poly bags and improved watering regime gave the highest enhancement in mushroom yield. However, only the improved watering regime did not show any improvement in mushroom yield (Table 2.16). Heaviest wt fruit bodies were harvested from Phosphotika biofertilizer mixed treatment, followed by using perforated poly bags and improved watering schedule. Combining phosphotika biofertilizer mixing with spray of Veradix-2 led to lightest wt. fruit bodies. The study is not conclusive as mushroom yield data of very limited period could be recorded due heavy infection of wet bubble disease.

### v) Evaluation of decomposed SMS as a source of N for button mushroom compost production

Compost for button mushroom was prepared by utilizing different doses of spent mushroom substrate obtained from button compost. The treatment composed of 0, 50, 75 and 100% substitution of chicken manure in the compost formulation prescribed by DMR. The short method of composting was adopted for composting process. Strain U-3 was utilized for mushroom crop production. The results confirmed that

**Table 2.16. Effect of different cultural practices on yield of button mushroom (*A. bisporus*)**

| Treatment | Yield parameters of *A. bisporus* | | | | | |
|---|---|---|---|---|---|---|
| | First harvest (days post-casing) | Mushroom yield (kg/q compost) | No. of fruit bodies/ q compost | Av fruit body wt. (g) | Wet mushroom (kg/q compost) | Bubble infected (kg/q compost) |
| Treat 1* | 16.19 ± 0.10 | 11.10 (+15.75 %) | 755 | 14.71 | 1.70 | |
| Treat 2** | 16.69 ± 0.19 | 11.84 (+23.46%) | 849 | 13.96 | 1.70 | |
| Treat 3*** | 17.19 ± 0.19 | 10.84 (+13.03 %) | 809 | 13.40 | 1.79 | |
| Treat 1 + Treat 2 | 16.56 ± 0.16 | 11.85 (+23.57 %) | 862 | 13.76 | 1.56 | |
| Treat 1 + Treat 3 | 17.12 ± 0.12 | 10.19 (+6.26 %) | 788 | 12.93 | 1.91 | |
| Treat 2 + Treat 3 | 17.00 ± 0.18 | 11.15 (+16.27 %) | 817 | 13.65 | 1.72 | |
| Treat 1 + Treat 2 + Treat 3 | 16.75 ± 0.14 | 11.28 (+17.62 %) | 838 | 13.47 | 1.73 | |
| Control – 1 (no specific treat) | 17.37 ± 0.12 | 9.59 (±0.0 %) | 713 | 13.45 | 1.64 | |
| Control – 2 (perforated bags) | 16.94 ± 0.17 | 11.88 (+23.88 %) | 864 | 13.74 | 2.01 | |
| Control – 3 (best watering regime) | 16.81 ± 0.24 | 9.64 (+0.005 %) | 721 | 13.36 | 1.56 | |
| Control – 4 (perforation + best watering regime) | 16.62 ± 0.12 | 12.00 (+25.13 %) | 825 | 14.56 | 1.54 | |

*Treat 1: PSB mixing in compost @ 0.75%, w/w at spawning; **Treat 2: *A. faecalis* inoculation in casing at casing;
***Treat 3: Veradix-2 spray (0.1%) on pin head initiation

compost formulation receiving chicken manure and spent mushroom substrate in equal proportion i.e., treatment 2 resulted in higher mushroom yield of 14.43 kg per 100 kg of wet compost. Control treatment yielded 13.49 kg/100 kg of compost whereas 100 % substitution of SMS resulted in low yield (11.23kg/ 100 kg of compost) (table 2.17).

**Table 2.17. Effect substitution of SMS on yield of button mushroom**

| Treatment | Yield (kg/100 kg) |
|---|---|
| $T_1$ (WS-500, WB, 25 Gypsum -25, 13.49 Urea-7.5, CM-250 and SMS-0) | |
| $T_2$ (WS-500, WB-25, Gypsum -25, 14.43 Urea-7.5, CM-125 and SMS-125) | |
| $T_3$ (WS-500, WB-25, Gypsum -25, 11.70 Urea-7.5, CM-62.5 and SMS-187.5) | |
| $T_4$ (WS-500, WB-25, Gypsum -25, 11.23 Urea-7.5, CM-0 and SMS-250) | |
| **Mean** | 12.71 |

WS- wheat straw; WB- wheat bran; CM- chicken manure;
SMS- spent mushroom substrate

## (c) Paddy Straw Mushroom i) Culture viability, commercial scale cultivation and shelf life studies on the silver-silk straw mushroom, *Volvariella bombycina*

*Volvariella bombycina* (Schaeff. : Fr.) Sing., is an edible mushroom belonging to the family Pluteaceae, commonly called as Silky rosegill or Silver-silk straw mushroom. It forms yellow silky fruit bodies, hence known as silver-silk straw mushroom. It has similarity in life cycle, hymenial cell type, cystidia and basidia to that of *V. volvacea*. However, contrary to *V. volvacea*, it requires slightly lower temperature for mycelial growth and fruiting (26 to 30 °C) and its fruit bodies can be stored at 4 °C. *V. bombycina* is appreciated for its bioactive secondary metabolites; ergosta- 4,6,8(14), 22-tetraene-3-one, ergosterol peroxide, indole-3-carboxaldehyde, and indazole in liquid culture, isodeoxyhelicobasidin from culture broth, and for antioxidative, antitumor, hypocholesterolemic and antibacterial properties. The three distinguishing features of *V. bombycina* compared to that of *V. volvacea*

*viz*., growth and fruiting at lower temperature, good shelf life of fruit bodies on storage at refrigerated conditions and slow opening of the mature fruit bodies can make *V. bombycina* a better choice at least during three months (December to February) in the straw mushroom growing areas.

### ii) Viability study of mycelial cultures stored under refrigerated conditions

In this study, three strains of *V. volvacea* (DMRO-185, Accession No. JN086670; DMRO-247, Accession No. JN086663 and DMRO-463, Accession No. JN086677), two of *Volvopluteus earlei* (DMRO-482, Accession No. JN086659 and DMRO-483, Accession No. JN086658] and one identified as *V. bombycina* (Accession No. KC142120) were used. The three strains of *V. volvacea* used for the study were high yielding strains. All these strains were studied for viability of their mycelial cultures on storage under refrigerated conditions (4±2°C). The cultures of these strains were first grown on MEA Petridishes in triplicate and after attaining full growth of mycelial cultures on Petridishes, the Petridishes were shifted to refrigerator maintained at 4±2°C. One culture bit (6 mm dia.) from each strain was taken every day and put in the centre of freshly prepared MEA Petridish, followed by incubation at 34 ± 2°C for 7 days. The culture of the strain showing mycelial growth after seven days of incubation was considered as viable, while one not showing any mycelial growth was taken as inactive/dead.

Out of the tested strains, the cultures of strain DMRO-481 (Vb) of *V. bombycina* were viable up to 76 days of storage, the last day of testing at 4±2°C in refrigerator. The next best surviving strain was DMRO-483 (Wv-3) of *Volvopluteus earlei*, where in the cultures were viable up to 50 days of storage. The cultures of three strains (DMRO- 463, DMRO-247 and DMRO-185) of *V. volvacea* were viable up to 9, 5 and 5 days of storage, respectively. The lowest viability was of the cultures of strain DMRO-462 (WV-2) of *Volvopluteus earlei* (Fig. 2.36).

**Fig. 2.36. Viability of mycelial cultures of different strains on storage under refrigerated conditions**

### iii) Enzyme assay of mycelial cultures

As the fungal cell wall is comprised of chitin, mannoproteins and ß-glucans, the three mycolytic enzymes *viz*., chitinase, protease and N-acetyl-ß-glucosaminidase mainly responsible for chitin and protein degradation were considered for the present study. Mycelial cultures of all six strains were grown separately in 50 ml malt extract broth in 100 ml Erlenmeyer flasks in triplicate and the mycelial extract such obtained was used for further studies.

The activity of three mycolytic enzymes namely, chitinase (EC 3.2.1.14), N-acetyl-ß-glucosaminidase (EC 3.2.1.30) and protease (EC 3.4.22.1), was assayed in the enzyme extract by incubating the reaction mixtures at 4 °C for one hour. Activity of chitinase was determined by incubating the reaction mixtures for 60 min at 4 °C. Activity of N-acetyl-ß-glucosaminidase was determined by using p-nitrophenyl-ß-N-acetyl glucosaminide (*p*-NPGlcNAc) as enzyme substrate and by following the method as for the chitinase. The protease activity was measured, with similar reaction conditions as for the chitinase, but with casein as the substrate.

Protease activity was highest in strain, DMRO-481 of *V. bombycina*, cultures of which were viable for the longest period of 76 days on storage under refrigerated conditions. It was followed by strains DMRO-483 (WV-3) of *Volvopluteus earlei*, and DMRO-463 of *V. volvacea*, cultures of which were viable for the second and third longest period of 50 and 9 days, respectively (Fig. 2.37). In rest of the strains, the activity was negligible. The activity of N-Acetyl-ß- glucosaminidase was highest in strain DMRO-

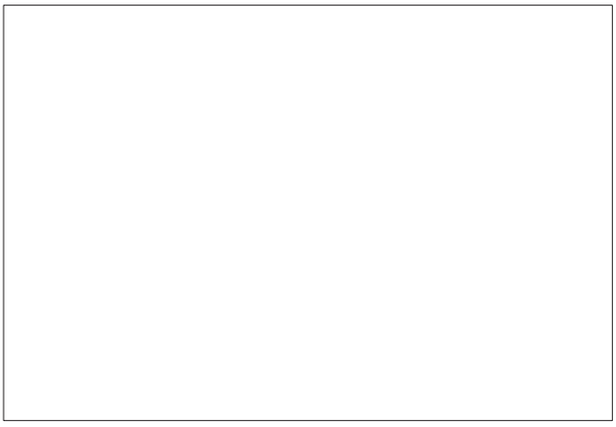


**Fig. 2.37. Chitinase activity in different strains of straw mushroom**

482 of *Volvopluteus earlei*, cultures of which were viable for the shortest period of 2 days. Rest of the strains exhibited almost similar level of activity (Fig. 2.38). The activity of chitinase was highest

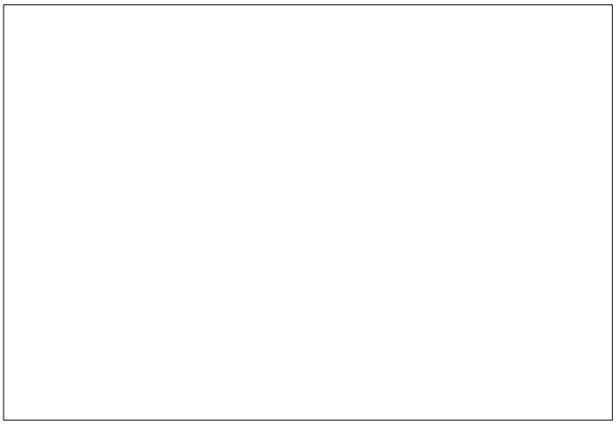


**Fig. 2.38. N-Acetyl-ß-glucosaminidase activity in different strains of straw mushroom**

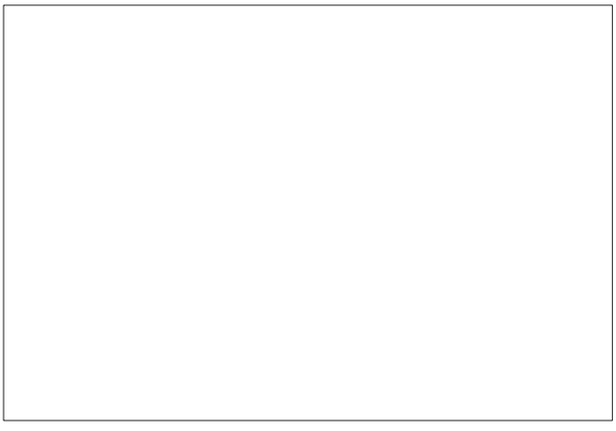


**Fig. 2.39. Protease activity in different strains of straw mushroom**

in strain DMRO-483 (WV-3) of *Volvopluteus earlei*, cultures of which exhibited viability for the second longest period of 50 days after strain DMRO-481 of *V. bombycina*. Second highest activity of chitinase was in strain DMRO-185 of *V. volvacea*, cultures of which exhibited viability up to 2 days only on storage at refrigerated conditions (Fig. 2.39).

### iv) Cultivation trial

The trial was conducted during March-April, 2013 by using only one strain (DMRO-481) of *V. bombycina*. The substrates prepared with paddy straw (PS), cotton ginning mill waste (CGMW) and 1:1, w/w combination of PS + CGMW were used for this trial. Beds involving three different quantity of substrate/bed (12, 15 and 18 kg) were prepared from all three types of substrates. Five replications each with two beds were kept for all nine treatments (beds with three different quantity of substrate/bed for all three types of substrates) in RBD. The temperature during mycelial colonization of substrate and fruiting was 26 ± 2 °C and 23 ± 2 °C, respectively. Except, bed temperature during spawn run and cropping, rest all conditions and protocols were similar to that for popular paddy straw mushroom, *V. volvacea*. Data for time taken for first harvest (days post-spawning), mushroom (sporocarp) yield (kg/q dry substrate), numbers of fruit bodies/q dry substrate and mean wt. of fruit bodies (g) were recorded for 20 days of cropping. The data was subjected to statistical analysis by single factorial ANOVA using AGRes software.

Earliest harvesting of sporocarps (24 and 25 days post-spawning) was from beds of 12 and 15 kg substrate quantity/bed prepared out of the substrate from 1:1, w/w combination of PS + CGMW. Beds prepared from pure PS substrate took longest time for first harvest (29.63 to 32.38 days). Sporocarp (mushroom) yield was significantly higher from beds of 18 kg substrate capacity, prepared out of composted substrate from 1:1, w/w combination of PS + CGMW, followed by beds of 12 kg substrate capacity prepared from same substrate. In substrate prepared from pure CGMW and 1:1, w/w combination of PS + CGMW, lowest sporocarp yield was in beds of 15 kg substrate capacity. In

case of substrate prepared from PS, the sporocarp yield and mean fruit body weight decreased with increase in quantity of substrate/ bed (Table 2.18). However in substrate of PS + CGMW, the mean fruit body wt. increased with increase of substrate quantity/bed.

