वार्षिक प्रतिवेदन
ANNUAL REPORT
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 National Research Centre for Mushroom was established in 1983 during the VIth five year Plan under the auspices of the Indian Council of Agricultural Research with the objectives of undertaking research on all aspects of mushrooms and also to impart training to the growers, researchers and entrepreneurs. During the last two and half decades, the Centre has made significant contributions in research and development of mushroom industry in the country. As a result the production has increased many folds during this period. Keeping in view the significant contribution, the Centre has been upgraded to Directorate from December, 2008. Initially the Centre worked mainly on white button mushroom but now it is focusing more on diversification in mushroom cultivation, devleloping high yielding strains and better mangement of pest and diseases as well as on better post harvest mangement practices.

Collection of germplasm is one the most important activity of the Centre and during the year National Mushroom Repository has been enriched by addition of 217 mushroom cultures. Wide genetic varibilty among 41 strains of *Pleurotus* species collected from AICMIP Centres was observed. While developing high yielding varieties, some single spore selections namely, CM-3 (SSI-16), CM-7 (SSI-6002) and CM-9 (SSI-4035) of *Agaricus bisporus* performed superiorly over U-3. One wild collection (WC-21) was domesticated, which produced brown fruiting bodies at quite a high temperature of 24-25°C. In paddy straw mushroom, strain OE-210, OE-274, OE-55-08, BBH-1 and BBH-5 were observed to be fast growing. Pinning was higher and earliest in strain, OE-272, followed by OE-274 and BBH-5. Pl-900 strain of *Pleurotus florida* gave 108.3% biological efficiency. The indoor method of compost preparation was perfected and an average yield of 14.07 kg mushrooms per quintal compost was obtained in forty days cropping period.

Survey of different farms in Haryana and Himachal Pradesh revealed the widespread incidence of wet bubble, yellow mould, brown plaster mould, scarids, phorids and red pepper mite. In IPM studies different plant materials were evaluated against *Mycogone perniciosa* causing wet bubble disease and few viz., *Allium cepa*, *Trachyspermum ammi*, *Nigella sativa* or *Coriandrum sativum* caused 100% inhibition to the mycelial growth under *in vitro* conditions. Studies conducted on status of carbendazim residues in processed and marketable mushrooms revealed that residue reduced by 28.57% to 81.86% in different mushrooms by simple washing. Simple washing or boiling in water for 10 minutes resulted in 31.57 to 87.57, 59.79 to 90.10% reduction in residue level of malathion and decamethrin, respectively. Boiling was more effective in lowering residue of both the insecticides than simple washing. At least three species were found to be associated with cobweb disease of different cultivated mushrooms in India and *Cladobotryum mycophilum* is potential cause of cobweb disease in *Agaricus bisporus*. *C. asterophorum* was found to be associated with different species of oyster mushroom.

Studies conducted on the packing of paddy straw mushroom revealed that the quality of paddy straw mushrooms stored in PP bags under open condition remained good up to 2 days irrespective of the storage condition.

Centre has organised a total number of 13 training programmes. One day Mushroom Mela was organised on 10th September, 2008 as regular activity of the Centre. It was attended by about 550 farmers, farm women, mushroom growers, researchers, extension workers and enterpreneurs from various States. During the Mushroom Mela, the Centre awarded ten progressive mushroom growers for adopting innovative practices in mushroom cultivation on large scale and mobilizing other farmers to adopt mushroom cultivation as source of income.

The Centre has developed infrastructure facility of Trainers 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.

Mushrooms have enormous potential as source of both dietary protein and health enhancing dietary supplements, and for the remediation of environmental pollution. Cosequently, worldwide mushroom industries and international mushroom organizations aspire to advance the knowledge of mushrooms and extend cultivation to include a wider range of climatic conditions than at present. At present out of about 15000 recognised mushroom species, 200 have been domesticated. In our country though we have introduced some new species for the cultivation but still major emphasis is on white button mushroom. In button mushroom there is urgent need to develop short duration varieties as well as modification of the production technology for quick harvest through nutrient management. Mushrooms like milky, oyster, paddy straw and shiitake need to be popularized.

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 the Centre.

(Manjit Singh)
Director

कार्य सारांश

राष्ट्रीय खुम्ब अनुसंधान केन्द्र ने वर्ष 2008 के दौरान, फसल उन्नयन, फसल उत्पादन, फसल संरक्षण, फसल पोषण एवं उपयोग, प्रसार एवं तकनीकी हस्तांतरण, शिक्षा एवं प्रशिक्षण तथा प्रकाशन में जो उपलब्धियां हासिल की हैं उनका सारांश यहाँ दिया जा रहा है।

फसल उन्नयन

(क) जैव सम्पदा का संग्रहण

इस वर्ष कुल 217 नमूने एकत्रित किये गए जिनमें से 192 प्रजातियों की पहचान जीनस स्तर तक की गई। पाई गई प्रजातियों में ऐमेनिटा ह्यूमेनिस, ऐमेनिटा हेमीबापा, ऑकरेशिया इत्यादि प्रमुख हैं। एकत्रित खुम्बों की बाहय संरचना संबंधित गुणधर्मों जैसे तना, गिल्स, पाइलस, वोल्वल एन्यूल, स्पोर प्रिंट तथा अन्य सूक्ष्मदर्शीय गुणों के आधार पर व्याख्या की गई है। ए. ह्यूमेनिस की टोपी 6.5 से 16 से. मी. चौड़ी थी, जो समय के साथ-साथ घंटाकार आकृति से अपेक्षाकृत कम उत्तल होती गई। इसका रंग मध्य में भूरा (6 इं. 7-6) तथा किनारों पर हल्का होता जाता है। भूरे संतरी से पीला भूरा (5 सी 4-6 सी 4) यह अक्सर वोल्वा अवशिष्ट रहित अरोगिल तथा खांचेदार होती है। यह 1.3 से 5.5 से.मी. लम्बी, निवक्र, वयनोतक सफेद से हल्का तथा 0.3-0.8 से.मी. मोटा होता है। ए. हेमीबापा की उप प्रजाति ऑकरेशिया का पाइल्स 8-18 से.मी. चौड़ा होता है, जो कि पहले घंटाकार से अर्द्धगोलाकार तथा बाद में उत्तल तथा चपटा हो जाता है। युवा अवस्था में यह थोड़ा सा ककुद युक्त भूरे पीले से हल्का भूरा यह सूनहरा भूरा (5 सी 6) सूनहरे भूरे से पीला भूरा (5 डी 5.7) व भूरा हो जाता है। छत्र पर साधारणतया वोल्वा अवशिष्ट अनुपस्थित होते हैं। इसके तट गुलिकीय तथा खाँचेदार होते हैं। इनकी लम्बाई 1.2-4.5 से.मी., निवक, वयनोतक सफेद से पीले सफेद होते हैं। इनकी मोटाई 0.5-1.0 से.मी. होती है। ए. हेमीबापा की उपप्रजाति हेमीबापा के फलनकाय 7-18.5 से.मी. चौड़े, स्पष्टतया ककुद युक्त संतरी (5 ए 7) गहरे संतरी (6 ए 8) से संतरी लाल (8 ए 8), गहरे पीले से पीले संतरी (4ए 8-ए 7) तथा तटों पर पीले संतरी (5 ए 8-ए 7) से क्रोम पीले तथा खांचेदार होते हैं।

(ख) जैव संपदाओं का चरित्र-चित्रण

अखिल भारतीय समन्वित मशरूम उन्नयन परियोजना केन्द्रों से एकत्रित की गई प्लूरोटस की 41 प्रजातियों का आर.ए.पी.डी. विश्लेषण 10 संयोगिक प्राइमर्स का प्रयोग करके किया गया। इन प्रजातियों में इंट्राफेसिफिक भिन्नता पाई गई। इन प्रजातियों में आनुवंशिक भिन्नता कम थी। पी. फॉसीलेट, पी. फलोरिडा, पी. साजोर काजू तथा नीली आयॅस्टर पी. आस्ट्रेटस के आर.ए. पी.डी. प्राफाईलों से विशिष्ट प्रजाति बैण्ड प्राप्त किए गए, जो यह दर्शाते हैं कि प्लूरोटस प्रजातियां आनुवांशिक तौर पर बिल्कुल भिन्न होती है। सभी जीन संरचनाओं में आर.टी.एस. क्षेत्र की लम्बाई जेल पर लगभग 690 थी। पी. डेजामोर तथा पी. डयूस में दोनों को मिलाकर यह 720 थी।

(ग) आनुवांशिक सुधार

ए. बाइस्पोरस की 24 प्रजातियां जिसमें भारत के जंगलों से एकत्रित कुछ जंगली प्रजातियां भी शामिल है, का मूल्यांकन उनकी उपज क्षमता जानने के लिए किया। आर. बी.डी. डिजाइन में लघु विधि द्वारा तैयार खाद के 10-10 कि.ग्रा. के बैगों में यह प्रयोग 8 बार किए गए। एकल बीजाणु संवर्धन सी.एम. 3 (एसएस 1-16), सी.एन. 7 (एसएस 1-6002) तथा सी.एम. 9 (एसएस 1-4035) ने

श्रेष्ठतर उपज दी। जंगलों से एकत्रित डब्ल्यू 21 का उत्पादन किया गया, जिससे कि 24-25^0 से. तापमान पर भूरे फलनकाय उत्पन्न हुए। अखिल भारतीय समन्वित मशरूम उन्नयन परियोजना कार्यशाला के दौरान ए. बाइस्पोरस की सात प्रजातियों की उत्पादन हेतु अनुशंसा की गई थी। इन प्रजातियों को आर.बी.डी. डिजाइन में तैयार की गई लघु विधि खाद की 10-10 कि. ग्राम के बैगों में 8 बार उगाकर इनका मूल्यांकन किया गया। सबसे अधिक पैदावार क्रमशः सी.एम. 12(19.78 कि.), सी.एम. 15(18.91 कि.) तथा सी.एम. 16(18.11 कि.) से प्राप्त हुई। यह पैदावार 100 कि. ग्राम कम्पोस्ट में से प्राप्त की गई। यह उपज सामान्य चैक एस-130 की अपेक्षा अधिक थी।

सी. इंडिका की 11 प्रजातियों में से एकल बीजाणु प्राप्त कर इन्हें कमरे के तापमान में संरक्षित किया गया। 35 से 40 दिनों तक 28^0 सें. तापमान पर उष्मायित करने के पश्चात इन्हें प्रतिलोमित सूक्ष्मदर्शी में देखने पर केवल कुछ ही जीवाणु दिखाई दिए। दुधिया खुम्ब की कुल 26 प्रजातियों को पास्चुरीकृत गेहूँ की तूड़ी माध्यम पर उगाया गया। इनमें से 22 प्रजातियों में अच्छा कवक जाल फैलाव देखा गया। कवक जाल फेलाव 15-18 दिनों में पूर्ण हुआ। आई.आई. एच.आर.-56 ओ.ई. 54, ओ.इ. 228 तथा ओ.इ. 229 प्रजातियों में कवक जाल फैलाव बहुत कम था, तथा इनमें फलनकाय 32-35^0 से. तापमान पर भी नहीं हुआ। सितम्बर-अक्टूबर महीने के परीक्षण के दौरान 4 प्रजातियों जिनमें की एक नई जंगली प्रजाति भी शामिल है, से बेहतर उपज प्राप्त की गई।

कैलोसाइवी इंडिका की 24 प्रजातियों की आनुवांशिक समानता व मॉलिकुलर परिर्वतन हेतु अध्ययन किया गया। 10 आर.ए.पी.डी. मारर्कस का उपयोग किया गया। आर. टी.एस. अनुक्रमों के मूल्यांकन से तथा एन.सी.बी.आई. डाटाबेस से तुलना करने के पश्चात ओ.ई. 54 की पहचान पी. फलोरिडा के रूप में की गई। पूर्ण आई.टी.एस. प्रक्षेत्रों के अनुक्रमांक छः प्रजातियों में से प्राप्त किए गए, जिनके नाम थेः ओ.इ. 152, ओ.इ. 331, ओ.इ. 342, ओ.इ. 344, ओ.इ. 345 तथा ओ.इ. 347। दो एस.एन.पी. की भी पहचान की गई। (एक एस.एन.पी.आई.टी.एस. 1 में तथा अन्य आई.टी.एस. दो प्रक्षेत्र में) कैलोसाइबी इंडिका के 15 प्रजातियों में क्रोमैटोग्राफस ने दोनों प्राइमर्स के साथ मिश्रित शिखर दिखाये।

पुलाल खुम्ब की कुल 7 प्रजातियों को कम्पोस्ट माध्यम पर उगाकर उनकी उपज क्षमता जानने हेतु उपयोग किया गया। लिग्नोसेलूलाईटिक एन्जाइम सक्रियता में एक्जोग्लूकॉनेज व एण्डोग्लूकॉनेज की उच्चतम सक्रियता बी.बी.एस.आर. 03 प्रजाति में पाई गई, जिसका अनुसरण एक्जोग्लूकॉनेज के लिए बी.बी.एस.आर. 02 तथा एण्डोग्लूकॉनेज के लिए बी. बी.एच-1 ने किया। बी. ग्लूकोसाइडेज की उच्चतम सक्रियता बी.बी.एस.आर. 02 प्रजाति में पाई गई, जिसका अनुसरण बी.बी.एच.-5 ने किया। जाईलेनेज, लैक्केज व पॉलिफिनॉल आक्सीडेज की सक्रियता सबसे अधिक क्रमशः डब्ल्यू डब्ल्य 08, बी.बी.एच-5 तथा बी.बी.एस.आर. 03 प्रजातियों में थी। इनमें से किसी एक प्रजाति में भी छः एन्जाईमों की उत्कृष्ट सक्रियता दर्ज नहीं की गई जबकि बीबीएसआर 02 तथा बी.बी.एस.आर. 03 में सभी एन्जाइमों की अच्छी सक्रियता देखी गई।

प्लूरोटस साजोर काजू की 19 प्रजातियों में त्रिज्य वृद्धि दर में व्यापक भिन्नता देखी गई। खुम्ब अनुसंधान निदेशालय के जीन बैंक से एकत्रित प्लूरोटस फलोरिडा की 19 प्रजातियों का मूल्यांकन उनकी उपज क्षमता जानने के लिए किया गया। पी 1-900 प्रजाति में फलनकाय शीघ्र हुआ तथा इसमें अधिकतम जैविक क्षमता (108.3%) पाई गई।

प्लूरोटस की एक प्रजाति जिसकी पहचान प्लूरोटस डेजामोर के रूप में की गई थी, का उत्पादन वर्ष 2008 के दौरान किया गया।

फसल उत्पादन

(क) ऐगेरिकस बाइस्पोरस के लिए आई.एन.आर.ए. तथा एंगलों डच विधियों को मिलाकर आंतरिक खाद तैयार की गई

अवयवों को ठीक से मिलाया गया तथा इन्हें दो दिनों तक भिगोया गया, फिर इन्हें फेज-I के कार्य के लिए बंकर में स्थानांतरित किया। फेज-I में छः दिनों के आंशिक खमीरीकरण के पश्चात पूरी खाद को बाहर निकाला गया तथा फिर इसे फेज-II के कार्य के लिए सूरंग में स्थानांतरित किया गया। इसके पश्चात कम्पोस्ट तैयार करने के लिए मानकीय पद्धति उपयोग की गई। फेज-II का कार्य 7 दिनों में पूर्ण हुआ। कम्पोस्ट में गेहूँ के पुआल का अनुपात 4.17 था। प्रति क्विंटल खाद में से औसतन 14.7 कि.ग्रा. खुम्ब की पैदावार चालीस दिनों के परीक्षण के दौरान प्राप्त की।

थर्मोफीलिक बैक्टीरिया जैसे की टेलरोमाइसीस, डूपोटाई पेसीलोमाईसीस वेरियोटाई, गिलमनालिया, हयूमीकोला, स्पोरोट्रिकम थर्मोफिले, थर्मोमाईसिस, लेन्यूगिनोसीस, थर्मोसीस, एयूरेनटिकास, हयूमीकोला फेसकोट्रा, हयूमीकोला ग्रेसिया के 8 विभिन्न अनुवांशिक स्ट्रेन, हयूमीकोला इन्सोलेन्स के 6 स्ट्रेन तथा साइटेलिडियम थर्मोफीलियम के 8 स्ट्रेनों का निरीक्षण उनका सेलूलोस अवकर्षण समर्थता जानने के लिए किया गया। सभी थर्मोफीलिक बैक्टीरिया तथा उनके आइसोलेटस में सबसे अधिक सैलूलोस कवकर्षण की क्षमता एच. ग्रेसिया में है। एच. ग्रेसिया के एच.जी. 4 स्ट्रेन में अधिक सक्रियता देखी गई, इसके बाद में एच. एनसोलेनस (एच.आई. 2) में देखी गई। इन 3 थर्मोफीलिक बैक्टीरिया के विभिन्न स्ट्रेनों में विभिन्न प्रकार की सैलूलोस कवकर्षण की संभावनाएं देखी गई। सभी परीक्षित बैक्टीरिया में से टी. डूपोनटी में सबसे खराब सैलूलोस अवकर्षण की क्षमता देखी गई। एन्जाइम उत्पादन के लिए अनुकूलतम कर्षण परिस्थितियों से यह ज्ञात हुआ कि एस. थर्मोफीलियम एक सशक्त सैलूलोस अवकर्षण करने वाला बैक्टीरिया है। एण्डोग्लूकॉनेज क्रिया के दौरान अनुकूलतम पी. एच. तथा तापमान क्रमशः 6.5 तथा 45^0 से. था। इसी प्रकार एण्डोग्लूकॉनेज क्रिया के दौरान अनुकूलतम पी.एच. तथा तापमन क्रमशः 5.5 तथा 60^0 से. था। तापमान का अध्ययन यह बताता है कि एस. थर्मोफीलिक 40^0 से 60^0 से. तापमान पर वृद्धि कर सकते हैं तथा सैलूलोस उत्पन्न कर सकते हैं, हालांकि एण्डोग्लूकॉनेज उत्पादन के लिए अनुकूलतम तापमान 60^0 से. तथा एण्डोग्लूकॉनेज के लिए 40^0 से. तापमान सही साबित हुआ। खाद बनाने की प्रक्रिया के फेज I तथा फेज-II में उच्चतम तापमान तथा पी.एच. में भिन्नता लाने के लिए एस. थर्मोफीलियम को एक अच्छे सेलूलोस उत्पादक के रूप में देखा गया। माध्यम में नाइट्रोजन मिलाने से एण्डो तथा एक्सोग्लूकेन्स उत्पादन पर चिह्नित प्रभाव देखा गया। एण्डोग्लूकॉनेज ने पोटाशियम नाइट्रेट सांद्रण को 0.50 से 1.0% तक प्रचूर मात्रा में सक्रिय किया। यूरिया से भी समान परिणाम प्राप्त किए गए। अमोनियम क्लोराइड 0.50% सांद्रण में एन्जाइम उत्पादन को प्रेरित करता है। एन्जाइम क्रिया को उच्चतर एन. स्तर पर यह पूर्णतया रोक देता है।

(ख) जैविक खुम्ब उत्पादन

बटन खुम्ब की दसवीं जैविक फसल सफलतापूर्वक उगाई गई। खुम्ब कलिकाएं केसिंग करने के 13 दिन पश्चात दिखाई दी, जबकि पहली तुड़ाई केसिंग करने के 18 दिनों पश्चात प्राप्त की गई। लम्बी अवधि द्वारा तैयार की गई एक क्विंटल खाद में से चार सप्ताहों में 10.13 कि.ग्रा. खुम्ब

की फसल प्राप्त की। कुल खुम्ब पैदावार की लगभग 80% पहले दो सप्ताह में तथा बाकि की बची 20% अंतिम दो सप्ताहों में प्राप्त की गई। ग्याहरवें परीक्षण में तीन सप्ताहों में एक क्विंटल तैयार खाद में से 7.43 कि. ग्राम खुम्ब की उपज प्राप्त की गई। प्रथम दो सप्ताहों में कुल खुम्ब पैदावार की लगभग 85% फसल तथा अंतिम एक सप्ताह में बाकि की बची 15% पैदावार प्राप्त की।

(ग) पुआल खुम्ब

पुआल खुम्ब के समान कवक जाल फेले हुए स्ट्रेन उपयोग किए गए तथा सभी ने खाद के पोषाधार को समान स्तर तक उपनिवेशित किया। सबसे अधिक कवक जाल वृद्धि स्ट्रेन बी बी एस आर-03 तथा ओ.ई.-55-08 में थी। विभिन्न स्ट्रेनों में से स्ट्रेन ओ.ई. 210, ओ.ई. 274, ओ.ई. 55-08, बी.बी.एच.-01 तथा बी.बी.एच. 5 में उपनिवेशन बाकि दो स्ट्रेनों की अपेक्षा जल्दी तथा बेहतर हुआ। ओ.ई. 272 में कलिकाएं सबसे पहले तथा अधिक थी, इसके बाद कलिकाएं ओ.इ. 274 तथा बी.बी.एच. 1 स्ट्रेन में दिखाई दीं। खुम्ब की फसल की पहली तुड़ाई 11.25 दिनों बाद ओ.इं. 272, बी.बी.एच-1 तथा बी. बी.एच-5 स्ट्रेनों से की। पहली तुड़ाई व कुल तुड़ाई के दौरान अधिकतम पैदावार ओ.ई. 272 स्ट्रेन में दर्ज की गई तथा इसके बाद बी.बी.एच.-1 तथा बी.बी.एच. 5 में दर्ज की गई। दूसरे फलश के दौरान अधिकतम पैदावार ओ.इ. 272 स्ट्रेन में दर्ज की गई तथा इसके बाद बी.बी.एच.-1 तथा बी.बी.एच.-5 में दर्ज की गई। दूसरे फ्लश के दौरान खुम्ब की अधिकत्तर पैदावार ओ.इ.-210 स्ट्रेन में तथा बाद में बी.बी.एच.-5 स्ट्रेन में थी। 100 कि.ग्रा. कम्पोस्ट में से खुम्ब कलिकाओं की संख्या के आधार पर थोड़ी विभिन्नता थी। सबसे अधिक संख्या बी.बी.एच.-5 तथा इसके बाद ओ.इ. 210 में दर्ज की गई। फलनकाय का औसतन भार सबसे अधिक स्ट्रेन ओ.इ.-274(14.05 ग्राम) तथा तत्पश्चात ओ.ई.-272(13.15 ग्राम) स्ट्रेनों में पाया गया।

(घ) विशिष्ट खुम्बें

लघु विधि द्वारा तैयार खाद पर मैक्रोलेपियोटा प्रोसीरा का उत्पादन प्रयोग लाया गया। कवक जाल फैलाव 25^0 से. 28^0 से. तापमान पर 32 से 37 दिनों में पूर्ण हुआ। केसिंग आवरण चढ़ाने के 20-25 दिनों के बाद कलिकाएं निकलनी प्रारम्भ हुई। कुछ फलनकाय उत्पन्न हुए। मैक्रोलेपियोटा प्रोसीरा की अतिरिक्त कोशिकीय एन्जाइम प्रोफाइल से ये पता लगा कि इसमें लिग-पेराआक्साइडस तथा लेकेज की अच्छी क्रिया होती है, माध्यम में गेहूँ का चोकर मिलाने से इस क्रिया में बढ़ोत्तरी होती है।

दो वृद्धि नियामक जी.ए. तथा काईनेटिन एगोसाइबी एगेरिटा के उत्पादन में उल्लेखनीय योगदान नहीं देते हैं। ये वृद्धि नियामक न तो उपनिवेशन अवधि को घटाते हैं तथा न ही उत्पादन में प्रचुर मात्रा में बढ़ोतरी करते हैं।

लेटिंना इडोडस गेहूँ के पुआल तथा बुरादे दोनों पर अकेले एवं मिलाने पर उपनिवेशित होते हैं। यह उपनिवेशन के लिए धान पुआल पर (48 दिन), गेहूँ के पुआल तथा बुरादे (50:50) पर (58 दिन) तथा अकेले बुरादे पर (68 दिन) का समय लेती है। बुरादे पर अधिकतम पैदावार (400 ग्राम, 1500 ग्राम शुष्क पोषाधार) दर्ज की गई जबकि गेहूँ के पुआल पर फलनकाय उत्पन्न नहीं हुए।

फसल संरक्षण

मईकोगॉन पर्निसियोसा तथा ए. बाइस्पोरस के विरूद्ध पात्रे तथा जीवे परिस्थितियों में विभिन्न पौध पदार्थों के अर्क, कुछ तेल तथा साईगोल्ड के दो वाणिज्य संरूपणों का मूल्यांकन किया। ताजा अर्कों में से कवक जाल वृद्धि में

टेगेटस इरेक्टा अर्क के कारण 27.34% अवरोध हुआ, जिसका अनुसरण पार्थनियम एस.पी. (16.5%) ने किया। शुष्क अर्कों में से किसी भी मामले में वृद्धि का अवरोध दर्ज नहीं किया गया। एल्कोहॉलिक अर्कों में से सबसे अधिक निरोध केनबीस स्टीवा (भाग) (32.91%) के कारण हुआ, जिसका अनुसरण केलिस्टोमोन लेंसियोलेटस (22.2%) ने किया।

