वार्षिक प्रतिवेदन

ANNUAL REPORT

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ICAR-Directorate of Mushroom Research
Chambaghat, Solan-173 213 (H.P.), India

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Published by : **Dr. R.C. Upadhyay**
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Printed at : Yugantar Prakashan (P) Ltd., New Delhi-110064
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PREFACE

India has achieved food security; however, our struggle for nutritional security is still on. In the near future, the increasing population, depleting agricultural land, deteriorating environment, water shortage and demand for quality food are going to be the vital issues. It is important to diversify agricultural activities to meet these challenges. Mushroom cultivation recycles agro-residues, much of which is otherwise burnt in the field. In changing agricultural scenario, secondary agriculture is going to play a pivotal role and mushroom fits very well in this category. Our country can emerge as a major player in mushroom production utilizing available abundant agricultural residues. Mushroom being an indoor crop, utilizes vertical space and requires only 25-30 litre water for production of one kg mushroom, thus offering a solution to shrinking agricultural land and water.

With rapid urbanization and increased production of agro-residues along with increased food production, there will be a need to radically change the way we look at agriculture. High-tech agriculture including mushroom cultivation is going to gain importance in coming decades. Mushroom production in the world has increased rapidly in the last few decades and the trend is likely to pickup in our country as well. Continuous skill upgradation of human resources will be indispensable to keep pace and to move ahead in R&D.

During the year a total no of 236 specimens were collected for the first time from Tripura and Meghalaya and 210 specimens have been identified upto genus level. Pure tissue cultures of 173 specimens were obtained and deposited in the Gene Bank of DMR,Solan. Five bruising resistant hybrid strains of *Agaricus bisporus* have been evaluated for yield and quality. A patent has been filed for short duration cultivation technology of *Lentinula edodes* mushroom.

Director

CONTENTS

EXECUTIVE SUMMARY

ICAR-Directorate of Mushroom Research has made significant progress in research, transfer of technology and human resource development during 2014-15. The achievements in the area of Crop Improvement, Crop Production, Crop Protection, Post Harvest Technology, Transfer of Technology, Education and Training and Publications are summarized here.

Fungal forays were undertaken in the forest areas of Himachal Pradesh, Mizoram, Tripura and Gujrat. A total number of 236 specimens were collected and 210 specimens identified upto genus level. Further, pure tissue cultures of 173 specimens were obtained and deposited in the Gene Bank of DMR, Solan.

Yield evaluation test have been carried out for all the five browning resistant hybrids (NBS-1, NBS-2, NBS-3, NBS-4 and NBS-5 on large scale cultivation trials two times during the period of report. In both the trials, each of hybrids was tested on 1000 kg compost along with two controls U-3 and DMR-03. Out of the five hybrids tested two performed very well at DMR, Solan. The two hybrids also showed promising results on commercial scale trials at Balaji Mushroom Farms, Baramati, Pune, Weikfield Mushrooms, Pune and Flex Foods, Dehradun.

The pure mycelial culture from white coloured *Volvariella volvacea* fruit body, collected from Port Blair region of Andaman and Nicobar Islands, India was raised using tissue culture raising technique on Malt Extract Agar (MEA) medium at 32±2 °C. The mycelial growth characteristics of the white strain of *V. volvacea* were studied against two high yielding brown strains (OE-210 and BBSR-007) of *V. volvacea.* One strain each from three different groups as depicted in phylogenetic tree was used in the study.

The initial evaluation trial for paddy straw mushroom was conducted at comparatively lower temperature conditions, revealed lowest first harvest time of 11.93 days in white strain, GVv-01. It also gave the highest fruit body yield (20.79 kg/q dry substrate) and the mean fruit body weight (20.74 g) compared with four high yielding brown strains of *V. volvacea.* The study proved the white strain as superior strain in all respects giving first harvest nearly two days earlier, and fruit body yield and mean fruit body wt. higher by nearly 28 and 37%, respectively than the best performing brown strain (BBSR-007). This strain also revealed its ability to give superior fruit body yield at lower temperature conditions, where the high yielding brown strains failed.

The randomly drawn fifteen to twenty fruit bodies from one brown strain (BBSR-007) and one white strain (GVv-01) of *V. volvacea* were got analyzed for fifteen different parameters *viz*., dry matter, ash, crude fibre, carbohydrates, protein, fat, vitamin-D and 8 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). The proximate nutritional analysis of the fruit bodies of white and brown strains of *V. volvacea* revealed higher contents of ash, crude fibre and all seven minerals (potassium, sodium, calcium, iron, copper, zinc and magnesium) in fruit bodies of the white strain compared with the fruit bodies of brown strain. The enhancement ranged between lowest of 6.62% for zinc to highest of 50.68% for calcium.

The crop of four mushroom species *viz*., *Agaricus bisporus* (white button mushroom), *Pleurotus eous* (pink oyster mushroom), *Lentinula edodes* (Shiitake) and *V. volvacea* (paddy straw mushroom) was raised at Mushroom Farm of the Directorate during 2014-15 by following the standard package of practices. The four species were tested for their nutritional composition varied in protein content from lowest of 18.85 % in *L. edodes* to highest of 38.10 % in *V. volvacea*. The second highest level of protein (29.14 %) was in *A. bisporus*, followed by *P. eous* (19.59 %). Fat (0.97 %) was lowest in *V. volvacea*, followed by *P. eous* (1.05 %), *L. edodes* (1.22 %) and *A. bisporus* (1.56 %). Vitamin D content was highest

in *A. bisporus* (984 IU/g), followed by *P. eous* (487 IU/g) and *V. volvacea* (462.04 IU/g). It was lowest in *L. edodes* (205 IU/g). The elemental contents of sodium, potassium and iron were also lowest in *L. edodes*. Out of these three, sodium and potassium contents were highest in *A. bisporus*, while iron in *P. eous*. Zinc was highest (162.18 mg/kg) in *P. eous* and manganese (17.48 mg/kg) in *L. edodes*. The potassium/sodium ratio was highest in *L. edodes*, where it was 254.58 compared with only 84.07 in *A. bisporus*. Selenium was recorded only in *A. bisporus*, whereas in rest cases it was not detectable.

A short duration cultivation technology for shiitake cultivation developed. Using this technology the first crop/harvest can be taken just in 45 days as compared to 75-80 by earlier available technology. We have filed patent for developing this technology. Further , Five strains (DMR-Shiitake-388S, DMR-Shiitake-388, DMR-38, DMR- 16 and DMR- 22), of shiitake were evaluated. DMR-Shiitake-388S gave fruiting in the shortest duration (44 days). Shiitake -388 also took 52 days whereas other strains took more than 65 days for fruiting on sterilized saw dust substrate.

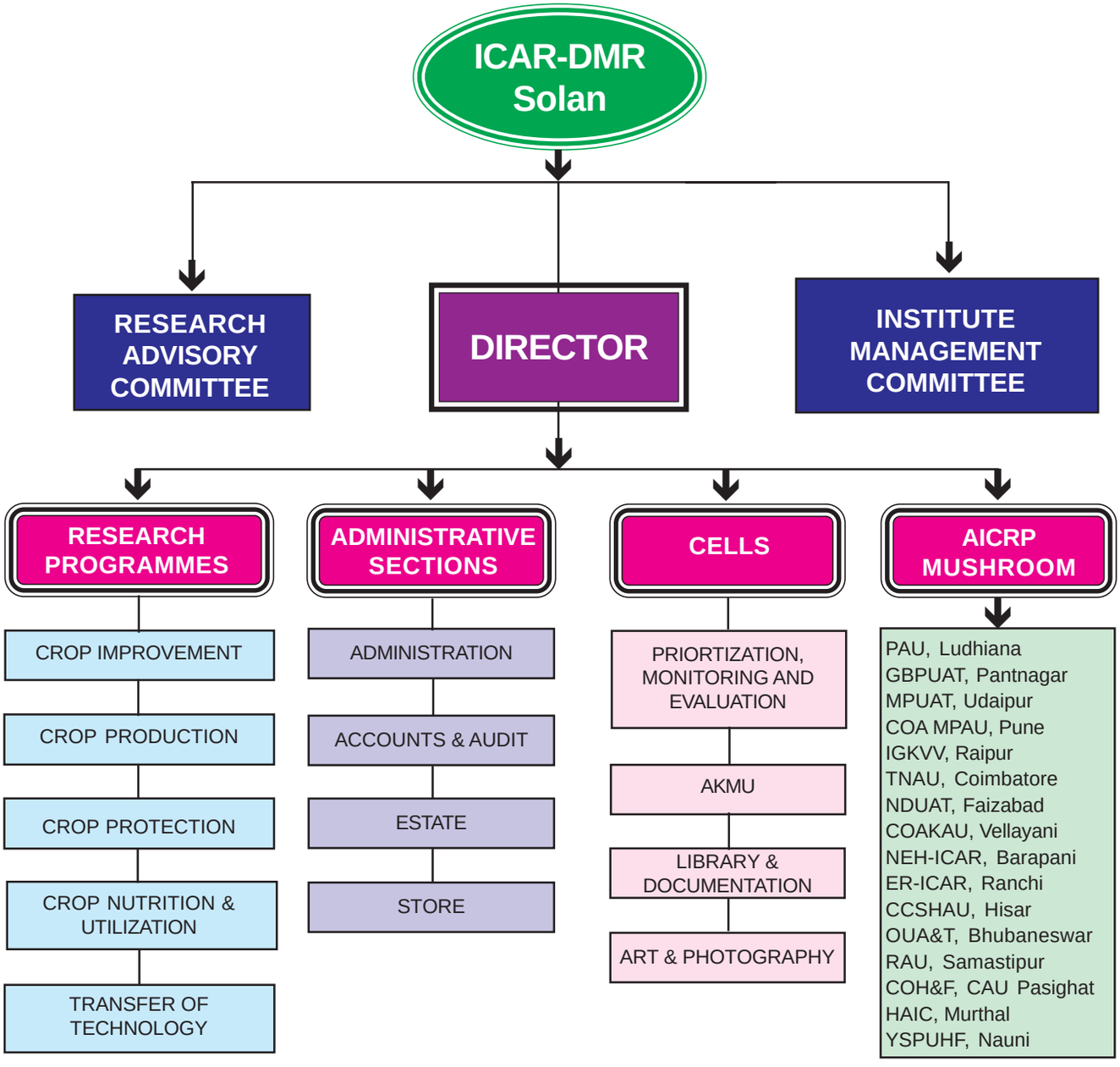
Antioxidant activity of *L. connatus* was studied following standard protocol. Anti oxidant activity was found to be 57.89% while reducing activity and scavenging effect of DPPH radical was found to be 62.04% and 43.80%, respectively.

A trial was conducted during October-December, 2014 by using button mushroom SMS in four different proportions i.e. 0, 20% (N balancing), 20% (no N balancing) and 30% (no N balancing) w/w to wheat straw, keeping standard composition as the control treatment.

The sequences of *Cladobotryum* spp were analysed using Mega 6.0 software for maximum likelyhood analysis using 1000 bootstrap comparisons. Out of five fungicides and two other chemicals tried, chlorothalonil and carbendazim proved equally effective in managing wet bubble disease among all the fungicides.

Mushroom based new products and fortified mushroom products have been developed including mushroom fortified corn extrudates, fortified cakes, ready to cook frozen mushroom tikki. Effect of cooking by various methods (Boiling, frying and microwaving) on antioxidant properties have been studied and shallow quick frying of mushrooms was found to be the most potent method of cooking mushrooms to have the best carryover of antioxidants of mushrooms in cooked diet.

ORGANOGRAM OF ICAR-DMR, SOLAN



1. INTRODUCTION

Mushroom Research in India began in the 60s in the states of Himachal Pradesh and Jammu & Kashmir, and remained confined to these states with focus only on white button mushroom. The National Centre for Mushroom Research & Training (NCMRT) now known as ICAR-DMR was established in 1983 under the auspices of the Indian Council of Agricultural Research. In India, mushroom production systems are of mixed type i.e., both seasonal as well as high-tech cultivation. Although mushroom production in the country is at a young stage, growth rate, both in terms of productivity as well as production, has been phenomenal. The current production is over 120,000 tonnes with the button mushroom holding a major share. About 10-15% of button mushroom production is through seasonal cultivation in huts while the remaining production is under controlled conditions. The cultivation of other mushrooms like oyster, paddy straw and milky mushroom is mainly seasonal.

To upgrade our knowledge across the globe on mushrooms, International collaboration is especially needed in the areas of germplasm conservation and maintenance, genetic improvement, cultivation aspects, nutritional and nutraceutical properties, etc. It was really overwhelming for us to hold the 8th International Conference on Mushroom Biology and Mushroom Products (ICMBMP) in India. It was a great opportunity to interact and learn new horizons of mushroom science with researchers from around the world. The 8th ICMBMP was hosted in the historic city of Delhi, India at the National Agricultural Science Centre Complex from 19-22 November 2014.

The conference, with 70 participants from 26 countries from outside India, including about 150 scientists, 40 entrepreneurs, 30 farmers and 20 students from India, was held for four days with multifarious activities ranging from oral presentations, poster presentations, exhibitions, scientists-farmer interaction, a field visit, and networking. The Conference included one theme lecture, 13 keynote addresses, 63 oral and 128 poster presentations covering diverse topics such as mushroom diversity, genetics, biochemistry, biology & development, medicinal aspects, value addition, economics of mushroom production, etc. The topics were divided into ten sessions.

Like earlier years, the germplasm collection activities were continued. The Directorate was dedicated towards imparting on- and off-campus trainings to farmers and trainees.

2. RESEARCH ACHIEVEMENTS

A. Crop Improvement

1. Mushroom Genetic Resources

Germplasm collection and identification of wild fleshy fungi

Fungal forays were undertaken in the forest areas of Himachal Pradesh, Mizoram, Tripura and Meghalaya. A total no of 236 specimens were collected and210 specimens identified upto genus level. All the specimens have been preserved in the Herbarium of DMR, Solan. All the specimens were examined for their macroscopic features in the field along with their field photographs. Pure tissue cultures of 173 specimens were obtained and deposited in the Gene Bank of DMR,Solan.

Survey and collection of wild mushrooms from Tripura : Surveys were conducted for the collection of wild fleshy fungi on 22-24th August 2014. Collected 137 wild mushrooms growing as saprophytes on humus and forest litter, lignicolous as wood degrader and as mycorrhizic associated with trees from June to September, 2014 in the different parts of forest of Tripura. Individual

Fig. 2.1. Some interesting fleshy fungi collected from protected forest areas of Tripura

mushroom specimen was photographed in the natural habitat and documented by noting the ecological and morphological characters. Each specimen has been given a unique number and kept in paper bag. The specimens were used for tissue cultures and spore prints in the lab. for their morphological and anatomical identification. In total 137 wild specimens were collected and out of which, 82 tissue cultures were obtained on artificial selective media . All the pure cultures were deposited in the herbarium and Gene Bank of DMR, Solan.

Identification based on anatomical and morphological characters: All the specimens were identified on the bases of their morphological characters. The important specimens collected were *Agaricus, Mycena, Marasmius, Gymnopus, Xylaria, Ganoderma, Termitomyces, Phallus, Inocybe, Lactarius, Amanita, Auricularia, Pycnosporus, Russula, Coprinus, Leucocoprinus, Conocybe, Stropharia, Tremella, Crepidotus, Collybia* etc. *Schizophyllum commune* (edible mushroom) and *Pleurotus sp,* (edible mushroom) are sold in Tripura market@ Rs.300/kg (Fig. 2.2).

Fig. 2.2: Wild mushroom in Tripura market

Identification based on anatomical and morphological characters: All the specimens were identified on the bases of their anatomical and morphological characters (Fig. 2.3). The important specimen collected were *Pholiota adipose*, *Trametes hirsute*, *Trametes polyzona*, *Pleurotus pulmonarius* (edible mushroom), *Schizophyllum commune* (edible mushroom) sold in Mizoram market@ 250/kg.

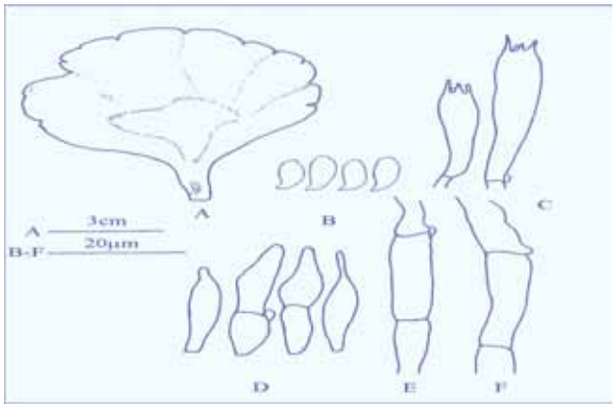


Fig. 2.3. Anatomical studies of *Pleurotus* sp.

Some of the interesting specimens which were identified by anatomical characters are as follows:

1. *Lentinus* sp. Specimen No. T 5/14

Locality: - Senorkoot, Tripura

GPS data:- N23^{0}44'269", E091^{0}16' 124", Altitude-36 m., date of collection 21-08-2014

Habitat and habit:- Lignicolous on dead palm wood and epigeous.

Macroscopic characters:-

Basidopcarp small, lentinoid, caespitose. Pileus 2-4 cm, pinkish white, infundibuliform, Margin irregular, non striate, inflexed non hygrophanous, coriaceous. Lamellae unequal, decurrent, crowded, forking and smooth. Stipe 3-4 cm in length x 0.5 cm broad, central, hollow, tough, white, fleshy.

2. *Crepidotus sp.* Specimen No. T-89/14

Locality:- Garji (Udaipur) Tripura.

GPS data:- N23^{0}44'483" E092^{0}38'942" Altitude-89 m, date of collection 24-08-2014

Habitat and habit:- growing on soil, pleurotoid, scattered and epigeous.

Macroscopic characters:-

Basidiocarp small, 1cm in height, pleurotoid. Pileus 4-5 cm in dia, flabelliform, irregular. Pileus margin irregular, non striate, inflexed, dry, non hygrophanous, glabrous. Lamellae unequal, present in 4-5 sets, coriaceous, light brown, crowded, decurrent, non separable, 2-3mm broad and smooth. Stipe lateral, 2-2 cm x 0.6cm cartilaginous, central, equal through out the length, smooth. Ring and volva absent.

3. *Gymnopus* sp . Specimen No. T-82/14

Locality:- Paratia (Udaipur) Tripura.

GPS data:- N23^{0}44.483' E091^0 26.31' Altitude- 78 m, date of collection 24-08-2014

Habitat and habit:- lignicolous,scattered to gregarious and epigeous.