The requirement of comparatively lower temperature for vegetative growth and fruiting in *V. bombycina* (26 to 30 °C) to that of *V. volvacea* (30 to 35 °C) makes it a better choice for cultivation mainly under subtropical conditions, where temperature remains at moderate level. It also supports for its cultivation as a filler crop during winter season (November to February) in traditionally *V. volvacea* growing regions of South-East Asian countries. The sporocarp yield at par to that of *V. volvacea* by using the composted substrate of cotton ginning mill waste + paddy straw further proves its worth to substitute the traditionally grown straw mushroom, *V. volvacea*. The longer viability of mycelial cultures and superior shelf life of fruit bodies on storage at 4±2 °C further make it a better choice as it saves the labour involved in mycelial culture maintenance and enhances scope of long distance marketing.

The good nutritional profile further makes it a good choice for adoption for cultivation.

## Specialty mushrooms (d) Shiitake i)

### Development of compost formulation

Compost was prepared for shiitake cultivation using wheat straw, calcium nitrate and ammonium nitrate. Pasteurization was done at 65°C for 12 h or consecutively at 65°C for 12 h for two days or 75°C for 8 h. Shiitake was successfully grown in compost consecutively pasteurized at 65°C for 12h for two days.

### ii) Development of compost using thermophilic fungi for the cultivation of shiitake

Wheat straw compost was prepared for shiitake cultivation using two thermophilic fungi (*Humicola insolens*, *Scytlidium thermophillum* @0.1% ) and one bacterium, *Bacillus subtilus.* Compost was supplemented with 1 per cent $CaCO_3$. Pasteurization was done at 60°C for 6 h.

**Table 2.18. Yield potential of *V. bombycina* on beds with different quantity of substrate/bed prepared out of different substrates**

| Substrate and Time taken for Sporocarp yield No. of fruit bodies/ Mean fruit body substrate quantity first harvest (days (kg/q dry substrate) q dry substrate wt. (g) (kg/bed) post-spawning) |
|---|
| CW – 12 25.13 ± 0.44 14.69 223 69.98 CW – 15 25.50 ± 0.63 10.37 184 56.41 CW – 18 24.63 ± 0.42 14.47 235 61.67 CW + PS – 12 24.00 ± 0.38 16.54 323 51.26 CW + PS – 15 25.00 ± 0.98 13.35 228 58.48 CW + PS – 18 26.13 ± 1.82 18.66 276 67.54 PS – 12 32.38 ± 1.32 14.50 284 51.00 PS – 15 29.63 ± 1.63 7.88 183 43.04 PS – 18 32.38 ± 1.95 11.82 287 41.13 DMRO-463 22.00 ± 0.12 9.98 283 35.31 DMRO-282 No pinning — — — DMRO-283 No pinning — — — CD $_{0.05}$ 2.63 36.84 5.02 CW – cotton ginning mill waste, PS – paddy straw, — (no data), 12, 15, 18 – quantity of composted substrate in kg |

Compost became ready in 5 -6 days. None of the compost was successful for shiitake cultivation. Initially spawn started colonizing the substrate but after few days it gets restricted only in that patch. Later on bacterial contamination was there.

### (e) Milky mushroom i) Evaluation of milky mushroom strains

Six strains (CI-13-1, CI-13-2, CI-13-3, CI-13- 4, CI-13-4 and CI-13-6) of *Calocybe indica* evaluated on wheat straw. CI-13-6 gave the highest yield followed by CI-13-1 and CI-13-2 (Fig 2.40). Rest of the three strains did not produce any fruit body. Strain CI-13-06 gave 937g yield per bag.

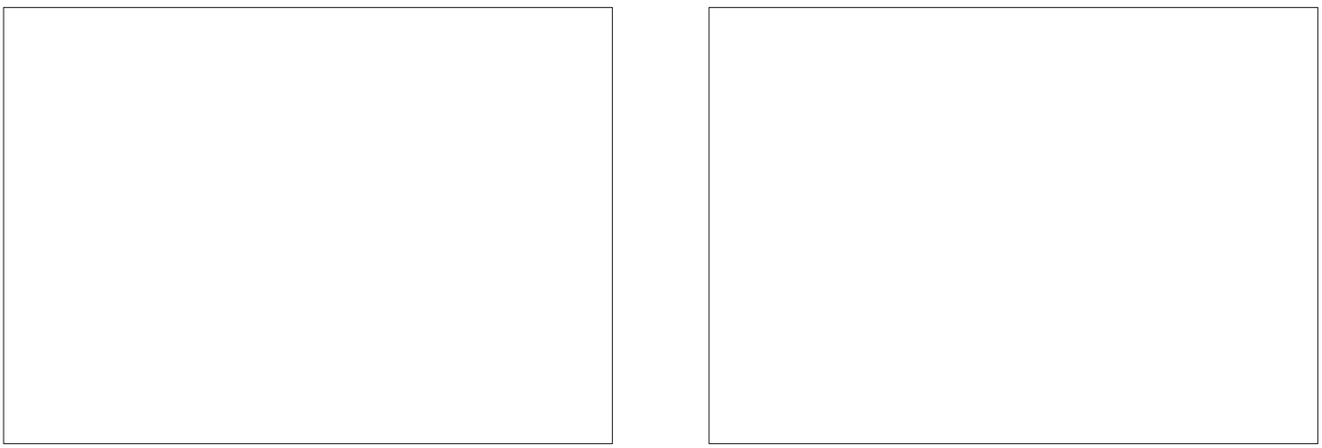


**Fig. 2.40. Evaluation of different strains of Milky mushroom**

**Fig. 2.41. Spawn run on ZEPT Trial**

### ii) Evaluation of zero energy tunnel method for substrate production of *Calocybe indica*

Zero energy poly tunnel was evaluated for the substrate preparation of milky and oyster mushroom. The compost/substrate became ready in five days. Spawn run was little slow in milky mushroom but the yield obtained were comparable to CST for both milky and oyster mushroom (Fig. 2.41).

### (f) *Phellorinia* mushroom

Different substrates viz. wheat straw, paddy straw, cotton waste and saw dust were attempted for the cultivation of *Phellorina*. All the substrates were successfully colonized by *Phellorina* but the fastest spawn run was in cotton waste. After the spawn run bump type structure resembling primordia developed in all the substrates after removing the PP bag. But no further differentiation took place in any substrate even after giving other treatments like casing and watering form the bottom or from the top and double jacketed containers.

### (g) *Cordyceps* sp i) Evaluation of different media for fructification

Two strains of *B. subtilis* ( S-3 and S-4) were preincubated in nutrient agar and nutrient broth.

The bacteria in nutrient broth were inoculated in to the medium comprising sucrose, magnesium sulfate, sodium dihydrogen phosphate and disodium phosphate and were incubated at 37 C with agitation speed of 175 rpm for 72 hrs. Culture was centrifuges at 2400Xg. Cell free solution was separated using membrane filter. The levan products were harvested using 75% volume of cold ethanol. To cultivate *Cordyceps* sp 25 g rice powder in 25 ml nutrient solution supplemented with monopotassium phosphate and magnesium sulphate was packed in to 250 ml conical flasks and sealed. The flasks were autoclaved at 121 C for 2 hours. After cooling medium was inoculated with 5 ml od seed culture. The flasks were incubated at 20 C for 7 days in the dark. After colonization of the medium by mycelim, plastic film cover was pricked. When mycelium on the surface turned orange in color, they were placed under incandescent light to induce fruiting (Fig. 2.42).

*(DMR-06-Developing cultivation technologies for Indigenous edible mushroom Lentinula, Calocybe Indica, Cordyceps and Phellorinia mushrooms )*

### (h) Winter mushroom i) Evaluation of coir pith based substrate for winter mushroom cultivation

Coir pith, saw dust along with wheat bran was utilized in different proportion for substrate preparation for winter mushroom cultivation. The substrate characteristics such as pH, EC and nitrogen content were assessed both initially as well as after completion of cropping. One kg substrate was filled in bags and sterilized in

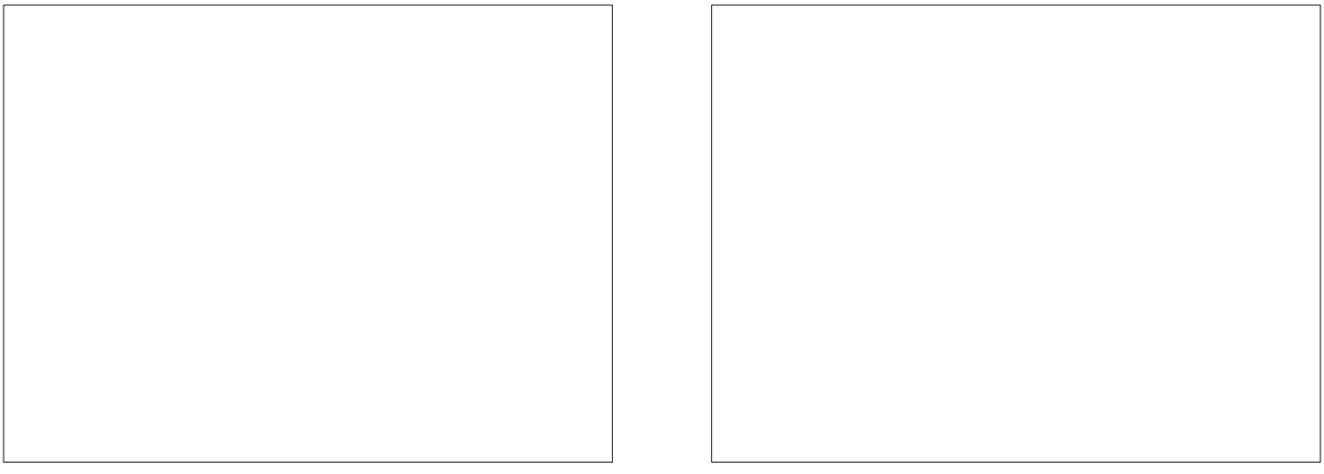


**Fig. 2.42. Mycelial growth of *Cordyceps* sp. in growth medium**

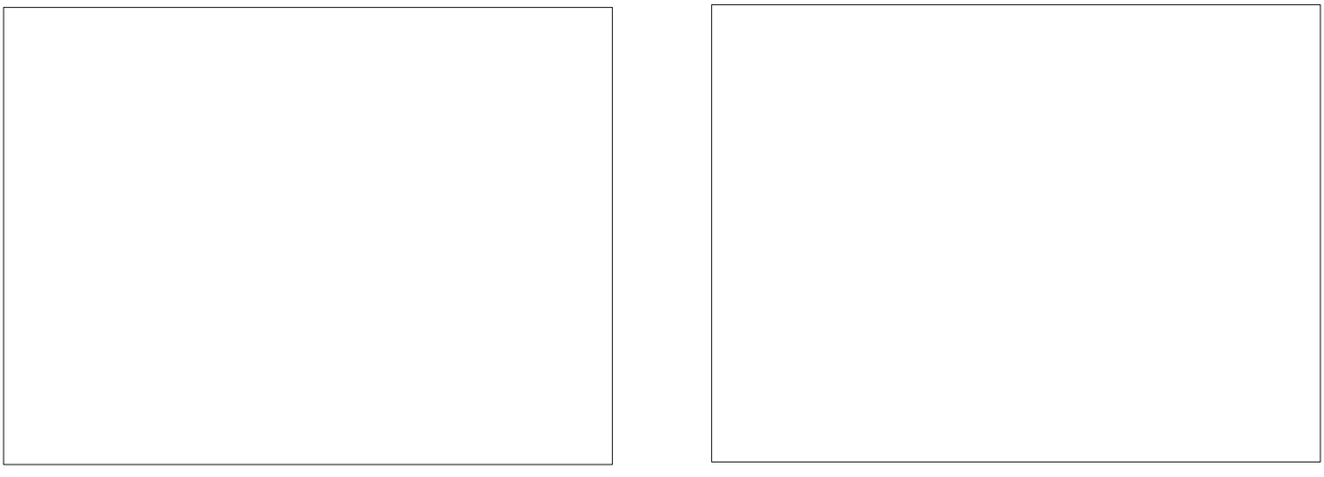


**Fig. 2.43. Growth of winter mushroom on saw dust and coir pith based formulation**

autoclave at 22 lbs for half an hour. The sterilized bags were cooled and spawned at the rate of 3% on wet weight basis. Spawned bags were kept in cropping room at 25 ± 2 °C. Upon spawn run completion, polybags were removed and bags were exposed to 16 ± 2 °C. Yield from individual bags was recorded regularly Fig. 2.43). Saw dust based formulation produced the maximum yield of 115.3 g/ kg wet substrate (Table 2.19). The increased proportion of coir pith decreased the winter mushroom yield. The 80 % coirpith based substrate yielded the lowest of 30.6 g/ kg wet substrate. Further, fruit bodies were of dark brown in nature as compared to light yellowish brown colour in control.

**Table 2.19. Yield performance of winter mushroom on different substrates**

| S. | Treatment details | Yield No. (g/bag) |
|---|---|---|
| 1 | Saw dust 80 % + wheat bran 20 % | 115.3 |
| 2 | Saw dust 60 % + Coir pith 20 % + wheat bran 20 % | 92.2 |
| 3 | Saw dust 40 % + Coir pith 40 % + wheat bran 20 % | 70.8 |
| 4 | Saw dust 20 % + Coir pith 60 % + wheat bran 20 % | 61.0 |
| 5 | Coir pith 80 % + wheat bran 20 % | 30.6 |

# C. Crop Protection

## (a) Diseases i) Management of wet bubble through bacterial isolates

Bacterial isolates B-9 (*Bacillus*), B-18 (*Alcaligene*) and B20 (*Pseudomonas*) isolates proved to be promising biocontrol agents for the management of wet bubble disease both under laboratory and mushroom house conditions. When no bacterial isolate was used and button mushroom bags were inoculated with *Mycogone* the yield was 2.08 kg per quintal compost. Addition of bacterial isolates individually or in combination resulted in remarkably higher yields. Highest was with B-18 isolate (Table 2.20).