विभिन्न तेलों में से एम. पर्निसियोसा के कवक जाल में वृद्धि का 100% निरोध ऐलियम सीपा (प्याज) ट्रेकीस्पेरमम, नाईजेला स्टीवा तथा कोरिएडंरम सोडियम (धनिया) के तेलों के कारण हुआ। ए. बाइस्पोरस के कवक जाल वृद्धि में 100% निरोध लहसून, अजवयान तथा साइगोल्ड के तेल के कारण हुआ। कार्बेनेडिजिम उपचार के बाद जैविक परिस्थितियों में अधिकतम पैदावार दर्ज की गई, जिसका अनुसरण नीम के तेल तथा गार्डोनिया ने किया। अधिकतम संख्या में रोगग्रस्त फलनकाय ए. सीपा तेल के मामले में दर्ज किए जिसका अनुसरण रिसिनस काम्युनिस (एरंड) के तेल ने किया।

संसाधित तथा बेचने योग्य खुम्बों में कार्बेनेडिजम का अवशोषित स्तर जानने के लिए अध्ययन किए गए। इससे यह ज्ञात हुआ कि विभिन्न खुम्बों की साधारण धुलाई से अवशेष 28.6% से 81.9% तक कम हए हैं। पोटाशियम डी. सल्फाइट (के.एम.एस.) से धोने के बाद अवशेषों के स्तर का कम ह्रास हुआ। खुम्बों की एस्कार्विक अम्ल में धुलाई, दो दिनों तक कमरे के तापमान पर भण्डारण, दो दिनों तक फ्रिज में भण्डारण, भट्टी में सुखाने और उबालने या पकाने पर कार्बेन्डेजिम के अवशोषित स्तर में क्रमशः 13.1-60.9%, 10.1-8.2%, 35.7-80.5%, 1.2-79.3% व 33.9-86.9% के मध्य हानि हुई।

विभिन्न स्रोतों से एकत्रित किए गए खुम्ब के नमूनों का विश्लेषण किया गया तथा पाया गया कि लगभग सभी नमूने कार्बेन्डेजिम से संदुषित थे, यहां तक की जैविक तौर पर उगाई गई बटन खुम्ब में भी कार्बेन्डेजिम के अवशेष स्पष्ट मात्रा में पाए गए। अधिकतम अवशेष सीमा (एमआरएल) 1 पीपीएम होती है, किसी भी नमूने में कोर्बोन्डेनिम की इससे अधिक मात्रा नहीं पाई गई। विभिन्न वृद्धि अवस्थाओं के दौरान फसल पर कार्बोन्डेजिम का छिड़काव किया गया तो कार्बेन्डेजिम अवशेषों का थोड़ा उच्चतर स्तर (0.345 पी.पी.एम.) पाया गया।

भाप द्वारा पास्चरीकृत खाद पर नियंत्रित परिस्थितियों में श्वेत बटन खुम्ब ऐगेरिकस बाइस्पोरस के स्ट्रेन-II को उगाया गया।

भाप द्वारा पास्चरीकृत खाद पर नियंत्रित परिस्थितियों में श्वेत बटन खुम्ब ऐगेरिकस बाइस्पोरस के स्ट्रेन-II को उगाया गया। इसमें मैलाथियॉन तथा डेकामेथरीन कीटनाशकों की दृढ़ मौजूदगी पाई गई। पहले प्रयोग में केसिंग के समय 5 विभिन्न सांद्रणों पर एकल छिड़काव किया गया तथा छिड़काव के 14 दिनों के पश्चात जी.एल.सी. पद्धति द्वारा फलनकायों पर अवशेष की उपस्थिति का आकलन किया गया। मैलाथियॉन के अवशेष 0.32 से 0.79 पी.पी.एम. तथा डेकामेथरिन के अवशेष 0.26 से 0.61 पी.पी.एम. के मध्य पाए गए। जब इन दोनों कीटनाशकों के सांद्रण में बढ़ोतरी की गई तो अवशेष के स्तर में भी संगत वृद्धि हुई।

एक अन्य प्रयोग में जब एक सप्ताह के अन्तराल के दौरान इन कीटनाशकों का पहला, दूसरा तथा तीसरा छिड़काव किया गया तो मैलाथियॉन के अवशेष क्रमशः 0.46, 0.88 तथा 0.95 पी.पी.एम. तथा डेकामेथारिन के अवशेष क्रमशः 0.38, 1.04 तथा 1.82 पी.पी.एम. थे।

अवशेष की उपस्थिति को जानने के लिए किए गए इन उपचारों के बाद जब फलनकाय से नमूने लेकर उन्हें पानी में 10 मिनट तक धोया या उबाला गया तो अवशेष के स्तरों में कमी आई, मैलाथियॉन में 31.6 से 87.6% मध्य व डेकामेथरिन में 59.8 से 90.1% के मध्य दोनों कीटनाशकों के अवशेष को कम करने में साधारण धुलाई की अपेक्षा उबालना अधिक प्रभावी पाया गया। स्थानीय बाजार तथा खुम्ब उत्पादकों से बटन खुम्ब के दस नमूने एकत्रित किए गए। इन नमूनों में से 60% नमूनों में कीटनाशक पाए गए। न्यूक्यिोटाईड अनुक्रम की तुलना 5.8 एस.आर.आर.एन.ए. जीन की सहायता से 15 क्लेडोबोट्रियम के 15 आइसोलेट्स की पहचान की। ये आइसोलेट्स एगेरिकस बाइस्पोरस, कैलोसाइबी इंडिका, प्लूरोट्स साजोर काजू, पी. सेपिडज, पी. फ्लोरिडा तथा पी. आस्ट्रेटस से एकत्रित किए गए थे, इन्हें तीन टैक्सा-कलेडोबोट्रियम डेंड्रोयडिस, सी. माईकोफिलयम व सी. एक्ट्रोफोरम में रखा गया। सी. डेंड्रोयडिस के संवधर्नों की मॉलिकुलर पहचान करके उन्हें सी. माइकोफिलियम तथा सी. एस्ट्रोफोरम में पुनअभिहित किया गया। भारत में उत्पादित विभिन्न खुम्बों में से तीन ऐसी नस्लें पाई गई जो कि काबवैब रोग से ग्रस्त थी तथा यह पाया गया कि एगेरिकस बाइस्पोरस में काबवैब रोग का प्रमुख कारण सी. माईकोफिलियम है न कि सी. ड्रेंड्रोयिडस जैसा कि पहले वर्णित किया जाता था। ढिंगरी खुम्ब की विभिन्न नस्लों में काबवैव रोग का प्रमुख कारण सी. एस्ट्रोफोरम है तथा यह भी पाया गया कि इसका व्यापक भौगोलिक वितरण हुआ है जो कि ढिंगरी उत्पादन के लिए संभाव्य खतरा है।

न्यूक्यिोटाईड अनुक्रम की तुलना 5.8 एस.आर.एन.ए. जीन की सहायता से ब्लास्ट, एन.एस.बी.आई., सू.एस.ए. डेटा बेसिस तकनीक प्रयोग कर हाईपोमाईसेस पर्निसियोसा की मोलिकुलर पहचान में भिन्नता (90-91%) देखी गई तथा इसे नई जीन संख्या इ.यू. 380 317 का नाम दिया गया।

कलेडोबीट्रियम आइसोलेट्स की अतिरिक्त कोशिकीय एन्जाईम प्रोफाइल से ज्ञात होता है कि बहुत से आइसोलेट्स में पेक्टीनेज की सक्रियता सबसे अधिक थी, उसके बाद जाईलेनेज, सी-1 सेल्यूलेज और सी.एक्स सेल्यूलेज अनुसरण करते पाए गए। इसी प्रकार वर्टिसिलियम आइसोलट की अतिरिक्त कोशिकीय एन्जाईम प्रोफाइल से ज्ञात हुआ कि इसमें सबसे अधिक सक्रियता पेक्टीनीज की थी, उसके बाद काईटिनैस तथा सी.एक्स सेल्सूलेज ने इसका अनुसरण किया।

एगेरिकस बाइस्पोरस तथा वाल्वेरिएला वाल्वेसिया खुम्बों से एकत्र किए गए जीवाणुओं के 10 आईसोलेट्स का मौलिकुलर चरित्र-चित्रण 16 एस.आर. आर.एन.ए.जीन आधारित आई.टी.एस. अनुक्रम द्वारा किया गया। इन आरसोलेटस की आर.ए.पी.डी. तकनीक पर आधारित फाइलों जैनेटिक विश्लेषण इन्हें 5 फाईलोजेनेटिक समूहों में प्रदर्शित करता है।

स्यूडामोनास के 10 आइसोलेट्स के पारस्परिक अध्ययन से यह ज्ञात हुआ कि इनमें से 8 आइसोलेटस ने फलैमुलिना वेलूटिप्स की वृद्धि का अवरोध किया जबकि सभी 10 आइसोलेटस ने वोल्वेरिएला वाल्वेसिया की वृद्धि का भिन्न सीमाओं तक अवरोध किया। फलैमुलिना वेलूटिप्स की वृद्धि में सबसे अधिक अवरोध आइसोलेट सं.5 में देखा गया, उसके बाद 6 तथा 9 दोनों में देखा गया। इन दोनों के परिणामस्वरूप 38.9% अवरोध हुआ। वाल्वेरिएला वाल्वेसिया की वृद्धि में आइसोलट 9 ने 66.6% अवरोध किया जिसका अनुसरण आइसोलेट 5 (61.1%) तथा आइसोलेट 6(44.4%) ने किया।

फसल पोषण एवं उपयोग

दिल्ली क्षेत्र से एक नई गेनोडरमा एकत्रित की गई जो कि सड़े हुए गुलमोहर के पेड़ पर उगी हुई थी। जी. ल्यूसिडियम द्वारा 0.05% एन में उच्चतम परऑक्सीडेज उत्पन्न हुआ तथा इसके बाद 0.2% एन में उत्पन्न हुआ। अन्य उपचारों में नगण्य सक्रियता देखी गई।

अवस्तर में लिग्नोलाईटिक (एम.एन.परऑक्सीडेज) तथा सैल्यूलाईटिक (एनॉग्लूकॉनेज) एन्जाईम के उत्पादन गतिशीलता का वास्तविक उत्पादन परिस्थितियों में एस.एफ.एफ. के अन्तर्गत अध्ययन किया गया। यद्यपि सैल्यूलेज की अपेक्षा परऑक्सीडेज दिखाई दिए तथा वे शिखर पर जल्दी पहुँच गए। परन्तु इसके बाद कोई निश्चित प्रवृति नहीं देखी जा सकी। बचे हुए चक्र के दौरान पूरा समय दोनों गतिविधियों को उच्च स्तर पर बनाए रखा गया जब तक कि पहला फ्लश खत्म नहीं हो गया।

गेनोडरमा ल्यूसीडियम से जल में घुलनशील एलकोहल व अघुलनशील पॉलीसैक्राइड के अर्क की उपज शुष्क खुम्बों (613 कि.ग्रा. प्रति 100 ग्राम ताजा के बराबर) की अपेक्षा ताजा खुम्बों (832 कि.ग्रा.) में उच्चतम थी।

मैप मशीन का उपयोग कर मोडिफाईड एटमॉसफेरिक पैकेजिंग (एम.ए.पी.) पर प्रयोग किए गए जिससे यह ज्ञात हुआ कि 100 गेज के पी.पी. बैग में भण्डारित खुम्ब 4 दिनों तक अच्छी रहती है। पुआल खुम्ब की पैकिंग पर अध्ययन किया इससे यह ज्ञात हुआ कि भण्डारण परिस्थितियों को ध्यान में रखे बिना यदि गुणवत्ता पुआल खुम्ब का भण्डारण खुली परिस्थितियों में पी.पी. बैग में करें तो यह 2 दिनों तक अच्छी रहती है।

गेहूँ के पुआल, धान के पुआल तथा बुरादे को पास्चरीकृत करने हेतु एक छोटे पोर्टेबल पास्चुराईजेशन चैम्बर का डिजाइन तैयार कर विकसित किया गया, दोनो हीटर लगाने के बाद अपेक्षित पास्चुराईजेशन तापमान (75 से 80^0 से.) 11 घंटों में प्राप्त किया गया। जबकि एक हीटर पोषाधार का अपेक्षित पास्चुराइजेशन तापमान प्राप्त करने में 23 घंटे लेता था।

तकनीकी हस्तांतरण

केन्द्र में अप्रैल-मई, 2008 के दौरान देशी तकनीकी-बटन खुम्ब के लिए खाद के आवरण के रूप में जली हुई धान की भूसी को गोबर व मिट्टी के साथ विभिन्न अनुपातों में मिलाकर बड़े पैमाने पर प्रयोग किए गए। यह प्रयोग देसी तकनीक को परखने व सुधारने हेतु किए गए। कवक जाल युक्त कम्पोस्ट पर जली हुई धान की भूसी पर आधारित विभिन्न केसिंग आवरणों को बिछाया गया तथा कमरें की उत्पादन परिस्थितियों को बनाए रखा। इन आवरणों के नाम हैः जली हुई धान की भूसी + मिट्टी (1:1 वी/वी), जली हुई धान की भूसी + मिट्टी + गोबर की खाद (1:1:1 वी/वी), जली हुई धान की भूसी + गोबर की खाद (2:1 वी/वी), जली हुई धान की भूसी + गोबर की खाद (1:2 वी/वी), नारियल की मज्जा + गोबर की खाद + जली हुई धान की भूसी (2:1:2 वी/वी), जली हुई धान की भूसी + स्पेन्ट कम्पोस्ट की वर्मी कम्पोस्ट (1:1 वी/वी), तथा तीन नियंत्रित उपचार -गोबर की खाद + नारियल की मज्जा (4:6 वी/वी), धुली तथा रसायन से उपचारित गोबर की खाद + नारियल की मज्जा (4:6 वी/वी), बी.आर. एच. + स्पेंट कम्पोस्ट की वर्मी कम्पोस्ट को 1:1 की दर से आवरण को सुधारने हेतु वैकल्पिक मिलाया जाता है। इन

उपचारों में से जली हुई धान की भूसी + मिट्टी (1:1 वी/वी), जली हुई धान की भूसी + मिट्टी + गोबर की खाद मट्टी (1:1:1 वी/वी), तथा जली हुई धान की भूसी + गोबर की खाद (2:1 वी/वी), उपचारों ने नियंत्रित उपचारों की तुलना में अच्छी उपज दी।

वर्ष के दौरान निदेशालय ने किसानों, महिलाओं, उद्यमियों, अधिकारियों तथा अनुसंधानकत्ताओं के लिए कुल 13 प्रशिक्षण कार्यक्रम आयोजित किए। प्रत्येक वर्ष की भाँति इस वर्ष भी 10 सितम्बर, 2008 को मशरूम मेले का आयोजन किया गया। मेले का उद्घाटन डा. राजीव बिंदल, माननीय स्वास्थ्य, आयुर्वेद तथा स्वास्थ्य शिक्षा मंत्री, हिमाचल प्रदेश ने किया। मेले में विभिन्न राज्यों जैसे कि हिमाचल प्रदेश हरियाणा, पंजाब, उत्तर प्रदेश, महाराष्ट्र, मध्यप्रदेश, छत्तीसगढ़, बिहार, झारखंड, दिल्ली, उत्तराखंड, आसाम, गुजरात, केरल, कर्नाटक तथा तमिलनाडू के लगभग 550 किसानों, महिलाओं, खुम्ब उत्पादकों, अनुसंधानकर्त्ताओं, विस्तार कार्य-कर्त्ताओं तथा व्यावसायियों ने भाग लिया। इस अवसर पर खुम्ब की उन्नत उत्पादन तकनीकियों तथा अन्य संबंधित पहलुओं पर एक प्रर्दशनी का भी आयोजन किया गया, जिसमें विभिन्न सरकारी संस्थाओं, भारतीय कृषि अनुसंधान परिषद के संस्थान तथा विश्वविधालयों, सरकारी वित्तीय संस्थाओं, खाद तथा स्पान उत्पादकों, खुम्ब उत्पादन निर्माताओं, बीज तथा कीटनाशक व रसायनिक पदार्थों के निर्माता तथा गैर सरकारी संस्थाओं ने अपनी बहुमूल्य सूचनाओं, तकनीकियों व उत्पादों का प्रदर्शन किया तथा अपनी सेवाएं मशरूम मेला के प्रतिभागियों को प्रदान की। खुम्ब उत्पादकों की समस्याओं के समाधान हेतु एक किसान गोष्ठी का भी आयोजन किया गया। किसानों तथा खुम्ब उत्पादकों द्वारा उगाई गई समस्याओं के जबाब विशेषज्ञों द्वारा क्रमबद्व तरीके से दिए गए।

मशरूम मेले के दौरान निदेशालय ने दस प्रगतिशील खुम्ब उत्पादकों को पुरस्कृत किया। इन किसानों ने बड़े पैमाने पर खुम्ब उत्पादन की नवीनतम तकनीकियां अपनाई तथा अन्य किसानों को खुम्ब उत्पादन को आय के स्रोत के रूप में अपनाने के लिए एकजुट किया।

प्रकाशन

वर्ष के दौरान निदेशालय के वैज्ञानिकों द्वारा 10 शोध पत्र राष्ट्रीय व अंतर्राष्ट्रीय जर्नल्स में प्रकाशित किए गए। एक किताब, 3 अध्याय, 2 तकनीकी बुलेटिन व सात प्रचलित लेखों का भी प्रकाशन हुआ।

EXECUTIVE SUMMARY

The achievements of the Centre during 2008 in area of Crop Improvement, Crop Production, Crop Protection, Crop Nutrition and Utilization, Transfer of Technology, Education and Training and Publications are summarized here.

CROP IMPROVEMENT

(a) Germplasm Collection: During the year, 217 specimens of different wild mushrooms were collected and out of them 192 were identified up to genus level. These also included wild mushroom specimens like *Amanita hunanensis, Amanita hemibapha* subsp. *ochracea, Amanita hemibapha* sub sp. *hemibapha.* The details of morphological characters especially related to pileus, volval remmants, lamellae, stipe, volva, annule, spore print and other microscopic structures of these *Amanita species* were described.The pileus of *A. hunanens* was 6.5-16 cm wide, campanulate to hemispherical at first then convex to applanate with age, often with broad umbo, brown (6E7-6) in centre, lighter towards margin, brownish orange to pale grey-brown (5C4-6C4), glabrous, often without volval remnants; margin sulcate-striate, striations 1.3-5.5 cm long, decurved; context white to off white, 0.3-0.8 cm thick. *A. hemibapha* sub sp. *ochracea* had 8-18 cm wide pileus, campanulate to hemispheric at first, convex then flattened in age, slightly umbonate, brownish yellow (5C6) to light brown or golden brown to yellowish brown (5D5-7), brown (6D8) in younger stage, volval remnants usually absent on pileus; margin tuberculate-striate, striations 1.2-4.5 cm long, decurved; context white to yellowish white below cuticle, 0.5-1.0 cm thick. The fruit bodies of *A. hemibapha* subsp. *hemibapha* were 7-18.5 cm wide, distinctly umbonate, orange (5A7) at umbo, deep orange (6A8) to orange red (8A8) outwards, deep yellow to yellowish orange (4A8-A7) to chrome yellow (5A8-A7) towards margin; margin sulcate-striate.

(b) Germ plasm Characterization: RAPD analysis using 10 random primers revealed wide interspecific variation among 41 strains of *Pleurotus* species collected from AICMIP Centres . However, within species genetic variation was low. Species-specific unique bands were obtained in number of RAPD profiles of *P. fossulatus*, *P. florida*, *P. sajor-caju* and blue oyster *P. ostreatus*, indicating that *Pleurotus* species are genetically quite divergent. 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).

(c) Genetic Improvement: Twenty-four strains of *A. bisporus* including some of the wild collections from India were evaluated for their yield potential with 8 replications each consisting of 10 kg short method compost in RBD design. Single spore selections CM-3 (SSI-16), CM-7 (SSI-6002) and CM-9 (SSI-4035) performed superiorly over the control U-3. Wild collection WC-21 was domesticated, which produced brown fruiting bodies at 24-25°C. Seven strains of *A. bisporus*, as recommended by AICMIP workshop, were evaluated in RBD design with 8 replications each consisting of 10 kg short method compost. Three strains namely CM-12, CM-15 and CM-16 with 19.78, 18.91 and 18.11 kg mushrooms/100 kg compost, respectively, were the higher mushroom yielder than the standard check S-130.

Spore prints from 11 strains of *C. indica* were obtained and preserved at room

temperature. Only few germlings were observed under inverted microscope after 35-40 days incubation at 28°C. A total of 26 strains of milky mushroom were spawned in pasteurized wheat straw substrate. Good to excellent spawn run was observed in 22 strains and it took 15-18 days for complete spawn-run. However, in strains IIHR-56, OE-54, OE-228 and OE-229 the spawn run was very slow and these did not fructify at 32-35°C. Four strains including one newly domesticated wild strain yielded superiorly during September-October, trial.

Molecular variation and genetic identities were studied among 24 germplasm strains of *C. indica* using 10 RAPD markers and by amplification of 5.8S rRNA gene along with ITS regions. ITS sequence analysis revealed the identity of OE-54 as *P. florida* after comparison with NCBI database. Complete ITS region sequences were obtained only in six strains namely OE-152, OE-331, OE-342, OE-344, OE-345 and OE-347 wherein two SNPs (one SNP in ITS1 and another in ITS2 region) were identified. While in 15 strains of *C. indica* the chromatographs showed mixed peaks with both the primers.

In paddy straw mushroom a total of 7 different strains were evaluated for their yield potential on composted substrate. In lignocellulolytic enzyme activity profile, the highest activity of exoglucanase and endoglucanase was recorded in strain, BBSR-03, followed by strain BBSR-02 for exoglucanase and BBH-1 for endoglucanase. The highest activity of β-glucosidase was in strain BBSR-02, followed by BBH-5. The activity of xylanase, laccase and polyphenol oxidase were highest in strain WW-08, BBH-5 and BBSR-03, respectively. No single strain was recorded to have superior activity of all the six enzymes, while strains BBSR-02 and BBSR-03 were recorded to have good activity of the entire enzymes.

Large variation in the radial growth rate among 19 *Pleurotus sajor- caju* strains was observed. Nineteen strains of *Pleurotus florida* collected from Gene Bank of NRCM, Solan were evaluated for their yield and morphological characterization on pasteurized wheat straw during winter months. Strain Pl-900 gave earliest fruiting and the highest biological efficiency (108.3%). A *Pleurotus* species tentatively identified as *Pleurotus djamor* was cultivated during 2008.

CROP PRODUCTION

(a) Preparation of indoor compost by using combination of INRA and Anglo Dutch methods for *Agaricus bisporus*: The ingredients were thoroughly mixed and wetted for two days before their transfer to bunker for phase-I operation. After 6 days of partial fermentation in phase-I, entire compost mass was taken out and transferred to tunnel for usual phase-II operations. Standard methodology was employed thereafter for compost production. Phase II operation was completed in 7 days. Wheat straw to compost ratio was 4.17. An average yield of 14.07 kg mushrooms per quintal compost was obtained from the trial in forty days of cropping.

Thermophilic fungi viz. *Talaromyces dupontii*, *Paeciliomyces variotii*, *Gilmannalia, Humicola*, *Sporotrichum thermophile*, *Thermomyces lanuginosus*, *Thermoascus aurantiacus*, *Humicola fascoatra*, 8 strains of *Humicola grisea*, 6 strains of *Humicola insolens* and 8 strains of *Scytalidium thermophilum* were screened to asses their cellulose degradation potential *in vitro*. Among all the thermophilic fungi and their isolates, *H. gresea* possess the highest cellulose degrading ability. HG-4 strain of *H. grisea* showed the highest activity followed by ST- 7 (*S. thermophilum*) and then *H. insolens* (HI- 2). Different strains of these 3 thermophilic fungi possess different cellulose

degrading potential. *T. dupontii* showed poor cellulose degrading ability among all the test fungi. Optimization of cultural conditions for enzyme production revealed that *S. thermophilum* is a potent cellulose degrader. The pH and temperature optima for endoglucanase activity were 6.5 and 45°C, respectively. Similarly, pH and temperature optima for exoglucanase activity were 5.5 and 45°C, respectively. Temperature studies indicated that *S. thermophilum* can grow and produce cellulases at 40°C to 60°C, however, 60°C proved to be optimum for exoglucanase production and 45 °C for endoglucanase. It was also revealed that *S. thermopilum* is a good cellulase producer at varying pH and higher temperature normally obtained during phase I and phase II of composting. Addition of nitrogen in the medium had marked effect on the production of endo and exo-glucanase. Endo glucanase was stimulated considerably at 0.50-1.0% potassium nitrate concentration. Similar results were obtained with urea. Ammonium chloride also induces the enzyme production at 0.50% N concentration, however it completely suppressed the enzyme activity at higher N level.

