वार्षिक प्रतिवेदन
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2007-2008

राष्ट्रीय खुम्ब अनुसंधान केन्द्र
NATIONAL RESEARCH CENTRE FOR MUSHROOM

(भारतीय कृषि अनुसंधान परिषद्)
(Indian Council of Agricultural Research)

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PREFACE

The achievements of National Research Centre for Mushroom during 2007-2008 are summarized under various heads. During the year National Mushroom Repository has been enriched by addition of 261 mushroom cultures of which some are new records for India. Molecular variation and genetic identities studied among 18 wild and cultivated strains of *A. bisporus* revealed that strains ARP-230 and ARP-231 were quite divergent strains, and displayed unique bands in the RAPD profiles. The brown wild strains exhibited comparatively more DNA polymorphism than the cultivated white strains. Genetic improvement studies on temperate and tropical mushrooms conducted resulted in the development of four high-yielding strains *of Calocybe indica* viz., OE-334, OE-343, OE-345 and OE-348 with 82.1, 64.5, 74.3 and 61.2% B.E., respectively. Hybrid S-31 of *Lentinula edodes* has been identified as high yielding strain giving 95.5% BE. Among 12 strains of *Volvariella volvacea* showing superior growth characteristics quite a high variation was observed in lignocellulolytic enzyme activity.

NRCM continued its efforts to prepare quality compost through indoor composting with the help of thermophilic fungi and encouraging results have been obtained. Cultivation technology of *Macrolepiota procera* has been standardized in the Centre and it will help in diversification. Efforts were made to increase the yields of *Lentinula edodes, Agrocybe aegerit*a and *Flammulina velutipes* by adding growth hormones and supplementing the cultivation substrates. Gibberellic acid, IBA and kinetin @ 20 ppm proved to be the best growth hormones for enhancing the mycelial growth of *Agrocybe aegerita*, *Flammulina velutipes* and *Lentinula edodes*, respectively.

Survey of different mushroom farms revealed the widespread incidence of wet bubble, yellow mould, *Sclerotium*, brown plaster mould, inkcaps, lipstick mould and *Chetomium* spp. Among pests sciarid, phorid and mites were common in most of the farms. Incidence of red pepper mite (*Pygmephorus sellnicki*) was recorded for the first time in one of the mushroom farm in H.P. Studies on the persistence of malathion and decamethrin in *Agaricus bisporus* revealed that the residue of malathion varied from 0.32 to 0.79 ppm and of decamethrin from 0.26 to 0.61 ppm. Washing with water or boiling for 10 minutes resulted upto 87-90% decrease in residue level. Boiling was more effective in lowering the residue level of both the insecticides and carbendazim than washing with water. Screening of different strains of paddy straw mushroom against phorid flies revealed that OE- 12 and OE-1222 were highly susceptible and OE-210 was resistant. Fifteen *Cladobotryum* isolates collected from different mushroom units were catalogued into four taxa namely, *Hypomyces aurantius, Cladobotryum dendroides, C. mycophilum* and *C. astrophorum*. No inter or intra species ITS length diversity was detected in ten isolates of *Mycogone perniciosa*.

Studies conducted on modified atmospheric packaging (MAP) of button mushroom in PET containers under refrigerated and ambient condition revealed that diffusion channel method was found to be the best method for storage to prolong the shelf life of button mushroom up to 8 days in ambient storage. A compost conveyor has been designed to carry compost to the bunker or elsewhere. The multi purpose substrate-mixing drum has also been designed and fabricated and a trimming machine was developed at NRCM-workshop to trim the mushroom stipe.

During the year under report, the Centre has organised a total number of 8 on & off-campus training programmes for farmers, farmwomen, entrepreneurs & reseachers. One day Mushroom Mela was organised on 10th September, 2007 as regular activity of the Centre. It was attended by about 450 farmers, farm women, mushroom growers, researchers, extension workers and businessmen from various States. Kisan Goshthi was also held to answer the problems in mushroom

cultivation faced by mushroom growers. During the Mushroom Mela, the Centre awarded four progressive mushroom growers -Sardar Harpal R/O Kurkshetra (Haryana), Smt. Asha Kiran Gupta, R/O Kurkshetra (Haryana), Subedar Seva Singh R/O Amritsar (Punjab) and Sh. Ratan Thakur R/O Solan (HP) for adopting innovative practices in mushroom cultivation on larger scale and mobilizing other farmers to adopt mushroom cultivation as source of income.

One scientist has been trained in Developing Winning Research Proposals in Agricultural Research. Besides this, Er. Nathan also submitted his thesis to Tamil Nadu Agricultural University, Coimbatore and completed his Ph.D (Agricultural Processing) degree.

The Centre has developed infrastructure facilities like Teacher Training Centre. The Centre has been also provided with 180 KVA Generator Set and work of electrical Sub Station of 630 KVA has been completed.

Seeing the potentials of mushrooms as a livelihood generator and the prospects for developing protein rich-food, pharmaceuticals and agrowaste management through mushroom cultivation, the action plan envisaged is being focused on tapping these potentials and prospects. The emphasis ought to is being given for collection, conservation and effective utilization of indigenous mushroom genetic resources for achieving the goal of the high production and productivity of the cultivated mushroom in the country. The critical inputs like seed (quality spawn), productive compost/ substrates and quality water and suitable environment are being arranged for augmenting the production. As the availability and the survival of quality spawn is a major limiting factor in the mushroom production, the establishment of standard spawn laboratories either in private or public sectors under the quality control and overall guidance of National Centre shall be a priority in the next couple of years. The greater emphasis is being given for diversified cultivation of various mushroom species suited to varied agro-climatic zones of the country. The establishment of low-cost mechanized farms should be encouraged in the country with the technical guidance of NRCM. The unorganized marketing is a major handicap in the popularization of mushrooms as an income generating venture and as a means of rural livelihood. The establishment of cool-chains through cooperative movement and involvement of NGOs in the marketing and promotion of mushrooms shall be an important priority.

The Centre is indebted to ICAR for financial support and Division of Horticulture for technical guidance. The editorial committee members of this annual report deserve appreciation for their sincere efforts in reflecting the significant achievements of NRCM.

(R.P. Tewari)
Director

कार्य सारांश

वर्ष 2007-08 के दौरान राष्ट्रीय खुम्ब अनुसंधान केन्द्र ने अनुसंधान, प्रसार व मानव संसाधन विकास के क्षेत्र में उल्लेखनीय प्रगति की है, जिसका विवरण फसल उन्नयन, फसल उत्पादन, फसल संरक्षण, फसल पोषण एवं उपयोग, प्रसार एवं तकनीकी हस्तांतरण, खुम्ब सूचना प्रौद्योगिकी, शिक्षा एवं अन्य कार्यकलापों के अंतर्गत प्रस्तुत किया गया है।

फसल उन्नयन

क) जैव संपदा संग्रहणः- इस वर्ष कुल 261 जंगली खुम्बों के नमूने एकत्र किये गये, जिनमें से 206 नमूने एगेरीकेल्स वर्ग के पाये गये। पायी गईं प्रमुख प्रजातियाँ (जेनेरा) हैं: *एगेरिकस, एल्नीकोला, एमेनिटा, अनेलेरिया, आरमीलेरिया, बोलेटीनस, बोलीटस, कैंथिरीलस, क्लोरोफिलम, क्लाईटोसाईब, कोनोसाईब, कोर्टीनेरियस, सिस्टोडर्मा, डेस्कोलिया, इन्टोलोमा, गोमफस, जिमनोपाईलस, हिबेलोमा, हाईग्रोफोरस, इनोसाईबी, क्हनेरोमाइसिस, लैक्केरिया, लैक्टेरियस, लेपियोटा, लेन्टिाईनस, लेपिस्टा, ल्यूकोपैक्सिलस, लायोफिलम, मारस्मियस, माईसीना, नेमेटोलोमा, ऑडीमेनसियला, पेनियोलस, फैईयोकोलाईबिया, प्लूरोटस, प्लूटीयस, पॉलीपोरस, सेथइरिल्ला रूसूला, स्ट्रोबिलोमाईसेस, स्ट्रोफेरिया ट्राईकोलोमा, टयूबेरिया, टाईलोपीलस एवं वॉल्वेरियेला।*

ख) जंगली खुम्बों का वर्गीकरणः इस वर्ष वर्ग एग्रीकॉयड के अलावा गैस्ट्रोमाईसीट्स एवं एफाईलोफोरेल्स वर्ग के खुम्बों के बहुत से नमूने एकत्र किये गये, जिनमें से एकत्र किये गये कुछ नमूने इस प्रकार हैं: *ऑरिकुलेरिया फोम्स, गैनोडर्मा, जाइरोमितरा, हेवेला, हर्सियम, हाईडनम, इन्नोनोटस, लाईकोपरडॉन, मोरकेला, पिजाईजा, राईजोपोगॉन, स्पैरासिस* व *ट्रिमेला*। व्यवसायिक तौर पर उगाई जा रही खुम्बों की प्रजातियों जैसे *प्लूरोटस, स्ट्रोफेरिया, वॉल्वेरियेला, लेन्टिनस, हर्सियम, ऑरिकुलेरिया* आदि के संबंधित जंगली खुम्बें भी एकत्र की गईं, जो मशरूम प्रजनन कार्यक्रम के तहत प्रजाति उन्नयन दृष्टि से बहुत महत्वपूर्ण है।

ग) जैव संपदाओं का चरित्र-चित्रणः- *एगेरिकस बाईस्पोरस* की 18 जंगली व काश्त की जा रही प्रजातियों के मॉलिकुलर विश्लेषण से ज्ञात होता है कि ए०आर०पी०-230 व ए०आर०पी०-231 प्रजातियां बिल्कुल भिन्न हैं व विशिष्ट आर०ए०पी०डी० बैण्ड को प्रदर्शित करती हैं। काश्त की जा रही श्वेत प्रजातियों की तुलना में जंगली भूरी प्रजातियों में डी०एन०ए० बहुरूपता अधिक प्रदर्शित होती है। आई०टी०एस०-1 व आई०टी०एस०-4 प्राईमर्स का प्रयोग करते हुए *ए० बाईस्पोरस* की 18 जंगली व काश्त की जा रही प्रजातियों से आई०टी०एस०-1, 5.8 एस० आर० आर०एन०ए० जीन व आई०टी०एस०-2 को एक इकाई के रूप में लेकर विस्तारित किया गया। प्रजाति ए०आर०पी०-223 (ए-27) को छोड़कर अन्य सभी प्रजातियों की आई०टी०एस० प्रोफाईल में कोई बदलाव नहीं देखा गया। ए०आर०पी०-223 की कवक आकार की भिन्न थी तथा छोटा आई०टी०एस० डी०एन०ए० बैण्ड को प्रदर्शित करता है। *एगेरिकस* वंश के 30 आनुवांशिक रूप से भिन्न प्रजातियों की आई०टी०एस० अनुक्रमों का अध्ययन किया गया। एस०एन०पी० का चार मूल युग्मों की पोजीशन्स का परीक्षण किया गया। *एगेरिकस* प्रजातियों में 5.8 एस० आर० आर०एन०ए० जीन के आई०टी०एस०-1 में एक तथा तीन आई०टी०एस०-2 प्रक्षेत्र में मिले।

चौबीस प्राईमर्स के 175 आर०ए०पी०डी० मारकर्स में विस्तारित करके, *ए० बाईस्पोरस* की 22 श्वेत छत्रक प्रजातियों की मॉलिकुलर विभिन्नता व आनुवांशिक पहचान का अध्ययन किया गया जिनमें 53.75 प्रतिशत पॉलिमॉर्फिक थे। आनुवांशिक समानता सूचकांक 0.64 से 0.99 के बीच पाया गया तथा औसतन सूचकांक 0.81 प्रतिशत पाया गया। प्रजातियों में 92.7 प्रतिशत व संकरों में 84.3 प्रतिशत आनुवांशिक समानता देखने को मिली। आई०टी०एस०-2 प्रक्षेत्र में 522 व 563 *न्यूक्लियोटाइड* स्थिति पर दो सिंगल *न्यूक्लियोटाइड पॉलिमॉर्फिज्म* की पहचान भिन्न प्रजातियों में की गई। इस अध्ययन से प्रतीत होता है कि संकरों के जर्मप्लाज्म की पहचान करने व श्वेत बटन खुम्ब की प्रजातियों में इंट्रास्फेसिफिक मॉलिकुलर वेरियेशन की पहचान के लिये आर०ए०पी०डी० मारकर्स महत्वपूर्ण व विश्वसनीय तकनीकी है।

घ) आनुवांशिक सुधार :- शीतोषण एवं उष्णकटिबंधीय खुम्बों - *एगेरिकस, प्लूरोटस, वॉल्वेरियेला* एवं *लेन्टीनुला* के आनुवांशिक उन्नयन के लिये अध्ययन किये गये। देश के विभिन्न भागों से एकत्र किये गये *एगेरिकस* जाति के जंगली जर्मप्लाज्म का *एगेरिकस बाईस्पोरस* के उत्पादन योग्य व जंगली जर्मप्लाज्म के साथ फाईलोजेनेटिक संबंध स्थापित करने हेतु *एगेरिकस* जाति के जंगली जर्मप्लाज्म के डी०एन०ए० का विश्लेषण किया गया। एकत्रित देशी जंगली खुम्बों से प्राप्त आई०टी०एस० डी०एन०ए० को एम्पलीफाई व क्रमबद्ध किया गया। *एगेरिकस बाईस्पोरस* के 22 प्रजातियों व संकरणों का स्पॉन उनकी उपज व गुणवत्ता मूल्यांकन हेतु तैयार किया गया।

कैलोसाईबी इंडिका की 26 प्रजातियों को पास्चुरीकृत भूसे पर उगाकर मूल्यांकित किया गया। फलन ट्रायल के द्वारा 21 प्रजातियों में से 4 उच्च उपज देने वाले प्रजाति -ओ०ई०-334, ओ०ई०-343, ओ०ई०-345 व ओ०ई०-348 जिनकी जैव परिवर्तन क्षमता (बी०ई०) क्रमशः 82.1, 64.5, 74.3 व 61.2 प्रतिशत थी, को चिंहित किया गया। *कैलोसाईबी इंडिका* की 19 प्रजातियों का आनुवांशिक समानता व मॉलिकुलर परिवर्तन हेतु अध्ययन किया। इन 19 जंगली व उत्पादित प्रजातियों को एक यूनिट के रूप में आई०टी०एस०-1, 5.8 एस० आर०आर०एन०ए० जीन व आई०टी०एस०-2 को एमप्लीफाई किया गया। सभी में पी०सी०आर० ने एक ही उत्पाद दिया जिनकी आई०टी०एस० प्रोफाईलों की लंबाई में कोई परिवर्तन नहीं था। *कैलोसाईबी इंडिका* के 18 प्रजातियों के आर०ए०पी०डी० विश्लेषण में डी०एन०ए० पॉलिमॉर्फिज्म दिखाई दी।

सर्वश्रेष्ठ वृद्धि गुणों से परिपूर्ण *वॉल्वेरियेला वॉल्वेसिया* के 18 प्रजातियों का 'माल्ट एक्ट्रेक्ट अगर' माध्यम पर पैट्रीडिश में तथा निर्जीवीकृत पुआल माध्यम में कोनीकल फ्लास्क में उगाया गया। प्रजाति ओ०ई० 215 में एरियल तंतुओं को सबसे अधिक पाया गया। इसके बाद क्रमशः प्रजाति ओ०ई०-273, ओ०ई०-209 व ओ०ई०-212 में एरियल तंतुओं को पाया गया। इन प्रजातियों में क्लेमाईडोस्पोर्स का बनना नहीं पाया गया। एरियल तन्तु व क्लेमाईडोस्पोर्स केवल पांच प्रजातिओं - ओ०ई०-273, ओ०ई०-274, ओ०ई०-12 व ओ०ई०-215 में बनते पाये गये। लिग्नोसेलूलाईटिक एन्जाइमस् - एक्जोग्लूकॉनेज, एण्डोग्लूकॉनेज, बीटा-ग्लूकोसाइडेज, जाईलेनेज, लैक्केज व पॉलिफिनॉल ऑक्सीडेज की सक्रियता भिन्न प्रजातियों में भिन्न-भिन्न पाई गई। सेलूलेजिज की श्रेणी में, सबसे तेज गति से वृद्धि करने वाली प्रजाति ओ०ई०-215 जाईलेनेज (2.24 म्यू) व एक्जोग्लूकॉनेज (1.00 म्यू) की उच्चतम सक्रियता को प्रदर्शित करती है जबकि बीटा-ग्लूकोसाइडेज की सक्रियता

मध्यम थी। इसके बाद ओ०ई० 212 प्रजाति का स्थान है जिसमें जाईलेनेज, एण्डोग्लूकॉनेज व बीटा-ग्लूकोसाइडेज की सक्रियता उत्कृष्ट पायी गई। धीमी गति से वृद्धि करने वाली प्रजातियों में ओ०ई०-213 व ओ०ई०-12 में एण्डोग्लूकॉनेज की सक्रियता बहुत कम थी। पी०सी०आर० की सहायता से 5.8 एस० आर०आर०एन०ए० जीन प्रक्षेत्र पर आई०टी०एस०-1 व आई०टी०एस०-2 के दोनों तरफ से गुजारने पर सभी 12 पैतृक प्रजातियों में लगभग 720 बी०पी० का आई०टी०एस० एमप्लीकॉन प्राप्त हुआ। जिससे यह सुनिश्चित होता है कि सभी स्ट्रेन (प्रजातियॉं) एक ही जाति (*वॉल्वेरियेला वॉल्वेसिया*) की हैं।

प्रत्येक प्रजाति (स्ट्रेन) की लगभग 60-80 बैण्डस् व पांच प्राईमर्स के आधार पर पैतृक स्ट्रेन (प्रजातियों) की आर०ए०पी०डी० विश्लेषण से प्राप्त संयुक्त फाईलोजेनेटिक विश्लेषण से स्वयं प्रजातियों में वृहद इंट्रा-स्पेसिफिक परिवर्तन (10-28 प्रतिशत) का होना ज्ञात होता है।

फाईलोजेनेटिक विश्लेषण पांच भिन्न फाईलोजेनेटिक क्लेड्स का होना बताता है, जिसमें पहले क्लेड में 3 प्रजातियां, दूसरे में 6 प्रजातियां तथा शेष तीन क्लेड्स में एक-एक प्रजाति शामिल हैं।

लेन्टिनुला इडोड्स में संकरणो व 15 पैतृक प्रजातियों की डी०एन०ए० क्रमबद्धता की गई, जिनके आई०टी०एस० प्रक्षेत्रों में सार्थक आनुवांशिक भिन्नता पाई गई। पिछले वर्ष की तुलना में, इस वर्ष सभी प्रजातियों व संकरणों से उच्च जैव-परिवर्तन क्षमता प्राप्त हुई जो 54.2 प्रतिशत (ओ०ई०-21) से 95.5 प्रतिशत (संकर एस०-31) के मध्य पाई गई।

फसल उत्पादन

क) श्वेत बटन मशरूम (*एगेरिकस बाईस्पोरस*)

भूसे को प्रमुख अवयव के रूप में प्रयोग कर अंतः कम्पोस्टिंग प्रक्रिया पर उत्पादन परिक्षण किये गये। कम्पोस्ट तैयार करने हेतु सभी अवयवों को ठीक से 2 दिनों तक मिलाया गया, इसके बाद इन्हें तीन दिनों के लिये फेज-I बंकर में स्थानांतरित किया गया, तदुपरांत फेज-II कार्य किये गये। इससे 3.2 गुणा कम्पोस्ट प्राप्त हुई, तैयार कम्पोस्ट में नमी 67.52 प्रतिशत, पी०एच० 7.3 व नाईट्रोजन 1.78 प्रतिशत थी।

विभिन्न मशरूम फार्मों से एकत्र किये गये कम्पोस्ट के नमूनों से मीजोफिलिक कवक - *स्यूकर स्यूजीलस, एसपर्जीलस फ्यूमीगेटस, पेनिसीलियम* स्पी०, *फ्यूजेरियम* स्पी०, *ट्राईकोडर्मा विरीडी, पेसीलोमाईसीस बेरियोटाई, सेपिडोनियम महेश्वरीयनम, वर्टीसीलियम* स्पी० तथा थर्मोफीलिक कवक - *एस० थर्मोफीलम, एच० इन्सोलेंस, एच० ग्रेसिया* को पृथक किया गया। इस वर्ष *जियोट्राईकम* स्पी०, *टेलेरोमाईसी डूपोटाई* व *टी० इमर्सोनी* की नई प्रविष्टि हुई।

पृथक किये गये ग्यारह थर्मोफीलिक बैक्टीरिया में से पाँच ग्राम पोजेटिव व शेष ग्राम निगेटिव थे। इसी प्रकार पृथक किये गये मीजोफिलिक बैक्टीरिया में से 4 ग्राम पोजेटिव व 7 ग्राम निगेटिव थे। सभी ग्राम पोजेटिव आईसोलेट्स छड़ आकार के थे जो जोड़ों में, तीन के ग्रुप में, गुच्छों में या लम्बी जंजीर में विन्नयासित थे। ग्राम निगेटिव आईसोलेटस् भी, एक को छोड़कर जो एक लम्बी श्रृंखला में त्रिभुज आकार के थे, अन्य सभी छड़ आकार के थे।

ब) विशिष्ट खुम्ब उत्पादन

तरल माध्यम में 20 पी०पी०एम० सांद्रता के जिब्रेलिक अम्ल मिलाना *एग्रोसाईबी एजीरीटा* की कवक जाल की वृद्धि कारक हेतु अच्छा हार्मोन साबित हुआ। *लेन्टिनुला इडोडस* के लिये काईनेटिन (20 पी०पी०एम०) एक अच्छा कवक जाल वृद्धि कारक हार्मोन सिद्ध हुआ।

मैक्रोलेपियोटा प्रोसीरा को लघु विधि से तैयार किये गये कम्पोस्ट पर सफलतापूर्वक उगाया गया। कवक जाल फैलाव 27-28° सेल्सियस 30-35 दिनों में पूर्ण हुआ। केसिंग आवरण चढ़ाने के 18-21 दिनों बाद कलिकायें निकलना प्रारंभ हुई। *एग्रोसाईबी एजीरीटा* उत्पादन हेतु, बुरादा उत्कृष्ट पोषाधार साबित हुआ है क्योंकि भूसे से तैयार पोषाधर से प्राप्त 50 प्रतिशत जैव परिवर्तन क्षमता की तुलना में बुरादा से तैयार पोषाधार से 62 प्रतिशत जैव परिवर्तन क्षमता मिली है। गेहूं के चोकर को 10 प्रतिशत की दर से बुरादे में संपूरित करने पर जैव परिवर्तन क्षमता में वृद्धि हुई। प्रति किलोग्राम शुष्क पोषाधार (बुरादा) में 50 मिलीग्राम एस्पराजीन मिलाने पर *फ्लैमुलिना वेलूटिप्स* में कवक जाल फैलाव अति उत्तम व उत्पादकता में बढ़ोत्तरी प्राप्त हुई। काईनेटिन को 20 पी०पी०एम० की दर से प्रयोग करने पर *फ्लैमुलिना वेलूटिप्स* की उपज में उच्चतम (40 प्रतिशत जैव परिवर्तन क्षमता) बढ़ोत्तरी मिली। अन्य दो वृद्धि नियंत्रक हारमोन -इण्डोल व्यूटेरिक अम्ल व जिब्रेलिक अम्ल के प्रयोग से भी उपज में वृद्धि हुई है। बुरादे में 40 प्रतिशत की दर से गेहूं का चोकर मिलाने से *लेन्टिनुला इडोड्स* की उच्चतम उपज (80 प्रतिशत जैव परिवर्तन क्षमता) मिली। इसी संपूरक की दर घटाने पर उपज में कमी पायी गई।

फसल संरक्षण

हिमाचल प्रदेश, हरियाणा व पंजाब में स्थिति मशरूम फार्मों का सर्वे करने से ज्ञात हुआ कि इन राज्यों में वेट-बबल, स्कलोरेशियम, पीला फफूंद व इंकी कैप्स का वृहद प्रकोप है। हरियाणा के मोरनी हिल्स में वेट बबल बीमारी का भयानक प्रकोप देखने को मिला। हिमाचल प्रदेश के विभिन्न भागों में इंकी कैप्स, भूरा परत फफूंद, लिपस्टिक फफूंद, *कीटोमियम* स्पी० जनित बीमारियों का प्रकोप मिला। सभी भ्रमण किये गये फार्मों में सियारिड, फोरिड व माईट्स का प्रकोप पाया गया। एकत्र व प्राप्त किये गये कम्पोस्ट के नमूनों में से अधिकांश नमूनों में सूत्रकृमियों की उपस्थिति मिली। हिमाचल प्रदेश के एक फार्म पर रेड पिपर माईट को पहली बार देखा गया है।

एगेरिकस बाईस्पोरस में मैलाथियॉन व डेकामेथरिन की दृढ़ मौजूदगी पर अध्ययन से ज्ञात होता है कि मैलाथियॉन की अवशेष मात्रा 0.32 से 0.79 पी०पी०एम० तथा डेकामेथरिन की अवशेष मात्रा 0.26 से 0.61 पी०पी०एम० के मध्य मौजूद थी। दोनों कीटनाशकों की मात्रा में वृद्धि करने पर उनके अवशेष की मौजूदगी के स्तर में भी बढ़ोत्तरी हुई। जब दोनों कीटनाशकों के छिड़कावों की संख्या बढ़ाई गई तो उनका अवशेष अधिक पाया गया। अवशेष की उपस्थिति को जानने के लिये किये गये इन उपचारों से जब फलनकाय के नमूने लेकर उन्हें पानी में 10 मिनट तक धोया या उबाला गया तो अवशेष के स्तर में औसतन कमी मैलाथियॉन में 31.57 से 87.57 प्रतिशत के मध्य व डेकामेथरिन में 59.79 से 90.10 के मध्य पायी गई। साधारण धुलाई की अपेक्षा उबालना दोनों कीटनाशकों के अवशेष को कम करने में अधिक प्रभावी पाया गया।

कार्बेन्डेजिम का अवशोषित स्तर जानने के लिये विभिन्न उपचारों में पाया गया कि फलनकायों की एस्कॉर्विक एसिड में धुलाई, दो दिनों तक सामान्य तापमान पर भण्डारण, दो दिनों तक फ्रिज में भण्डारण, भट्टी में सुखाने और उबालने या पकाने पर कार्बेन्डेजिम के अवशेषित स्तर में क्रमशः 28.57 से 81.86, 13.09-60.95, 10.11-81.23, 35.71-80.47, 1.19-79.34 व 33.92-86.90 प्रतिशत के मध्य कमी पायी गई।

पुआल मशरूम की विभिन्न प्रजातियों को फोरिड व सियारिड मक्खियों के प्रति सहनशीलता को परखने पर ज्ञात हुआ कि प्रजाति ओ०ई०-12 व ओ०ई०-1222 फोरिड मक्खियों के प्रति बहुत अधिक सुग्राही, ओ०ई०-55, ओ०ई०-56, ओ०ई०-57, ओ०ई०-58, ओ०ई०-59 व ओ०ई०-60 प्रजातियाँ कम सुग्राही व प्रजाति ओ०ई०-210 का प्रतिरोधी होना पाया गया। ओ०ई० 211 व ओ०ई०-129 प्रजातियां सियारिड मक्खियों के प्रति बहुत अधिक सुग्राही थी। विभिन्न इकाईयों से एकत्र किये गये *क्लेडोबोट्रियम* के 15 आईसोलेट्स की आनुवांशिक सूचीबद्धता व मॉलिकुलर पहचान न्यक्लियोटाईड अनुक्रम की तुलना 5.8 एस० आर० आर०एन०ए० जीन की सहायता से ब्लास्ट नेटवर्क एगेंस्ट एन०सी०बी० आई० डेटा बेसिस तकनीक प्रयोग कर उन्हें चार टेक्सा-*हाईपोमाईसेस ऑरनटियस, क्लेडोबोट्रियम डेंड्रोयडिस, सी० माईकोफिलम* व *सी० एस्ट्रोफोरम* में रखा गया। *माईकोगॉन पर्निसियोसा* के 10 आइसोलेट्स में परस्पर व मध्य आई०टी०एस० लम्बाई में कोई भिन्नता देखने को नहीं मिली। आर०डी०एन०ए० की आई०टी०एस० प्रक्षेत्र के विस्तारीकरण से प्राप्त न्यूक्लियोटॉयड अनुक्रम के आधार पर इन सभी आईसोलेट्स की पहचान *माईकोगॉन पर्निसियोसा* के रूप में कर एन०सी०बी०आई० जीन बैंक में ई०यू० 380317 के नाम से जमा की गई। *डेहिलियोमाईसेस* व *बर्टीसीलियम फंजीकोला* की एक्ट्रासेलूलर एन्जाईम प्रोफाईल से ज्ञात होता है कि दोनों में लैक्केज एन्जाईम की सक्रियता सबसे अधिक थी उसके बाद बीटा-ग्लूकोसाइडेज, पेक्टीनेज, जाईलेनेज सी०-1 सेल्यूलेज और सी०एक्स सेल्यूलेज अनुसरण करते पाये गये।

विभिन्न फार्मों से विभिन्न खुम्बों के एकत्र किये गये जीवाणुओं के 14 आईसोलेट्स का मॉलिकुलर चरित्र-चित्रण 16 एस० आर०आर०एन०ए० जीन आधारित आई०टी०एस० अनुक्रम द्वारा किया गया। इन 14 आईसोलेट्स की आर०ए०पी०डी० तकनीकी पर आधारित फाईलोजेनेटिक विश्लेषण इन्हें 7 फाईलोजेनेटिक समूहों में प्रदर्शित करता है।