**Table 2.20. Effect of Bacterial consortia on *Mycogone* inhibition Bacterial isolate Yield ( kg per 100 g compost) Inoculated Uninoculated**

| |
|---|
| 1 (B9 - *Bacillus*) 10.73 9.25 2 (B18 - *Alcaligene*) |
| 10.55 10.37 3 (B20 - *Pseudomonas*) 10.57 8.57 1+2 |
| 10.98 9.07 1+3 9.72 8.44 2+3 9.18 9.28 1+2+3 |
| 10.54 7.53 Control 10.55 2.08 |

## ii) Management of wet bubble through chemicals

Out of five fungicides (Carbendazim, Mancozeb, Formalin, Chlorothalonil, Sporgon) and two other chemicals ($K_2HPO_4$, $CaCl_2$) tried, carbendazim proved most effective in managing wet bubble disease among all the fungicides/ chemical tested at two concentration. Sporgon also proved equally good at all the three concentrations tried. Mancozeb was as effective as the two other chemicals $K_2HPO_4$ and $CaCl_2$. In control the yield was as low as 2.03 kg per quintal of compost. None of the chemicals, however, have label claims for use in mushroom (Table 2.21).

**Table 2.21. Management of wet bubble through chemicals**

| Fungicide | Concentration | Yield (kg/ q compost) (%) inoculated | | uninoculated |
|---|---|---|---|---|
| Carbendazim | 0.10 | 10.87 | 12.35 | 0.15 10.75 11.04 0.20 8.91 10.59 |
| Mancozeb | 0.10 | 8.70 | 7.35 | 0.15 6.33 6.85 0.20 6.52 5.90 |
| Formalin | 0.10 | 7.63 | 10.24 | 0.15 9.70 9.39 0.20 9.39 9.93 |
| Chlorothalonil | 0.10 | 9.82 | 10.77 | 0.15 9.03 9.63 0.20 9.92 11.80 |
| Sporgon | 0.10 | 10.54 | 11.95 | 0.15 10.37 11.36 0.20 10.90 11.89 |
| $K_2HPO_4$ | 0.10 | 8.36 | 12.60 | 0.15 5.37 12.62 0.20 6.39 12.60 |
| $CaCl_2$ | 0.10 | 8.24 | 12.62 | 0.15 7.54 11.84 0.20 7.43 10.11 |
| Control | | 2.03 | 11.66 | |

## iii) Effect of pre spawning of casing soil on the survival of *Mycogone perniciosa*

Pre spawning of casing soil with spawn of button mushroom 5-20 days prior to

**Table 2.22. Yield in *Mycogone* infected bags using casing soil pre spawned with button mushroom spawn**

| Treatment | Yield (kg/100kg compost) in casing soil treated days prior to pasteurization | | | |
|---|---|---|---|---|
| | 5 days | 10 days | 15 days | 20 days |
| Spawned* + Inoculated** | 11.65 | 13.74 | 12.56 | 13.06 |
| Inoculated** Unspawned ]+ Uninoculated | 8.46 | 10.41 | 10.14 | 11.08 |
| | 13.57 | 12.53 | 10.80 | 13.98 |

*Spawned with *Agaricus bisporus* @ 0.5%
**Inoculated with *Mycogone* @0.1%

pasteurization resulted in reduced incidence of wet bubble disease (Table 2.22).

### iv) Effect of casing soil moisture contents and pasteurization temperature on the survival of *M. perniciosa*

Lower moisture contents of casing soil at the time of pasteurization favours the survival of *Mycogone perniciosa. Mycogone* failed to survive in casing soil having moisture contents 60% or above at 60°C or more temperature (Table 2.23).

**Table 2.23. Effect of casing soil moisture and pasteurization temperature on the survival of *M. perniciosa***

| Moisture Pasteurization Yield (kg / q compost) (%) temp. (°C) and duration Uninoculated Inoculated with *M. perniciosa* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 50 | 60-65 /8h | 11.39 | 6.82 | 55 | 12.97 | 7.66 | 60 | 10.52 | 8.41 |
| 65 | 12.81 | 10.17 | 67 | 12.60 | 13.82 | 70 | 13.69 | 13.40 | |
| 50 | 65-67/8h | 11.38 | 6.70 | 55 | 9.10 | 8.45 | 60 | 12.19 | 8.74 |
| 65 | 12.63 | 11.70 | 67 | 12.99 | 12.09 | 70 | 13.10 | 12.80 | |
| 50 | 67-70/6h | 12.55 | 7.42 | 55 | 10.70 | 7.26 | 60 | 12.94 | 9.30 |
| 65 | 11.93 | 10.80 | 67 | 12.60 | 12.20 | 70 | 12.71 | 12.06 | |

*(DMR-08-Integrated Pest and Disease Management in Mushrooms)*

### (b) Pests i) Efficacy of different chemicals against mushroom flies

To test the efficacy of different chemicals (belonging to different groups) five insecticides viz. Imidacloprid, Malathion, Dichlorvos, Cypermethrin and Thiamethaxam at four different concentrations were tested using knock down chamber. Exposure period was kept at 3 seconds and mortality count was done after 10 minutes of exposure. Morbid flies were considered as dead. Maxium mortality was recorded at highest concentration tested ( 0.05%). However, in case of imidacloprid, malathion and dichlorvos conc. of 0.01% resulted in almost similar mortality as observed in case of 0.05% concentration (Table 2.24).

**Table 2.24. Efficacy of different insecticides against mushroom flies in knock down chamber**

| Insecticide | Conc.(%) | Corrected mortality (%) Phorids | | | | Scairids | |
|---|---|---|---|---|---|---|---|
| Imidacloprid | 0.001 | 62.38 | 15.07 | 0.005 | 73.50 | 26.97 | 0.01 |
| 91.44 | 88.88 | 0.05 | 93.15 | 92.85 | | | |
| Malathion | 0.001 | 4.26 | 7.92 | 0.005 | 41.87 | 35.71 | 0.01 |
| 81.92 | 65.86 | 0.05 | 85.46 | 66.66 | | | |
| Dichlorvos | 0.001 | 7.69 | 44.44 | 0.005 | 35.89 | 52.38 | 0.01 |
| 92.30 | 88.09 | 0.05 | 97.43 | 89.67 | | | |
| Cypermethrin | 0.001 | 19.65 | 22.21 | 0.005 | 45.29 | 40.47 | 0.01 |
| 58.97 | 58.72 | 0.05 | 92.30 | 65.07 | | | |
| Thiamethaxam | 0.001 | 8.53 | 11.10 | 0.005 | 14.52 | 26.97 | 0.01 |
| 52.12 | 61.10 | 0.05 | 67.51 | 75.39 | | | |

# D. Post Harvest Technology

## (a) Shelf life studies of the fruit bodies of *V. bombycina* stored under refrigerated conditions

The freshly harvested unopened fruit bodies of average wt. (60 g/fruit body) were stored at refrigerated (4 ± 2 °C) and ambient temperature (20 ± 4 °C) conditions. The fruit bodies were kept in transparent plastic trays (5-6 fruit bodies/tray) with two holes of 5 mm dia. each on the top lid. Three replications were kept for each treatment. The changes in fruit body wt. (%), visual quality (colour, texture and odour) and nutritional attributes were recorded for next seven days of storage. The changes in the nutritional attributes *viz*., ash, fat, protein, carbohydrates, crude fibre and vitamin D at 0 day and after 7 days of storage under refrigerated conditions were got analyzed at PBTI, Mohali (Punjab).

The rate of loss in wt. of fruit bodies stored under refrigerated conditions was less than 1.00% per day, while it was 11.23 to 14.43% per day in fruit bodies stored under ambient conditions (Table 2.25). The keeping quality of fruit bodies stored under refrigerated conditions was almost at par with fresh fruit bodies even after their storage for 7 days (Fig. 2.44). The fruit bodies stored under ambient conditions were acceptable only up to one day of storage. There were also changes in nutritional composition (± 4.17 to 6.95 % of the total values in fresh mushrooms) of the fruit bodies on their storage for 7 days under refrigerated conditions (Table 2.26). The significant change was in vitamin D content, which increased by 76.64 % over its value in fresh fruit bodies, after storage for 7 days under refrigerated conditions.

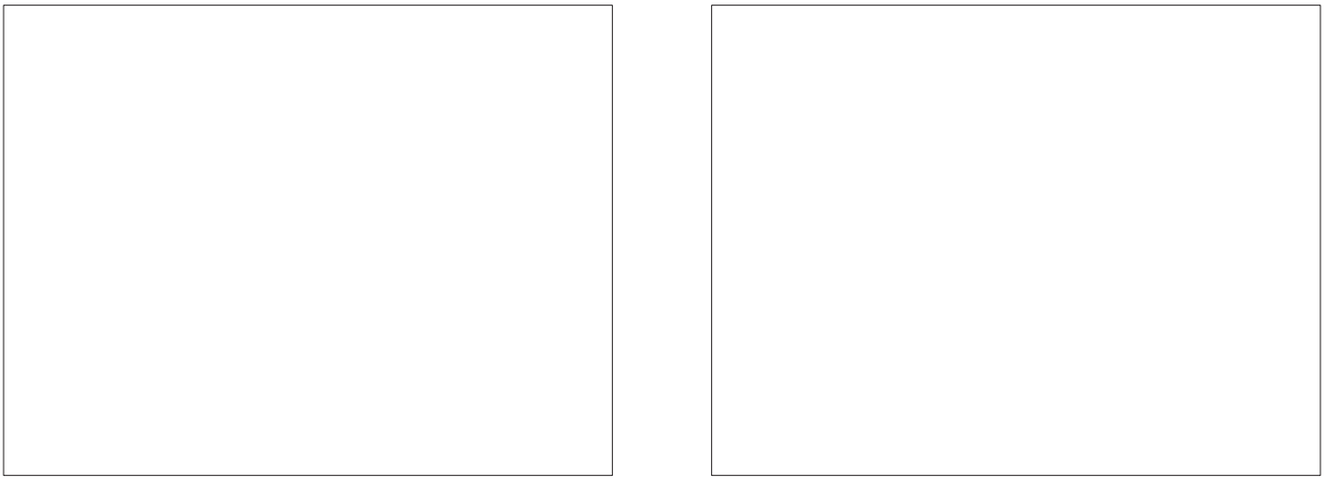
**Table 2.25. Loss in weight and quality of fruit bodies of *V. bombycina* stored under different conditions Storage**

| Period (days) | Changes in quality attributes (weight and visual quality) on storage for different periods | | Weight loss (%) | | Quality loss (visual on a scale of 1 to 5) | |
|---|---|---|---|---|---|---|
| | Refrigerated conditions (4±2°C) | Ambient conditions (20±3 °C) | Refrigerated conditions (4±2°C) | Ambient conditions (20±3 °C) | | |
| 0 (Fresh) | 0.00 (306.08 g) | 0.00 (350.38 g) | 5 | 5 | 1 | 0.749 |
| 14.43 | 5 | 4 | 2 | 1.325 | | |
| 25.66 | 5 | 2 | 3 | 2.29 | | |
| 38.66 | 5 | 1 | 4 | 3.57 | | |
| Not usable | 4.5 | | | | | |
| Not usable | 7 | 5.80 | 4.5 | | | |

Note: Quality in the scale of 5 to 1, where 5 is best and 1 is very poor, data is the mean of three replications, data in parenthesis is of actual wt of fresh fruit bodies

**Table 2.26. Changes in nutritional composition of *V. bombycina* stored under refrigerated conditions Nutritional attributes on dry wt. basis**

| Fresh fruit bodies | Fruit bodies stored for 7 days (4±2 °C) | Changes (± %) |
|---|---|---|
| Ash (%) | 9.37 | 9.95 + 6.19 |
| Fat (%) | 2.05 | 1.93 - 5.85 |
| Protein (%) | 34.38 | 31.99 - 6.95 |
| Carbohydrates (%) | 46.07 | 47.99 + 4.17 |
| Crude fibres (%) | 13.51 | 14.09 + 4.29 |
| Vitamin-D (IU/g) | 109.995 | 194.3 + 76.64 |



Fresh fruit bodies Fruit bodies after storage for 7 days

**Fig 2.44. Quality of fresh and seven days old stored fruit bodies of *V. bombycina* at refrigerated temperature**

### (b) Comparative nutritional composition of the mushroom fruit bodies of *V. volvacea* and *V. bombycina*

The homogenously drawn fifteen to twenty fruit bodies from two representative strains, one each of *V. volvacea* and *V. bombycina* were got analyzed for fifteen different parameters *viz*., dry matter, ash, crude fibre, carbohydrates, protein, fat, vitamin-D and 7 different minerals (calcium, sodium, potassium, iron, zinc, copper, magnesium and selenium) from Punjab Biotechnology Incubator, Mohali, India (a NABL accredited Agriculture and Food Testing Laboratory, Govt. of Punjab, India). Standard procedures of AOAC were used for the determination of different nutritional parameters.

Dry matter was 24.23 % higher in fruit bodies of *V. volvacea* compared to *V. bombycina*. Ash, fat and carbohydrates contents were higher in *V. bombycina* fruit bodies to the extent of 3.99, 111.34 and 8.91 %, respectively than of *V. volvacea*. The contents of other important constituents like protein, crude fibre, vitamin D and calcium were higher @ 18.58, 228.35, 331.83 and 55.17 % in *V. volvacea* compared to *V. bombycina* fruit bodies. The contents of iron and potassium were at par in fruit bodies of two mushrooms, while *V. bombycina* fruit bodies were richer in copper, zinc and magnesium compared to *V. volvacea* fruit bodies. Selenium was negligible in fruit bodies of the two *Volvariella* species (Table 2.27).