(b) Organic mushroom production: Tenth organic crop of button mushroom was raised successfully. Pinheads appeared after 13th day of casing, while first harvest (days post-casing) was achieved after 18 days. The 4 weeks of cropping yielded 10.13 kg mushroom / quintal of finished compost prepared by long method . Nearly 80% of the total mushroom yield was achieved in the first two weeks while rest 20% yield was achieved in the last two weeks. In the 11th trial 3 weeks of cropping yielded 7.43 kg mushroom / quintal of finished compost. The first 2 weeks yielded 85% of the total mushroom yield, while the later 1 week yielded rest 15% of the total mushroom yield.

(c) Paddy straw mushroom: The strains showing mycelial growth typical of paddy straw mushroom were used and all colonized the composted substrate almost at same level. However, mycelial density was higher in strains, BBSR-03 and OE-55-08. Among different strains, strain OE-210, OE-274, OE-55-08, BBH-1 and BBH-5 colonized earlier and better than other two strains. However, pinning was higher and earliest in strain, OE-272, followed by OE-274 and BBH-5. Earliest mushroom harvest was in 11.25 days in strains, OE-272, BBH-1 and BBH-5. The highest mushroom yield during first flush as well as total was recorded in strain, OE-274, followed by strain, BBH-1. In second flush the highest mushroom yield was in strain, OE-210, followed by BBH-5. Trend with respect to number of fruiting bodies from 100 kg compost was bit different and the highest number was recorded in strain, BBH-5, followed by OE-210. Average fruiting body weight was the highest in strain, OE-274 (14.05g), followed by OE-272 (13.15g).

(d) Speciality mushrooms: Cultivation trial on *Macrolepiota procera* was undertaken on short method compost. The spawn run was completed in 32-37 days at 25-28°C. The primordia initiated after 20-25 days after the application of casing layer. Few fruit bodies were produced. Extracellular enzyme profile of *Macrolepiota procera* showed that it has good activity of lig-peroxidase and laccase which further increased by supplementing the medium with wheat bran.

Two growth regulators GA and kinetin significantly enhanced the production of *Agrocybe aegerita*. These growth regulators did not considerably reduce the colonization period but significantly resulted in enhancement in the production.

Lentinula edodes colonized both wheat straw and saw dust alone or in combination and it took shortest time (48 days) on wheat straw followed by 58 days on wheat straw + saw dust (50:50) and saw dust alone(68 days). The

maximum yield (400g / 500g dry substrate) was recorded on saw dust alone whereas no fruit bodies were produced on wheat straw alone.

CROP PROTECTION

Various plant material extracts, certain oils and two commercial formulation of neem and SAI GOLD were evaluated against *Mycogone perniciosa* and *A. bisporus* under *in-vitro* and *in-vivo* conditions. Among fresh extracts , *Tegetes erecta* extract caused 27.34% inhibition of mycelial growth followed by *Parthenium* sp. (16.5%). Among dry extracts no inhibition was recorded in any case. Among the alcoholic extracts *Cannabis sativa* caused maximum (32.9%) inhibition followed by *Callistomon lanceolatus* (22.2%).

Among different oils, *Allium cepa*, *Trachyspermum ammi*, *Nigella sativa* and *Coriandrum sativum* caused 100% inhibition of mycelial growth of *M. perniciosa* whereas garlic oil, ajwain oil, sai gold caused 100% inhibition of mycelial growth of *A. bisporus*.Under *in-vivo* conditions the maximum yield was recorded in case of carbendazim treatment followed by neem oil and *Gardenia* sp. Maximum number of diseased fruit bodies were recorded in case of oil of *A. cepa* followed by extracts of *Ricinus cumminis*.

Studies conducted on status of carbendazim residues in processed and marketable mushrooms revealed that residue reduced to 28.6% to 81.9% in different mushrooms by simple washing, however, washing with potassium disulphite (KMS) comparatively resulted in less decrease in residue levels. Corresponding losses due to washing with ascorbic acid, storing at room temperature for two days, storing in refrigerator for two days, oven drying and boiling or cooking of samples ranged from 13.1-60.9%, 10.1-8.2%, 35.7-80.5%, 1.2-79.3% and 33.9-86.9%,respectively.

Analysis of mushroom samples collected from different sources revealed that almost all the samples were contaminated with carbendazim. Residues of carbendazim were detected in appreciable quantities even on organically grown button mushroom. However, none of the samples contained total carbendazim residue above maximum residue limit (MRL) of 1 ppm.When repeated sprays of carbendazim were given during different growth stages of the crop, slightly higher level of carbendazim residue (0.345ppm) was detected.

Persistence of malathion and decamethrin was estimated in white button mushroom, *Agaricus bisporus*, Strain S-11 grown on steam pasteurized compost under controlled conditions. In the first experiment single spray of these insecticides at 5 different concentrations were given at the time of casing and residue in fruit bodies after 14 days of spray estimated by GLC method. 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.

In another experiment where single, double and three sprays of these insecticides were given at weekly intervals, the residue of malathion was 0.46, 0.88 and 0.95 ppm and that of decamethrin was 0.38, 1.04 and 1.82ppm, respectively.

Overall reduction in the residue levels ranged from 31.6 to 87.6% in malathion and 59.8 to 90.1% in decamethrin when fruit body samples from all these treatments were washed or boiled in water for 10 minutes. Boiling was more effective in lowering residue of both the 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.

The nucleotide sequence comparisons of 5.8S rRNA identified 15 *Cladobotryum* isolates, isolated from *Agaricus bisporus, Calocybe indica* and *Pleurotus sajor-caju, P. sapidus, P. florida* and *P. ostreatus,* into three taxa viz., *Cladobotryum dendroides , C. mycophilum* and *C. asterophorum*. In the light of molecular identification the cultures of *C. dendroides* were redesignated as *C. mycophilum* and *C. asterophorum*. At least three species were found to be associated with cobweb disease of different cultivated mushrooms in India and *C. mycophilum* is potential cause of cobweb disease in *A. bisporus* and not *C. dendroides* as described earlier. *C. asterophorum* was found to be associated with different species of oyster mushrooms and suggests wide geographical distribution and is a potential threat to *Pleurotus* cultivation.

The nucleotide sequence comparisons of 5.8S rRNA gene of *Hypomyces perniciosus* using BLAST, NCBI, USA databases showed distinct molecular identities (90-91%) with other mushroom pathogen and have been assigned new Gen accession number EU 380317.

Extracellular enzyme profile of *Cladobotryum* isolates revealed that most of the isolates have the highest activity of pectinase followed by xylanase, C_1 cellulase and Cx cellulase. Similarly extracellular enzyme profile of *Verticillium* isolate revealed the highest activity of pectinase follwed by chitinase and Cx cellulase.

Molecular characterization of 10 isolates of bacteria collected from *A. bisporus* and *Volvariella volvacea*, undertaken by ITS sequencing of 165 rRNA gene and subsequent phylogenetic analysis using RAPD technique exhibited 5 phylogenetic groups.

Interaction studies revealed that out of ten isolates of *Pseudomonas,* 8 isolates inhibited the growth of *Flammulina velutipes* whereas all the ten isolates inhibited the growth of *V. volvacea* to varying extent. However, the maximum (50%) inhibition was noticed with isolate number V in case of *F.velutipes* followed by VI and IX both resulting in 38.9% inhibition. In *V volvacea* isolate IX inhibited the growth upto 66.6% followed by isolate V (61.1%) and isolate VI (44.4%).

CROP NUTRITION AND UTILIZATION

The highest Mn Peroxidase was produced by *Genoderma lucidum* in 0.05% N followed by 0.2%N. Negligible activities were noticed in other treatments.

Dynamics of lignolytic (Mn peroxidases) and cellulolytic (enoglucanase) enzyme production in the substrate under actual growing conditions was studied under the SSF. Though peroxidases appeared and peaked earlier than cellulase but no definite trend could be observed there after. Very high levels of both the activities were maintained throughout the rest of the cycle till the first flush was over.

The yield of water soluble—alcohol insoluble polysaccharides extract from *G. lucidum* was higher from the fresh (832 mg) than from dried (631 mg per 100 g fresh eq.)

Experiments conducted on the modified atmospheric packaging (MAP) using the MAP machine revealed that mushroom stored in 100 gauge PP bags remained good up to 4 days.

Studies conducted on the packing of paddy straw mushroom revealed that the quality paddy straw mushrooms stored in PP bags of open condition remained good up to 2 days irrespective of the storage condition.

A mini portable pasteurization chamber was designed and developed for the pasteurization of wheat straw, paddy straw and sawdust. When both the heaters were switched on, the required pasteurization temperature of 75-80°C was

achieved in 11 hours and the single heater took 23 hours to achieve the required pasteurization temperature of the substrate.

TRANSFER OF TECHNOLOGY

A large scale trial was laid out to verify and refine ITK about use of burnt rice husk mixed with F.Y.M. and soil in different ratio as casing material in button mushroom during the months April – May, 2008 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 and chemically treated, FYM + coir pith (4:6 v/v) unleached and chemically treated, and FYM + coir pith (4:6 v/v) leached and pasteurized were applied on spawn run compost and cropping conditions were maintained in the rooms. BRH + vermicompost of spent compost in 1:1 ratio has been added as alternate to refine the formulations. Out of these treatments, burnt rice husk + soil (1:1v/v), burnt rice husk + soil + FYM (1:1:1v/v) and burnt rice husk + FYM (2:1v/v) treatments have given good yield as compared to control treatment.

The Centre has organised a total number of 13 training programmes for farmers, farm women, entrepreneurs, officers & reseachers.

One day Mushroom Mela was organised on 10th September, 2008 as regular activity of the Centre. It was inaugurated by Dr.Rajeev Bindal, Hon'ble Minister of Health, Ayurveda and Health Education, Himachal Pradesh. It was attended by about 550 farmers, farm women, mushroom growers, researchers, extension workers and businessmen from various States viz; Himachal Pradesh, Haryana, Punjab, Uttar Pradesh, Maharashtra, Madhya Pradesh, Chattishgarh, Bihar, Jharkhand, Delhi, Uttrakhand, Assam, Gujrat, Kerala, Karnataka and Tamil Nadu. An exhibition on improved mushroom cultivation technologies and other related aspects was organised in which various Government Organization, ICAR Institutes/ University, Government 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.

A Kisan Goshthi was also held to answer the problems in mushroom cultivation faced by mushroom growers. The problems raised by farmers and mushroom growers were replied by experts in a very systematic manner.

During the Mushroom Mela, the Centre awarded 10 progressive mushroom growers for adopting innovative practices in mushroom cultivation on large scale and mobilizing other farmers to adopt mushroom cultivation as source of income.

PUBLICATIONS

During the year, the scientists of the DMR have published 10 research papers in referreed national and international journals, 1 book, 3 book chapters, 2 technical bulletins and 7 popular articles.

INTRODUCTION

The world trade of mushrooms is increasing day by day due to their demand particularly in Europe, USA and Canada. Total annual trade of medicinal and edible mushrooms is about US $ 50 billion. India's share in International market is very low and mainly button and morel mushroom are marketed. India has vast potential for mushroom production due to the availability of agro wastes in abundance, diversified agro climate and cheap manpower. India produces about 600 million tones of agro wastes per annum which includes about 130 million tones of wheat straw, 85 million tonnes of paddy straw, 186 million tonnes of sugarcane bagasse, 30 million tonnes of maize straw, 36.24 million tones of millet straw, 13.14 million tones of pulses straw, 25.58 million tonnes of oilseeds waste, 16.19 million tonnes of cotton waste and rest from coconut, jute and other crops. Besides this good quantity of waste is available from agro industries and poultry which can also be utilized for mushroom production. If we utilize even 1% of the agro waste India can produce about 3.0 million tones of mushroom per annum, million tonnes of spent mushroom substrate (SMS) and employment to millions.

SMS has its own unique traits suitable to be utilized as organic manure, adsorbs the organic and inorganic pollutants and harbours diverse category of microbes having capabilities of biological break down of the organic xenobiotic compounds. It is also used as substrate for biogas (energy) generation, has several potentials and multiple benefits, such as possibility to utilize feed stocks of high moisture contents, ability to be scaled to suit family as well as community needs, effluent being a good source of manure which can replace chemical fertilizers, and can give indirect economic benefits to the users.

National Research Centre for Mushroom is located in Chambaghat, Solan, the mushroom city of India. There is no regional station of the Centre but for the multi-locational testing of technology under varied agro-climatic conditions, an All India Coordinated 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 217 mushroom cultures were depostited in the National Mushroom Repository of the Centre. While studing the genetic variability among 41 strains of *Pleurotus* species collected from AICMIP Centres wide DNA variation was observed using 10 random primers. Some single spores namely, CM-3 (SSI-16), CM-7 (SSI-6002) and CM-9 (SSI-4035) of *Agaricus bisporus* were observed to be higher yielder than U-3. One high temperature requiring wild collection WC-21 was domesticated, which produced brown fruiting bodies at 24-25°C. Among different strains of paddy straw mushroom, strain OE-210, OE-274, OE-55-08, BBH-1 and BBH-5 were observed to be fast growing. OE-274 gave the highest mushroom yield followed by strain, BBH-1. In comparative growth rate studies large variation in the radial growth rate among

19 *Pleurotus sajor- caju* strains was observed. In *Pleurotus florida* strain Pl-900 gave the highest biological efficiency (108.3%) among the nineteen evaluated for their yield potential.

An average yield of 14.07 kg mushrooms per quintal compost was obtained in forty days cropping on the compost prepared by indoor composting using combination of INRA and Anglo Dutch methods.Wheras 7.43 kg -10.13 kg mushrooms/100kg of finished compost were harvested in 4 weeks cropping period in the two experiments on organic mushroom farming. Among the different substrates evaluated for the production of *Lentinula edodes*, saw dust proved to be the best.

Severe incidence of scarids, phorids and red pepper mite, *Pygmephorus sellnicki* was recorded in most of the farms surveyed during the year. Among the different plant products evaluated against *Mycogone perniciosa,* oils of *A.cepa*, *Trachyspermum ammi*, *Nigella sativa* or *Coriandrum sativum* caused 100% inhibition to the mycelial growth under *in vitro* conditions. Studies conducted on the effect of processing on the residue levels revealed that carbendazim residue reduced to 28.57% to 81.86% by simple washing. Washing or boiling of mushrooms in water for 10 minutes, resulted in reduction of residue levels 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.

At least three species were found to be associated with cobweb disease of different cultivated mushrooms in India and *C. mycophilum* is potential cause of cobweb disease in *Agaricus bisporus*. Interaction studies revealed that out of ten isolates of *Pseudomonas,* 8 isolates inhibited the growth of *Flammulina velutipes* whereas all the ten isolates inhibited the growth of *Volvariella volvacea* to varying extent.

Studies conducted on the packing of paddy straw mushroom revealed that paddy straw mushrooms stored in PP bags in open condition remained good up to 2 days irrespective of the storage condition. A mini portable pasteurization chamber was designed and developed for the pasteurization of wheat straw, paddy straw and sawdust.

During the year the Centre organised 13 training programmes for farmers, farmwomen, entrepreneurs & reseachers. One day Mushroom Mela was organised on 10th September, 2008 which was attended by about 550 farmers, farm women, mushroom growers, researchers, extension workers and businessmen from various States. The Centre awarded ten progressive mushroom growers for adopting innovative practices in mushroom cultivation during the Mushroom Mela. Kisan Goshthi was also held to answer the problems in mushroom cultivation faced by mushroom growers.

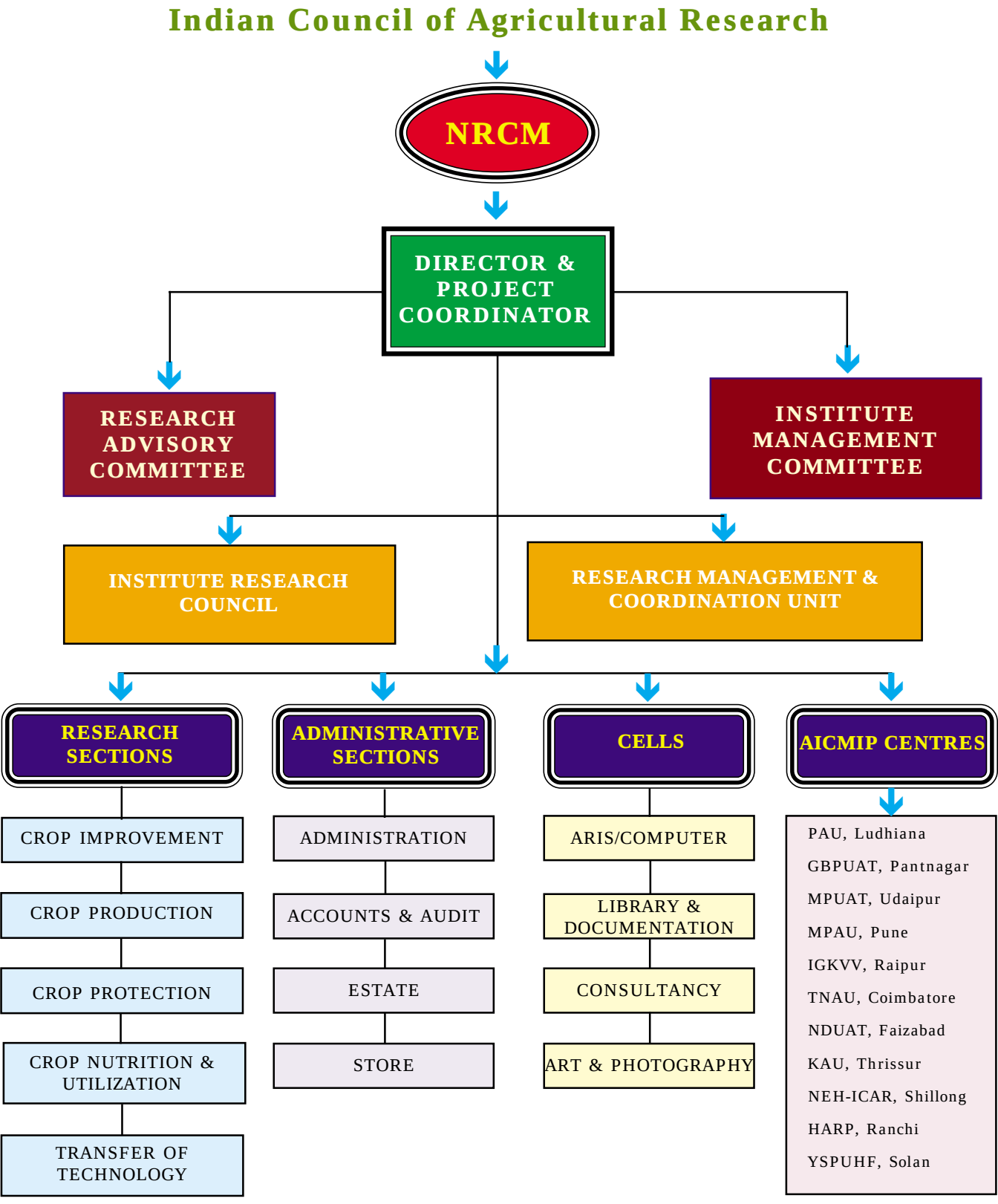
Staff and Finance

The Centre has a sanctioned strength of 18 scientists + 1 Director, 14 Technical, 16 administrative and 11 supporting staff. The staff in position on 31.12.2008 was 10 scientists, 14 technical, and 16 administrative and 9 supporting staff. The annual budget of the Centre for the year 2008-2009 was Rs.200.00 Lakh (Plan) and Rs. 220 Lakh (Non Plan). The centre earned Rs.9.70 Lakhs 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.

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 and 2500 back volumes of journals. It subscribes eight foreign journals and thirty-two Indian journals.



Organizational structure of NRCM, ICAR, Solan

CROP IMPROVEMENT

1. Mushroom Genetic Resources

1.1 Survey, collection and identification of wild fleshy fungi

Fungal forays were conducted in the forest areas of Himachal Pradesh, Uttrakhand, Delhi, Punjab, Haryana and Chandigarh. In all 217 specimens were collected and 192 specimens were identified upto genus level. The detailed anatomical description of some of the important specimens is as bellow:

1.1.1 *Amanita hunanensis* Y.B. Peng & L.H. Liu Acta. Microbio. Sinica 21: 152, Pl. I (1981)

Pileus 6.5-16 cm wide, campanulate to hemispherical at first then convex to applanate with age, often with broad umbo, brown (6E7-6) in centre, lighter towards margin, brownish orange to pale grey-brown (5C4-6C4), glabrous, often without volval remnants; margin sulcate-striate, striations 1.3-5.5 cm long, decurved; context white to off white, 0.3-0.8 cm thick.

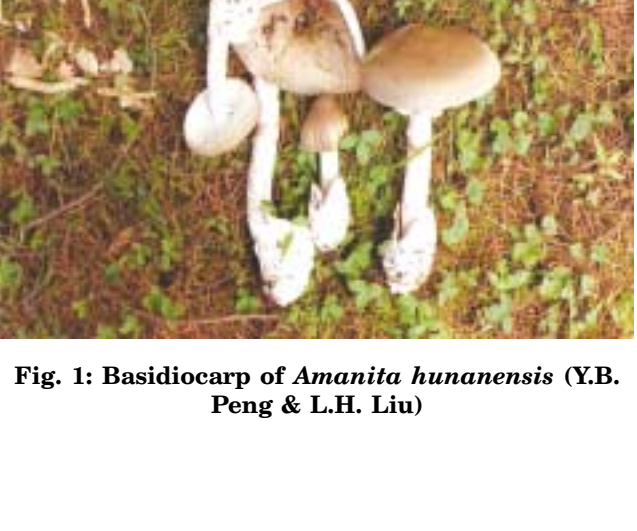


Fig. 1: Basidiocarp of *Amanita hunanensis* (Y.B. Peng & L.H. Liu)

Lamellae free to narrowly adnexed, moderately distant, whitish, 0.8-1.2 cm broad; lamellulae truncate of various lengths. Stipe 9-13 × 1.3-1.9 cm, tapering upwards or subcylindric, whitish, often with fine light brown fibrils; context whitish, soft. Volva saccate, 3.5 - 5.5 × 1-2.8 cm, thick, membranous, lobed, white to whitish, with inner surface darker. Annulus superior, membranous, thin, whitish, with flocculose edge. Taste and odor not recorded. Spore print in mass- white (Fig.1).

Pileipellis 50-120 μm thick; suprapellis 20-30 μm, partially gelatinized, made up of subradially arranged filamentous hyphae, 3.5-7.5 μm wide, branched, hyaline, loosely interwoven, septa with clamps; subpellis 50-70 μm thick made up of compactly arranged filamentous hyphae, 3.5-10 μm wide, branched, septa often clamped; vascular hypahe rare. Pileus context: composed of compactly arranged filamentous hyphae, 2.5-9 μm wide, branched, septate, mixed with long- cylindric to long ellipsoid cells, 150-450 × 10-40 μm, subclavate to fusiform cells, 40-180 × 20-50 μm; vascular hyphae often upto 7 μm wide. Lamella trama bilateral; mediostratum, 20-60 μm thick, comprising sub-clavate or cylindric cells, 40-120 × 20-50 μm, intermixed with filamentous hyphae, 3-10 μm wide, branched, thin-walled, often clamped; lateral stratum comprising fusiform to narrowly clavate cells, 40-80 × 10-25 μm, mixed with filamentous hyphae 2-8 μm wide, diverging an angle of 30^0-40^0 to the central stratum, septa with clamps. Subhymenium 30-50 μm thick, with 2-3 layers of ovoid, subglobose or globose to irregular ellipsoid cells, 14-25 × 9-17 μm. Basidia 26-50 × 6.5-13.5 μm, clavate, 4-spored, sterigmata 2.5-4.5 μm long, often granulated, basal septa with clamps. Marginal cells of lamlellae: 15-45 × 10-20 μm, broadly clavate to pyriforms, subglobose to globose

cells, thin walled, often 2-3 in chains. Annulus: consisting of abundant filamentous hyphae, 1.5 -7 μm wide, interwoven, branched, mixed with few inflated broadly ellipsoid to subclavate, 50 -130 × 10-40 μm, subglobose to globose cells, 30-50 × 20-30 μm; vascular hyphae few, often up to 6 μm wide. Stipe context made up of longitudinally oriented acrophysalides, long-cylindric, long-clavate to long-fusiform cells, 150-400 × 20-65 μm, mixed with filamentous hyphae, 2-9 μm wide, thin walled, branched. Volval remnants on stipe base: comprising fairly abundant filamentous hyphae, 3-10 μm wide, thin walled, hyaline, branched, septate, interwoven, septa with clamps; inflated cells, globose to subglobose, 30-120 × 47-105 μm, ellipsoid to broadly ellipsoid, 60-110 × 30-80 μm, sometimes clavate to broadly clavate or pyriform cells, 50-120 × 20-60 μm; inner surface: similar to exterior surface with scarce inflated cells.

Basidiospores**:** [50/1/1] (8.1-) 8.6 - 11.7 (-12.6) x 5.4-7.2 (-8.1) μm; L'= 9.5 μm; W'= 6.4 μm; Q= (1.28-) 1.33-1.6 (-1.85); Q' = 1.47; ellipsoid to broadly ellipsoid, inamyloid, colorless, thin-walled, hyaline, smooth; apiculus small up to 0.9 μm long; contents often as single refractive guttule (Fig. 2).