Macroscopic characters:-

Basidiocarp armillarioid, medium up to 5 cm in height. Pileus 4.5 cmin dia.chocolate brown, cyathiform, regular, striated, entire, uplifted, dry, hygrophanous. Surface glabrous, coriaceous. Lamellae unequal,4 sets of lemallae, initially white then brownish white, subdistant, adnate, 2 mm broad and waxy. Stipe central, 4.0 x 0.4 cm, equal, cartilaginous, hollow and fibrous.

4. *Chlorophyllum* sp . Specimen No. T-78/14

Locality:- Paratia (Udaipur) Tripura.

GPS data:- N23^{0}44.483' E091^0 26.31' Altitude- 78 m, date of collection 24-08-2014

Habitat and habit:- lignicolous, scattered to gregarious and epigeous.

Fig. 2.4. Wild fleshy fungi from Meghalaya

Macroscopic characters:-

Basidiocarp lepiotoid, medium up to 11 cm in height. Pileus 6-7 cmin dia.,applanate with short raised umbo in the centre., regular, striated upto 2-3 cm , entire, uplifted, dry, non hygrophanous. Lamellae unequal,3 sets of lemallae, initially white then greenish yellow, crowded, adnexed, 5-7 mm broad smooth. Stipe central, 10.8 x 0.4 cm, equal, obclavate, terete, smooth, fibrous, hollow. Annulus present superior, single, patchy.

Wild mushrooms from Meghalaya

Survey for collection of wild mushrooms from Meghalaya were undertaken on 17th and 18th Sept,2015 and a total number of thirty five collections were made which includes *Scleroderma, Amanita, Hebeloma, Lactarius, Boletus ,Boletellus, Gomphus, Laccaria, Gymnopilus Tricholoma* 7 Spp, *Auricularia* and *Gomphidius* (Fig. 2.4).

2. Genetic Improvement

Genetic improvement of Button Mushroom (*Agaricus bisporus)*

Yield evaluation test have been carried out for all the five browning resistant hybrids (NBS-1, NBS-2, NBS-3, NBS-4 and NBS-5 on large scale cultivation trials two times during the period of report. In both the trials, each of hybrids was tested on 1000 kg compost along with two controls U-3 and DMR-A03. Out of the five hybrids tested two performed very well at DMR, Solan. The two hybrids also showed promising results on commercial scale trials at Balaji Mushroom

Fig. 2.5. Crop of NBS-1 (Left) Balaji Agro-products

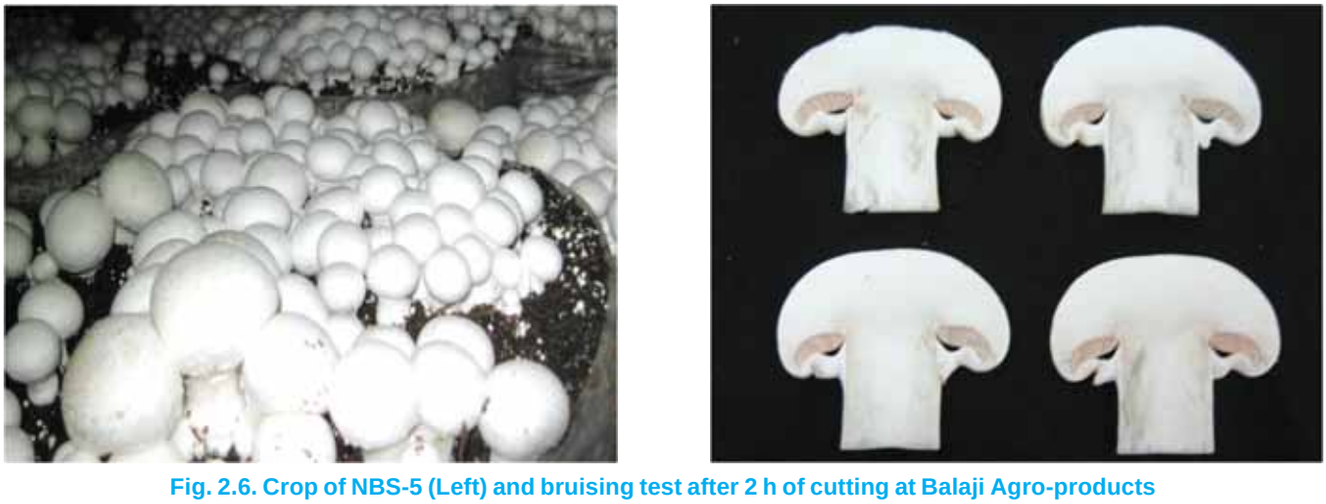


Fig. 2.6. Crop of NBS-5 (Left) and bruising test after 2 h of cutting at Balaji Agro-products

Table.2.1. Average yield of two selected non-browning hybrids of button mushroom at DMR, Solan

Strain	Average yield (kg/100 kg compost)	
	Trial – 1	Trial - 2
NBS-1	17.50	18.30
NBS-5	16.80	15.75
U-3-control	14.00	15.3

Farms (Figs. 2.5 & 2.6), Baramati, Pune; Weikfield Mushrooms, Pune and Flex Foods, at Dehradun. NBS-1 and NBS-5 yielded 25 and 23 per cent at Balaji Mushroom farm, respectively while 22 and 23 per cent at Weikfiled mushrooms. At Flex food, Dehradun also both the two strains (NBS-1 and NBS-5) performed very well and gave 17 & 19% yield, respectively, which was at par with strains imported from outside India i.e. A-15 and S-465 (Table 2.1).

Also the fruit bodies were tested for their browning analysis after two hours of mechanical injury (Fig. 2.7). All the hybrids showed no browning even after two hrs of injury. The yield of NBS-1 and NBS-5 was found significantly higher than the controls. Hybrid NBS-2, NBS-3 and NBS-4 yielded statistically at par with the control U-3 but lower than DMR-03. The enzymatic studies (Laccase, Tyrosinase and polyphenol oxidase) have been done to identify the reason for browning resistance in the hybrids.

Another variety (U3-54) has been put for commercial level trial and is performing excellent at Balaji Mushroom Farm at Baramati. The production level reported so far is 22 kg per 100 kg compost in two flushes. An average yield of 22.8, 22.65 and 18.50 kg per 100 kg compost was obtained at Murthal, Pantnagar and DMR, Solan

Fig. 2.7. Bruising test of fruit bodies at Tirupati Balaji Agro-products

Table.2.2. Enzyme profiles of Non-browning strains with control

Hybrids	Enzyme profiles (δA_{470} by 0.001/min/g protein)			Phenols (δg/g mushroom sample)	Protein (mg/g mushroom)
	Tyrosinase	PPO	Laccase		
NBS-1	25.763	193.218	10.660	33.328	5.003
NBS-2	38.729	246.469	9.204	33.708	5.288
NBS-3	44.711	280.085	4.924	50.852	4.332
NBS-4	35.366	287.943	6.666	36.549	4.700
NBS-5	22.413	253.423	6.241	33.009	5.235
Control (U-3)	51.212	397.778	13.824	36.146	4.919
Control (A-15)	55.186	490.705	30.984	47.185	4.626
Critical Difference	1.256	40.782	5.404	1.462	0.269
Standard Error	0.602	19.55	2.59	0.7	0.124
Coefficient of Variance (CV)	0.36	1.382	4.842	0.418	3.134

during 2013-14. Two browning resistant hybrids NBS-1 and NBS -5 and one single spore selection U3-54 were recommended for release.

All the strains developed were evaluated on long method compost also but in the first trial, they failed to perform along with the control (strain U-3). The parameters of the compost were tested and it was found that the compost had higher moisture percent of 72%. Next experiment is planned with varied moisture percent.

Developed and got synthesized 40 IRAP and REMAP primers along with 30 SSR primers on the basis of in silico analysis of *Agaricus* genome. Testing of the primers is under progress. 500 single spore isolates have been isolated from 5 different strains i.e. France wild, U-3, A-15, U-3-54 and U-3-58 strains of *Agaricus bisporus*. Yield trials of the isolates are yet to be done.

Evaluation of *Pleurotus sajor caju* hybrid strains : Thirty six hybrid strains developed by mating single spores from four different parent strains of *Pleurotus sajor caju* were evaluated for yield on pasteurized wheat straw. The Biological efficiency varied from 23.3% to 92% in 35 days. Highest yield was recorded in strain no PSCH-36 and PSCH-35(92% and 84%BE respectively.) The yield data are presented in Table 2.3.

Table 2.3. Yield data of *Pleurotus sajor-caju* hybrid strains on pasteurized wheat straw

S.No.	Hybrid strain/Parent	BE%
1.	PSC H-1	42.3
2.	PSC H-2	47.3
3.	PSC H-3	37
4.	PSC H-4	37.33
5.	PSC H-5	55
6.	PSC H-6	70
7.	PSC H-7	71.3
8.	PSC H-8	71
9.	PSC H-9	50.7
10.	PSC H-10	58.33
11.	PSC H-11	51.3
12.	PSC H-12	56.7
13.	PSC H-13	58.0
14.	PSC H-14	74.0
15.	PSC H-15	64.6
16.	PSC H-16	64.7
17.	PSC H-17	30.0
18.	PSC H-18	75.3
19.	PSC H-19	78.0
20.	PSC H-20	71.3
21.	PSC H-21	81.7
22.	PSC H-22	59.7
23.	PSC H-23	57.7
24.	PSC H-24	40.7
25.	PSC H-25	57.7
26.	PSC H-26	65.0
27.	PSC H-27	33.0
28.	PSC H-28	57.0
29.	PSC H-29	62.7
30.	PSC H-30	37.0
31.	PSC H-31	46.7
32.	PSC H-32	53.7
33.	PSC H-33	67.7
34.	PSC H-34	37.3
35.	PSC H-35	84.0
36.	PSC H-36	92.0
37.	DMRP-112	67.0
38.	DMRP-214	37.0
39.	DMRP-233	59.0
40.	DMRP-255	23.3

Characterization of white strain of *Volvariella volvacea* and optimization of its fruit body yield

The paddy straw mushroom, *Volvariella volvacea*, is known for its unique aroma and texture, and grows well between 28-35°C. This has given it a status of a prominent tropical/sub-tropical mushroom with round the year availability of market. Besides lower biological efficiency (about 10 to 15 % on rice straw), the brownish colour of fruit bodies is the matter of concern for augmenting its wider acceptability. Till now the research efforts have remained confined up to improvement in substrate preparation/cultivation processes and to a limited extent on strainal improvement. Thus, the present study was aimed at selecting *V. volvacea* strain with whitish fruit bodies and optimizing its productivity compared

with strains giving traditionally brown coloured fruit bodies.

(i). Genetic characterization of the white strain of *V. volvacea*

The pure mycelial culture from white coloured *V. volvacea* fruit body, collected from Port Blair region of Andaman and Nicobar Islands, India was raised using tissue culture raising technique on Malt Extract Agar (MEA) medium at 32±2 °C. The mycelial culture was molecularly identified by extracting its DNA and amplification of the ITS regions of 5.8S rRNA gene using PCR, followed by sequencing and blasting of the PCR amplified amplicon. The improved consensus sequence was blasted using BLASTn tool of NCBI for species identification. The consensus sequence was also submitted to NCBI database with accession number KC142107. The isolated culture was identified as of *Volvariella volvacea*.

(ii). Sequence alignment, phylogeny and evolutionary relationship with high yielding brown strains of *V. volvacea*

The improved consensus sequence of the ITS region of 5.8S rRNA gene of the test culture (GVv-01) along with consensus sequences of four high yielding brown strains *viz*., OE-210, OE-272, OE-274 and BBSR-007 (DMR, Solan Accession Nos. DMRO-185, DMRO-245, DMRO-247 and DMRO-463) of *V. volvacea* with NCBI Accession Nos. JN086670.2, JN086662.1, JN086663.1 and JN086677.1, respectively were studied for variability in their nucleotide sequences by 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.

The five strains used in the study including four high yielding brown strains and one white strain, formed three different groups in phylogenetic tree deduced from the sequences of 5.8S rRNA gene. The first group included all three high yielding brown strains (OE-272, OE-274 and BBSR-007), while the second and third groups were having only one white (GVv-01) and one brown strain (OE-210), respectively (Fig. 2.7). The study proved the distinctness of the white strain from rest 4 brown strains of *V. volvacea*. In nucleotides sequence variability, the PCR amplicon of 5.8S rRNA gene of white strain, GVv-01 was shortest in length (617 nucleotides). It was short by 21 nucleotides compared with three high yielding brown strains (OE-272, OE-274 and BBSR-007) and short by 19 nucleotides compared with brown strain OE-210 (Fig. 2.8). Compared with the four high yielding brown strains of *V. volvacea*, the white strain, GVv-01 exhibited a deletion of 21 nucleotides in ITS-2 region of the 5.8S rRNA gene. This in itself is an information of very high importance, as along with other morphological growth features, this long stretch of 21 nucleotides deletion makes this strain an entirely a new strain. Such types of information are missing in mushrooms and specially in *V. volvacea*.

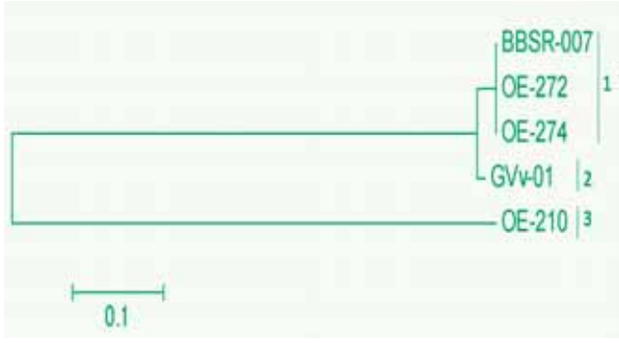


Fig. 2.8. Phylogenetic tree derived from the sequences of the 5.8S rRNA gene of the white and high yielding brown strains of *V. volvacea*. The NJ-tree was constructed using neighbors joining algorithm in MEGA 5.0 software

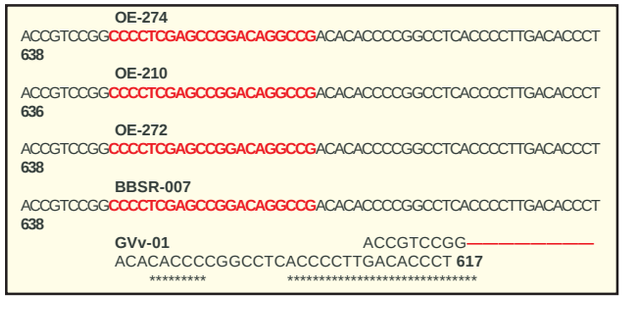


Fig. 2.9. ClustalW analysis of the ITS-2 region of 5.8S rRNA gene of four high yielding brown and one white strain of *V. volvacea*

(iii). Mycelial growth characteristics of the white and brown strains of *V. volvacea*

The mycelial growth characteristics of the white strain of *V. volvacea* were studied against two high yielding brown strains (OE-210 and BBSR-007) of *V. volvacea.* One strain each from three different groups as depicted in phylogenetic tree was used in the study. The strains were studied for radial mycelial growth (dia. in mm) and colony morphology on Malt Extract Agar (MEA) in Petridishes, and the downward mycelial growth (in mm) along with aerial mycelial growth and chlamydospore formation on pounded paddy straw filled in wide mouth test tubes at 34 ± 2° C. The downward mycelial growth was measured in mm along the extent and the density of the mycelial growth. Three replications were kept for each strain.

All the three strains attained same level of radial growth (90 mm) on MEA after 7 days of incubation at 34 ± 2 °C. However, the strains varied with respect to extent and density of aerial hypha, and the colour of chlamydospores formed. The white strain (GVv-01) formed highest and dense level of aerial hypha of creamy white colour. The brown strain OE-210 formed least extent and dense aerial hypha compared to rest two strains. The colony formed by white strain was creamy in colour, while it was brownish and white in rest two brown strains. On paddy straw, the strains varied in downward mycelial growth and it was highest of 68 mm in white strain, compared to 60.11 and 43.11 mm in brown strain BBSR-007 and OE-210, respectively. The extent and density of aerial hypha was highest in white strain, which formed light brownish chlamydospores (Table 2.4).