फसल पोषण एवं उपयोग

श्वेत बटन खुम्ब की पैट जार में मॉडिफाईड एटमॉसफेरिक पैकेजिंग (एम०ए०पी०) पर किये गये प्रयोगों से ज्ञात होता है कि प्रसारण नलिका विधि श्वेत बटन मशरूम को सामान्य तापमान (18±1° सेल्सियस) पर भण्डारण लम्बे समय तक (8 दिनों तक) करने का सबसे अच्छी विधि है। इस उद्देश्य के लिये 15 सें०मी० लम्बी 3 मिली मीटर चौड़ी प्रसारण नलिका युक्त भण्डारण डिब्बे को बहुत ही उचित पाया गया।

उपरोक्त प्रयोग रेफ्रिजरेटिड दशाओं में भी किये गये तथा ज्ञात हुआ कि इस विधि से रेफ्रिजरेटिड दशाओं में श्वेत बटन मशरूम को 12 दिनों तक भण्डारित किया जा सकता है।

देशी मशीनों का विकास

कम्पोस्ट को बंकर में या किसी अन्य स्थान पर पहुंचाने के लिये एक कम्पोस्ट कन्वेअर की डिजाईन तैयार कर विकसित किया गया। इस कम्पोस्ट कन्वेअर द्वारा कम्पोस्ट

को यार्ड से पास्चुराईजेशन कक्ष व बंकर में 5 टन/घण्टे की दर से पहुंचाया जा सकता है। आवश्यकतानुसार इसकी ऊंचाई को 6 से 10 फीट तक समायोजित किया जा सकता है।

एक बहु-उद्देश्यी पोषाधार मिश्रण ड्रम का निर्माण किया गया है। इस मशीन से श्वेत बटन मशरूम उत्पादन हेतु कम्पोस्ट बनाने के विभिन्न प्रकार के अवयवों को मिलाने में कम पानी, समय व मजदूरों की जरूरत होती है। मशरूम उद्यम के अन्य कार्य जैसे केसिंग मिश्रण को मिलाना, पोषाधारों का मिश्रण तैयार करना, बीजाई आदि इस मशीन द्वारा किये जा सकते हैं। मशरूम के तने की छटाई हेतु ट्रिमिंग मशीन भी केन्द्र पर विकसित की गई है। यह मशीन लगातार घूमने वाला ब्लेड, स्टेम डिस्चार्ज ट्रे व एक मोटर युक्त है। मशीन को ताजे तोड़े गये मशरूम से जॉचने से ज्ञात हुआ कि मशीन मशरूम के तने को 6.9 से 8.6 मि०मी० की ऊंचाई से काट सकती है तथा औसतन ऊंचाई 7.7 मि०मी० प्राप्त हुई।

प्रसार एवं तकनीकी हस्तांतरण

देशी तकनीकी - खाद के आवरण के रूप में जली हुई धान की भूसी को गोबर व मिट्टी के साथ विभिन्न अनुपातों में मिलाकर मशरूम उत्पादकों द्वारा प्रयोग में लाई जा रही है। इस देशी तकनीकी को परखने व सुधारने हेतु प्रयोग किये गये। कवक जाल युक्त कम्पोस्ट पर जली हुई धान की भूसी से तैयार सात केसिंग आवरणों को बिछाया गया तथा तीन प्रकार के नियंत्रित केसिंग आवरणों से तुलना की गई। उपयुक्त दशाएं प्रदान करने पर सभी देशी केसिंग आवरणों में मशरूम की उपज मिली परन्तु प्रथम तुड़ान का समय अलग-अलग था।

इस वर्ष भी एक देशी तकनीक को एकत्र किया गया। सोलन के एक प्रगतिशील खुम्ब उत्पादक ने फेज-1 के दौरान कम्पोस्ट की ढेरी के भीतरी भागों में हवा पहुंचाने के लिये देशी तरीका इजाद किया है। कंपोस्टिंग यार्ड के फर्श में 2 फीट के अंतराल पर 3 इंच मोटाई के छिद्रित प्लास्टिक पाईप लगाये गये हैं। इस छिद्रित पाईप युक्त फर्श पर कम्पोस्ट की ढेरी बनाई जाती है तथा एक पंखे की सहायता से इन छिद्रित पाईपों की सहायता से हवा को कम्पोस्ट के भीतर प्रवेश कराया जाता है। इस सुविधा से आधुनिक बंकर की आवश्यकता पूर्ण हो जाती है।

वर्ष के दौरान केन्द्र ने मशरूम उत्पादकों, महिलाओं व अनुसंधानकर्ताओं के लिये 8 अंतः व बाह्य परिसरीय मशरूम उत्पादन प्रशिक्षण कार्यक्रम आयोजित किये। प्रत्येक वर्ष की भांति, इस वर्ष भी मशरूम मेला-2007 का आयोजन 10 सितम्बर, 2007 को किया गया। मेले का उद्घाटन डा० जगमोहन सिंह, माननीय कुलपति, डा० यशवन्त सिंह परमार औद्यानिकी एवं वानिकी विश्वविद्यालय, नौणी, सोलन (हि०प्र०) के कर कमलों द्वारा हुआ। मेले में विभिन्न राज्यों से लगभग 450 किसानों, स्वयं सहायता समूहों, महिलाओं, खुम्ब उत्पादकों, प्रसार कार्यकताओं ने भाग लिया। इस मौके पर एक प्रदर्शनी का भी आयोजन किया गया जिसमें विभिन्न संस्थाओं ने मशरूम व उससे संबंधित विषयों पर अपनी-अपनी तकनीकियों का प्रदर्शन किया। मेले में मशरूम उत्पादकों की समस्याओं के समाधान हेतु, एक किसान गोष्ठी का आयोजन किया गया। मशरूम मेले के समापन समारोह के दौरान केन्द्र ने चार प्रगतिशील खुम्ब उत्पादकों को पुरस्कृत किया जिसमें से हरियाणा राज्य से दो प्रगतिशील मशरूम उत्पादकों - सरदार हरपाल सिंह, निवासी भौर सैंयदा, कुरूक्षेत्र व श्रीमती आशा किरन, निवासी कुरूक्षेत्र, पंजाब से सूबेदार सेवा सिंह निवासी डेहरीवाला, अमृतसर तथा हिमाचल प्रदेश से श्री रतन ठाकुर निवासी चम्बाघाट, सोलन (हि०प्र०) थे।

शिक्षा एवं प्रशिक्षण

इस वर्ष केन्द्र ने मानव संसाधन विकास के क्षेत्र में महत्वपूर्ण प्रगति की है। डा० एम०सी० यादव, वरिष्ठ वैज्ञानिक ने फिक्की, दिल्ली द्वारा आयोजित इंटरनेशनल कांफ्रेंस - एग्रीकल्चरल बॉयोटेक्नोलॉजी में दिनांक 17-18 सितम्बर, 2007 में भाग लिया। डा० टी० अरूमुगानाथन, वैज्ञानिक ने नार्म, हैदराबाद द्वारा आयोजित 6 दिवसीय प्रशिक्षण - डवेल्पिंग रिसर्च प्रोपोजल्स इन एग्रीकलचरल रिसर्च 24-29 मार्च, 2008 में भाग लिया। उन्होंने तमिलनाडू कृषि विश्वविद्यालय, कोयम्बटूर में 'स्टडीज ऑन प्रोसेसिंग ऑफ कम्पोस्ट फॉर बटन मशरूम प्रोडक्शन एण्ड स्टोरेज ऑफ फ्रेश बटन मशरूम (*एगेरिकस बाईस्पोरस*)' विषय पर पी०एच०डी० शोध ग्रंथ भी प्रस्तुत किया व अपनी पी०एच०डी० डिग्री कृषि प्रसंस्करण में पूर्ण की है।

प्रकाशन

वर्ष के दौरान केन्द्र के वैज्ञानिकों द्वारा 13 शोध पत्र राष्ट्रीय व अंतर्राष्ट्रीय जर्नल्स में प्रकाशित किये गये हैं। दो किताबें, 11 अध्याय, 5 तकनीकी बुलेटिन व 5 फोल्डर्स का प्रकाशन हुआ है।

EXECUTIVE SUMMARY

The Centre has made significant progress n research, transfer of technology and human esource development. The achievements of ational Research Centre for Mushroom uring 2007-2008 are summarized under the eads; Crop Improvement, Crop Production, rop Protection, Crop Nutrition and tilization, Transfer of Technology, Education nd Training and Publications.

ROP IMPROVEMENT

a) Germplasm collection: During the year 261 wild mushrooms were collected and 206 collections belong to order Agaricales. The major genera collected were *Agaricus, Alnicola, Amanita Anellaria, Armillaria, Boletinus, Boletus, Cantherellus, Chlrophyllum, Clitocybe, Conocybe, Cortinarius, Cystoderma, Descolea, Entoloma, Gomphus, Gymnopilus, Hebeloma, Hygrophorus, Inocybe, Kuhneromyces, Laccaria, Lactarius, Lentinus, Lepiota, Lepista, Leucopaxillus, Lyophyllum, Marasmius, Mycena, Naematoloma, Oudemansiella, Paneolus, Phaeocollybia, Pleurotus, Pluteus,* Polyporus, *Psathyrella, Russula, Strobilomyces, Stropharia, Tricholoma, Tubaria, Tylopilus* and *Volvariella.*

b) Taxonomy of wild mushrooms: In addition to agaricoid specimens of several Gasteromycetes, Aphyllophorales were also collected. Some of the genera collected were *Auricularia, Fomes, Ganoderma, Gyromitra, Helvella, Hericium, Hydnum, Innonotus, Lycoperdon, Morchella, Peziza, Rhizopogon, Sparassis* and *Tremella.* Wild relatives of commercial cultivated mushrooms genera such as *Pleurotus, Stropharia, Volvariella, Lentinus, Hericium, Auricularia* etc. have been obtained, which have great potential in breeding programmes for strain improvement of these important mushrooms.

(c) Germ plasm characterization: Molecular characterization of 18 wild and cultivated strains of *A. bisporus* revealed that strains ARP-230 and ARP-231 were quite divergent strains, and displayed unique bands in the RAPD profiles. The brown wild strains exhibited comparatively more DNA polymorphism than the cultivated white strains. ITS1, 5.8S rRNA gene and ITS2 were amplified as a single unit from 18 wild and cultivated strains of *A. bisporus* using ITS1 and ITS4 primers. In all cases, the PCR yielded a single product without any visible length variations in the ITS profiles except in ARP-223 (A-27), which has shown morphologically distinct mycelium characteristics, exhibited visible smaller ITS DNA band. ITS sequences were generated from 30 genetically diverse strains of *Agaricus* strains. SNPs were observed at four base pair positions – one in ITS1 and three in ITS2 region of 5.8S rRNA gene among the *A. bisporus* strains.

Molecular variation and genetic identities studied among 22 white pileus cultivars of *Agaricus bisporus* wth twenty-four primers, amplified 175 RAPD markers, of which 53.7% were polymorphic. Genetic similarity index varied from 0.64 to 0.99 with average of 0.81. The varieties exhibited 92.7% genetic similarity, while the hybrids showed 84.3% similarity amongst them. Two single nucleotide polymorphisms (SNPs) at 522 and 563 nucleotide positions in ITS2 region which distinguished different strains within the species. This study demonstrates that the RAPD markers are useful and robust tools for the identification of hybrids in the germ plasm

and for detection of intraspecific molecular variation in white button mushroom cultivars.

(d) Genetic improvement: Studies on the genetic improvement of temperate and tropical mushrooms were conducted in *Agaricus, Pleurotus, Volvariella* and *Lentinula*. Indigenous wild germ plasm of *Agaricus* species collected from different parts of India was subjected to DNA analysis for establishing phylogenetic relationship with known cultivated and wild germ plasm of *A. bisporus*. The ITS DNA from the wild indigenous collections was amplified and sequenced. The spawn of 22 strains and hybrids of *A. bisporus* was prepared for yield and quality evaluation on pasteurized compost. Twenty-six putative strains of *C. indica* were evaluated using 2.5% wheat grain spawn and pasteurized wheat straw as the substrate. Four high-yielding strains *viz*., OE-334, OE-343, OE-345 and OE-348 with 82.1, 64.5, 74.3 and 61.2% B.E., respectively, were identified among 21 strains which fructified during August-September. Molecular variation and genetic identities were studied among 19 germplasm strains of *C. indica*. ITS1, 5.8S rRNA gene and ITS2 were amplified as a single unit from 19 wild and cultivated strains of *C. indica*. In all cases, the PCR yielded a single product without any length variations in the ITS profiles. RAPD analysis revealed DNA polymorphism among 18 strains of *C. indica*.

Twelve strains of *V. volvacea* showing superior growth characteristics were grown on Malt Extract Agar in petridishes and pounded sterilized paddy straw substrate in conical flasks. Aerial hyphae were highest in strain, OE-215 followed by OE-273, OE-209 and OE-212. The strains did not show chlamydospore formation. The aerial hyphae and chlamydospores were formed only in 5 strains. Strains, OE-273, OE-274, OE-12 and OE-215 formed both aerial hyphae and chlamydospores. The activity of lignocellulolytic enzymes viz, exoglucanase, endoglucanase, β-glucosidase, xylanase, laccase and polyphenol oxidase varied in different strains. Among cellulases, the fastest growing strain, OE-215 exhibited highest activity of xylanase (2.24 U) and exoglucanase (1.00 U), while medium level of β-glucosidase. It was followed by strain, OE-212 which showed superior activity of xylanase, endoglucanase and β-glucosidase. The poor growing strain, OE-55 completely lacked xylanase activity, while strains, OE-213 and OE-12 showed very low activity of endoglucanase. The PCR amplification of 5.8S rRNA gene region encompassing ITS 1 & ITS 2 on either sides, revealed an ITS amplicon of approximately 720 bp in all the 12 parent strains, thereby confirming that all strains belong to a single species, *V. volvacea*. The combined phylogenetic analysis of RAPD profiles of parent strains by using five primers and including about 60-80 bands for each strain, revealed wide intra-specific variations (10 to 28%) within the strains. The phylogenetic analysis revealed 5 distinct phylogenetic clades comprised of; 3 strains in 1st, 6 in 2nd and 1 each in rest three.

In case of *Lentinula edodes* DNA sequences of fifteen parents and hybrids were aligned using CLUSTAL X 1.83 computer software programme and found significant genetic diversity among the ITS regions. Higher biological efficiencies in all the elite strains and hybrids as compared to previous season were obtained ranging from 54.2% in OE-21 to 95.5% in Hybrid S-31.

CROP PRODUCTION

(a) Button mushroom, *A. bisporus*

Indoor composting: Indoor composting cultivation trial using wheat straw as the base material was conducted. The compost

preparation procedure involves mixing the ingredients thoroughly for two days then transferring to Phase-I bunker for three days and finally for usual Phase-II operations. At the end wheat straw to compost conversion ratio came to 3.2 times. Compost so prepared had moisture contents of 67.52%, pH 7.3 and N 1.78%.

Mucor pusillus, Aspergillus fumigatus, Penicillium sp., *Fusarium* sp., *Trichoderma viride, Paecelomyces varioti, Sepedonium maheshwarianum, Verticillium* sp. and *S.thermophilum, H.insolens, H.grisea* were isolated as the predominant mesophilic and thermophilic fungi, respectively from different samples collected from various mushroom farms located in different parts of the country. *Geotrichum* sp., *Talaromyce dupontii* and *T. emersoni* were observed as new records in this year.

Out of 11 thermophilic bacteria isolated, 5 were gram + and rest were gram –ve. Similarly among mesophilic bacterial isolates, 4 were gram + and 7 were gram –ve. Among the gram +ve isolates, all were rod shaped which were arranged in pairs, triads, clusters or in long chains, the gram-ve isolates were also rods except one which was coccus in long chains

(b) Cultivation of speciality mushrooms: Gibberellic acid at 20 ppm concentration proved to be the best growth hormone for enhancing the mycelial growth of *Agrocybe aegerita* in liquid medium whereas, IBA (20 ppm) proved to be the best growth hormone for *Flammulina velutipes.* Kinetin (20 ppm) turned to be the best growth hormone for *Lentinula edodes. Macrolepiota procera* was grown successfully on short method compost. The spawn run was completed in 30-35 days at 27-28°C. The primordia initiated after 18-21 days after the application of casing layer. In case of *Agrocybe aegerita* saw dust proved to be superior substrate as it resulted in 62 per cent biological efficiency as compared to 50 per cent obtained on wheat straw. Supplementation of sawdust with 10 per cent wheat bran resulted in enhanced biological efficiency. Addition of 50mg asparagine per Kg of dry cultivation substrate resulted in excellent spawn run and enhanced productivity of *Flammulina velutipes.* Kinetin @ 20ppm gave the highest increase in yield giving 40 per cent BE whereas the other two growth regulators tried also showed significant increase in the yield of *Flammulina velutipes.*

Addition of 40 per cent wheat bran in saw dust resulted in highest (80%) biological efficiency of *Lentinula edodes.* Supplementation at the lower rates with the same supplement resulted in lower yields as compared to higher supplementation rates.

CROP PROTECTION

Survey of different farms in Haryana, Himachal Pradesh and Punjab revealed the widespread incidence of wet bubble, yellow mould, *Sclerotium*, brown plaster mould and inkcaps. Severe incidence of wet bubble was recorded at Morni Hills (Haryana). Ink caps, brown plaster mould, lipstick mould and *Chetomium* spp were observed in different parts of H.P. Sciarid, phorid and mites were common in most of the farms visited. Compost samples collected/ received showed the presence of nematodes. Incidence of red pepper mite(*Pygmephorus sellnicki)* was recorded for the first time in one of the mushroom farm in H.P.

Studies on the persistence of malathion and decamethrin in *Agaricus bisporus* (S-11) revealed that the residue of malathion varied from 0.32 to 0.79 ppm and of decamethrin from 0.26 to 0.61 ppm. With the increase in

concentration of both the insecticides there was corresponding increase in the residue levels.

The residues of both the insecticides were higher when number of sprays were increased. When fruit body samples from all these treatments were washed or boiled in water for 10 minutes , overall reduction in the residue levels ranged from 31.57 to 87.57% in malathion and 59.79 to 90.10% in decamethrin. Boiling was more effective in lowering the residue of both the insecticides than simple washing.

Different treatments of mushroom samples namely, washing with water, washing with ascorbic acid, storing at room temperature for two days, storing in refrigerator for two days, oven drying and boiling or cooking resulted in decrease in residue level of carbendazim from 28.57% -81.86, 13.09- 60.95, 10.11-81.23, 35.71-80.47, 1.19-79.34 and 33.92-86.90%, respectively.

Screening of different strains of paddy straw mushroom against phorid and sciarid flies revealed that OE- 12 and OE-1222 were highly susceptible whereas, OE- 55-60 was less susceptible to phorids. However, OE-210 was resistant to phorid flies. OE-211 and OE-129 were found to be highly susceptible to sciarids.

The nucleotide sequence comparisons of 5.8S rRNA gene using BLAST network services against NCBI data bases facilitated molecular identification and genetic cataloguing of 15 *Cladobotryum* isolates collected from different mushroom units, into four taxa namely, *Hypomyces aurantius*, *Cladobotryum dendroides*, *C. mycophilum* and *C. astrophorum*. No inter or intra species ITS length diversity was detected in ten isolates of *Mycogone perniciosa*. The nucleotide sequence obtained by amplification of ITS region of rDNA identified as *Mycogone perniciosa*, submitted to NCBI Gene Bank, and named as EU-380317.Extracellular enzyme profile of *Diehliomyces* and *Verticillium fungicola* revealed that both have the highest activity of laccase, followed by β-glucosidase, pectinase, xylanase C_1 cellulase and C_x cellulase. Similarly, *Chaetomium* showed the maximum activity of xylanase, followed by β-glucosidase, and C_1 cellulase.

Molecular characterization of 14 isolates of bacteria collected from different mushrooms from different mushroom units was undertaken by ITS sequencing of 16S r RNA gene. Phylogenetic analysis of 14 bacterial isolates using RAPD technique exhibited 7 phylogenetic groups.

CROP NUTRITION AND UTILIZATION

Experiments were conducted on the modified atmospheric packaging (MAP) of button mushroom in PET jars. Diffusion channel method was found to be the best method of storage to prolong the shelf life of button mushroom up to 8 days in ambient storage (18±1^{o}C). Storage containers provided with 3 mm diameter and 15 cm length diffusion channel were found to be highly suitable for the purpose.

Post harvest technology of mushrooms: Experiments were conducted on the modified atmospheric packaging (MAP) of button mushroom in PET containers under refrigerated condition revealed that diffusion channel method was found to be the best method for storage to prolong the shelf life of button mushrooms up to 12 days under refrigerated condition. Storage containers provided with 3 mm diameter and 15 cm length diffusion channel were found to be highly suitable for the purpose.

DEVELOPMENT OF INDIGENOUS MACHINERY

A compost conveyor has been designed to carry compost to the bunker or elsewhere. The developed compost conveyor can carry the

compost from the yard to the tunnel and bunker at the rate of 5 tonnes/h. The height may be adjusted as per the requirement from 6 feet to 10 feet.

The multi purpose substrate-mixing drum has also been designed and fabricated at NRCM, Solan. The machinery was found suitable for pre wetting of various ingredients of *Agaricus bisporus* compost, without wastage of water in less time and labour consumption. Various important operations of mushroom industries such as mixing of substrates, spawning, mixing of casing materials etc. can also be achieved through this equipment.

A trimming machine has also been developed at NRCM-workshop to trim the mushroom stipe. This portable type machine consists of a continuous rotating blade, stem discharge tray and a synchronize motor. Freshly harvested button mushrooms were used for the study and it was found that the stem could be effectively cut for the varying height of 6.9 to 8.6 mm with an average value of 7.7 mm.

TRANSFER OF TECHNOLOGY

For the refinement of ITK about use of burnt rice husk mixed with F.Y.M. & soil in different ratio as casing material in button mushroom was tested. The burnt rice husk based different casing formulations namely burnt rice husk+soil (1:1v/v), burnt rice husk+soil+FYM (1:1:1v/v), burnt rice husk+FYM (2:1v/v), burnt rice husk+FYM (1:2 v/v), burnt rice husk+FYM (1:1 v/v), coir pith + FYM+ burnt rice husk (2:1:2 v/v) , burnt rice husk+vermicompost of spent compost(1:1 v/v), and three control treatments-FYM+coir pith (4:6 v/v) leached & chemically treated, FYM+coir pith (4:6 v/v) unleached & chemically treated, and FYM+coir pith (4:6 v/v) leached & pasteurized were applied on spawn run compost. Burnt rice husk+vermicompost of spent compost in 1:1 ratio has been added as alternate to refine the formulations. All the combination yielded mushrooms but time of first harvest varied. A progressive mushroom grower of Solan district has developed indigenously under stacking aeration system in the compost pile during phase-I. He has fitted perforated plastic pipes(3 " dia) widthwise in the cemented floor of compost yard at around two feet interval in order to maintain proper aeration in the compost pile during phase-I. This system inserts air forcefully in the compost pile from bottom to top and develops aerobic conditions for growth of micro organism in the compost. The device fulfills requirement of bunker system.

During the year under report, the Centre has organised a total number of 8 on & off-campus training programmes for farmers, farmwomen, entrepreneurs & reseachers.

One day Mushroom Mela was organised on 10th September, 2007 as regular activity of the Centre. It was inaugurated by Dr. Jagmohan Singh, Vice Chancellor Dr. Y.S. Parmar University of Hort. & Forestry, Solan (H.P.) It was attended by about 450 farmers, farm women, mushroom growers, researchers, extension workers and businessmen from various States. Kisan Goshthi was also held to answer the problems in mushroom cultivation faced by mushroom growers. During the Mushroom Mela, the Centre awarded four progressive mushroom growers -Sardar Harpal R/O village Bhour sainda, Kurkshetra (Haryana), Smt. Asha Kiran Gupta, R/O Kurkshetra (Haryana), Subedar Seva Singh R/O village Dehriwal, Amritsar (Pb) and Sh. Ratan Thakur R/O Chambaghat, Solan (HP) for adopting innovative practices in mushroom cultivation on larger scale and mobilizing other farmers to adopt mushroom cultivation as source of income.

EDUCATION AND TRAINING

During the period Er. T.Arumuganathan attended 6 days Training Programme on "Developing Winning Research Proposals in Agricultural Research" from 24 to 29th March, 2008. at National Academy of Agricultural Research Management, Hyderabad. He also submitted a thesis entitled "Studies on processing of compost for button mushroom production and storage of fresh button mushroom (*Agaricus bisporus*)" to Tamil Nadu Agricultural University, Coimbatore and completed his Ph. D (Agricultural Processing) degree. Dr. M.C. Yadav participated in International Conference on "Agricultural Biotechnology" held from 17-18 September 2007 at FICCI, Federation House, New Delhi.

PUBLICATIONS

During the year, the scientists of the Centre have published 13 research papers in referreed national and international journals, 2 books, 11 book chapters, 5 technical bulletins, 5 folders and contributed 3 abstracts to different scientific forums.

INTRODUCTION

The ever increasing population particularly in third world countries is creating problem of food and nutritional security, health and employment. Increase in crops' production is resulting in agricultural wastes in abundance throughout the world creating environmental pollution. The worldwide development of mushroom production including India is due to the fact that mushrooms have been recognized as valuable health food, their ability to grow on wide range of agro wastes and agro climate and in the end providing valuable organic manure make it a unique commodity. During the last one decade the world production has jumped from 6 million tonnes in 1997 to 12 million tonnes in 2002 creating employment to millions mainly due to diversification in mushroom production scenario. In India mushroom production has also shown many fold increase from 5000 tones during 1990 to 1, 00,000 tones at present. However, this is still below 1% of the total world production.

India has vast potential for mushroom production due to the availability of agro wastes in abundance, diversified agro climate and cheap manpower. The world trade of mushrooms is increasing day by day due to their demand particularly in Europe, USA and Canada. Asian countries are dominating the market due to low cost of production and diversification in production particularly of subtropical, tropical and medicinal mushrooms. It is estimated that more than 3000 million tones of cereal straw was generated during 1999 and about half of it remained unused. If one third of cereal straw is used to produce mushroom with average biological efficiency (60-75%) about 800 million M.T. of fresh mushroom can be produced. Besides, 1057million M.T. of bagasse, 6476 thousand M.T. of coffee pulp, 6152 thousand M.T. of coffee wastes, 9386 thousand M.T .of cotton seed hulls and 14073 thousand M.T. of sunflower seed hulls were generated. Similarly sawdust, wood chips, used tea wastes, banana leaves, maize stalks and cobs etc. are generated. These all can be used to produce mushrooms thus generating valuable food with better nutritional and medicinal values, enormous employment and spent mushroom substrate can be used to produce organic manure for the field crops. The cultivation of 3 million tones of mushroom from just 1% of the available biomass will generate million tones of spent mushroom substrate (SMS) which has its own unique traits suitable to be utilized as organic manure. The cultivation of mushroom on different substrates increases the crude protein, crude fibre and crude ash contents of spent mushroom substrate (SMS) in addition to enhanced *in vitro* crude protein digestibility. In addition to being a rich nutrient source for various field crops, spent mushroom substrate possesses unique physico-chemical and biological properties, which make SMS an ideal bioremediative agent for various environmental protection activities. The countries producing agricultural wastes in abundance, having suitable agro-climate for mushrooms production and man power will lead in this field. China is already leading in this field and India has every potential to become major mushroom producing countries in the world.

National Research Centre for Mushroom is located in mushroom city of India (Solan). Its office and laboratory buildings are situated at Chambaghat, Solan (HP) on NH-22. There is no regional station of the centre but for the multi-locational testing of technology under varied agro-climatic conditions, an All India Co-ordinated Mushroom Improvement Project (AICMIP) has been sanctioned and established with its Headquarter at National Research Centre for Mushroom, Solan (HP). The Director of NRC for Mushroom, Solan (HP) also functions as the Project Co-ordinator of the project. Presently, coordinating centres of

AICMIP are located at Ludhiana (Punjab), Pantnagar (UP), Coimbatore (Tamil Nadu) Pune (Maharashtra), Raipur (MP) Faizabad (UP), Udaipur (Rajasthan), Thrissur (Kerala), Shillong (Meghalya), Ranchi (Jharkhand) and Nauni, Solan (HP) – as Co-operating Centre.

Achievements

During the year National Mushroom Repository has been enriched by addition of 261 mushroom cultures of which some are new records for India. Germplasm characterization of *Agaricus bisporus* strains revealed that strains ARP-230 and ARP-231 were quite divergent strains, and displayed unique bands in the RAPD profiles. The brown wild strains exhibited comparatively more DNA polymorphism than the cultivated white strains. Genetic improvement studies on temperate and tropical mushrooms were conducted and strain OE-334 of *Calocybe indica* resulted in the highest 82.1% B.E. Hybrid S-31 of *Lentinula edodes* has been identified giving 95.5% B.E. Indoor composting process has been further refined with the help of thermophilic fungi and encouraging results were obtained. Cultivation technology of *Macrolepiota procera* has been standardized in the Centre. Efforts were made to increase the yields of *Lentinula edodes*, *Agrocybe aegerit*a and *Flammulina velutipes* by adding growth hormones and supplementing the cultivation substrates. Gibberellic acid, IBA and kinetin @ 20 ppm proved to be the best growth hormones for enhancing the mycelial growth of *Agrocybe aegerita*, *Flammulina velutipes Lentinula edodes*, respectively.

Survey of different mushroom farms revealed the widespread incidence of wet bubble, yellow mould, *Sclerotium*, brown plaster mould, inkcaps, wet bubble ink caps, brown plaster mould, lipstick mould, *Chetomium* spp, sciarid, phorid and mites in most of the farms. Studies on the persistence of malathion and decamethrin in *Agaricus bisporus* revealed that the residue of malathion varied from 0.32 to 0.79 ppm and of decamethrin from 0.26 to 0.61 ppm. When fruit body samples from all these treatments were washed or boiled in water for 10 minutes, boiling was found to be more effective in lowering the residue of both the insecticides and carbendazim than simple washing. Screening of different strains of paddy straw mushroom against phorids flies revealed OE-210 as resistant strain against phorid flies. Fifteen *Cladobotryum* isolates collected from different mushroom units were catalogued into four taxa namely, *Hypomyces aurantius, Cladobotryum dendroides, C. mycophilum* and *C. astrophorum*. No inter or intra species ITS length diversity was detected in ten isolates of *Mycogone perniciosa*.