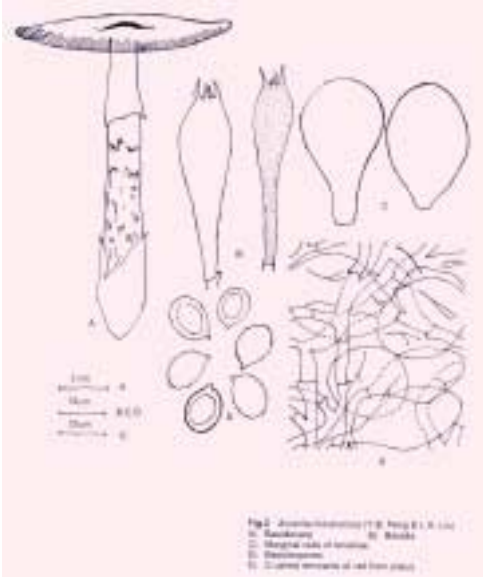


Fig.2: Microscopic details of *Amanita hunanensis*

1.1.2 *Amanita hemibapha* subsp. *ochracea* Z.L. Yang var. nov. Die *Amanita*-Arten von Südwestchina

Pileus: 8-18 cm, wide, campanulate to hemispheric at first, convex then flattened in age, slightly umbonate, brownish yellow (5C6) to light brown or golden brown to yellowish brown (5D5-7), brown (6D8) in younger stage, volval remnants usually absent on pileus; margin tuberculate-striate, striations 1.2-4.5 cm long, decurved; context white to yellowish white below cuticle, 0.5-1.0 cm thick. Lamellae free to narrowly adnexed, sub-crowded to moderately distant, light yellow, 0.9-1.7 cm broad, lamellulae truncate to subtruncate of various ranks. Stipe 9.5-16 x 1.4-2.3 cm, tapering upwards, yellowish, covered with appressed zigzag yellowish brown fibrils or squamules. Annulus superior, yellowish to yellowish brown, pendent, membranous, thin, persistent. Volva saccate, thick, membranous, often with 2-3 limbs, white, inner surface darker, orangish brown 3.5-6.5 x 2-4 cm, sometimes with darker *limbus internus*. Odour- not known. Taste- not known. Spore print in mass- white (Fig. 3).

Fig.3: Basidiocarp of *Amanita hemibapha* subsp. *ochracea* (Z.L. Yang)

Pileipellis: 40-115 μm thick, suprapellis, 15 -25 μm thick, gelatinized, consisting of subradially arranged filamentous hyphae, 1.5-8 μm wide, branched, hyaline, thin walled, interwoven, septa often clamped; vascular hyphae often up to 7.5 μm wide; subpellis 40-75 μm thick, consisting of compactly arranged interwoven filamentous hyphae, 3-8 μm wide, septa often with clamps; vascular hyphae few, 3-8 μm wide. Pileus context: consisting of filamentous, branched, interwoven hyphae, 2-8 μm wide, intermixed with inflated long subclavate, long cylindric to subcylindric cells 180-480 × 10-30 μm, fusiform to subfusiform cells, 50-150 × 20-50 μm. Lamella trama bilateral; mediostratum 30-50 μm thick, made up of fairly abundant long ellipsoid to cylindric or narrowly clavate cells, 60-200 x 15-40 μm, mixed with abundant filamentous hyphae 1.5-6 μm wide; often clamped; lateral stratum made up of fusiform to subfusiform or subclavate cells, 30-70 × 10-20 μm, mixed with filamentous hyphae, 2-8 μm wide, diverging, curved towards mediostratum, septa often bearing clamps. Subhymenium 25-40 μm thick, with 2-3 layers of subglobose to ovoid or short ellipsoid cells, 8-25 x 7-20 μm. Basidia 28-50 x 7-12 μm, clavate, 4- spored, sterigmata 2.3-4.5 μm long, basal septa with clamps. Marginal cells: 20-50 × 10-30 μm, broadly clavate to subglobose or globose, thin walled, hyaline, often 2-3 in chain. Stipe context: made up of longitudinally acrophysalides, long cylindric, subcylindric, long subclavate cells 100-280 × 20-35 μm, mixed with filamentous hyphae, often up to 8 μm wide. Annulus: made up of abundant filamentous hyphae, 2-8 μm wide, branched, septate; septa with clamps, intermixed with scattered, few inflated subglobose or ovoid, ellipsoid to broadly ellipsoid cells, 20-40 × 10-35 μm. Volval remnants on stipe base made up of fairly abundant irregularly arranged, interwoven, filamentous hyphae, 3.5-7.5 μm wide, hyaline, thin walled, branched, septa with clamps; inflated cells scarce to scattered, subglobose to ovoid often up to 120 × 100 μm, broadly ellipsoid to ellipsoid cells, 65-140 x 20-70 μm; inner surface: similar to exterior surface with more abundant filamentous hyphae.

Basidiospores: [55/2/2] (7.6-) 8.1 - 10 (-10.8) x 5.6 - 6.6 (-7.2) μm; L'= 9.1 μm; W'= 6.2 μm; Q= 1.3 - 1.58 (-1.71); Q'= 1.49; ellipsoid, sometimes elongate, inamyloid, thin-walled, colorless, hyaline, smooth; apiculus upto 1 μm long; content often as single refractive guttule (Fig. 4).

Fig.4: Microscopic details of *Amanita hemibapha* subsp. *ochracea*

1.1.3 *Amanita hemibapha* subsp. *hemibapha* (Berk. & Br.) Sacc., *Syll. Fung*. **5**: 13. (1887).

Pileus 7-18.5 cm wide, distinctly umbonate, orange (5A7) at umbo, deep orange (6A8) to orange red (8A8) outwards, deep yellow to yellowish orange (4A8-A7) to chrome yellow (5A8-A7) towards margin; margin sulcate-striate. Lamellae pastel yellow to light yellow (2A4), or yellow (3A7), 1- 1.6 cm broad, lamellulae truncate to subtruncate, of various lengths. Stipe 10.5-15 × 1.6-2.4 cm, yellowish orange (4A7) above annulus, maize yellow (4A6) to deep yellow (4A8) downwards, covered with

appressed zigzag, finely ornamented yellowish fibrils to small squamules above and below annulus. Annulus superior, membranous, pendant, orangish yellow to pale yellow. Volva saccate, membranous, lobed with 2-3 limbs, thin at margin, thick at base, 0.4-0.6 cm thick, white, 4.5-6.5 × 2.4-3.5 cm, sometimes with thick and small, orange limbus internus (Fig. 5).

Fig.5: *Amanita hemibapha* subsp. *hemibapha* (Berk. & Br.) Sacc.

Basidia 43-65 × 9-14 μm, clavate, 4-spored, sometimes 1-2-spored, with sterigmata 2.4-5 μm long, thin-walled, hyaline; basal septa with clamps. Basidiospores: [80/3/3] (6.6-) 7.5-9.1 (-10) × (5-) 5.8-7.5 (-8.3) μm; (L= 7.6-9.3 μm; L'= 8.3 μm; W= 6.1-7.5 μm; W'= 6.7 μm; Q= (1.11-) 1.12-1.28 (-1.42); Q= 1.22-1.24; Q'= 1.23; broadly ellipsoid to subglobose, inamyloid, colourless, thin-walled, hyaline, smooth, with apiculus up to 1.6 μm long, with contents as single to many refractive oil droplets; spores white in deposit (Fig. 6).

Habitat and distribution: Solitary-scattered, sometimes gregarious; on humicolous soil under *Quercus leucotricophora, Rhododendron arboreum, Myrica esculenta, Lyonia ovalifolia, Pinus roxburghii,* and *Picea smithiana.* Originally

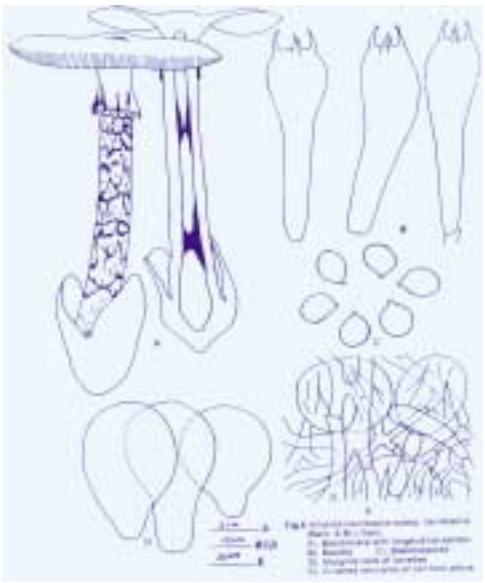


Fig.6: Microscopic details of *Amanita hemibapha* subsp. *hemibapha*

described from Sri Lanka and reported (using the name *A. hemibapha* in a broad sense) from India: by Berkeley from Khasi Hills, Assam as *Agaricus caesareus* Scop.; by Bakshi from Dehradun, Uttarakhand (vide Manjula); by Dhancholia from Orissa; and by Kumar *et al.* from Himachal Pradesh as *Amanita caesarea* (Scop. per Fr.) Grev. Stirps *Hemibapha* is very well and widely represented in the forests of Himachal Pradesh (India).

(Survey, collection and identification of wild fleshy fungi, Project - NCM-15)

1.2 Germplasm Characterization

Molecular and morphological characterization of *Pleurotus* germplasm

RAPD analysis of *Pleurotus* germplasm: RAPD analysis using 10 random primers revealed wide DNA variation among 41 strains of *Pleurotus* species collected from AICMIP Centres (Table-1). However, within species genetic variation was low. Species-specific unique bands were obtained in number of RAPD profiles of *P. fossulatus*, *P. florida*, *P. sajor-caju* and blue oyster *P. ostreatus*, indicating that

Table 1. List of wild and cultivated strains of *Pleurotus* species used in molecular analysis

Sl. No.	Species	DNA code	Strain code	Germplasm description
1.	*P. sajor-caju*	800	P-10	Cultivated strain 1
2.	*P. sapidus*	801	P-40	Cultivated strain
3.	*P. fossulatus*	802	P-80	Cultivated strain
4.	*P. citrinopileatus*	803	P-202	Cultivated strain 2
5.	*P. opentiae*	804	P-203	Cultivated strain
6.	*P. florida*	805	P-204	Cultivated strain 4
7.	*P. flabellatus*	806	P-205	Cultivated strain
8.	*P. florida*	807	P-206	Cultivated strain 5
9.	*P. cornucopiae*	808	P-207	Cultivated strain 2
10.	*P. sajor-caju*	809	P-208	Cultivated strain 3
11.	*P. sajor-caju*	810	P-209	Cultivated strain 4 (Malaysian strain)
12.	*Pleurotus* spp.	811	P-211	Wild strain
13.	*P. florida*	812	P-212	Cultivated strain 1
14.	*P. sajor-caju*	813	P-213	Cultivated strain 5
15.	*Hypsizygus ulmarius*	814	P-214	Intra-specific Cross (6 x 23-8)
16.	*Hypsizygus ulmarius*	815	P-215	Intra-specific Cross (6 x 23-10)
17.	*P. sajor-caju*	816	P-216	Intra-specific Cross (13 x 35 D-5)
18.	*P. sajor-caju*	817	P-217	Intra-specific Cross (13 x 35 D-2)
19.	*P. sajor-caju*	818	P-218	Intra-specific Cross (13 x 35 D-1)
20.	*P. sajor-caju*	819	P-219	Intra-specific Cross (13 x 35 D-7)
21.	*P. citrinopileatus*	820	P-100	Cultivated strain 1
22.	*P. cornucopiae*	821	P-120	Cultivated strain 1
23.	*P. djamor*	822	P-201	Wild strain
24.	*P. sajor-caju*	823	P-221	Intra-specific Cross (13 x 47 A-13)
25.	*P. sajor-caju*	824	P-223	Intra-specific Cross (13 x 47 A-3)
26.	*P. sajor-caju*	825	P-224	Intra-specific Cross (13 x 47 A-8)
27.	*Pleurotus* spp.	826	P-228	Inter-specific Cross (13 x 56 B-10)
28.	*Pleurotus* spp.	827	P-231	Inter-specific Cross (13 x 56 B-10)
29.	*Pleurotus* spp.	828	P-235	Inter-specific Cross (13 x 56 B-10)
30	*Pleurotus* spp.	829	P-236	Inter-specific Cross (13 x 56 B-10)
31	*P. sajor-caju*	830	P-242	Cultivated strain 6
32.	*P. florida*	831	P-243	Cultivated strain 2
33.	*Hypsizygus ulmarius*	832	P-245	Cultivated strain 1
34.	*P. sajor-caju*	833	P-247	Cultivated strain 2
35.	*P. sajor-caju*	834	P-248	Cultivated strain 7
36.	*P. sajor-caju*	835	P-249	Cultivated strain 8
37.	*P. florida*	836	P-250	Cultivated strain 3
38.	*P. ostreatus*	837	P-251	Cultivated strain
39.	*Hypsizygus ulmarius*	838	P-252	Cultivated strain 2
40	*Hypsizygus ulmarius*	839	P-253	Cultivated strain 3
41	*P. eous*	840	P-244	Wild strain

Pleurotus species are genetically quite divergent.

1.2 ITS amplification and ITS RFLP: 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 with ITS length polymorphism. *P. djamor* and exhibited visible larger ITS DNA band on the gel (Fig. 7). 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).

The restriction digestion analysis of ITS DNA was performed with tetracutter enzymes *viz*., *Bsu*RI (*Hae* III; 5'- GGCC-3'), *Mae*II (*Tai*I; 5'-ACGT-3'), *Hin*61 (*Hha*I; 5'-GCGC-3') and *Tru*1I (*Mse*I; 5'-TTAA-3'). Enzyme specific buffers were used in the reaction and the mixtures were incubated at specified temperature 1.5 h. The enzymes *Bsu*RI and *Mse*I were found useful in the grouping of species (Fig. 8). ITS sequence data have been obtained for most of the valid *Pleurotus* taxa and it will soon be supplemented with morph-physiological data for the re-designated species.

(Genetic characterization of mushroom germplasm of NRCM Gene Bank, Project- NCM-29)

2. Genetic Improvement

2.1 Genetic manipulations for high yield and better quality in button mushroom

2.1.1 Evaluation of heterokaryotic SSIs and hybrids: Twenty-four strains of *A. bisporus* that included some of the wild collections from India were evaluated for yield

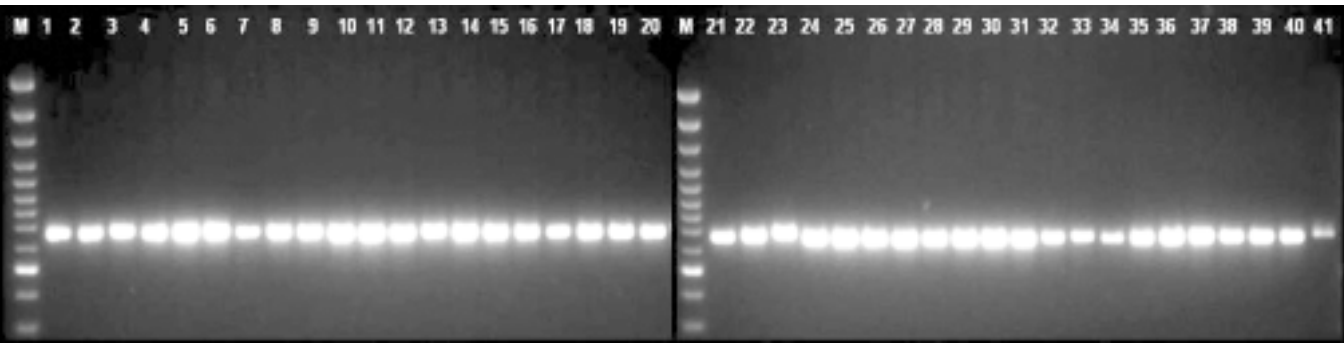


Fig. 7: ITS DNA from 41 wild and cultivated strains of *Pleurotus* species. M: DNA ladder, lanes 1-41: correspond to strains listed under serial No. 1-41 in Table 1

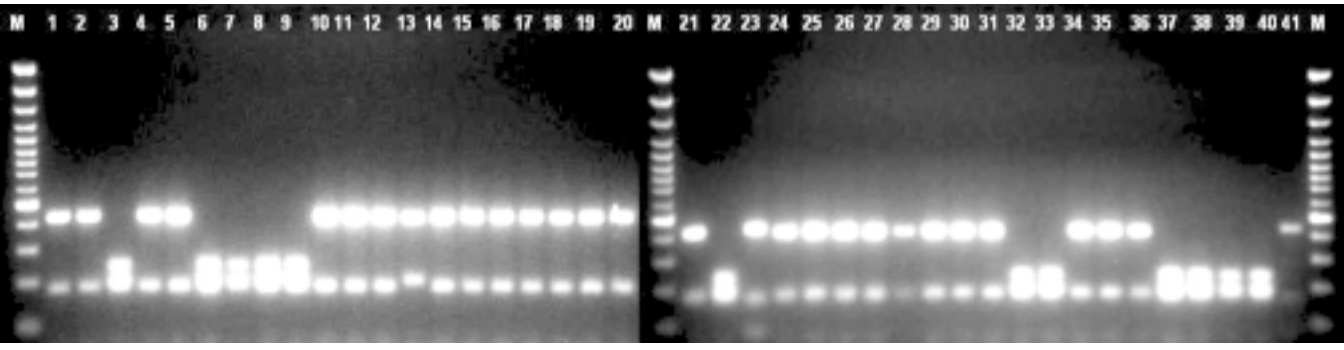


Fig. 8: ITS DNA restriction digestion analysis of wild and cultivated strains of *Pleurotus* species with enzyme *Bsu*RI. M: DNA ladder, lanes 1-41: correspond to strains listed under serial No. 1-41 in Table 1

in RBD design with 8 replications each consisting of 10 kg short method compost. Single spore selections CM-3 (SSI-16), CM-7 (SSI-6002) and CM-9 (SSI-4035) performed superiorly over the control U-3 (Fig. 9). Wild collection WC-21 was domesticated, which produced brown fruiting bodies at 24-25°C.

2.1.2 Evaluation of strains under AICRP on Mushroom: Seven strains of *A. bisporus*, as recommended by AICMIP workshop held on 26-27th October 2006, were evaluated in RBD design with 8 replications each consisting of 10 kg short method compost. Three strains namely CM-12, CM-15 and CM-16 with 19.78, 18.91 and 18.11 kg mushrooms/ 100 kg compost, respectively, were the higher mushroom yielder than the standard check S-130.

(Genetic manipulations for high yield and better quality in button mushroom, Agaricus species, Project –NCM-37)

Genetic enhancement for higher yield and better quality in milky mushroom (*Calocybe indica*)

Development of protocols for single spore germination: Spore prints from 11 strains of *C. indica* were obtained and preserved at room temperature. Spores from two strains namely OE-46 and OE-344 were serially diluted in sterile Milli-Q water up to 10^{-4} dilutions and

Fig. 9: Better quality fruiting bodies in CM-9 above , brown fruiting bodies in CM-16 and first flush in CM-3 below

were plated on modified Lambert's medium for single spore germination. Only few germlings were observed under inverted microscope after 35-40 days incubation at 28°C.

2.1.4 Evaluation of strains of *C. indica*: A total of 26 strains of milky mushroom were spawned in pasteurized wheat straw substrate. Good to excellent spawn run was observed in 22 strains and it took 15-18 days for complete spawn-run. However, in strains IIHR-56, OE-54, OE-228 and OE-229 the spawn run was very slow and these did not fructify at 32-35°C. Four strains (Table -2) including one newly domesticated wild strain yielded superiorly during September-October, 2008 trial (Fig. 10).

Table 2: Yield and its contributing traits of different strains of *Calocybe indica*

Sl. No.	Strain	Spawn run	Total no. of fruitbodies/ 5 bags**	Av. weight of fruitbody (g)	Total yield (g)/5 bags**	Biological Efficiency (%)
1.	OE-46	+++	152	29.1	4290	57.2
2.	OE-230	++	145	22.1	3150	42.0
3.	OE-231	+++	163	19.3	3120	41.6
4.	OE-330	++	136	22.1	3100	41.3
5.	OE-331	++	153	23.1	3380	45.1
6.	OE-333	+++	143	25.3	3500	46.7
7.	OE-334	+++	179	34.5	6160	82.1
8.	OE-335	++	182	23.4	4260	56.8
9.	OE-336	+++	128	30.2	3840	51.2
10.	OE-337	+++	150	22.4	3070	40.9
11.	OE-338	+++	138	19.5	2640	35.2
12.	OE-339	+++	152	25.1	3700	49.3
13.	OE-340	++	126	22.5	2530	33.7
14.	OE-341	++	131	27.5	3610	48.1
15.	OE-342	+++	103	32.6	3300	44.0
16.	OE-343	+++	191	27.2	4840	64.5
17.	OE-344	+++	117	39.1*	4290	57.2
18.	OE-345	+++	201	27.4	5570	74.3
19.	OE-346	+++	142	30.4	4300	57.3
20.	OE-347	+++	126	28.9	3550	47.3
21.	OE-348	+++	172	27.2	4590	61.2
	C.D. (5%)	-	NS	7.9	-	-

*Significantly different at 5% level of significance
** Bag = 5Kg wet substrate

Fig. 10: Bumper crop of wild strain WC-Chd (left side) and a close view of fruiting body of this strain (right side).

2.1.5 DNA analysis of *Calocybe* germplasm: Molecular variation and genetic identities were studied among 24 germplasm strains of *C. indica* using 10 RAPD markers (Fig. 11) and by amplification of 5.8S rRNA gene along with ITS regions. Twenty-one strains were

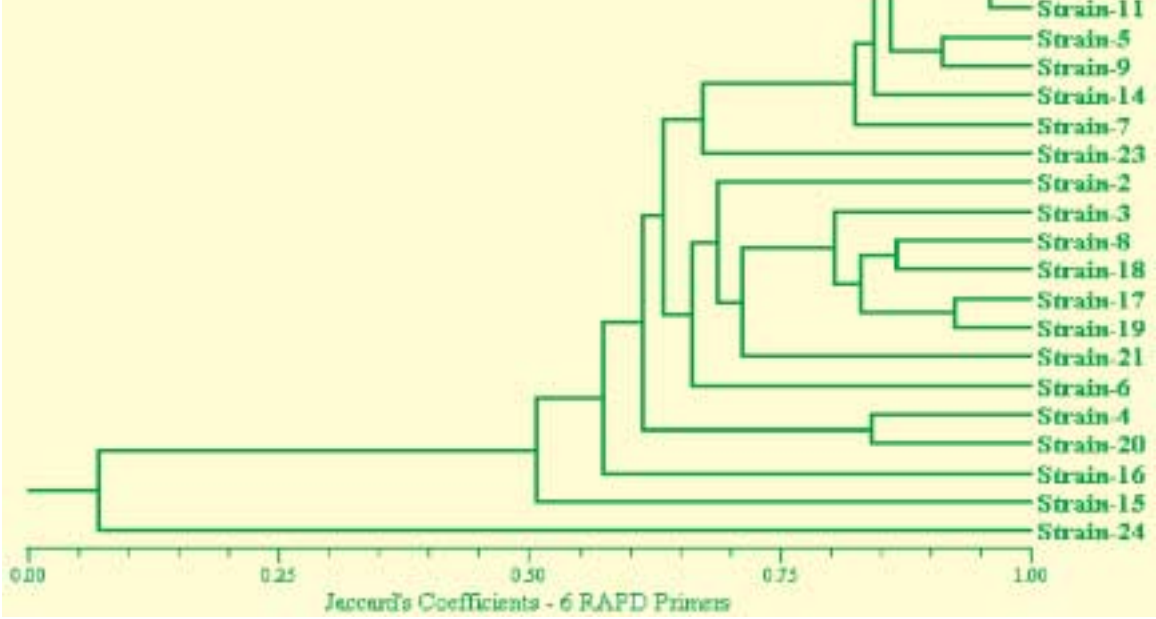


Fig. 11: UPGMA dendrogram showing genetic relationship among 24 strains of *C. indica*.

sequenced using ITS1 and ITS4 primers at Delhi University, South Campus, New Delhi. ITS sequence analysis revealed the identity of OE-54 as *P. florida* after comparison with NCBI database. Complete ITS region sequences were obtained only in six strains namely OE-152, OE-331, OE-342, OE-344, OE-345 and OE-347 wherein two SNPs (one SNP in ITS1 and another in ITS2 region) were identified. While in 15 strains of *C. indica* the chromatographs showed mixed peaks with both the primers.

(Genetic enhancement for higher yield and better quality in milky mushroom (Calocybe indica, Project-NCM-36)

2.2 Evaluation of different strains of paddy straw mushroom for yield and quality using composted substrate prepared from 1: 1 w/w, combination of cotton ginning mill waste and paddy straw

A total of 7 different strains, including 3 old but superior performing strains, 2 superior performing SSIs and two newly received strains were used for evaluating their yield potential on composted substrate prepared from 1: 1, w/w combination of cotton ginning mill waste and paddy straw, 5% chicken manure (d. b) and 1.5% calcium carbonate (d. b) by following two stage compost preparation method of 8 days. The spawning was done @ 1.5% (w. b) and the beds were kept covered with clean plastic sheets for 5 days before their opening for pin head induction. Fluorescent light was also provided for 5-6 hours/day.