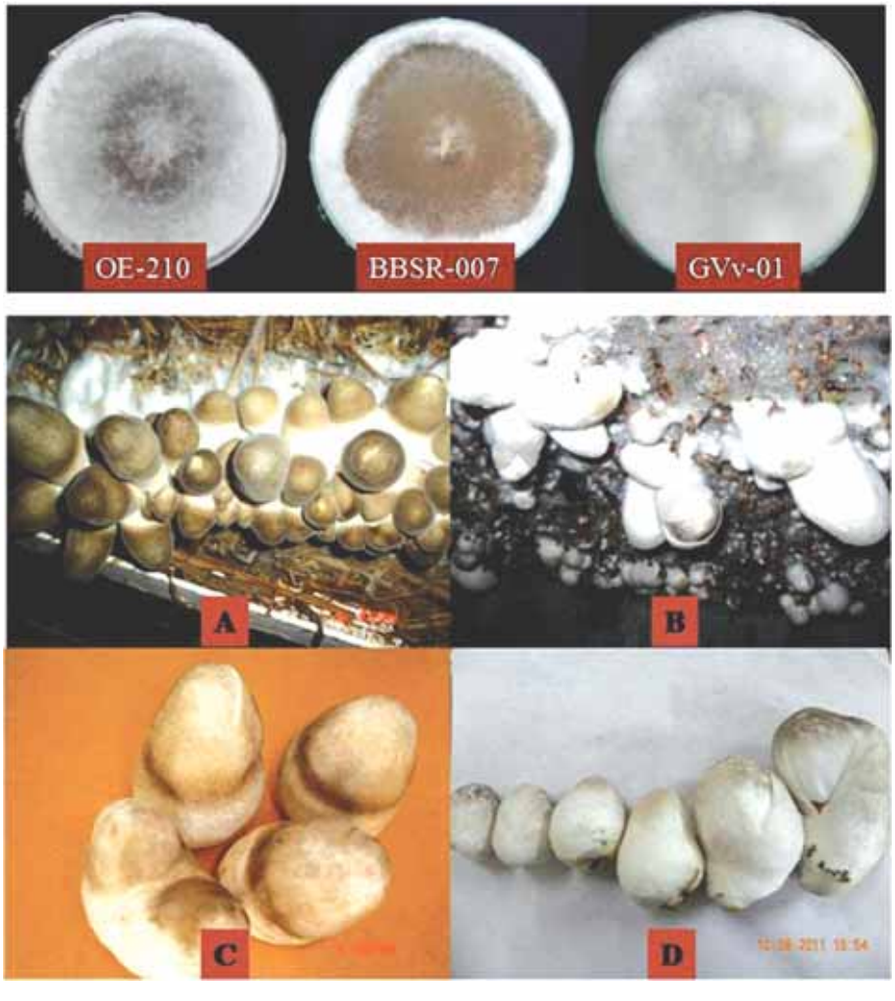


Fig. 2.10. Mycelial growth and fruit body characteristics of white and brown strains of *V. volvacea*

Table 2.4. Mycelial growth characteristics of selected brown and white strains of *Volvariella volvacea* on malt extract agar and paddy straw media

Strains	Mycelial Growth Characteristics								
	MEA medium in Petridishes					Paddy straw in Test tubes			
	Radial growth (mm)	Aerial mycelial growth		Chlamydospores	Colony colour	Downward mycelial growth (mm)	Aerial mycelial growth		Chlamydospores
		Density	Growth				Density	Growth	
GVv-01	90mm	5+	5+	Light orange	Creamy white	68.00	2+	3+	Light brownish
BBSR-007	90mm	4+	4+	Brownish circle	Brownish white	60.11	2+	2+	Brownish
OE-210	90mm	4+	3+	Brownish circle	White	43.11	2+	2+	Light Brownish circle

+ Scare; 5+ highest; - absent

(iv). Enzyme assay

The activity of extracellular lignocellulolytic enzymes of one white (GVv-01) and two high yielding brown strains (OE-210 and BBSR-007) was studied first by growing them on sterilized paddy straw substrate with 70% moisture in flasks. The enzymes were extracted from the mycelium-colonized substrate in 50 ml phosphate buffer (0.1 M), pH 7.0 by keeping the buffer mixed substrate at 40 °C for 30 min in an incubator shaker maintained at 100 rpm. The extract was filtered through glass microfibre filter (GF-C) and stored at 4 °C for further use. The enzyme assay was carried out in triplicate for all the enzymes (exoglucanase, endoglucanase, β-glucosidase, xylanase, laccase and polyphenol oxidase) and data were subjected to statistical analysis using AGRES software. One unit of laccase and polyphenol oxidase activity was calculated as change in absorbance of 0.001 min^{-1} ml^{-1} of enzyme source at 25 ^{o}C, while that of FPase, CMCase and xylanase as the m mol glucose released h^{-1} ml^{-1} of enzyme source.

The strains did show variation at the level of the activities of extracellular lignocellulolytic enzymes and the white strain exhibited highest activity of laccase, while lowest of exoglucanase and polyphenol oxidase compared with two high yielding brown strains of *V. volvacea*.

B. Crop Production

Button mushroom

Use of spent compost of button mushroom for compost making for button mushroom cultivation

The trial was conducted during October-December, 2014 by using button mushroom SMS in four different proportions i.e. 0, 20% (N balancing), 20% (no N balancing) and 30% (no N balancing) w/w to wheat straw, keeping standard composition as the control treatment (Table 2.5). The temperature in compost piles prepared with substitution of wheat straw with different proportions of SMS exhibited 1 to 9 °C higher temperature at different turnings. The ratio of wheat straw to ready compost ranged between lowest of 2.80 in control (standard formulation) to highest of 3.31 in 30% wheat straw substitution with SMS. One hundred twenty bags each with 10 kg compost capacity with 8 replications of 15 bags from each treatment were kept for fruit body yield studies.

The total organic carbon was highest of 38.6% in 20% SMS substitution with N balancing at the end of phase-I. However, at the end of phase-II it was almost at par in all treatments. The decrease in carbon content from end of phase-I to end of phase-II was highest (3.9%) in treatment with 20% SMS substitution along with N balancing, while it was lowest of 0.8% in control treatment. Similarly the organic matter was highest in 20% SMS substitution treatment with N balancing at end of phase-I of composting, which also revealed its highest decrease during pasteurization and conditioning period (Table 2.6). Lowest difference in organic matter content from phase-I and phase-II compost was lowest of 1.3 % in control treatment. The nitrogen content, both after phase-I and phase-II was higher in compost with higher proportions of SMS substitution. The values of phosphorus were highest in control treatment, while that of potassium in compost with higher proportions of SMS. C:N ratio was almost same in all treatments at spawning stage (17-18). However, it was higher in SMS substitution treatments (22-24) compared with control (21).

The fruit body yield data of 3 flushes revealed that there was insignificant difference in yield between control and two SMS (20 & 30% without N balancing) treatments. The treatment with 20% SMS along with N balancing gave superior yield during first flush, however appearance of dry bubble disease resulted in lower fruit body yield compared with rest of the treatments (Fig. 2.11). Although the mean fruit body wt. did not differ in different treatments, however it was highest in treatment with 20% SMS substitution along with N balancing (Table 2.7).

Table 2.5. Composition of compounding mixture in different composting treatments with SMS as a substitute of wheat straw (1st trial).

Compost ingredients	Quantity of composting ingredients (kg) in different composting treatments			
	Treat-1 (control)	Treat-2	Treat-3	Treat-4
Wheat straw	700	560	560	490
Poultry manure	490	275	392	343
Wheat bran	105	84	84	73.5
Urea	10.5	8.4	8.4	7.4
Gypsum	25	25	25	25
Button mushroom spent compost (at 60% moisture)	-	350	350	525
N% at beginning of composting	1.60	1.60	1.63	1.67
Conversion rate (wheat straw to ready compost)	2.8	3.18	3.27	3.31

Table 2.6. Quality characteristics of the compost in different treatments after phase-I and phase-II stages

Parameter	Quality characteristics of compost in different treatments							
	Treat-1 (control)		Treat-2		Treat-3		Treat-4	
	During filling	After filling	During filling	After filling	During filling	After filling	During filling	After filling
Total organic carbon (%)	35.5	34.7	38.6	34.7	37.7	35.8	36.5	35.4
Organic matter (%)	61.2	59.9	66.6	59.9	64.9	61.7	62.9	61.0
Total nitrogen (%)	1.7	1.9	1.6	1.9	1.75	2.0	1.6	2.1
Phosphorus (%)	0.8	0.9	0.5	0.7	0.6	0.8	0.7	0.7
Potassium (%)	1.6	1.8	1.5	1.6	1.8	1.9	1.7	1.8
C:N	21	18	24	18	22	18	23	17

Table 2.7. Fruit body yield in different composting treatments

Treatments	Fruit body yield (kg/q compost)	Nos. of fruit bodies/q compost	Mean fruit body wt. (g)
T-1	16.82	1431	11.75
T-2	13.93*	1101	12.65
T-3	16.10	1368	11.77
T-4	16.27	1364	11.93
$CD_{0.05}$	2.54	195	1.86

* Treatment was far superior in the beginning but yield losses occurred due to disease during 2nd and later flushes

Fig. 2.11. Photographs of infected and healthy crop of *A. bisporus* in two different treatments

Evaluation of different watering regimes for fruit body yield of button mushroom

Five different watering regimes *viz*., i) routine daily light watering up to end of the crop, ii) watering on every alternative day, iii) watering at a gap of 2 days, iv) watering at gap of 3 days and v) heavy watering on 0, 4th, 7th day after casing and regular light watering afterward. Although the difference in fruit body yield was insignificant in different treatments, except of watering after every fourth day. However, highest fruit body yield was recorded in treatment received heavy watering on 0, 4th, 7th days followed by light watering up to the end of crop, followed by treatment with routine daily light watering (Table 2.8). Although the

Table 2.8. Fruit body yield in different water spraying treatments

Watering spraying treatments	Fruit body yield (kg/q compost)	Nos. of fruit bodies/ q compost	Mean fruit body wt. (g)
Routine normal spray (FYM + Spent compost + BRH, 2:2:1, v/v)	16.70	1391	12.00
Alternative day	15.72	1346	11.67
On every third day	15.90	1427	11.14
On every fourth day	14.29	1377	10.38
Heavy spray on 1,4 and 7th day, followed by routine light spray	16.84	1483	11.36
$CD_{0.05}$	2.43	159	2.30

difference in mean fruit body wt. was insignificant between different treatments, however, it was highest in treatment with routine light watering regime up to the end of the crop, followed by watering on every alternative day.

Paddy Straw Mushroom

Cultivation trial

The cultivation trials were conducted at environment controlled mushroom growing unit of the Directorate. The first trial was conducted by involving four high yielding brown strains and one white strain at comparatively low temperature conditions (25-28 °C) using composted substrate prepared from 1:1, w/w combination of paddy straw (PS) and cotton ginning mill waste (CGMW). The paddy straw based ready to use spawn was used for the trial. Five replications each with two beds of 15 kg composted substrate were used for each strain and the experiment was conducted in Randomized Block Design (RBD). The second trial was conducted by using four strains including three high yielding brown strains also used in first trial and one white strain by following the same protocol as for the first trial but at optimum temperature conditions (32-35 °C) recommended for the brown strains of *V. volvacea*. The last two fruit body yield optimization trials were conducted by using only white strain (GVv-01) of *V. volvacea*. The substrates prepared with PS, CGMW and 1:1, w/w combination of PS + CGMW were used for these trials. 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 treatments (beds with three different quantity of substrate/bed for all three types of substrates) in RBD. Standard cropping conditions and protocols were adopted for conducting the trials. Data for time taken for first harvest (days post-spawning), mushroom (fruit body) yield (kg/q dry substrate) and mean wt. of fruit bodies (g) were recorded for 15 days of cropping. The data was subjected to statistical analysis by single factorial ANOVA using AGRes software.

The initial evaluation trial conducted at comparatively lower temperature conditions, revealed lowest first harvest time of 11.93 days in white strain, GVv-01. It also gave highest fruit body yield (20.79 kg/q dry substrate) and the mean fruit body weight (20.74 g) compared with four high yielding brown strains of *V. volvacea*. In evaluation trial conducted at optimum temperature conditions (30-35 °C) for *V. volvacea* cultivation, shortest time for first harvest (11 days) was again recorded in white strain compared with brown strains. This strain also gave significantly higher fruit body yield (41.12 kg/q dry substrate) and mean fruit body weight (20.40 g) compared with brown strains. The study proved the white strain as superior strain in all respect, giving first harvest nearly two days earlier, and fruit body yield and mean fruit body wt. higher by nearly 28 and 37%, respectively than the best performing brown strain (BBSR-007). This strain also revealed its ability to give superior fruit body yield at lower temperature conditions, where the high yielding brown strains failed (Table 2.9).

The white strain evaluated on beds with three different quantities of substrate/bed prepared from

Table 2.9. Fruit body yield of brown and white strains of *V. volvacea* at different temperature conditions on composted substrate of paddy straw and cotton ginning mill waste

Strain	Time taken for first harvest (days post-spawning)		Mushroom yield (kg/q dry substrate)		Average fruit body wt. (g)	
	Low temperature	Optimum temperature	Low temperature	Optimum temperature	Low temperature	Optimum temperature
OE-210 (brown)	13.25	13.22	7.51	18.17	7.83	6.40
OE-272 (brown)	15.00	ND	1.75	ND	10.29	ND
OE-274 (brown)	13.88	13.94	7.75	31.38	8.12	15.18
BBSR-007 (brown)	12.62	13.11	8.93	32.21	14.83	14.90
GVv-01 (white)	11.93	11.00	20.79	41.12	20.74	20.40
$CD_{0.05}$	1.87	1.32	3.06	2.94	3.21	2.85

Low temperature – 25 to 28 °C, Optimum temperature – 30 to 35 °C, ND – not done

PS, CGMW and 1:1, w/w combination of PS + CGMW, revealed lowest first harvest time of 9.0 days in 15 kg substrate beds of CGMW, followed by 9.67 days in 18 kg substrate beds of CGMW. In trial-1, the beds prepared from CGMW took 1-3 days less time for first harvest than beds of PS + CGMW and PS alone. The difference in first harvest time was not so significant in trial-II (Table 2.9). However, lowest time was again recorded in beds of CGMW. In trial-I, the effect of the quantity of substrate used for bed making was more significant compared to trial-II. In trial-I, beds prepared with 18 kg substrate/bed of CGMW gave higher fruit body yield compared with beds prepared with 12 and 15 kg substrate/bed. The trend was just reverse with beds prepared with PS and beds with smaller quantity of substrate/bed gave higher fruit body yield compared to beds with higher substrate/bed. The difference in fruit body yield in relation to quantity of substrate used/bed was not evident in case of substrate prepared with 1:1, w/w combination of PS + CGMW both in trial-I and II. Not much relationship could be established with the type of substrate and the quantity of substrate/bed with the mean fruit body wt. in all the three substrate types (Table 2.10).

Table 2.10. Yield potential of white strain of *V. volvacea* on beds with different quantities and types of substrate

Substrate ans substrate quality (kg/bed)	Time taken for first harvest (days post-spawning)			Mushroom yield (kg/q dry substrate)			Average fruit body wt. (g)		
	Trial - I	Trial - II	Average	Trial - I	Trial - II	Average	Trial - I	Trial - II	Average
CGMW – 12	10.17	12.75	11.46	30.49	25.25	27.87	19.66	19.33	19.50
CGMW – 15	9.0	12.12	10.56	30.43	23.63	27.03	19.87	20.91	20.39
CGMW – 18	9.67	12.75	11.21	33.17	18.08	25.63	19.12	16.89	18.01
CGMW + PS - 12	11.17	13.37	12.27	35.04	22.2	28.62	20.96	20.51	20.74
CGMW + PS - 15	10.83	12.62	11.73	36.21	16.02	26.12	22.23	19.34	20.79
CGMW + PS - 18	11.33	12.37	11.85	35.86	22.29	29.08	20.98	18.33	19.66
PS – 12	12.17	12.75	12.46	31.78	26.64	29.21	20.24	19.37	19.81
PS – 15	12.33	12.87	12.60	23.02	28.71	25.87	20.66	19.75	20.21
PS – 18	12.67	13.00	12.84	19.57	26.33	22.95	23.31	17.55	20.43
$CD_{0.05}$	1.19	0.98	-	2.67	2.83	-	2.38	2.64	-

CGMW – cotton ginning mill waste, PS – paddy straw, 12, 15, 18 – quantity of composted substrate in kg

Comparative nutritional analysis of the mushroom fruit bodies of white and brown strains of *V. volvacea*

The randomly drawn fifteen to twenty fruit bodies from one brown strain (BBSR-007) and one white strain (GVv-01) of *V. volvacea* were got analyzed for fifteen different parameters *viz*., dry matter, ash, crude fibre, carbohydrates, protein, fat, vitamin-D and 8 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 dry matter, ash, crude fibre, fat, carbohydrate and protein content. Mineral constituents (iron, copper, zinc, selenium and magnesium) were determined by using ICP-MS method 999.10, while sodium and potassium by using flame photometer. Calcium was determined by Titrimetric Macro method, 910.01. Vitamin D as Vitamin D_2 was determined using HPLC as per the protocol standardized at PBTI, Mohali.

The proximate nutritional analysis of the fruit bodies of white and brown strains of *V. volvacea* revealed higher contents of ash, crude fibre and all seven minerals (potassium, sodium, calcium, iron, copper, zinc and magnesium) in fruit bodies of the white strain compared with the fruit bodies of brown strain. The enhancement ranged between lowest of 6.62% for zinc to highest of 50.68% for calcium. The fruit bodies of white strain exhibited lesser levels of dry matter, fat, protein and vitamin D compared to fruit bodies of brown strain (Table 2.11). For these four parameters, except of vitamin D, the difference in other contents was not significant between two strains. The two strains differ marginally with respect to protein content and the difference was only 3.20%. Selenium was not detected in the fruit bodies both types of strains. In nut shell, the white strain was superior in minerals and crude fibre contents, while the brown strain in vitamin D content, rest other parameters were by and large at similar levels.

The white strain (GVv-01) formed a different clade in phylogenetic tree than rest four brown

Table 2.11. Proximate composition of the fruit bodies of the brown and white strain of *V. volvacea*

Nutritional parameters	Brown strain of *V. volvacea*	White strain of *V. volvacea*	Difference over brown strain (± %)
Dry matter (%)	10.10	9.0	-10.89
Ash (%)	9.01	10.30	+14.32
Fat (%)	0.97	0.79	-18.56
Carbohydrate (%)	42.30	42.83	+1.25
Protein (F=6.25) (%)	38.10	36.88	-3.20
Crude Fibre (%)	4.40	6.02	+36.82
Vitamin D (IU/g)	462.04	268.55	-41.88
Potassium (%)	4.16	5.34	+28.37
Sodium (mg/kg)	345.34	417.08	+20.77
Potassium: Sodium	120.46	128.03	+6.28
Calcium (mg/100 g)	39.74	59.88	+50.68
Iron (mg/kg)	72.51	84.59	+16.66
Copper (mg/kg)	42.55	56.13	+31.92
Zinc (mg/kg)	94.28	100.52	+6.62
Magnesium (%)	0.11	0.15	+36.36

strains, deduced from the 5.8S rRNA gene sequences of these strains. A deletion of 21 nucleotides long was also recorded in ITS-2 region of 5.8S rRNA gene of this strain compared with brown strains. The white strain exhibited highest downward mycelial growth on pounded paddy straw and formed morphologically distinct colony on Malt Extract Agar medium. It gave highest fruit body yield both at 25-28 and 30-35 °C temperature conditions with shortest first harvest period compared with brown strains. It also yielded well on composted substrates of cotton ginning mill waste, cotton ginning mill waste + paddy straw (1:1, w/w) and paddy straw alone. The mean fruit body wt. of this strain ranged between 16.89 to 23.31 g on different substrates and was more compared to brown strains. The fruit bodies had higher crude fibre, ash and contents of calcium, potassium, sodium, zinc, magnesium, copper and iron compared to fruit bodies of brown strains. Considering all aspects, the white strain can be a good substitute of commonly grown brown strains for boosting the production of *V. volvacea*.

Proximate composition of different mushroom varieties

Mushrooms are nutritionally important as they are rich in protein, fibres and minerals, while poor in fats. Besides this, mushrooms are also rich source of vitamin B1, B2, B12, C, D, and E. Mushrooms are also important from nutraceutical point of view as they contain several compounds like unsaturated fatty acids, phenolic compounds, tocopherols, ascorbic acid and carotenoids. The nutritional attributes of edible mushrooms and the health benefiting effects of the bioactive compounds they contain, make mushrooms a health food. However, the values presented in different studies vary from sample to sample, contributed by different methodologies employed. The comparative nutritional information on the commonly cultivated mushrooms is still scanty. In present study, it was intended to provide information about the nutritional value and chemical composition of the most popular cultivated species; *A. bisporus* (white button mushroom), *Pleurotus eous* (pink oyster mushroom), *Lentinula edodes* (Shiitake) and *V. volvacea* (paddy straw mushroom) produced and marketed in India.