Studies conducted on modified atmospheric packaging (MAP) of button mushroom in PET containers revealed that diffusion channel method was found to be the best method for storage to prolong the shelf life of button mushrooms up to 8 days in ambient storage. A compost conveyor has been designed to carry compost to the bunker or elsewhere. The multi purpose substrate mixing drum has been designed and fabricated and a trimming machine has also been developed at NRCM-workshop to trim the mushroom stipe.

During the year under report, the Centre has organised a total number of 8 on & off-campus training programmes for farmers, farmwomen, entrepreneurs & reseachers. One day Mushroom Mela was organised on 10th September, 2007 as regular activity of the Centre. It was attended by about 450 farmers, farm women, mushroom growers, researchers, extension workers and businessmen from various States. During the Mushroom Mela, the Centre awarded four progressive mushroom growers -Sardar Harpal, Smt. Asha Kiran Gupta, both from Kurkshetra (Haryana), Subedar Seva Singh R/O Amritsar

(Punjab) and Sh. Ratan Thakur R/O, Solan (HP) for adopting innovative practices in mushroom cultivation on larger scale and mobilizing other farmers to adopt mushroom cultivation as source of income.

One scientist has been trained on Developing Winning Research Proposals in Agricultural Research.

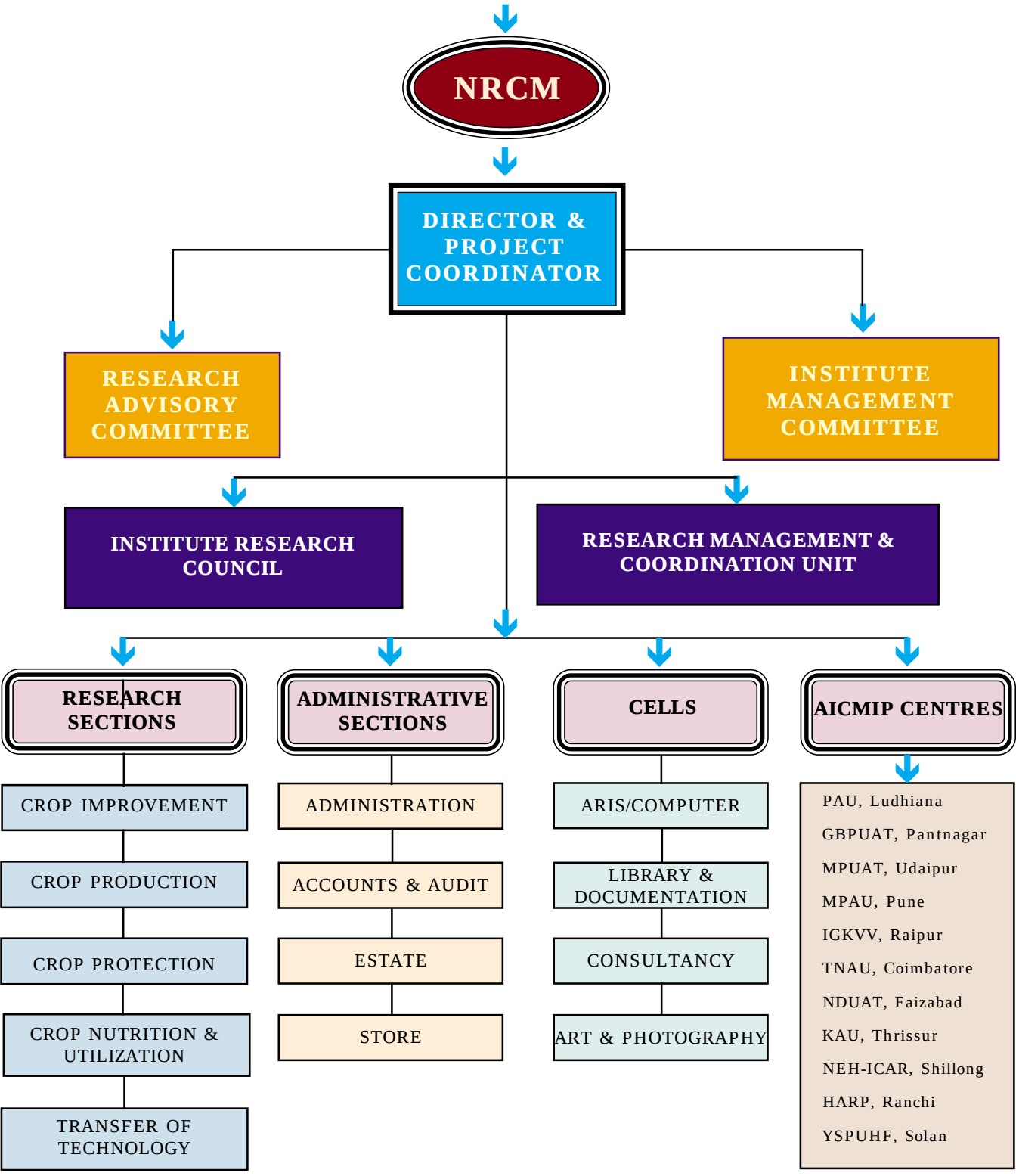
Staff and Finance

The Centre has a sanctioned strength of 18 scientists + 1 Director, 14 Technical, 16 administrative and 11 supporting staff. The staff in position on 31.03.2008 was 12 scientists, 14 technical, 16 administrative and 9 supporting staff. The annual budget of the centre for the year 2007-2008 was Rs.128.00 Lakh (Plan) and Rs. 228.60 Lakh (Non Plan), the expenditure was Rs. 127.90 (Plan) and Rs.228.60 lakh (Non Plan). The centre earned Rs.9.70Lakhs as revenue during the year by sale of literature, mushroom cultures, spawn, fresh mushrooms, pickles, consultancy, training and other services.

Facilities

- Thirteen environmental controlled cropping rooms.
- Modern composting units comprising of 4 indoor bunkers, 4 bulk chambers, covered outdoor composting platform and related structures.
- Five well equipped laboratories with all sophisticated equipments.
- Sale of pure starter cultures of all the commercial strains of edible mushropoms and quality seed.
- Excellent Library facilities with access to world literature on mushrooms through internet, periodicals on mushroom and its related disciplines from all over the world, reference services and CD-ROM search service. It has presently number of accessions including 1289 books, 2500 back volumes of journals. It subscribes eight foreign journals and thirty-two Indian journals.

Indian Council of Agricultural Research



Organizational structure of NRCM, ICAR, Solan

1. CROP IMPROVEMENT

1. Mushroom Genetic Resources

1.1 Collection and identification of wild mushrooms

Project - NCM-15: Survey, collection and identification of wild fleshy fungi (PI: Dr. R.C.Upadhyay)

Fungal forays were conducted in the forest areas of Himachal Pradesh namely Reserve forest Dhalli, Jalori pass, Khada Pathar, Chindi, Kalatop, Khajjiar forest. Parts of the south Rajasthan were also visited for collection of wild mushrooms. In all 261 wild mushrooms were collected and majority (206) of the collections belongs to order Agaricales. All the specimens were examined and photographed under natural conditions. The ecology of each taxa was studied in which it was found growing. Family wise list of agaricoid genera and their collections are mentioned in Table-1.

Table 1. List of agaricoid and other specimens collected familywise

S. No	Family	Genera (No. of species collected)
1	Agaricaeae	*Agaricus* (7), *Chlrophyllum* (3), *Cystoderma* (1) *Lepiota* (2)
2	Amaniataceae	*Amanita* (18)
3	Bolbitiaceae	*Conocybe* (1), *Descolea* (2)
4	Boletaceae	*Boletinus* (1), *Boletus* (3), *Strobilomyces* (2), *Tylopilus* (1)
5	Coprinaceae	*Anellaria* (1), *Paneolus* (3), *Psathyrella* (5)
6	Cortinariaceae	*Alnicola* (1)*Cortinarius* (7), *Gymnopilus* (1), *Hebeloma* (1), *Inocybe* (15), *Phaeocollybia* (1)
7	Crepidotaceae	*Tubaria* (1)
8	Entolomataceae	*Entoloma* (1)
9	Gomphidiaceae	*Gomphus* (4)
10	Hygrophoraceae	*Hygrophorus*
11	Pluteaceae	*Pluteus* (2), *Volvariella* (3)
12	Polyporaceae	*Lentinus* (2), *Pleurotus* (3), Polyporus (4)
13	Russulaceae	*Cantherellus* (14), *Lactarius* (5), *Russula* (3)
14	Strophariaceae	*Kuhneromyces* (1), *Naematoloma* (9), *Stropharia* (2)
15	Tricholomatacea	*Armillaria* (2), *Clitocybe* (6), *Laccaria* (3), *Lepista* (2), *Leucopaxillus* (2) *Lyophyllum* (7), *Marasmius* (2), *Mycena* (3), *Oudemansiella* (5), *Tricholoma* (5)
16	Order Aphyllophorales & d Gasteromycetales	*Auricularia* (2), *Fomes* (1), *Ganoderma* (4), *Gyromitra* (1), *Helvella* (3), *Hericium* (4), *Hydnum* (3), *Innonotus* (1), *Lycoperdon* (1), *Morchella* (2), *Peziza* (1), *Rhizopogon* (1), *Sparassis* (2), *Tremella* (2)

Efforts were made to isolate the culture of each specimen immediately on different mycological media (Potato Dextrose Agar & Malt Extract Agar) but only 160 cultures could be isolated. Remaining specimens were mycorrhizic in nature and were difficult to culture. Plates were incubated at 25°C for 6-10 days. Cultures were examined for their purity and pure cultures so obtained were stored at 4°C and in liquid paraffin.

Descolea spp. (Fig. 1) was collected and it was found to have aromatic halogenated compounds.

Fig. 1: *Descolea* **sp. on ground**

Several light and dark spored specimens of *Phoecollybia*, *Hypsizygus*, *Rickenella*, *Leucopaxillus*, *Cystoderma*, *Hygrophorus*, *Alnicola*, *Inocybe* and *Gymnopilus* are under identification.Some of the collections examined are described below.

Amanita foetidissima Reid & Eicker in *Mycol Res* 95: 83 (1991)

Pileus up to 5.5 cm in diam., conico-convex when young, then convex; surface moist, viscid, centre fulvous, golden wheat (11D7), margin clay buff; covered with floccose velar squamules which adhere on touch; margin incurved, appendiculate, with remanants of universal veil, cortina well developed; cuticle fully peeling, flesh 6mm in thickness, creamish white, unchanging; odour strong, pungent, disagreeable. Lamellae free, crowded, 2-4 sized, off white, 5 mm thick in young carpophores, edges smooth. Stipe up to 12.5 cm long and 1.0 to 1.1cm thick, equal in diam., throughout, base sub-bulbous, solid, cream (9D2) to clay buff, covered densely with floccose whitish squamules, annulus membranous, fugacious, covered with floccose squamules underside; universal veil present floccose, friable, not volvate. Spores 8.5-10 x 6-8.5 µm, subglobose, thin walled, apiculate, strongly amyloid, with large refractive guttule. Basidia 49-53 x 8-11 µm, 2-4 spored, elongated clavate, thin walled with guttulate contents. Lamellae edge sterile consists of detersile velar elements; cystidia absent. Pileus cuticle made of gelatinous, radially parallel, thin walled, hyaline hyphae measuring 3-9 µm in dia., elements of velar squamules arranged loosely in chains, individual element large, globose to doliform, thin walled, hyaline, measuring 25-120 x 20-55µm, clamp-connections present in narrow hyphae.

Collection examined Village Patti (1500m), Solan H.P., India; growing on soil in groups. Acc. No. NCM -75/02, 13.8.02.

The present specimen belongs to the genus *Amanita*. It goes in the section *Lepidella* due to amyloid spores, pileus margin smooth not sulcate-striate, volva floccose, pulverulent, friable (saccate volva absent), volval remains adhering to pileus; pileus margin appendiculate; annulus floccose to fugacious. All the macroscopic and microscopic characters show resemblances with the key characters provided for the section *Lepidella* and *A. foetidissima* by Pegler & Shah Smith (1997). The present collection constitutes a new fungus record for India.

Lacrymaria glareosa **(Favre) Watling** in *Notes from Royal Botanic Garden Edinburgh* 37: 379, 1979.

Pileus up to 4.4 cm in dia., convex, without umbo; surface dry, non-hygrophanous, buffish, light brown with dark brown centre, fulvous;

minutely fibrillose to glabrous; margin appendiculate with cortinal fibrils; non-striate; cuticle fully peeling, flesh membranous up to 2 mm in thickness; odour none. Lamellae adnate to adnexed; crowded, unequal, 3-5 sized, 3-4 mm in breadth, membranous, purplish brown to cigar brown, edges smooth to slightly wavy. Spore deposit fuscous black. Stipe up to 9.5 cm long, 6-9 mm broad; slightly tapering upwards; cylindrical, hollow; surface lighter than pileus, covered with fibrils, cortinal veil well developed, superior, pale at maturity, appears as black fibrills on stipe due to deposition of blackish spores. Spores 9-11.5(12) x 6-7.5 µm, ellipsoid, appears limoniform due to protracted germ pore, ornamentations strongly developed, coarse, irregular, tuberculate, crowded verrucose, tubular apex bearing broad germ pore; purplish black, discolouring or becoming purple amethyst in conc. H_2SO_4. Basidia 22-27 x 8-11 µm, 2-4 spored, clavate, thin walled, hyaline. Gill edges sterile, cheilocystidia abundant, 53-74 x 5-8 µm, cylindric to lageniform with sub-capitate apex, measuring 10-12 µm in dia., thin walled, hyaline. Pleurocystidia 33-40 x 10-11 µm, ventricose to broadly fusoid, clavate to sub-cylindrical, thin walled, hyaline. Pileus cuticle consists of erect swollen, vesiculose cells, overlain by filamentous brownish inflated hyphae up to 14 µm in dia., context made up of interwoven, thin walled hyaline hyphae measuring 18 µm in dia. Hymenophoral trama regular, formed of thin walled, hyaline hyphae, 12 µm in dia.; subhymenium narrow; veilar hyphae thin walled, hyaline, measuring 5-9 µm in dia.; caulocystidia present on stipe towards apex above cortinal veil, similar to cheilocystidia in shape and size. Clamp connections present in all types of hyphae.

Collections examined IHBT Campus, Palampur, H.P., India, growing in association with grass roots on soil; Acc. No. NCM-27/03, FHKV-1HB-57, 29.07.03.

The present specimen is typical of the genus *Lacrymaria* due to blackish purple warty spores with prominent germ pore and discolouring to purplish amethyst in conc. H_2SO_4. World over ten *Lacrymaria* spp. have been recorded (Hawksworth *et al.* 1995). The above examined specimen shows similarity with two species i.e. *Lacrymaria lacrymabunda* (syn. *Psathyrella velutina*) and *L. glareosa*, but this specimen is different from both these species by the presence of prominent pleurocystidia which are absent in both these species (Watling and Gregory 1987).

***Pluteus plautus* (Weinmann) Gillet,** *Hyménomycètes de france* 394, 1874 Sensu Weinmann, Métrod non Pearson 1952.

Pileus up to 3.6 cm in dia., convex then expanded at maturity centre slightly depressed, margin raised; surface dry, non-hygrophanous; centre light brown, margin dirty white, centre new cocoa (7A7), margin piping rock (13A2) to gravil (13A4), cuticle entire at disc elsewhere disrupted to form plate like squamulose scales exposing underlying dirty buff context; margin irregular, striate, splitting at maturity, involute; flesh membranous, buff, unchanging; odour agreeable. Lamellae free, moderately crowded to crowded, unequal, 3-sized, buff coloured, pearl blush (12A5) to sun burn (13A7), membranous, non-separable, 6 mm in breadth, edge smooth to slightly wavy. Stipe up to 3.4 cm long and 4 mm in thickness, cylindrical, equal in dia., base fibrous, mycelioid; surface creamish white, slightly brown at the base due to hairs, indistinctly striate upwards, stuffed; annulus absent. Spores 5.5-8 x 4-6.5 (7) µm, sub-globose, smooth, double walled, hyaline, guttulate, hilum open pore type. Basidia 31-36 x 8-11 µm, lageniform, fusoid, 4-spored, guttulate. Gill edge sterile; cheilocystidia abundant, ventricose, clavate, lageniform, with narrow base, some cystidia having transverse septa towards apex, hyaline, some having grannular material towards apex, large

sized, measuring 33-68 x 13-32 µm. Pleurocystidia abundant measuring 55-88 x 13-29 µm, lageniform, fusoid, obtuse apex, thin to thick walled, voluminous. Pileus cuticle made up of palisade of cylindrical cells having obtuse apex, measuring up to 20 µm in dia., with pale yellow context; oleioferous hyphae abundant measuring 2-4 µm in dia., with obtuse apex. Hymenophoral trama bilateral convergent. Subhymenium well developed; clamp connections absent.

Collection examined NRCM Campus (1500 m), Solan, H.P., India, growing scattered on decomposed *Agaricus bisporus* compost; Acc. no. NCM 24/03, 09.07.03.

P. plautus can be identified due to its striated non hygrophanous brown cap and stipe punctate with brownish hairs at the stipe base. The taxonomic details of this collection shows similarty with *Pluteus plautus* as given by Watling and Gregory (1986). The present specimen was found growing on decomposed organic matter while this species is known to grow on pinewood or its debris. This is the first record of this species from India.

Tricholomella constricta **(Fr.)** Zerova ex Kalamèès 1992, Persoonia 14 (4): 446.

Pileus 5 cm in dia., convex; surface glutinous, sticky; pure white, slightly fibrillose to almost glabrous; margin regular, non-striate, involute; cuticle fully peeling, flesh white, unchanging, 8 mm thick towards centre; odour typical of *Calocybe*. Lamellae sinuate to free, densely crowded, unequal, 3-sized, white, 4 mm in breadth, edge smooth. Spore deposit white. Stipe 9.2 cm in length, 1.2 to 2 cm in thickness, tapering at both ends, radicating base, rooting base up to 3 cm long; surface white, fibrillose, context tough, solid; annulus present, with faint ring zone. Spores 5.5-7 x 4-5 µm, ovoid ellipsoid, typically verrucose, hyaline, inamyloid. Basidia 33-45 x 6.5-9 µm, 2-4 spored, mostly 2 spored, thin to slightly thick walled, with numerous guttulate contents. Gill edge fertile; cystidia absent. Pileus cuticle consist of undifferentiated gelatinous epicutis; context hyphae hyaline, thin walled inflated up to 20 µm in dia. Hymenophoral trama regular made up of thin walled, hyaline hyphae, inflated up to 18 µm in dia.; subhymenium narrow, made up of interwoven hyphae; clamp connections present .

Collection Examined Narkanda (2700m), H.P., growing on soil in mixed forest; Harbarium Acc. No. NCM 95/03, 21.07.03 and N.R.C.M, Gene Bank culture no. X-415.

Entoloma canobrunescens **Horak**, *Nova Hedwigia Heft* 65: 188-189, 1980.

Pileus up to 5.5 cm in dia., convex; surface dry, hygrophanous, greyish brown, sepia (8C10), moose (8C11), barch mosch (8C12), appressed fibrillose; margin regular; non-striate, involute; cuticle fully peeling; flesh pale, 3.5 mm in thickness, unchanging; odour mild. Lamellae adnexed, crowded, unequal, 4-sized, buffish brown, edge smooth, concolorous, 7 mm in width. Spore deposit argillaceous pink. Stipe 5.3 cm long and 6 mm broad, cylindric, equal to slightly tapering towards base, longitudinally striate, fibrillose, stuffed then hollow. Spores 9-12 x 7-8(-9) µm, angular, 5-6 angled, thin walled, inner wall pinkish, apiculate, with single guttule. Basidia 35-45 x 10-12.5 µm, clavate, 4-spored, thin walled, with guttulate contents. Gill edge fertile; cystidia absent. Pileus cuticle made up of semi-errect, cellular elements with brownish contents measuring up to 23 µm broad hyphae; hymenophoral trama regular; context hyphae inflated up to 28 µm in dia. Clamp connections absent.

Collection examined Cheog (2260 m) H.P., growing on soil among mosses under *Cedrus deodara* tree in coniferous forest, Acc. No. NCM-139/03, 30.07.2003.

The taxonomic details of the present specimen are close to *Entoloma canobrunnescens* Horak except with slight difference in spore size i.e. spores of *E. canobrunnescens* are 10-11 x 7-7.5 µm (Horak 1980) where as spore size of present specimen is 9-12 x 7-8(-9) µm and secondly the umbo is not much conspicuous in the present specimen. This is a first record of this species from India.

Paxillus panuoides **(Fr.) Fr.** *Epicrisis Systematis Mycologici* 318, 1838.

Pileus up to 3.8 cm in size, braket type or kideney shaped, in tiers; surface dry, non hygrophanous, golden corn (9I6), at canter fulvous to buffish brown, appressed fibrillose, margin regular, non-striate, involute, culicle fully peeling, flesh up to 5 mm in thickness, creamish, unchanging, odour agreeable. Lamellae decurrent, crowded, branched, anastomosing towards base, corn husk (10E6), 1.5 mm in thickness, edge smooth. Spore deposit sienna brown (ochraceous). Stipe absent; attachment lateral. Spores 4-5 x 3-3.5 (4.5 x 3) µm, short ellipsoid, thin walled, minutely apiculate, apical pore absent, hyaline, dark blue in cotton blue, dextrinoid, yellow in KOH. Basidia 26-33 x 5.5-6 µm, clavate to cylindrical, 2-4 spored, sterigmata up to 3.5 µm long, with few contents to hyaline. Gill edge fertile; cystidia absent. Pileus cuticle made up of compactly arranged pale, filamentous, thin walled hyphae measuring 2.5-6 µm in dia.; context made up of interwoven hyphae inflated up to 11 µm in dia. Hymenophoral trama with central regular strand with bilateral, divergent hyphae. Clamp connections abundant, prominent .

Chemical Test: NaOH: brownish black on pileus surface and black on lamellae; $FeSO_4$: dark dirty green on pileus surface and greenish black on lamellae; Melzer's reagent: reddish brown on pileus surface and on lamellae; KOH: pale on pileus surface and yellow dark on lamellae.

Collection examined Sarahan (1100 m), H.P., India, growing in groups as overlapping tiers on decaying wood log of *Pinus* sp., Acc.No. NCM- 113/03, 25.07.03.

The presently examined specimen is typical of *Paxillus panuoides*. Its external and internal details are showing similarity in all aspects with *P. panuoides* as described by Watling and Gregory (1989). This fungus is characterized by lateral habit, absence of stipe, buff brown colouration, small sized spore and sienna coloured spore deposit. This is an edible fungus recorded for the first time from Himachal Pradesh.

1.2 Germ plasm Characterization

Project- NCM-29: Genetic characterization of mushroom germplasm of NRCM Gene Bank (PI: Dr. M.C. Yadav)

1.2.1 Molecular and morphological characterization of *Agaricus bisporus* germplasm (PI: Dr. M.C. Yadav)

1.2.1.1 RAPD analysis of *Agaricus* germ plasm: Genomic DNA from 18 wild and cultivated strains of *A. bisporus* was isolated using modified CTAB method and was purified with RNase. The quantified DNA samples were used in the molecular analysis. Four random primers viz., OPG-02, OPG-6, OPG-11 and OPG-12 were used in RAPD analysis. The strains ARP-230 and ARP-231 were found to be quite divergent strains, and displayed unique bands in the RAPD profiles. However, the use of multiple RAPD primers in the analysis will reveal the extent of genetic variation present in the germ plasm. The brown wild strains exhibited comparatively more DNA polymorphism than the cultivated white strains.

1.2.1.2 ITS amplification and sequencing of *Agaricus* strains: ITS1, 5.8S rRNA gene and ITS2 were amplified as a single unit from

18 wild and cultivated strains of *A. bisporus* using ITS1 and ITS4 primers. In all cases, the PCR yielded a single product without any visible length variations in the ITS profiles except in ARP-223 (A-27), which have shown morphologically distinct mycelium characteristics, exhibited visible smaller ITS DNA band. ITS sequences were generated from 30 genetically diverse strains of *Agaricus* strains.

The ITS nucleotide sequences were analyzed after generating the complementary and inverted sequences of ITS4 primer and then comparing with the ITS1 sequences by using GeneDoc software. SNPs were observed at four base pair positions – one in ITS1 and three in ITS2 region of 5.8S rRNA gene among the *A. bisporus* strains. ARP strains ARP-230 and ARP-231 were identified as *A. bitorquis* (Fig. 2).

1.3 Molecular analysis of *Pleurotus* germ plasm

1.3.1 RAPD analysis of *Pleurotus* germ plasm: RAPD analysis was performed in 20 strains of *Pleurotus* species using 4 random primers namely OPG-06, OPG-11, OPN-10 and OPO-03. Theses markers revealed genetic polymorphism among 20 strains of *Pleurotus* species collected from AICMIP Centres (Fig. 3). Some of the strains namely *P. flabellatus*, *P. florida* strain 1 and *P. florida* strain 4 displayed unique bands and were found to be more divergent than the other strains.

1.3.2 ITS amplification and Sequencing: ITS1, 5.8S rRNA gene and ITS2 were amplified as a single unit from 41 wild and cultivated strains of *Pleurotus* species using ITS1 (forward primer) and ITS4 (reverse primer). In all cases, the PCR yielded a single product

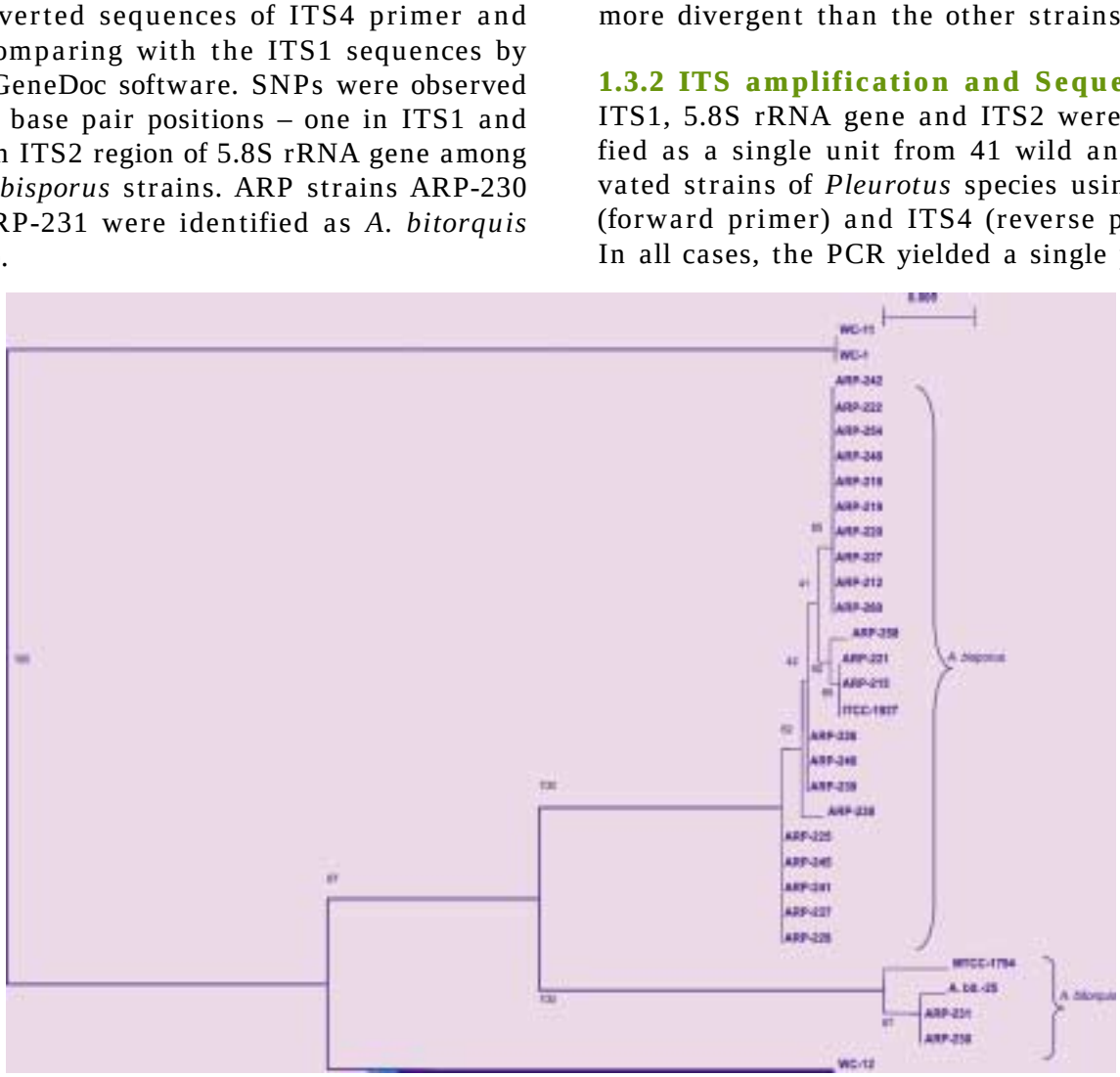


Fig. 2. Neighbour-joining phylogenetic tree inferred from sequence polymorphisms in the ITS region of *Agaricus* species. Numbers on the branches denote per cent bootstrap support to each node

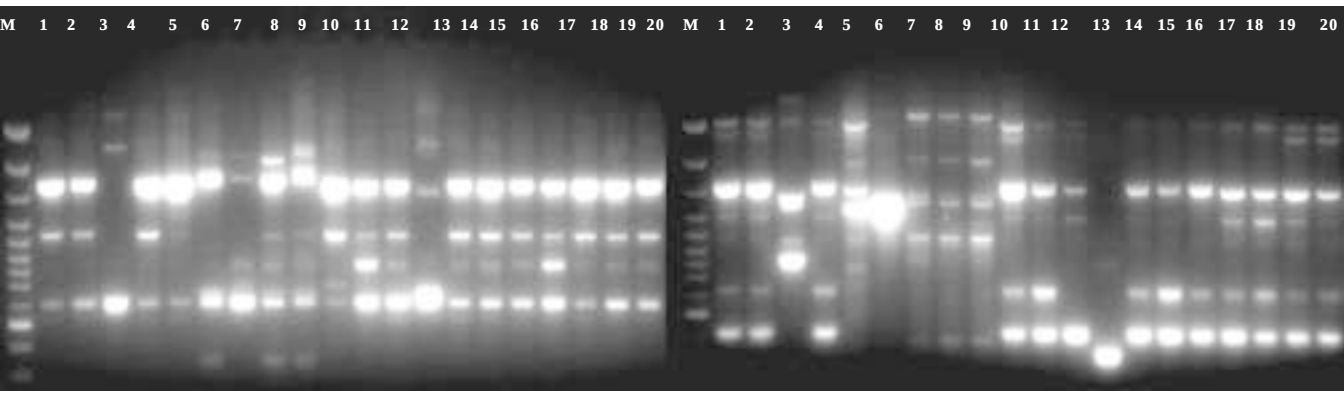


Fig. 3. RAPD profiles of 20 wild and cultivated strains of *Pleurotus* species with primers OPG-06 (a) and OPN-10

with ITS length polymorphism. *P. djamor* and exhibited visible larger ITS DNA band on the gel. The length of ITS region was approximately 690 bases on the gel in all genotypes except in *P. djamor* and *P. eous* (720 bases in both). ITS sequences were generated from 24 genetically diverse strains of *Pleurotus* species. Multiple sequence alignments of ITS regions showed two groups of strains first represented by *P. sajor-caju* and *P. citrinopileatus* carrying characteristic 10 bp deletion in ITS2 region, and the other group consisting of *P. florida* and *P. flabellatus* species (Fig. 4).