Among different strains, strain OE-210, OE-274, OE-55-08, BBH-1 and BBH-5 colonized earlier and better than other two strains. However, pinning was higher and earliest in strain, OE-272, followed by OE-274 and BBH-5 (Table-3). Earliest mushroom harvest was in 11.25 days in strains, OE-272, BBH-1 and BBH-5. Highest mushroom yield during first flush and in total was recorded in strain, OE-274, followed by strain, BBH-1. In second flush highest mushroom yield was in strain, OE-210, followed by BBH-5. Trend with respect to number of fruiting bodies from one quintal compost was bit different and highest number were recorded in strain, BBH-5, followed by OE-210. Average fruiting body weight was highest in strain, OE-274, followed by OE-272 (Table-4).

Table 3: Mycelial colonization, pinning and time taken for first harvest in different strains of *Volvariella volvacea*

Strain	Level of mycelial colonization	Pinning 6th day of spawning	Time taken for first harvest (days)
OE-210	+++	+	12.25 ± 0.25
OE-272	++	+++	11.25 ± 0.25
OE-274	+++	++	11.50 ± 0.50
OE-1222	++	+	12.25 ± 0.25
OE-55-08	+++	-	12.50 ± 0.50
BBH-1	+++	+	11.25 ± 0.25
BBH-5	+++	++	11.25 ± 0.25
CD (0.05%)			0.98

+= good; ++= very good; +++= excellent

Table 4: Yield performance of different strains of paddy straw mushroom (*Volvariella volvacea*) on composted substrate of paddy straw and cotton ginning mill waste

Strain	Mushroom yield (kg/q dry substrate)			No. of fruiting bodies/q dry substrate			Fruiting body wt. (g)		
	1st flush	2nd flush	Total	1st flush	2nd flush	Total	1st flush	2nd flush	Total
OE-272	23.2	2.6	25.7	1717	247	1963	13.6	10.5	13.2
OE-274	27.5	4.6	32.4	2010	317	2327	13.6	14.8	14.1
OE-210	17.9	5.7	23.6	1740	710	2450	10.3	7.9	9.6
OE-1222	16.1	2.0	18.1	1793	233	2027	9.0	9.7	9.0
OE-55-08	20.6	3.9	24.5	1923	520	2443	10.8	7.6	10.2
BBH-1	25.1	3.9	29.0	1950	340	2290	13.2	12.0	13.0
BBH-5	22.9	5.1	28.0	2180	360	2540	10.5	13.8	10.9
CD (0.05%)	5.2	2.3	6.2	515.5	214.7	699.4	3.4	3.7	3.0

b) Characterization of newly received strains based upon mycelial growth characteristics on different types of growth media and their enzymes activities

All the seven strains were grown on malt extract medium in petriplates in triplicate, and wheat grain and paddy straw based spawn media in glucose bottles and polypropylene bags, respectively for 7 days at 32 ± 2°C. The strains were characterized based upon the level of mycelial colonization, type of growth, mycelial growth density, presence of chlamydospores etc. On malt extract agar highly dense growth of mycelia was recorded in strain, WW-08, followed by BBSR-07 and BBSR-02 (Table-5). Chlamydospore formation was not recorded in any of the strains as it is considered as the late phenomenon. Strain WW-10 revealed the poorest growth.

Table 5: Morphological growth characteristic of different strains of *Volvariella volvacea*

Strain	Mycelial growth characteristics				
	Mycelial growth		Aerial mycelial growth		Chlamydospores
	Extent	Type	Density	Growth	
BBH	Complete	Evenly spread	+ + +	+ +	_
BBH-5	Complete	Evenly spread	+ + + +	+ +	_
BBSR-02	Complete	Evenly spread	+ + + + +	+ + + +	_
BBSR-03	Complete	Evenly spread	+ + +	+ + +	_
BBSR-07	Complete	Evenly spread	+ + + + +	+ + + + +	_
WW-08	Complete	Evenly spread	+ + + + + +	+ + + + + +	_
WW-10	Negligible	Very less(localized)	+	+	_

+ - scare; ++++++ - highest; - absent.

On wheat grains only 3 strains were characterized, out of which strain WW-10 showed very thick mycelial growth with no chlamydospore formation. However, on paddy straw all the 7 strains were characterized and rest all showed good growth except WW-10. Strains, BBSR-07 and WW-10 showed superior growth of aerial mycelia along with highest density of chlamydospore formation. The aerial mycelial growth was highest in strain, BBSR-02 (Table-6).

In lignocellulolytic enzyme activity profile, highest activity of exoglucanase and endoglucanase was recorded in strain, BBSR-03, followed by strain, BBSR-02 for exoglucanase and BBH-1 for endoglucanase. The highest activity of β-glucosidase was in

Table 6: Mycelial growth characteristics of different strains of *Volvariella volvacea* on wheat grain and paddy straw based spawn substrates

Strain	Mycelial growth characteristics						
	Wheat grain			Paddy straw			
	Level of growth	Type	Chlamydospores	Level of growth	Type	Aerial mycelia	Chlamydospores
BBH	+ + +	Evenly spread	Absent	Complete	Patchy (+ + + +)	+++++	Absent
BBH-5	+ + +	Evenly spread	Absent	Complete	Uniform (+ + +)	+++	Absent
BBSR-02	_	_	_	Complete	Patchy (++)	8 +	+++
BBSR-03	_	_	_	Complete	(++)	5+	+++
BBSR-07	_	_	_	Complete	(++++)	5+	5+
WW-08	+ + + +	Highly thick	Absent	Complete	(++++)	6+	6+
WW-10	_	_	_	Abnormal growth	Restricted	_	_

Table 7: Extracellular lignocellulolytic enzymes activity of different strains of *Volvariella volvacea*

Strain	Enzyme Activity*					
	Exoglucanase	Endoglucanase	β-glucosidase	Xylanase	Laccase	Polyphenol oxidase
BBH-1	0.1731	0.3069	0.1598	0.216	4.610	3.833
BBH-5	0.3583	0.3184	0.5247	0.767	24.055	10.444
BBSR-02	0.5353	0.2726	0.7074	0.640	-1.444	19.610
BBSR-03	0.7522	0.4264	0.3591	0.684	22.611	34.499
BBSR-07	0.3159	0.3132	0.1592	0.477	11.550	24.722
WW-08	0.2284	0.2348	0.4216	0.881	3.610	6.055
WW-10	0.1182	-0.0479	0.3948	0.123	-0.833	0.722

strain BBSR-02, followed by BBH-5. The activity of xylanase, laccase and polyphenol oxidase were highest in strain, WW-08, BBH-5 and BBSR-03, respectively. No single strain was recorded to have superior activity of all the six enzymes, while strains; BBSR-02 and BBSR-03 were recorded to have good activity of all the enzymes (Table-7).

Evaluation of different strains of paddy straw mushroom for yield and quality using composted substrate prepared from 1: 1 w/w, combination of cotton ginning mill waste and paddy straw

A repeat trial was conducted by using the same basal ingredients and same protocol of substrate preparation by using five new strains and two superior performing SSI with distinguished fruiting body shape and colour. All the five strains showing mycelial growth typical of paddy straw mushroom were used and all colonized the composted substrate almost at same level. However, mycelial density was higher in strains, BBSR-03 and OE-55-08. The pinning was earlier and superior in strains, BBH-1, BBSR-07 and OE-55-08 (Table -8).

Among different strains, the highest mushroom yield during first flush and in total was recorded in strain, BBSR-07, followed by BBSR-02. During second flush the highest mushroom yield was in strain, BBSR-02, followed by BBSR-07. The mushroom yield obtained in strain BBSR-07 was significantly superior than other strains. The number of fruiting bodies/q of composted substrate was the highest in strain, BBSR-02, followed by BBSR-07. The average fruiting body weight during first flush was the highest in strain, BBH-1, followed by BBSR-03 and BBSR-03. During second flush the difference in fruiting body weight was not significant. However, in total the fruiting body weight was superior in strain BBH-1, followed by BBSR-03 and BBSR-07 (Table-9).

Table 8: Composted substrate colonization by different strains of *Volvariella volvacea*

Strain	Mycelial growth characteristics					
	Level of colonization		Mycelial density	Pinning	Contaminants	Time taken for first harvest (days post-spawning)
	Extent	Type				
BBH	Complete	Evenly spread	+ +	+ +	_	10 ± 0.000
BBH-5	Complete	Unevenly spread	+	+	_	10 ± 0.000
BBSR-02	Complete	Unevenly spread	+ +	+	_	10 ± 0.000
BBSR-03	Complete	Evenly spread	+ + +	+	_	9.5 ± 0.289
BBSR-07	Complete	Unevenly spread	+ +	+ +	_	9.5 ± 0.289
OE-55-08	Complete	Evenly spread	++++	++	_	10.5 ± 0.289
CD (0.05%)						0.428

+ - scare; + + + + - highest; - absent

Table 9: Yield performance of different strains of paddy straw mushroom (*Volvariella volvacea*) on composted substrate of paddy straw and cotton ginning mill waste

Strain	Mushroom yield (kg/q dry substrate)			No. of fruiting bodies/q dry substrate			Fruiting body wt. (g)		
	1st flush	2nd flush	Total	1st flush	2nd flush	Total	1st flush	2nd flush	Total
BBH-1	28.62	5.25	33.87	1706	453	2158	17.21	11.46	15.70
BBH-5	25.33	5.05	30.38	1765	388	2154	14.75	12.95	14.39
BBSR-002	29.93	6.93	36.85	2327	581	2908	12.75	12.12	12.57
BBSR-003	28.40	6.13	34.53	1774	476	2250	16.00	12.98	15.20
BBSR-007	32.12	6.85	41.97	2318	508	2826	15.24	13.52	14.90
OE-55-08	23.20	1.42	25.00	1939	124	2062	12.48	11.38	12.41
OE-55-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CD (0.05%)	3.777	1.735	3.941	312.470	155.402	270.267	3.9723	3.3469	3.4060

In quality characteristics of the fruiting bodies of different strains, the strains were recorded to vary in the per cent dry weight, contents of the protein, sodium, potassium and calcium. The strains of BBSR series received from same region did show least differences in different parameters and hence seem to be quite close to each other. Almost similar was the trend in mushroom yield. The only SSI, OE-55-08 was found to possess the highest dry weight and protein, while the contents of sodium and calcium was lower than other strains (Table-10).

Table 10: Quality characteristics of fruiting bodies of different strains of *Volvariella volvacea* (5th trial)

Strain	Quality Characteristics					
	Fruiting body weight (g)	Dry matter (%)	Protein (%)	Na	K	Ca
BBH	16.60	10.406	21.787	216.0	1.935	334.5
BBH-5	14.84	10.527	20.912	297.0	2.257	334.5
BBSR-02	12.42	9.200	24.15	292.5	2.325	337.5
BBSR-03	14.68	9.990	24.85	345.0	2.106	334.5
BBSR-07	15.36	9.336	24.325	258.0	2.163	336.0
OE-55-08	11.97	11.224	28.612	247.5	2.227	322.5

Units: Na/Ca - mg/100g of dry mushroom; K - g/100g of dry mushroom.

(Integrative use of cultivation technologies and molecular techniques for enhancing yield and quality of paddy straw mushroom, Volvariella spp., Project –NCM-40)

2.3.1 Evaluation of *Pleurotus* species

It has been reported that faster mycelial growing strains are high yielder therefore, faster growing strains can be used for breeding work. Nineteen *Pleurotus sajor caju* strains collected from the Gene Bank of NRCM, Solan were evaluated for their mycelial growth rate on Malt Extract Agar (2%) at 25±1^{0}C. There was large variation in radial growth among all the strains(Table-11) The radial growth ranged from 27.0 mm/day to 9.8 mm/day. Maximum mycelial growth was obtained in Pl-330 (27 mm/day) followed by Pl-320 and Pl-540 (22.33 and 22.25 mm/day).

2.3.2 Evaluation of *Pleurotus florida* strains for yield and phenotypic characterization

Nineteen strains of *Pleurotus florida* collected from Gene Bank of NRCM, Solan were evaluated for their yield and morphological characterization on pasteurized wheat straw during winter months (Feb-March, 2009). There were six replications of 1 kg dry substrate in each variety. Spawn run was completed in 18-23 days. Bags spawned with Pl-900 gave earliest fruiting on 18th day and it also gave the highest biological efficiency of 108.3% (Table-12) followed by strain No. Pl-890, Pl-870 and Pl-

Table 11: Radial growth of *Pleurotus sajor caju* on malt extract agar medium

Sl.No.	Strains	Growth rates (mm/days)	Growth Characteristics
1.	Pl-10	19.8	Strandy thick, white, no zonation
2.	Pl-10A	9.8	Strandy thick, white, no zonation
3.	Pl-160	17.2	Standy white, slightly zonatin
4.	Pl-170	17.2	Standy white, slightly zonation
5.	Pl-320	22.3	Strandy thick white, no zonation
6.	Pl-330	27.0	Strandy thick white, no zonation
7.	Pl-540	22.2	Strandy thick white, no zonation
8.	Pl-680	15.0	Aerial, white. Strandy, no zonation
9.	Pl-690	17.5	Aerial, white. Strandy, no zonation
10.	Pl-700	21.5	Slightly zonate, thin white
11.	Pl-730	18.5	Slightly zonate, thin white
12.	Pl-740	19.3	White slightly cottony aerial hyphae
13.	Pl-750	20.0	White slightly cottony aerial hyphae
14.	Pl-760	15.8	White, slightly cottony, aerial hyphae, distinctly zonation
15.	Pl-770	17.5	Slight aerial hyphae
16.	Pl-780	17.5	Strandy thick white
17.	Pl-790	20.0	No zonation
18.	Pl-1140	20.0	No zonation
19.	Pl-1150	20.0	No zonation

Table 12: Yield performance of different *Pleurotus florida* strains on pasteurized wheat straw in winter (Feb-March)

Sl.No	Strain	BE (%)	Average fruit body wt (g)
1.	P-1	75.80	14.49
2.	P-15	29.66	11.06
3.	Pl-20	16.25	8.22
4.	Pl-30	61.00	13.96
5.	Pl-70	—	—
6.	Pl-250	98.80	16.25
7.	Pl-390	74.67	16.65
8.	Pl-450	74.00	12.40
9.	Pl-550	63.33	16.30
10.	Pl-610	36.17	12.47
11.	Pl-670	22.80	11.17
12.	Pl-870	100.6	14.08
13.	Pl-880	72.00	16.14
14.	Pl-890	104.5	15.59
15.	Pl-900	108.3	15.26
16.	Pl-910	90.80	14.49
17.	Pl-920	76.50	13.30
18.	Pl-930	75.70	18.00
19.	OE-43	70.30	11.08

250 (104.5%, 100.6% and 98.8% BE, respectively). There was no fructification in strains Pl-70. Lowest yield (16.25% BE) was recorded in Pl-20. One of the strain was observed to be spore deficient and basidiospores were observed in fructifications.

2.3.3 Morphological, anatomical and molecular characterization of *Pleurotus* species

One *Pleurotus* species tentatively identified as *Pleurotus djamor* was cultivated during summer. The taxonomic description of the species was: Pileus (2.8-) 9.5-11.6 cm wide, flabellate with rise central zone, depressed in the center, colour light grayish orange, surface hygrophanous, consistency coriaceous; margin irregular, split, non-striate, recurved; cuticle non-to little bit peeling; context whitish, 4 mm thick. Lamellae: decurrent, crowded, whitish, up to 5 mm broad, edges dentate, lamellulae of 6-8 ranks. Stipe: lateral, small, 1.5-2 x 1.3-2.5 cm, creamish whitish, tapering downwards, glabrous; context creamish white. Taste: mild; odour: fungoid.

Basidiospores: [24/1/1] 7.7-9 (-10) x 3.6-4.5 μm, L= 8.7 μm; W=3.9 μm; Q= 2.2, long ellipsoid to cylindric, apiculate, thin walled, hyaline, contents granulated. Basidia: 19.5-30 x 4.5-8 μm, clavate, (2-)4- spored thin walled, sterigmata small up to 4 μm long, basal septa with clamps, some matured basidia thick walled. Pleurocystidia: none. Cheilocystidia: 16-29 x 6-11 μm, clavate, sometimes with obtuse projection at apex, thin walled, growing in group, basal septa often with clamps. Hymenophoral trama: irregular, hyphal system dimitic, generative hyphae branched, thin to thick, pale yellowish walled, septa clamped, 3-14 μm wide, hyphae broader in the middle stratum; skeletal hyphae 3-10 μm wide, thick walled, hyphal ends rounded. Subhymenium: made up of non-inflated, branched, clamped hyphal elements. Pileipellis: hyphal system monomitic; parallel, compactly arranged hyphae, 3.5-14.5 μm wide, branched, septa clamped, thin to extremely thick, pale yellowish walled (often up to 2.2 μm thick); hyphae in the center sub-erectly arranged, clavate ended hyphae. Stipe cuticle: made up of dimitic hyphae; generative hyphae 2.5-6 μm wide, thin to thick, pale yellowish walled, branched, clamped; skeletal hyphae 2.5-4.5 μm wide, wall thickness up to 2 μm wide, hyphal ends rounded.

(Improvement in cultivation of oyster and developing hybrid strains, Project –NCM-38)

1. Button mushroom

1.1 Indoor composting using combination of INRA and Anglo Dutch methods

Experiment on indoor composting was conducted 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	700 kg
Wheat bran	70 kg
Urea	15 kg
Cotton seed cake	20 kg
Gypsum	40 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
+6 day	Emptying the tunnel, turning and mixing of the compounding mixture and filling the compost in Phase-II tunnel. Phase-II operation over

Ingredients were thoroughly mixed and properly wetted so as to achieve around 75% moisture percentage. 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 inches height) and were trampled hard by running Bob cat 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 they were 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 @ 15 min/2 hours with the help of a timer installed for the purpose. A temperature between 70-75°C was 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 45-52 °C. Full penetration of air was noticed in the compost. Further no foul smell was noticed while performing phase -1 in bunker. After 6 days of partial fermentation in phase-I tunnel, entire compost mass was taken out and was transferred to phase-II tunnel for usual phase-II operations. Standard methodology was practiced thereafter for compost production. Phase II operation was over in 7 days time.

Physical parameters and yield

Moisture of the compost at filling was 72% while it came down to 69% at spawning, however, pH at filling was 7.8 while it was 7.3 at spawning. Wheat straw to compost conversion ratio was 4.17 times. An average yield of 14.07 kg mushrooms per quintal compost could be obtained from the trial in forty days of cropping.

Indoor composting through bunker (hot process- INRA method) and phase II tunnel (cold process – Anglo Dutch method)

Compost was prepared using following formulation.

Compost ingredients	Quantity
Wheat straw	2.0 ton
Chicken manure	800 kg
Wheat bran	200 kg
Urea	30 kg
Gypsum	60 kg

Ingredients were thoroughly mixed and properly wetted so as to achieve around 75% moisture percentage. 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 inches height) and were trampled hard by running Bobcat several times over the wetted ingredients. After three days of their thorough mixing and wetting half of the mass was directly transferred to phase II tunnel while half was shifted to bunker. In the phase II tunnel compost was kept for 10 days performing usual phase II operations including conditioning and pasteurization. Here compost temperature was kept in the range of 45-56^{0}C excepting at 59- 60^{0}C for 6 hours for pasteurization (cold process). On 10th day compost was taken out and spawned. In the bunker compost was subjected to the conditions as mentioned for experiment one and thereafter usual phase II operations were followed (hot process). Here total duration of the composting was 13 days.

Physical parameters and yield

Moisture of both the compost at filling was 72% while it came down to 70% at spawning for cold compost and it was 68% for hot compost. pH at filling was 7.9 for both the composts, while it was 7.4 and 7.2 for cold and hot composts, respectively at spawning. Wheat straw to compost conversion ratio was 3.1and 3.7 times for cold and hot composts, respectively (Table-1). Compost production by cold process escaping phase–I condition was partial successful as 30% of the total bags did not yield as spawn disappeared from theses bags after casing. Few of the bags also showed *Coprinus* infection. An average yield of 7.0 kg mushrooms/q compost could be obtained from the trial in thirty days of cropping in cold compost. Hot process compost yielded 9.4 kg mushrooms/q compost in the same period.

Isolation and identification of thermophilic fungal flora of different composts

Around 30 compost samples collected from the Centre and from the growers were analyzed for the presence of thermophilic fungi. *S.thermophilum*, *H.insolens* and *H.grisea* were dominantly isolated from different compost samples. These fungi showed lot of variability in terms of colony character, colour, spore size, pigment production etc.

Table 1: Physical parameters and yield obtained with indoor compost prepared by cold and hot process

Trial	pH at filling	pH at spawning	Moisture at filling (%)	Moisture at spawning (%)	Condition of spawn run	Conversion ratio	Yield kg/q compost
Cold compost	7.9	7.4	70.0	68.0	++	3.10	7.00
Hot compost	7.9	7.2	68.0	70.0	+++	3.70	9.40

Cellulose degrading potential of thermophilic fungi isolated from mushroom compost

Thermophilic fungi namely *Talaromyces dupontii*, *Paeciliomyces variotii*, *Gilmannalia, Humicola*, *Sporotrichum thermophile*, *Thermomyces lanuginosus*, *Thermoascus aurantiacus*, *Humicola fascoatra*, 8 strains of *Humicola grisea*,6 strains of *Humicola insolens* and 8 strains of *Scytalidium thermophilum* were screened to asses their cellulose degradation potential. All the fungi and their different strains used in this study were isolated from white button mushroom compost.

Filter paper as a sole carbon source was used in the study in a liquid medium containing: NH_4NO_3 -1.0g , KH_2PO_4 - 1.0g , $MgSO_4.7H_2O$ -0.5g, $FeSO_4.7H_2O$ - 0.01g , Yeast extract - 0.03g and Distilled water -1000ml.

A circular piece of Whatmann filter paper no. 42 of known weight was kept suspended in each of 250ml Erlenmeyer flask containing 60ml of the medium. After autoclaving, each flask was inoculated with a 7mm mycelial disc cut from the margin of 5 days old culture of the test fungus. The flasks were incubated at 52°C for 21 days and were given a regular shaking by swirling the flasks daily for 1min. The treatments were run in 4 replicates, with a proper control without filter paper disc. After incubation the filter paper from each flask was taken out, washed with distilled water, dried at 60°C to a constant weight and reweighed, to determine the loss in weight. The fungal mycelium obtained from the culture medium was collected, washed, dried and weighed.

Results recorded (Table- 2) indicate that among all the thermophilic fungi and their isolates, *H. gresea* possess the highest cellulose degrading ability. 8 different strains of this organism were used among which strain HG-4 showed the highest activity followed by *S. thermophilum* (ST- 7) and then *H. insolens* (HI-2). Different strains of these 3 thermophilic fungi possess different cellulose degrading potential. *T. dupontii* showed poor cellulose degrading ability among all the test fungi.

Studies on the production of cellulases by *S.thermophilum*

The production of cellulase by *S. thermophilum* was measured by growing it in a wheat extract medium and activity measured after 5 days against glucose standard. The cellulase activity of the isolate was 0.049μmole of glucose released/h/ml of filtrate, 0.060 μmole of glucose released/h/ml of filtrate, 0.138 μmole of p-nitro phenol released/h/ml of filtrate for Endoglucanase, Exoglucanase and ß-glucosidase, respecively. Out of these enzymes ß- glucosidase activity was the highest after 5 days of incubation.

Optimization of cultural conditions for enzyme production revealed that *S. thermophilum* is a potent cellulose degrader. The pH and temperature optima for Endoglucanase activity were 6.5 and 45°C, respectively. Similarly, pH and temperature optima for Exoglucanase activity were 5.5 and 60°C, respectively. Temperature studies indicated that *S. thermophilum* can grow and produce cellulases at 40°C to 60 °C although 60 °C proved to be optimum for Exoglucanase production and 45°C for Endoglucanase. Results indicated that *S. thermopilum* is a good cellulase producer at varying pH and higher temperature normally obtained during phase I and phase II of composting.