The crop of four mushroom species *viz*., *Agaricus bisporus* (white button mushroom), *Pleurotus eous* (pink oyster mushroom), *Lentinula edodes* (Shiitake) and *Volvariella volvacea* (paddy straw mushroom) was raised at Mushroom Farm of the Directorate during 2014-15 by following the standard package of practices. Twenty randomly selected fresh fruit bodies of average size and from first flush of all four mushroom species were first dried at ambient temperature (20-25 °C) for four days followed by drying in hot air oven at 60 °C for 16-18 hours till constant weight is achieved. The dried fruit bodies were grinded in a mixer grinder and sealed. The samples were coded for maintaining un-biasness at analysis level. Three samples were kept for each mushroom.

The samples were got analyzed for fifteen different parameters *viz*., carbohydrates, protein, fat, vitamin-D and 6 different minerals (sodium, potassium, iron, zinc, manganese 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 fat, carbohydrates and protein content. Mineral constituents (iron, zinc, selenium and manganese) were determined by using ICP-MS method 999.10, while sodium and potassium by using flame photometer. Vitamin D as Vitamin D_2 (Ergocalciferol) was determined using HPLC as per the protocol standardized at PBTI, Mohali. It was determined at a wavelength of 266 nm by using Eclipse XCB-C18 column, DAD (UV-VIS) detector and Methanol/Acetonitrile/Water as the mobile phase.

The four mushroom varieties tested for their nutritional composition varied in protein content from lowest of 18.85 % in *L. edodes* to highest of 38.10 % in *V. volvacea*. The second highest level of protein (29.14 %) was in *A. bisporus*, followed by *P. eous* (19.59 %). Fat (0.97 %) was lowest in *V. volvacea*, followed by *P. eous* (1.05 %), *L. edodes* (1.22 %) and *A. bisporus* (1.56 %). Vitamin D content was highest in *A. bisporus* (984 IU/g),

Table 2.12. Nutritional composition of different mushrooms

Nutritional parameters (dry wt. basis)	Mushroom variety			
	Agaricus bisporus	*Pleurotus eous*	*Volvariella volvacea*	*Lentinula edodes*
Protein (%)	29.14	19.59	38.10	18.85
Carbohydrates (%)	51.05	64.34	42.30	63.60
Fat (%)	1.56	1.05	0.97	1.22
Vitamin D (IU/g)	984	487	462.04	205
Sodium (mg/kg)	500.8	208.87	345.34	82.49
Potassium (%)	4.21	2.70	4.16	2.10
Potassium : Sodium	84 : 1	129 : 1	120 : 1	255 : 1
Iron (mg/kg)	85.86	183.07	72.51	37.55
Manganese (mg/kg)	7.97	6.47	-	17.48
Zinc (mg/kg)	79.64	162.18	94.28	89.63
Selenium (mg/kg)	1.34	ND	ND	ND

(Minimum Detection Limit 1.25 mg/kg)

followed by *P. eous* (487 IU/g) and *V. volvacea* (462.04 IU/g). It was lowest in *L. edodes* (205 IU/g). The elemental contents of sodium, potassium and iron were also lowest in *L. edodes*. Out of these three, sodium and potassium contents were highest in *A. bisporus*, while iron in *P. eous*. Zinc was highest (162.18 mg/kg) in *P. eous* and manganese (17.48 mg/kg) in *L. edodes*. The potassium/sodium ratio was highest in *L. edodes*, where it was 254.58 compared with only 84.07 in *A. bisporus*. Selenium was recorded only in *A. bisporus*, whereas in rest cases it was not detectable (Table 2.12).

Effect of UV light exposure on vitamin D content in *Agaricus bisporus* and *Volvariella volvacea*

Among vitamins, vitamin D is the most sought after vitamin as there are very limited vegetarian sources of this vitamin. Mushrooms are natural source of vitamin D, however it is found in larger quantities in wild mushrooms compared to cultivated mushrooms, attributed to their exposure to sunlight. The ultraviolet (UV) radiation present in sunlight catalyzes a unique photochemical reaction whereby the fungal sterol, ergosterol, is converted to vitamin D through a series of photochemical and thermal reactions, similar to that occur in human skin. To simulate the natural process of vitamin D synthesis commercial mushroom growers have recently incorporated sources of UV light into their production processes. In order to harvest the real benefits of this natural process of vitamin D enrichment, studies on refinement of the dose as well as the duration of UV light were conducted with the harvested fruit bodies of white button and paddy straw mushroom.

The study was carried out with two mushroom species, *A. bisporus* (white button mushroom) and *V. volvacea* (paddy straw mushroom) considering their popularity in the country. The freshly harvested fruit bodies of two mushroom species were exposed to UV light of 254 nm for varied duration starting from 15 minutes to 240 minutes keeping unexposed fruit bodies as controls. Fruit bodies from all treatment were first dried at 25-30 °C for 4 days, followed by their drying at 60 °C in a hot air oven till constant weight is achieved. The dried fruit bodies were grinded in a mixer grinder and packed in an air tight polypropylene bag by hermetical sealing. The samples were got analysed for vitamin D content from PBTI, Mohali.

Variations were recorded with respect to vitamin D content in two mushrooms as well as two strains of *A. bisporus* used in the study (Table

Table 2.13. Vitamin D profile of *Volvariella volvacea* and *Agaricus bisporus* after exposing their fresh fruit bodies to UV light (254 nm) for different duration.

UV light treatment (duration in min)	Vitamin D content (IU/g of dry mushroom powder)		
	Agaricus bisporus		*Volvariella volvacea*
	Strain DMR-3	Horst U3	
15 minutes	180.5	419.29	312.61
30 minutes	38.3	488.03	448.12
45 minutes	38.8	621.06	414.11
60 minutes	30.8	400.82	280.20
120 minutes	36.1	207.5	323.12
180 minutes	59.1	422.4	131.84
240 minutes	65.0	588.99	231.06
Control I (normal fluorescent light)	93.7	380.62	224.10
Control-II (without fluorescent light)	42.7	ND	231.62

2.13). The vitamin D content in *A. bisporus* strain U3 was nearly 1.5 times more than in *V. volvacea* at different duration of exposure to UV light. Contrary to this the vitamin D content in *A. bisporus* strain DMR-3 was nearly 10 folds lesser than the strain Horst U3. Among different durations of exposure to UV light, 15 and 45 minutes exposure in case of strains DMR-3 and Horst U3 of *A. bisporus*, respectively and 30 minutes in case of *V. volvacea* stimulated highest vitamin D formation (Table 2). In case of *A. bisporus*, the vitamin D content again started increasing in 180 and 240 minutes duration of exposure to UV light. Such a phenomenon was not noticed in case of *V. volvacea*. The drying of *A. bisporus* fruiting bodies under fluorescent light led to higher vitamin D content compared to drying in absence of fluorescent light (Table 2.13).

Specialty mushrooms

Shiitake

Developing cultivation technologies for Indigenous edible mushroom *Lentinula, Calocybe Indica, Cordyceps* and *Phellorinia* mushrooms

A short duration cultivation technology for shiitake cultivation developed by using this technology the first crop/harvest can be taken just in 45 days as compared to 75-80 by earlier available technology. We have filed one patent for developing this technology. Further , Five strains (DMR-Shiitake-388S, DMR-Shiitake-388, DMR-38, DMR- 16 and DMR- 22), of shiitake were evaluated for short fruiting in short period. DMR-Shiitake-388S gave fruiting in the shortest duration (44 days). Shiitake -388 also took 52 days whereas other strains took more than 65 days for sterilized fruiting on saw dust substrate.

Technology for short duration fruiting in shiitake

Cultivation was carried out on sawdust (tuni, mango, safeda, oak and poplar) and wheat bran (10:1)

Mixed substrate was filled in Poly Propylene bags (1.2- 1.5kg wet/ bag)

Bags sterilized in an autoclave at 22 psi for 90 min.

Grain spawn was inoculated @3% (wet wt basis, top spawning) and bags incubated at 4 hr/20 hr light / dark cycles at 23-25°C. Spawn run took 36-40 days including bump formation and browning.

Cold water treatment treatment by immersing the spawn run synthetic logs in cold water (6-8 ° C)

for 10-15 minutes after removing PolyPropylene bag

A room temperature of 20-22°C, RH (85-90%) and light for 10-12 hours were maintained.

After 3-4 days of the cold water treatment small primordia developed which mature into full grown fruit bodies in next 3-4 days

Preparation of compost for shiitake cultivation

Compost was prepared for shiitake cultivation using wheat straw and calcium nitrate and ammonium nitrate. Pasteurization was done at 60-63°C for 8 h. Spawn run was patchy and later the substrate infected with *Trichoderma* and Bacteria.

Evaluation of Milky Mushroom strains

Five strains of *Calocybe indica* namely CI-14-01, CI-14-02, CI-14-03, CI-14-04 and CI-14-05 were evaluated for yield using chemically treated wheat straw (Table 2.14). CI-14-03 gave the highest yield (57.86kg/ q substrate) followed by CI-14-02(42.13kg/ q substrate) and CI-14-01(32.80 kg/q substrate).

Attempting cultivation of *Phellorinia*

Different substrates viz. Wheat straw and saw dust were attempted for the cultivation of *Phellorinia*. Both the substrates were successfully colonized by *Phellorinia.* After the spawn run bump type structure resembling primordia developed. But no further differentiation took place.

Phylogenetic analysis of *Phellorinia* species

Phylogenetic analysis of *Phellorinia* species has been done using ITS 5.8S rDNA sequences using minimum evolution method, maximum likelyhood analysis and confirmed by baysing statistics tools. The evolutionary history was inferred by using the Maximum Likelihood method based on the Tamura-Nei model. Pairwise distances estimated using the Maximum Composite Likelihood (MCL) approach, and then selecting the topology with superior log likelihood value. The sequence data was also subjected to Baysian analysis to calculate the posterior predictive distribution to do predictive inference, i.e., to predict the distribution of a new, unobserved data point using Mr Bayes software using Markov Chain Monte Carlo (MCMC) Methods. All the ten sequences subjected to phylogenetic analysis grouped the sequences in to 3 three major clades suggesting at least three different species of *Phellorinia* exist amongst the collected specimens. The confirmation of the results of maximum likelyhood analysis was done through baysian analysis (Figs. 2.12 & 2.13).

Studies on antioxidant activity of *Lentinus connatus*

Antioxidant activity of *Lentinus connatus* was studied following standard protocol. Anti oxidant activity was found to be 57.89% while reducing activity and scavenging effect of DPPH radical was found to be 62.04% and 43.80%, respectively.

Table 2.14. Evaluation of various strains of *Calocybe indica*

Strain	Days for spawn run	Days for first harvest	Yield per quintal dry substrate(kg)	Number of fruit bodies	Avr fruit body weight (g)
CI-14-01	27	50	32.80	103	31.68
CI-14-02	24	48	42.13	100	42.02
CI-14-03	24	48	57.86	135	42.72
CI-14-04	28	54	21.66	71	30.41
CI-14-05	28	49	34.80	87	39.67
CD.05			1.79		

Fig. 2.12. Molecular Phylogenetic analysis of *Phellorinia* spp. by Maximum Likelihood method with 1000 bootstrap comparisons. The tree with the highest log likelihood (-1169.7879) is shown. The tree is drawn to scale, with branch lengths measured in the number of substitutions per site (next to the branches). The analysis involved 8 nucleotide sequences. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated. There were a total of 676 positions in the final dataset. Evolutionary analyses were conducted in MEGA6 [9].

Studies on the cultivation of *Cordyceps* sp.

Different media such as saw dust, wheat grains and other media such as Malt extract medium, Asthana & Hawkers medium, starch agar medium and Czapekdox medium was tested for fruiting of *Cordyceps* sp. Excellent fruiting was recorded in one of the medium after 21 days of inoculation (Fig. 2.14).

Fig. 2.14. *Cordyceps sp*.

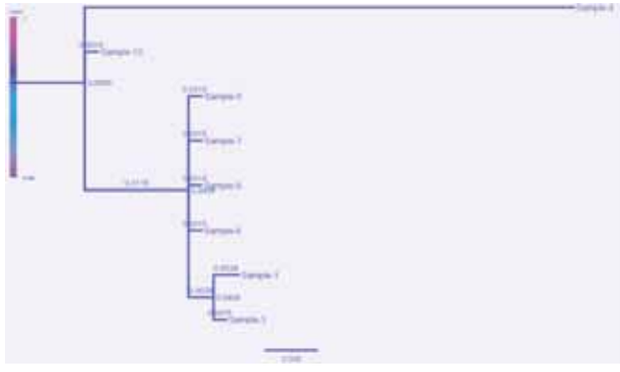


Fig. 2.13. Phylogram of *Phellorinia* sequences generated by Mr Bayes based on Baysian analysis on the basis of posterior predictive distribution by MCMC methods. The Phylogram validated maximum likelihood analysis by Mega 6 software [Credible sets of trees (237 trees sampled): 50 % credible set contains 50 trees; 90 % credible set contains 94 trees; 95 % credible set contains 100 trees; 99 % credible set contains 106 trees] [10]

Cultivation of *Schizophyllum commune* on wheat straw

Schizophyllum commune is a common ligninolytic mushroom found growing on different kinds of wooden logs or outer bark of living trees in temperate, sub tropical and tropical conditions. The fruit bodies are small (2-4cm in dia), fan shaped with a very short stem or stipe. This mushroom is consumed by the local people in north eastern states of Mizoram (Passi mushroom) Arunachal Pradesh and Meghalaya., where it is collected during rainy season and sold in the local market @ Rs. 300-400/Kg depending upon the availability. It is also consumed by the people of Madagascar and Dutch East Tribes and they habitually chew carpophores of *Schizophyllum*.Spawn of three strains was prepared on sterilized wheat grains in polypropylene bags following the standard method of spawn preparation.Wheat straw and saw dust after soaking in water for 12 hours were autoclaved (22 lb. p.s.i.) for 60 minutes in P.P. bags. Mycelial growth was completed in 15 days on wheat straw while it took 20- 24 days on saw

Fig. 2.15. Wild *Schizophyllum commune* on log

Fig. 2.16. Mycelium growth of *Schizophyllum commune* on sterilized saw dust and wheat straw

Fig. 2.17. Fruiting of *Schizophyllum commune* on wheat straw

dust at 25-30^{0}C. The fruiting temperature is between 25-32^{0}C and RH between 50-60%.Strain no. DMRP-179 gave maximum biological efficiency of 55-70% on wheat straw in 30-40 days (Figs. 2.15-2.17).

C. Crop Protection

(a) Diseases

The sequences of *Cladobotryum* spp were analysed using Mega 6.0 software for maximum likelyhood analysis using 1000 bootstrap comparisons. The evolutionary history was inferred by using the Maximum Likelihood method based on the Tamura-Nei model. Pairwise distances were estimated using the Maximum Composite Likelihood (MCL) approach. The analysis involved 15 nucleotide sequences. There were a total of 775 positions in the final dataset. The sequence data was also subjected to Baysian analysis also to calculate the posterior predictive distribution to do predictive inference, i.e., to predict the distribution of a new, unobserved data point using Mr Bayes software using Markov Chain Monte Carlo (MCMC) Methods. The tree shows three major groups referring to three species *Cladobotryum dendroides, Cladobotryum mycophilum and Cladobotryum asterophorum.* It was confirmed by the analysis that *Cladobotryum dendroides, Cladobotryum mycophilum* was found associated with cobweb disease of white button and milky mushrooms, whereas *Cladobotryum asterophorum* was exclusively found to be associated with *Pleurotus* species (Figs. 2.18 & 2.19).

It was again observed lower moisture contents of casing soil at the time of pasteurization favours the survival of *Mycogone perniciosa.*

Out of five fungicides and two other chemicals tried, chlorothalonil and carbendazim proved equally effective in managing wet bubble disease among all the fungicides.

Pre spawning of casing soil 20 days prior to pasteurization with grain spawn , liquid

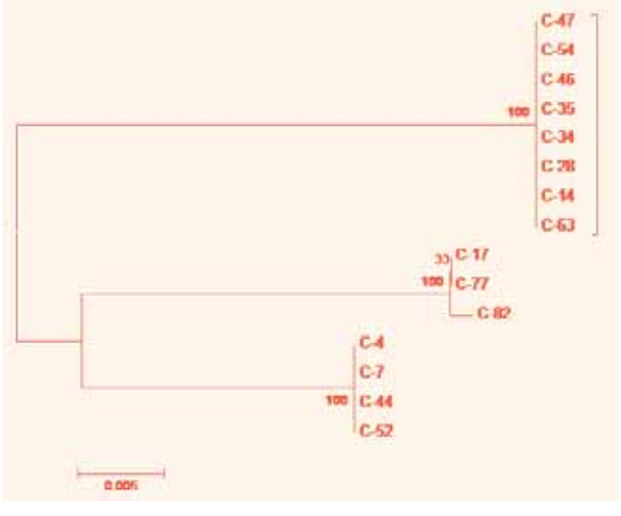


Fig. 2.18. Sequence analysis of ITS-5.8S rDNA of *Cladobotryum* isolates by Mega 6 software using maximum likelihood method with 1000 bootstrap comparisons. The tree shows three major groups referring to three species *Cladobotryum dendroides, Cladobotryum mycophilum* and *Cladobotryum asterophorum*

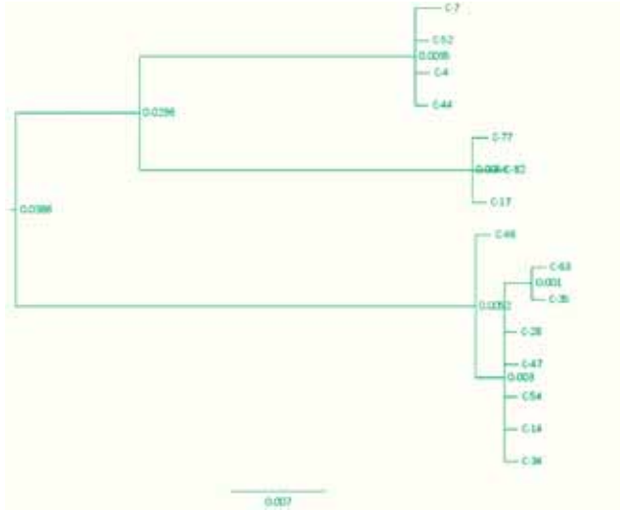


Fig. 2.19. Phylogram generated by Mr Bayes based on Baysian analysis on the basis of posterior predictive distribution by MCMC methods. The Phylogram validated maximum likelihood analysis by Mega 6 software (Credible sets of trees (11070 trees sampled): 50 % credible set contains 3569 trees; 90 % credible set contains 9570 trees; 95 % credible set contains 10320 trees; 99 % credible set contains 10920 trees

spawn of button mushroom, spawn run compost and grinded mushrooms resulted in reduced incidence of wet bubble disease. Maximum reduction was recorded with spawn run compost, followed by grain spawn. Liquid spawn was least effective (Table 2.15).