**Table 2.27. Comparative nutritional composition of the fruit bodies of *V. volvacea* and *V. bombycina***

| Parameter Fruit bodies (dry wt. basis) *V. volvacea* | Difference with respect to *V. bombycina* (± %) *V. bombycina* (brown strain) |
|---|---|
| Dry matter (%) 8.13 10.10 -24.23 Ash (%) 9.37 9.01 +3.99 Fat (%) 2.05 0.97 +111.34 Carbohydrate (%) 46.07 42.30 +8.91 Protein (F=6.25) (%) 34.38 38.10 -10.82 Crude Fibre (%) 13.51 4.40 +207.04 Vitamin D (IU/g) 106.995 462.04 -331.83 Calcium (mg/100 g) 25.61 39.74 -55.17 Potassium (%) 4.12 4.16 -0.97 Sodium (mg/kg) — 345.34 — Iron (mg/kg) 72.5 72.51 0.00 Copper (mg/kg) 50.2 42.55 +17.98 Zinc (mg/kg) 119.95 94.28 +27.28 Magnesium (%) 0.12 0.11 +9.09 Selenium (mg/kg) —*ND (MDL 1.0 mg/kg) — * ND-not detected, MDL-method detection limit, — Not | |

done

# E. Spent Mushroom Substrate

## (a) Characterization of SMS runoff water

Two polythene-lined pits of one cubic feet size were made to collect runoff water from SMS site. One pit is made on the non-dumped SMS site to collect the normal runoff from rainfall which serves as a control for comparison. Runoff samples were collected regularly during last year and characterized for its organic matter, salt and nutrient contents (Fig 2.45). This characterization

**Fig. 2.45. Runoff water collected from SMS site**

will leads to the assessment of impact of SMS runoff on surrounding land and soil. The results showed that pH of the water was slightly lesser in the SMS dumped site compared to non-dumped sites (Table 2.28). The electrical conductivity was higher in fresh SMS dumped site followed by well decomposed SMS site and lesser in non-dumped site. In the same fashion, dissolved organic matter content is also higher in fresh SMS site.

**Table 2.28. Run off water characteristics of SMS composting site**

| Parameter | Fresh SMS dumped Site | Decomposed SMS-Non Site | SMS site |
|---|---|---|---|
| OC % | 0.040 | 0.004 | 0.001 |
| pH | 6.90 | 7.07 | 7.39 |
| EC (dS m -1 ) | 0.57 | 0.19 | 0.10 |
| N (ppm) | 197.57 | 95.63 | 111.67 |
| $HCO_3^-$ (meq $L^{-1}$) | 345.3 | 398.0 | 538.6 |
| $CO_3^{3-}$ (meq $L^{-1}$) | - | - | - |

## (b) Evaluation of SMS based growing medium for rooftop cultivation of Pea

This SMS based rooftop cultivation trial was carried out using pea as a test crop. Spent mushroom substrate both of fresh as well as well decomposed was used in the preparation of soilless growing medium preparation. Fresh SMS, well-decomposed SMS, coir pith, loam soil, farm yard manure were utilized for preparation of growing medium in different proportion in combination with NPK fertilizers (Fig 2.46a & b). Growing medium properties were recorded both initial as well as end of the cropping. Growth parameters as well as yield were recorded at regular interval. It was found that well decomposed SMS in combination with reccommended NPK gave highest plant yield of 541.3 g whereas control yielded low (398.0 g) (Table 2.29).

**Fig. 2.46a. SMS based rooftop growing medium Fig. 2.46b. Pea crop at flowering stage**

**Table 2.29. Evaluation of SMS based growing medium for rooftop cultivation of Pea**

| S. No Treatment details Plant height Number of pods (No./m $^2$) 100 grain weight Yield (kg/m $^2$) |
|---|
| 1 Soil + FYM - 2:1 42.0 316 50.23 2360 2 Soil + FYM + SMS : 1:1:1 62.0 556 50.92 3018 3 Soil + CP + SMS : 1:1:1 58.0 592 49.38 3075 4 CP + SMS : 75:25 56.0 511 48.21 2498 5 CP + SMS : 50:50 60.5 545 48.60 3200 6 CP + SMS : 25:75 56.0 465 48.01 2500 7 Soil : SMS: 75:25 60.0 546 51.11 2427 8 Soil : SMS : 50:50 55.0 597 48.65 1590 9 Soil : SMS : 25:75 60.0 445 49.98 1650 10 SMS : 100 % 56.0 478 50.50 1470 |

## (c) SMS based medium for horticultural plants

Ten nursery growing med a were formulated from sand, soil, FYM, Fresh SMS, decomposed SMS and coir pith. *Primula melacoides*, a winter annual flowering plant was used as a test crop. All the treatments were replicated thrice under randomized block design. Each replication consist of five potted plants. The physical and chemical properties of the growing medium were assessed before and after the cropping. The plant growth parameters such as plant height, diameter and number of flower stalks were recorded at monthly interval. The highest plant height of 32.83 cm was recorded in the control treatment which received soil, sand and FYM in equal proportion. The next best height growth (29.30 cm) was observed in the treatment receiving soil, well decomposed SMS and FYM in equal proportion. The number of flower stalk was more in the treatment receiving fresh SMS, soil and FYM in equal proportion (24.00) whereas the lowest (12.33) was obtained in the growing medium composed of coir pith, soil and FYM in equal proportion (Table 2.30). The more number of flower stalks in fresh SMS based medium might be due to the stress associated with that medium.

**Table 2.30. Influence of different growing medium on the growth of *Primula melacoides***

| S. No Treatment details Plant height (cm) Average number of flower stalks per plant |
|---|
| 1 Soil + Sand + FYM 32.83 17.67 2 Coco pith + Soil + FYM 22.43 12.33 3 Fresh SMS + Soil + FYM 25.50 24.00 4 Fresh SMS + Sand + FYM 25.07 14.00 5 Fresh SMS + Sand + FYM 23.90 20.33 6 SMS + Soil + FYM 29.30 23.67 7 SMS + Sand + FYM 26.37 22.00 8 SMS + Sand + FYM 28.93 22.67 9 SMS 25.67 18.00 10 SMS + Fresh SMS 25.00 13.00 |

# 3. TRANSFER OF TECHNOLOGY

Technology was transferred to the farmers through regular trainings (detail in the next chapter), interaction during the visit to DMR and Mushroom Mela in addition to various invited talks by resource persons.

## 1. Mushroom Mela-2013

One day National Mushroom Mela was organized on 13th September, 2013 at the Directorate as a regular activity of the Directorate. It was inaugurated by Dr. Vijay Singh Thakur, Hon'ble Vice Chancellor, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan. Sh. J.S. Bhatia, Executive Director, Centre for Development of Advanced Computing, Mohali was the guest of Honour during this occasion. It was attended by more than 700 farmers, farmwomen, mushroom growers, researchers, extension workers and businessmen from various states *viz*, Himachal Pradesh, Haryana, Punjab, Odisha, Maharashtra, Rajasthan, Andhra Pradesh, Delhi, West Bengal, Jharkhand, Bihar, Uttar Pradesh, Uttrakhand, Madhya Pradesh and Tamil Nadu.

An exhibition on improved technologies of mushroom cultivation and other related aspects was also organized on this occasion in which various Govt. Organizations, ICAR Institutes/ Universities, Govt. financial organizations, compost and spawn producers, manufacturers of Air handling system, chilling system, environment controlled cropping rooms, mushroom product, seed and pesticides and chemical producers and NGOs displayed their valuable information/technologies/products and provided their services to the participants of the

**Fig 3.1. Inauguration of Mushroom Mela 2013 Fig. 3.2. Distinguished guest visiting exhibition during mushroom mela 2013**

**Fig. 3.3. Kisan Goshthi during mushroom mela 2013 Fig. 3.4. Farmers on visit of exhibition during mushroom mela 2013**

Mushroom Mela. The Exhibition was inaugurated by the chief guest Dr. Vijay Singh Thakur. During the mela eight new strains, two each of Button, Paddy straw and Shiitake mushrooms, while one each of Milky and *Macrocybe gigantea* were released. Computer based software was also launched for selection of mushroom species for cultivation in any specific region of the country, mushroom germplasm of the country, profit calculation and nitrogen balance in mushroom substrate.

To create awareness on various improved technologies/practices to mushroom cultivation to the participants, visit of the growing units of the Directorate was conducted and demonstrations on improved strains and mushroom cultivation technologies were given to the participants of Mushroom Mela.

A Kisan Goshthi was organized to solve the problems faced by the mushroom growers. The queries raised by mushroom growers and farmers were replied by panel of experts.

During the Mushroom Mela, the Directorate felicitated five progressive/ innovative mushroom growers for adopting innovative practices in mushroom cultivation on a larger scale and mobilizing other farmers to adopt mushroom cultivation as source of income. The farmers mentioned below were selected from across the country (Table 3.1).

## 2. Participation in national/state level exhibitions

To create awareness about mushroom cultivation and its health benefits the Directorate

**Table 3.1. Farmers selected for progressive mushroom growers from all over India Sl. No**

| Name of the farmer Remarks |
|---|
| 1 Sh. Naveen Patwal & Sh. Amit Kumar, i) For adopting and introduction of latest compost making and Vill.- Kotwal Alampur, P.O.- Zhebra Roorkee, mushroom cultivation practices. Haridwar, Uttarakhand ii) Being engineers by profession, they promoted entrepreneurship instead of running after jobs. iii) For promoting mushroom and imparting training to other mushroom growers of the region. |
| 2 Sh. Jitender Malik i) For developing low cost compost turner and improvised hole Village - Seenkh,Panipat - 132104 making machine for thatched hut erection, both required for Button Haryana mushroom cultivation. ii) For promoting and popularizing mushroom among the rural mass of Haryana. |
| 3 Mr. Sandip, S/o Ch. Satbir Singh, i) For adopting short method of composting along with seasonal Village – Siswala, Hisar, Haryana cultivation of button mushroom. ii) For adopting the simplified methods of cooling of cropping rooms and taking off season crop. iii) For adopting environment friendly water harvesting and spent compost reusing techniques. |
| 4 Sh. Sanjit Kumar Mohanty, i) Adopting large scale cultivation of Paddy straw and Oyster Rashmirekha Mushroom Seeds, mushroom in rotation. Gobardhanpur, P.O. – Pipili, Puri – 752104 ii) Establishing processing unit and large scale processing of (Odisha) mushrooms for value added products. iii) For popularizing mushroom among masses and imparting trainings to needy farmers. iv) Adopting the advanced methods of mushroom cultivation. |
| 5 Thiru. A.R. Mohamed Khan i) For promoting and adopting Oyster mushroom cultivation at a Team Agro Foods, 1/91, Viruganoor (Post), large scale. Kallakuruchi - 606 203, dist-Villupuram ii) For production and popularizing of mushroom based value (TamilNadu) added products in the states of Tamil Nadu and Kerala. |

| Date Exhibition/ Fair | Staff attended |
|---|---|
| 30th October, Exhibition organized for the farmers of tribal areas of Himachal Pradesh alongside training programme | Sh. Guler Singh Rana 2013<br>Sh. Tej Ram |
| 9-13 February, Krishi Vasant-2014 from 9-13 February, 2014 at Central Institute of Cotton Research, Nagpur, Maharashtra | Sh. Guler Singh Rana 2014<br>Sh. Jeet Ram |

participated in various state and national level exhibitions and fairs by establishing a stall and by distributing the free literature of the Directorate.

### 3. Advisory service to farmers/ Mushroom growers/ Businessman/ unemployed youths

Advisory services through postal extension letters on various aspects of mushroom cultivation, training and marketing were provided. Queries on mushroom cultivation, training were replied through telephone and e-mails. On an average 6-7 queries per day were received either by phone/ mail/ letters and were replied. A total of 78 groups, comprised of 1679 farmers, 641 students and 111 government officials visiting the institute were briefed regularly about the various facilities and services rendered by DMR, Solan.

### 4. Science Day celebration

Science day was celebrated on 28th Feb 2014 at DMR, Solan. More than 300 students from seven local schools visited DMR and they were exposed to various facets of mushroom cultivation and medicinal and nutritional value of mushroom.

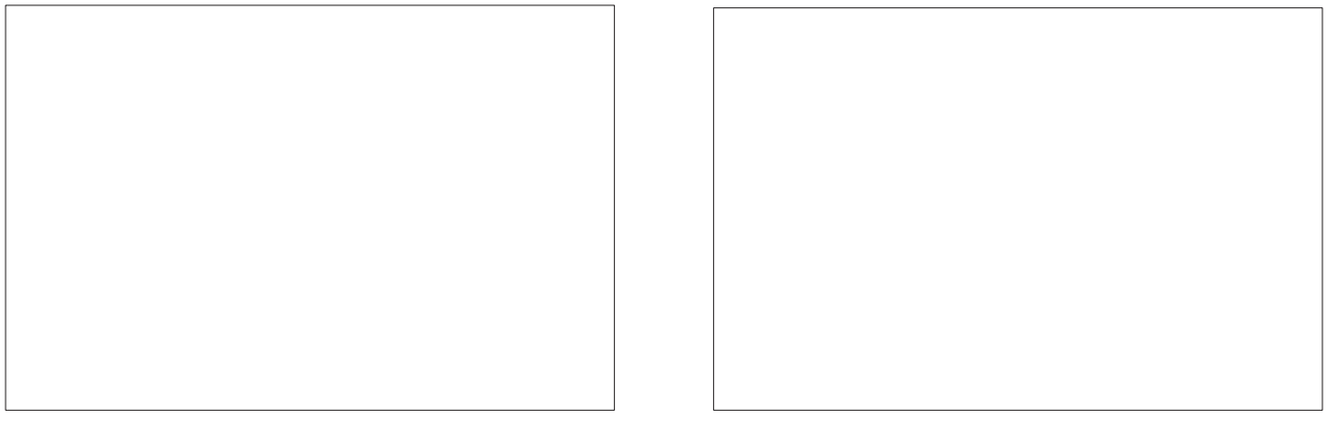


**Fig. 3.5. School children visiting DMR, Solan on the occasion of science day**

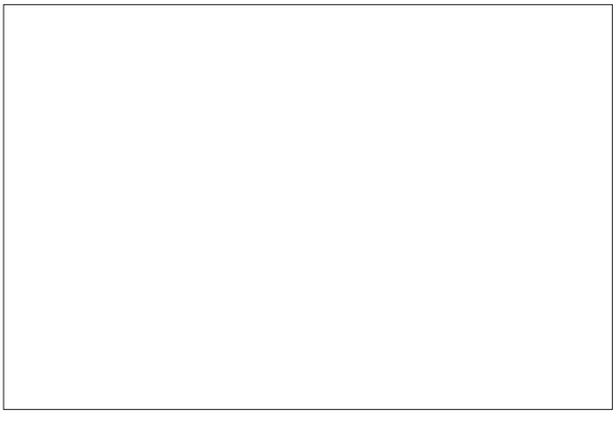
# 4. TRAINING COURSES ORGANIZED

During 2013, the Directorate organized five on campus training programmes for farmers, unemployed youths, entrepreneurs, officers and scientists of KVKs.