Effect of different nitrogen sources, forms and levels on the production of cellulases by *S.thermophilum*

Various nitrogen sources like NH_4Cl_2, KNO_3 and Urea were evaluated for the growth of *S.thermophilum* and production of cellulases. *S.thermophilum* produced significant activities of endo and exo-glucanase on wheat straw

Table 2: **Cellulose degrading potential of thermophilic fungi isolated from mushroom compost**

Name of the organism	Cellulose utilized (wt.(g) loss in filter paper)	Average dry wt. of mycelium(g)	
		Treatment	Control
Talaromyces dupontii	0.337	0.2268	0.0250
Paeciliomyces variotii	0.287	0.2576	0.0330
Gilmannalia humicola	0.258	0.2888	0.0199
Sporotrichum thermophile	0.221	0.2012	0.0222
Thermomyces lanuginosus	0.297	0.2800	0.0286
Thermoascus auranticus	0.252	0.2721	0.0355
Humicola fascoatra	0.240	0.3122	0.0144
Humicola insolens (HI-1)	0.190	0.3057	0.0318
HI-2	0.026 ***	0.2591	0.0275
HI-3	0.042	0.2453	0.0229
HI-4	0.063	0.2960	0.0231
HI-5	0.093	0.2960	0.0411
HI-6	0.270	0.3900	0.2435
Humicola gresea (HG-1)	0.034	0.2907	0.0320
HG-2	0.036	0.2892	0.0286
HG-3	0.040	0.2833	0.0228
HG-4	0.005****	0.3323	0.0087
HG-5	0.024	0.2999	0.0186
HG-6	0.075	0.2478	0.0246
HG-7	0.020	0.3145	0.0271
HG-8	0.269	0.0144	0.0086
Scytalidium thermophilum (ST-1)	0.240	0.3324	0.0225
ST-2	0.102	0.4700	0.3800
ST-3	0.060	0.4000	0.3700
ST-4	0.090	0.4450	0.3600
ST-5	0.120	0.4100	0.3650
ST-6	0.087	0.4050	0.3700
ST-7	0.058***	0.4125	0.3900
ST-8	0.078	0.4800	0.3630

medium without N fortification. Addition of nitrogen in the medium had marked effect on the production of Endo and Exoglucanase. Endo glucanase was stimulated considerably at 0.50-1.0% potassium nitrate concentration. However, further increase above this dose caused a sharp decline in enzyme activity. Similar results were obtained with urea. Ammonium chloride also induces the enzyme production at 0.50% N concentration, however it completely suppressed the enzyme activity at higher N level.

Exo-glucanase production by urea was considerably stimulated at 0.50% - 1.0%-N concentration. Potassium nitrate also stimulated the enzyme at these concentrations. However, ammonium chloride induces the enzyme production at 0.5% concentration only. Further increase in dose of this chemical steadily declined the enzyme production.

(Improved methods of composting for white button mushroom, Agaricus bisporus, Project-NCM-16)

1.2 Organic button mushroom production

For raising 10th crop of organic button mushroom, the compost was prepared using wheat straw – 1000 kg, poultry manure – 800 kg, brewers grains – 400 kg, cotton seed cake – 60 kg, wheat bran – 150 kg and gypsum – 35 kg with 1.60% initial nitrogen. Composting schedule followed was -6, -4, -2, 0 / 0, 3, 6, 9, 11, 13, 15 and followed by filling for phase-II in bulk chamber. Spawning was done with wheat grain based spawn of hybrid A-15 @ 0.75% of the wet weight of the finished compost. The spawned bags were incubated at 24 ± 1°C for 15 days and the spawn run was completed with in 15 days time. Case run was achieved with in 8 days. Pinheads appeared after 13th day of casing, while first harvest (days post-casing) was achieved after 18 days.

During 4 weeks of cropping 10.13 kg mushroom / q compost were harvested. The first 2 weeks yielded near 80% of the total mushroom yield. The 3rd week yielded good number of fruiting bodies but with very small individual fruiting weight. The individual fruiting body weight also varied during different stages of cultivation and it was the highest of 16.29 g during first flush, followed by 14.17 g during second flush (Table -3).

For raising 11th crop of organic button mushroom the compost was prepared and spawning was same as for crop 10. The spawned bags were incubated at 24 ± 1°C and the spawn

Table 3: Mushroom yield and yielding attributes of 10th organically raised button mushroom crop

Yielding attribute	Weekly yielding pattern				Total mushroom yield (Kg/q compost)
	1st	2nd	3rd	4th	
Mushroom yield (kg/q compost)	4.31 ± 0.18	3.78 ± 0.13	1.40 ± 0.10	0.72 ± 0.07	10.13 ± 0.23
Number of fruiting bodies/q compost	264.6 ± 10.6	266.8 ± 0.7	176.6 ± 10.0	60.0 ± 5.8	695.5 ± 14.8
Average fruiting body weight (g)	16.29	14.17	7.93	11.92	14.56

run was completed with in 9 days time. Case run was achieved in 5 days. Pinheads appeared after 10th day of casing, while first harvest (days post-casing) was achieved after 15 days.

During 3 weeks of cropping 7.43 kg mushroom / q compost were harvested. The first 2 weeks yielded near 85% of the total mushroom yield. There was a sudden decrease in mushroom yield due to heavy infestation of mites and other pests, which forced early termination of the crop. The individual fruiting body weight also varied during different stages of cultivation and it was the highest (18.10 g) during second week of cropping, followed by 13.08 g during first week of cropping (Table -4).

Recycling of spent mushroom substrate as manure for field crops

During 2008 season, experiment was laid out by mixing the aerobically recomposted button mushroom spent substrate @ 12, 15, 20 and 25 kg /plot of 2 x 3 m^2. The trail for capsicum and tomato were laid out simultaneously by using the local cultivars. In capsicum the highest plant growth was recorded in plots with 12 kg SMS, followed by 20 kg. However, in tomato the difference in plant growth was less significant and highest growth was recorded in plots with 25 kg SMS/plot. The capsicum fruit yield gradually decreased with increasing rate of SMS/plot and the highest fruit yield was

Table 4: Mushroom yield and yielding attributes of 11th organically raised button mushroom crop

Yielding attribute	Weekly yielding pattern			Total mushroom yield (Kg/q compost)
	1st	2nd	3rd	
Mushroom yield (kg/q compost)	4.15 ± 0.17	2.16 ± 0.12	1.12 ± 0.08	7.43 ± 0.22
Number of fruiting bodies/q compost	317.8 ± 12.5	183.2 ± 9.7	95.4 ± 7.1	597.9 ± 16.8
Average fruiting body weight (g)	13.08	18.10	11.69	12.43

Table 5: Effect of different quantity of recomposted button mushroom SMS used as manure in capsicum and tomato cultivation

Treatment (SMS in kg/plot)	Vegetative growth, fruit yield and fruit wt.					
	Capsicum			Tomato		
	Plant growth (visual)	Fruit yield (ton/hec)	Fruit wt (g)	Plant growth (visual)	Fruit yield (ton/hec)	Fruit wt (g)
12 kg (20 t/hec)	++++++	5.572	61.66	++++++	19.625	108.03
15 kg (25 t/hec)	+++	4.728	52.53	+++++	20.732	95.68
20 kg (33.33 t/hec)	+++++	4.753	62.45	++++++	20.767	102.98
25 kg (41.66 t/hec)	+++	2.714	49.86	+++++++	25.647	102.59

obtained in plots receiving the lowest dose of SMS. The trend was almost just reverse in tomato and the highest fruit yield was harvested from plots receiving the highest dose of the SMS. The fruit weight was highest in plots received the lowest dose of SMS. There was insignificant difference in fruit yield of both capsicum and tomato in middle level SMS applications i.e. 15 and 20 kg SMS/plot. However, average fruit weight was higher from plots received higher dose of SMS (Table-5).

Organic mushroom production and quality produce, Project-NCM-31

2. Speciality Mushrooms

Cultivation of *Macrolepiota procera*

Cultivation trial on *Macrolepiota procera* was undertaked on short method compost. The spawn run was completed in 32-37 days at 25-28°C. The primordia initiated after 20-25 days after the application of casing layer. Few fruit bodies were produced and later on heavy infestation of nematodes was observed.

Enzyme profile of *Macrolepiota procera*

Extracellular enzyme profile of *Macrolepiota procera* presented in Table-6 showed that it has good activity of Lig-peroxidase which further increased by supplementing the medium with wheat bran. Similarly it also have good activity of laccase and the same trend was observed with respect to supplementation. The activity of PPO also increased with supplementation. *M. procera* also has some activities of endo-glucanase, exo-glucanase and β-glucosidase and supplementation resulted in slightly increased activity of all these enzymes.

The data presented in Table-7 revealed that *F.velutipes* show good activity of Endo-glucanase, Exo-glucanse β-glucanase, Mn-peroxidase and Xylanase. Supplementation of the medium with 10, 20 and 50ppm with asparagine resulted in slight enhancement in the activity of all the enzymes. The highest activity of endo-glucanase (34.72 $Uh^{-1}ml^{-1}$) and exo-glucanse (40.6 $Uh^{-1}ml^{-1}$) was recorded in the medium supplemented with 50ppm asparagines whereas it was 43.6 $Umin^{-1}ml^{-1}$ in Mn-peroxidase.

Table 6: Extracellular enzyme profile of *Macrolepiota procera*

Isolate	*Weight	C_x-glu	C_1-glu	β-glu	Xyla	Lig-per	Lac	PPO
				$Uh^{-1}ml^{-1}$			$Umin^{-1}ml^{-1}$	
T-1	17	2.1	1.2	3.6	1.3	99.9	5.7	1.9
T-2	18	3.1	2.6	3.3	1.7	100.5	5.9	1.9
T-3	18	3.2	2.6	3.6	1.5	103.0	6.9	2.7
T-4	18	3.8	2.9	3.9	1.5	109.8	6.8	2.9
T-5	20	3.8	2.9	4.7	1.7	109.2	7.3	3.5
CD (0.05)	2.8	0.5	0.6	1.2	0.5	15.6	2.4	0.8

*Dry mycelial weight (mg/ml)
Cellulases and hemicellulases:
Unit= μ mole glucose release ml^{-1} h^{-1}
Laccase and PPO:
Unit= change in OD by 0.001 ml^{-1} min^{-1}

Table 7: Extracellular enzyme profile of *Flammulina velutipes*

Isolate	*Weight	C_x-glu	C_1-glu	β-glu	Xylan	Mn-per	Lac	PPO
				$Uh^{-1}ml^{-1}$			$Umin^{-1}ml^{-1}$	
T-1	20	32.2	34.7	30.2	31.3	23.9	0.0	0.0
T-2	22	32.6	34.6	29.0	34.5	29.3	2.4	0.0
T-3	18	34.2	36.5	32.5	35.6	37.3	0.0	0.0
T-4	11	34.7	40.6	32.7	35.3	43.6	0.0	0.0
CD (0.05)	3.6	4.8	6.3	4.5	8.2	5.0	-	0.0

* Dry mycelial weight after 10 days (mg/ml)
Cellulases and hemicellulases:
Unit= μ mole glucose release ml^{-1} h^{-1}
Laccase and PPO:
Unit= change in OD by 0.001 ml^{-1} min^{-1}

Extracellular enzyme profile of *Flammulina velutipes*

Effect of different growth hormones on the mycelial growth of *Agrocybe aegerita*

The data presented in Table-8 revealed that both the growth regulators did not have any significant effect on the production of *Agrocybe aegerita*. These growth regulators did not considerably reduce the days for the completion of spawn run but significantly resulted in enhancement in the production.

Table 8: Effect of different growth regulators on the yield of *Agrocybe aegerita*

Growth regulator	Rate(%)	*Days taken for spawn run	Yield
GA	10	27	200
	20	26	220
	50	26	200
Kinetin	10	27	180
	20	27	200
	50	27	190
Control			**180**
CD (0.05)			**19.5**

Effect of cultivation substrates on the productivity of *Lentinula edodes*

The cultivation trials on *Lentinula edodes* revealed that it was able to colonize both wheat straw and saw dust alone or in combination and it took shortest time (48 days) on wheat straw followed by 58 days on wheat straw + saw dust (50:50) and saw dust alone (68days). The Maximum yield (404g/ 500g dry substrate) was recorded on saw dust alone whereas no fruit bodies were produced on wheat straw alone.

(Standardization of cultivation technology of specialty mushrooms, Project- NCM-18)

1. Insect-Pests and Diseases of Mushrooms

1.1 Survey and surveillance of pests and diseases

Survey of different farms surrounding Murthal (Haryana) revealed the widespread incidence of wet bubble, yellow mould and brown plaster mould. Severe incidence of scarids, phorids and red pepper mite *Pygmephorus sellnicki* was also recorded in most of the farms surveyed during the year. These mites were observed to make pits in the fruit bodies and resulted in browning of the cap.

Efficacy of botanicals against *Mycogone perniciosa*

Various plant materials extracts namely *Cannabis sativa, Ricinus cummunis, Callistomon lanceolatus , Citrus* spp., *Eucalyptus* spp. *Dhatura* spp., *Solanum khasianum, Thuja compacta* and certain oils viz neem, garlic, corriender, tulsi, kalonji, aajwain as well as two commercial formulations of neem and sai gold were evaluated against *M. perniciosa* and *A. bisporus* both under *in-vitro* and *in-vivo* conditions. Three types of extrcation method viz., alcholic extraction, dry extraction and fresh extracts were used for preparing the extracts. Aqueous plant extract was added to malt extract agar medium prepared in 150 ml conical flasks so as to obtain the final concentration of 1% of the extract in the medium. The medium was poured into sterilized Petri plates @ 20 ml per plate and after solidification, inoculations were done with 8 mm dia mycelial disc cut from 7 days old cultures and incubated at 25°C. Each treatment was replicated five times. Medium with sterile distilled water served as control. Grain spawn of *M. perniciosa* and *A. bisporus* were prepared on wheat grain. *Agaricus bisporus* (S-11) crop was raised on pasteurized compost as per the standard cultural practices. Ten kg compost was filled per bag and spawning was done @0.5%. Each treatment was replicated ten times. Inoculum of *M. perniciosa* was added @ 1g/ bag (10 kg compost) at the time of casing. To evaluate the efficacy under mushroom house condition, 1% and 2% extract of selected plant materials were applied at the time of casing and subsequently at 7 days intervals. Bags devoid of inoculum and botanicals served as control. Standard package of practices for cultivation were adopted throughout the experiment.

Perusal of data in Table -1 reveal that among the fresh extracts , extract of *T. erecta* caused 27.34% inhibition of mycelial growth followed by *Parthenium* spp (16.52%). Increase in mycelial growth was recorded in *Nyctanthes aror-tritis, Gardenia* spp, *R. cumminis* and *Euclyptus* spp. Among dry extracts no inhibition of growth was recorded in any case. Among alcoholic extracts *C. sativa* caused the maximum inhibition of 32.9% followed by *C. lanceolatus* (22.2%).

When different oils were tested, oil of *A.cepa*, *Trachyspermum ammi*, *Nigella sativa* and *Coriandrum sativum* caused 100% inhibition of mycelial growth of *M. perniciosa* (Table -2). Garlic oil, Ajwain oil, Econeem and Sai gold caused 100% inhibition of mycelial growth of *A. bisporus*.

Under *in-vivo* conditions (Table -3) maximum yield (1098g) was recorded in case of carbendazim treatment followed by neem oil and *Gardenia* spp. The maximum number of diseased fruit bodies were recorded with oil of *A. cepa* (717) followed by extracts of *R. cumminis*.

2. Status of carbendazim residues in processed and marketable mushrooms

Crops of *Agaricus bisporus* (A-15) and *M. procera* were raised on pasteurized compost as per the standard cultural practices. Ten kg

Table 1: Effect of different plant extracts against *M. perniciosa*

Plant	Growth of *M. perniciosa* (mm)					
	Fresh extract		Dry extract		Alcoholic extract	
	Radial growth (mm)	%Inhibition	Radial growth (mm)	%Inhibition	Radial growth (mm)	%inhibition
Dhatura strumonium	50.0	0.0	-	-	-	-
Tagetus erecta	62.1	27.3	-	-	60.8	14.8
Nyctanthes aror-tristis	55.0	+9.1	-	-	79.6	11.6
Parthenium spp	71.3	16.5	-	-	NT	-
Callistomon lanceolatus	52.0	+13.8	50.0	0.0	70.0	22.2
Cannabus sativa	43.2	13.6	-	-	60.4	32.9
Gardenia spp	57.6	+13.2	40.6	0.0	80.0	11.1
Thooja campacta	42.0	16.0	50.0	0.0	75.0	16.7
Ricinus cummunis	61.0	+18.0	40.7	0.0	71.2	20.9
Eucalyptus spp	55.0	+9.1	40.9	0.0	78.8	12.4
Control	50.0		40.6		90.0	-

Table 2: Effect of different commercial and oil products against *M. perniciosa*

Oil/ product	*M. perniciosa*		*A. bisporus*	
	Radial growth(mm)	%Inhibition	Radial growth(mm)	%Inhibition
Neem oil	39.6	56.0	25.6	57.3
Garlic oil	0.0	100.0	0.0	100.0
Corriender oil	0.0	100.0	37.0	38.3
Tulsi oil	10.6	88.2	0.0	0.0
Ajwain oil	0.0	100.0	0.0	100.0
Kalonji oil	0.0	100.0	33.6	44.0
Econeem	16.0	82.2	0.0	100.0
Sai gold	28.8	68.0	0.0	100.0
Carbendazim	18.6	79.3	0.0	100.0
Control	90.0		60.0	

Table 3: Effect of some oils and plant products on *M.perniciosa*

Product/ oil	Yield (g/q of substrate)	
	Healthy fruit body	Diseased fruit body
Neem oil	987	14
Sai gold	980	210
Immidacloprid	658	460
Oil of *Allium cepa*	628	717
Oil of *Coriandrum sativum*	721	138
Oil of *Ocimum sabctum*	645	369
Oil of *Trachyspermum ammi*	558	202
Oil of *Nigella sativa*	498	80
Gardenia sp	984	148
Cannabis sativa	792	109
Nyctanthes aror-tristis	660	370
Thooja compacta	760	392
Callistomon lanceolatus	689	386
Ricinus cummunis	780	518
Eucalyptus spp	934	276
Carbendazim	1098	50

compost was filled in each bag and spawning was done @ 0.5%. Each treatment was replicated ten times. Crops of *Calocybe indica* and *P. sajor-caju* were raised on steam pasteurized wheat straw. Five kg substrate was filled per bag and spawning was done @ 5% and 2% , respectively. Commonly used fungicide, carbendazim was sprayed @ 0.1% on fruiting bodies just one day before harvest. In order to assess the effect of storage and processing, harvested fruit bodies were pooled and 100 g each was subjected to different treatments viz., washing with plain water (samples were washed and rubbed with hands for one minute), washing with potassium disulphite (0.1%), washing with ascorbic acid (0.1%), stored at room temperature and in refrigerator or at 4^0C for two days, oven drying and boiling for 10 minutes. Oven dried mushrooms were rehydrated before extraction. Each sample was analysed for residue content in the same manner as described for unprocessed sample.

In another experiment, mushroom samples (200g) were collected from different sources (market, mushroom growers, NRCM general crop and NRCM organically grown crop) and analysed for the residue of carbendazim. The samples were processed immediately to avoid any loss of fungicide during storage. Representative sample of mushrooms (100g) were homogenized in a mixer and extraction was carried out using ethyl acetate.

The results obtained are presented in Table-4. The data revealed that residue reduced to 28.57% to 81.86% in different mushrooms by simple washing, however, washing with potassium disulphite (KMS) resulted in increased residue levels. Corresponding losses due to washing with ascorbic acid, storing at room temperature for two days, storing in refrigerator for two days, oven drying and boiling or cooking of samples ranged from 13.09-60.95%, 10.11-81.23%, 35.71-80.47%, 1.19-79.34% and 33.92-86.90%, respectively.

The results of samples collected from different sources are presented in Table-5. The data reveal that almost all the samples were found contaminated with carbendazim and even button mushroom grown organically, residues of carbendazim were detected in appreciable quantities. However, none of the samples contained total carbendazim residue above maximum residue limit (MRL) of 1 ppm. Carbendazim residue in different samples ranged from 0.114 ppm to 0.604 ppm. When repeated sprays of carbendazim were given during different growth stages of the crop, slightly higher level of carbendazim residue was detected.

able 4: Effect of processing on persistence of carbendazim in different mushrooms

Mushroom	Treatment (residue in ppm)							
	Fresh unwashed	Washed with water	Washed with KMS	Washed with ascorbic acid	Stored at room temp-erature 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

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
FarmerMamleag		-	S-11	-	ND
Farmer-2Kasouli patta	-	-	S-11	-	0.260
Farmer-3Kasouli patta	-	-	S-11	-	0.260
Farmer-4Garu	-	-	U-3	1st	0.136
FarmerBalhedi	-	-	S-11	-	ND
Farmer-5Subathu	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

3. Residues of malathion and decamethrin and effect of washing and cooking in white button mushroom, *Agaricus bisporus*

Agaricus bisporus (S-11) crop was raised on pasteurized compost as per the standard cultural practices. Ten kg compost was filled in each bag and spawning was done @ 0.5%. Each treatment was replicated ten times. Control bags were sprayed with water. In one set malathion and decamethrin were sprayed only once at five different concentrations (0.001%, 0.005%, 0.01%, 0.05%, 0.1%) at the time of casing. In second set one spray @ 0.01% concentration was given at the time of casing and second spray seven days after casing. In third set one spray @ 0.01% was given at the time of casing and second spray seven days after casing and third spray 7 days after the second spray. Samples of fruit body were collected at first harvest for residue analysis using GC equipped with FID. In another experiment, mushroom samples were collected from different sources (market, growers, NRCM) and analysed for the residue of above mentioned insecticides.

Collected samples were homogenized in a mixer. From 100g homogenized material 5g sample was taken to which 10g Florosil was added to make free flowing powder. Sample was extracted with 50 ml ethyl acatate, concentrated to 1-2 ml and cleaned up in silica gel column and extracted with 10ml, 10% acetone in hexane solution. Elutant was evaporated to dryness and at 40-45^{0}C. Residue was redissolved in 5 ml ethyl acetate and injected 0.5µl in to GC.

Chrometographic analysis: Perkin Elmer Clarus 500 model equipped with FID was used. Oven, injector and detector temperature were set at 220, 250 and 250^{0}C, respectively. The column used was Elite-5 (cross bond 5% diphenyl-95% dimethyl polsiloxane) 30mX 0.53mm ID, 0.5um df fused silica capillary column. Nitrogen was used as carrier gas at 16 µL /minute. Before the use, GLC column was primed with several injections of standards of both the insecticides till a constant response was obtained. Suitable aliquots of sample extracts were injected in to GLC. The concentration of insecticide present in the sample was quantified by comparison of peak height of sample chromatograms with those of standards run under identical operating conditions. Under these operating conditions retention time of malathion and decamethrin was 3.38 and 4.75 minutes, respectively.

In order to assess the effect of washing and boiling or cooking on the dissipation of insecticides residues, samples (100g) were washed and rubbed with hands for one minute in a small dish containing fresh water. Chopped samples were also boiled or cooked for 10 minutes using quantities of water enough to dip the samples. During boiling or cooking the container was covered with a lid. Each washed , boiled or cooked sample was extracted, cleaned up analysed for the residues content in the same manner as described for unprocessed samples. Perusal of data (Table-6) reveals that residue of malathion although below the tolerance limit was detected in all the concentrations tested. When single spray of different concentrations of malathion was given at the time of casing , residues level varied from 0.32 ppm to 0.79 ppm. Corresponding increase in residue level was recorded in the treatment where two and three sprays of malathion (0.01%) were given . However, residue level in all the treatments was found to be below the tolerance limit . The present investigation reveal that residue level of malathion does not rise above maximum permissible limit of 3 ppm even when variable concentrations and repeated sprays were given. In the present investigation it was observed that spraying malathion at 0.1% concentration during different growth stages did not affect the yield of *A. bisporus*. In the present investigations, residue level exceeded the tolerance limit only in those treatment where two and three sprays were given. When mushroom samples were collected

Table 6: Malathion and decamethrin residues in *A. bisporus*

Days after treatment	Treatment concentration (%)	Residue (ppm) *	
		Malathion	Decamethrin
14	0.001	0.32	0.26
14	0.005	0.39	0.34
14	0.010	0.46	0.38
14	0.050	0.54	0.54
14	0.100	0.79	0.61
	Control	ND	ND
$RL_{50\ (Hours)}$		15.05	7.52
$T_{to\ 1}$ (days)		0.23	0.22

*Average of 10 replications
·ND= not detected

Table 7: 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

from different sources , 60% sample were found to be contaminated with the residue of malathion and decamethrin although level was below the tolerance limit (Table-7).

Effect of processing

The initial residues in different concentrations of malathion was reduced by 31.57% to 59.09% by simple washing of mushrooms (Table-8). Corresponding losses due to boiling or cooking of samples ranged from

able 8: Effect of processing on the residue of malathion and decamethrin in *A. bisporus*

No. of sprays	Treatment concentration (%)	Residue (ppm)					
		Malathion			Decamethrin		
		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 percentage reduction, UW= Unwashed, W= washed, B= boiled

50.52% to 87.5%. In case of decamethrin initial residues was reduced by 59.79% to 76.92% by simple washing of mushrooms. Corresponding losses due to boiling or cooking of mushrooms ranged from 77.27% to 90.10%. In case of decamethrin boiling process reduced the residues to the safe level up to 0.05% concentration tested.

It is thus concluded that malathion at 0.1% and decamethrin at 0.05% if applied at the time of casing and subsequently after 7 days would protect the mushrooms from pest infestation and keep it safe from residue hazards. Safe waiting period of one day is suggested.

When mushroom samples were collected from different sources, residue of both the insecticides were recorded (Table-9) in some of the samples, although residue was below the permissible level.