Table 2.15. Management Wet bubble disease through pre spawning of casing with *A.bisporus*

Treatment	Yield (kg) per 100 kg compost	Percent decrease over control (T 10)
T 1 (Grain spawn)	10.8	-25.51
T 2 (liquid spawn)	6.8	-53.10
T 3 (Spawn run compost)	11.2	-22.75
T 4 (Grinded mushroom)	8.0	-44.82
T 5 (Control-I)	14.5	-
T 6 (Control-II)	6.8	-53.10
T 7 (Control-III)	2.5	
CD 0.5	1.1	

Similarly addition of 3+9+B-18 resulted in significant increase in mushroom yield (Table 2.17) as compared to Control-III (Inoculated with pathogen).

Table. 2.16. Management of Wet bubble disease through bio agents

Treatment	Yield (kg) per 100 kg compost	Percent decrease over control (T 10)
T 1	12.2	-15.86
T 2	12.2	-15.86
T 3	11.5	-20.68
T 4	8.2	-43.44
T 5	12.8	-11.72
T 6	14.5	-
T 7	6.8	-53.10
T8	2.5	
CD 0.5	1.5	

(b) Pests

Among the different plant products tested by using knock down chamber, maximum mortality of 94.78% was recorded in case of rhizome extract of *Achorus* sp. Least mortality of 11.28 % was recorded in case of Waxal-AA.

Table 2.17. Evaluation of plant products against sciarid flies

Plant product	% mortality	Corrected mortality
Econeem	34.28	18.61
Neem jeevan	45.45	31.81
Electra	42.85	20.56
Sai gold	41.66	27.07
Waxal-AA	29.03	11.28
Rhizome extract of *Achorus* sp	95.83	94.78

D. Post Harvest Technology

Mushroom based new products and fortified mushroom products have been developed including mushroom fortified corn extrudates, fortified cakes, ready to cook frozen mushroom tikki. Fortification levels of mushroom in extrudates were optimized for sensory and nutritional properties to a level of 20% paste and 10% mushroom powder for both single and twin screw extruders.

Ready to cook (3 min fry) frozen mushroom tikki was developed and cohesive binding properties of mushroom shreds was optimized by using response surface methodology and taking shred size, corn starch concentration and parfrying time as the variables. Optimization was done on basis of fat absorption characteristics, textural and sensory properties.

Mushroom fortified cakes have been developed and fortification to a level of 20% (as wheat flour replacement) has been found to be optimum according to sensory and textural properties of both cake and batter prior to baking.

Antioxidant evaluation of edible mushrooms (*A. bisporus, P. ostreatus, C. indica, L. edodes* and *V. volvacea*) of India was done on the basis of % DPPH inhibition, TBA reactives and total phenols. The results demonstrated that *A. bisporus* has maximum DPPH inhibition activity as well as TBA reactives whereas *P. ostreatus* has maximum total phenolic content.

Effect of cooking by various methods (Boiling, frying and microwaving) on antioxidant properties have been studied and shallow quick frying of mushrooms was found to be the most potent method of cooking mushrooms to have the best carryover of antioxidants of mushrooms in cooked diet.

Post-Harvest Management

Development of mushroom based products

a) Sensory and nutritional properties of mushroom fortified extrudates

Corn grits and mushroom powder or paste was blended with final moisture content of 14% and the material was extruded by both single and twin screw extruder. Effect on nutritional and sensory properties of corn extrudates was studied and optimization of fortification level of both mushroom powder and mushroom paste was done according to Agres data software. Analysis was done for expansion ratio, bulk density, color, appearance, flavor, texture, moisture, protein, fat, ash and fiber content of products. A set of 15 semi trained panelists were employed for sensory evaluation and data was analyzed for ranks statistically.

Fortification level of corngrits: mushroom powder (90:10) and corngrits: mushroom paste (80:20) was optimized according to sensory evaluation. The optimized product had improved levels of protein and fiber content. The work concluded with development of mushroom fortified corn extrudates as a preferred and nutritional snack for children (Table 2.18).

Fig. 2.20. Mushroom fortified corn extrudates

Table 2.18. Protein, fiber and ash analysis of mushroom fortified corn extrudates

Type of extruder	Feed material	Ratio	Protein (%)	Fiber (%)	Ash (%)
Single screw extruder	Maize:Mushroom paste	100:0	7.83	6.75	1.07
		90:10	8.38	7.15	1.39
		80:20	**8.51**	**7.19**	**1.41**
		70:30	8.6	7.28	1.42
	Maize:Mushroom powder	100:0	7.83	6.75	1.07
		90:10	**9.41**	**7.5**	**2.1**
		80:20	10.61	7.78	2.12
		70:30	11.4	7.81	2.18
Twin screw extruder	Maize:Mushroom paste	100:0	7.7	6.35	1.1
		90:10	8.54	6.8	1.44
		80:20	**8.58**	**6.9**	**1.45**
		70:30	8.61	7.12	1.48
	Maize:Mushroom powder	100:0	7.7	6.35	1.1
		90:10	**9.49**	**7.4**	**1.97**
		80:20	10.32	7.9	2.1
		70:30	11.47	8.31	2.18

b) Frozen Mushroom Tikki

Mushoom shreds have poor adhesive and cohesive properties due to lack of starch in them. Tikki is an Indian snack time delicacy generally made of potatoes with other ingredients. Mushrooms were used instead of potatoes to develop a novel product from mushrooms without the use of potato for binding. Three parameters were chosen as variables (shred size, par-frying time and corn flour dosage). Analysis was done for sensory, textural and nutritional characteristics with fat absorption being the prime indicator. The results demonstrated that lowest shred size and highest par frying time and highest dosage of corn flour resulted in optimized product with good overall acceptability.

c) Mushroom Fortified Cakes

Sponge cakes were fortified with button mushroom powder (*A. bisporus*) and product optimization was done. Partial replacement of wheat flour with mushroom powder in sponge cakes can be a prospective method to enhance the nutritional value of cake thereby impacting the general well-being of consumers. The effect of this supplementation on physical, nutritional and sensory characteristics of sponge cake and batter was evaluated. For batter preparation, whole eggs were taken in kitchen aid bakery mixer (Sanco) and whipped to soft peak stage at speed of 3 for 2 min. this was further continued with addition of castor sugar slowly along with whipping. The whipping speed was further increased to 6 and 9 for 1 min each. Then wheat flour blend with mushroom powder was added to the whipped mixture slowly with simultaneous mixing at speed of 2 for 1 min which was then increased to 3 and 6 for 2 min each. The melted butter and glycerine was added finally and mixed at speed of 2 for 20 sec. each batter formulation (200 g) was placed in aluminum baking tin and baked in electric oven at 220 ^{O}C for 20 min. After baking the cakes were cooled upside down on a wire rack for 30 min at room

Table 2.19. Mushroom powder wrt cake flour in cake samples

Trial Number	Wheat flour : mushroom powder
1	100:0
2	90:10
3	80:20
4	70:30
5	60:40
6	50:50

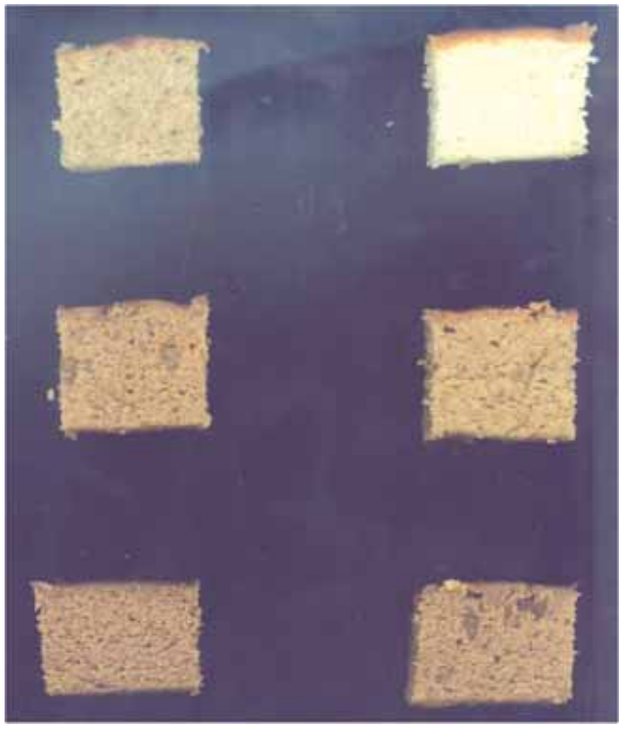


Fig. 2.21. Mushroom fortified cake samples

temperature and the stored in plastic bags before analysis.

Specific gravity and specific volume of batter was analyzed along with expansion ratio, textural, sensory and nutritional parameters of cake.

d) Comparative evaluation of antioxidant properties of mushrooms of India

Five cultivated mushroom species (*A. bisporus*, *P. ostreatus, C. indica, V. volacea* and *L. edodes)* were evaluated for their antioxidant activity, TBA reactives and total phenolic content. The analysis was carried out using entire mushroom fruit body. The data presented in Table 3 shows antioxidant ativity (%DPPH inhibition), TBA reactives and total phenols in mushrooms from India (Table 2.20).

e) Evaluation of effect of cooking on antioxidant activities of common edible mushrooms of India

Mushrooms are generally not consumed raw but are either cooked or processed to various culinary dishes industrially or at home. Cooking processes bring about a number of changes in physical characteristics and chemical composition of vegetables. There are various studies on quantification of antioxidants in mushrooms but less work has been done on effect of cooking on antioxidant properties. The main objective of this study was to evaluate different edible mushrooms of India for antioxidant activity, TBA reactives and total phenols. *A. bisporus, P. ostreatus, C. indica, V. volvacea* and *L. edodes* were evaluated. Also effect of cooking by boiling, stir frying and microwaving on these properties was done to understand the carryover of antioxidants in mushrooms. The observed values of antioxidant potential, TBA reactives and total phenols as affected by each of the cooking methods has been listed in Table 2.21.

Table 2.20. Antioxidant properties of mushrooms

S.No	Mushroom	Antioxidant activity (% DPPH inhibition)	TBA reactives (OD)	Total phenols (GAE/ g extract.)
1	*A.bisporus*	59.33	0.344	567.90
2	*P.ostreatus*	21.36	0.128	626.26
3	*V. volvacea*	45.33	0.297	572.89
4	*C. indica*	37.08	0.234	596.07
5	*L. edodes*	31.86	0.111	531.98

Table 2.21. Antioxidant potential, TBA reactives and total phenols as affected by each of the cooking methods

S.No	Mushroom	Processing	Antioxidant activity		TBA reactives		Total phenols	
			(% DPPH inhibition)	% retention	(OD)	% retention	(GAE/ g extract.)	% retention
1	*A. bisporus*	Fresh	59.33	100	0.344	100	567.90	100
2		Microwaved	56.15	94.64	0.153	44.47	548.82	96.64
3		Boiled	52.28	88.11	0.088	25.58	554.43	97.62
4		Fried	57.33	96.62	0.092	26.74	1399.55	246.44
5	*P. ostreatus*	Fresh	21.36	100	0.128	100	626.26	100
6		Microwaved	18.6	87.07	0.103	80.46	612.99	97.88
7		Boiled	16.23	75.98	0.086	67.18	542.08	86.55
8		Fried	33.59	157.25	0.082	64.06	1140.29	182.07
9	*V. volacea*	Fresh	45.33	100	0.297	100	572.89	100
10		Microwaved	36.31	80.10	0.109	36.70	520.67	90.88
11		Boiled	39.2	86.47	0.076	25.58	490.24	85.57
12		Fried	47.94	105.75	0.088	29.62	1011.56	176.47
13	*C. indica*	Fresh	37.08	100	0.234	100	596.07	100
14		Microwaved	27.07	73.00	0.108	46.15	560.04	93.95
15		Boiled	26.37	71.11	0.11	47.00	537.59	90.18
16		Fried	39.86	107.49	0.102	43.58	970.03	162.73
17	*L. edodes*	Fresh	31.86	100	0.111	100	531.98	100
18		Microwaved	26.19	82.20	0.085	76.57	528.6	99.36
19		Boiled	24.43	76.67	0.081	72.97	451.06	84.78
20		Fried	45.89	144.03	0.079	71.17	943.09	177.27

Training on post-harvest management of mushrooms for women

One day training was organized for women on post-harvest management of mushrooms and they were taught about methods of making pickles, soup, cakes, biscuits and candy from mushrooms. Twenty one participants were there in all for the training. Feedback of training from the participants was recorded.

Fig. 2.22. Training on mushroom pickle making

3. TRANSFER OF TECHNOLOGY

1. Training programmes conducted

During 2014, the Directorate organized five on campus training programmes for farmers, unemployed youths, entrepreneurs, officers and scientists of KVKs.

2. Mushroom Mela-2014

One day National Mushroom Mela was organized on 10th September, 2014 at the Directorate, which is a regular activity of the Directorate. It was inaugurated by Prof. Virender Kashyap, Hon'ble Member of Parliament, Shimla, HP (Fig. 3.1). It was attended by around 800 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 Mushroom Mela. The Exhibition was inaugurated by the chief guest Prof. Virender Kashyap (Fig. 3.2).

Fig. 3.1. Inauguration of Mushroom Mela 2014

Fig. 3.2. Distinguished guest visiting exhibition during mushroom mela 2014

Fig. 3.3. Kisan Goshthi during mushroom mela 2014

Fig 3.4. Farmers being given a live demonstration during mushroom mela 2014

Table 3.1. Farmers selected for progressive mushroom growers from all over India

Sl. No	Name of the farmer	Remarks
1	Mrs. Jayanti Pradhan Managing Director Gopal Biotech Agro Farm (GBAF) At- Kendupali,Po- Godbhaga Dist-BargarhState- ODISHA Pin-768111	i. Preparing, packaging and marketing value added mushroom products such as mushroom pickles, nuggets, papad and dehydrated mushroom powder. ii. Running and managing three cafeteria in the name of "MUSHROOM PLAZA" in four district head-quarters of Western Odisha iii. Imparting training to individual farmers, Farmer Interest Groups, SHGs, NGOs, CBOs and public sectors
2	Sh. Kanwal Singh Chauhan Vill.-AternaDistrict- Sonepat Haryana – 131 023	i. Farmer's training school is established at Village Aterna which is run by Bhartiya Shiksha Grameen Vikas Avam Anusandhan Samiti. ii. Received various awards such as IARI Fellow farmer award, Progressive Farmer, Udyan Ratan Award, N.G. Ranga Farmer Award etc.
3	Sh. Sangam Kurade 373, D.B. Marg, Miramar, Panji, Goa – 403 001, Goa	i. Awarded as "Outstanding Achiever" by Minister for Food Processing Industries (MOFPI), Government of India (2010). ii. Vice President, Goa State Industries Association and member of various government bodies for industries and agriculture.
4	Sh. Yussouf Khan VPO. Nangal Salangri,Tehsil & District Una, Himachal Pradesh -174303	i. Supplies nearly 90% of the total compost produced to mushroom growers of difficult areas of HP. ii. Converts the spent mushroom compost in to valuable manure and uses in chemical free cultivation ofdifferent vegetables under green house and field cultivation of vegetables. iii. Given employment to 15 semi-skilled and skilled workers.

To create awareness on various improved technologies/practices of 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 in front of the participants of Mushroom Mela.

In the afternoon session 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 (Fig. 3.3).

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.

3. Participation in national/state level exhibitions

To create awareness about mushroom cultivation and its health benefits the directorate participated in few state and national level exhibitions and fairs by establishing a stall and by distributing the free literature of the Directorate.

Date	Exhibition/ Fair	Staff attended
18-19 Dec., 2014	State level Sangoshthi and Exhibition, Dehradun	Dr. Yogesh Gautam
9-13 Feb., 2015	Kissan Mela organized by CPRI, Shimla at CPRS Patna	Dr. Yogesh Gautam Sh. Guler Singh Rana
10-11 Mar., 2015	Kissan Mela organized by the Divya Himachal	Dr. Yogesh Gautam Sh. Raj Kumar

4. Advisory service to farmers/ Mushroom growers/ Businessmen/ 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 8-10 queries per day were received either by phone/ mail/ letters and were replied. A total of 85 groups, comprising 1886 farmers, 946 students and 125 government officials visiting the institute were briefed about the various facilities and services rendered by DMR, Solan.

New additions

Four number Information kiosks were procured and got installed in the Directorate at different places. Videos related to mushroom cultivation, recipes and video galleries have been installed in the kiosks for viewing by visitors.

Conference held

The eighth International Conference on Mushroom Biology and Mushroom Products, which is a continuum of the conferences organized by World Society of Mushroom Biology and Mushroom Products since 1993 after every three years, was held at NASC Complex, New Delhi from 19-22 November, 2014.In this conference there were 231 contributions as abstracts that were grouped into 10 sessions. Full papers were received for 90 presentations. The presentations were grouped into 10 sessions that are: (i) Biodiversity and taxonomy, (ii) Genomics, genetics and breeding, (iii) Bioinformatics and nanotechnology, (iv) Biology, biochemistry, physiology and development, (v) Waste conversion & utilization, substrates, casing and crop management, (vi) Myco-molecules, medicinal, nutritional and nutraceutical properties, (vii) Mycorrhizal, entomopathic and other novel mushrooms, (viii) Pests and diseases, (ix) Value addition and mushroom products and (x) Economics, social, IT and marketing issues. Volume I contains the papers included in sessions I to V.

Fig. 3.5. Photographs related to the eighth International Conference on Mushroom Biology and Mushroom Products

Science Day celebration

Science day was celebrated on 28th February, 2015 at ICAR-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.