Off campus training / Workshop on Mushroom Technology- Present Scenario and Future Prospects in India was jointly organized by IIT, Delhi and DMR, Solan in Delhi during 16-18 Dec 2013. 50 participants from 5 states participated.

Off campus training was organized at RAU, Pusa (Samastipur) Bihar during 20-21 March 2014. The details of on-campus trainings are as below.

| S. No. | Training programme | Date | Sponsoring agency | No. of trainees | Course Director & course coordinator |
|---|---|---|---|---|---|
| 1. | Training programme on mushroom cultivation technology for entrepreneurs. 9 | April - May, 2013 | ICAR | 30 | Dr. O. P. Ahlawat |
| 2. | Training programme on mushroom cultivation technology for farmers and unemployed youths. May, 2013 | 18 th - 24 th | ICAR | 59 | Dr. R.C. Upadhyay Dr. Satish Kumar |
| 3. | Training programme on mushroom cultivation technology for farmers / unemployed youths –II. September, 2013 | 19 th - 25 th | ICAR | 54 | Dr. V.P. Sharma Dr. K. Manikandan |
| 4. | Training programme on mushroom technology for Scientists and Subject Matter Specialists of KVKs and SAUs 5. Training programme on mushroom cultivation | 13 th - 18 th October, 2013 | ICAR | 18 | Dr. O. P. Ahlawat Dr. K. Manikandan |
| | technology for farmers of NEH States | 11 th - 23 rd November, 2013 | ICAR | 18 | Dr. Satish Kumar Dr. K. Manikandan |



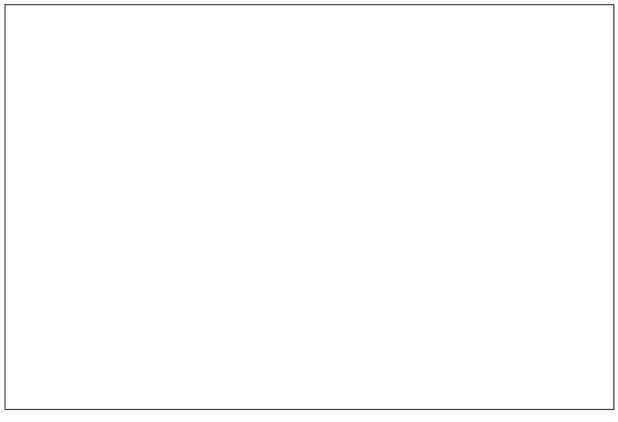


**Fig. 4.1. Trainees doing practical with their own hands**

# 5. AICRP CENTRES

With a view to test and disseminate the technology developed at Directorate of Mushroom Research and its Centres in different agro- climatic regions of the country and popularize mushrooms as secondary agriculture along with the existing farming system, the All India Coordinated Research Project on Mushroom (AICRPM) was launched during VI Five-Year Plan on 01.04.1983 with its Headquarters at Directorate of Mushroom Research, Solan (HP). The Director of DMR, Solan (HP) also functions as the Project Co-ordinator of the project. The mandate of AICRP (Mushroom) is to coordinate and monitor multi- location trials with improved mushroom varieties / hybrids, cultivation practices related to crop production, crop protection measures and post harvest technology, all aimed at increasing production, productivity and utilization of mushroom in the country.

Initially, the All India Coordinated Mushroom Improvement Project started with six Centres. At present, 14 Coordinating and two co-operating Centres are working under AICRPM. These are:

### ICAR Institute based

- ICAR Research Complex for NEH Region, Barapani (Meghalya)
- ICAR Research Complex for Eastern Region Research Centre, Ranchi (Jharkhand)

### State Agricultural Univesrsity based

- Punjab Agricultural University, Ludhiana (Punjab)
- Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu)
- G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand)
- CoA, Mahatma Phule Agricultural University, Pune (Maharashtra)
- N.D.University of Agriculture and Technology, Faizabad (UP)
- Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (Chattisgarh)
- Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan)
- CoA, Kerala Agricultural University, Vellayani (Kerala)
- C.C.S. Haryana Agricultural University, Hisar (Haryana)
- Orissa University of Agricultute and Technology, Bhubaneswar (Orissa)
- Rajendra Agricultural University, Samastipur, Pusa (Bihar)
- Co H&F, Central Agricultural University, Pasighat (Arunchal Pradesh)

### Co-operating Centres

- Dr.Y.S.Parmar University of Horticulture & Forestry, Nauni, Solan (HP).
- Haryana Agro-Industrial Corporation Research and Development Centre, Murthal (Haryana)

# 6. PUBLICATIONS

## Research Papers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Upadhyay, RC. 2013. Mushroom Biodiversity of Himalayas and their conservation. National conference on Biodiversity Conservation: Embracing our future ,preserving our past,27-28 Sept,2013, The IIS University, Jaipur.

Upadhyay, RC, Dohroo Aradhna, Tirmali A, Kamal Shwet and Singh Manjit. 2013. *Isaria sinclarii* – a new entomogenous fungus for India. Abstract for the Indian Mushroom -2013 conference at PAU, Ludhiana ,16-17 April, 2013.

## Book chapter

Kannan, P, Manikandan K and Ponmani S. 2013. Non Edible Oilcake: A Novel Approach For Soil Health Management. In: Role of tree borne oil seeds byproducts for pest, disease and soil management under organic agriculture. Pub: Dry land agriculture research station, TNAU, Coimbatore, Tamil Nadu.

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BC Suman, Kumar Satish and Gupta Dharmesh. 2013. खुम्ब की खेती, Published by Indian Mushroom Growers Association, Chambaghat, Solan (HP). p 72.

# 7. APPROVED ON-GOING RESEARCH PROJECTS

| On-going Research Projects of DMR | Institute Title | Researchers | Period |
|---|---|---|---|
| **Code DMR-2** Genetic Improvement of *button*, *Pleurotus* and *Volvariella* mushrooms | DMR (Pleurotus) | Dr. Manjit Singh Program leader Dr. R.C. Upadhyay PI (Pleurotus) Dr. O.P. Ahlawat PI (Volvariella) Dr. Shwet Kamal PI (button) Dr. K. Manikandan Co-PI | April, 2010 to March, 2015 |
| **DMR-3** Improvement in cultivation technology of white button mushroom & effective utilization of Spent Substrate | DMR | Dr. O.P. Ahlawat PI Dr. K. Manikandan Co-PI | April, 2010 to 31st March, 2015 |
| **DMR-6(a)** Developing cultivation technologies for Indigenous edible mushrooms, *Lentinula*, *Calocybe indica*, *Cordyceps* and *Phellorina*. | DMR | Dr. V.P. Sharma PI Dr. Manjit Singh Co-PI Dr. Satish Kumar Co-PI Dr. Shwet Kamal Co-PI Dr. K. Manikandan Co-PI | April, 2010 to March, 2015 |
| **DMR-6(b)** Basic studies on cultivation technology of morel mushroom | DMR | Dr. Shwet Kamal PI Dr. V.P. Sharma Co-PI Dr. K. Manikandan Co-PI | January, 2012 to November, 2014 |
| **DMR-8** Integrated Pest and Disease Management in Mushrooms | DMR | Dr. Satish Kumar PI Dr. V.P. Sharma Co-PI | April, 2010 to 31st March, 2015 |
| **DMR-9** Development of Web based Mushroom Expert System | DMR | Dr. K. Manikandan PI All Scientists of Co-PI | April, 2011 to 31st March, 2015 |

| Externally Funded Projects | Title of the Project | PI of the Project | Duration | Funding Agency |
|---|---|---|---|---|
| 1. | Agrowaste Management, Bioremediation and Processingi) Refinement in w.e.f. 01.10.2013 indoor compost technology for white button mushroom using thermophilic organisms. (till 30.09.2013) | Dr. O.P. Ahlawat | 01.08.2006 to 31.03.2014 | ICAR (AMAAS) Microbes in Post Harvest Dr. B. Vijay |
| 2. | Microbial diversity and Identification i) Strengthening, authentication and exploitation of mushroom biodiversity at the National Mushroom Repository for human welfare. | Dr. R.C. Upadhyay | 01.08.2006 to 31.03.2014 | ICAR (AMAAS) |
| 3. | Refinement in spawn production technology. | Dr. V.P. Sharma | 16.01.2012 to 15.01.2015 | MM-1 (HP) |
| 4. | Development of spatial decision support system for round the year cultivation and its popularization in India | Dr. K.Manikandan | 01.08.2012 to 31.07.2015 | SERB, DST, New Delhi |
| 5. | DBT's Twinning Programme for the NE titled "Characterization and Utilization of Mushrooms biodiversity of Mizoram" | Dr.R.C.Upadhyay | 21.03.2013 to 20.03.2016 | DBT, New Delhi |
| 6. | Assessment and genetic manipulation of *Volvariella volvacea* (paddy straw mushroom) for shelf life and yield | Dr. O.P. Ahlawat | 01.09.2013 to 31.08.2016 | SERB, DST, New Delhi |

# 8. CONSULTANCY PROVIDED BY DMR

Consultancy was provided to the following Mushroom Units in the form of preparation of Techno-Economic Feasibility Reports **(TEFR)** and advice on mushroom cultivation during the year 2013-2014.

1. Mr. Orlando Rodrigues, Managing Director, Goa State Horticultural Corporation Limited, Kullagor, Tonca Caranzalem-Goa – 403002.

2. Ms. Hiresha Verma, 13, Prakash Lok, Phase-II, Shimla Bye Pass, Dehradun (Uttarakhand) – (Two Nos. project reports).

3. Mr. A.K. Gopinadhan, M/s. Kriskav Agritech, 26, Third A Cross Domlur Second Stage, Bangalore – 560071 (Karnataka).

4. Mr. Naresh Kumar Sharma, Naresh Mushroom Grower, Village Ghatru, PO Chanwag, Tehsil Sunni, Distt. Shimla (HP) – 171103.

5. Mrs. Shanlang W Kharbangar, Smit, Shillong, Meghalaya.

6. Mr. Prem Chand S/o Sh. Sita Ram, Village Katirumajra, PO Bruna, Tehsil Nalagarh, Distt. Solan (HP).

7. Mr. Gagandeep Singh, M/s. Gazal Foods Private Limited, 24D, Sushant Lok 1, Gurgaon, Haryana – 122009.

8. Mr. Naveen Jain, Village Chappar, PO Khanpura, Distt. Karnal (Haryana).

9. Mr. Vipin Prakash S/o Sh. Umed Singh & Mr. Gurjeet Singh S/o Sh. Nirmal Singh, Village Jivanwala, PO Fatehpur Tanda, Tehsil Rishikesh, Distt. Dehradun (UK) – 248140.

10. Mr. Ram Kumar and Mr.Dinesh Kumar, VPO Kharal, Tehsil Narwana, Distt. Jind (Haryana) – 126116.

11. Mr. Jagat Ram, Village Kashipur, PO Nihargarh, Tehsil Poanta Sahib, Distt. Sirmour (HP).

12. Mr. Praveen Chaudhary, Village & PO Mahem, Distt. Rohtak (Haryana).

13. Mr. Narender Sehrawat, Village Bhanguri, PO & Tehsil Hathin, Distt. Patwal (Haryana).

14. Mr. Akhilesh C. Yadav, 94-FF, Arsh Complex, Near Gae No.1, Greater Noida – 201310 Budh Nagar (UP).

15. Mr. Jagat Ram, Village Kashipur, PO Nihargarh, Tehsil Poanta Sahib, Distt. Sirmour (HP).

16. Mr. Ashok Kumar Aneja, 215, IInd Floor, Kailash Hills, New Delhi.

17. Mr. Vedvati Thainvi, Village Kharel, PO Rarughati, Tehsil Rajgarh, Distt. Sirmour (HP) – 173101.

18. Mrs. Sunita D/o Sh. Ramwshwar Dass, VPO Murthal, Tehsil & Distt. Sonipat (Haryana).

19. Mr. Amit Kumar, Old Bus Stand, Bass Mohalla, Mahendergarh (Haryana) – 123029.

20. Mr. Madan Lal Aggarwal & Mr. Neeraj, M/s. A.S. Agro Mushroom Farm, Village Himayupur, Dist. SAS Nagar, Mohali (Pb.).

21. Mr. Digvijay Kumar, Village Horlbigha, PO Ajnoura, Panchayal Ajaypur, PS Noorsrai, Distt. Nalanda, Bihar – 803114.

22. Mr. Ravi Verma S/o Sh. Amarchand Verma, Village Kanswala, PO Darlaghat, Tehsil Arki, Distt. Solan (HP).

23. Mr. Harbhajan Singh S/o Sh. Ram Krishan, Village Sherpur, PO Resham Majri, Distt. Dehradun (UK).

24. Mrs. Hema Bindu Patnaik, W/o Sh. Feroz Patnaik, Aneek Gali, Parlekhmundi, Distt. Gajpati (Odisha) – 761200.

25. Mr. Kartar Singh S/o Sh. Fikra, Village & PO Mandkola, Tehsil Hathin, Distt. Palwal (Haryana) – 121102.

26. Mr. Sammar Pal S/o Sh. Raghuvir Singh, Krishna Colony, Ward No.4, Near Khaunta Mandir, Tehsil & Distt. Palwal (Haryana) – 121102.

27. Sh. B. K. Jhabhar, Chairman, M/s. K.G.V.K. Agro Limited, Rukka Village, Ormanji, Ranchi – 835217 (Jharkhand).

28. Mr. Nandlal Kumar, Shilli, Ranchi, Jharkhand.

29. Mr. Sita Ram S/o Sh. Noranglal, Village Ghandiwadi, Tehsil Bhadra, Distt. Hanumangarh (Rajasthan).

30. M/s. Unitek Agrotek, Village Tigri, PO Kharera, Distt. Yamunanagar (Haryana) – 135001.

31. Mr. Tasing Jamoh, Village & PO Pasighat, Distt. East Siang, Arunachal Pradesh – 791102.

32. Mr. Thaimu Jamoh, Village Mirku, PO Pasighat, Distt. East Siang, Arunachal Pradesh – 791102.

33. Mr. Kulbhushan Sharma, Village Agwahi, PO Shoghi, Tehsil & Distt. Shimla (HP) – 171219.

34. Mr. Sukhsandarshan Singh Thainvi, Village Kharel, PO Rarughat, Tehsil Rajgarh, Distt. Sirmour (HP).

35. Mr. Veer Singh S/o Sh. Shyam Lal & Mr. Dharminder Kumar S/o Sh. Balwant Rai, Village Garihi Kotaha, PO Raipur Rani, Tehsil & Distt. Panchkula (Haryana).

36. Sh. Narender Singh S/o Sh. Geeta Ram, Village Palog, PO Dagsech, Tehsil Sadar, Distt. Bilaspur (HP) – 174032.

37. Mr. Rajvir Gill S/o Sh. Sukhchain Singh & Mr. Sonu Kumar Bansal S/o Sh. Chokha Ram, M/s. R.S. Mushroom Udyog, Sehajpura Road, Samana, Patiala (Punjab) – 147101.

38. M/s. Malik Mushroom Farm, Village Barta, PO Dhanori, Tehsil Narwana, Distt. Jind (Haryana).

39. Mr. Shiv Kumar Upadhyay, Village Gangapur, PO Dighita Police Station, Kochas, Distt. Rohtas (Bihar).

40. Mr. Shambhu Kumar, PO Narwan, P.S. Mamhi, Distt. Saran (Bihar).

41. Mr. Rakesh Kumar Village Nanubhogaria, PO Dimber, Tehsil Rajgarh, Distt. Sirmour (HP) – 173101.

42. Mr.Nityanand, Village Bhagnog, PO Dimber, Tehsil Rajgarh, Distt. Sirmour (HP) – 173101.

43. Mr. Chander Mohan Sharma, Village Naher Bagh, PO Churadhar, Tehsil Rajgarh, Distt. Sirmour (HP) – 173101.

44. Mr. Shiv Kumar Upadhyay, Village Gangapur, PO Dighita, P.S. Kochas, Distt. Rohtas (Bihar).

45. Mr. Janardan Prasad, # 912, Sector-9, Panchkula (Haryana).

46. Mr. Jitender Kumar, M/s. Jai Agri Farm, Village Bislamjra, PO Fatehabad, Tehsil & Distt. Fatehabad (Haryana).

47. M/s. Global Agro Products, Village IIEEA, Post Sanuasar, Tehsil Palampur, Distt. Sriganganagar (Rajasthan).

48. M/s.Surati Chauhan, Village Khajra (Charach), PO Saraku, Tehsil Pachhad, Distt. Sirmour (HP) – 173024.

49. Mr. Surendra Kumar Bajpai, 128/4701, Deviki Nagar, Kanpur – 208011.

50. Mr.Nityanand, Village Bhagnog, PO Dimber, Tehsil Rajgarh, Distt. Sirmour (HP) – 173101.

51. Mr. Narender Singh S/o Sh. Geeta Ram, Village Palog, PO Dagsech, Tehsil Sadar, Distt. Bilaspur (HP) – 174032.

52. Mr. Abhishek Dubey, B-7, Krishna Homes (HS), Sector-29, Prodhikoran, Ronet Pune – 411044 (MS).

53. Mr. Raman Singla, M/s. Shree Agro Foods, Plot No.6, Radhika Farms, Village Sidhuwal Bhadson Road, Patiala (Punjab) – 147001.

# 9. COMMITTEE MEETINGS

**a. Institute Management Committee:** One meeting of IMC was held at DMR, Solan on 23.08.2013

1. Dr. Manjit Singh, Director, DMR, Solan Chairman

2. ADG (Hort.II), ICAR, KAB-II, New Delhi-110012. Member 3. Director of Horticulture, Govt. of Himachal Pradesh, Shimla Member 4. Director of Horticulture, Govt. of Punjab, Chandigarh Member 5. Director of Research, Dr. Y.S. Parmar UH&F, Nauni, Solan Member 6. Dr. R.L.Sharma, Head (Retd.), PP, Deptt. of Mycology & Plant Pathology, Member

Dr. Y.S. Parmar UH & F, Nauni, Solan (H.P.). 7. Dr. V.K. Baranwal, Principal Scientist, Div. of Plant Pathology, IARI, New Delhi Member 8. Dr. Rajesh Rana, (Economics), Central Potato Research Institute, Shimla Member 9. Dr. O.P. Ahlawat, Principal Scientist, DMR, Solan Member 10. Sh. Anil Kumar Agarwal, Finance & Accounts Officer, DWR, Karnal Member 11. Administrative Officer, DMR, Solan Member-

Secretary

**Fig. 9.1. Committee meetings held at DMR, Solan**

**b. Research Advisory Committee (RAC): The members of RAC (w.e.f. 14.01.2013 to 13.01.2016) (Vide ICAR order no.7-1/2013-I.A-V dated 19.01.2013) are:** One meeting of RAC was held on 15-16 June, 2013.

1. Dr. S.S. Chahal, Former, Vice Chancellor, Chairman MPUA & T, Udaipur

2. Dr. S.K. Malhotra, Asstt. Director General (Hort.II) Member 3. Dr. M.P. Thakur, Dean, College of Agriculture Member
(IGKV), Rajnandgaon, Chattisgarh

4. Dr. R.D. Singh, Ex- Prof. & Head Pl. Path., MPUA&T, Udaipur Member 5. Dr. B.M. Sharma,

Former Programme Director, Member
Centre for Mushroom Resarch & Training,
CSK HPKV, Palampur – 176062 (HP)

6. Dr. Manjit Singh, Director, DMR, Member Chambaghat, Solan (HP) – 1732113.

7. Dr. R.C. Uapdhyay, Principal Scientist, DMR, Member Chambaghat, Solan (H.P.) – 173213. Secretary

### c. Institute Research Council (IRC)

Two Meetings of Institute Research Committee (IRC) were held on 9-10th May, 2013 and 30th October, 2013 attended by all the Scientists under the Chairmanship of Dr.Manjit Singh, Director.

### d. Core Committee Meeting

Five meetings of core committee held at DMR, Solan on 20.02.13, 24.05.13, 06.07.13, 25.07.13 and 13.11.13.

1. Dr.Manjit Singh - Chairman 2. Sh.A.N. Vashisth - AO 3. Dr.O.P. Ahlawat - AFACO 4. Sh.R.K.

Bhatnagar - AAO 5. Sh.Rajinder Sharma - Asstt. 6. Sh.Bhim Singh - Asstt. 7. Sh.T.D. Sharma -

Asstt. 8. Sh.Dharam Dass - UDC 9. Sh.Sanjeev Sharma - LDC

**e. Institute Joint Staff Council:** Meetings of IJSC held at DMR, Solan on dated 28-03-2013, 20-09-2013.

#### Office side Members

1. Dr.R.C. Upadhyay, Principal Scientist 2.

Dr.Satish Kumar, Principal Scientist 3. Dr.K.

Manikandan, Scientist 4. Administrative Officer

5. AFACO 6. Sh.R.K. Bhatnagar, AAO

**Staff side member**

1. Sh.N.P. Negi, Assistant (Member CJSC) 2.

Sh.Roshan Lal Negi, LDC 3. Sh.Jia Lal, Technical

Officer 4. Sh.Jeet Ram, T-3 (Secretary IJSC) 5.

Sh.Nika Ram, SSS 6. Sh.Tej Ram, SSS

**f. Grievance Cell:** No grievance was reported and hence no meeting was held

**Elected Members of Grievance Committee** **SN Name & designation Category Capacity**

| |
|---|
| 1 Dr.K. Manikandan, Scientist Scientific Member 2 Sh.Rajinder Sharma, Asstt. Administrative Member 3 Sh.Ram Swaroop, Tech.Asstt. Technical Member 4 Sh.Tej Ram, SSS SSS Member |

**Nominated Office Side Members Of Grievance Committee** **SN Name & designation**

| **Category Capacity** |
|---|
| 1 Dr.O.P. Ahlawat, Pri. Scientist Scientific Chairman 2 Dr.Satish Kumar, Pri.Scientist Scientifoc Member(Office side) 3 Administrative Officer Administrative Member(Office side) 4 Asstt.Finance & A/Cs Officer Audit Member(Office side) |

**g. Consultancy Processing Cell (CPC)**

One meeting of Consultancy Processing Cell (CPC) was held on 20.02.2014.

**h. PME Cell**

Three meetings of PME Cell were held on 01.08.2013, 01.10.2013 and 23.01.2014.

Chairman Dr. VP Sharma Member Dr. OP Ahlawat Member Dr. Satish Kumar

Member secretary Dr. K Manikandan Assistant Sh. Deep

Thakur

### I. Scientists-Technical Personnel Meeting

Nine meetings of Scientists and Technical Personnel were held on 5.4.2013, 17.5.2013, 26.6.2013, 26.7.2013, 30.8.2013, 27.9.2013, 16.11.2013, 21.2.2014 and 28.3.2014.

### J. Friday Meetings of Scientists

Fifteen meetings of Scientists were held on 10.5.2013, 27.5.2013, 7.6.2013, 21.6.2013, 5.7.2013, 12.7.2013, 19.7.2013, 2.8.2013, 16.8.2013, 23.8.2013, 8.11.2013, 6.12.2013, 20.12.2013, 7.2.2014, and 14.3.2014.

### K. Other Meetings

1. Meeting of all Staff Members including RA/SRFs with Dr. Manjit Singh, Director on 24.1.2014 in connection with Innovative Research and Enhancing Efficiency.

2. RFD meetings on 28.3.2014. 3. Meeting of All Scientists, AO, AAO Dealing Assistant

(Purchase) held on 24.10.2013. 4. RAC – Discussion Meeting – 11.6.2013. 5. XII Plan

Meet 9.4.2013.

### L. Women Cell

1. Chairman Director 2. Members i) Admn.Officer

ii) Smt.Shailja Verma, TO iii) Smt.Shashi Poonam, LDC

3. Member Secretary Smt.Reeta, Technical Officer

### राजभाषा कार्यान्वयन समिति (हिन्दी समिति):

डा. मनजीत सिंह, निदेषक – अध्यक्ष डा. आर.सी. उपाध्याय, प्रधान वैज्ञानिक – सदस्य डा. के. मणीकंडन, वैज्ञानिक – सदस्य श्री अ.ना वषिष्ठ प्रषासनिक अधिकारी/प्रभारी राजभाषा कार्यान्वयन – सदस्य श्रीमती रीता, तकनीकी अधिकारी – सदस्या

श्रीमती सुनीला ठाकुर, आषुलिपिक & सदस्या श्री सतेन्दर कुमार ठाकुर, व.लिपिक – सदस्य सचिव

## राजभाषा कार्यान्वयन समिति द्वारा वर्ष 2013–14 के दौरान किये गए कार्यों का संक्षिप्त विवरण

भारत सरकार की राजभाषा नीति के कार्यान्वयन को सुनिष्चित करने तथा निदेषालय द्वारा संपादित किये जाने वाले कामकाज में हिन्दी का प्रयोग सुनिष्चित करने के उद्देष्य से निदेषालय में राजभाषा कार्यान्वयन समिति का गठन किया गया है। राजभाषा कार्यान्वयन के लिए निदेषालय में अलग से कोई अधिकारी व कर्मचारी न होने के बावजूद राजभाषा कार्यान्वयन समिति द्वारा किए गये प्रयासों के फलस्वरूप निदेषालय में हिन्दी के कामकाज व प्रचार–प्रसार में अपेक्षित सफलता प्राप्त हुई है। निदेषालय द्वारा वर्ष 2013–14 के दौरान किये गये कार्यों का संक्षिप्त विवरण निम्नानुसार हैः–

## राजभाषा वार्षिक कार्यक्रम पर कार्यान्वयन

राजभाषा विभाग, गृह मंत्रालय, भारत सरकार द्वारा जारी राजभाषा वार्षिक कार्यक्रम पर निदेषालय की राजभाषा कार्यान्वयन समिति की त्रैमासिक बैठकों में चर्चा हुई तथा दिए गए दिषा–निर्देषों के अनुरूप लिए गए निर्णयों के अनुसार कार्रवाई की गई तथा निदेषालय के सभी अधिकारियों व कर्मचारियों को वार्षिक कार्यक्रम के अनुसार निर्धारित लक्ष्य प्राप्त करने हेतु पत्राचार किया गया।

## राजभाषा विभाग, नई दिल्ली एवं भारतीय कृषि अनुसंधान परिषद्, नई दिल्ली से प्राप्त पत्रों/परिपत्रों पर कार्रवाई

इस अवधि में राजभाषा कार्यान्वयन सम्बन्धी नवीनतम निर्देषों/नियमों से सम्बन्धित विभिन्न प्रकार के पत्र/परिपत्र आदि राजभाषा विभाग, भारतीय कृषि अनुसंधान परिषद से प्राप्त हुए जिन पर कार्रवाई वांछित थी, के ऊपर कार्रवाई की गई तथा उन्हें सभी संबंधित अधिकारियों व कर्मचारियों को उनकी जानकारी व आवष्यक कार्रवाई हेतु परिचालित किया गया।

## तिमाही हिन्दी प्रगति रिपोर्ट का संकलन तथा समीक्षा

निदेषालय में राजभाषा कार्यान्वयन सम्बन्धी प्रगति के आँकड़े प्राप्त कर जारी त्रैमासिक रिपोर्ट प्रोफार्मा में सभी आँकड़ों को संकलित कर निदेषालय की समेकित हिन्दी प्रगति रिपोर्ट तैयार की गई। इस समेकित रिपोर्ट को भारतीय कृषि अनुसंधान परिषद को भेजा गया। इस रिपोर्ट की समीक्षा की गई तथा पाई गई कमियों को इंगित कर दूर करने के लिए सभी अधिकारियों व कर्मचारियों को प्रेषित किया गया।

## हिन्दी प्रोत्साहन योजना का कार्यान्वयन

राजभाषा विभाग द्वारा जारी निर्देषों के अनुरूप निदेषालय में सरकारी कामकाज मूल रूप में हिन्दी में करने के लिए प्रोत्साहन योजना सभी अधिकारियों व कर्मचारियों के लिए लागू की है। पूरे वर्ष में किए गए

कार्यों को मध्य नजर रखते हुए एक मूल्यांकन समिति का गठन किया जाता है जो फाईलों व अन्य कार्यों का अवलोकन कर प्रथम, द्वितीय व तृतीय पुरस्कारों का निर्णय करती है।

## त्रैमासिक बैठकों का आयोजन

राजभाषा कार्यान्वयन समिति की त्रैमासिक बैठकों का नियमित आयोजन किया गया। बैठकों में राजभाषा वार्षिक कार्यक्रम में निर्धारित किए गए लक्ष्यों को प्राप्त करने, समय–समय पर राजभाषा विभाग एवं भारतीय कृषि अनुसंधान परिषद् से प्राप्त निर्देषों/आदेषों के अनुपालन पर चर्चा की गई तथा इन बैठकों में लिए गए निर्णयों को लागू करने के लिए कार्रवाई की गई।

## त्रैमासिक राजभाषा कार्यषालाओं का आयोजन

निदेषालय में त्रैमासिक राजभाषा कार्यषालाओं का नियमित आयोजन किया गया। इन कार्यषालाओं में हिन्दी में कार्य करने में आ रही बाधाओं पर चर्चा की गई तथा उनका निराकरण करने के लिए उपाए सुझाए गए।

निदेषालय के सभी अधिकारियों व कर्मचारियों के लिए सभी प्रकार के प्रपत्र द्विभाषी रूप में तैयार किए गए है व सभी के कंप्यूटरों पर डाउनलोड किए गए ताकि वे दिन–प्रतिदिन कार्यालय प्रयोग में इन प्रपत्रों को प्रयोग में लाएं।

## हिन्दी सप्ताह का आयोजन

16–21 सितम्बर, 2013 तक 'हिन्दी सप्ताह' के दौरान हिन्दी में आयोजित प्रतियोगिताओं व वर्ष (अक्टूबर, 2012 से 13 सितम्बर, 2013) में सर्वाधिक कार्य करने वाले अधिकारियों/कर्मचारियों को दिनांक 21.09.2013 को नकद पुरस्कार दिए गए जिसका विवरण निम्नलिखित हैः–

### 1. श्रुतलेखन प्रतियोगिता (दिनांक 16 सितम्बर, 2013)

प्रथम & श्री सुनीला ठाकुर द्वितीय
– श्रीमति षषी पूनम तृतीय – श्री
दीप कुमार ठाकुर

### 2. सुलेख प्रतियोगिता (दिनांक 16 सितम्बर, 2013)

प्रथम – श्रीमति सुनीला ठाकुर
द्वितीय – डा. जीत राम तृतीय –
श्रीमति रीता भाटिया

### 3. निबंध प्रतियोगिता (दिनांक 17 सितम्बर, 2013)

प्रथम – डा. वी. पी. शर्मा द्वितीय –
डा. सतीष कुमार तृतीय – श्री दीप
कुमार ठाकुर

### 4- fVli.kh izfr;ksfxrk ¼fnukad 17 flrEcj] 2013½

प्रथम – श्रीमति षषी पूनम द्वितीय –
श्री दीप कुमार ठाकुर तृतीय –
श्रीमति सुनीला ठाकुर

### 5. तकनीकी लेख प्रतियोगिता (दिनांक 18 सितम्बर, 2013)

प्रथम & श्री जीत राम
द्वितीय – श्री ज्ञान चंद

### 6. प्रार्थना पत्र (चतुर्थ श्रेणी कर्मचारियों के लिए ) 18.09.2013

प्रथम – श्री विनय षर्मा द्वितीय
– श्री अजीत कुमार तृतीय –
श्री राज कुमार

### 7. कम्प्यूटर पर टंकण प्रतियोगिता दिनांक 20 सितम्बर, 2013

प्रथम & श्री रोषन लाल नेगी
द्वितीय – श्रीमति षषी पूनम तृतीय
– श्री दीप कुमार ठाकुर

### 8. वैज्ञानिक उपलब्धियां लिखना (केवल वैज्ञानिकों के लिए) 21.09.2013

प्रथम & डा. ओम प्रकाष अहलावत
द्वितीय – डा. सतीष कुमार तृतीय – डा.
वी.पी. षर्मा

**भारतीय कृषि अनुसंधान परिषद, नई दिल्ली के पत्र संख्या 1(13)/96–हिन्दी दिनांक 11 मई, 2001 के अनुसार सरकारी कामकाज मूल रूप से हिन्दी में करने के लिये प्रोत्साहन योजना के तहत दिये गये पुरस्कार :–**

### 1. प्रथम पुरस्कार (2 पुरस्कार प्रत्येक 1600/– रूपये)

1) श्री दीप कुमार ठाकुर 2) श्री राजैन्द्र षर्मा

### 2. द्वितीय पुरस्कार (3 पुरस्कार प्रत्येक 800/– रूपये)

1) श्रीमति सुनीला ठाकुर 2) श्री तुलसी दास षर्मा 3) श्री एन.पी. नेगी

### 3. तृतीय पुरस्कार (5 पुरस्कार प्रत्येक 600/– रूपये)

1) श्री भीम सिंह सहोता 2) श्रीमति षषी पूनम 3) श्री सतेन्दर कुमार ठाकुर 4) श्री रोषन लाल नेगी 5) श्री लेख राज राणा

इन सबके फलस्वरूप निदेषालय के वैज्ञानिक/अधिकारियों/कर्मचारियों में हिन्दी में कार्य करने की प्रवृत्ति बढ़ी है और वर्तमान में काफी प्रषासनिक कामकाज हिन्दी में संपादित हो रहा है। इसमें निदेषालय के वैज्ञानिकों, अधिकारियों व कर्मचारियों का सतत् सहयोग प्राप्त हुआ है जिसके परिणामस्वरूप हम लक्ष्य को प्राप्त करने की ओर अग्रसर हो रहे हैं। इसके लिए हमें निदेषक महोदय का उचित मार्गदर्षन तथा सहयोग हमेषा ही प्राप्त हुआ है।

## निदेषालय की वार्षिक हिन्दी प्रगति संबंधी मुख्य गतिविधियाँ एवं उपलब्धियाँ

राजभाषा कार्यान्वयन समिति की प्रमुख–प्रमुख गतिविधियों और उपलब्धियों का सार–गर्भित संक्षिप्त–विवरण वार्षिक हिन्दी प्रगति रिपोर्ट के रूप में प्रस्तुत किया जाता है।

1. निदेषालय के 80 प्रतिषत से अधिक कार्मिक हिन्दी में प्रवीणता/कार्यसाधक ज्ञान प्राप्त है इसलिए यह निदेषालय राजभाषा नियम 10(4) के अंतर्गत भारत सरकार के गजट में हिन्दी कार्यालय के रूप में अधिसूचित किया जा चुका है।

2. हिन्दी में प्राप्त या हिन्दी में हस्ताक्षरित सभी पत्रों में से जिन पत्रों का उत्तर देना अपेक्षित समझा गया, उन पत्रों का उत्तर केवल हिन्दी में अथवा हिन्दी–अंग्रेजी द्विभाषीय रूप में दिया गया।

3. निदेषालय की अधिकतर बैठकों को कार्यवृत्त हिन्दी में तैयार किए गए। 4. राजभाषा अधिनियम, 1963 की धारा 3(3) तथा अन्य नियमों की अनुपालना के संदर्भ में निदेषालय के

प्रत्येक अधिकारी व कर्मचारी को समय–समय पर कार्यालय आदेष जारी किए गए व इनकी षत–प्रतिषत अनुपालन सुनिष्चित करवाने के प्रयास किए जा रहे है।

5. हिन्दी पत्राचार के निर्धारित लक्ष्यों को प्राप्त करने की दिषा में सतत्–प्रयास जारी है। 6. सभी 42 मानक फॉर्मों को द्विभाषी रूप में तैयार कर लिया गया है तथा सतत् कोषिषें की जा रही है
की सभी कार्मिक इन्हें हिन्दी में ही भरें। 7. निदेषालय के सभी 30 कम्पयूटरों में हिन्दी सॉफटवेयर को डाउनलोड किया गया है। इससे कम्पयूटर

पर काम करने वाले प्रत्येक अधिकारी व कर्मचारी को अपनी इच्छानुसार हिन्दी में अथवा हिन्दी और अंग्रेजी दोनों में किसी भी भाषा में एक साथ काम कर सकते है।

8. निदेषालय के सभी अधिकारियों का हिन्दी की जानकारी संबंधी रोस्टर तैयार किया गया है। 9. निदेषालय के सभी साईन बोर्ड, सूचना बोर्ड, नाम पट्ट व अन्य इसी प्रकार के बोर्ड द्विभाषी रूप में तैयार
करवाए गए हैं। 10. निदेषालय के प्रषिक्षण कार्यक्रमों के लिए प्रषिक्षण सार–संग्रह (ट्रेनिंग कम्पेडियम) हिन्दी व अंग्रेजी दोनो
भाषाओं में उपलब्ध है। 11. कोड मैनुअलों और अन्य कार्यविधि साहित्य हिन्दी में उपलब्ध है। 12. निदेषालय में प्रत्येक वर्ष की भांति इस वर्ष भी मषरूम मेले का आयोजन 10 सितम्बर, 2013 को

आयोजित किया गया। इस अवसर पर मुख्य पंडाल के सभी चित्रों के षीर्षक, ग्राफ, हिस्टोग्राफ आदि हिन्दी में प्रदर्षित किए गए। मल्टीमीडिया के माध्यम से मषरूम संबंधी जानकारी आकर्षक ढंग से प्रस्तुत की गई तथा किसानों, छात्रों व अन्य अंगतुकों को मषरूम साहित्य हिन्दी में उपलब्ध कराया गया।

13. दूरदर्षन तथा आकाषवाणी पर भी निदेषालय के वैज्ञानिकों व तकनीकी अधिकारियों की मषरूम विषय पर हिन्दी में वार्ताएं प्रसारित होती रहती है जिनसे मषरूम उत्पादकों की समस्याओं का समाधान होता है।

14. इसके अतिरिक्त खुम्ब संबंधी प्रौद्योगिकियों पर 8 फोल्डरों का नवीनीकरण कर हिन्दी में पुनः प्रकाषित किए गए।

15. इसके अतिरिक्त डा. मनजीत सिंह, निदेषक एवं अध्यक्ष, राजभाषा कार्यान्वयन समिति के सतत् निजी–सहयोग और मार्गदर्षन के तहत हिन्दी की तिमाही बैठकों व कार्याषालाओं का समय पर आयोजन व निदेषालय में कार्यरत सभी अधिकारियों व कर्मचारियों के आपसी सहयोग और मेलमिलाप के साथ राजभाषा कार्यान्वयन संबंधी गतिविधियां निरंतर प्रगति की ओर अग्रसर हो रही है।

# 10. WINTER / SUMMER SCHOOL / SEMINARS / SYMPOSIA / CONFERENCES ATTENDED/ ORGANISED

## Dr. Manjit Singh

1. Organized and attended Indian Mushroom Conference - 2013 from 16-17 April 2013 at PAU, Ludhiana.

2. Attended and delivered a Lead Lecture on "Nu- tritional Importance of Mushrooms" during the workshop on Mushroom Technology - Present Scenario and Future Prospects in India jointly organized IIT Delhi and DMR, Solan at IIT, New Delhi from 16-17 December 2013.

3. Attended and delivered a talk on "Current Scenario of Mushroom Cultivation in India" in the National Symposium on "Mushroom for Medicinal Value and Nutritional Security under Changing Climatic Conditions" at Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni on 27-28 December 2013.

4. Attended and delivered a talk in Conference on "Draft Policy for Utilization and Manage- ment of Paddy Straw" at Chandigarh on 3-4 January 2014.

5. Attended a delivered a Plenary Lecture in National Symposium on "Emerging Trends in Botanical Sciences" held at Punjabi University, Patiala from 17-18 February 2014.

6. Attended and delivered a Lead Lecture in the National Conference on "Perspective and Trends in Plant Sciences and Biotechnology" held at Deptt. of Botany, Panjab University, Chandigarh on 21.02.2014.

## Dr. R C Upadhyay

1. Key note speaker in the National conference on "Biodiversity Conservation: Embracing our future, preserving our past, on 27-28 Sept,2013at the IIS University, Jaipur and presented the paper "Mushroom Biodiversity of Himalayas and their conservation".

2. Attended the "Indian Mushroom conference " at PAU, Ludhiana and was Co Chairman of the 1st Session. 3. Attended the AICRP workshop at PAU, Ludhiana on 17th and 18th April, 2013 and attended 3 days workshop on Mushroom Production technology-Present scenario and future prospects in India on16th and 17th dec,2013 at IIT, Delhi and presented lecture on Cultivation of *Pleurotus*: prospects of different species including king oyster in India.

5. Attended the AICRP workshop at RAU, Pusa, Samastipur on 20th and 21st March, 2013and Co-Chairman of the second session and Chairman of the V session .

## Dr. VP Sharma

1. Attended "Indian Mushroom Conference" held at PAU, Ludhiana w.e f. 16-17 April, 2013 Attended AICR-M workshop and presented three varieties, two for shiitake and for milky for release at PAU, Ludhiana w.e.f.17-18 April, 2013.

2. Attended "Two days High Level Seminar" at Nalanda, Bihar and delivered lecture on disease management w.e.f. 26-27, July, 2013.

3. Attended "State Level Horticultural officer's workshop on fruit and flower crops and presented three varieties for inclusion in Package of Practice w.e.f. 8-9, Oct., 2013.

4. Attended "One day Workshop on RTI in JNU Campus New Delhi 11, Oct., 2013.

5. Attended "One day Workshop on RFD in NASC, New Delhi on 28 Oct., 2013.

6. Attended "Workshop on mushroom Technology- present scenario and future prospects in India" at IIT, Delhi w.e.f. 16-18, Dec., 2013.

7. Keynote speaker in the National symposium on “Mushrooms for Medicinal Value and nutritional Security under changing climatic conditions” Held at Dr YSP University of Horticulture and Forestry Nauni w.e.f Dec. 27-28, 2013.

8. Attended “workshop on Mini mission Project at Palampur w.e.f. 30-31 Jan, 2014.

9. Attended “Seed Platform Workshop” in Bangalore on 22, Feb, 2014 and presented one project with a budget of 65 lakhs.

10. Attended AICRP-M workshop at RAU, Pusa w.e.f.20-21March, 2014.

### Dr. OP Ahlawat

1. Attended XV Annual Workshop of All India Coordinated Research Project on Mushroom from April 17-18, 2013, at PAU, Ludhiana.

2. Attended National Mushroom Conference- 2013 from April 16-17, 2014 at PAU, Ludhiana.

3. Attended Stakeholders’ “Workshop on Revision of State Biotechnology Policy” from Oct., 29-30, 2013 at Holiday Home, Shimla.

4. Attended Workshop on Mushroom Technology-Present Scenario and Future Prospects from 16th-18th December 2013 at IIT, New Delhi.

5. Delivered lectures on button mushroom compost preparation and crop management of button mushroom crop during training programme on “Bee-Keeping and Mushroom Cultivation” from 03-07 February, 2014 at NITTTR, Chandigarh for the faculty of Polytechnic Colleges.

6. Attended XVI Annual Workshop of All India Coordinated Research Project on Mushroom from March 20-21, 2014 at RAU, Samastipur, Pusa, Bihar.

### Dr. Satish Kumar

1. Attended XV Annual Workshop of All India Coordinated Research Project on Mushroom from April 17-18, 2013, at PAU, Ludhiana.

2. Attended National Mushroom Conference- 2013 from April 16-17, 2014 at PAU, Ludhiana.

3. Attended XVI Annual Workshop of All India Coordinated Research Project on Mushroom from March 20-21, 2014 at RAU, Samastipur, Pusa, Bihar.

### Dr. Shwet Kamal

1. Attended XV workshop of All India Coordinated Research project on Mushroom during 16-17 May 2013 at PAU, Ludhiana.

2. Attended Indian Mushroom Conference – 2013 during 15-16 May 2013 at PAU, Ludhiana

3. Attended NAIP sponsored international training on development of retroelement based makers for fertility, strain and species identification in mushrooms during 2 Sep to 1 Dec 2013 at Dept of Biology, University of Leicester, UK.

4. Attended One day symposium on “Mapping the epigenomes of plants and animals” at John Innes Centre, Norwich Research Park, Norwich, UK on 14 October 2013.

5. Attended XVI Annual Workshop of All India Coordinated Research Project on Mushroom from March 20-21, 2014 at RAU, Samastipur, Pusa, Bihar.

### Dr. K Manikandan

1. Attended National Mushroom Conference- 2013 from April 16-17, 2014 at PAU, Ludhiana.

2. Attended “One day Workshop on RFD in NASC, New Delhi on 28 Oct., 2013.

3. Attended “National symposium on “Mushrooms for Medicinal Value and nutritional Security under changing climatic conditions” Held at Dr YSP University of Horticulture and Forestry Nauni w.e.f Dec. 27-28, 2013.

# 11. DISTINGUISHED VISITORS

Dr. N K Krishna Kumar, Deputy Director General (Hort), ICAR visited DMR and inaugurated the administrative building on 8th April 2013.

Dr. Harsh Vardhan Batra, Director, Defense Food Research Laboratory, Mysore visited DMR on 17th May, 2013.

Mrs. Promila Bhardwaj, Chief Commissioner of Income Tax, Shimla visited DMR on 7th November, 2013.

Shri. Arwind Kaushal, Additional Secretary, DARE and Secretary ICAR, New Delhi visited DMR on 16th November, 2013.

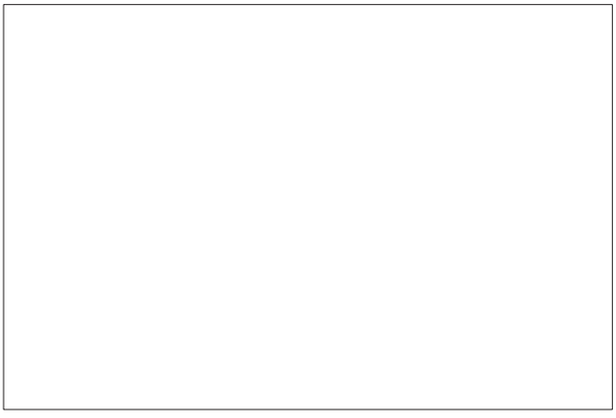

**Fig. 11.1. Dr. NK Krishna Kumar, DDG (Hort) visited DMR and inaugurated the administrative building on 8th April 2013**

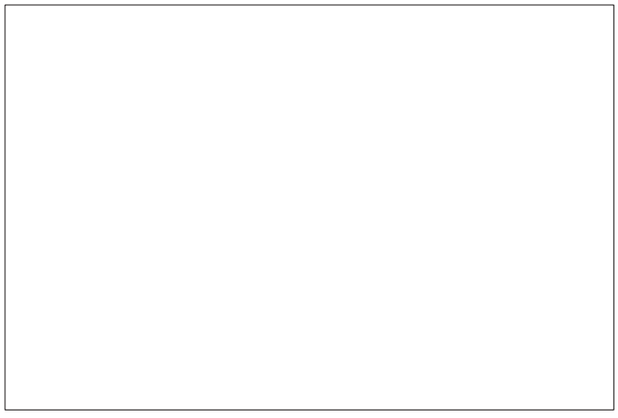

**Fig. 11.2. Shri Arwind Kaushal, Secretary, ICAR visited DMR on 16th Nov 2013**

# 12. PERSONNEL AND FACILITIES

**Table 12.1. Cadre strength of scientists at the Directorate of Mushroom Research, Chambaghat, Solan (HP) 173213 as on 31.12.2013**

| Sl. | Name of the Discipline | No of scientific post sanctioned | No of scientific post filled | No of scientific post vacant |
|---|---|---|---|---|
| 1 | Scientist Agricultural sciences and environmental management | 1 | - | 1 |
| 2 | Scientist Agricultural biotechnology | 1 | - | 1 |
| 3 | Sr. Scientist Agricultural biotechnology | 1 | 1 | - |
| 4 | Scientist Agricultural entomology | 1 | 1 | - |
| 5 | Scientist Agricultural extension | 2 | 1 | 1 |
| 6 | Scientist Food Technology | 1 | 1 | - |
| 7 | Scientist Flexi discipline(food Technology) | 1 | 1 | - |
| 8 | Scientist Genetics and Plant breeding | 2 | - | - |
| 9 | Principal Scientist Plant pathology | 1 | - | 1 |
| 10 | Sr. Scientist Plant pathology | 2 | 2 | - |
| 11 | Scientist Plant pathology | 2 | 1 | 1 |
| 12 | Scientist Soil Science | 1 | 1 | - |
| | **Grand Total** | **16** | **9** | **7** |

**Table 12.2. Cadre strength of technical, administrative and supporting category SN Designation Pay band and Grade**

| Pay | Sanctioned posts | In position posts | Vacant posts | Total Technical posts |
|---|---|---|---|---|
| 1 T-4 9300-34800 + GP 4200/- | 2 | 2 | - | 2 |
| 2 T-II-3 5200-20200 + GP 2800/- | 2 | 2 | - | 2 |
| 3 T-2 5200-20200 + GP 2400/- | 1 | 1 | - | 1 |
| 4 T-1 5200-20200 + GP 2000/- | 9 | 7 | 2 | 9 |
| | **Grand total** | 14 | 12 | 2 14 |
| **Administrative posts** | | | | |
| 1 Administrative Officer 15600-39100 + GP 5400/- | 1 | 1 | - | 1 2 |
| Asstt.Admn.Officer 9300-34800 + GP 4600/- | 1 | 1 | - | 1 3 |
| Asstt.Fin. & A/Cs Officer 9300-34800 + GP 4600/- | 1 | 1 | - | 1 4 |
| Private Secretary 9300-34800 + GP 4600/- | 1 | 1 | - | 1 5 |
| Assistant 9300-34800 + GP 4200/- | 4 | 4 | - | 4 6 |
| Personal Assistant 9300-34800 + GP 4200/- | 1 | 1 | - | 1 7 |
| UDC 5200-20200 + GP 2400/- | 2 | 2 | - | 2 8 |
| Stenographer Gr.III 5200-20200 + GP 2400/- | 1 | 1 | - | 1 9 |
| LDC 5200-20200 + GP 1900/- | 2 | 3* | - | 3(-1) |
| **Grand total** | 14 | 15 | - | 15 (-1) 1 |
| Skilled support staff Rs.5200-20200 + GP 1800/- | 10 | 08 | 2 | 10 |

(Supporting staff) Due to revised Cadre Strength of Administrative Staff one post of LDC is excess which will be adjusted in near future.

**Table 12.3. Staff in position at DMR (HP) SN Name of employee Email Designation**

1 Dr.Manjit Singh dirdmur@icar.org.in Director 2 Dr.R.C. Upadhyay rcupadhyay@icar.org.in Principal Scientist 3 Dr.B. Vijay bvijay@icar.org.in Principal Scientist 4 Dr.V.P. Sharma vpsharma@icar.org.in Principal Scientist 5 Dr.O.P. Ahlawat opahlawat@icar.org.in Principal Scientist 6 Dr.Satish Kumar satisht@icar.org.in Principal Scientist 7 Dr.Shwet Kamal shwetkamal@icar.org.in Senior Scientist 8 Sh.Mahentesh Shirur mahanteshs@icar.org.in Scientist 9 Dr.K. Manikandan kmanikandan@icar.org.in Scientist

**Administrative staff**

1 Sh AN Vashisth aodmr@gmail.com Administrative Officer 2 Sh.R.K. Bhatnagar ddodmr@gmail.com Assistant Administrative Officer 3 Sh.Surjit Singh surjits@icar.org.in PS 4 Smt.Sunila Thakur sunilat@icar.org.in PA 5 Sh.Rajinder Sharma - Assistant 6 Sh.Bhim Singh - Assistant 7 Sh.T.D. Sharma tdsharma66@gmail.com Assistant 8 Sh.Deep Kumar deep.kthakur@gmail.com Steno Gr.III 9 Sh.N.P. Negi - Assistant 10 Sh.Satinder Thakur - UDC 11 Sh.Dharam Dass - UDC 12 Smt.Shashi Poonam - LDC 13 Sh.Roshan Lal Negi - LDC 14 Sh.Sanjeev Sharma - LDC

**Technical staff**

1 Sh.Sunil Verma sunilverma@icar.org.in Assistant chief technical officer 2 Smt.Reeta reetabhatia@icar.org.in Sr. Technical Officer 3 Smt.Shailja Verma shailjaverma@icar.org.in Sr. Technical Officer 4 Sh.Jia Lal - Technical Officer 5 Sh.Gian Chand - Sr technical assistant 6 Sh.Lekh Raj Rana - Technical assistant 7 Sh.Ram Swaroop - Technical assistant 8 Sh.Dala Ram - Driver T-4 9 Sh.Ram Lal - Driver T-4 10 Sh.Jeet Ram - Technical assistant T-3 11 Sh.Guler Singh Rana - Technical assistant T-3 12 Sh.Deepak Sharma deepak_zz@rediffmail.com Technical assistant T-3

**Skilled supporting staff**

1 Sh.Naresh Kumar - SSS- Grade-III 2 Sh.Nika Ram - SSS- Grade-III 3 Sh.Tej Ram - SSS- Grade-II 4 Smt.Meera Devi - SSS- Grade-II 5 Sh.Raj Kumar - SSS- Grade-II 6 Sh.Ajeet Kumar - SSS- Grade-II 7 Sh.Arjun Dass - SSS- Grade-I 8 Sh.Vinay Sharma - SSS- Grade-III

## Transfer

1. Sh.Arjun Dass, SSS transferred from DMR, Solan to CPRI, Shimla on 01.08.2013 (FN)

## Joining

1. Sh.A.N. Vashisth has joined as Administrative Officer at this Directorate on 21.08.2013 (AN).

## Modified assured career progression (MACP)

1. Dr. Shwet Kamal, Senior Scientist was placed in Pay Band IV Rs. 37400 -67000 + GP 9000/ - w.e.f. 16.03.2013.

2. Smt.Sunila Thakur, PA granted financial up gradation in the pay band of Rs.9300-34800 + GP 4600/- w.e.f. 06.12.2013.

## Probation & confirmation

1. Sh.N.P. Negi cleared probation period w.e.f. 29.06.2013 on the post of Assistant.

## Sports

A contingent of 25 men from Directorate of Mushroom Research, Solan participated in ICAR Inter-Zonal sports meet held at Indian Institute of Pulses Research, Kanpur from 20-23 March, 2014.

# 13. BUDGET POSITION

**Table 13.1. Budget position under Non-Plan and Plan for the year 2013-14 S. No. Head of Accounts Non-Plan**

**Allocation Non-Plan Exp. Plan Allocation Plan Exp.**
**2 0 1 3 - 1 4 2 0 1 3 - 1 4 2 0 1 3 - 1 4**

**2 0 1 3 - 1 4 A . C a p i t a l I** L a n d

**- - - - i i** W o r k s **- - - - i i i**

E q u i p m e n t **2 . 7 5 2 . 7 5** 3 5 . 0 0

**2 2 . 5 2 i v** I n f o r m a t i o n

T e c h n o l o g y **- - - -**

**v** L i b r a r y **- -** 5 . 0 0

5 . 0 0 **v i**

F u r n i t u r e & F i x t u r e

**- - - -**

**vii** Others **1.00 1.00 - - Total- non-plan capital assets 3.75 3.75 40.00 27.52 B. Revenue - - - -**

I **Establishment expenses - - - -**

I Establishment Charges **284.79 269.3.9 - -**

i i W a g e s **- - - -**

iii O.T.A **0.11 0.11 - - Total Estt. Charges 284.90 269.45 - - General Revenue - 1 Pension & Other Retirement Benefits 69.50 67.48 - - 2 Traveling Expenses I) TA Domestic/Transfer TA 2.50 2.50 6.00 5.95 Total Travelling Allowance 2.50 2.50 6.00 5.95**

3 Research & Operational Expenses **10.00 10.00** 42.55 **42.54**

4 Administrative Expenses **46.50 46.50** 33.50 **33.37**

5 Misc. Expenses **3.60 3.55** 7.75 **7.86**

6 H.R.D. **- 1.00 - -**

7 15% Repair **- 12.20 - 12.18 Total- Non-Plan Revenue 417.00 103.00 103.00 102.90 NEH - - 1.00 1.00 TSP - - 1.00 0.85 Grand Total:(Capital & Revenue) 420.75 403.23 145.00 132.27**