Table 9: Residue of malathion and decamethrin in button mushroom collected from different sources

Sl. 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

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

2. Molecular characterization of pathogenic fungi causing diseases in mushrooms

Samples of different moulds/ mycoparasites infecting different mushroom were collected from different mushroom units located in Murthal, Gannaur, Solan, Shimla, Bilaspur, and Sonepat. In all fifty two samples were collected. Moulds/ mycoparasites were isolated and pure cultures were raised. Different fungi namely, *Mycogone, Sepedonium*, *Sclerotium*, *Fusarium*, *Papulaspora*, *Trichoderma*, *Verticillium* and *Dactylium* were found to be associated with different mushrooms. *Dactylium, Sclerotium*, *Mycogone* and *Sepedonium*, were isolated from the compost of button mushroom. *Dactylium* spp were isolated from *Agaricus bisporus* (A-15) *Calocybe* and *Pleurotus* spp. Five samples of *Dactylium* were also collected from *Agaricus bisporus*, two from *Pleurotus* and and two from *Calocybe* and pure culture were raised.

2.1 Molecular characterization of *Cladobotryum* and *Mycogone*

Cladobotryum species associated with cobweb disease of edible mushrooms were isolated from fruit bodies of *Agaricus bisporus, Calocybe indica* and *Pleurotus sajor-caju, P. sapidus, P. florida* and *P. ostreatus*. The nucleotide sequence comparisons of 5.8S rRNA identified 15 *Cladobotryum* isolates into three taxa, *Cladobotryum dendroides* , *C. mycophilum* and *C. asterophorum*. The RAPD primers exhibited both inter and intra- specific variations among the test isolates and separated them into seven distinct phylogenetic sub-clades. In the light of molecular identification the cultures of *C. dendroides* were redesignated as *C. mycophilum* and *C. asterophorum*. The present studies indicates that at least three species are associated with cobweb disease of different cultivated mushrooms in India and *C. mycophilum* is potential cause of cobweb

disease in *Agaricus bisporus* and not *C. dendroides* as described earlier. *C. mycophilum* has wide host range and it can also infect milky mushroom. *C. asterophorum* was found to be associated with different species of oyster mushrooms and suggests wide geographical distribution and is a potential threat to the *Pleurotus* cultivation.

Wet bubble is a major disease in *Agaricus bisporus*. The symptoms, microscopic examination and pathogenicity tests of the fungus validate the pathogen as *Hypomyces perniciosus*. The nucleotide sequence comparisons of 5.8S rRNA gene of the pathogen using BLAST, National Centre for Biotechnology Information (NCBI), USA databases showed distinct molecular identities (90-91%) with other mushroom pathogen and have been assigned new Gen accession number EU 380317.

2.2 ITS- RFLP of Various fungal moulds

All the 12 mycoparasites and moulds of mushrooms exhibited ITS lengths between 600-800 bp on gel electrophoresis (Fig.1). The RAPD profiles generated using three primers Viz., OPA-10, OPB-10 and OPB-11 exhibited significant polymorphism in bending patterns (Fig.2, 3, 4). A combined dendrogram of all the three random primers distinguished all the mycoparasites from each other (Fig.5).

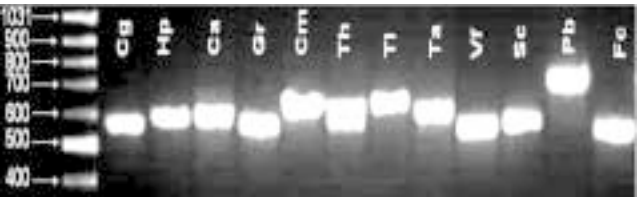


Fig. 1. ITS profile of different mycoparasites and moulds of mushroom

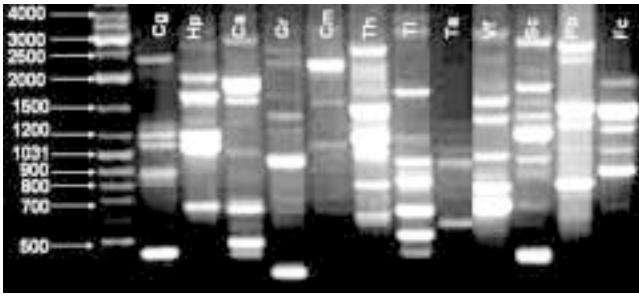


Fig. 2. RAPD profiles of different mycoparasites and moulds of mushroom using OPA-10 primer

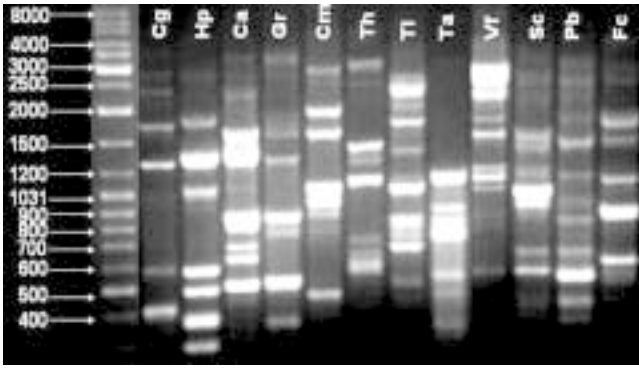


Fig. 3. RAPD profiles of different mycoparasites and moulds of mushroom using OPB-10 primer

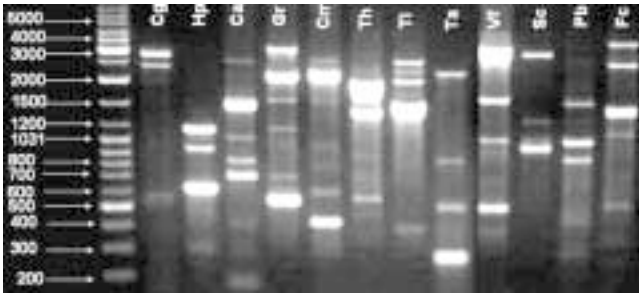


Fig. 4. RAPD profiles of different mycoparasites and moulds of mushroom using OPB-11 primer

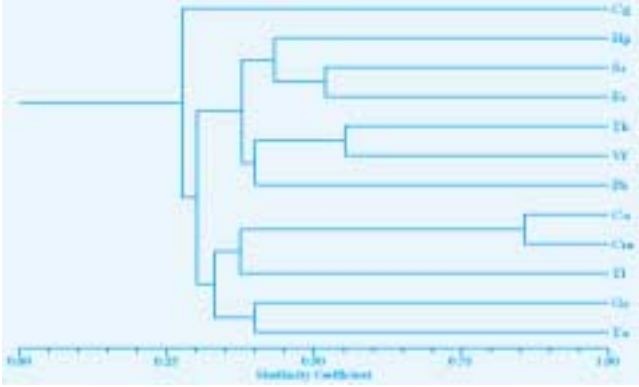


Fig. 5. UPGMA dendrogram showing genetic relationship between different mycoparasites and moulds of mushrooms

All the three arbitrary decamer RAPD primers amplified the genomic scorable DNA unique fragments and exhibited variations among the test isolates and showed their individuality. Group-I included *Chaetomium globosum* Group-2 (*Hypomyces perniciosus*), Group-3 (*Sepedonium chryospermum*), Group-4 (*Fusarium chlamydosporum*), Group-5 (*Trichoderma harzianum*, Group-6 (*Verticillium fungicola*), Group-7 (*Papulospora byssina*), Group-8 (*Cladobotryum asterophorum*), Group-9(*Cladobotryum mycophilum)*, Group-10 (*Trichoderma longibrachiatum*), Group- 11 (*Gliocladium roseum)* and Group-12 (*Trichoderma asperellum).* The ITS sequences of Gen accession numbers EF651792, EU 380317, EU816370, EF-017709, EU816372, EU816368, EU816369, EU-340833, EU-340834,EU 810161, EU816371 and EU 810160, of all the test pathogens has been submitted to NCBI database and are available in public domain for comparisons.

Three arbitrary decamer RAPD primers amplified unique scorable DNA fragments and exhibited variations among different mycoparasites of edible mushrooms. *Taq* 1 restriction enzyme produced unique ARDRA profiles in four important mycoparasites, namely, *Hypomyces perniciosus* (200bp), *Cladobotryum asterophorum* (280bp), *Cladobotryum mycophilum* (300bp), and *Papulospora byssina* (400bp). Whereas, *Msp* 1 restriction enzyme yielded unique profiles for identification of (*Chaetomium globosum* (440bp), *Trichoderma harzianum* (380bp), *Trichoderma longibrachiatum* (300bp), and *Sepedonium chryospermum* (350bp) moulds, that can be used as genetic markers for quick detection of these mycoparasites without resorting each time to DNA sequencing.

2.3 Extracellular enzyme profile of *Cladobotryum* species associated with mushrooms

Extracellular enzyme profile of *Cladobotryum* isolates revealed that most of the isolates have high activity of pectinase and xylanase, C-1 cellulase and Cx cellulase. Similarly extracellular enzyme profile of *Verticillium* isolate revealed good activity of pectinase, chitinase and Cx cellulose.

(Molecular and physiological characterization of moulds associated with mushrooms, Project-NCM-32)

3. Molecular characterization of various bacterial isolates associated with mushrooms

Molecular characterization of 10 isolates of bacteria collected from *Agaricus bisporus* and *Volvariella volvacea*, were undertaken by ITS sequencing of 16S rRNA gene (Fig.6). Phylogenetic analysis of 10 bacterial isolates using RAPD technique exhibited 5 phylogenetic groups.

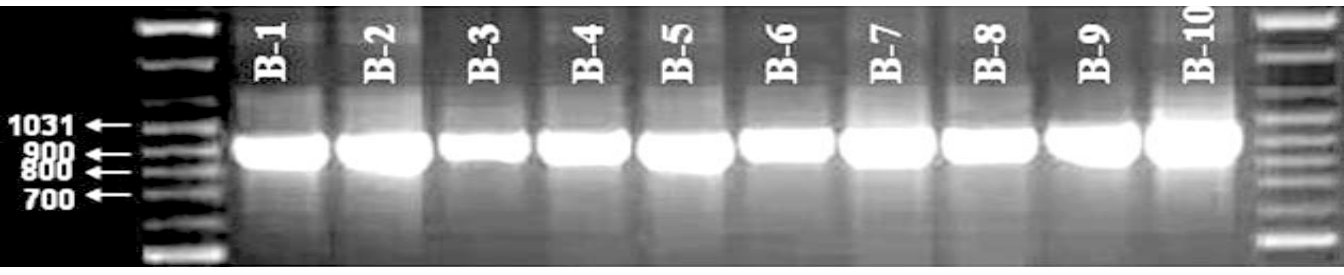


Fig. 6. ITS profile of bacterial isolates

Interaction studies

The data presented in Table-10 revealed that out of ten isolates, 8 isolates inhibited the growth of *Flammulina velutipes* whereas all the ten isolates inhibited the growth of *Volvariella volvacea* to varying extent. However, the maximum (50%) inhibition was noticed with isolate number V in case of *F.velutipes* followed by VI and IX both resulting in 38.9% inhibition. In *V volvacea* isolate IX inhibited the growth upto 66.6% followed by V (61.1%) and isolate VI (44.4%).

(Etiology, molecular characterization and management of bacterial diseases of mushrooms, Project-NCM-41)

Table 10: Interaction of different mushrooms with different isolates of bacteria

Mushroom	Different isolates of *Pseudomonas* species									
	Average diametric growth (cm)									
	Control	I	II	III	IV	V	VI	VII	VIII	IX	X
Flammulina velutipes	9.0	6.3 (30.0)	9.0 (0.0)	7.3 (18.9)	6.5 (27.8)	4.5 (50.0)	5.5 (38.9)	6.3 (30.0)	9.0 (0.0)	5.5 (38.9)	6.0 (33.3)
Volvariella volvacea	9.0	5.5 (38.9)	8.5 (5.5)	7.5 (16.7)	7.0 (22.2)	3.5 (61.1)	5.0 (44.4)	6.0 (33.3)	8.5 (5.5)	3.0 (66.6)	6.5 (27.8)

1. Studies on the medicinal mushroom *Ganoderma lucidum*

1.1 Pilot scale production

During the year under report pilot scale production of *Ganoderma* was attempted in controlled cropping rooms of the Centre. Excellent crop was raised and demonstrated during the Mushroom Mela on 10th September. (Fig.1).

Fig. 1. Execellent crop of *Ganoderma lucidum*

1.2 Optimum bag size

Preliminary efforts were made to grow *Ganoderma* in trays. Sterilized bags were spawned then 5 bags contents emptied in plastic trays for the spawn run and fruiting, but it failed due to contamination over the larger area of the trays.

In yet another trial, bags of various sizes (1,2,3,4,5 Kg wet weight) were tried for growing *Ganoderma.* While 4 and 5 kg bags failed due to improper sterilization. However, two and three kg bags gave equally good fruiting.

1.3 Production of Mn-peroxidases by *G. lucidum*

Production of Mn-peroxidases by *G. lucidum* was studied on saw dust under low N (0.025, 0.050%) and high N (0.20 and 0.40%) in liquid culture. Highest Mn-Peroxidase was produced in 0.05% N followed by 0.2%N. Negligible activities were noticed in other treatments.

Dynamics of lignolytic (Mn-peroxidases) and cellulolytic (enoglucanase) enzyme production in the substrate under actual growing conditions was studied under the SSF. Though peroxidases appeared and peaked earlier than cellulase but no definite trend could be observed there after. Very high levels of both the activities maintained throughout rest of the cycle till the first flush was over.

1.4 Extraction of polysachharides

Study was conducted to extract water soluble-alcohol insoluble polysaccharides from fresh+ homogenized and dried + pulverized (0.25mm). The yield of polysaccharides was higher from the fresh (832 mg) than from dried (631 mg per 100 g fresh eq.) fructification.

2. Post harvest technology of mushrooms

2.1 MAP studies on button mushroom under ambient condition

Experiments were conducted on the modified atmospheric packaging (MAP) of button mushroom using the MAP machine(Fig.2). Fresh button mushrooms were used for the study and 100 gauge polythene and 100 gauge polypropylene bags were used for the study. Nitrogen gas (80%) and CO_2 (15%) gas were flushed inside the package and sealed in the platform of MAP machine and stored in ambient condition. Button mushrooms were also vaccum packed and kept in ambient condition for storage. Various quality characteristics studied for the stored button mushrooms were weight loss, gill opening and whiteness. It was observed that mushroom stored in 100 gauge PP bags were found good upto 4 days (Fig. 3).

Fig. 2. Button mushrooms being packed in MAP machine

Fig. 3. Quality of button mushrooms on the 4th day of storage under MAP condition

2.2 Packaging studies on paddy straw mushroom

Freshly harvested paddy straw mushrooms were packed in PP bags in open condition, PP bags in sealed condition, plastic container in air tight condition and paper envelope (Fig.4). The packed paddy straw mushrooms were stored in ambient condition, 10-18°C temperature, freezer and refrigerated conditions. The various quality parameters viz., veil opening, weight loss, off-smell, texture and leakage of water were observed. It was observed that the quality paddy straw mushrooms stored in PP bags of open condition were found good up to 2 days irrespective of the storage condition.

Fig. 4. Paddy straw mushrooms stored in different packaging materials

(Modified atmosphere packaging and storage of mushrooms, Project-NCM-35)

3. Development of Indigenous machinery for spawn and mushroom production

3.1 Design and Development of portable pasteurization chamber

A mini portable pasteurization chamber was designed (Fig.5) and developed for pasteurization of wheat straw, paddy straw and sawdust for compost preparation of oyster mushroom, milky mushroom and *Ganoderma*

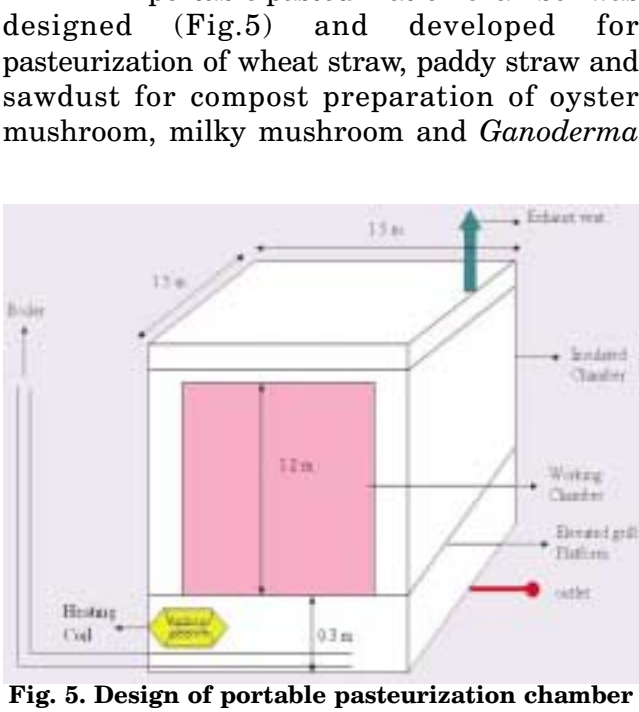


Fig. 5. Design of portable pasteurization chamber

Fig. 6. Portable pasteurization chamber

lucidum cultivation. The size (Fig.6) of the mini pasteurization chamber is 1.7 m (length) X 1.5 m (height) X 1.5 m (width).

The heat input for the chamber is from the electric heaters (03 KW, 2 Nos.) and there is an alternate provision to use steam boiler (MS steam pipe 15 mm dia.) for pasteurizing the substrate. A grated floor was fabricated using 40 mm MS flat at a distance of 05 mm and at a height of 0.3 m to support the loose substrate and / or substrate in gunny bags. 50 mm MS angle was used in the frame of the chamber and 14 gauge MS sheet was used to cover the frame. A thermostat was provided in the chamber, which will switch off the power supply when the required temperature of the water is attained.

Experiments were conducted in the newly developed portable pasteurization chamber to prepare the substrate for oyster mushroom cultivation. Wheat straw was used as the substrate and 50 kg of dry wheat straw was filled in the gunny bags. The gunny bags filled with wheat straw were kept inside the water filled in the chamber. It was observed that when both the heaters were switched on, the required pasteurization temperature of 75-80°C was achieved in 11 hours and the single heater took 23 hours to achieve the required pasteurization temperature for the wheat straw substrate.

(Network project on development of Indigenous machinery for spawn and mushroom production)

1. Cultivation trials of oyster mushroom in the evaporatively cooled mushroom growing room

In the cultivation trial of oyster mushroom conducted in the eveporatively cooled mud house and low cost mushroom houses, good crop yield was obtained (Fig. 1 and 2).

Fig. 1. Oyster mushroom crop in mud house

Fig. 2. Oyster mushroom crop in low cost mushroom house

2. Performance evaluation of Mushroom Stipe Cutting machine for milky mushroom

For evaluating the performance of stipe cutting machine (Fig.3) freshly harvested milky mushroom was used for the study and it was found that the stem could be effectively cut (Fig.4) for the varying height of 7.2 to 8.8 mm with an average value of 8 mm.

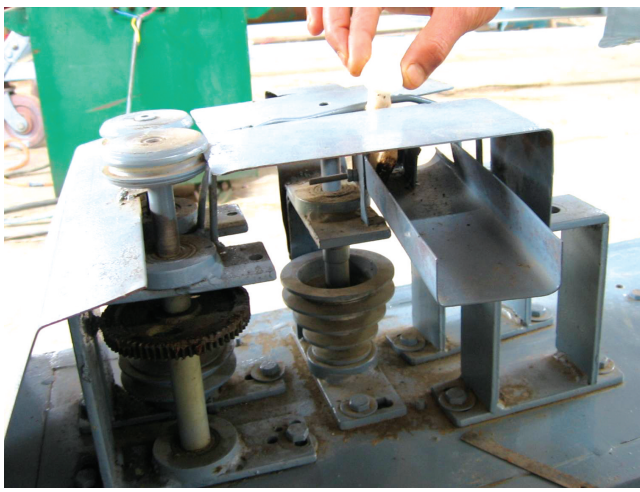


Fig. 3. View of mushroom stipe cutting machine during working

Fig. 4. Close view of milky mushroom fruit bodies trimmed by stipe cutting machine

(Studies on development of evaporatively cooled mushroom growing room and low cost mechanization for mushroom industry, Project-NCM-25)

1. Verification of indigenous technical knowledge

To verify and refine ITK about use of burnt rice husk mixed with F.Y.M. and soil in different ratio as casing material in button mushroom by mushroom growers, a large scale trial was laid out during April-May, 2008 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. Out of these treatments, burnt rice husk +soil (1:1v/v), burnt rice husk +soil + FYM (1:1:1v/v) and burnt rice husk + FYM (2:1v/v) treatments have given good yield as compared to control treatment.

2. Transfer of Technology

2.1 Training Programmes Conducted

During 2008, the Centre organised a total number of 13 On and Off campus training programmes (Fig. 1) for farmers, farmwomen, entrepreneurs, officers & reseachers.

3. Mushroom Mela-2008

One day Mushroom Mela was organised on 10th September, 2008 as regular activity of the Centre. It was inaugurated by Dr.Rajeev Bindal, Hon'ble Minister of Health, Ayurveda and Health Education, HP (Fig. 2 and 3). It was attended by about 550 farmers, farm women, mushroom growers, researchers, extension workers and businessmen from various States viz; Himachal Pradesh, Haryana, Punjab, Uttar Pradesh, Maharashtra, Madhya Pradesh, Chattishgarh, Bihar, Jharkhand, Delhi, Uttrakhand, Assam, Gujrat, Kerala, Karnataka and Tamil Nadu.

Fig.1. Practical demonstration of mushroom cultivation to the farmers

Fig. 2. Dr. Rajiv Bindal Hon'able Minister of Health, Ayurveda and Health Education, visiting the exhibition stalls during mushroom mela 2008

An exhibition on improved mushroom cultivation technologies and other related aspect was organised in which various Govt. Organization, 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.

Fig. 3. Dr. Rajiv Bindal Hon'able Minister of Health, Ayurveda and Health Education, releasing publications during mushroom mela 2008

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

In the afternoon session of Mushroom Mela, a Kisan Goshthi was held to answer the problems in mushroom cultivation faced by mushroom growers. The problems raised by farmers and mushroom growers were replied by experts in a very systematic manner.

During the Mushroom Mela, the Centre awarded 10 progressive mushroom growers for adopting innovative practices in mushroom cultivation on larger scale and mobilizing other farmers to adopt mushroom cultivation as source of income.

4. Participation in national/state level exhibitions

In order to create awareness about mushroom cultivation, the Centre has participated in Regional Kisan Mela organised by IIVR Varansi from 28-31 Jan.,09 at Vanarasi, Kisan Mela organised by UHF, Nauni, Solan(HP) on 28 Jan., 2009, AGRO TECH-2008 organized by CII(NR), Chandigarh at Prade Ground, Chandigarh from 28 Nov., to 1st Dec. 2008 and "Bharat Nirman Jan Soochana Abhiyan" Exhibition organised by Press Information Bureau, Ministry of Information and Broadcasting, Shimla(HP) at Kunihar (Solan) form 27 June-1 July, 2008.

5. Foreign Consultancy

Dr M.P. Sagar trained field officers, youths and mushroom growers in mushroom cultivation technology during the training programme jointly organized by Commonwealth Youth Programme Asia Centre, Chandigarh(India) and Ministry of Youth & Sport, Dhaka, Bangladesh from 25th to 31st May, 2008 at Youth Centre, Savor, Dhaka.

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 provided. Queries on mushroom cultivation and training were replied through telephone and e-mail. On an average 4 queries per day were received and replied.

Collection, Documentation and Validation of Indigenous Technical Knowledge about Mushrooms Cultivation, Project-NCM-30

TRAINING COURSES ORGANISED

S. No.	Name of training programme	Sponsored by	No. of Trainees	Course Director/ Course Coordinator
1.	Five days sponsored training programme on mushroom production technology for farmers and farm women of Kokrajhar (Assam) w.e.f. 3rd - 7th, April, 2008.	BTC, Kokrajhar (Assam)	14	M.P.Sagar
2.	Ten days National training programme on mushroom production technology for Entrepreneurs w.e.f. 22nd April to 1sh May, 2008.	NRCM, Solan	20	Dr. B.Vijay Dr. M.P. Sagar
3.	Seven days training on mushroom production for farmers of Hamirpur district (HP) w.e.f. 16th to 22nd, June, 2008.	ATMA, Hamirpur	30	Dr S.R Sharma Dr. V.P. Sharma
4.	Seven days training on mushroom production for farmers, farm women and youths w.e.f. 24th to 30th June, 2008.	NRCM, Solan	63	Dr. B.Vijay Dr. M.P. Sagar
5.	Seven days training on mushroom production for farmers, farm women and youths of Una district (HP) w.e.f 21st to 27th Aug., 2008.	ATMA, Una	20	Dr. R.C. Upadhyay Dr M.C.Yadav
6.	Ten days sponsored training programme on mushroom production technology for entrepreneurs of HP w.e.f. 29th Oct. - 6th Nov. & 26th Nov., 2008.	HP-STEP, Shimla	20	Dr. B.Vijay Dr. M.P. Sagar
7.	Seven days training on mushroom production for farmers of Kangra (HP) w.e.f. 2nd - 8th Dec., 2008.	ATMA, Kangra	26	Dr.O.P. Ahlawat Dr. M.P. Sagar
8.	Six days training programme on mushroom production technology for Scientists and Research Associates w.e.f. 27th March- 2nd April, 2008.	VPKAS, Almora	7	Dr B. Vijay Dr M.P. Sagar
9.	Seven days training on mushroom production for farmers of Rampur, Shimla (HP) w.e.f. 23rd -29th May, 2008.	BDO, Rampur	30	Dr R.D.Rai Dr A. Nathan
10.	Seven days training on mushroom production for DRDA farmers of Bilaspur district (HP) w.e.f. 15th -21st Oct., 2008.	DRDA, Bilaspur	30	Dr B Vijay Sh Sunil Verma
11	Seven days training on mushroom production for farmers sponsored by ATMA, Hamirpur w.e.f. 12th -18th Nov., 2008.	ATMA, Hamirpur	30	Dr B Vijay Dr Satish Kumar
12	Seven days training on mushroom production for farmers of Kangra (HP) w.e.f. 23rd - 29th sept., 2008.	NRCM, Solan	81	Dr B Vijay Sh Sunil Verma
13	Seven days training on mushroom production for farmers w.e.f. 15th - 18th Dec., 2008.	Jharkhand Gangadhar Shastri Rastrya Vikas Mission Ranchi	20	Sh Sunil Verma

Fig. 1. Substrate preparation for oyster mushroom cultivation by trainees during farmers training at NRCM

Fig. 2. Practical demonstration of spawn preparation to the trainees

Fig. 3. Practical demonstration of pickle preparation to the trainees

1. Summer Training of scientist/ Students

1. Dr. N. Earanna, Associate Professor, Department of Biotechnology, University of Agricultural Sciences, GKVK campus, Bangalore, worked for two months under "INSA VISITING SCIENTIST FELLOWSHIP SCHEME" w.e.f. 31st July to 30th September, 2008 with Dr. M.C.Yadav.

2. Ms Vanita Gautam, M.Sc (Biotechnology), H.N.B. Garwal University Srinagar, Uttaranchal, completed her Project "Molecular characterization of fungal and bacterial pathogens associated with mushrooms" under the guidance of Dr V.P. Sharma.

3. Miss Jaya Student of M.Sc. Microbiology Uttranchal College of Science and Technology, Dehradun completed her project w.e.f. 07.05.08 to 07.08.08 under the guidance of Dr B. Vijay.

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.

PUBLICATIONS

A. Research Papers

1. Ahlawat, O.P., Gupta, Pardeep and Dhar, B.L. 2008. Profile of the extra cellular lignocellulolytic enzymes as a tool to select the promising strains of *Volvariella volvacea* (Bull. ex Fr.) Sing. *Indian J Microbiol,* 48: 389-396.

2. Vijay, B., Mediratta, V, and Ahlawat, O.P. 2007. Evaluation of different compost formulations for white button mushroom cultivation. *Indian Journal of Mushrooms* XXV: 25-29.

3. Palaniselvam, V., Chinnanchetty, G., Venkatachalam, P., Kathirvel, K. and Arumuganathan, T. 2007. Development and performance evaluation of packed bed solar drier for drying oyster mushroom, *Pleurotus florida*. *Mushroom Research,* 16(2): 103-109.

4. Arumuganathan, T., Manikantan, M.R., Rai, R.D., Anandakumar, S. and Khare, V. 2009. Mathematical modelling of drying kinetics of milky mushroom in a fluidized bed drier. *International Agro Physics*, 23(1): 1-7.

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 (1&2): 43-52.

6. Kasthuri, R., Kartheeswaran, S., Thangavel, K., Viswanathan, R. and Arumuganathan, T. 2007. Studies on qualities of canned milky mushroom *(Calocybe indica)*. *Indian Journal of Mushrooms*, XXV (1&2): 38-42.

7. Vijay, B., Mediratta, Vishal and Ahlawat,O.P. 2007. Evaluation of different compost formulations for *Agaricus bisporus* (white button mushroom) cultivation. *Indian Journal of Mushrooms,* 25 (1&2): 25-29.

8. Upadhyay, R.C., Kaur Aman jeet, Deepika Kumari and Semwal, K.C. 2008. New records and taxonomy of Agaricales from north western Himalaya. *Journal of Mycology and Plant Pathol*ology, 38 (1): 158-163.

9. Sharma, V.P. and Sharma. S.R. 2009. Molecular identification and cultivation of the black poplar culinary medicinal mushroom *Agrocybe aegerita* (V.Brig.) Singer (Agaricomycetideae). *International Journal of Medicinal Mushrooms*, 11(1): 87-91.

10. Tandon, Gayatri and Sharma, V.P. 2007. Effect of growth regulators on the quality and productivity of *Calocybe indica*. *Indian Journal of Mushrooms,* 25:53-55.

A. Books

1. Sagar, M.P., Tewari, R.P. and Vijay, B. 2008. Prarambhik Mushroom Utpadan. DMR, Solan(HP),India. p.139

B. Book Chapters

1. Arumuganathan, T. and Dhar, B.L. 2008. Kam moolya ka mausami mushroom uthpadan kaksh. In: *Prarambhik mushroom uthpadan* (M.P.Sagar, R.P.Tewari and B.Vijay, eds.). pp: 49-52. NRCM, Solan (HP), India

2. Yadav, M.C., and Tewari, R.P. 2008. Climate Change impact on mushroom. In: *Brain storming Session on Impact Assessment of Climate Change for Research Priority Planning in Horticultural Crops* (S.S. Lal, P.M. Govindakrishnan, V.K. Dua, J.P. Singh and S.K. Pandey, eds.), pp. 178-184, CPRI, Shimla.

3. Sharma, V.P., Tewari, R.P. and Sharma, S.R. 2008. Impact of climate change on mushroom production and integrated pests

and disease management strategies. In: *Impact assessment of climate change for research priority Planning in horticulture Crops*. (S.S. Lal, P.M. Govindakrishnan, V.K. Dua, J.P. Singh and S.K. Pandey, eds.), pp 218-221, CPRI, Shimla.

D. Technical Bulletins

1. Ahlawat, O.P. and Sagar, M.P. 2008. *Mushroom Poshadhar Awshes ka Prabandhan*. National Research Centre for Mushroom, Chambaghat, Solan (HP) p. 46.

2. Rai, R.D. and Arumuganathan, T. 2008. Post harvest technology of mushrooms. National Research Centre for Mushroom, Chambaghat, Solan (HP) p. 84.

F. Reports

1. Ahlawat, O.P. and Kumar, Satish and Arumuganathan, T. 2008. Compilation and editing of AICRPM Annual Report 2007-08, NRCM, Solan (HP) p.58.

2. Ahlawat, O.P., Kumar, Satish, Arumuganathan, T. and Tewari, R.P. 2008. Compiled and edited 25 Years of AICRP (Mushroom), NRCM, Solan (HP) p.95.

3. Sharma, V.P., Kumar, Satish and Sagar, M.P. 2007-08. Compiled and edited NRCM Annual Report 2007-2008, NRCM, Solan , p. 86.

G. Popular/ Technical Articles

1. Ahlawat, O.P. 2008. Upaj vardhi hetu jaivik ve rashyanic utprarko ka paryog. In: *Prarambhik mushroom uthpadan* (M.P. Sagar, R.P. Tewari and B. Vijay, eds.). pp.63-66. NRCM, Solan (HP), India.

2. Ahlawat, O.P. 2008. Puwal mushroom (*Volvariella*) ki kheti. In: *Prarambhik mushroom uthpadan* (M.P. Sagar, R.P. Tewari and B. Vijay, eds.). pp. 94-98. NRCM, Solan (HP), India.

3. Ahlawat, O.P. 2008. Khumb utpadanoprant paryukt khad (poshadhar) ka punae estemal In: *Prarambhik mushroom uthpadan* (M.P. Sagar, R.P. Tewari and B. Vijay, eds.). pp. 119-122. NRCM, Solan (HP), India.

4. Arumuganathan, T and Rai, R.D. 2008. Shwet button khumb ke mulyavardhak uthpad. In: *Prarambhik mushroom uthpadan* (M.P. Sagar, R.P. Tewari and B. Vijay, eds.). pp: 116-118. NRCM, Solan (HP), India.

5. Sharma, V.P. 2008.Vishist Kumbo ki Kheti. In: *Praramhik mushroom Utpadan* (M.P. Sagar, R.P. Tewari and B. Vijay, eds.). pp 90-93. NRCM, Solan (HP), India

6. Kumar, Satish. 2008. Khumb ke kere makoron aur sutarkrimiyon ka prabhadhan. In: Praramhik mushroom Utpadan (M.P. Sagar, R.P. Tewari and B. Vijay, eds.). pp 104-110. NRCM, Solan (HP), India

7. Sharma, S.R. 2008. Khumb ki Bimariyan. In: Praramhik mushroom Utpadan (M.P. Sagar, R.P. Tewari and B. Vijay, eds.). pp 99-103. NRCM, Solan (HP), India.

APPROVED ONGOING RESEARCH PROJECTS

Institute Code	Title	Researchers		Period/Remarks
NCM-15	Survey, collection and identification of fleshy fungi	Dr. R.C. Upadhyay	Principal Investigator	Jan., 1998 – 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, 2009
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 Dr. R.D. Rai	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., 1997 – continued
NCM-31	Organic mushroom production and quality produce	Dr. B.L. Dhar Dr. O.P. Ahlawat Dr. J.K. Dubey Dr. S.K. Patyal	Principal Investigator Co-Investigator Co-Investigator Co-investigator	March, 2002 to March, 2009
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, 2009
NCM-41	Etiology, molecular characterization and management of the bacterial diseases of mushrooms	Dr. V.P. Sharma Dr. S.R. Sharma Dr. Satish Kumar Dr. O.P. Ahlawat	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	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 Nov., 2009	DST

Consultancy Provided by the Scientists of NRCM

1. Sh. Jasphool Singh, Farmer in Horticulture, # 46, Sector-I, Rohtak – 124001 Techno Economic Feasibility Report was prepared.
2. Mr. Mohit Mehra, RIA Agro A1/98, Sector-7, Rohini, Delhi – 110 085 Techno Economic Feasibility Report was prepared.

a) Institute Management Committee: No meeting of IMC was held during the period. New IMC has been constituted for a period three years w.e.f. 23.07.2008

Constitution of IMC

1.	Dr. R.P. Tewari, Director, Directorate of Mushroom, Chambaghat, Solan (H.P.) – 173213	-	Chairman
2.	Dr. Umesh Srivastava, Assistant Director General (Hort.II), Indian Council of Agricultural Research, Krishi Anusandhan Bhavan-II, PUSA, New Delhi – 110 012.	-	Member
3.	Dr. D.K. Arora, Director, National Bureau of Agriculturally Important Microorganisms(NBAIM), Kusmaur, MAU Nath Banjan (U.P.).	-	Member
4.	Dr. Prakash Nayak, Principal Scientist/Project Coordinator, Central Potato Research Institute, Shimla (H.P.).	-	Member
5.	Dr. Meera Pandey, Principal Scientist(Mushroom), Indian Institute of Horticulture Research, Bangalore.	-	Member
6.	Dr. V.P. Sharma, Principal Scientist, Directorate of Mushroom Research, Chambaghat, Solan (H.P.) – 173213.	-	Member
7.	Sh. Raj Kumar, Administrative Officer, Directorate of Mushroom Research, Chambaghat, Solan (H.P.) – 173213.	-	Member Secretary

(b) Research Advisory committee: One meeting held on 12-13 May, 2008

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

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)

(c) Institute Research Council (IRC)

The meeting of Institute Research Council (IRC) was held on 2nd September, 2008 and was attended by all the scientists under the Chairmanship of the Director, NRCM, Solan.

(d) Core Committee

Five meetings of Core Committee were held on 08.01.2008, 02.08.2008, 25.08.2008, 25.10.2008 & 25.11.2008 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/Estate Officer	-	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

Five meetings of Sectional Incharges were held on 02.05.2008, 05.04.2008, 12.06.2008, 12.09.2008 and 28.11.2008 under the Chairmanship of Dr. R.P. Tewari, Director.

Dr. R.P. Tewari, Director	Chairman
Dr. S.R. Sharma, Sectional Incharge, Crop Protection Section	Member
Dr. R.D.Rai, Sectional Incahrge, Crop Nutrition & Utilization Section	Member
Dr. R.C. Upadhyay, Head, Crop Improvement Section	Member
Dr. B. Vijay, Sectional Incharge, Transfer of Technology	Member
Sh. Jiwan Lal, AFACO	Member
Sh. Raj Kumar, Administrative Officer	Member Secy.

(f) Senior Officer's Meetings

One meeting of Senior Officer's of this Centre was held on 03.03.2008 under the Chairmanship of Dr. R.P. Tewari, Director. All The Scientists, AAO, AFACO are the Members & Administrative Officer is the Member Secretary.

(g) Institute Joint Staff Council (IJSC)

Three meetings of IJSC were held on 04.02.2008, 13.06.2008 and 14.11.2008 under the Chairmanship of Dr.R.P. Tewari, Director. The Members of IJSC 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. Official Side Members

Dr. R.C. Upadhyay, Principal Scientist	-	Chairman
Dr. B.Vijay, Principal Scientist	-	Member
Sh. Raj Kumar, Admn. Officer	-	Member
Sh. Jiwan Lal, AFACO	-	Member
Sh. Rishi Ram, AAO	-	Member Secretary

II. Staff Side Members

Dr. Satish Kumar, Senior Scientist	-	Member (Scientific category)
Sh. Rajinder Sharma, Asstt.	-	Member (Admn. category)
Sh. Guler Singh, T-2 (Electrician)	-	Member (Technical category)
Sh. Raj Kumar, SSG-II	-	Member (Supporting staff)

(i) Consultancy Processing Cell (CPC)

Three meetings of Consultancy Processing Cell (CPC) were held 03.01.2008, 03.03.2008 and 12.08.2008 under the Chairmanship of Dr. B. Vijay, Principal Scientist.

Followings are the Members of CPC :

1. Dr. B. Vijay, Principal Scientist	-	Chairman
2. Dr. O.P. Ahlawat, Senior Scientist	-	Member Secretary
3. Sh. Raj Kumar, Admn. Officer	-	Member
4. Sh. Jiwan Lal, AFACO	-	Member
5. Sh. Deep Kumar Thakur, Steno(Gr.III)	-	Dealing Assistant

(j) Rajbhasha 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
श्रीमती रीता, तकनीकी अधिकारी	-	सदस्या
श्रीमती सुनीला ठाकुर, आशुलिपिक	-	सदस्या
श्री दीप कुमार ठाकुर, आशुलिपिक	-	सदस्य सचिव

राजभाषा कार्यान्वयन समिति द्वारा वर्ष 2008 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 का अतिरिक्त कार्यभार श्री दीप कुमार ठाकुर, आशुलिपिक (ग्रेड-III) को सौंपा गया है। केन्द्र द्वारा वर्ष 2008 के दौरान राजभाषा के क्षेत्र में किये गए कार्यों का संक्षिप्त ब्यौरा निम्न प्रकार 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 को कहा 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। 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। ये कार्यशालाएं केन्द्र के निदेशक महोदय की अध्यक्षता में हुई जिसमें लगभग प्रत्येक कार्यशाला में निदेशक महोदय द्वारा केन्द्र के सभी अधिकारियों व कर्मचारियों को राजभाषा के लक्ष्यों को पूरा करने का आह्वान किया गया। केन्द्र में कुल 50 अधिकारी व कर्मचारी होने की वजह से कार्यशाला का आयोजन इस प्रकार किया गया कि केन्द्र के सभी अधिकारियों व कर्मचारीओं की भागीदारी बढ़े। इसी क्रम में प्रधान वैज्ञानिकों, वरिष्ठ वैज्ञानिकों, वैज्ञानिकों व प्रशासनिक अधिकारी को हिन्दी में व्याख्यान देने के लिए आमंत्रित किया गया जिसमें उन्होंने अपने-2 क्षेत्रों में हो रहे कार्यों को हिन्दी में प्रदर्शित करने के अतिरिक्त हिन्दी में कार्य को बढ़ाने के सकारात्मक सुझाव दिए जिन पर अमल किया गया/जारी है।

केन्द्र के सभी अधिकारियों व कर्मचारियों को सभी प्रकार के प्रफोर्मा द्विभाषी तैयार कर इंटरनेट के माध्यम से उनके कम्प्यूटरों पर डाउनलोड किए गए।

केन्द्र के सभी अधिकारियों व कर्मचारियों के लिए सभी प्रकार के प्रफोर्मा द्विभाषी तैयार किए गए व सभी के कंपयूटरों पर इंटरनेट के माध्यम से डाउनलोड किए गए ताकि वे दिन-प्रतिदिन कार्यालय प्रयोग में इन प्रफोर्मा को प्रयोग में लाए तथा समय को व्यर्थ नष्ट न कर अपना अधिक से अधिक ध्यान अनुसंधान के कार्यों की तरफ लगा सके।

हिन्दी सप्ताह का आयोजन

केन्द्र में दिनांक 15-20 सितम्बर, 2008 को हिन्दी सप्ताह मनाया गया जिसमें केन्द्र के अधिकारियों व कर्मचारियों के लिए निम्नलिखित प्रतियोगिताएं आयोजित की गईः-

1. श्रुतलेखन
2. सुलेख
3. निबंध (वि ियः मंहगाई कारण एवं निवारण)
4. टिप्पणी

   (उपरोक्त सभी प्रतियोगिताएं सभी अधिकारयों व कर्मचारियों के लिए आयोजित की गई)।
5. तकनीकी लेख (जिसका विषयः तकनीकी कार्यक्षमता बढ़ाने के उपाय)

   (तकनीकी कर्मचारियों के लिए)
6. कम्पयूटर पर टंकण प्रतियोगिता **(प्रशासनिक कर्मचारियों के लिए)**
7. प्रार्थना पत्र लेखन **(चतुर्थ श्रेणी कर्मचारियों के लिए)**
8. वाद-विवाद प्रतियोगिता प्रतियोगिता(जिसका विषयः निदेशालय का पिछले 25 वर्षों का अनुसंधान कृषकों के हित में है)

   (वैज्ञानिकों 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, 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।

चित्र. 1. श्री एन.पी. नेगी हिन्दी में सर्वाधिक कार्य करने के लिए तृतीय पुरस्कार प्राप्त करते हुए

केन्द्र की वार्षिक हिन्दी प्रगति संबंधित मुख्य गतिविधियाँ एवं उपलब्धियाँ

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

1. केन्द्र के 80 प्रतिशत से अधिक कार्मिक हिन्दी में प्रवीणता/कार्यसाधक ज्ञान प्राप्त है इसलिए यह निदेशालय राजभाषा नियम 1976 के नियम 10(4) के अंतर्गत भारत सरकार के गजट में हिन्दी कार्यालय के रूप में अधिसूचित किया जा चुका है।

2. दिनांक 28.03.2008, 20.06.2008, 30.08.2008 व 10.12.2008 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 10.03.2008, 23.06.2008, 15.09.2008, 10.12.2008 को राजभाषा कार्याशालाओं को आयोजन किया गया।

4. केन्द्र की बेबसाईट हिन्दी में बनाने के प्रयास जारी है।

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

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

7. 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 (व्यक्तिगत) जारी किए गए व इनकी शत-प्रतिशत अनुपालन सुनिश्चित करवाने के प्रयास किए गए।

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

9. 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।

10. केन्द्र के सभी 10 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।

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

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. हिन्दी पुस्तकों की खरीद की गई व लक्ष्य को प्राप्त करने की दिशा में प्रयारत है।

16. हिन्दी में हो रहे कार्यों की एक एलबम भी तैयार करने की दिशा में प्रयास जारी है।

17. 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।

Dr. B. Vijay

- Attended one-day brain storming session on Agro waste Management and Value Added products- Challenges Ahead. Organized by NBAIM, Mau, under AMAAS at New Delhi on 11th Nov., 2008.

- Attended biennial workshop of AICMIP and seminar on mushroom diversification held at DMR, Solan, w.e.f. 26-28 Dec., 09.

Dr. M.C. Yadav

- Attended Brain storming Session on Global warming w.e.f. 6-7th Sept., 2008 CPRI Shimla.

Dr. O.P. Ahlawat

- Participated in Programme Advisory Committee (PAC) Meeting on Plant Sciences of Dept of Science and Technology (DST) on 23-24 May, 2008 at Institute of Himalayan Bioresource Technology (IHBT), Palampur (HP).

- Attended Interactive Meeting on Nutrient Dynamics in Horticulture Crops on 14-15 June, 2008 at IIHR, Bangalore.

- Attended National Seminar on Mushroom Diversification and Scientists Industry Interface on 26th Dec., 2008 at DMR, Solan (HP).

- Attended XI Biennial Workshop of All India Coordinated Research Project on Mushroom on 27-28 Dec., 2008 at DMR, Solan (HP).

Dr. R.C. Upadhyay

- Attended National Seminar on Mushroom Diversification and Scientists Industry Interface on 26th Dec., 2008 at DMR, Solan (HP).

Fig. 1. XIth Biennial Workshop of AICMIP at NRCM

- Attended XI Biennial Workshop of All India Coordinated Research Project on Mushroom on 27-28 Dec., 2008 at DMR, Solan (H.P.).

- Attended Project Review meeting of CSIR, New Delhi at IMTECH, Chandigarh on 20th March, 2008 and presented the Research work.

Dr. V.P. Sharma

- Attended the ICAR Training cum Workshop on IP and Technology management "Genetic Engineering" w.e.f. 23rd-25th April, 08. at Division of Plant Pathology, IARI New Delhi

- Attended Brain storming Session on Global warming w.e.f. 6-7th Sept., 2008 CPRI Shimla

- Attended Seminar on Mushroom Divesification and Scientists industry interface held at NRCM , Chambaghat on 26th Dec., 2008.

- Attended XIth Biennial Group Meeting of All India Coordinated Research Project on Mushroom held at NRCM , Chambaghat on 27th - 28th Dec., 2008.

DISTINGUISHED VISITORS

1. Sh Vikram Verma Member of Parliament visited NRCM on 25th May, 2008.

2. Dr J.C. Katyal Hon'ble Vice Chancellor,CCS, HAU, Hisar visited NRCM on 20th June, 2008.

3. Dr Ratan Lal Jat, Chairman, Rajasthan State Seed Corporation, Jaipur, Rajasthan visited NRCM on 9h July, 2008.

4. Dr H.P. Singh, DDG (Hort.), inaugurated Electrical Sub station at NRCM, Solan on 5th Sept., 2008

Fig. 1. Dr H.P. Singh Inaugurating Sub station at NRCM

Fig. 2. Members of Parliament Committee visiting cropping rooms

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	Principal 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-6, Lib.)
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 (T1-3)
Sh. Ram Swaroop	Technical Assistant (T-2)
Sh. Parma Nand	Mushroom Assistant (T1-3)
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 Poonam	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. Om Parkash Ahlawat, promoted through CAS from Sr.Scientist to the post of Principal Scientist w.e.f. 04.01.2008

Smt.Reeta, TO Library promoted through assessment from TO(T-5) to TO(T-6) w.e.f. 20.08.2008.

ACP

Sh.Roshan Lal Negi, LDC granted next higher pay scale under ACP Scheme w.e.f. 17.06.2008.

Transfers

Dr. S.K. Singh, Principal Scientist transferred from DMR, Solan to CAZRI, Jodhpur, Rajasthan and relieved of his duties in the afternoon of 10.06.2008

Er.T. Arumuganathan, Scientist (SS) transferred from DMR, Solan to CPCRI, Kasargod, Kerala and relieved of his duties in the afternoon of 20.12.2008.

Retirement

Dr.R.P. Tewari, Director, DMR retired on superannuation from his services in the afternoon of 31.12.2008.

Fig. 1. Dr R.P. Tewari, Director, retired on superannuation from his services

New Appointment

Dr. Manjit Singh joined as Director DMR Solan w.e.f. 01.01.2009.

Fig. 2. Dr Manjit Singh joined as new Director of the Directorate of Mushroom Research

Study leave

Sh.Yogesh Gautam, Scientist (SS) Computer Application granted Study leave for 3 years w.e.f. 08.02.2008 to 07.02.2011 for completing Ph.D on Computer from HP University, Shimla.

Sports

The DMR, Chambaghat, Solan (H.P.) Contingent of 25 Nos. (23 Men and 2 women) participated in ICAR Zonal Sports Meet held at National Dairy Research Institute, Karnal w.e.f. 23-26th September, 2008. In the men events, the Centre participated in Volley Ball (Smashing & Shooting), Badminton, Kabaddi, Chess, Table Tennis and Carrom Board. In the women events Ms. Sunila Thakur won first prizes in Shot put and Long Jump events. In the women Single event Ms. Sunila Thakur won the I st prize. In the Badminton double team event the women Team of NRCM won the I st prize.

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) Teacher Training Centre building completed

Under Non Plan

(1) Repair of roof of Main Laboratory building

(2) Repair of roof of Auditorium building

(3) Repair of roof of Hostel building

(4) Development of parking in front of Main building

Announcement

National Research Centre for Mushroom has been upgraded on Directorate of Mushroom Research w.e.f. 26th Dec., 2008.

Fig. 3. National Research Centre for Mushroom upgraded as Directorate on Mushroom Research