Swach Bharat Mission

Under the Swach Bharat Mission of the government, cleaning of the environment is carried by the entire staff on one Saturday per month.


Fig. 3.6. School children visiting DMR, Solan on the occasion of science day

Fig. 3.7 The staff cleaning the premises


Fig. 3.8. Superannuation of Dr. Manjit Singh, Director, ICAR-DMR, Solan on 31.03.2015

4. TRAINING COURSES ORGANIZED

S. No.	Training	Date	Sponsoring agency	No. of trainees	Course Director & course coordinator
1.	Training programme on mushroom cultivation technology for entrepreneurs.	23rd April – 2nd May, 2014	ICAR	49	Dr. O. P. Ahlawat Dr. K. Manikandan
2.	Training programme on mushroom cultivation technology for farmers and unemployed youths-I	21st - 27th May, 2014	ICAR	78	Dr. Satish Kumar Dr. Shwet Kamal
3.	Training programme on mushroom cultivation technology for farmers/ unemployed youths –II.	24th - 30th September, 2014	ICAR	73	Dr. V.P. Sharma Dr. Satish Kumar
4.	Training programme on mushroom production technology for Scientists and Subject Matter Specialists of KVKs and SAUs	18th - 24th July, 2014	ICAR	18	Dr. R.C Upadhyay Dr. K. Manikandan
5.	Training programme on mushroom cultivation for farmers from Odisha	16th – 20th December, 2014	ICAR	30	Dr. O. P. Ahlawat Dr. Satish Kumar

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 ICAR-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 coordinating centres

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

State Agricultural University based coordinating centres

- 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)
- College of Horticulture and Forestry, Central Agricultural University, Pasighat (Arunchal Pradesh)

Co-operating Centres

- Dr.Y.S.Parmar University of Horticulture & Forestry, Nauni, Solan (HP).
- HAIC Murthal (Haryana)

6. PUBLICATIONS

Research Papers

Ahlawat OP and Savoie JM (2014). Screening of biological, morphological and molecular characteristics of single-spore isolates collections of the straw mushroom, *Volvariella volvacea* (Higher basidiomycetes) from India. ***International Journal of Medicinal Mushrooms*** 16(4): 395-408.

Sharma VP, Kamal S, Upadhyay RC, Kumar S, Sanyal SK, Singh M. (2015). Taxonomy, Phylogeny, Cultivation and Biological Activities of a Lentinus species from Andman & Nicobar islands (India). ***Emir. J. Food Agric***. Online First: 24 Apr, 2015. doi:10.9755/ejfa.2015.04.135

Sharma VP, Satish Kumar and Shwet Kamal (2014) *Coprinellus* and *Coprinopsis*: aggressive competitors of button mushroom during rainy season cultivation. *International Research Journal of Natural and Applied Sciences* **Vol 2 (3): 155-163.**

Sharma VP, Shwet Kamal and Satish Kumar. 2014. Amplified ribosomal DNA restriction analysis and arbitrary primer based RAPD: useful genetic markers for mycoparasite diagnostics in edible mushrooms. *Mush. Res.* 23 (2): 211-217.

Sharma VP, Manjit Singh, Raj Kumar, Satish Kumar, Shwet Kamal and Manju Sharma. 2014. Effect of spawn to spawn multiplication on productivity of *Agaricus bisporus. Mush. Res.* 23 (1): 17-20

Sharma VP, Manjit Singh, Satish Kumar, Shwet Kamal and Rajender Singh. 2015. Phylogeny and physiology of *Phellorinia*: a delicacy of Indian desert. 2015. *International Research Journal of Natural And Applied Sciences* 2 (4):1-17.

Papers presented in seminar/symposia

Ahlawat OP, Kaur Harleen and Singh Manjit (2014). Breeding for higher fruit body yield and quality in *Volvariella volvacea.* Presented in **8th International Conference on Mushroom Biology and Mushroom Products**, 19-22 Nov., 2014, NASC, New Delhi, I

Ahlawat OP, Mohapatra KB, Kaur Harleen and Singh Manjit (2014). Genetic variability in strains of *Volvariella volvacea* collected from the state of Odisha, India. Presented in **8th International Conference on Mushroom Biology and Mushroom Products**, 19-22 Nov., 2014, NASC, New Delhi, India.

Ahlawat OP, Mohapatra KB, Kaur Harleen and Singh Manjit (2014). Genetic variability in strains of *Volvariella volvacea* collected from the state of Odisha, India. In: **Proceedings of the 8th International Conference on Mushroom Biology and Mushroom Products**. Singh M et al. (eds), pp. 135-144, 19-22 Nov., 2014, NASC, New Delhi, India.

Atri, N.S., Babita Kumari, R. C. Upadhyay. 2014. Taxonomy, sociobiology nutritional and nutraceutical potential of termitophilous and lepiotoid mushroom from North west India. 8th International conference on Mushroom and mushroom Products,19th to22nd Nov, 2014, New Delhi, pp.479-489.

Bhim Pratap Singh, R C Upadhyay and C. Lallawmsanga. 2014. Use of local glutinous rice(Buhbai) for the mushroom spawn production in Mizoram, Northeast India. Evaluation of *Schizophyllum commune* strains for artificial domestication. 8th International conference on Mushroom and mushroom Products,19th to22nd Nov, 2014, New Delhi.

Bhim Pratap Singh, R C Upadhyay and C. Lallawmsanga. 2014. Assessing Biodiversity of wild mushrooms in Mizoram, Northeast India. 8th International conference on Mushroom and mushroom Products,19th to22nd Nov, 2014, New Delhi.

Bindvi Arora. 2014. Effect of cooking by various methods on antioxidant properties of various species of mushrooms of India. Proceedings of 8th International Conference on Mushroom Biology and Mushroom Products.

Gautam, Y. Marwaha, S, Singh, Pal, Singh, AJ, Kumar, R, Manikandan, K and Kumar, S. 2014. Information needs, technical efficiency and interactive system for mushroom stakeholders. In. Abstracts of 8th International Conference on Mushroom Biology and Mushroom Products. Pp.161. 19-22 Nov. 2014, NASC, New Delhi

Hofrichter, M.René Ullrich, Harald Kellner, Ramesh C. Upadhyay, Katrin Scheibner. 2014. Fungal unspecific peroxygenases: A new generation of oxygen-transferring biocatalysts. 8th International conference on Mushroom and mushroom Products,19th to22nd Nov, 2014, New Delhi, pp.172-181

Kamal Shwet, Manjit singh, R.C. Upadhyay, VP Sharma, Satish Kumar, and Mamta Gupta. 2014. Development of browning resistant strains in white button mushroom (*Agaricus bisporus).* Abstract No. II-P-7.

Kamal, S, Manjit Singh, R.C.Upadhyay, V.P. Sharma, Mamta Gupta, V. Arunachalam, and Pat Heslop Harrison. 2014 . Identification of WRKY transcripton factors in *Agaricus bisporus* (white button mushroom). 8th International conference on Mushroom and mushroom Products,19th to22nd Nov, 2014, New Delhi, pp.167-171.

Kamal, S, Manjit Singh, R.C.Upadhyay, V.P. Sharma, Satish Kumar and Mamta Gupta. 2014. Development of browning resistant strains in in *Agaricus bisporus* (white button mushroom). 8th International conference on Mushroom and mushroom Products,19th to22nd Nov, 2014, New Delhi.

Kumar, S and Sharma, VP. 2014. Studies on abiotic disorders of button mushroom. In. Abstracts of 8th International Conference on Mushroom Biology and Mushroom Products. Pp.137. 19-22 Nov. 2014, NASC, New Delhi

Kumar, S, Singh, M. Sharma, VP and Kamal, S. 2014. Estimation of cordycepin and determination of antioxidant properties in different species of *Cordyceps*. In. Abstracts of 8th International Conference on Mushroom Biology and Mushroom Products. Pp.48. 19-22 Nov. 2014, NASC, New Delhi

Kumar, S. Kamal, S. Sharma, VP and Singh, M. 2014. Collection, isolation, identification and cultivation of *Pleurotus pulmonarius* in India. In. Abstracts of 8th International Conference on Mushroom Biology and Mushroom Products. Pp.70. 19-22 Nov. 2014, NASC, New Delhi

Sanyal, Sanjeev Kumar, GS Dhingra, Shwet Kamal and Ritu (2014). Taxonomic and molecular studies of some resupinate Agaricomycetous fungi from India. Abstracts of 8th International Conference on Mushroom Biology and Mushroom Products 19-22 Nov 2014, pp20.

Sharma, VP , Kumar, S. and Kamal, S. 2014. Molecular characterization of *Cladobotryum* species associated with cobweb disease of mushrooms. In. Abstracts of 8th International Conference on Mushroom Biology and Mushroom Products. Pp.135. 19-22 Nov. 2014, NASC, New Delhi

Sharma VP, Satish Kumar, Shwet Kamal, Raj Kumar and Rajender Singh (2014). Integrated approaches for the management of *Mycogone perniciosa* causing wet bubble disease. Abstracts of 8th International Conference on Mushroom Biology and Mushroom Products 19-22 Nov 2014, pp132.

Upadhyay R.C., Shwet Kamal, and Manjit Singh. Developing spore deficient strain of *Pleurotus flabellatus"* 8th International conference on Mushroom and mushroom Products,19th to22nd Nov, 2014, New Delhi.

Upadhyay R.C., Shwet Kamal, Sharma, V.P. and Manjit Singh. 2014. Cultural practices and supplementation of cotton seed hulls for growing king oyster mushroom strains. 8th International conference on Mushroom and mushroom Products,19th to22nd Nov, 2014, New Delhi

Upadhyay, R.C. , Bhim Pratap Singh, Shilpa Sood and Veena Devi. 2014. Evaluation of *Schizophyllum commune* strains for artificial domestication. 8th International conference on Mushroom and mushroom Products,19th to 22nd Nov, 2014, New Delhi.Upadhyay R.C., Shwet Kamal, Manjit Singh. 2014.

Upadhyay, R.C. and Astha Tripathi. 2014 Lignocellulolytic enzymes of *Calocybe indica*. 8th International conference on Mushroom Biology and mushroom Products,19th to22nd Nov, 2014, New Delhi, 225-230.

Book

Manjit Singh, RC Upadhyay, VP Sharma, OP Ahlawat, Satish Kumar, Shwet Kamal, Bindvi Arora and Mamta Gupta. Proceedings of 8th International conference on Mushroom Biology and Mushroom Products, held at NASC complex New Delhi, Directorate of Mushroom Research, Solan. pp. 639.

Manjit Singh, RC Upadhyay, VP Sharma, OP Ahlawat, Satish Kumar, Shwet Kamal, Bindvi Arora and Mamta Gupta. Abstract book of 8th International conference on Mushroom Biology and Mushroom Products, held at NASC complex New Delhi, Directorate of Mushroom Research, Solan. pp. 165.

Atri, N.S., Babita Kumari, Sapan Kumar, R.C. Upadhyay, Arvind Gulati, Ashu Gulati and Lata. 2015. Nutritional profile of wild edible mushrooms of north india. book edited by Dr. S.K. Deshmukh, Dr J. K. Misra, Prof. J.P. Tiwari and Dr. Tamás Papp and entitled "Applications of Fungi and their management Strategies CRC Press.

Popular articles

Ahlawat OP and Singh Manjit (2014). Cultivation of *Volvariella bombycina*, a temperate mushroom species. ICAR NEWS (Oct-Dec 2014) 20(4): 1-2.

Gautam, Y. **"Swasth haddiyon ke liye khao mushroom"** in Shoolini Samachaar, 11 September 2014.

Gautam, Y. **"ICT dwara krishi prasaar"** in Shoolini Samachaar, 11 September 2014.

7. APPROVED ON-GOING RESEARCH PROJECTS

On-going Research Projects of DMR

Institute Code	Title	Researchers		Period
DMR-2	Genetic Improvement of *button*, *Pleurotus* and *Volvariella* mushrooms	Dr. Manjit Singh Dr. R.C. Upadhyay Dr. O.P. Ahlawat Dr. Shwet Kamal Dr. K. Manikandan	Program leader PI (*Pleurotus*) PI (*Volvariella*) PI (button) Co-PI	April, 2010 to 31st March, 2015
DMR-3	Improvement in cultivation technology of white button mushroom & effective utilization of spent substrate	Dr. O.P. Ahlawat Dr. K. Manikandan	PI Co-PI	April, 2010 to 31st March, 2015
DMR-6(a)	Developing cultivation technologies for Indigenous edible mushrooms, *Lentinula*, *Calocybe indica*, *Cordyceps* and *Phellorina*.	Dr. V.P. Sharma Dr. Manjit Singh Dr. Satish Kumar Dr. Shwet Kamal Dr. K. Manikandan	PI Co-PI Co-PI Co-PI Co-PI	April, 2010 to March, 2015
DMR-6(b)	Basic studies on cultivation technology of morel mushroom	Dr. Shwet Kamal Dr. V.P. Sharma Dr. K. Manikandan	PI Co-PI Co-PI	January, 2012 to November, 2014
DMR-8	Integrated Pest and Disease Management in Mushrooms	Dr. Satish Kumar Dr. V.P. Sharma	PI Co-PI	April, 2010 to 31st March, 2015
DMR-9	Development of Web based Mushroom Expert System	Dr. K. Manikandan All Scientists of DMR, Solan	PI Co-PI	April, 2011 to 31st March, 2015
DMR-11	Evaluation and process optimization of biofuel production from spent mushroom substrate	Kumari Bindvi Arora Dr.Shwet Kamal	PI Co-PI	January, 2015 to December, 2015
DMR-12	Formulation and process optimization of mushroom products and byproducts utilization	Kumari Bindvi Aroral Dr.V.P. Sharma Dr.Shwet Kamal	PI Co-PI Co-PI	February, 2015 to January, 2016

Externally Funded Projects

Title of the Project	PI of the Project	Tentative cost of the Project	Period/Remarks
1. Refinement in spawn production technology.	Dr. V.P. Sharma	‘ 17.46 lakhs	16.01.2012 to 15.01.2015
2. DBT’s Twinning Programme for the NE titled “Characterization and Utilization of Mushrooms biodiversity of Mizoram”	Dr.R.C.Upadhyay	` 72.97 lakhs	21.03.2013 to 20.03.2016
3. Assessment and genetic manipulation of *Volvariella volvacea* (paddy straw mushroom) for shelf life and yield	Dr. O.P. Ahlawat	‘ 22,52,800.00	01.09.2013 to 31.08.2016
4.”Studies on identification, antimicrobial, antioxidant and nutritional index as well as standardization of cultivation of some wild mushrooms of Tripura”	Dr. R.C. Upadhyay	‘ 28.35 lakhs	01.04.2014 to 31.12.2016

8. CONSULTANCY PROVIDED BY ICAR-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 2014-2015.

1 **Sh.Durga Ram Sharma**, Village Mohtu, PO. Rajana, Tehsil Renukaji, Distt. Sirmour (HP)

2 **Mr.Tarun Kumar,** R-54, Advocate Colony, Sector-12, Pratap Vihar, Near Vijaya Nagar Thana, Ghaziabad (UP) 201001

3 **Mr.Madan Lal,** Village Dochi, PO. Sadhupul, Tehsil Kandaghat, Distt. Solan (HP) 173215

4 **Mr.Abhihek Dubey,** B-7, Krishna Home (HS), Sector-29, Prodhikoran Ronet Pune, 411044 (MH)

5 **Mr.Shambu Dayal Shukla,** Village Firsachurra, Tehsil Bilaspur, Distt. Pilibhit, (UP)

6 **Mr.Rishi Rai,** Village Kuffer (Ser-Manon), PO -Shaya-Chabron, Tehsil -Rajgarh, Distt. Sirmour (HP)173101

7 **Mr.Ranjit Singh,** C/o Raj Verma, Dharampur (HP)

8 **Mr.Prithi Chand**, Village-Manoh, PO Karohta, Tehsil Bhoranj, Distt. Hamirpur (HP) 176044

9 **Mr.Lokeshwar Dutt Sharma,** S/o Sh.Ram Krishan, Village Aljho, PO. Sadhupul, Tehsil. Kandaghat, Distt. Solan (HP) 173215

10 **Mr.Nabin Chandra Bera,** Village – Bhabanipur Davi Gali, PO. Pipili, Tehsil Pipli, Distt. Puri, Odisha.

11 **Mr.Jitendra Behera,** S/o Sh.Yudhisthir Behera, College Bye Pass, Anand Nagar, Dhenkanal, Odisha

12 **Sh.Ram Karan,** Village – Dingri Dhini, PO. Malhoti, Tehsil Pachad, Distt. Sirmour (HP)

13 **Mr.Vedvati Thainvi,** Village Kharel, PO. Rarughati, Tehsil Rajgarh, Distt. Sirmour (HP)

14 **Mr.Sunil Kumar,** S/o Sh.Bishamber Dass, Villages – Toka, PO. Hamirpur, Tehsil. Naraingarh, Distt. Ambala (Hry) 134203

15 **Mr.Mahinder Singh,** S/o Sh.Sita Ram, Villages – Toka, PO. Hamirpur, Tehsil. Naraingarh, Distt. Ambala (Hry) 134203

16 **Mr.Samir Gurung,** S/o Late Sh.D.V. Gurung, Village – Parmaguri, PO. Sukhia Pokhari, Distt. Darjleeling (WB) 734221

17 **Ms.Seema,** NH-I, 113/13, 540 Landmark, Kutail, Villages – Karnal, Hry.