2. Genetic Improvement

Project–NCM-37: Genetic manipulations for high yield and better quality in button mushroom (*Agaricus* species)(PI: Dr. Mahesh C. Yadav)

2.1 Phylogenetic analyses in wild *Agaricus* germ plasm

Indigenous wild germ plasm of *Agaricus* species collected from different parts of India was subjected to DNA analysis for establishing

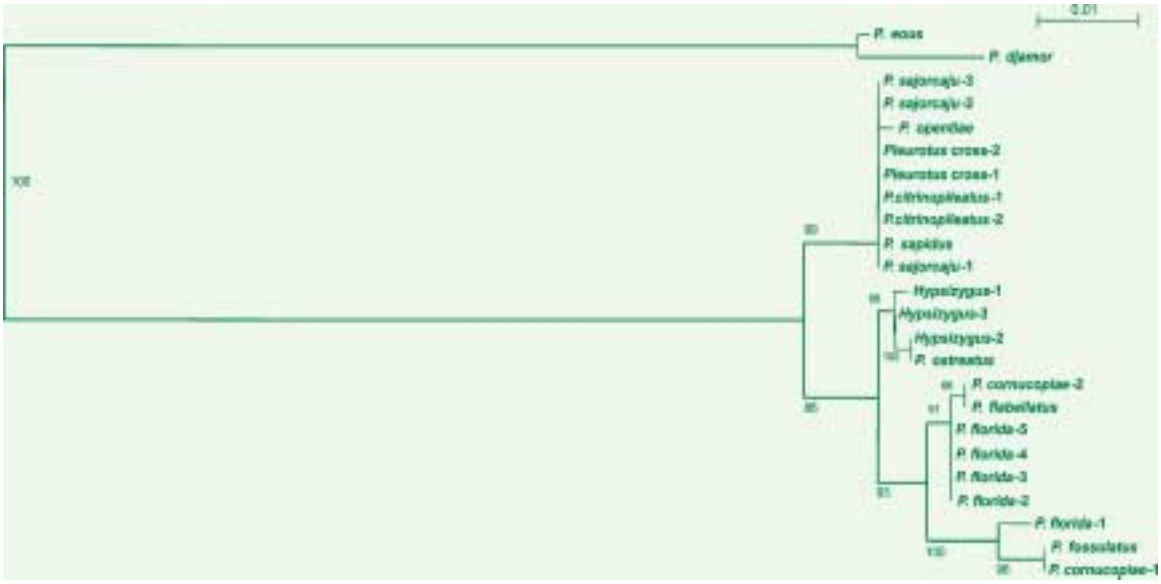


Fig. 4. Neighbour-joining phylogenetic tree inferred from sequence polymorphisms in the ITS region of *Pleurotus* species. Numbers on the branches denote per cent bootstrap support to each node

phylogenetic relationship with known cultivated and wild germ plasm of *A. bisporus*. The ITS DNA from the wild indigenous collections was amplified and sequenced. Multiple sequence alignments of ITS regions showed three groups of germplasm strains. First group represented by strains of *A. bisporus* (A-9, A-21, A-32, and WC-24) along with related *Agarics* spp. (WC-12 and WC13), while the second group consisted of WC-21, WC-1, WC-11 and WC-559. Wild strain WC-560 formed solitary cluster (Fig. 5).

2.2 Breeding in Button Mushroom *Agaricus bisporus*

2.2.1 Evaluation of heterokaryotic SSIs and hybrids: The spawn of 22 strains and hybrids of *A. bisporus* was prepared for yield and quality evaluation on pasteurized compost. The trial is currently under cropping.

2.2.2 Evaluation of strains under AICMIP: An experiment on the evaluation of seven different strains of *A. bisporus* along with S-130 as standard check variety, as recommended in AICMIP workshop held on 26-27th October, 2006, was laid out in RBD design with 8 replications each consisting of 10 kg short method compost. Only two strains namely CM-12 and CM-15 with 20.63 kg and 20.78 kg mushrooms/ 100kg compost, respectively, were the higher mushroom yielder than the standard check S-130. However, all other strains were at par with the control.

Project-NCM-36: Genetic enhancement for higher yield and better quality in milky mushroom (*Calocybe indica*) (PI: Dr. Mahesh C. Yadav)

2.3 Evaluation of genetically diverse strains of *C. indica*

Twenty-six putative strains of *C. indica* were spawned using 2.5% wheat grain spawn. Pasteurized wheat straw with 68% moisture was used as the cultivation substrate. Five replications each containing 5 kg wet-substrate were used for each strain. Pasteurized casing soil was applied as 2 cm

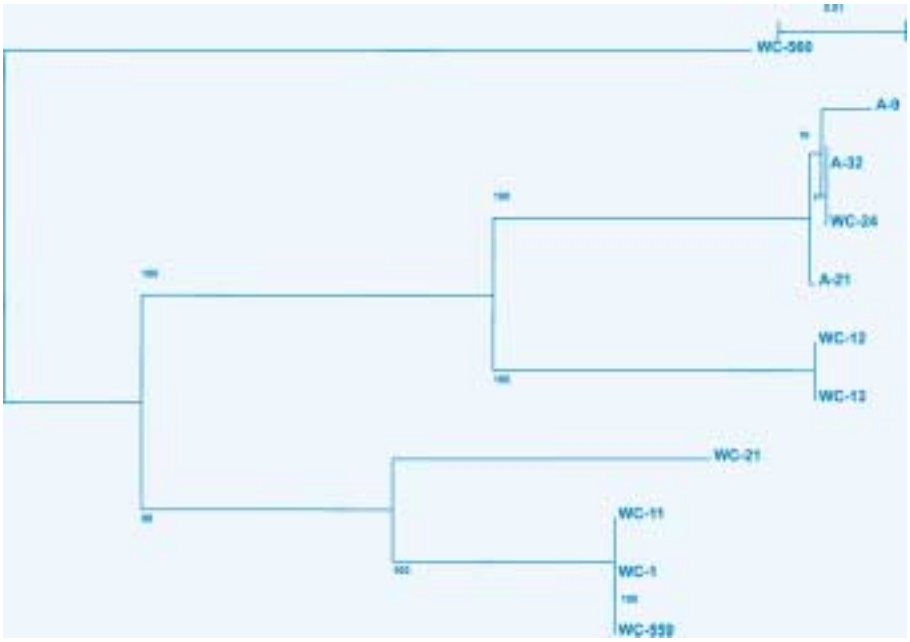


Fig. 5. Neighbour-joining phylogenetic tree inferred from sequence polymorphisms in the ITS region of *Agaricus* species. Numbers on the branches denote per cent bootstrap support to each node

thick layer on complete spawn-run bags. First flush was harvested after 16 days of casing.

Four high-yielding strains *viz*., OE-334, OE-343, OE-345 and OE-348 with 82.1, 64.5, 74.3 and 61.2% B.E. respectively, were identified among 21 strains which fructified during August-September, 2007 (Fig. 6).

2.3.1 Molecular analysis of *Calocybe* germ plasm

Molecular variation and genetic identities were studied among 19 germ plasm strains of *C. indica*. ITS1, 5.8S rRNA gene and ITS2 were amplified as a single unit from 19 wild and cultivated strains of *C. indica*. In all cases, the PCR yielded a single product without any length variations in the ITS profiles (Fig. 7, left side). Six strains were sequenced at Delhi University, South Campus, New Delhi. ITS sequence analysis revealed the identity of OE-7 as *P. ostreatus* after comparison with NCBI database. Ten random primers *viz*., OPG-01 to OPG-11 were used in the RAPD amplification reactions. Strain OE-7 displayed unique bands in most of the RAPD profiles (Fig. 7, right side) and was found to be quite divergent, thus proving it as a different species from the other strains. RAPD analysis revealed DNA polymorphism among 19 strains of *C. indica*.

Fig. 6. A prominent effect of light on the growth (positive phototropism) of *C. indica* fruitbodies (left) and large fruitbodies in strain OE-344 (right)

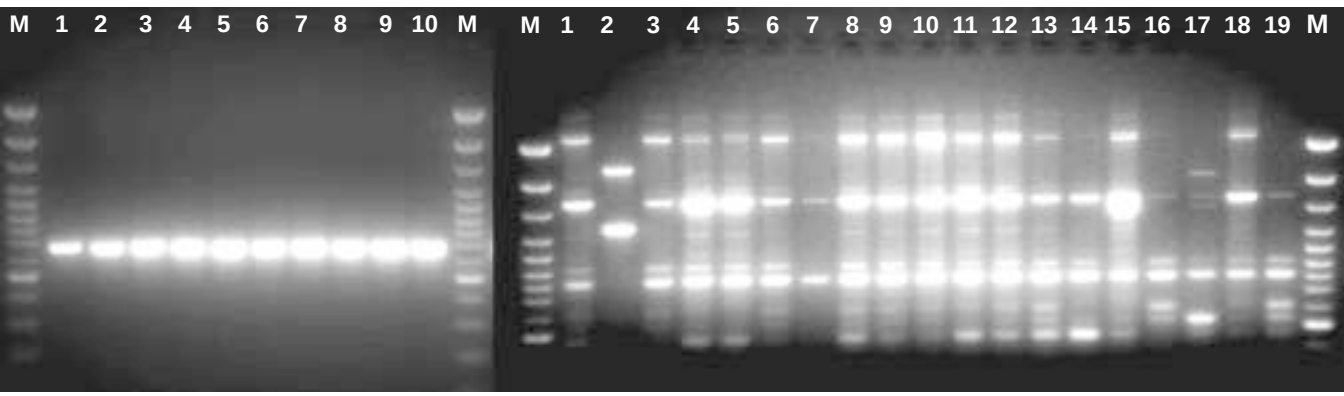


Fig. 7. ITS profiles of 10 strains (Left side) and RAPD profiles of 19 strains (right side) of milky mushroom

2.4 Project –NCM-40: Integrative use of cultivation technologies and molecular techniques for enhancing yield and quality of paddy straw mushroom ,*Volvariella* spp- (PI: Dr. O.P.Ahlawat)

Different tools for characterization of paddy straw mushroom, *Volvariella volvacea* (Bull ex Fr.) Sing. strains for selecting a potential high yielder Mushroom strains and their morphological studies

Out of 26 parent strains of *V. volvacea*, 12 strains showing superior growth characteristics (mycelial growth rate, mycelial growth intensity, intensity of aerial hyphae and chlamydospores) were used for further studies. The 12 strains with 'normal type' mycelial growth characteristics (vigorously growing mycelia with abundant aerial and horizontal hyphae, mycelia usually thick at the margins of agar plate) were grown on Malt Extract Agar in petridishes and pounded sterilized paddy straw substrate in conical flasks by incubating at 32 ± 2°C in BOD incubator for 8 days.

Data presented in Table -2 show that 9 strains attained more than 90 mm radial growth after 8 days of incubation at 32 ± 2°C, while in rest of the strains the growth ranged between 60-65mm. Five strains showed thin growth, while 3 thick, 1 thin fluffy, 1 thick strandy and rest 2 highly fluffy. Aerial hyphae were highest in strain, OE-215 followed by 3 strains (OE-273, OE-209 and OE-212). The strains did not show chlamydospore formation, as these develop only after 12-15 days of incubation . As per the morphological

Table 2. Morphological growth characteristics of different strains of paddy straw mushroom on different cultural media under *in vitro* conditions

Strain	Growth characteristics on different media (8th day of growth)							
	Malt extract agar				Pounded paddy straw			
	a	b	c	d	a	**	b	c
OE-272	90mm(Tn)	+	-	N	Complete	+	-	-
OE-273	95mm(Tk)	+++	-	N	Complete	++	+	++
OE-274	90mm(Tn)	+	-	N	Complete	+	+	+
OE-12	65mm(TnF)	++	-	N	Complete	++	+	+
OE-55	60mm(TkS)	-	-	N	Complete	+	-	-
OE-140	90mm(Tk)	++	-	N	Complete	+++	+	-
OE-209	90mm(Tn)	+++	-	N	Complete	+	-	-
OE-210	95mm(Tk)	++	-	N *	90% of total bag	++	-	-
OE-211	95mm(Tn)	++	-	N*	Complete	+	-	-
OE-212	100mm(Uniform)	+++	-	N*	Complete	+++	-	-
OE-213	65mm(Tn)	+	-	N	Complete	+++	-	+
OE-215	100mm(HF)	++++++	-	N*	Complete	+++	+	+
SE	2.05	0.46+		-	-	0.27+	0.15+	0.20+
$CD_{0.05}$	4.11							

a-mycelial growth level; b-aerial mycelia; c-chlamydospores intensity; d-growth type (N-normal); Tn-thin; Tk-thick; TnF-thin fluffy; Tks-thick strandy; HF-highly fluffy ; *-best with respect to all parameters; **-visual growth; - complete absence; + 10-15%; ++ 30-40%; +++ well spreaded; ++++++ very dense

characteristics exhibited, all strains were of normal type. On pounded sterilized paddy straw, the substrate colonization was complete in all strains on 8th day of incubation, except strain, OE-210 in which it was only 90 % of the substrate in flasks. Visually, the mycelial growth was superior in 4 strains (OE-140, OE-212, OE-213 and OE-215) followed by strains, OE-273, OE-12 and OE-210. The growth was poor in strains, OE-272, OE-55, OE-209 and OE-211. The aerial hyphae and chlamydospores were formed only in 5 strains each. Strains, OE-273, OE-274, OE-12 and OE-215 produced both aerial hyphae and the chlamydospores.

Enzyme assay

Extracellular lignocellulolytic enzymes production potential of 12 parent strains was studied 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) of 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) fitted in a three-piece filter funnel (Whatman). The exoglucanase, endoglucanase, xylanase, β-glucosidase, laccase and polyphenol oxidase activity was measured by following the standard protocol detailed by different workers.

The activity of lignocellulolytic enzymes viz, exoglucanase, endoglucanase, β-glucosidase, xylanase, laccase and polyphenol oxidase varied in different strains. Among cellulases, the fastest growing strain, OE-215 exhibited highest activity of xylanase (2.24 U) and exoglucanase (1.00 U), while medium level of β-glucosidase. It was followed by strain, OE-212 which showed superior activity of xylanase, endoglucanase and β-glucosidase. Another fast growing strain, OE-273 exhibited fairly good activity of only xylanase and exoglucanase. (Table-3). The poor growing

Table 3. Lignocellulolytic enzymes activities of parent strains of paddy straw mushroom, *Volvariella volvacea*

Strain	Enzyme activity					
	Exoglucanase	Endoglucanase	Xylanase	β-glucosidase	Laccase	Polyphenol oxidase
OE-272	0.70	1.19	2.05	0.71	1.75	5.23
OE-273	0.50	0.05	1.41	1.03	1.12	1.38
OE-274	0.46	0.81	1.02	1.18	1.13	1.20
OE-12	0.55	0.28	1.28	1.50	1.32	1.98
OE-55	0.28	1.07	ND	1.06	1.13	ND
OE-140	0.93	0.82	1.71	0.82	1.63	ND
OE-209	ND	1.16	1.92	0.09	ND	0.75
OE-210	0.54	1.24	0.80	2.50	1.88	6.50
OE-211	0.02	0.74	1.43	2.10	0.55	1.23
OE-212	0.37	1.18	1.20	1.10	ND	1.45
OE-213	0.46	0.46	1.95	2.04	1.66	0.93
OE-215	1.00	0.61	2.24	1.31	0.32	0.68
$SECD_{0.05}$	0.0500.101	0.0630.130	0.1030.208	0.1080.221	0.0360.078	0.0360.078

Cellulases-µmol glucose released $h^{-1}ml^{-1}$; laccase and polyphenol oxidase-change in absorbance of 0.001 $min^{-1}ml^{-1}$ and β-glucosidase-µmol pNP released h^{-1} ml^{-1}; ND-not detected

strain, OE-55 completely lacked xylanase activity, while strains, OE-213 and OE-12 showed very low activity of endoglucanase.

Protein profile and protein estimation

The mycelial cultures of different strains were raised by inoculating the pure culture in 100 ml production medium containing (g l^{-1}): glucose 20, peptone 30, yeast extract 5, $(NH_4)_2SO_4$ 10, KH_2PO_4 5, Mg SO_4 0.05 and pH 5.5 (19) in conical flasks. Three flasks were kept for each strain and mycelial growth was obtained by incubating the flasks at 32 ± 2°C for 7 days in BOD incubator. The medium along with mycelial growth was homogenized with K Ultra Turrax T 18 Basic Homogenizer at 18,000 to 22,000 rpm for 5 min. Further shaking of paste was done at 100 rpm for 30 min. in incubator shaker maintained at 35°C. The protein extract was obtained by extracting the paste through Whatman GF C filter paper at room temperature. However, for mushroom fruiting bodies, the 25 g fruiting bodies were grounded in 50 ml of 0.05 M citrate buffer pH 4.0, in a pestle and mortar. The rest of the procedure adopted was same as for the mycelial cultures. The protein profiles of different strains were studied by using 10 % as separating and 5% as stacking gel, respectively. The gels were stained with brilliant blue R-250 at room temperature. The total protein content in fruiting bodies and mycelial cultures of different strains was determined in triplicate according to Lowry's method.

The total protein content of mycelial cultures and fruiting bodies varied in different strains and was the highest in strain, OE-140. In majority of the strains, protein content was recorded higher in mycelial cultures than the fruiting bodies. It is attributed to the use of 50 ml of the buffer for making paste of the 25 g fruiting bodies during protein extraction, where as the mycelia were homogenized directly in the growing medium. In protein profiles, the strains, OE-273 and OE-210 differed only at one band from other strains, while rest of the strains did not differ with respect to presence or absence of bands. Total protein content of different strains showed more variations than the protein profiles. The two strains, OE-273 and OE-210 lacking in one protein band were recorded to grow profusely on malt extract agar and exhibited similar level of exoglucanase activity. However, strains, OE-272, OE-140, OE-209 and OE-55 possessing good activity of β-glucosidase along with either of endoglucanase, xylanase and laccase, were recorded to have superior protein content in their mycelial cultures (Table- 4). The protein contents of fruiting bodies did not vary much and it ranged between 1.10 to 1.90 mg ml^{-1} of extract. The

Table 4. Protein contents of the fruiting bodies and mycelium cultures of different strains of *V. volvacea*

V. volvacea strain	Protein content (mg ml^{-1} of enzyme extract)	
	Fruiting bodies	Mycelial cultures
OE-272	1.30	2.40
OE-273	ND	2.05
OE-274	1.20	1.60
OE-12	1.17	2.04
OE-55	1.49	2.70
OE-140	1.80	2.75
OE-209	1.10	2.50
OE-210	1.70	1.40
OE-211	1.55	2.35
OE-212	1.40	2.06
OE-213	1.15	1.01
OE-215	1.90	1.95
SE	0.046	0.046
$CD_{0.05}$	0.092	0.092

ND-not determined

fruiting bodies of strains (OE-215, OE-140 and OE-210) with superior activity of xylanase and laccase or β-glucosidase exhibited superior protein content than strains with lower activity of xylanase or laccase.

DNA extraction and Amplification of 5.8S r RNA gene

All the 12 parent strains were grown as liquid shake culture in 25 ml malt extract broth in 100 ml Erlenmeyer flasks at 32 ± 2°C for 7 days. The genomic DNA was extracted from approximately 100 mg of freeze dried fungal mycelia by crushing in 1.5 ml micro-centrifuge tubes using micro-pestles. Genespin Plant Genomic DNA Preparation kit (Banglore Genie Ltd.) was used for DNA extraction as per the protocol supplied by the manufacturer. The polymerase chain reaction (PCR) primers, ITS-1 and ITS-4 were used to amplify the ITS region of ribosomal DNA. Amplification by PCR was performed in a total reaction mixture of 50 µl containing 0.4 µl Taq DNA polymerase (6 U ml^{-1}), 5 µl of 10X PCR buffer (10 mM Tris-HCl, pH-8.3, 500 mM KCl, 15 mM $MgCl_2$), 0.4 µl of dNTP mix (25 mM each of dATP, dCTP, dGTP and dTTP), 1 µl each of ITS-1 and ITS-4 primers (10 mM), 2 µl of 5% glycerol and 5 µl of genomic DNA containing around 40 ng DNA in dH_2O. The reactions were performed in a Master cycler gradient (Eppendorf, AG 22331 Hamburg, Germany) in 36 cycles of 1 min denaturation at 95°C, 30 sec annealing at 50°C, 1 min 20 sec elongation at 72°C and ending by 10 min final elongation step at 72°C with lid heating option at 104°C.

The PCR amplification of 5.8S rRNA gene region encompassing ITS-1 & ITS-2 on either sides, revealed an ITS amplicon of approximately 720 bp in all the 12 parent strains, thereby confirming that all the strains belong to a single species, *V. volvacea*).

RAPD analysis

Initially 20 arbitrary primers of OPB series supplied by Operon Biotechnologies, Gmbh, Germany, were used to screen against different strains of *V. volvacea*, based upon the reproducibility of the banding patterns generated by them. However, after initial screening only 5 primers were used for PCR amplification. Multilocus genotyping was performed by RAPD using five primers, namely OPB-1 (5' GTTTCGCTCC-3'), OPB-2 (5'- TGATCCCTGG-3') OPB-3 (5- 'CATCCCCCTG-3'), OPB-4 (5'- GGACTGGAGT-3') and OPB-5 (5'- TGCGCCCTTC-3'). PCR amplification was performed in a reaction mixture of 25 µl containing 2 µl primer (50 pM ml^{-1}), 0.2 µl dNTP mix (25 mM each), 1 µl $MgCl_2$ (25 mM), 1 µl Taq DNA polymerase (6U ml^{-1}), 2.5 µl 10 X PCR buffer (100 mM Tris-HCl, pH-8.3, 15 mM $MgCl_2$, 250 mM KCl), 2 µl glycerol (5%) and 12.3 µl of dH_2O. To this mixture, 4 µl of genomic DNA (approx 40-60 ng) was added and amplifications were performed in above mentioned Master cycler gradient with initial denaturation at 94°C for 3 min, followed by 38 cycles of 94°C for 40 sec, 40°C for 40 sec, 72°C for 1 min and final elongation at 72°C for 10 min with lid heating option at 104°C. The PCR amplified products were electrophoretically separated on 1.6% agarose gel, prepared in 1 X TAE and run at 50 V for 3 h. The staining was done with ethidium bromide and the gel was visualized and photographed using Gel Documentation System (Syngene). The photographs were scored for presence and absence of scorable bands with the assumption of positional homology. The analysis of strains was carried out in triplicate with all primers to ensure minimum experimental errors of reading of wrong bands. The band profiles of each gel were scored visually and recorded as presence (1) or absence (0) of bands and binary

data matrix was constructed. The data were analysed to obtain Jaccard's similarity coefficients using NTSYS – PC software version 2.1. The similarity coefficients were used to construct a dendrogram using UPGMA (Unweighted Pair Group Method using Arithmetic Average) and the SAHN (Sequential Hierarchial and nested clustering) options available in the NTSYS programme. Distinct banding patterns were recorded for each primer for 12 strains, which facilitated their characterization.

The combined phylogenetic analysis of RAPD profiles of parent strains by using five primers and including about 60-80 bands for each strain, revealed wide intra-specific variations (10 to 28%) within the strains. The phylogenetic analysis revealed 5 distinct phylogenetic clades comprised of; 3 strains in 1st, 6 in 2nd and 1 each in rest three (Fig 8).

The fast growing strains were found to possess superior activity of xylanase, exoglucanase, endoglucanase or β-glucosidase, while superior activity of an individual enzyme was not found sufficient to support fast mycelial growth. The strains also varied in their laccase and polyphenol oxidase activities and the fastest growing strain, OE-215 showed very low activity of these enzymes. The other two fast growing strains, OE-209 and OE-212, completely lacked the laccase activity, while another fast growing strain, OE-273 had fairly good level of laccase and PPO activities. The slow growing strain, OE-213 possessed low activity of PPO and medium level activity of laccase. The study reveals that the vegetative growth of *V. volvacea* is not much controlled by the activity of its laccase and polyphenol oxidase enzymes.

In present study, all the strains exhibited a single ITS amplicon of 720 bp, which revealed that all strains, belonged to one species. The grow-out trails had also proved the validity of these strains to belong to the species *V. volvacea*.

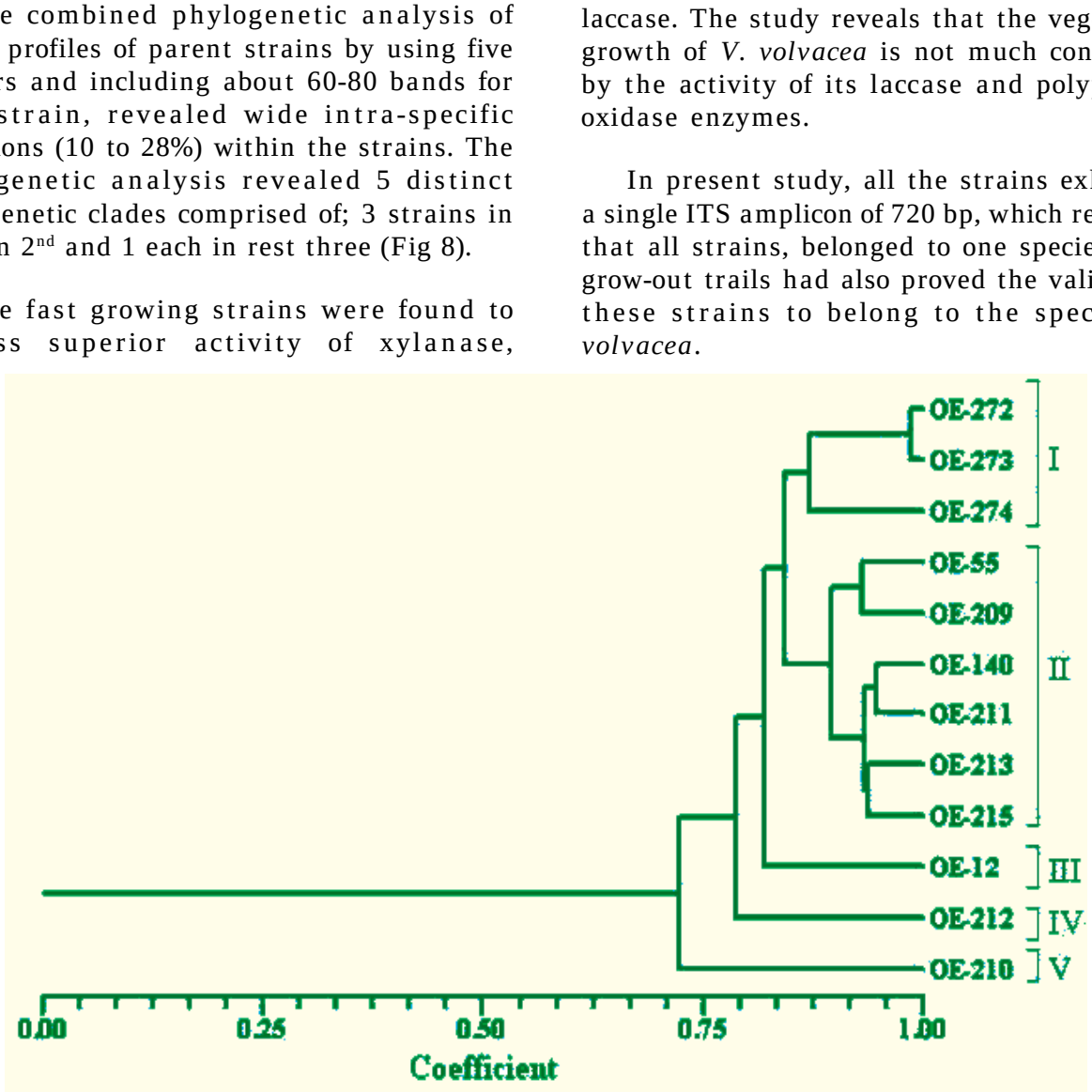


Fig. 8. Combined phylogenetic tree of *Volvariella volvacea* parent strains

In combined phylogenetic analysis of RAPD profiles, the biggest group comprised of 6 strains, out of which 4 strains (OE-209, OE-211, OE-213 and OE-215) were of same origin, while the next group comprised of 3 strains (OE-272, OE-273 and OE-274), and all were of same origin (Bhubeneswar, Orissa). The next three groups comprised of one strain each. The strain, OE-210 which varied at one protein band in protein profile, grew profusely on malt extract agar, grew slowly on paddy straw substrate, possessed highest activity of four lignocellulolytic enzymes (endoglucanase, β-glucosidase, laccase and polyphenol oxidase) also showed the highest dissimilarity of 28% with other strains. It was followed by strain, OE-212 with 21% dissimilarity, which exhibited superior mycelial growth both on malt extract agar and paddy straw substrate and with second best endoglucanase activity. The strain, OE-12, with 17% dissimilarity, grew slowly on malt extract agar medium and did not exhibit superior activity of either of the enzymes.

The present study revealed a relationship between the origin of the strains and its phylogenetic belongingness and it can be attributed to the origin of strains from a common parent in that area. The present study will provide a more logistic solution towards selection of a strain for its use in commercial cultivation.

2.5 Genetic improvement in Shiitake (*Lentinula edodes*) mushroom

Project:- NCM-33-: Molecular characterization and genetic improvement in Shiitake (*Lentinula edodes*) mushroom (PI: Dr S.K. Singh)

2.5.1 Molecular characterization of newly acquired *Lentinula edodes* germplasm

The DNA sequences of fifteen parents and hybrids were aligned using CLUSTAL X 1.83 computer software programme and found significant genetic diversity among the ITS regions as shown in the figure 9.

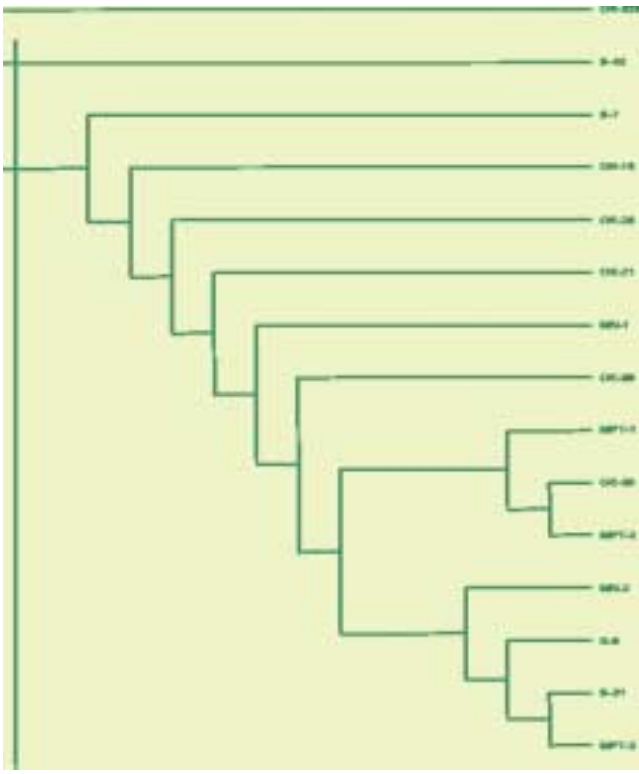


Fig. 9. Genetic diversity among the ITS regions of fifteen parents and hybrids

2.5.2 Conservation and maintenance of *Lentinula edodes* germplasm

All the collected Shiitake mushroom germplasm accessions newly developed SSI's and hybrids were subcultured for further experiments and to continue breeding work.

2.5.3 Fructification and comparative biological efficacy field trial

Sixteen shiitake elite strains and hybrids were tested for yield performance and comparative biological efficiencies. In general, higher biological efficiencies in all the elite strains and hybrids as compared to previous season were obtained ranging from 54.2% in OE-21 to 95.5% in Hybrid S-31 (Table-5) This year saw dust spawn was used to inoculate saw-

Table 5. Yield performance of shiitake elite strains and hybrids

Strain/ Hybrid	Yield (grams)	Biological efficiency (%)
OE-16	433.3	57.8
OE-21	406.6	54.2
OE-28	663.3	88.4
OE-38	665.0	88.6
OE-59	623.3	83.1
OE-329	430.0	57.3
MN-1	543.3	72.4
MN-2	421.6	56.2
MPT-1	640.0	85.3
MPT-2	420.0	56.0
MPT-3	536.6	71.5
S-9	621.6	82.9
S-31	716.6	95.5
S-42	526.0	70.1
S-57	523.3	69.8
CD	**80.9**	**10.8**

dust amended substrate. The spawn run period was also reduced from 4-4½ months to approximately 3 months. Instead of using costly sucrose, simple sugar was used in fixed proportion to facilitate spawn run period. Utmost care was taken in the management of environmental conditions i.e., temperature during spawn run, pin head formation and fruit maturity. Now with three cropping season's data it can be ascertained that the growing conditions are standerdised and repeated chilling treatment can be avoided simply by following precise temperature, relative humidity, fresh air exchange, and light intensity during different stages of development. One Hybrid HY-22 is under field trial and is performing very well.

2.5.4 Breeding for higher yield and bioactive medicinal compounds

Isolation and quantification of bioactive medicinal compound lentinan both in parents and hybrids

An improved protocol for enhanced extraction of the Lentinan from shiitake mushroom (*Lentinula edodes*) has been developed. The protocol comprises extraction in water, precipitation with alcohol, defatting with ether and freeze drying. The protocol yields the highest Lentinan reported till date. Since the protocol will be patented following ICAR procedure, the details of the methodology is not described in details.

1. Button mushroom, *A. bisporus*

Project: -NCM-16: Improved methods of composting for white button mushroom (*Agaricus bisporus*) (PI- Dr. B.Vijay)

1.1 Indoor composting using low temperature regime.

Experiment on indoor composting was conducted in the season by taking wheat straw as base material. Compost was prepared using following formulation and time schedule.

Compost ingredients	Quantity
Wheat straw	1.0 ton
Chicken manure	400 kg
Wheat bran	70 kg
Urea	15 kg
Cotton seed cake	20 kg
Gypsum	30 kg

Time schedule	Operation
-2 day	Wetting and mixing of the ingredients out doors
-1 day	Turning, trampling by Bobcat and thorough mixing of the ingredients, addition of water
0 day	Filling in the phase-I tunnel
+3 day	Emptying the tunnel, turning and mixing of the ingredients, addition of water and re filling the Phase-I tunnel
+6 day	Filling the phase-II tunnel
+12 day	Phase-II operation over

Ingredients were thoroughly mixed and properly wetted so as to achieve around 75% moisture. Run off water was regularly collected and sprinkled over the wetted straw. On the following day these wetted ingredients were than spread over the composting yard (around 8-10" height) and trampled hard by running Bobcat several times over the wetted ingredients so as to increase the bulk density of the ingredients and also to shred the straw. After two days of their thorough mixing and wetting, it was transferred to phase-I bunker, for phase-I operation. This material weighed around 4 tons and height of the compost in the bunker was kept up to 1.8- 2 meters. Temperature sensors were installed on the top and in the center of the pile in the bunker and blower fan switched on @ 10 min./hour. A temperature between 42-48°C could be recorded in the centre of the pile and at top to 8" deep of the pile. Temperature on the sides of the compost mass along the walls was in the range of 38-42°C. Full penetration of air was noticed in the compost. Further no foul smell was noticed while performing phase -1 in bunker. After 3 days of partial fermentation in phase-I tunnel, entire compost mass was taken out remixed and filled in the same tunnel. After 3 days, this compost was transferred to tunnel for usual phase-II operations. Standard methodology was employed thereafter for compost production.

1.2 Physical parameters and total yield

Moisture of the compost at filling was 70% while it came down to 67.52 % at spawning. pH at filling was 8.0 while it was 7.3 at spawning. N% at filling was 1.68 while it increased to 1.78 at spawning. Wheat straw to compost conversion ratio was 3.2 times (Table-1). An average yield of 12.30 kg mushrooms 100Kg compost could be obtained from the trial in fifty days of cropping.

Table 1. Physical parameters and yield obtained with indoor compost

Trial	pH at filling	pH at spawning	Moisture % at filling	Moisture % at spawning	N % at filling	N% at spawning	Conversion ratio	Yield kg/q compost
1.	7.82	7.3	70.0	67.52	1.68	1.78	3.20	12.30

1.3 Isolation and identification of mesophilic and thermophilic fungal flora of different composts collected across the country

Around 42 compost samples collected from different locations of the country were analysed for the presence of mesophilic and thermophilic fungi. *Mucor pusillus*, *Aspergillus fumigatus*, *Penicillium* sp., *Fusarium* sp., *Trichoderma viride*, *Paecelomyces varioti*, *Sepedonium maheshwarianum* and *Verticillium* sp. were isolated among the mesophilic fungi. Their colony forming units ranged between 16.00 to 56.3 cfu/g of compost. These organisms have been brought in the pure form and preserved for future studies.

Among the thermophilic fungi *S.thermophilum*, *H.insolens* and *H.grisea* were dominantly isolated from different compost samples. Their colony count ranged between1.0 to 40.0 /g of compost. Additional fungi isolated this year were *Geotrichum* sp.,*Talaromyces dupontii* and *T. emersonii*

These fungi together with those isolated last year have also been brought under pure culture. These fungi are showing lots variability in terms of colony character, colour, spore size and pigment production. Eight and 6 different strains of *S. thermophilum* and *H. insolens*, respectively have tentatively been identified and kept in record for future studies.

1.4 Isolation of bacteria from different composts

The compost samples collected from different farmers in and around Solan were analysed for thermophilic bacterial count (Thbc) and total bacterial count (TBC). The bacteria were isolated following dilution plate technique using 10^{-7} dilution on single nutrient agar medium. Incubation temperature for Thbc was 48°C. whereas for TBC was 25°C.

Eleven representative colonies were selected from the Thbc plates and again 11 were selected from TBC plates on the basis of colony morphology, colour, size and shape etc. Cfu of Thbc and TBC ranged from 1.8 to $3.96x10^8$ and 1.6 to $3.5x10^8$, respectively. All the isolates were broadly classified into two major groups (gram +ve and gram –ve). Out of 11 thermophilic bacteria 5 were gram + and rest were categorized as gram –ve. Similarly among mesophilic bacterial isolates, 4 were gram +ve and 7 were gram –ve. Among the gram +ve isolates, all were rod shaped which were arranged in pairs, triads, clusters or in long chains, the gram-ve isolates were rods except one which was coccus in long chains.

In order to classify the mode of metabolism of bacterial isolates, catalase test was carried out. Out of Thbc , 6 were catalase +ve and 5 were catalase –ve. Similarly out of 11 TBC, 5 were catalase +ve and rest were negative.

1.5 Temperature and media studies on different strains of *Scytalidium thermophilum*

Above studies were conducted on four media and four temperature ranges on eight different strains of *S. thermophilum* collected from different parts of the country. In general malt extract medium (MEA) proved to be the best medium for all the strains studied as it offered more growth of different strains

compared to other media tried. However, strain 1,2 and 3 preferred MEA, strain 4, PDA, strain 5 and 6 yeast starch agar (YSA), strain 7 and 8 compost extract agar (CEA) for their maximum growth (Table –2).

Table 2. Average growth (mm) of different strains of *Scytalidium thermophilum* in different media after 3 days

S. thermophilum strain	PDA	MEA	CEA	YSA
1	28.78	46.50	0.00	31.36
2	64.5	65.89	37.5	24.30
3	55.00	61.50	60.67	45.66
4	45.66	36.10	42.50	35.33
5	64.50	71.33	56.66	87.16
6	70.33	70.33	47.50	73.33
7	45.66	36.89	44.16	30.40
8	41.66	47.83	51.66	28.00

Temperature studies on above strains were conducted at five temperature ranges namely 25,35,45,50 and 55°C. *S. thermophilum* is a thermophilic fungi, however 25 and 35°C. temperature's were taken in the study to know whether these different strains can grow at mesophilic temperature ranges or not.

Surprisingly few of the strains like 3 and 5 grew very well at 25 and at 35°C. although their growth rate was comparatively slower as compared to thermophilic range. Nonetheless this is an very important finding as these strains can further be exploited for compost production at low temperature under indoor compost production (Anglo Dutch method) and further they can also be multiplied during the mycelial colonization of white button mushroom as extra nutrition.

Different strains behaved differently at different temperatures confirming that these are the different strains of *S. thermophilum*. Optimum temperature of these strains was 45°C and strain 8 was the fastest growing fungus (Table-3).

Table 3. Average growth of different strains of *Scytalidium thermophilum* at different temperatures

Strain	Average growth of different strains of *S. thermophilum* at different temperatures (°C)				
	25	35	45	50	55
1	26.83	44.56	74.50	59.66	63.83
2	20.83	0.00	67.33	83.33	73.16
3	45.33	50.22	79.83	68.5	63.16
4	25.83	52.3	74.5	67.16	70.83
5	45.83	50.6	82.00	76.5	68.16
6	14.66	28.78	78.83	80.16	58.66
7	15.50	0.00	76.16	71.33	60.66
8	13.00	0.00	88.33	89.5	84.00

1.6 pH studies on different strains of *S. thermophilum*

All the eight strains of *S. thermophilum* were studied for growth parameters on different pH ranging from 5 – 10. Seven mm bit of each strain was inoculated using cork borer in 90mm Petri plates containing sterilized YSA medium and Petri plates were closed by Para film. Three replications were kept for each strain and cultures were incubated at 45°C for 3 days. A beaker full of water was kept inside the incubator so as to minimize the water loss at higher temperature.

Data were recorded after every 24 h interval for respective changes in colony diameter. Data obtained (Table- 4) are the average of colony of three replications kept for each strain for 72 hours at different pH values.

All the strains of *S.thermophilum* showed lot of variations in their respective pH for growth. Maximum growth of different strains was achieved at different pH 8,7.5,9.0 and 9.5 in decreasing order. Highly acidic pH did not favour the growth of different strains.

1.7 Evaluation of *S. thermophilum* (X-21) and *H. insolens* (I-9) for compost production under mushroom house conditions

Compost was prepared by the following formulation

Wheat straw	1000 kg
Chicken manure	700 kg
Urea	15 kg
Cotton seed cake	20 kg
Gypsum	40 kg

Above ingredients were thoroughly wetted so as to achieve around 75% moisture. They were than divided into two equal halves. One halve was inoculated with the above two fungi @ 250 g inoculum each grown on wheat grains. While other half was kept as such and served as control. These two-piles/ heaps were allowed to ferment as such in the yard for two days after that both the compost masses were transferred to phase –II tunnel and blower fan switched on. Temperature of the tunnel was kept between 45-59°C at different stages of its

Table 4. Average growth of different strains of *Scytalidium thermophilum* at different pH levels

Strain	Average growth of different strains of *S. thermophilum* at different pH levels										
	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
1	62.33	55	34.33	46.66	62.33	85	70.66	79.83	82.83	82.16	76.5
2	63	82.16	56.83	90	63.5	68.66	90	85.33	90	83.66	69.66
3	61.5	33.55	-	-	-	48.66	39	-	40	-	22.16
4	37.17	40.83	37.16	47.83	37.16	53.33	60	57.16	64.33	65.66	56.5
5	46.5	59.66	34.33	71.83	46.5	65.83	90.0	68.33	64.5	80.83	72.82
6	54.8	39.16	35	48.66	54.33	56.66	90	58.66	66.16	74.16	63.33
7	83.5	75	37.16	37	83.5	64.5	90	90	54	90	77.66
8	38.5	48.33	-	51.33	38.5	52.66	73.5	48.16	35.3	69.33	61

- Contamination occurred in the plates

Table 5. Physical parameters and yield of *A. bisporus* obtained in total indoor compost (Inoculated)

Treatment	Physical parameters					
	Moisture% at filling	Moisture% at spawning	pH at spawning	Conversion ratio	Ammonia (ppm)	Yield (Kg/q compost)
Inoculated	75.00	69.00	7.4	2.92	3.00	16.76
Control	75.00	67.00	7.2	3.33	9.00	8.70

conditioning and pasteurization. Composts were kept in the tunnel for 12 days. An ammonia concentration in the treated pile was 3 ppm while it was 9 ppm for control treatment. A very heavy population build up of inoculated fungi (*S. thermophilum* and *H. insolens*) was noticed in the inoculated treatment. Control treatment yielded low population of different strain of *S thermophilum*. A total of 1.46 and 1.65 tons of final compost was obtained in inoculated and control treatments. A very high yield of 16.76-kg/ 100 kg compost was obtained in the treated compost compared to only 8.70 kg obtained in control pile (Table – 5). Experiment will however, be repeated this year to confirm the finding.

1.8 Evaluation of different compost formulations for *A.bisporus* cultivation

This experiment was conducted with the view to supplement straw with higher doses of organic nitrogen sources (up to 20%) keeping initial N level between 1.4-1.8%. Composts with different additives were prepared with the under mentioned formulations (Table –6)

Six different piles were prepared using above formulations. Compost was prepared by long method in 28 days time. Data obtained on physical parameters are presented in Table-7. During composting highest average

Table 6: Ingredients used in composts production

Ingredients	Pile-1 (kg)	Pile-2 (kg)	Pile-3 (kg)	Pile-4 (kg)	Pile-5 (kg)	Pile-6 (kg)
Wheat straw	200	200	200	200	200	200
Chicken manure	100	100	100	100	150	80
Cotton seed meal	40	00	0.0	00	0.0	0.0
Wheat bran	0.0	0.0	0.0	0.0	12	20
Urea	2.0	2.0	2.0	2.0	0.0	3.0
Cotton seed cake	0.0	40-	0.0	0.0	20.0	0.0
Soybean meal	0.0	0.0	0.0	40	15.0	0.0
Soybean Nutri	0.0	0.0	40	0.0	0.0	0.0
Gypsum	15	15	15	15	15	15
Cold N%	1.70	1.80	1.81	1.72	1.40	1.42

Table 7. Physical parameters and yield obtained in different composts

Treatment	Physical parameters and yield obtained in different composts					
	Av. temp. Phase-1	Final pH	Final moisture (%)	Total compost produced (kg)	Condition of spawn run	Yield (kg/q compost)
P-1	65.30	7.60	59.00	410	++	8.06
P-2	64.30	7.50	54.00	460	+	5.73
P-3	66.25	7.60	56.00	410	+	5.62
P-4	63.50	7.50	58.00	420	++	7.78
P-5	63.75	7.60	55.00	450	+	1.65
P-6	66.00	7.50	56.00	460	+++	11.53

temperature was recorded in T- 3 treatment (66.25°C) whereas lowest was recorded in T-4 (63.5 °C) where wheat straw was supplemented with chicken manure and soybean. pH at spawning ranged between 7.5-7.6. Almost equal compost was produced in different treatments (410-460 kg). It was observed that addition of organic additives in larger amount had negative impact on the yield of white button mushroom and very low yields were obtained in different treatments excepting in T-6 where no organic nitrogen was added (11.53 kg/100 kg compost). In rest of the treatments yields ranged between 1.65- 8.06 kg of mushrooms.

2. Speciality mushrooms

Project- NCM-18: Standardization of cultivation technology of specialty mushrooms (PI-Dr.S.R.Sharma).

2.1 Effect of different growth hormones on the mycelial growth of *Agrocybe aegerita, Flammulina velutipes* and *Lentinula edodes*

Gibberellic acid (20 ppm) and IBA at 20 ppm concentration proved to be the best growth hormones for *Agrocybe aegerita* and *Flammulina velutipes*, respectively in liquid medium, whereas, kinetin at 20 ppm concentration proved to be the best growth hormone for *Lentinula edodes*. Gibberellic acid at 20 ppm concentration proved to be the best growth hormone for *Flammulina velutipes* and *Lentinula edodes*, whereas,Kinetin at 20 ppm concentration proved to be the best growth hormone for *Agrocybe aegerita* in solid medium.

2.2 Cultivation of *Macrolepiota procera*

Macrolepiota procera cultivation trial was repeated and the crop was successfully grown on short method compost. The spawn run was completed in 30-35 days at 27-28°C. The primordia initiated after 18-21 days after the application of casing layer. The fruit bodies (Fig. 1) were 12-28cm long with average weight of 32g.

Fig. 1. Fruit bodies of *Macrolepiota procera*

2.3 Effect of cultivation substrates on the productivity of *Agrocybe aegerita*

Cultivation trials carried out on two substrates viz. wheat straw and sawdust. Saw dust proved to be superior substrate as it resulted in 62 per cent biological efficiency as compared to 50 per cent obtained on wheat straw. Supplementation of sawdust with 10 per cent wheat bran resulted in enhanced biological efficiency.

2.4 Effect of different Growth regulators on the yield of *Agrocybe aegerita*

It is evident from the data presented in Table-8 that GA @ 20ppm resulted in the highest increase in yield of *Agrocybe aegerita* giving 60 per cent BE whereas the other two growth regulators tried did not show any pronounced effect.

2.5 Effect of Asparagine on the productivity of *Flammulina velutipes*

Addition of 50mg asparagine per Kg of dry cultivation substrate resulted in excellent spawn run and enhanced productivity of *Flammulina velutipes*. The spawn run was completed in just 15 days as compared to 25-28 days in control. Addition of asparagine at 50mg per Kg dry sawdust significantly enhanced the productivity of *Flammulina velutipes*.

2.6 Effect of different Growth regulators on the productivity of *Flammulina velutipes*

It is evident from the data presented in Table- 9 (Fig. 2) that Kinetin @ 20ppm gave the highest increase in yield giving 40 per cent BE whereas the other two growth regulators

Table 8. Effect of different Growth regulators on the yield of *Agrocybe aegerita*

GR	Rate (ppm)	*Days taken for spawn run	Yield (g/400g dry substrate)	BE (%)
GA	10	27	220	55
	20	26	240	60
Kinetin	10	26	205	51
	20	28	210	52
IBA	10	27	210	52
	20	27	195	49
Control		31	200	50
CD0.05			32.5	

Table 9: Effect of different Growth regulators on the productivity of *Flammulina velutipes*

GR	Rate (ppm)	*Days taken for spawn run	Yield (g/400g dry substrate)	BE (%)
GA	10	22	140	35
	20	22	132	33
Kinetin	10	20	150	37
	20	19	160	40
IBA	10	23	133	33
	20	23	140	35
Control		30	112	28
CD0.05			22.4	

Fig. 2. Fruit bodies of *Flammulina velutipes*

tried also showed significant increase in the yield of *Flammulina velutipes*.

2.7 Effect of supplementation on the productivity of *Lentinula edodes*

Supplementation of sawdust at the rate of 20, 30 and 40 per cent enhanced the yield of *Lentinula edodes*, whereas substrate without supplementation resulted in poor spawn run and very poor yields.

2.8 Physiological and Enzymatic studies on *Macrolepiota procera*

Physiological studies carried out on *Macrolepiota* revealed that dextrose peptone yeast agar medium (64.5 mm) was the best. Among the different temperature, 30ºC supported the maximum growth and pH-5 proved the best. Asparagine and manitol proved to be the best nitrogen and carbon sources, respectively. Enzymatic studies revealed that chitinase was the most active enzyme, followed by laccase and pectinase in *Macrolepiota*.

1. Insect Pests and Diseases of Mushrooms

Project:- NCM-34:Exploitation of indigenous microbes, plant products and pesticides for the management of pests and diseases associated with mushrooms (PI:Dr Satish Kumar)

1.1 Survey and surveillance of major pests and diseases

Survey of different farms surrounding Murthal (Haryana) revealed the widespread incidence of wet bubble, yellow mould, *Sclerotium* , brown plaster mould and inkcaps. Severe incidence of wet bubble was recorded at Morni Hills. Ink caps, brown plaster mould, lipstick mould and *Chetomium* spp was observed at Basal, Vakanaghat and adjoining area of Solan. Sciarid, phorid and mites were common in most of the farms visited. Compost samples collected/ received showed the presence of nematodes in most of the samples. Very severe incidence of red pepper mite *Pygmephorus sellnicki* was recorded for the first time in one of the mushroom farm at Seri, near Solan. This mite is known to carry die back disease. These mites create pits on the cap, browning and these mites feed on mycelial thread which causes wobbling of mushroom on only one mycelial thread.

1.2 Residues analysis of malathion and decamethrin in *Agaricus bisporus* and effect of processing on the residue level

Persistence of malathion and decamethrin was estimated in white button mushroom (Strain S-11) grown on steam pasteurized compost under controlled conditions. In the first experiment single spray of these insecticides at 5 different (0.001%, 0.005%, 0.01%, 0.05%, 0.1%) concentrations was given at the time of casing and residues were estimated by GLC method in fruit bodies after 14 days of spray. The residue of malathion (Table-1) varied from 0.32 to 0.79 ppm and of decamethrin from 0.26 to 0.61 ppm. With the increase in concentration of both the insecticides there was corresponding increase in the residue levels. In the second experiment where 1,2 and 3 sprays of these insecticides were given at weekly intervals , the residue of both the insecticides was higher when more

Table 1. Effect of processing on the residues of malathion and decamethrin in *A. bisporus*

		Residue (ppm)					
		Malathion			Decamethrin		
No. of sprays	Treatment concentration (%)	UW	W	B	UW	W	B
One	0.001	0.32	0.17(46.88)	0.04(87.50)	0.26	0.06(76.92)	0.05(80.76)
One	0.005	0.39	0.20(48.72)	0.11(71.79)	0.34	0.08(76.47)	0.07(79.40)
One	0.01	0.46	0.27(41.30)	0.11(76.08)	0.38	0.15(60.52)	0.06(84.21)
One	0.05	0.54	0.30(44.44)	0.11(79.62)	0.54	0.17(68.51)	0.12(77.77)
One	0.10	0.79	0.42(46.83)	0.26(67.08)	0.61	0.24(60.65)	0.12(80.32)
Two	0.01	0.88	0.36(59.09)	0.26(70.45)	1.04	0.26(75.00)	0.13(87.50)
Three	0.01	0.95	0.65(31.57)	0.47(50.52)	1.82	0.75(59.79)	0.18(90.10)

Figures in parentheses represent the percentage reduction, UW= Unwashed, W= washed, B= boiled

number of sprays were given as compared to single spray (Table-2). When fruit body samples from all these treatments were washed or boiled in water for 10 minutes, overall reduction in the residue levels ranged from 31.57 to 87.57% in malathion and 59.79 to 90.10% in decamethrin. Boiling was more effective in lowering the residue of both the

Table 2. Effect of number of sprays of malathion and decamethrin on residue level in *A. bisporus*

No of sprays	Residue (ppm)	
	Malathion (0.01%)	Decamethrin (0.01%)
1	0.46	0.38
2	0.88	1.04
3	0.95	1.82

insecticides than simple washing. Out of ten button mushroom samples collected from local market and mushroom growers the insecticides were detected in 60% of the samples. (Table- 3)

Table 3. Residue of malathion and decamethrin in button mushroom collected from different sources

S. No.	Residue (ppm)		
	Source	Malathion	Decamethrin
1	LM	0.543	0.163
2	LM	0.105	0.087
3	Farmer	ND	0.201
4	Farmer	ND	ND
5	NRCM	0.132	0.102
6	LM	0.167	ND
7	Farmer	ND	ND
8	Farmer	ND	0.027
9	LM	0.083	0.390
10	NRCM	0.249	ND

1.3 Effect of processing on persistence of carbendazim in different mushrooms

Residues of carbendazim, was estimated by spraying 0.1% concentration on the crop one day before harvest. It was observed (Table-4)

Table 4. Effect of processing on persistence of carbendazim in different mushrooms

	Treatment (residue in ppm)							
Mushroom	Fresh unwashed	Washed with water	Washed with KMS	Washed with ascorbic acid	Stored at room temperature for 2 days	Stored in refrigerator for 2 days	Oven dried	Boiled
C.indica	0.794	0.144 (81.86)	0.936 (+15.17)	0.310 (60.95)	0.149 (81.23)	0.155 (80.47)	0.164 (79.34)	0.104 (86.90)
A. bisporus (A-15)	0.168	0.120 (28.57)	0.230 (+26.95)	0.146 (13.09)	0.151 (10.11)	0.108 (35.71)	0.166 (1.19)	0.111 (33.92)
M. procera	0.134	0.037 (72.38)	0.397 (+66.24)	NT	NT	NT	0.072 (46.26)	NT
P.sajor-caju	0.399	0.115 (71.17)	0.402 (+0.75)	0.292 (26.81)	0.212 (46.86)	0.235 (41.10)	0.153 (61.65)	0.193 (51.62)

Figures in parentheses are per cent increase or decrease in residue level
NT = not tested

that initial residue reduced to 28.57% to 81.86% in different samples by simple washing. Corresponding losses from 13.09-60.95%, 10.11-81.23%, 35.71-80.47%, 1.19-79.34% and 33.92-86.90% due to washing with ascorbic acid, storing at room temperature for

Table 5. Residue of carbendazim (ppm) in different samples of mushrooms

Source	Compost	Spray schedule	Strain	Flush	Residue detected (ppm)	
NRCM	Organic	Nil	A-15	3rd	0.288	
NRCM	SMC	Nil	S-11	3rd	0.389	
NRCM	SMC	Nil	S-11	1st	0.165	
NRCM	Organic	Nil	A-15	3rd	0.271	
NRCM	SMC	Spray at casing	A-15	1st	ND	
NRCM	SMC	Spray at casing + 7 days after casing	A-15	1st	0.345	
NRCM	Organic(room 1)	Nil	A-15	3rd	0.604	
NRCM	Organic(room 10)	Nil	A-15	3rd	0.311	
Farmer-1	SMC	3 sprays	U-3	3rd	0.114	
Farmer Mamleag		-	S-11	-	ND	
Farmer-2 Kasouli patta	-	-	S-11	-	0.260	
Farmer-3 Kasouli patta	-	-	S-11	-	0.260	
Farmer-4 Garu	-	-	U-3	1st	0.136	
Farmer Balhedi	-	-	S-11	-	ND	
Farmer-5 Subathu	SMC	Nil	S-11	1st	0.333	
Market-1	-	-	U-3	-	ND	
Market-2	-	-	U-3	-	0.222	
Market-3	-	-	S-11	-	ND	
Market Sample-4	-	-	U-3	-	0.220	
Market Sample-5	-	-	U-3	-	0.365	
Market Sample-6	-	-	U-3	-	0.211	
Market -7	-	-	-	-	ND	
Market-8	-	-	-	-	0.206	

SMC = Short method compost, ND = not detected

two days, storing in refrigerator for two days, oven drying and boiling or cooking of samples, respectively were recorded. Carbendazim residues although below maximum permissible limit (Table-5) were detected in all the mushroom samples collected from different sources.

1.4 Screening of different strains of paddy straw mushroom against phorids

Screening of different strains of paddy straw mushroom against phorid flies was carried under *in-vitro* conditions. Among the different strains, OE- 12 and OE-1222 proved to be highly susceptible to phorids. Comparatively less feeding was observed in OE- 55-60 strain. However, no feeding was recorded in OE-210 strain even after 48 hours.

1.5 Screening of different strains of paddy straw mushroom against sciarids

Among the different strains, OE-211 and OE 129 proved to be highly susceptible to sciarids. Comparatively less feeding was observed in OE-272, OE-273, OE-12 and OE-12-22. No feeding was observed in OE-209 and VV-01 strains.

2. Project:-NCM-32: Molecular and physiological characterization of moulds associated with mushrooms (PI: Dr. V.P. Sharma)

2.1 Molecular characterization of pathogenic fungi causing diseases in mushrooms

Molecular characterization of 15 isolates (Fig.1) of *Cladobotryum* collected from different mushroom units was undertaken by ITS sequencing of 5.8S r RNA gene. Phylogenetic analysis of 15 *Cladobotryum* isolates using RAPD technique exhibited seven phylogenetic groups. The nucleotide sequence comparisons of 5.8S rRNA gene using BLAST network services against NCBI data bases facilitated molecular identification and genetic cataloguing of 15 *Cladobotryum* isolates into four taxa namely, *Hypomyces aurantius*, *Cladobotryum dendroides*, *C. mycophilum* and *C. astrophorum*. The sequences obtained were submitted to NCBI Gene Bank and Gen accession number obtained EU 340832, EU 340833, EU 340834 and EU 340835 are available in public domain for comparisons.

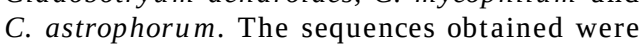


Fig. 1. ITS lengths of 5.8S gene regions of *Cladobotryum* isolates

Molecular characterization of three isolates of *Papulaspora*, two isolates of *Chaetomium* and two isolates of *Diehliomyces*, revealed no genetic variability in these isolates.

No inter or intra species ITS length diversity was detected in ten isolates of *Mycogone perniciosa* (Fig.2,3). The nucleotide sequence obtained by amplification of ITS region of rDNA identified as *Mycogone perniciosa*, submitted to NCBI Gene Bank, and named as EU-380317.

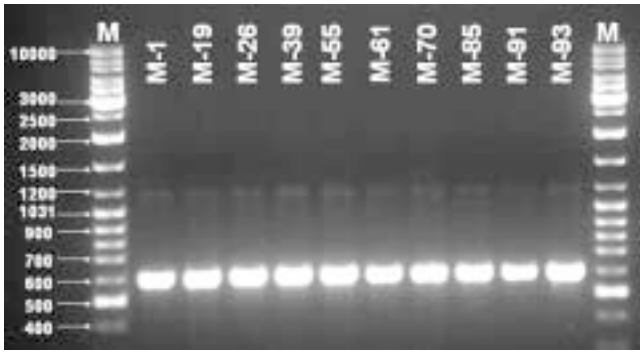


Fig. 2. ITS profiles of *Hypomyces perniciosus* isolates

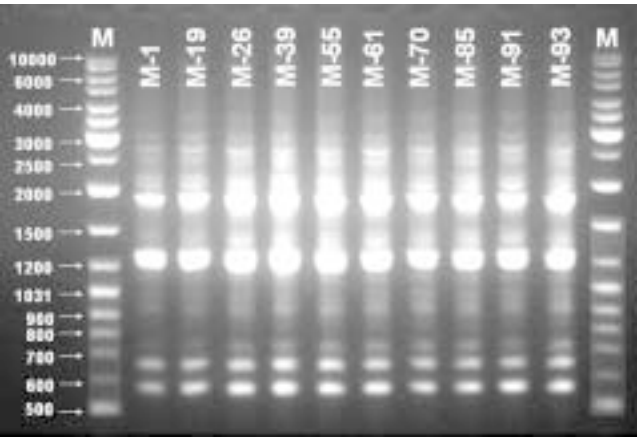


Fig. 3. RAPD profiles of *Hypomyces perniciosus* isolates using OPA-4 primer

2.2 Restriction Fragment Length Polymorphism of Various fungal moulds

Various fungal pathogens and moulds namely *Chaetomium*, *Mycogone*, *Cladobotryum*, *Sepedonium*, *Papulaspora*, *Trichoderma*, *Verticillium* and *Fusarium* were subjected to Restriction Fragment Length Polymorphism by using eight restriction enzymes namely Eco R-1, Bgl II, Alu 1, Msp 1, Hinf 1 Bsu R1 Bam H1 and Taq in order to identify some restriction enzymes for quick detection of virulent pathogens. Analysis work is in progress.

2.3 Extracellular enzyme profile of *Diehliomyces*, *Chaetomium* and *Verticillium* species associated with mushrooms

Extracellular enzyme profile of *Diehliomyces* and *Verticillium fungicola* revealed that both have the highest activity of laccase, followed by β-glucosidase, pectinase, xylanase C-1 cellulase and Cx cellulase. Similarly, *Chaetomium* showed the maximum activity of xylanase, followed by β-glucosidase, and C-1 cellulase.

3. NCM-41: Etiology, molecular characterization and management of bacterial diseases of mushrooms (PI: Dr. V.P. Sharma)

3.1 Molecular characterization of various bacterial isolates associated with mushrooms

Molecular characterization of 14 isolates (Fig.4) of bacteria collected from different mushrooms from different mushroom units was undertaken by ITS sequencing of 16S r RNA gene. Phylogenetic analysis of 14

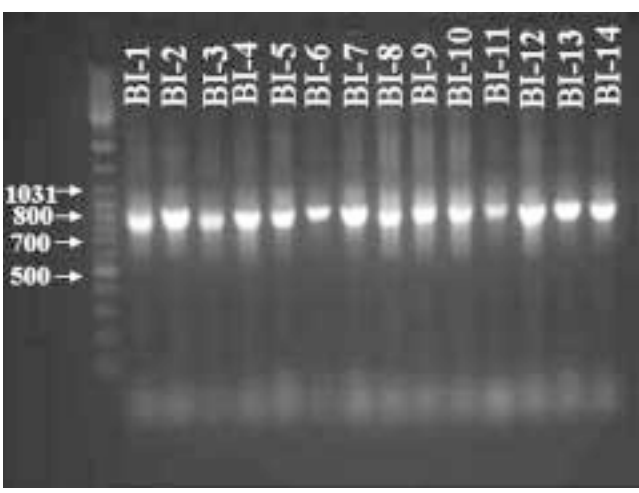


Fig. 4. ITS profile of 14 bacterial isolates

bacterial isolates using RAPD technique exhibited 7 phylogenetic groups. The ITS product has been submitted for DNA sequencing and after that the exact identification at molecular level will be established.

1. Post harvest technology of mushrooms

Project-NCM-35: Modified atmosphere packaging and storage of mushrooms (PI: Er. T. Arumuganathan)

1.1 MAP studies on button mushroom under refrigerated condition

Experiments were conducted on the modified atmospheric packaging (MAP) of button mushroom in PET containers under refrigerated condition (Fig. 1). The variation in the gas composition was measured using the CO_2/O_2 meter. The various quality analysis conducted for the stored button mushrooms were weight loss, gill opening, enzymatic browning, non-enzymatic browning, protein, protease, phenols, poly phenol oxidase, total sugars, vitamin C and free amino acids. Diffusion channel method was found to be the best method of storage to prolong the shelf life of button mushrooms up to 12 days under refrigerated condition.

Storage containers provided with 3 mm diameter and 15 cm length diffusion channel were found to be highly suitable for the purpose.

Fig. 1. Button mushrooms stored with diffusion chambers at refrigerated condition in PHT Laboratory

5. RECYCLING OF SPENT MUSHROOM SUBSTRATE

Spent mushroom substrate (SMS) is an organic waste released from mushroom farms after harvesting of full crop of mushrooms.

1. Recycling of button mushroom SMS as manure for field crops

The button mushroom SMS was decomposed by natural, aerobic and anaerobic methods of recomposting and was used as manure for different vegetables crops namely, ginger, onion and brinjal.

In case of ginger, 18 months old SMS recomposted by different methods was used for cultivation. The results revealed that anaerobically fermented SMS along with recommended dose of chemical fertilizers gave higher plant height among different SMS treatments and the effect was at par with recommended dose of fertilizers, while it was minimum in control. Higher emergence of stems/rhizome was observed in aerobic SMS treatment along with chemical fertilizers. However, germination percentage of rhizomes and number of leaves/stem were observed higher in anaerobic SMS treatment along with fertilizers. Yield/unit area was also recorded higher in anaerobically fermented SMS along with fertilizers along with better physical quality attributes which were at par with standard dose and aerobic SMS treatment + chemical fertilizers (Table- 1)

Table 1. Effect of SMS recomposted by different methods on vegetative growth, yield and quality of ginger (*Zingiber officinale*)

Treatment	Vegetative growth attributes				Yield q/ha	Physical quality parameters of fresh rhizome		
	Plant height (cm)	No. of stems emerged/ rhizome	Germination (%)	No. of leaves/stem		Length (cm)	Breadth (cm)	Thickness (cm)
FYM	58.57	3.21	76	13	120.9	8.5	4.0	2.8
Standard dose	81.4	3.35	82.68	17	151.11	10.5	5.0	3.2
NW SMS-18	56.3	3.17	65.50	14	110.55	8.0	3.9	2.6
NW SMS-18 + Chem Fert	70.67	3.56	70.68	15	117.78	9.60	4.5	3.0
AnF SMS -18	54.25	3.24	68.0	16	119.40	8.35	4.0	2.8
AnF SMS -18 + Chem Fert	78.50	3.55	80.0	17	144.44	10.20	5.15	3.1
AeF SMS -18	60.40	3.20	66.75	16	112.90	8.30	4.1	2.9
AeF SMS -18 + Chem Fert	77.33	3.64	77.32	16	128.00	10.35	4.9	3.0
Mean	67.18	3.37	73.37	13.33	125.64	9.23	4.44	2.93
SE	2.98	0.05	1.76	1.43	3.99	0.28	0.14	0.05
CD(0.05)	6.59	0.11	3.86	3.15	8.77	0.62	0.30	0.11

NW-Naturally weathered, AnF-Anaerobically fermented, AeF-Aerobically fermented, SMS-Spent mushroom substrate, FYM-Farm Yard Manure

Quality parameters of rhizome showed higher dry matter in anaerobically fermented SMS treatment + chemical fertilizers and minimum in FYM. TSS of fresh rhizome among different treatments varied from 5.0 to 6.0 °Brix, with maximum in anaerobic SMS + fertilizers, which was at par with recommended dose of fertilizers. This treatment also contributed towards lower fibre content and higher non soluble solids (NSS) in fresh rhizome which are considered as the best attributes for processing purpose.

Onion (*Allium cepa* L.) cultivation was carried out with 8 different treatments constituting of FYM, recommended dose of fertilizers, 18 months old SMS recomposted by following the natural, aerobic and anaerobic methods of recomposting and combination of SMS recomposted by different methods with recommended dose of chemical fertilizers. Plant height, number of leaves/plant, length of bulb, diameter of bulb were superior in anaerobically, aerobically recomposted SMS in combination with recommended dose of chemical fertilizer and standard dose of fertilizers. The gross yield/m^2 was statistically at par in anaerobically recomposted SMS + chemical fertilizers, aerobically recomposted SMS + chemical fertilizers, naturally weathered recomposted SMS + chemical fertilizers and standard fertilizers treatment. The net yield was highest in anaerobically recomposted SMS + chemical fertilizers and naturally weathered recomposted SMS + chemical fertilizers treatments (Table- 2).

The quality parameters viz., Total soluble solids, dry matter (%), pyruvic acid and ascorbic acid contents were also analysed in fruits obtained from different treatments. Almost all quality parameters were higher in combined treatment of chemical fertilizers with anaerobically, aerobically and naturally recomposted SMS treatments along with standard dose of fertilizer treatment (Table -3).

Brinjal (*Solanum melongena*) cultivation was undertaken with 9 different treatments constituting of absolute control, standard fer-

Table 2. Effect of SMS recomposed by different methods on growth and yield parameters of onion (*Allium cepa* L.)

Treatment	Plant height (cm)	No of leaves/ plant	Length of bulb (cm)	Diameter of bulb (cm)	Gross Yield/ m^2 (kg)	Net Yield of bulb/m^2 (kg)
FYM	36.21	6.0	3.23	3.75	1.48	0.98
St. Dose	38.42	8.0	4.35	5.11	2.06	1.19
NW SMS	36.16	6.5	3.15	3.80	1.62	0.98
NW SMS + Fert.	37.75	7.0	3.05	4.90	2.09	1.33
Ae SMS	36.50	6.0	3.12	3.85	1.73	1.07
Ae SMS+ Fert.	38.12	7.5	4.40	5.00	2.00	1.11
An SMS	37.26	6.4	3.50	4.20	1.62	1.09
An SMS+ Fert.	38.49	7.8	4.30	5.55	2.22	1.51
Mean	37.36	6.9	3.64	4.52	1.85	1.16
$CD_{0.05}$	0.67	0.54	0.41	0.48	0.19	0.12

NW-Naturally weathered, AnF-Anaerobically fermented, AeF-Aerobically fermented, SMS-Spent mushroom substrate, FYM-Farm Yard Manure

Table 3. Effect of SMS recomposed by different methods on quality parameters of onion bulb (*Allium cepa* L.)

Treatment	TSS (°Brix)	Dry matter (%)	Pyruvic acid (%)	Ascorbic acid (mg/100 g)
FYM	12.0	15.03	0.410	26.75
St. Dose	12.0	16.72	0.418	29.50
NW SMS	12.1	15.50	0.409	25.20
NW SMS + Fert.	11.8	16.00	0.412	27.40
Ae SMS	12.0	15.60	0.410	26.60
Ae SMS+ Fert.	11.5	14.70	0.412	28.10
An SMS	12.2	15.40	0.411	27.40
An SMS+ Fert.	12.3	17.46	0.416	29.45
Mean	11.99	16.05	0.410	27.55
$CD_{0.05}$	0.17	0.57	0.002	0.99

NW-Naturally weathered, AnF-Anaerobically fermented, AeF-Aerobically fermented, SMS-Spent mushroom substrate, FYM-Farm Yard Manure

tilizer, FYM, and 12 & 24 months old SMS recomposted by following the natural, aerobic and anaerobic methods of recomposting. The 24 months old aerobically recomposted SMS gave highest number of fruits/plot followed by control; while highest yield was obtained from standard fertilizer treatment followed by 24 and 12 months old anaerobically/aerobically recomposted SMS, respectively. Fruit weight was also superior in standard fertilizer and 24 months old anaerobically recomposted SMS. Out of different SMS treatments the 12 & 24 months old aerobically and anaerobically recomposted SMS gave superior results than FYM alone (Table -4).

Table 4. Effect of SMS recomposed by different methods on yield and fruit weight of brinjal (*Solanum melongena*)

Treatment	No. of Fruits / plot	Yield / plot (g)	Fruit weight (g)
Standard dose	105.66	6141.25	77.49
FYM	100.00	5325.00	53.25
Aerobic SMS (12 months old)	104.66	5451.66	52.08
Anaerobic SMS (12 months old)	93.33	4685.00	50.20
Natural SMS (12 months old)	86.00	4383.33	50.97
Aerobic SMS (24 months old)	111.0	5161.66	46.50
Anaerobic SMS (24 months old)	103.00	5656.66	54.92
Natural SMS (24 months old)	83.0	4456.66	53.48
Control	107.66	5003.33	46.47

2. Bioremediation of Insecticides through SMS

In addition to being a rich nutrient source for various field crops, spent mushroom substrate originated from different edible mushrooms have unique physico-chemical and biological properties, which make SMS an ideal bioremediative agent for various environmental protection activities. Lignolytic enzymes activities of SMS of different mushrooms and the microbes thriving well on spent mushroom substrates were investigated with an aim to test their suitability in bioremediation of different chemicals.

2.1 Lignolytic activities of SMS of different mushrooms

The oyster mushroom spent substrate mixed with nitrogen rich supplement such as cotton waste exhibited highest activity of laccase followed by SMS obtained from hybrid strain of oyster mushroom. In button mushroom SMS the compost prepared by unidentified actinomycetes exhibited highest activity of laccase (Fig. 1). However, for manganese peroxidase, the SMSs obtained from cotton waste supplemented substrate and button mushroom compost prepared by thermophilic bacteria exhibited highest activity (Fig. 2).

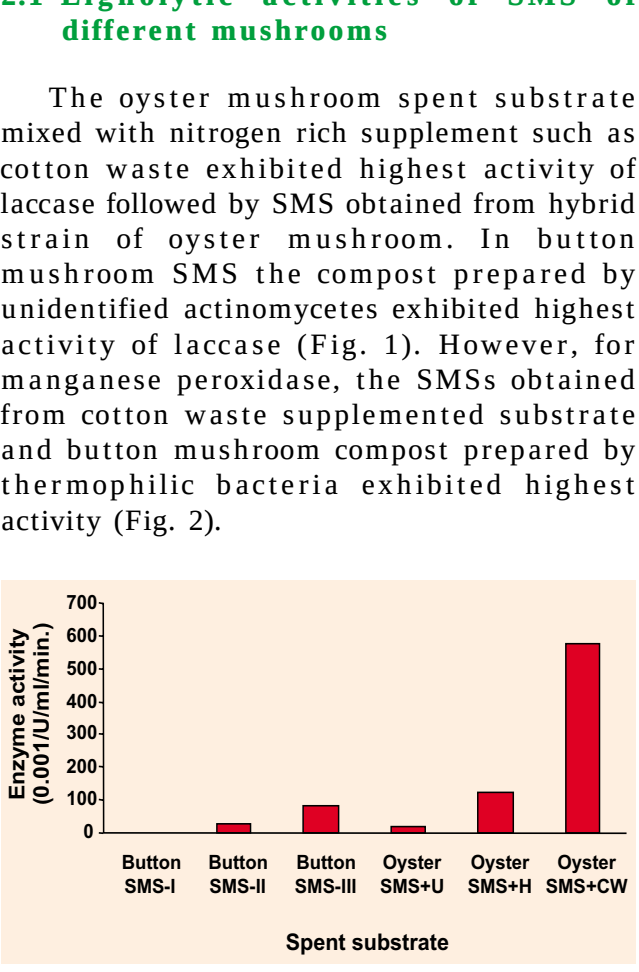


Fig. 1. Laccase activity in spent substrates samples of *A. bisporus* and *Pleurotus* sp.

2.2 Lignolytic activities of SMS associated microbes

The spent mushroom substrate from oyster (*Pleurotus* spp.) and button (*Agaricus bisporus*) mushrooms were used for isolation of distinctly different fungi and bacteria. Two fungi and 2 bacteria from button mushroom spent substrate, while 4 fungi and 6 bacteria from oyster mushroom spent substrate were used in the study. Out of 6 fungi, the fungus isolated from button mushroom spent substrate was found to possess highest level of lignin peroxidase and manganese peroxidase activities, respectively. However, arylalcohol oxidase and laccase activities were higher in fungi isolated from oyster mushroom spent substrate (Fig. 3).

Among 8 bacteria analysed for various enzymes activities, highest activity of laccase, manganese peroxidase and lignin peroxidase were recorded among bacteria isolated from spent oyster mushroom substrate, while activity of aryl alcohol oxidase was recorded highest in isolates from spent button mushroom substrate (Fig. 4). Lignin peroxidase activity was recorded in only one bacterial isolate, out of 8 isolates evaluated; however, it was in two fungi out of 6 fungi evaluated. Laccase, aryl alcohol oxidase and manganese peroxidase enzymes activities were more

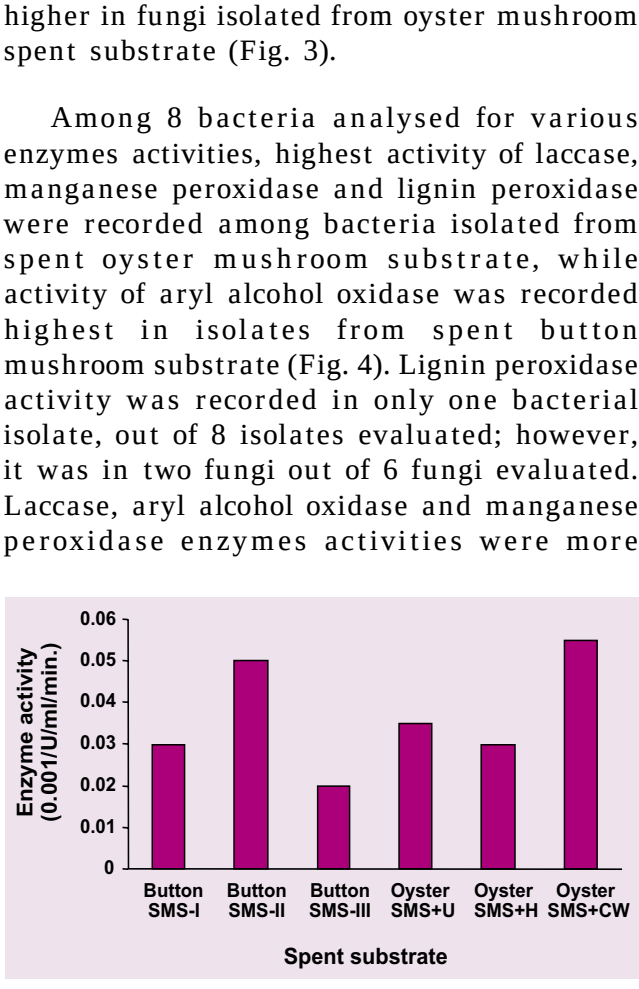


Fig. 2. Manganese peroxidase activity in spent substrates samples of *A. bisporus* and *Pleurotus* sp.

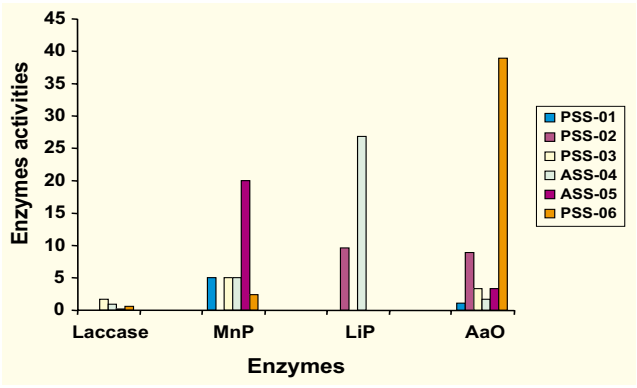


Fig. 3. Ligninolytic enzymes activities profile of fungi isolated from spent substrates of *A. bisporus* and *Pleurotus* sp.

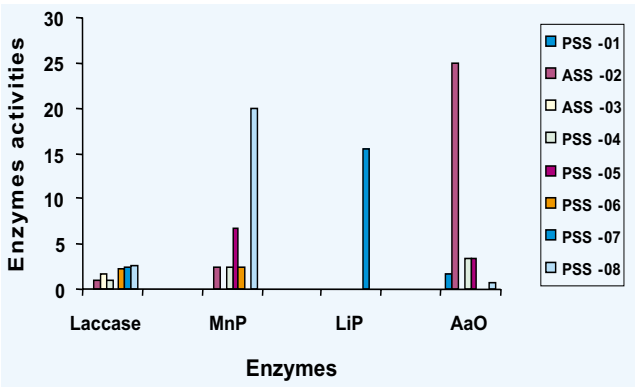


Fig. 4. Ligninolytic enzymes activities profile of bacteria isolated from spent substrates of *A. bisporus* and *Pleurotus* sp.

common in spent mushroom substrate microbes than other two enzymes.

2.3 Bioremediation of insecticides with SMS

Figures 5 and 6 depict the degradation of 2 insecticides mixed @ 100mg/g of soil along with three different proportions of SMS (10, 20 & 30%). The degradation was monitored at regular intervals for 6 months duration under *in situ* conditions. The degradation of insecticides (Malathion and Deltamethrin) was maximum in 30% SMS amended soil and the concentration of insecticides reduced to just half of its initial concentration after one month duration. In case of Malathion, the residue level decreased to 55.35mg/g of soil with in one month of SMS mixing and to 1.14mg/g of soil in six months time. However, in Decis (deltamethrin), the degradation was much faster and it was not detectable after 5 months of SMS mixing. Almost similar trend was recorded in 20% SMS treatment and the results were at par with 30% SMS treatment. In control treatment, degradation of different insecticides was slow and was far less as compared to SMS incorporated soil.

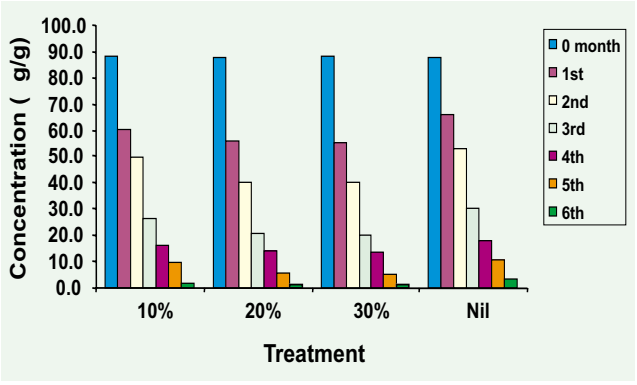


Fig. 5. Effect of SMS mixed in different proportions in soil on bioremediation of Malathion during tomato cultivation under *in-situ* conditions

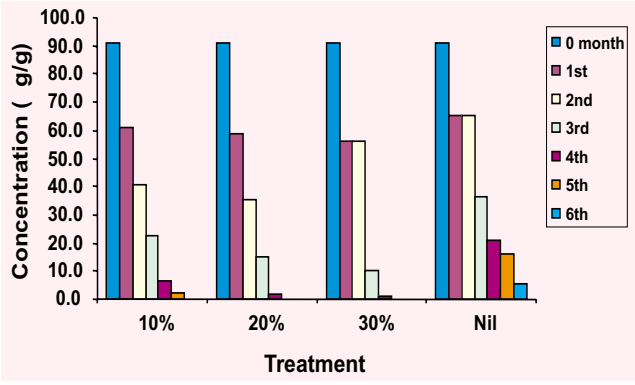


Fig. 6. Effect of SMS mixed in different proportions in soil on bioremediation of Decis during tomato cultivation under *in-situ* conditions

3. Textiles dyes decolourization potential of Spent Mushroom Substrate

3.1 Crude enzyme extract

The crude enzyme extracts obtained from spent button and oyster mushroom substrates were mixed with solutions of different dyes prepared in phosphate buffer of 4.0 pH in ratio of 1: 10 and 1:20. In 8 dyes used in the study, highest decolorization with extract from spent button mushroom substrate was recorded on the 10th day of study, while in oyster mushroom extract highest decolourization was on 2nd and 4th day of extract mixing. Highest decolorization was recorded with crude enzyme study than the other two other components of spent substrate viz. mixed microflora and the mushroom mycelia.

3.2 Mushroom mycelia

On growing button and oyster mushroom mycelia in the presence of various dyes in malt extract broth; highest decolorization was recorded on the 10th day of inoculation in with button mushroom mycelia, while it was from 15th to 18th days of inoculation with oyster mushroom mycelia. The overall decolorization at different intervals of investigation was far lower than in crude enzyme extract mixed study and it was about 50 to 75% to that in the crude enzyme extract study.

3.3 Mixed culture from spent substrate

The mixed microbial culture from spent substrates of button and oyster mushrooms were inoculated in malt extract broth containing different dyes. Highest dyes decolorization was recorded from 2nd to 5th day of incubation with button mushroom spent substrate mixed microbial inoculant. However, with oyster mushroom spent substrate mixed microbial inoculant highest decolorization in the range of 65% to 94.6% was recorded in different dyes from 3rd to 5th day of incubation. The dominant microbes in mixed microflora from button mushroom spent substrate during decolorization were recorded as bacteria, which multiplied at faster rate than fungi. The long lasting effect on decolorization of various dyes was recorded in mixed culture and mushroom mycelia inoculation studies than in crude enzyme extract study.

3.4 Mushroom mycelial growth in presence of dyes and their adsorption on mycelia

The button mushroom mycelia was resistant against 7 dyes, while oyster mushroom mycelia against 5 dyes. In comparison to button mushroom, higher mycelial biomass of about 4 to 9 fold was recorded in oyster mushroom. The per unit weight dye adsorption/entrapment potential was 2 to 40 times higher in button mushroom mycelia than in oyster mushroom mycelia (Table-5). The study revealed much higher resistance in button mushroom against various dyes, however, the slow growth rate of button mushroom might have contributed towards lower mycelial biomass and higher adsorption potential.

Table 5. Effect of different dyes on the growth of *Agaricus bisporus* and *Pleurotus* spp and dye adsorption on mycelial surface

Textile dye	*A. bisporus* mycelial growth (visual)	Mycelial dry weight (mg)		Dye adsorption in µg/g dry wt. of mycelium	
		A. bisporus	*Pleurotus* spp	*A. bisporus*	*Pleurotus* spp
Black Grey	++++	106.5	656.0	4610.27	2232.25
Brown	+++	97.5	819.0	4603.85	118.88
Orange Yellow	++++	118.0	-	3790.23	-
Navy Blue	++++	131.3	-	1071.46	-
Carbon Black	+++	83.0	792.0	1612.60	45.88
Blood Red	++++	116.0	437.0	1876.60	487.88
light Green	++++	129.5	912.0	1522.39	165.43
Cherry Red	+	—	-	—	-

6. DEVELOPMENT OF INDIGENOUS MACHINERY

Project: -ICAR -: Network project on development of Indigenous machinery for spawn and mushroom production (PI: Dr. R.P.Tewari)

1. Development of Compost conveyor

A compost conveyor has been designed to carry compost to the bunker or elsewhere saving the labour and time. The conveyor (Fig.1) is 18' length and 2' width and is carried on four wheels of 8" dia out of which two front wheels are caster wheels to facilitate easy turning. The conveyor belt is housed in 1 ½" MS angle frame driven by 2 HP motor with variable speed pulley and belt mechanism on to 8" roller drums of 2'6" width. The compost conveyor is legged by four MS pipes 3" dia with height and elevation adjusting mechanism. MS angle 1 ½" pieces are fixed on conveyor belt width wise at a distance of 12" to facilitate efficient picking of compost. There is end stopper at the picking side of conveyor to increase the compost carrying efficiency. The developed compost conveyor can carry the compost from the yard to the tunnels and bunkers at the rate of 5 tonnes/h. The height may be adjusted as per the requirement from 6 feet to 10 feet.

The multi purpose substrate-mixing drum has been designed and fabricated in the Centre. The machinery was found suitable for pre wetting of various ingredients of *Agaricus bisporus* compost, without wastage of water in less time and labour consumption. This machine can be used for mixing of ingredients for mixing the substrate for shiitake and *Ganoderma* mushrooms. Various important operations of mushroom industries such as mixing of substrates, spawning, mixing of casing materials etc. can also be achieved through this equipment

The batch type substrate mixer is designed for manually operations. The mixer consists (Fig.2) of a base frame having MS C-channel 75x 40 x 4 mm to accommodate 800 mm dia GI Drum so that the height of the feeding window (470 x 470 mm) is around 600 mm from the ground which is very much comfortable for the worker to feed the substrate raw material. The feeding window is of sliding type to ease the operation. The drum is mounted on 2 nos. block bearings (25 mm) with integral welded bond with the center shaft. The center shaft having 16 numbers spokes spaced spirally on the shaft at 60 mm, 90 mm & 120 mm distance to evenly mix the substrate. The handle is shaped such as to minimize the torque and subsequently the manual effort to turn the drum.

Fig. 1. Compost conveyor

Fig. 2. Substrate mixing drum

NCM-25-: Studies on development of evaporatively cooled mushroom growing room and low cost mechanization for mushroom industry

2. Fabrication of Mushroom Stipe Cutting machine

A machine (Fig. 3, 4) was developed at the workshop of this centre to trim the mushroom stipe. This portable type machine consists of a continuous rotating blade, stem discharge tray and a synchronize motor. The mushroom which need to be trimmed should be kept in the trimming zone and the stem will be cut once the rotating sharp blade comes in contact with the mushroom fruit body.

Freshly harvested button mushroom was used for the study and it was found that the stem could be effectively cut for the varying height of 6.9 to 8.6 mm with an average value of 7.7 mm.

Fig. 3. Front view of mushroom stipe cutting machine

Fig. 4. Close view of mushroom stipe cutting machine during working

Project-NCM-30:Collection, Documentation and Validation of Indigenous Technical Knowledge about Mushrooms Cultivation (PI: Dr. M.P.Sagar)

1. Verification of indigenous technical knowledge

To verify and refine ITK about use of burnt rice husk mixed with F.Y.M. & soil in different ratio as casing material in button mushroom by mushroom growers, large scale trial was laid out at the Centre. The burnt rice husk based different casing formulations namely burnt rice husk+soil(1:1v/v), burnt rice husk+soil+FYM(1:1:1v/v), burnt rice husk+FYM(2:1v/v), burnt rice husk+FYM(1:2 v/v), burnt rice husk+FYM(1:1 v/v), coir pith + FYM+ burnt rice husk (2:1:2 v/v) , burnt rice husk+vermicompost of spent compost(1:1 v/v), and three control treatments-FYM+coir pith (4:6 v/v) leached & chemically treated, FYM+coir pith (4:6 v/v) unleached & chemically treated, and FYM+coir pith (4:6 v/v) leached & pasteurized were applied on spawn run compost and required conditions were maintained in the cropping room. BRH+Vermicompost of spent compost in 1:1 ratio has been added as alternate to refine the formulations. All the combination are yielding mushrooms but time of first harvest (fruiting) is varying .

Few new ITKs - traditional outdoor methods of paddy straw mushroom cultivation, soaking of harvested paddy straw mushroom in water, and under stacking aeration system during phase-I of composting were investigated and explained below.

In Orissa , farmers grow paddy straw mushroom in backyard in orchard using traditional bed cultivation on raised platform. Beds are covered by polythene sheet to maintain moisture in the bed. The harvested paddy straw mushroom packed in gunny bags is soaked in water during night and sent to market early in the morning. This practice is very much common amongst the growers in Orissa. The purpose of this practice is to enhance self life of produce as this mushroom's keeping quality is very poor.

A progressive mushroom grower of Solan district has developed indigenously under stacking aeration system in the compost pile during phase-I . He prepares 40-50 tons of compost at a time. In order to maintain proper aeration in the compost pile during phase-I, he has fitted perforated plastic pipes (3“ dia.) widthwise in the cemented floor of compost yard at around two feet interval. The outer ends of the pipes are closed and inner ends of these pipes are connected to a pipe of one feet diameter, that is fitted longitudinally and across the pipes at the one side of compost yard. The big pipe is also closed at outer end, and inner end is connected with a blower. This system inserts air forcefully in the compost pile from bottom to top and develops aerobic conditions for growth of micro organism in the compost. Generally, one perforated pipe is fitted in the cemented platform longitudinally, on which stacking of compost material is done keeping it middle. The device fulfils requirement of bunker system.

2. Use of Paddy straw Mushroom Spent Substrate for Vermicomposting

In order to have premilary information about preparation of vermicompost out of paddy straw mushroom spent compost, trial was laid out at the Centre during the year in kutcha tank. Tank method of vermicomposting was adopted for conducting the experiment. It was observed that paddy straw mushroom spent substrate couldbe converted into vermicompost in two months. The period of

conversion depends upon population of earthworms and optimum temperature during the process.

3. Transfer of Technology

3.1 Training Programmes Conducted

During the year under report, the Centre has organised a total number of 8 on & off-campus training programmes for farmers, farmwomen, entrepreneurs & reseachers.

Fig.1. Practical demonstration of mushroom cultivation during mushroom training

Fig.2. Trainees learning preparation of mushroom pickles

3.2 Mushroom Mela-2007

One day Mushroom Mela was organised on 10th September, 2007 as regular activity of the Centre. It was inaugurated by Dr. Jagmohan Singh, Vice Chancellor Dr. Y.S. Parmar University of Hort. And Forestry, Solan(H.P.) It was attended by about 450 farmers, farm women, mushroom growers, researchers, extension workers and businessmen from various States viz; Himachal Pradesh, Haryana, Punjab, Uttar Pradesh, Maharashtra, M.P.,Bihar, Delhi, Uttrakhand,Gujrat and Tamil Nadu.

Fig.3. Dr Jagmohan Singh Hon'ble Vice Chancellor UHF, Nauni addressing participants during mushroom mela

Fig. 4. Dr Jagmohan Singh Hon'ble Vice Chancellor UHF, Nauni visiting the exhibition stalls during mushroom mela

Fig. 5. Dr Jagmohan Singh Hon'ble Vice Chancellor UHF, Nauni releasing technical bulletins during mushroom mela

Fig.6. Dr R.C. Upadhyay giving demonstration of cultivation technology of various mushrooms

An exhibition on improved mushroom cultivation technologies and other related aspect was organised in which 10 Govt. Organisation, ICAR Institutes/University, Govt. financial organisation, compost and spawn producers, mushroom product manufacturer, seed and pesticides and chemicals producers and NGOs displayed their valuable information/technologies/products and provided their services to the participants of Mushroom Mela.

In order to create awareness to the participants with various improved technologies/practices of mushroom cultivation, farm visit of the Centre,s growing unit was conducted and demonstrations on improved technologies were given in front of participants of Mushroom Mela.

A Kisan Goshthi was also held during Mushroom Mela to answer the problems in mushroom cultivation faced by mushroom growers. The problems raised by farmers and mushroom growers were replied by experts.

During the Mushroom Mela, the Centre honoured four progressive mushroom growers -Sardar Harpal R/O village Bhour sainda, Kurkshetra (Haryana), Smt. Asha Kiran Gupta, R/O Kurkshetra (Haryana), Subedar Seva Singh R/O village Dehriwal, Amritsar (Punjab) and Sh. Ratan Thakur R/O Chambaghat, Solan (Himachal Pradesh) for adopting innovative practices in mushroom cultivation on larger scale and mobilizing other farmers to adopt mushroom cultivation as source of income.

Fig.7. Smt. Asha Kiran Gupta being felicitated as progressive farmer during mushroom mela

3.3 Participation in national/state level exhibitions

In order to create awareness about mushroom cultivation, the Centre has participated in national & state level exhibitions namely, "Regional Kisan Mela"

organised by IIVR Varansi from 3-5 Nov.,07 at Motihari(Bihar), "Horti Expo-2008" organized by ITPO , New Delhi, at Pragati Maidan from 31st Jan. to 2nd Feb, 2008, "Rashtriya Kisan Mela" organised by IIVR, Varansi from 9-10 Feb., 2008 and "Exhibition cum Kisan Mela" organised by CPRIC Modipuram,Meerut form 8-9 Feb., 2008

3.4 Teaching to farmers/entrepreneurs/ SMS

The Centre had conducted eight sponsored training programmes for farmers and entrepreneurs at the Centre. All the scientists delivered lectures on various aspects of mushrooms.

3.5 Preparation of extension literature and other publications

Two multicoloured folders-white button mushroom and oyster mushroom were got reprinted for distribution at various occasions.

3.6 Advisory service to farmers / Mushroom growers /businessman / unemployed youths

Advisory services through postal extension letters on various aspects of mushroom cultivation, training and marketing were also provided. Queries on mushroom cultivation and training were also replied through telephone and e-mail.

8. TRAINING COURSES ORGANISED

S. No.	Name of training programme	Sponsored by	No. of Trainees	Course Director/ Course Coordinator
1.	Ten days National training programme on mushroom production technology for Entrepreneurs w.e.f. 19th to 28th April, 2007	Paid training programme of the Centre	33	Dr. R.P.Tewari Dr.M.C.Yadav
2.	Seven days training on mushroom production for farmers sponsored by Mid Himalayan Watershed Dev. Project, Solan(H.P.) w.e.f. 3rd to 9th May, 2007.	MI-WDP, Solan	25	Dr. S.R.Sharma Dr. Satish Kumar
3.	Seven days training on mushroom production for farm women sponsored by CDP, Solan(H.P.) w.e.f. 15th to 21st May, 2007.	CDPO, Solan	35	Dr. B.Vijay Sh. Yugesh Gautum
4.	Seven days training on mushroom production for farmers sponsored by DRDA, Chamba (H.P.) w.e.f. 7th to 13th June, 2007.	DRDA, Chamba	40	Dr. B.L.Dhar Dr. M.P. Sagar
5.	Seven days training on mushroom production for farmers and unemployed youths w.e.f. 20 to 26th June, 2007.	NRCM, Solan	45	Dr R.P.Tewari Dr. M.P.Sagar
6.	Seven days training programme on mushroom production technology for Farmers and unemployed youths w.e.f. 19th to 25h Sept, 2007.	NRCM,Solan	83	Dr. B.Vijay Sh. Sunil Verma
7.	Seven days training on mushroom production for farmers sponsored by DRDA, Chamba(H.P.) w.e.f. 4th to 10th Oct, 2007.	DRDA,Chamba(HP)		Dr.R.C.Upadhyay Dr. S.K. Singh
8.	Seven days training on mushroom production for Associate scientists and RAs of NAIP Sponsored by VPKAS, Almora (UK) w.e.f. 27th March to 2nd April, 2008.	VPKAS,Almora	6	Dr. M.P.Sagar

9. EDUCATION AND TRAINING

Training of Scientists

1. Er. T.Arumuganathan attended 6 days Training Programme on "Developing Winning Research Proposals in Agricultural Research" organized under National Agricultural Innovation Project (NAIP) held at National Academy of Agricultural Research Management, Hyderabad from 24 to 29th March, 2008.

2. Er. T.Arumuganathan submitted a thesis entitled "Studies on processing of compost for button mushroom production and storage of fresh button mushroom (*Agaricus bisporus*)" to Tamil Nadu Agricultural University, Coimbatore and completed his Ph. D degree (Agricultural Processing).

1. Summer Training of scientist/ Students

TEACHING

1. Dr. Alka Karwa, PI, DST Project, Biotechnology Department, Amravati University, Amravati (Maharashtra), undergone one month training on "Molecular Biology of Mushrooms" under the guidance of Dr. M.C.Yadav.

2. Ms Kumud, M.Sc (Biotechnology), G.I.C.T.S., Gwalior (M.P.) completed her Project "Molecular and biochemical studies on wet bubble (*Mycogone perniciosa*.)" under the guidance of Dr. V.P. Sharma.

3. Ms Rinki Gosain, M.Sc (Biotechnology), Chaudhary Charan Singh, Meerut (U.P.) completed her Project "Molecular and biochemical studies on yellow mould (*Sepedonium* spp.)" under the guidance of Dr. V.P. Sharma.

4. Mr Arun Kumar, M.Sc (Biotechnology), Chankya Vishwavidyalaya, Bhopal (M.P.) completed his summer training on "Physiological and Molecular studies on false truffle" under the guidance of Dr. V.P. Sharma.

5. Ms Arti Sharma, M.Sc (Biotechnology), Shooling institute of Life Sciences and Buisness Management, Solan completed her Project "Molecular and biochemical studies on cobweb disease (*Cladobotryum* spp.)" under the guidance of Dr. V.P. Sharma.

6. Ms Kajal Banyal, M.Sc (Biotechnology), Shooling institute of Life Sciences and Buisness Management, Solan completed her Project "Physiological and Molecular studies on yellow mould fungi" under the guidance of Dr. V.P. Sharma.

7. Ms Sakshi Sharma, M.Sc (Biotechnology), Shooling institute of Life Sciences and Buisness Management, Solan completed her Project "Physiological and Molecular studies on *Fusarium* disease associated with button mushroom" under the guidance of Dr. V.P. Sharma.

8. Miss. Shikha Sharma, M.Sc. (Final year) student of Department of Biotechnology, Uttaranchal College of Science and Technology, HNB Garhwal University, Dehradun, has completed her three months Dissertation Project on "RAPD markers as a tool for assessment of strainal variation in button mushroom *Agaricus bisporus*" under the guidance of Dr. M.C.Yadav.

9. Miss. Bhumika Mahajan, M.Sc. (Final year) student of Department of Microbiology, Uttaranchal College of Science and Technology, HNB Garhwal University, Dehradun, completed her three months Project Report on "Use of RAPD markers in DNA Fingerprinting of Edible fungus *Agaricus bisporus*" under the guidance of Dr. M.C.Yadav.

10. Miss. Neetika Gupta, M.Sc. (Final) student of Department of Biotechnology, Shoolini Institute of Life Sciences and Business Management, Solan, has completed her Training Project on "DNA techniques for mushroom genome analysis" under the guidance of Dr. M.C.Yadav.

11. Miss. Anita Sharma, M.Sc. (Final) student of Department of Biotechnology, Shoolini Institute of Life Sciences and Business Management, Solan, has completed her Training Project on "DNA techniques for mushroom genome analysis" under the guidance of Dr. M.C.Yadav.

12. Miss. Shailesh Tiwari, M.Sc. (Biotechnology) has completed her Training Project on "Molecular Markers for Genomic Analysis in Edible Mushrooms" under the guidance of Dr. M.C.Yadav.

10. AICMIP CENTRES

The All India Coordinated Mushroom Improvement Project (AICMIP) came into existence during VIth Five-Year Plan on 01.04.1983 with its Headquarters at National Research Centre for Mushroom, Solan (HP). The Director of NRC for Mushroom, Solan (HP) also functions as the Project Co-ordinator of the project. Initially the AICMIP started with six Centres at Punjab Agricultural University, Ludhiana (Punjab), G.B.Pant University of Agriculture and Technology, Pantnagar (UP), C.S. Azad University of Agriculture and Technology, Kanpur (UP), Bidhan Chandra Krishi Vishwa Vidyalaya, Kalyani (West Bengal), Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu) and Mahatma Phule Agricultural University, Pune (Maharashtra). At a later stage during VIIth Plan one new Centre at Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (MP) was added and two existing Centres at Kanpur (UP) and Kalyani (West Bengal) were dropped. However, three new Centres during VIIIth Five Year Plan and 3 Co-ordinating and one co-operating Centres during IXth Five Year Plan have been added to the existing list of Centres by dropping one at Goa. At present, 10 Co-ordinating and one co-operating Centres are working under AICMIP programme with its Headquarters at NRCM, Solan which are listed below:

- Punjab Agricultural University, Ludhiana (Punjab).
- Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu).
- G.B. Pant University of Agriculture and Technology, Pantnagar (Uttranchal)
- Mahatma Phule Agricultural University, Pune (Maharashtra).
- N.D.University of Agriculture and Technology, Faizabad (UP).
- Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (MP).
- Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan).
- Kerala Agricultural University, Thrissur (Kerala).
- ICAR Research Complex for NEH Region, Barapani (Meghalya).
- Horticulture and Agroforestry Research Programme (ICAR Research Complex for Eastern Region), Ranchi (Jharkhand).
- Dr.Y.S.Parmar University of Horticulture & Forestry, Nauni, Solan – Co-operating Centre.

11. PUBLICATIONS

A. Research Papers

1. Ahlawat, O.P., Sagar, M.P., Raj, Dev, Rani, Indu C., Gupta, Pardeep and Vijay, B. 2007. Effect of spent mushroom substrate on yield and quality of capsicum. *Indian Journal of Horticulture* **64 (4)**: 430-434.

2. Ahlawat, O.P., Sagar, M.P., Raj, Dev, Gupta, Pardeep and Vijay, B. 2007. Effect of recomposted button mushroom spent substrate on the yield of Wheat (*Triticum aestivum* L.). *Mushroom Research* **16 (1)**: 41-46.

3. Ahlawat, O.P., Gupta, Pardeep, Kamal, Shwet and Dhar, B.L. 2008. Development of molecular and biochemical markers for selecting a potential high yielding strain of paddy straw mushroom (*Volvariella volvacea*). *J. Pl. Biochem. Biotech*. **17 (1)**: 57-63.

4. Ahlawat, O.P., Raj, Dev, Sagar, M.P., Gupta, Pardeep, and Vijay, B. 2007. Effect of recomposted of button mushroom spent substrate on growth, yield and quality of Ginger (*Zingiber officinale*). *Indian Journal of Mushrooms* **XXIV**: 13-18.

5. Arumuganathan, T., Tewari, R.P., Kumar, Rajesh and Kamal, Shwet. 2007. Mechanisation in Indian mushroom industry – status and future perspectives. *Indian Journal of Mushrooms* **XXV**: 43-52.

6. Gayatri, Tondon and Sharma, V.P. 2007. Effect of growth regulators on the quality and productivity of *Calocybe indica*. *Indian Journal of Mushrooms* **XXV**:53-55.

7. Gayatri, Tondon , Sharma, V.P. and Suman, B.C. 2006. Role of temperature and light on the productivity of milky mushroom *Indian Journal of Mushrooms* **XXIV**: 10-12.

8. Kumar, Satish and Sharma, V.P. 2006. Slugs as new pest of shiitake, *Lentinula edodes*. *Mushroom Research* **15**: 159.

9. Mahfooz, S., Yadav, M.C., Kamal, S., Singh, S.K. and Prakash, A. 2007. Genetic variation in extracellular lignolytic enzymes and their effect on mushroom yield in single spore progenies of *Agaricus bisporus*. *Mushroom Research* **16** (**1**): 1-7.

10. Semwal, K.C., Tuloss, R.E., Bhatt, R.P., Stephanson, S.L. and Upadhyay, R.C. 2007.New records of *Amanita* section *Amanita* from Garhwal Himalaya, India. *Mycotaxon* **101**:331-348.

11. Semwal, K.C., Bhatt, R.P. and Upadhyay, R.C. 2007. New records of section *Phalloideae* of the genus *Amanita* from Garhwal Himalaya, India. *Mushroom Research* **16** (2) 61-67.

12. Sharma, V.P., Sharma, S.R and Kumar, Satish. 2008. Effect of various supplements on lignocellulolytic enzyme production and yield of culinary- medicinal mushroom *Flammulina velutipes* (w. Curt.: Fr.) Singer (agaricomycetidae). *International Journal of Medicinal Mushrooms* **10**: 87-92.

13. Yadav, M.C., Challen, M.P. , Singh, S.K. and Elliott, T.J. 2007. DNA analysis reveals genomic homogeneity and single nucleotide polymorphism in 5.8S ribosomal RNA gene spacer region among commercial cultivars of the button mushroom *Agaricus bisporus* in India. *Current Science* **93** (**10**): 1383-1389.

B. Books

1. Suman, B. C. and Sharma, V.P. 2007. *Mushroom Cultivation in India*. Daya Publishing House, Delhi (India) 179pp.

2. Rai, R.D., Singh, S.K., Yadav, M.C. and Tewari, R.P. 2007. *Mushroom Biology and Biotechnology* (Edited book), P. 388, Mushroom Society of India, Solan

C. Book Chapters

1. Ahlawat, O.P., Gupta, Pardeep and Kumar, S. 2007. Spent mushroom substrate – a tool for bioremediation. In: *Mushroom Biology and Biotechnology* (R.D. Rai, S.K. Singh, M.C. Yadav and R.P. Tewari, eds.), pp. 341-366, Mushroom Society of India, NRCM, Solan (HP), India.

2. Dhar, B.L. and Ahlawat, O.P. 2007. Organic farming of mushrooms – importance, status and technology. In: In: *Ibid*, pp. 149-165.

3. Kumar, Satish, Sharma, S.R. and Sharma, V. P. 2007.Biological control of insect-pests of Mushrooms. In: *Ibid*, pp 229-244

4. Kumar, Satish, Sharma, S.R. and Sharma, V. P. 2007. Studies on persistence of malathion on white button mushroom. In: *Ibid*, pp. 255-258

5. Rai, R.D., Singh, S.K. and Yadav, M.C. 2007. Biological diversity in the genus *Ganoderma*. In: *Ibid*, pp. 79-87.

6. Rai, R.D. and Arumuganathan, T. 2007. Value-addition in mushrooms. In: *Ibid*, pp. 265-291.

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8. Sharma, V.P., Sharma, S.R. and Kumar, Satish. 2007.Cultivation of least exploited commercial mushrooms. In: *Ibid*, pp. 167-192.

9. Singh, S.K., Yadav, M.C and Rai, R..D. 2007. Molecular characterization and cryopreservation of germplasm of edible mushrooms. In: *Ibid*, pp. 63-78.

10. Vijay, B., Mediratta, Vishal, Singh, S.K. 2007. Studies on thermophilic fungi of *Agaricus bisporus* compost – a review. In: *Ibid*, pp 127 –148.

11. Yadav, M.C., Singh, S.K. and. Rai, R.D. 2007. Mushroom genome-current status and implications for genetic improvement. In: *Ibid*), pp. 41-61.

D. Technical Bulletins

1. Ahlawat, O.P. and Tewari, R.P. 2007. Cultivation Technology of Paddy Straw Mushroom (*Volvariella volvacea*). National Research Centre for Mushroom, Solan (HP), India p. 36.

2. Ahlawat, O.P. and Sagar, M.P. 2007. Management of Spent Mushroom Substrate. National Research Centre for Mushroom, Solan (HP), India p. 48.

3. Ahlawat, O.P., Sagar, M.P. and Tewari, R.P. 2007. Puwal Mushroom (*Volvariella volvacea*) Utpadan. National Research Centre for Mushroom, Solan (HP), India p. 39.

4. Dhar, B.L,.Tewari, R.P. and Arumuganathan, T. 2007. *Vyavsaik button khumb farm ki sanrachna. Technical Bulletin* National Research Centre for Mushroom, Solan (HP), India. p. 27.

5. Sharma, S.R., Kumar, Satish and Sharma, V.P. 2007. *Diseases and Competitor Moulds of Mushrooms and their Management*. National Research Centre for Mushroom, Solan (HP), India p. 81.

E. Folders

1. Sharma, V.P., Sharma, S.R. and Kumar, Satish. 2007. Cultivation of winter mushroom (*Flammulina velutipes*). NRCM, Solan.

2. Sharma, V.P., Sharma, S.R. and Kumar, Satish. 2007.Cultivation of black poplar mushroom (*Agrocybe aegerita*). NRCM, Solan.

3. Kumar, Satish Sharma, V.P. and Sharma, S.R. 2007.Cultivation of shiitake

mushroom (*Lentinula edodes*). NRCM, Solan.

4. Kumar, Satish Sharma, S.R. and Sharma, V.P. 2007. *Shwet button khumb mein wet bubble (Mycogone) ka pravandhan*. NRCM, Solan.

5. Kumar, Satish Sharma, S.R. and Sharma, V.P. 2007. 2007. *Khumb ke keeron makoron aur sutarkriminon ka pravandhan*. NRCM, Solan.

F. Reports

1. Ahlawat, O.P. and Kumar, Satish. 2007. Compiled and edited AICMIP Annual Report 2006-07, NRCM, Solan (HP) P. 1-50.

2. Sharma, V.P., Kumar, Satish and Sagar, M.P. 2007. Compiled and edited NRCM Annual Report 2006-2007, pp. 89 + vi, NRCM, Solan.

3. Sharma, S.R., Rai, R.D., Yadav, , M.C. and Verma, Shailja. 2007. Compiled, revised and edited NRCM Perspective Plan: Vision-2025 p. 36+ i-viii.

4. Yadav, M.C., Singh, S.K. and Verma, Shailja. 2007. Compiled and edited *Mushroom Newsletter* Volume 12 (2): 1-8, July-December, 2006 and 13 (1): 1-8, January-June, 2007.

G. Popular/ Technical Articles

1. Ahlawat, O.P. 2007. Indoor Cultivation Technology for Paddy Straw Mushroom. www.nrcmushroom.org

2. Ahlawat, O.P. 2007. Recycling of Spent Mushroom Substrate to use as organic manure. www.nrcmushroom.org

3. Ahlawat, O.P., Kumar, Satish, Sharma, V.P. and Tewari, R.P. 2007. Production of paddy straw mushroom using paddy straw and cotton waste. ICAR News (October – December) 13 (4): 3.

4. Ahlawat, O.P., Kumar, Satish and Tewari, R.P. 2008. Dual-purpose spent mushroom substrate. ICAR News (January – March) 14 (1): 20.

5. Anandakumar, S., Kailappan, R. and Arumuganathan, T. 2007. Microorganisms for Production of Fermented Milk Products. *Beverage & Food World*. 34(8): 45-46.

6. Dhar, B.L., Gautam, Yogesh and Arumuganathan, T. 2007. Kumbh utpadan hethu bahu upyogi jhopadiyan. *Chathrak*. 4 & 5: 19-20.

7. Sharma, V.P., Sharma, S.R. and Kumar, Satish. 2007. *Auricularia Kumb ki Kheti*. *Chatrak* 4 & 5 : 29-30.

8. Sharma, V.P., Kumar, Satish and Sharma, S.R. 2007. *Kumb ke sutarkrimi avam unka prabandhan*. *Chatrak* 4 & 5: 31-33.

H. Abstracts

1. Yadav, M.C. 2007. DNA Markers in Crop Improvement. In: Summer School on "Recent Advances in Agricultural Sciences" at COA, CSAUAT, Kanpur, Uttar Pradesh.

2. Yadav, M.C. 2007. Mushroom Farming – A Harbinger of Prosperity and Health Food in Uttar Pradesh. In: *Ibid*.

3. Upadhyay, R.C., Ullrich , R., Deepika Kumari Tripathi, A. and Hofrichter , M. 2007. Ligninolytic oxidases and peroxidases enzymes from wild mushroom species Paper presented in the National conference on "Fungal Diversity:Impact and Exploitation", 5th and 6th Oct, 2007, Thapar university, Patiala.

12. ONGOING RESEARCH PROJECTS

Institute Code	Title	Researchers		Period/Remarks
On-going research projects of NRCM				
NCM-15	Survey, collection and identification of fleshy fungi	Dr. R.C. Upadhyay	Principal Investigator	Jan., 98 – continued
NCM-29	Genetic characterization of mushroom germplasm of NRCM, Gene Bank	Dr. M.C. Yadav Dr. R.C. Upadhyay Dr. S.K. Singh	Principal Investigator Co-Investigator Co-investigator	Aug.,2002 to July, 2007
NCM-37	Genetic manipulations for high yield and better quality in button mushroom (*Agaricus* species)	Dr. M.C. Yadav Dr. S.K. Singh	Principal Investigator Co-Investigator	Aug., 2006 to July, 2011
NCM-36	Genetic enhancement for higher yield and better quality in milky mushroom (*C.indica*)	Dr. M.C. Yadav Dr. S.K. Singh Dr. R.P. Tewari	Principal Investigator Co-Investigator Co-investigator	Aug., 2006 to July, 2010
NCM-33	Molecular characterization and genetic improvement in medicinal mushroom shiitake (*Lentinula edodes*)	Dr. S.K. Singh Dr. M.C. Yadav	Principal Investigator Co-Investigator	July, 2005 to June, 2009
NCM-16	Improved methods of composting for button mushroom	Dr. B. Vijay Dr. O.P. Ahlawat Dr. R.P. Tewari	Principal Investigator Co-Investigator Co-investigator	Sept.,1998 – continued
NCM-38	Improvement in cultivation of oyster and developing hybrid strains	Dr. R.C. Upadhyay Dr. R.P. Tewari	Principal Investigator Co-Investigator	Jan., 2007 to Dec., 2012
NCM-40	Integrative use of cultivation technologies and molecular techniques for enhancing yield and quality of paddy straw mushroom, *V. volvacea*	Dr. O.P. Ahlawat Dr. R.D. Rai Dr. V.P. Sharma Dr. Satish Kumar	Principal Investigator Co-Investigator Co-Investigator Co-investigator	Jan., 2007 to Dec., 2012
NCM-18	Standardization of cultivation technology of specialty mushrooms	Dr. S.R. Sharma Dr. V.P. Sharma Dr. Satish Kumar Dr. R.P. Tewari	Principal Investigator Co-Investigator Co-Investigator Co-investigator	Dec.,97 – continued
NCM-31	Organic mushroom production and quality produce	Dr. B.L. Dhar Dr. O.P. Ahlawat Dr. J.K. Dubey, Dr. Amit Nath	Principal Investigator Co-Investigator Co-Investigator Co-investigator	March, 2002 to March, 2007
NCM-34	Exploitation of indigenous microbes, plant products and pesticides for the management of pests and diseases associated with mushrooms	Dr. Satish Kumar Dr. S.R. Sharma Dr. V.P. Sharma	Principal Investigator Co-investigator Co-Investigator	July, 2006 to June, 2011

Institute Code	Title	Researchers		Period/Remarks
NCM-32	Molecular and physiological characterization of moulds associated with mushrooms	Dr. V.P. Sharma Dr. S.R. Sharma Dr. Satish Kumar Dr. S.K. Singh	Principal Investigator Co-investigator Co-investigator Co-Investigator	July, 2004 to June, 2009
NCM-35	Modified atmosphere packaging and storage of mushrooms	Er. T. Arumuga-nathan Dr. R.D. Rai	Principal Investigator Co-Investigator	Aug., 2006 to July, 2010
NCM-25.	Studies on development of evaporatively cooled mushroom growing rooms and low cost mechanization for mushroom industry	Er.T. Arumuga-nathan Dr. R.P. Tewari	Principal Investigator Co-Investigator	July, 1999 to July, 2007
NCM-39	Development of expert system for cultivation of different types of mushrooms	Dr. Y. Gautam	Principal Investigator	Jan., 2007- Dec., 2009
NCM-30	Collection, documentation and validation of indigenous technical knowledge about mushroom cultivation	Dr. M.P. Sagar Dr. B. Vijay	Principal Investigator Co-Investigator	Feb., 04 to July, 2007
NCM-41	Etiology, molecular characterization and management of the bacterial diseases of mushrooms	Dr. V.P. Sharma Dr. S.R. Sharma Dr. O.P. Ahlawat Dr. Satish Kumar	Principal Investigator Co-Investigator Co-Investigator Co-Investigator	Aug., 2007 to July, 2011

Externally Funded Projects

Title of the Project	PI/Co-PI of the Project	Duration	Funding Agency
Collection, identification and culturing of Agricoid and Polyphorid fungi from North Western Himalayas for new drug discovery	Dr. R.C. Upadhyay	July, 2004 to June, 2008	CSIR
Development of indigenous machinery for spawn and mushroom production	Dr. R.P. Tewari	Nov.,2004 to Nov., 2008	Network Project
Agrowaste management, bioremediation and microbes in post harvest processing	Dr. B. Vijay Dr. R.P. Tewari Dr. M.P. Sagar	Aug., 2006 to July, 2009	ICAR
Microbial diversity and identification	Dr. R.C. Upadhyay	Aug., 2006 to July, 2009	ICAR
Standardization of conditions for exploitation of spent mushroom substrate for decolourization of colouring dyes	Dr. O.P. Ahlawat	Nov., 2006 to Oct., 2009	DST

Consultancy Provided by the Scientists of NRCM

1. Sh. Bharat Bhushan, Director, Diamond Mushrooms Limited, C/o M/s. Dina Nath Commission Agents (P) Limited, Old Grain Market, Kotkapura-151204, Distt. Faridkot (Punjab) - Techno Economic Feasibility Report was prepared.
2. Sh. Inder Jeet Bhickta, Village Charoal, P.O. Pamog, Tehsil Kotkhai, Distt. Shimla(H.P.) - Techno Economic Feasibility Report was prepared.
3. Sh. Randeep Singh, Village Cheog, P.O. Patta Mahlog, Distt. Solan (HP) Techno Economic Feasibility Report was prepared.

13. COMMITTEE MEETINGS

(a) Institute Management Committee: One meeting of IMC were held on 28.12.2007

1.	Dr. R.P. Tewari, Director, National Research Centre for Mushroom, Chambaghat, Solan (H.P.) – 173213.	-	Chairman
2.	Dr. Umesh Srivastava, Assistant Director General (Hort.), Indian Council of Agricultural Research, Krishi Anusandhan Bhavan-II, PUSA, New Delhi – 110 012.	-	Member
3.	Director of Horticulture, Directorate of Horticulture, Shimla – 2, Himachal Pradesh	-	Member
4.	Director, Horticulture & Food Processing, Uttaranchal, Udyan Bhavan, Chaubatia, Ranikhet, Distt. Almora (Utaranchal)	-	Member
5.	Dr. D.K. Arora, Director, National Bureau of Agriculturally Important Microorganisms(NBAIM), Kusmaur, MAU Nath Banjan (U.P.).	-	Member
6.	Prof. & Head, Deptt. of Mycology & Plant Pathology, Dr. Y.S. Parmar University of Hort. & Forestry, Nauni, Solan (H.P.).	-	Member
7.	Sh. Chandrashekhar H. Bhadsavle, At: Malegon, Post Neral, Taluka Karjat, Distt. Raigarh, Maharashtra – 410 101.	-	Member
8.	Sh. Karma Gyasto Bhutia, Lachng House, Chandmari, T.V. Tower Road, Gangtok, East Sikkim – 737202.	-	Member
9.	Dr. S.R. Sharma, Principal Scientist, National Research Centre for Mushroom, Chambaghat, Solan (H.P.) – 173213.	-	Member

10.	Dr. R.C. Upadhyay, Principal Scientist, National Research Centre for Mushroom, Chambaghat, Solan (H.P.) – 173213.	-	Member
11.	Dr. S.K. Chakraborty, Principal Scientist, Central Potato Research Institute, Shimla (H.P.).	-	Member
12.	Finance & Accounts Officer, National Dairy Research Institute, Karnal (Haryana).	-	Member
13.	Sh. Raj Kumar, Administrative Officer, National Research Centre for Mushroom, Chambaghat, Solan (H.P.) – 173213.	-	Member Secretary
14.	Dr. B. Vijay, Principal Scientist, National Research Centre for Mushroom, Chambaghat, Solan (H.P.) – 173213.	-	Special Invitee
15.	Sh. Jiwan Lal, National Research Centre for Mushroom, Chambaghat, Solan (H.P.) – 173213.	-	Special Invitee

(b) Research Advisory committee: One meeting held on 7-8 June, 2007

1. Dr. T.N. Lakhanpal,
Ex-Dean & Head,
Deptt. of Biosciences,
H.P. University, Summer Hill,
Shimla – 171 005.

2. Dr. C.L. Jandaik,
Geeta Bhavan,
House No.142, Ward No.6,
Oak's Street, Solan – 173 213 (HP).

3. Dr. S.S. Sokhi,
Ex. Addtitional
Director of Extension Education (PAU),
318-D, BRS Nagar,
Ludhiana – 141 012.

4. Dr. Satyavir,
Dean, CoA (Retd.),
EG-15, Ashiana Gardens,
Bhiwadi – 301 019, Distt. Alwar (Raj.)

5. Prof. (Dr.) N. Samajpati,
Prof. & Head (Retd.),
Flat No.9, First Floor, Telirbag Bhawan,
P-3, Sashi Bhusan De Street,
Kolkata – 700 012, India.

6. Dr. R.P. Tewari,
Director,
National Research Centre for Mushroom,
Chambaghat, Solan (HP).

7. Asstt. Director General (H-II),
Indian Council of Agricultural Research,
Krishi Anusandhan Bhavan-II, Pusa,
New Delhi – 110 012.

8. Dr. B. Vijay,
Principal Scientist/Member Secy.,
NRC for Mushroom,
Solan – 173 213 (HP).

Fig. 1. Dr T.N Lakhanpal, Chairman RAC conducting meeting at NRCM

(c) Staff Research Council (SRC)

The meeting of Staff Research Council (SRC) was held on 29th August, 2007 and was attended by all the scientists under the Chairmanship of the Director, NRCM, Solan.

(d) Core Committee

Two meetings of Core Committee were held on 20.07.2007 and 08.01.2008 under the chairmanship of Dr. R.P. Tewari, Director.

Members

(i)	Dr. R.P. Tewari, Director	-	Chairman
(ii)	Dr. R.D. Rai, Principal Scientist/ S.O. (P-I)	-	Member
(iii)	Dr. V.P. Sharma, Principal Scientist/E.O.	-	Member
(iv)	Sh. Raj Kumar, A.O.	-	Member Secretary
(v)	Sh. Rishi Ram, AAO/DDO/S.O. (P-II)	-	Member
(vi)	Sh. Jiwan Lal, AFACO	-	Member
(vii)	Sh. Sh. R.K. Bhatnagar, Asstt. (Audit)	-	Member
(viii)	Sh. Rajinder Sharma, Asstt. (Store Purchase)	-	Member
(ix)	Sh. Bhim Singh, Asstt. (Cash)	-	Member
(x)	Sh. Tulsi Dass Sharma, Dealing Asstt.(Estate)	-	Member
(xi)	Sh. Deep Kumar Thakur, Dealing Asstt.(Hostel)	-	Member

(e) Sectional Heads Meeting

Two meetings of Sectional Heads were held on 30.06.2007 and 01.09.2007 under the chairmanship of Dr. R.P. Tewari, Director.

Dr. R.P. Tewari, Director	-	Chairman
Dr. S.R. Sharma, Head, Crop Protection Section	-	Member
Dr. R.D. Rai, Head, Crop Nutrition & Utilization Section	-	Member
Dr. B.L. Dhar, Head, Crop Production Section	-	Member
Dr. R.C. Upadhyay, Head, Crop Improvement Section	-	Member

Dr. B. Vijay, Head, Crop Production Section	-	Member
Dr. V.P. Sharma, Estate Officer	-	Member
Dr. O.P. Ahlawat, Incharge Library	-	Member
Dr. M.P. Sagar, Incharge Auditorium	-	Member
Sh. Rishi Ram, AAO	-	Member
Sh. Jiwan Lal, AFACO	-	Member
Sh. Raj Kumar, Administrative Officer	-	Member Secy.

(f) Senior Officer's Meetings

Two meetings of Senior Officer's of this Centre were held on 12.06.2007 and 03.03.2008 under the Chairmanship of Dr. R.P. Tewari, Director. All the Scientists, AO, AAO and AFACO attended the meetings.

(g) Institute Joint Staff Council (IJSC)

Three meetings of IJSC were held on 02.06.2007, 31.08.2007 and 04.02.2008 under the Chairmanship of Dr. R.P. Tewari, Director. The Members of IJSC (w.e.f. 01.04.2007 to 09.01.2008) are:

I. Official Side Members

Dr. R.P. Tewari, Director, Chairman

Dr. B. Vijay, Principal Scientist

Dr. O.P. Ahlawat, Senior Scientist

Dr. Satish Kumar, Senior Scientist

Sh. Jiwan Lal, AFACO

Sh. Rishi Ram, AAO

Sh. Raj Kumar, AO Secretary (Office Side)

II. Staff Side Members

Sh. Dala Ram, T-2, Member CJSC

Sh. Deep Kumar Thakur, Secretary(Staff Side)

Smt. Reeta, T.O.(Library)

Sh. Sanjeev Sharma, LDC

Sh. Nika Ram, SS Gr.III

Sh. Ajeet Kumar, SS Gr.I

The Members of IJSC (w.e.f.10.01.2008 to 31.03.2008) are:

I. Official Side Members

Dr. R.P. Tewari, Director, Chairman

Dr. R.D. Rai, Princal Scientist

Dr. M.P. Sagar, Senior Scientist

Sh. Raj Kumar, Admn. Officer, Secretary(Official Side)

Er. T. Arumugunathan, Scientist

Sh. Jiwan Lal, AFACO

Sh. Rishi Ram, AAO

II. Staff Side Members

Sh. R.K. Bhatnagar, Assistant, Member CJSC

Sh. Bhim Singh, Assistant

Sh. Gian Chand, Boiler Attendant(T-4)

Sh. Lekh Raj Rana, Tech. Asstt.(T-3), Secretary(Staff Side)

Sh. Tej Ram, SS Gr.II, Member IJSC

Sh. Ajeet Kumar, SS Gr.II

(h) Grievance Cell

Since no grievance of any employee came hence no meeting was held.

(i) Consultancy Processing Cell (CPC)

Four meetings of Consultancy Processing Cell (CPC) were held 01.05.2007, 08.05.2007, 03.01.2008 and 03.03.2008 under the Chairmanship of Dr. B. Vijay, Principal Scientist.

Followings are the Members of CPC :

1.	Dr. B. Vijay, Principal Scientist	-	Chairman
2.	Dr. S.K. Singh, Principal Scientist	-	Member
3.	Sh. Raj Kumar, Admn. Officer	-	Member
4.	Sh. Jiwan Lal, AFACO	-	Member
5.	Dr. O.P. Ahlawat, Senior Scientist	-	Member Secretary

(j) Rajbhasa Implementation Committee(Hindi Committee)

राजभाषा कार्यान्वयन समिति (हिन्दी समिति)

डा. राजेन्द्र प्रसाद तिवारी, निदेशक	-	अध्यक्ष
डा. सतीश कुमार, वरिष्ठ वैज्ञानिक	-	सदस्य
डा. मदन पाल सागर, वरिष्ठ वैज्ञानिक	-	सदस्य
श्री राज कुमार, प्रशासनिक अधिकारी	-	सदस्य
इं. टी. अरमुगनाथन, वैज्ञानिक	-	सदस्य
श्रीमती रीता, तकनीकी अधिकारी	-	सदस्या
श्रीमती सुनीला ठाकुर, आशुलिपिक	-	सदस्या
श्री दीप कुमार ठाकुर, आशुलिपिक	-	सदस्य सचिव

राजभाषा कार्यान्वयन समिति द्वारा वर्ष 2007-08 के दौरान किये गए कार्यों का संक्षिप्त विवरण

भारत सरकार की राजभाषा नीति के क्रियान्वयन को सुनिश्चित करने तथा केन्द्र द्वारा संपादित किये जाने वाले कामकाज में हिन्दी का प्रयोग सुनिश्चित करने के उद्देश्य से केन्द्र में राजभाषा कार्यान्वयन समिति का गठन किया गया है। राजभाषा क्रियान्वयन के लिए केन्द्र में अलग से कोई अधिकारी व कर्मचारी न होने के बावजूद राजभाषा कार्यान्वयन समिति द्वारा किए गये प्रयासों के फलस्वरूप केन्द्र के कामकाज में हिन्दी के प्रचार-प्रसार में अपेक्षित सफलता प्राप्त हुई है। केन्द्र द्वारा वर्ष 2007-08 के दौरान किये गये कार्यों का संक्षिप्त विवरण निम्नप्रकार से है:-

राजभाषा वार्षिक कार्यक्रम पर क्रियान्वयन

राजभाषा विभाग, गृह मंत्रालय, भारत सरकार द्वारा जारी राजभाषा वार्षिक कार्यक्रम पर केन्द्र की राजभाषा कार्यान्वयन समिति की त्रैमासिक बैठकों व वरिष्ठ अधिकारियों की बैठक में चर्चा हुई तथा दिए गए दिशा-निर्देशों के अनुरूप लिए गए निर्णयों के अनुसार कार्रवाई की गई तथा केन्द्र 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 परिषद से प्राप्त पत्रों/परिपत्रों पर कार्रवाईः-

इस अवधि में राजभाषा क्रियान्वयन सम्बन्धी नवीनतम निर्देशों/नियमों से सम्बन्धित विभिन्न प्रकार के पत्र/परिपत्र आदि राजभाषा विभाग, भारतीय कृषि अनुसंधान परिषद से प्राप्त हुए जिन पर वांछित 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

केन्द्र में राजभाषा क्रियान्वयन सम्बन्धी प्रगति के आँकड़े प्राप्त कर जारी त्रैमासिक रिपोर्ट प्रोफार्मा में सभी आँकड़ों को संकलित कर केन्द्र 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 क्रियान्वयन

राजभाषा विभाग द्वारा जारी निर्देशों के अनुरूप केन्द्र में सरकारी कामकाज मूल रूप में हिन्दी में करने के लिए प्रोत्साहन योजना केन्द्र के सभी अधिकारियों व कर्मचारियों के लिए लागू की है। केन्द्र में अन्य कोई योजना लागू न होने के कारण टाईपिस्ट/आशुलिपिक भी इसी योजना के अन्तर्गत आते हैं बशर्ते कि वे योजना की शर्तें पूरी करते हो। पूरे वर्ष में किए गए कार्यों को मध्य नजर रखते हुए एक मूल्यांकन समिति का गठन किया जाता है जो फाईलों व अन्य कार्यों का आवलोकन कर प्रथम, द्वितीय व तृतीय पुरस्कारों का निर्णय करती है।

त्रैमासिक बैठकों का आयोजन

राजभाषा कार्यान्वयन समिति की त्रैमासिक बैठकों का नियमित आयोजन किया गया। बैठकों में राजभाषा वार्षिक कार्यक्रम में निर्धारित किये गए लक्ष्यों को प्राप्त करने, समय-समय पर राजभाषा विभाग एवं भारतीय कृषि अनुसंधान परिषद 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

केन्द्र 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।

केन्द्र के सभी अधिकारियों व कर्मचारियों को सभी प्रकार के प्रपत्र द्विभाषी तैयार किए गए।

केन्द्र के सभी अधिकारियों व कर्मचारियों के लिए सभी प्रकार के प्रपत्र द्विभाषी तैयार किए गए व सभी के कंपयूटरों पर डाउनलोड किए गए ताकि वे दिन-प्रतिदिन कार्यालय प्रयोग में इन प्रपत्रों को प्रयोग में लाए।

हिन्दी सप्ताह का आयोजन

केन्द्र में दिनांक 14-21 सितम्बर, 2007 को हिन्दी सप्ताह मनाया गया जिसमें केन्द्र के अधिकारियों व कर्मचारियों के लिए निम्नलिखित प्रतियोगिताएं आयोजित की गईः-

1. श्रुतलेखन 2. सुलेख 3. तकनीकी लेख 4. निबंध 5. टिप्पणी 6. कम्पयूटर पर टंकण प्रतियोगिता 7. प्रार्थना पत्र लेखन 8. वाद-विवाद प्रतियोगिता, प्रतियोगिता संख्या 1, 2, 4 व 5 सभी कर्मचारियों के लिए व 3 न. केवल तकनीकी कर्मचारियों के लिए, 6 न. केवल प्रशासनिक कर्मचारियों के लिए, 7 न.केवल चतुर्थ श्रेणी कर्मचारियों व 8 न. प्रतियोगिता केवल वैज्ञानिकों के के लिए आयोजित की गई।

इन सबके फलस्वरूप केन्द्र के वैज्ञानिक/अधिकारियों/कर्मचारियों में हिन्दी में कार्य करने की प्रवृत्ति बढ़ी है और वर्तमान में काफी प्रशासनिक कामकाज हिन्दी में संपादित हो रहा है। इसमें केन्द्र के वैज्ञानिकों,

चित्र 2. श्रीमति मीरा देवी, प्रार्थना पत्र प्रतियोगिता में द्वितीय पुरस्कार प्राप्त करते हुए

चित्र 3. डा. वी.पी. शर्मा, वाद विवाद प्रतियोगिता में प्रथम पुरस्कार प्राप्त करते हुए

अधिकारियों व कर्मचारियों का सतत 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।

केन्द्र की वार्षिक हिन्दी प्रगति संबंधी मुख्य गतिविधियाँ एवं उपलब्धियाँ

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

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

2. दिनांक 25.06.2007, 14.09.2007, 12.12.2007 व 28.03.2008 को राजभाषा कार्यान्वयन समिति की बैठकें संपन्न हुई। सभी बैठकों की कार्यसूची वार्षिक कार्यान्वयन की अपेक्षाओं के अनुसार एवं अध्यक्ष महोदय, राजभाषा कार्यान्वयन समिति के अनुमोदन के बाद ही तय की गई।

3. दिनांक 19.06.2007, 24.09.2007, 31.12.2007 व 10.03.2008 को राजभाषा कार्याशालाओं का आयोजन किया गया जिसमें केन्द्र के सभी अधिकारियों व कर्मचारियों ने स्वेच्छा से भाग लेकर कार्यशालाओं के लक्ष्यों को सफलतापूर्वक प्राप्त किया।

4. हिन्दी में प्राप्त या हिन्दी में हस्ताक्षरित सभी पत्रों में से जिन पत्रों का उत्तर देना अपेक्षित था, उन पत्रों का उत्तर केवल हिन्दी में अथवा हिन्दी-अंग्रेजी के द्विभाषीय रूप में दिया गया।

5. केन्द्र की अधिकतर बैठकों के कार्यवृत्त हिन्दी में तैयार किए गए।

6. राजभाषा अधिनियम, 1963 की धारा 3(3) तथा अन्य नियमों की अनुपालना के संदर्भ में केन्द्र 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।

7. हिन्दी पत्राचार के निर्धारित लक्ष्यों को प्राप्त करने की दिशा में सतत-प्रयास जारी है।

8. सभी 46 मानक फॉर्मों को द्विभाषी रूप में तैयार कर लिया गया है तथा सतत कोशिशें की जा रही है की सभी कार्मिक इन्हें हिन्दी में ही भरें।

9. केन्द्र के सभी 26 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।

10. केन्द्र के सभी अधिकारियों का हिन्दी की जानकारी संबंधी रोस्टर तैयार किया गया है।

11. श्री दीप कुमार, सदस्य सचिव, राजभाषा कार्यान्वयन समिति व श्रीमती रीता भाटिया, सदस्य, राजभाषा कार्यान्वयन समिति ने राष्ट्रीय कृषि अनुसंधान प्रबंध अकादमी, हैदराबाद में दिनांक 4-6 दिसम्बर, 2007 तक तीन दिवसीय कार्यशाला 'राजभाषा अधिकारियों की समस्याएं' में भाग लिया।

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

13. केन्द्र के प्रशिक्षण कार्यक्रमों के लिए प्रशिक्षण सार-संग्रह (ट्रेनिंग कम्पेडियम) हिन्दी व अंग्रेजी दोनो भाषाओं में उपलब्ध है।

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

15. इसके अतिरिक्त डा. आर.पी. तिवारी, निदेशक एवं अध्यक्ष, राजभाषा कार्यान्वयन समिति के सतत निजी-सहयोग और मार्गदर्शन के तहत हिन्दी की तिमाही बैठकों व कार्याशालाओं का समय पर आयोजन व केन्द्र 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।

14. SEMINARS/SYMPOSIA/CONFERENCES ATTENDED

Dr. M.C. Yadav

- Participated in International Conference on "Agricultural Biotechnology" held from 17-18 September 2007 at FICCI, Federation House, New Delhi.

Dr. S.K. Singh

- Attended symposium on "Current status of mushroom biotechnology in India and future prospects" at Indian Institute of Horticultural Research (IIHR), Bangalore on 8th December, 2007
- Attended symposium on "Molecular Characterization of Edible Mushroom Germplasm" in 2nd Asian Congress of Mycology and Plant Pathology on Microbial Diversity for Asian Prosperity during 19-22 December,2007 at Osmania University, Hyderabad.

Er. T. Arumuganathan

- Attended workshop on "Application of High Pressure in Food Processing" organized by Central Institute of Post Harvest Engineering and Technology held at CIPHET, Abohar (Punjab) on 21st June, 2007.
- Attended "National Conference on Impact of Climate Change with Particular Reference to Agriculture" jointly organized by Agro Climate Research Centre, TNAU, Ministry of Science and Technology & Earth Sciences in association with Norwegian Embassy held at TNAU, Coimbatore on 22nd – 24th August, 2007.
- Participated in the Training Programme on "Developing Winning Research Proposals in Agricultural Research" organized under National Agricultural Innovation Project (NAIP) held at National Academy of Agricultural Research Management from 24 to 29th March, 2008.

15. DISTINGUISH VISITORS

1. Dr. Mangla Rai Hon'ble DG ICAR and Secretary DARE visited NRCM on 15th May, 2007.

2. Dr. A.K. Upadhyay, Secretary ICAR and Additional Secretary, visited NRCM on 24th April, 2007.

Fig. 1. Hon'ble DG, ICAR and Secretary DARE visiting Crop Improvement lab at NRCM

16. PERSONNEL AND FACILITIES

Name	Designation
Scientific	
Dr.R.P. Tewari	Director
Dr.S.R. Sharma	Principal Scientist (Pl.Path.)
Dr.R.D. Rai	Principal Scientist (Biochemistry)
Dr.R.C. Upadhyay	Principal Scientist (Pl.Path.)
Dr.B. Vijay	Principal Scientist (Pl.Path.)
Dr.S.K. Singh	Principal Scientist (Pl.Path.)
Dr.V.P. Sharma	Principal Scientist (Pl.Path.)
Dr.O.P. Ahlawat	Senior Scientist (Biotechnology)
Dr.M.C. Yadav	Senior Scientist (Genetics)
Dr.Satish Kumar	Senior Scientist (Entomology)
Dr.M.P. Sagar	Senior Scientist (Agril.Extension)
Sh.Yogesh Gautam	Scientist (SS)(Computer Application)
Er.T. Arumugnathan	Scientist (Agril.Engineering)
Technical	
Sh.Sunil Verma	Technical Officer (T-6)
Smt.Reeta	Technical Officer (T-5)
Sh.Jia Lal Verma	Technical Officer (T-5)
Smt.Shailja Verma	Technical Officer (T-5)
Sh.Gian Chand	Boiler Attdt. (T-4)
Sh.Lekh Raj Rana	Technical Assistant (T 1-3)
Sh.Ram Swaroop	Technical Assistant (T-2)
Sh.Parma Nand	Mushroom Assistant (T 1-3)
Sh.Jeet Ram	Mushroom Assistant (T-2)
Sh.Guler Singh Rana	Electrician (T-2)
Sh.Deepak Sharma	Electronic-cum-Computer Operator (T-2)
Sh.Dala Ram	Driver (T-3)
Sh.Ram Lal	Driver (T-3)
Sh.Ram Ditta	Driver (T-3)

Name	Designation
Administrative	
Sh.Raj Kumar	Administrative Officer
Sh.Jiwan Lal	Asstt.Finance & Accounts Officer
Sh.Rishi Ram	Asstt.Admn.Officer
Sh.R.K. Bhatnagar	Assistant
Sh.Rajinder Sharma	Assistant
Sh.Bhim Singh	Assistant
Sh.Surjit Singh	Personal Assistant
Sh.T.D. Sharma	UDC
Sh.N.P. Negi	UDC
Sh.Satinder Thakur	UDC
Smt.Sunila Thakur	Stenographer Gr.III
Sh.Deep Kumar	Stenographer Gr.III
Sh.Dharam Dass	LDC
Smt.Shashi Punam	LDC
Sh.Roshan Lal Negi	LDC
Sh.Sanjeev Sharma	LDC
Supporting	
Sh.Naresh Kumar	SSG-III (Safaiwala)
Smt.Dayawanti	SSG-IV (Safaiwala)
Sh.Nika Ram	SSG-III (Chowkidar)
Sh.Tej Ram	SSG-II (Chowkidar)
Smt.Meera Devi	SSG-II (Lab.Attdt.)
Sh.Raj Kumar	SSG-I (Lab. Attdt.)
Sh.Ajeet Kumar	SSG-II (Lab. Attdt.)
Sh.Arjun Dass	SSG-I (Messenger)
Sh.Vinay Sharma	SSG-I (Messenger)

Promotions

- Dr. V.P. Sharma, Sr Scientist promoted as Principal Scientist w.e.f. 19.05.2007.
- Sh. L.R. Rana promoted as T 1-3 w.e.f. 20.10.2004.
- Sh. Parma Nand promoted as T 1-3 w.e.f. 20.09.2005.

ACP

- Sh.Arjun Dass, SSG-I granted financial upgradation under ACP w.e.f. 06.10.2007 in the pay scale of Rs. 2610-3540.

Transfers

- Sh. Hari Singh, Administrative Officer transferred from NRCM, Solan to IARI, New Delhi w.e.f. 04.04.2007.

- Dr. B.L.Dhar, Principal Scientist transferred from NRCM, Solan to IARI, New Delhi w.e.f. 31.12.2007.

Joining

- Sh. Raj Kumar, Administrative Officer joined NRCM, Solan on dated 25.05.2007 (FN).

Sports

The NRCM Contingent of 27 Nos. participated in ICAR Zonal Sports Meet held at National Dairy Research Institute, Karnal w.e.f. 26-29th September, 2007. In the men events, the Centre participated in Volley Ball (Smashing & Shooting), Badminton, Kabaddi, Chess, Table Tennis and Carrom Board.

Infrastructural facilities developed

To improve the research and other Infrastructure of the Centre, the renovation and special repair/ incomplete work were initiated and completed.The allocated funds under Plan worth Rs.31.22 Lakhs and under non Plan Rs.63.00 Lakhs were utilized. The details of the complete works are as under:-

Under Plan

(1) C/O Teacher Training Facilities Centre

(2) Electrical Sub Station of 630 KVA Sub Station

Under Non Plan

(1) Repair of roof of Main building

(2) Repair of roof of Auditorium bldg.

(3) Repair of roof of Hostel and Type-II Qtr. Bldgs.

(4) Development of path leading to TTF bldg.

(5) Repair of Boundary around Type-I Qtr.

(6) Repair of Security post in residential bldg.