18 **Mr.Atul Kapoor,** Village – A1/76A, Ist Floor, Chhattar Pur Extn. New Delhi 110074

19 **Mr.Baljit Singh,** S/o Amjit Singh, Village Kakra, Tehsil. Bhawanigarh, Distt. Sangrur (PB)

20 **Mr.Santosh Kumar,** S/o Sh.Ram Singh, Village. Bharin, PO. Ropa Tehsil & Distt. Hamirpur (HP) 177001

21 **Mr.Chetanya Dev Sharma,** S/o Sh.Jainand Sharma, Village Shattal, PO. Deoth, Tehsil & Distt. Solan (HP)

22 **Ms.Meenakshi Biswal,** At: Kendupali, PO. Godbhaga, PS: Atabira, Distt. Bargarh, Odisha – 768111

23. **M/s Indo Mushroom Farm,** Chak, 2 STP Dhani, VPO. Haripura, Tehsil. Sangrur, Distt. Hanumangarh, Rajsthan – 335063

24 **Ms.Radha Devi** W/o Sh.C.R. Saklani, VPO. Giri Nagar, Tehsil Paonta Sahib, Distt. Sirmour (HP)

25 **Mr.Sunil Kumar** S/o Sh.Bishamber Dass, Village Toka, PO. Hamirpur, Tehsil Naraingarh, Distt. Ambala (Haryana)

26 **Mr.Jaspal,** S/o Sh.Ram Swaroop, VPO. Pallion, Tehsil Nahan, Distt. Sirmour (HP)

27 **Mr.Ramesh Chand,** S/o Sh.Mehar Singh, Village. Kandiwal, PO. Brahma Papri, Tehsil. Nahan, Distt. Sirmour (HP)

28 **Mr.Bhup Singh,** S/o Sh.Lekh Ram, VPO. Karidharni, Tehsil. Badra, Distt. Bhiwani (Haryana)

29 **Mr.Bhupinder Singh** VPO. Digrota, Tehsil. Satnali, Distt. Mahendergarh (Haryana)

30 **M/s Legume Farms,** 331/1, Walkehwar Vaddo, Bodiem-Tivimm Bardez, Goa

31 **Mr.Nitish Garg,** Uppli Sangrur Road, Sunam, Distt. Sangrur 148028

32 **Mr.Sanjay Gupta,** S/o Sh.Madan Lal Gupta, H.No. 16, Ward-2, Indira Colony, Old Janipur, Jammu

33 **Ms.Pooja Verma,** W/o Ashwani Kumar Kanda, 253, Urban Estate, Phagwara (PB)

34 **The Darla Khumb Production Marketing cum Processing Cooperative Society Ltd.,** Darlaghat, Tehsil Arki, Distt. Solan (HP)

35 **Mr.Rattan Chand,** Village Adarsh Nagar, Tehsil Nadon, PO. Putdyal, Distt. Hamirpur (HP)

36 **Mr.Chaman Lal,** Village Kashipur, PO. Nihalgarh,, Tehsil. Paonta Sahib, Distt. Sirmour (HP)

37 **Mr.Naresh Chand,** S/o Sh.Parma Nand, Village Kainthari PO. Dharmpur, Tehsil & Distt. Solan – 173209

38 **Mr.Ravinder Kumar,** Village Saheli, PO. Karsai, Tehsil. Barsar, Distt. Hamirpur (HP) 174312

39 **Mr.Suresh Kumar,** Village Lamachbur, PO. Dingerkiner, Tehsil. Sarah, Distt. Sirmour (HP)

40 **Mr.Surinder Kumar,** Village Kandyal, PO. Kalka, Tehsil. Kalka, Distt. Panchkula (Hry)

41 **Mr.Ram Chander,** Village Bargodam, PO. Kalka, Tehsil. Kalka, Distt. Panchkula (Hry)

42 **M/S Avaneesh Mushroom Training & Farming Centre,** Kolar Gold Fields, Karnataka

43 **Mr.Ramesh Chand,** Village Kathla, PO. Daro Dariya, Tehsil. Pachad, Distt. Sirmour (HP)

44 **Mr.B.N. Sharma,** Doon Agro Food Products, VPO. Missarwala, Paonta Sahib, Distt. Sirmour (HP)

45 **Mr.Manjit Singh,** Village Khanuwla, PO. Shivpur, Tehsil. Paonta Sahib, Distt. Sirmour – 173025

46 **Mr.Yoga Narasimha K.B.,** #63/A, 2nd Main, J.P. Nagar, 3rd Phase, Bangalore – 560 078

47. **Mrs.Neelam,** W/o Shishpal, Village Taharpur, PO. Khojkipur, Tehsil. Bapoli, Distt. Panipat – 132122

48 **Mr.Bhagi Rath,** S/o Sh.Tandu Ram, Village Guran, PO. Thachi, Sub Tehsil wai Chowki, Distt Mandi (HP) 175121

49 **M/s Himachal Mushroom Farm,** Village Bella Post Bikram Baj, Tehsil. Nahan, Distt., Sirmour (HP)

50 **M/s Simran Mushroom Farm,** Village Kherra, Post. Bikram Bag, Tehsil. Nahan, Distt. Sirmour (HP)

51 **Mrs.Satya Devi,** W/o Sh.Shalig Ram, Village Galahan, PO. Solan Tehsil and Distt. Solan (HP)

52 **Mr.Pardeep Sharma** S/o Sh.Hari Dutt Sharma, Village Dadhog, PO. Solan Brewary, Distt. Solan (HP)

53 **Mr.Rameshwar Dutt,** S/o Sh.Dutt Ram, VPO. Dharot, Tehsil & Distt. Solan (HP)

54 **Mr.Mohinder Pal,** S/o Sh.Om Parkash, Village Ber, PO. Chambaghat, Solan

9. COMMITTEE MEETINGS

a. Institute Management Committee: One meeting of IMC was held at ICAR-DMR, Solan on 21.07.2014.

1.	Dr. Manjit Singh, Director, DMR, Solan	Chairman
2.	Dr. S.K. Malhotra, 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.), PHT, Deptt. of Mycology & Plant Pathology, Dr. Y.S. Parmar UH & F, Nauni, Solan (H.P.).	Member
7.	Dr. V.K. Baranwal, Principal Scientist, Div. of Plant Pathology, Indian Agricultural Research Institute, 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, Directorate of Wheat Research, Karnal	Member
11.	Administrative Officer, DMR, Solan	Member-Secretary

Fig. 9.1. IMC and RAC meeting held at DMR, Solan

b. Research Advisory Committee (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): One meeting of RAC was held on 27-28 June, 2014.

1.	Dr. S.S. Chahal, Former, Vice Chancellor, MPUA & T, Udaipur 43-H, Bhai Randhir Singh Nagar, Ludhiana (Punjab)–141012	Chairman
2.	Dr. S.K. Malhotra, Asstt. Director General (Hort.II), Indian Council of Agricultural Research, Horticulture Division, Room No.426, Krishi Anusandhan Bhavan-II, Pusa, New Delhi – 110 012.	Member
3.	Dr. M.P. Thakur, Dean, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya(IGKV), Rajnandgaon, Chattisgarh.	Member
4.	Dr. R.D. Singh, (Ex- Prof. & Head Pl. Path., MPUA&T, Udaipur) 276, Gayatri Nagar-A, Durgapura, Jaipur – 302018 (Rajasthan)	Member
5.	Dr. B.M. Sharma, Former Programme Director, Centre for Mushroom Resarch & Training, Department of Plant Pathology, CSK HPKV, Palampur – 176062 (HP)	Member
6.	Dr. Manjit Singh, Director, ICAR-Directorate of Mushroom Research, Chambaghat, Solan (HP) – 1732113.	Member
7.	Dr. R.C. Uapdhyay, Principal Scientist, ICAR-Directorate of Mushroom Research, Chambaghat, Solan (H.P.) – 173213.	Member Secretary

c. Institute Research Council (IRC)

Two Meetings of Institute Research Committee (IRC) were held on 15th July, 2014 and 30th December, 2014 attended by all the Scientists under the Chairmanship of Dr. Manjit Singh, Director.

d. Core Committee Meeting

Three meetings of core committee held at DMR, Solan on 27.02.15, 17.03.15 and 23.03.15.

1.	Director	-	Chairman
2.	Dr.Satish Kumar	-	AO

3.	Sh.Tej Singh Bhatti	-	F&AO
4.	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 03.07.2014, 10.10.2014 and 14.01.2015

Office side Members

1. Dr.V.P. Sharma, Principal Scientist
2. Dr.Shwet Kamal, Sr.Scientist
3. Dr.Yogesh Gautam, Scientist
4. Ms Bindvi Arora, Scientist
5. Administrative Officer
6. AFACO

Staff side member

1. Sh.Roshan Lal Negi, LDC (Member CJSC)
2. Sh.Dharam Dass, UDC
3. Sh.Guler Singh Rana, Technical Assistant (Secretary IJSC)
4. Sh.Deepak Sharma, Technical Assistant
5. Sh.Ajeet Kumar, SSS
6. Sh.Vinay Sharma, SSS

f. Grievance Cell: Meetings of grievance Cell were held at ICAR-DMR on 18.07.2014 and 05.01.2015

Elected Members of Grievance Committee

SN	Name & designation	Category	Capacity
1	Dr.Shwet Kamal, Sr.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	Scientific	Member(Office side)
3	Administrative Officer	Administrative	Member(Office side)
4	Asstt.Finance & A/Cs Officer	Audit	Member(Office side)

G. PME Cell

Two meetings of PME Cell were held on 01.08.2014 and 16.01.2015.

Chairman	Dr. VP Sharma
Member	Dr. OP Ahlawat
Member	Dr. Satish Kumar
Member secretary	Dr. Yogesh Gautam

H. Scientists-Technical Personnel Meeting

Eleven meetings of Scientists and Technical Personnel were held on 11.4.2014, 08.5.2014, 20.6.2014, 18.7.2014, 21.8.2014, 26.9.2014, 17.10.2014, 19.12.2014, 23.01.2015, 20.02.2015 and 24.3.2015.

I. Friday Meetings of Scientists

Nine meetings of Scientists were held on 04.4.2014, 13.06.2014, 14.07.2014, 25.07.2014, 01.08.2014, 02.01.2015, 09.01.2015, 30.01.2015, 13.02.2015

J. Other Meetings

1. RFD meetings on 16.4.2014, 22.4.2014, 24.04.2014, 05.05.2014, 12.09.2014, and 23.01.2015

K. Women Cell

1.	Chairman	Ms. Bindvi Arora, Scientist
2.	Members	i) Admn.Officer ii) Smt. Reeta,ACTO ii) Smt.Shailja Verma, Sr. TO iii) Smt.Shashi Poonam, LDC
3.	Member Secretary	Smt.Sunila Thakur, PA

राजभाषा कार्यान्वयन समिति (हिन्दी समिति)

निदेशक	–	अध्यक्ष
डा. आर.सी. उपाध्याय, प्रधान वैज्ञानिक	–	सदस्य
डा. योगेश गौतम, वैज्ञानिक	–	सदस्य
प्रशासनिक अधिकारी/प्रभारी राजभाषा कार्यान्वयन	–	सदस्य
श्रीमती रीता, सहायक प्रमुख तकनीकी अधिकारी	–	सदस्या
श्रीमती सुनीला ठाकुर, निजि सहायक	–	सदस्या
श्री सतेन्दर कुमार ठाकुर, व.लिपिक	–	सदस्य सचिव

राजभाषा कार्यान्वयन समिति द्वारा वर्ष 2014–15 के दौरान किये गए कार्यों का संक्षिप्त विवरण

भारत सरकार की राजभाषा नीति के कार्यान्वयन को सुनिश्चित करने तथा निदेशालय द्वारा संपादित किये जाने वाले कामकाज में हिन्दी का प्रयोग सुनिश्चित करने के उद्देश्य से निदेशालय में राजभाषा कार्यान्वयन समिति का गठन किया गया है। राजभाषा कार्यान्वयन के लिए निदेशालय में अलग से कोई अधिकारी व कर्मचारी न होने के बावजूद राजभाषा कार्यान्वयन समिति द्वारा किए गये प्रयासों के फलस्वरूप निदेशालय में हिन्दी के कामकाज व प्रचार–प्रसार में अपेक्षित सफलता प्राप्त हुई है। निदेशालय द्वारा वर्ष 2014–15 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 निदेशालय की राजभाषा कार्यान्वयन समिति की त्रैमासिक बैठकों में चर्चा हुई तथा दिए गए दिशा–निर्देशों के अनुरूप लिए गए निर्णयों के अनुसार कार्रवाई की गई तथा निदेशालय 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 निर्देशों/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 आवश्यक कार्रवाई हेतु परिचालित किया गया।

तिमाही हिन्दी प्रगति रिपोर्ट का संकलन तथा समीक्षा

निदेशालय में राजभाषा कार्यान्वयन सम्बन्धी प्रगति के आँकड़े प्राप्त कर जारी त्रैमासिक रिपोर्ट प्रोफार्मा में सभी आँकड़ों को संकलित कर निदेशालय 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 निर्देशों के अनुरूप निदेशालय 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 गया तथा समिति द्वारा फाईलों व अन्य कार्यों का अवलोकन कर प्रथम, द्वितीय व तृतीय पुरस्कारों का निर्णय लिया गया।

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 निर्देशों/आदेशों के अनुपालन पर चर्चा की गई तथा इन बैठकों में लिए गए निर्णयों को लागू करने के लिए कार्रवाई की गई।

त्रैमासिक राजभाषा कार्यशालाओं का आयोजन

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

निदेशालय 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

15–20 सितम्बर, 2014 तक 'हिन्दी सप्ताह' के दौरान हिन्दी में आयोजित प्रतियोगिताओं व वर्ष (अक्टूबर, 2013 से 13 सितम्बर, 2014) में सर्वाधिक कार्य करने वाले अधिकारियों/कर्मचारियों को दिनांक 22.09.2014 को नकद पुरस्कार दिए गए जिसका विवरण निम्नलिखित है:–

1. श्रुतलेखन प्रतियोगिता (दिनांक 15 सितम्बर, 2014)

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

2. सुलेख प्रतियोगिता (दिनांक 15 सितम्बर, 2014)

प्रथम – श्री दीपक शर्मा
द्वितीय – श्रीमति रीता भाटिया
तृतीय – श्रीमति सुनीला ठाकुर

3. निबंध प्रतियोगिता (दिनांक 16 सितम्बर, 2014)

प्रथम – डा. सतीश कुमार
द्वितीय – श्री दीप कुमार ठाकुर
तृतीय – श्री दीपक शर्मा

4. टिप्पणी प्रतियोगिता (दिनांक 16 सितम्बर, 2014)

प्रथम – श्री दीप कुमार ठाकुर
द्वितीय – श्रीमति शशी पूनम
तृतीय – श्री संजीव शर्मा

5. सामान्य तकनीकी लेख प्रतियोगिता (दिनांक 17 सितम्बर, 2014)

प्रथम – श्री दीपक शर्मा
द्वितीय – श्री राम लाल

6. प्रार्थना पत्र (चतुर्थ श्रेणी कर्मचारियों के लिए) 17.09.2014

प्रथम – श्री विनय शर्मा

7. कम्प्यूटर पर टंकण प्रतियोगिता दिनांक 18 सितम्बर, 2014

प्रथम – श्रीमति शशी पूनम
द्वितीय – श्रीमति सुनीला ठाकुर
तृतीय – श्री सतेन्दर कुमार ठाकुर

8. वैज्ञानिक उपलब्धियां लिखना (केवल वैज्ञानिकों के लिए) 19.09.2014

प्रथम – डा. वी.पी.शर्मा
द्वितीय – डा. सतीश कुमार

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 संजीव शर्मा
2) श्री सतेन्दर कुमार ठाकुर

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

1) श्री एन.पी.नेगी
2) श्री दीप कुमार ठाकुर
3) श्रीमति शशी पूनम

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

1) श्री तुलसी दास शर्मा
2) श्री रोशन लाल नेगी
3) श्री लेख राज राणा

इन सबके फलस्वरूप निदेशालय के वैज्ञानिकों/अधिकारियों/कर्मचारियों में हिन्दी में कार्य करने की प्रवृत्ति बढ़ी है और वर्तमान में काफी प्रशासनिक कामकाज हिन्दी में संपादित हो रहा है। इसमें निदेशालय 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 निदेशक महोदय का उचित मार्गदर्शन तथा सहयोग हमेशा ही प्राप्त हुआ है।

निदेशालय 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. निदेशालय के 80 प्रतिशत से अधिक कार्मिक हिन्दी में प्रवीणता/कार्यसाधक ज्ञान प्राप्त है इसलिए यह निदेशालय 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. निदेशालय की अधिकतर बैठकों के कार्यवृत्त हिन्दी में तैयार किए गए।

4. राजभाषा अधिनियम, 1963 की धारा 3(3) तथा अन्य नियमों की अनुपालना के संदर्भ में निदेशालय के प्रत्येक अधिकारी व कर्मचारी को समय–समय पर कार्यालय आदेश जारी किए गए व इनकी शत–प्रतिशत अनुपालन सुनिश्चित करवाने के प्रयास किए जा रहे है।

5. हिन्दी पत्राचार के निर्धारित लक्ष्यों को प्राप्त करने की दिशा में सतत्–प्रयास जारी है।

6. सभी 42 मानक फॉर्मों को द्विभाषी रूप में तैयार कर लिया गया है तथा सतत् कोशिशें की जा रही है की सभी कार्मिक इन्हें हिन्दी में ही भरें।

7. निदेशालय 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. निदेशालय के सभी अधिकारियों का हिन्दी की जानकारी संबंधी रोस्टर तैयार किया गया है।

9. निदेशालय के सभी साईन बोर्ड, सूचना बोर्ड, नाम पट्ट व अन्य इसी प्रकार के बोर्ड द्विभाषी रूप में तैयार करवाए गए हैं।

10. निदेशालय के प्रशिक्षण कार्यक्रमों के लिए प्रशिक्षण सार–संग्रह(ट्रेनिंग कम्पेडियम) हिन्दी व अंग्रेजी दोनो भाषाओं में उपलब्ध है।

11. कोड मैनुअलों और अन्य कार्यविधि साहित्य हिन्दी में उपलब्ध है।

12. निदेशालय में प्रत्येक वर्ष की भांति इस वर्ष भी मशरूम मेले का आयोजन 10 सितम्बर, 2014 को आयोजित किया गया। इस अवसर पर मुख्य पंडाल के सभी चित्रों के शीर्षक, ग्राफ, हिस्टोग्राफ आदि हिन्दी में प्रदर्शित किए गए। मल्टीमीडिया के माध्यम से मशरूम संबंधी जानकारी आकर्षक ढंग से प्रस्तुत की गई तथा किसानों, छात्रों व अन्य अंगतुकों को मशरूम साहित्य हिन्दी में उपलब्ध कराया गया।

13. दूरदर्शन तथा आकाशवाणी पर भी निदेशालय के वैज्ञानिकों व तकनीकी अधिकारियों की मशरूम विषय पर हिन्दी में वार्ताएं प्रसारित की गई जिनमे मशरूम उत्पादकों की समस्याओं का समाधान किया गया।

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

15. इसके अतिरिक्त डा. मनजीत सिंह, निदेशक एवं अध्यक्ष, राजभाषा कार्यान्वयन समिति के सतत् निजी–सहयोग और मार्गदर्शन के तहत हिन्दी की तिमाही बैठकों व कार्याशालाओं का समय पर आयोजन व निदेशालय 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 8th International Conference on Mushroom Biology and Mushroom Products at NASC Complex, New Delhi from 19-22 November 2014 in which 70 participants from about 30 countries outside India participated in addition to 200 participants from within the country.
2. Attended workshop on Capacity Building from 5-7 June, 2014 at NASC Complex, New Delhi
3. Attended National Conference on Pre/Post-Harvest Losses and Value Addition in Vegetables held at IIVR, Varanasi on 12-13 July 2014.
4. Attended Regional Workshop on Strengthening partnership and refined methodology for on-station experiments of AICRP on IFS being organized by PDFSR, Meerut at HAU, Hisar 11.08.2014.
5. Attended XII Agricultural Science Congress on "Sustainable Livelihood Security for Smallholder Farmers" from 4-6 February 2015.
6. Attended and delivered a Plenary Lecture in National Symposium on "Mycological Research" held at Punjabi University, Patiala from 23-24 February, 2015.

Dr. R C Upadhyay

7. Invited by the Department of Biotechnology, New Delhi to attend brain storming session on Lipo polysachharides at JNTBGRI, Thiruvananthpuram on 13th June, 2015.
8. Organized "8th International Conference on Mushroom Biology and Mushroom Products" at NASC, New Delhi from 18thNov to 22nd Nov, 2015.

Dr. VP Sharma

1. Attended "EFC meeting along with Director with DG on 26th Nov., 2014 in Krishi Bhavan
2. Attended the 8th International conference on Mushroom Biology and Mushroom Products, held at NASC complex New Delhi w.e.f. 19-22 Nov., 2014,
3. Attended "One day Workshop on RFD in NASC, New Delhi on 24 Nov.., 2013.
4. Attended "Vision 2050 meeting along with Director with DDG on 25th Nov., 2014 in KAB-II.
5. Attended "Vision 2050 meeting along with Director with DG on 26th Nov., 2014 in Krishi Bhavan.

Dr. OP Ahlawat

1. Attended the 9th Programme Advisory Committee meeting on Plant Sciences under SERB at Visakhapatnam on 23-03-2015 and presented the progress report of the SERB, DST funded project.
2. Attended 8th International Conference on Mushroom Biology and Mushroom Products, 19-22 Nov., 2014, NASC, New Delhi, India.

Dr. Satish Kumar

1. Attended 8th International Conference on Mushroom Biology and Mushroom Products, 19-22 Nov., 2014, NASC, New Delhi, India.

Dr. Shwet Kamal

1. Participated XVI workshop of All India Coordinated Research project on Mushroom during 20-21 March 2014 at Rajendra Agricultural University, Pusa, Bihar.
2. 8th International Conference on Mushroom Biology and Mushroom Products during 19-22 Nov 2014 at NASC Complex, New Delhi

3. Attended DBT sponsored training on "Genomics and proteomics in plants and microbes towards translational research" scheduled from Jan 21 – February 10, 2015 at ICAR-IISR, Calicut, Kerala.

Dr. Yogesh Gautam

1. Attended 8th International Conference on Mushroom Biology and Mushroom Products, 19-22 Nov., 2014, NASC, New Delhi, India.

Participation in Trainings/Workshops/ Lectures delivered

Attended the Workshop on " Open Access to Agricultural Knowledge for Inclusive Growth and Development, NAARM, Hyderabad. 29-30 October, 2014.

Attended the meeting for presentation of RFD Mid-term achievements at NASC Complex on 25th November 2014.

Participated in the Workshop on "PME indicators and Implementation Strategy" Organized by NAAS-NAARM-IFPRI for PME Chairmans held at NASC Complex on 23rd February, 2015.

Delivered lecture on **"Mushroom utpadan ke kshetra mein viksit navintam taknik":** in State level sangoshthi and Exhibition, Dehradun. 18-19 December, 2014.

Delivered lecture on **"Status and scope of scientific mushroom production in the Eastern plains of India"** at Kissan Mela organized by CPRI, Shimla at CPRS Patna from 19-21 February 2015.

Delivered lecture on " **Latest developments in Mushroom Production Technology**" at the Kissan Mela organized by the Divya Himachal from 10-11 March at Subzi Mandi Solan.

Delivered lecture on "**Cyber Law**" in the Training Programme for Physics Lecturers (13th-18th October 2014) at SCERT, Solan (HP), on 14.10.2014.

Delivered lecture on "**Information Technology Act 2000 and onward**" in the Training Programme for Physics Lecturers (13th-18th October 2014) at SCERT, Solan (HP) on 14.10.2014.

Ms. Bindvi Arora

1. Advances in Microscopy organized by CIRCOT, Mumbai from Jan 19-21, 2015.

2. Entrepreneurship and management training for women government employees organized by EDI, Ahmedabad from Feb 2-6, 2015.

Ms. Mamta Gupta

1. Attended 8th International Conference on Mushroom Biology and Mushroom Products, 19-22 November, 2014, organized by World Society o Mushroom Biology, ICAR-Directorate of Mushroom Research and Mushroom Society of India, held at NASC Complex, New Delhi, India

2. Attended Professional Attachment Training on "Techniques for detection and Identification of viruses", 26th November, 2014 - 24th February, 2015 at National Bureau of Plant Genetic Resources, New Delhi

3. Participated in the Symposium cum workshop on "Applications of Flow Cytometry in Plant & Crop Research", organized at National Research Center for Plant Biotechnology, IARI, New Delhi and supported by Becton Dickinson India Pvt. Ltd., on 8th December, 2014

4. Attended National Symposium on "Innovative Approaches of Plant Disease Management for Sustainable Development", organized by Indian Phytopathological Society (Delhi Zone) at Division of Plant Pathology, IARI, Pusa, New Delhi, on January 17, 2015

5. Attended Interactive session on "PGR-Importance of present and future" with Dr. R. S. Paroda, organized by Indian Society of Plant Genetic Resources (ISPGR), on 5th February, 2015

11. DISTINGUISHED VISITORS

- Dr.N.K. Krishna Kumar, Deputy Director General (Hort. Science), ICAR visited ICAR-DMR on 29th August, 2014.
- 4-Member delegation from Japan namely Mr.Yasuhide Ito, Mr.Masahiko Murakami, Retd.Major General Takayuki Hirano and Ms.Tomomi Shingai visited ICAR-DMR on 26th December, 2014.

Fig 3.4. The DDG (Hort. Science), ICAR on his visit to ICAR-DMR

Fig. 3.5 Japanese delegation on visit to ICAR-DMR

Memorandum of Understanding between ICAR-NBAIM, Mau and ICAR-DMR, Solan for Developing Culture Collection of DMR as a node of NAIMCC, NBAIM for Long-term Preservation of Macro-Fungi

1. ICAR-DMR will be a node of NAIMCC for long term preservation of macro-fungi collected from within or outside India or introduced in the country.
2. All the cultures of macro-fungi/mushrooms available in the ICAR-DMR, Solan culture collection will be maintained for short and medium term at ICAR-DMR and will be transferred to ICAR-NBAIM, Mau for long term conservation.
3. These cultures will become a part of NAIMCC. The accession numbers given by ICAR-DMR will continue alongwith the NAIMCC numbers. In subsequent collections also the number will be assigned by DMR and the culture will be transferred to NBAIM for allocation of composite number as described.
4. All interested to deposit cultures of macrofungi will be advised to deposit with ICAR-DMR. Any cultures of macro-fungi deposited with NBAIM will be transferred to ICAR-DMR for short and medium term conservation until and unless these are unique mushroom cultures deposited only for conservation and/or registration.
5. The unique mushroom cultures maintained by ICAR-DMR and not meant for distribution can be kept in safe deposit in NAIMCC.
6. All the varieties/improved strains/hybrids of mushrooms developed by ICAR-DMR, Solan will be submitted to ICAR-NBAIM, Mau for registration.
7. NAIMCC owes the responsibility of conservation of all these cultures through long-term conservation techniques especially by freeze drying and cryopreservation tools. For this purpose, ICAR-DMR will supply the cultures along with relevant details to ICAR-NBAIM.
8. The request for supply of cultures by users will be forwarded to DMR and the charges thereof will be part of revenue of ICAR-DMR. In case, ICAR-DMR is not able to supply cultures, NAIMCC will supply the same and keep the revenue thus received at ICAR-NBAIM, Mau.
9. Consequent upon this agreement, an inter-institutional project involving DMR and NBAIM will be formulated for developing strategies/protocols for long term preservation of macro-fungi.

Manjit Singh
Director, ICAR-DMR, Solan

Arun K. Sharma
Director, ICAR-NBAIM, Mau

Countersigned by

Prof. Swapan K. Datta
DDG (CS), ICAR, New Delhi

Dr. N. K. Krishna Kumar
DDG (HS), ICAR, New Delhi

Place: New Delhi
Dated: 22.01.2015

12. PERSONNEL AND FACILITIES

Table 12.1. Cadre strength of scientists at the ICAR-Directorate of Mushroom Research, Chambaghat, Solan (HP) 173213 as on 31.12.2014

Name of the discipline	Pay band and grade pay	Scientist			Sr. Scientist			Principal Scientist			Total		
		A	B	C	A	B	C	A	B	C	A	B	C
Agrl.Engg. (ASPE)	15600-39100 + GP 6000/-	-	1	1	-	-	-	-	-	-	-	1	1
Agril Biotech-nology	15600-39100 + GP 6000 & 8000/-	1	-	1	1	-	1	-	-	-	2	-	2
Agril Entomology	15600-39100 + GP 6000/-	1	-	1	-	-	—	-	-	-	1	-	1
Agril Extension	15600-39100 + GP 6000/-	1	-	1	-	-	-	-	-	-	1	-	1
Flexi discipline (Computer Application)	15600-39100 + GP 6000/-	1	-	1	-	-	-	-	-	-	1	-	1
Food Technology	15600-39100 + GP 6000/-	1	-	1	-	-	-	-	-	-	1	-	1
Genetics & Pl breeding	15600-39100 + GP 6000/-	-	2	2	-	-	-	-	-	-	-	2	2
Plant Pathology	15600-39100 + GP 6000/- & 8000/- 37400-67000 + GP 10000	1	-	1	2	-	2	-	1	1	3	1	4
Soil Science	15600-39100 + GP 6000/-	-	1	1	-	-	-	-	-	-	-	1	1
Vegetable Science	15600-39100 + GP 6000/- & 8000/-	-	1	1	-	1	1	-	-	-	-	2	2
G. Total		6	5	11	3	1	4	-	1	1	9	7	16

A - In position; B – Vacant: C – Total

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	1	1	2
3	T-2	5200-20200 + GP 2400/-	1	1	-	1
4	T-1	5200-20200 + GP 2000/-	9	8	1	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	3	1	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	12	3	15 (-1)
1	Skilled support staff (Supporting staff)	Rs.5200-20200 + GP 1800/-	10	06	4	10

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 ICAR-DMR (HP)

SN	Name of employee	Email	Designation
1	Dr.Manjit Singh	director.mushroom@icar.gov.in	Director (till 31.03.2015)
2	Dr.R.C. Upadhyay	rcupadhyay.icar@gov.in	Principal Scientist
3	Dr.V.P. Sharma	vpsharma93.icar@gov.in	Principal Scientist
4	Dr.O.P. Ahlawat	ahlawat22.icar@gov.in	Principal Scientist
5	Dr.Satish Kumar	satish132.icar@gov.in	Principal Scientist
6	Dr.Shwet Kamal	shwetkamal.icar@gov.in	Senior Scientist
7	Dr.Yogesh Gautam	ygautamdmr.icar@gov.in	Scientist (SS)
8	Sh.Mahentesh Shirur	mshirur.icar@gov.in	Scientist
9	Ms.Bindvi Arora	bindvi.icar@gov.in	Scientist
10	Ms.Mamta Gupta	mamtagupta.icar@gov.in	Scientist
Administrative staff			
1	Sh.Rajinder Sharma	rajinder1.icar@gov.in	AAO
2	Sh.Surjit Singh	skanwar.icar@gov.in	PS
3	Smt.Sunila Thakur	sunilathakur.icar@gov.in	PA
4	Sh.Bhim Singh	bhim.icar@gov .in	Assistant
5	Sh.T.D. Sharma	tdsharma.icar@gov.in	Assistant
6	Sh.Deep Kumar	deep.icar@gov.in	Steno Gr.III
7	Sh.N.P. Negi	npnegi.icar@gov.in	Assistant
8	Sh.Satinder Thakur	satenderk.icar@gov.in	UDC
9	Sh.Dharam Dass	dharma.icar@gov.in	UDC
10	Smt.Shashi Poonam	shaship.icar@gov.in	LDC
11	Sh.Roshan Lal Negi	roshannegi.icar@gov.in	LDC
12	Sh.Sanjeev Sharma	sanjeevs.icar@gov.in	LDC
Technical staff			
1	Sh.Sunil Verma	sunilv.icar@gov.in	Assistant Chief Technical Officer (Farm)
2	Smt.Reeta	reeta30.icar@gov.in	Assistant Chief Technical Officer (Library)
3	Smt.Shailja Verma	shailjav1.icar@gov.in	Sr. Technical Officer (Art)
4	Sh.Gian Chand	gianchand1.icar@gov.in	Sr.Technical Assistant (Boiler)
5	Sh.Dala Ram	dalaram.icar@gov.in	Sr.Technical Assistant (Driver)
6	Sh.Ram Lal	ramlal.icar@gov.in	Sr.Technical Assistant (Driver)
7	Sh.Lekh Raj Rana	lekhraj.icar@gov.in	Technical Assistant (Farm)
8	Sh.Ram Swaroop	ramwaroop.icar@gov.in	Technical Assistant (Farm)
9	Sh.Jeet Ram	jeetram.icar@gov.in	Technical Assistant (Farm)
10	Sh.Guler Singh Rana	gulerrana.icar@gov.in	Technical Assistant (Electrician)
11	Sh.Deepak Sharma	depsun.icar@gov.in	Technical Assistant (Computer)
12	Sh.Raj Kumar	rajkumar1.icar@gov.in	Technical Assistant (Farm))
Skilled supporting staff			
1	Sh.Naresh Kumar	nareshkumar.icar@gov.in	SSS
2	Sh.Nika Ram	neekaram.icar@gov.in	SSS
3	Sh.Tej Ram	tejram.icar@gov.in	SSS
4	Smt.Meera Devi	meeradevi.icar@gov.in	SSS
5	Sh.Ajeet Kumar	ajeetkumar.icar@gov.in	SSS
6	Sh.Vinay Sharma	vinaysharma.icar@gov.in	SSS

Joining

1. Ms.Bindvi Arora has joined as Scientist (Food Technology) at this Directorate on 09.04.2014 (FN)

2. Dr.Yogesh Gautam has joined as Scientist (SS) at this Directorate on 07.08.2014 (FN) upon transfer from IASRI, New Delhi.

3. Ms.Mamta Gupta has joined as Scientist (Biotechnology) at this Directorate on 01.10.2014 (FN)

Modified assured career progression (MACP)

1. Sh.Deep Kumar Thakur, Steno Gr.III granted financial upgradation in the pay band of '.9300-34800 + GP 4600/- w.e.f. 03.10.2014

2. Sh.Dharam Dass, UDC granted financial up gradation in the pay band of Rs.5200-20200 + GP 2800/- w.e.f. 02.02.2014.

3. Smt.Shashi Poonam, UDC granted financial up gradation in the pay band of Rs.5200-20200 + GP 2800/- w.e.f. 09.02.2014.

Promotion

1. Smt.Reeta, Sr. Techncial Officer was promoted as Assistant Chief Techical Officer w.e.f. 20.08.2013.

2. Sh.Raj Kumar, SSS was promoted as Technical Assistant (T-1) w.e.f. 29.09.2014.

Superannuation

1. Sh.R.K. Bhatnagar, AAO was superannuated from Council services w.e.f. 30.04.2014

2. Sh. Jia Lal Garg, Technical Officer was superannuated from Coucil services w.e.f. 31.05.2014.

3. Sh. A.N. Vashisth, Administrative Officer was superannuated from Council services w.e.f. 31.07.2014.

4. Dr. Manjit Singh, Director, ICAR-DMR was superannuated from Council services w.e.f. 31.03.2015.

Sports

A contingent of 20 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 2014-15

S. No.	Head of Accounts	Non-Plan Allocation 2014-15	Non-Plan Exp. 2014-15	Plan Allocation 2014-15	Plan Exp. 2014-15
A. Capital					
I	Land	**-**	**-**	-	**-**
ii	Works	**-**	**-**	-	**-**
iii	Equipment	**3.00**	**2.98**	12.40	**12.39**
iv	Information Technology	**-**	**-**	8.60	8.60
v	Library	**-**	**-**	4.70	4.70
vi	Furniture & Fixture	**-**	**-**	-	-
vii	Others	**-**	**-**	-	**-**
Total-	**non-plan capital assets**	**3.00**	**2.98**	**25.70**	**25.69**
B	**Revenue**	**-**	**-**	-	**-**
I	**Establishment expenses**	**-**	**-**	-	**-**
I	Establishment Charges	**300.89**	**291.27**	-	**-**
ii	Wages	**-**	**-**	-	**-**
iii	O.T.A	**0.11**	**0.09**	-	**-**
	Total Estt. Charges	**301.00**	**291.36**	**-**	**-**
	General Revenue				**-**
1	**Pension & Other Retirement Benefits**	**92.00**	**92.00**	**-**	**-**
2	**Traveling Expenses**				
	I) TA Domestic/Transfer TA	**2.50**	**2.50**	**5.00**	**5.00**
	Total Travelling Allowance	**2.50**	**2.50**	**5.00**	**5.00**
3	Research & Operational Expenses	**19.00**	**18.59**	30.10	**30.10**
4	Administrative Expenses	**57.00**	**56.99**	25.20	**25.20**
5	Misc. Expenses	**3.50**	**3.50**	10.00	**9.98**
Total	**Revenue**	**475.00**	**464.94**	**70.30**	**70.28**
	NEH	**-**	**-**	**1.00**	**0.64**
	TSP	**-**	**-**	**1.00**	**1.00**
Grand Total: (Capital & Revenue)		**478.00**	**467.92**	**98.00**	**97.61**

Sl. No.	Head of Account	Allocation	Expenditure
1	Non-Plan	478.00 lakhs	467.92 lakhs
2	Plan	98.00 lakhs	97.61 lakhs
3	AICRP on Mushroom	245.00 lakhs	245.00 lakhs

		Target	Achieved
4	Revenue receipt	31.40 lakhs	35.38 lakhs

NOTES

NOTES


भाकृअनुप
ICAR
हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch