वार्षिक प्रतिवेदन
ANNUAL REPORT
2011

खुम्ब अनुसंधान निदेशालय
DIRECTORATE OF MUSHROOM RESEARCH
(भारतीय कृषि अनुसंधान परिषद्)
(Indian Council of Agricultural Research)
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It is their flavour and texture for which the mankind has long devoured the mushrooms; but scientific appreciation of their nutritional and medicinal attributes is a recent phenomenon. Mushrooms are perhaps the only fungi deliberately and knowingly consumed by human beings and these complement and supplement the human diet with various ingredients not encountered in or deficient in food items particularly of plant origin. Besides being a health food, mushrooms are gaining importance by virtue of their ability to secrete an array of extra cellular enzymes converting various agro-waste materials into high value food and valuable myco-medicinals. India has tremendous potential for their cultivation due to varied agro-climatic conditions, cheap labour and abundant supply of raw materials. The economic growth of the country has also given impetus to this commodity and a number of mushroom farms are coming up in different parts of the country. The mushroom production has reached nearly 1,20,000 metric tons per annum. Incorporation of mushrooms in the existing farming system can lead to diversification imparting sustainability, increased farm income and providing employment to the rural youth, women as well as school dropouts. With the increasing awareness about nutrition and neutraceuticals, the demand for quality foods including mushroom is increasing world over and in our country as well.

Survey and collection of mushrooms is an important activity of this Directorate and during the year National Mushroom Repository of this Directorate has been enriched by addition of 146 specimens. Large number of single spore isolates have been developed for developing high yielding strains in button mushroom. Two DNA markers have also been identified to distinguish fertile and non-fertile isolates. Various parameters like growth rate, morphological characteristics were analysed for screening high yielding strains in paddy straw mushroom.

Cotton waste and consortium of thermophillic fungi were successfully used for preparing button mushroom compost. and two wild species of were brought under cultivation, which gave higher yields. , a high temperature-requiring mushroom, was successfully cultivated on wheat straw. Physiological studies on have been done in respect of temperature, pH, carbon and nitrogen sources and mineral requirements. Strain OE-388 of shiitake and strain APK -2 of milky mushroom has been identified as the most promising high yielding strains.

Realising the fact that production can only be increased when consumption are increased, two regional mushroom mela and consumption fairs were held at Hoshiarpur in Punjab and Murthal in Haryana to address the problems faced by mushroom growers and to promote mushroom consumption among common masses. One day Mushroom Mela was also organized at this Directorate, which was attended by about 550 farmers from 20 States. Eight phone-in and field based programmes were telecasted on Doordarshan Kendra from Shimla on Krishi Darshan. Eight trainings programmes were organized in which 240 trainees got benefited.

The Directorate 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 Directorate.

(Manjit Singh)
Director

कार्य सारांश

खुम्ब अनुसंधान निदेशालय ने वर्ष 2011 के दौरान अनुसंधान, तकनीकी हस्तातरंण तथा मानव संसाधन के क्षेत्र में महत्वपूर्ण उपलब्धियां हासिल की है। वर्ष के दौरान खुम्ब अनुसंधान निदेशालय द्वारा फसल उन्नयन, फसल उत्पादन, फसल पोषण, प्रसार एवम् तकनीकी हस्तातंरण, शिक्षा एंवम् प्रशिक्षण तथा प्रकाशन में जो उपलब्धियां हासिल की है उनका विवरण यहां दिया जा रहा है।

वर्ष 2011 में कुल 146 जंगली खुम्बों के नमूने हिमाचल प्रदेश एंवम् अरूणाचल प्रदेश से एकत्रित किए गए। जिनकी पहचान प्रजाति स्तर तक की गई तथा इन्हें निदेशालय के संग्रहालय में संरक्षित किया गया। निदेशालय के जीन बैंक में कुल 112 खाद्य, अखाद्य एवम् विषैले खुम्बों के शुद्ध संवर्धन जमा किए गए।

श्वेत बटन खुम्ब की विभिन्न उपजातियों जैसे कि यू–3, ए–6, ए–94, ए–4, एस–11, एनसीएस–101, एस–465, ए–15, ए–2, डबलयूआई–1, डेल्टा, एस–130, बीएस–419 एवम् एस–454 से कुल 451 एकल बीजाणु संवर्धन बनाये गए। इनमें से 394 एकल बीजाणु संवर्धनों में से कुल 34 को अधिक उत्पादकता एवम् गुणवत्ता के आधार पर चयनित किया गया। इन 34 में से 8 एकल बीजाणु संवर्धनों को अखिल भारतीय खुम्ब उन्नयन परियोजना के अंर्तगत विभिन्न केन्द्रो पर मुल्याकित किया गया। कुल 394 मुल्यांकित एकल बीजाणु संवर्धनों में से 37 बांझ संवर्धनो की पहचान की गई। जिनके प्रयोग द्वारा कुल 48 अंर्तउपजाति संकर संवर्धन (यू–3 X ए–94) बनाए गए। संकर संवर्धनों की उत्पादकता का मूल्यांकन किया जा रहा है। 5 उपजाऊ तथा 13 बांझ एकल बीजाणु संवर्धनो के 30 संयोगिक प्राईमर द्वारा आर.ए.पी.डी. विश्लेषण से कुल 5 डी.एन.ए. बैंड उपजाऊ संवर्धनों में तथा 2 बैंड बांझ संवर्धनों में प्राप्त हुए। इन मार्कर बैंडों का सत्यापन ज्यादा उपजाऊ एवम् बांझ संवर्धनों में किया जाना है। इन संवर्धनों मे एस.एन.पी. मार्करों की खोज के लिए 10 उपजाऊ एवम् 8 बांझ संवर्धनों के अनुक्रमो का विश्लेषण किया गया तथा पाया गया कि उपजाऊ एंवम् बांझ संवर्धन अलग–अलग समूहों में विभक्त हो गए तथा एक अन्य समूह भी पाया गया जिसमें दोनों तरह के संवर्धनों का समावेश था। इस अन्य समूह के बनने का संभव कारण बांझ संवर्धनों में एक ही किस्म के दो प्रजनन केन्द्रकों का पाया जाना हो सकता है।

वर्ष के दौरान श्वेत बटन खुम्ब के प्रजाति मुल्यांकन पर दो प्रयोग किए गए, जिसमें कि प्रजाति ए.वी.एस. –2 तथा ए.वी.एस–7 ने छोटी विधि द्वारा बनाई गई खाद पर तथा ए.वी.एल–1 एवम् ए.वी.एल–6 ने लम्बी विधि द्वारा बनाई गई खाद पर अधिक उपज दी। जिन 8 एकल बीजाणु संवर्धनो को अखिल भारतीय खुम्ब उन्नयन परियोजना के अंर्तगत मुल्यांकित किया गया, उनका मुल्यांकन निदेशालय में भी किया गया तथा उनके समेकित विश्लेषण द्वारा एस.एस.आई.–3 तथा एस.एस.आई–2 को सफेद प्रजातियों में सर्वाधिक उपज एवम् गुणवत्ता वाले संवर्धन के रूप में पहचाना गया। जबकि भूरे एकल बीजाणु संवर्धनों में एस.एस.आई–6 एवम् एस.एस.आई–8 को अच्छे संवर्धनों के रूप में पहचाना गया।

पराली खुम्ब के दो उपजातियों मे लक्केज जीन के 6 अनुक्रम प्राप्त किए गए। जिसमें से विषम युग्मज उपजाति वी.वी–01 मे लक्केज जीन 1, 2, 3 एवम् 6 के आंशिक अनुक्रम तथा सम युग्मज उपजति बी.बी.एस.आर–003 मे लक्केज–3 के आंशिक अनुक्रम प्राप्त किए गए। उपजाति वी.वी.–01 एवम् वी.वी.एस. आर–003 के लक्केज–3 के अनुक्रम एन.सी.बी.आई. जीन बैंक मे एच.क्यू.–687205 एवम् जे.एफ.–313903 संख्या के अंर्तगत जमा किए गए। इन अनुक्रमों के

विशलेषण से 10 अनुक्रमों की विभिन्नता का पता चला। लक्केज–1 जीन में 16 इनट्रौनो का पता चला तथा वी.वी.–01 उपजाति की अमीनो–अम्ल के अनुक्रम मे एक अमीनो–अम्ल प्रकाशित जीन अनुक्रम के मुकाबले कम पाया गया। इन जीन अनुक्रमो मे विषम युग्मज होने के प्रमाण नहीं पाये गए। लक्केज–2 जीन अनुक्रम मे भी 16 इनट्रौन पाये गए तथा इस अनुक्रम में विषम युग्मज होने के प्रमाण पाये गए। उपजाति वी.वी.–01 एवम् बी.बी.एस.आर–003 के लक्केज–2 जीन के अनुक्रमों में कुछ स्थानों पर विभिन्नता पाई गई। पराली खुम्ब के लक्केज जीन मे इनट्रौनो की स्थिति के आधार पर उपजातियो को समूह–ए मे रखा गया। पराली खुम्ब की 17 उपजातियो का माल्ट–अगर एवम् नीचे की ओर कवक जाल की रैखिक वृद्धि के आधार पर तुलनात्मक अध्ययन किया गया। अधिकतर उपजातियो मे अधिक वृद्धि दर तथा भूरे क्लेमाइडोस्पोर माल्ट–अगर माध्यम पर पाये गए। इस खुम्ब की 16 प्रजातियो का तुलनात्मक अध्ययन धान के भूसे पर अधिक वृद्धि के लिए किण्वकों के उत्पादन के द्वारा किया गया। सर्वाधिक सेल्यूलोलिटिक एवम् जाइलोनोलिटिक सक्रियता उपजाति वी.वी.–01 तथा ओ.ई.–272 मे पाई गई। जबकि लिगनोलिटिक सक्रियता सबसे ज्यादा ओ.ई.–272 एवम् डबलयू.वी.–3 में पाई गई। इन उपजातियो के आई.टी.एस. विशलेषण में 10 उपजातियो मे एक जैसे बैंड (720 बी.पी.) बनाए। जबकि बाकी 4 उपजातियो मे यह बैंड 600 बी.पी. या कम पर प्राप्त हुए। इन मे से उपजाति डबलयू.वी.–2 एवम् डबलयू.वी.–3 को *वाल्वोपलूटियस अरलेई* के रूप मे पहचाना गया जो कि *वाल्वेरिएला* की एक नई प्रजाति है।

सोलन के विभिन्न स्थानों से खाद के नमूने एकत्रित किए गए तथा उनमे से कवकों का पृथककरण किया गया। सभी नमूनों मे *एस. थर्मोफिलम, एच. इनसोलेंस* एवम् *एच. ग्रीसिया* सबसे ज्यादा पाई गई। बटन खुम्ब के लिए खाद पूर्णतः आंतरिक विधि द्वारा *एस. थर्मोफिलम* (उपजाति एस. 21) एवम् *एच. ग्रीसिया* (उपजाति आई–33) के उपयोग से बनाई गई। कुल एक टन गेहूं के भूसे से 3.78 टन खाद का निर्माण हुआ जिसमे कि औसत उत्पादकता 8.82 किलो ग्राम/100 किलो ग्राम खाद द्वारा प्राप्त हुई। इन दोनों कवकों का प्रयोग छोटी विधि द्वारा बनाई गई खाद में अकेले तथा विभिन्न थर्मोफिलिक कवकों के साथ भी किया गया तथा सर्वाधिक उत्पादकता *एच. ग्रिसिया* द्वारा बनाई गई खाद तथा उसके बाद विभिन्न थर्मोफिलिक कवकों के मिश्रण से बनाई गई खाद में प्राप्त हुई। नाईट्रोजन स्रोत के रूप मे कपास की खल, अपशिष्ट खाद एवम् मुर्गी की बीठ को छोटी विधि से खाद बनाने के लिए उपयोग किया गया तथा सर्वाधिक उत्पादकता कपास की खल द्वारा बनी हुई खाद में प्राप्त हुई। जबकि पूरी तरह से मुर्गी की बीठ से मुक्त खाद मे उत्पादकता कम पाई गई। केसिंग मिटटी मे जिप्सम डालने से उत्पादन मे वृद्धि पाई गई। पश्च फसल प्रबंन्धन मे यह देखा गया कि बटन खुम्ब के 11 दिनों तक कमरे के तापमान भण्डारण पर उसमे यूरिया की मात्रा 1.07 प्रतिशत तक ब. गई।

इस वर्ष निदेशालय मे ऑयस्टर खुम्ब की दो जंगली प्रजातियों को अच्छी उपज के साथ सफलतापूर्वक उगाया गया। साथ ही ऑयस्टर खुम्ब के उत्पादन के लिए बैग मे 1" x 6" के छिद्र द्वारा पूरे खुले हुए बैग की तुलना मे अधिक उपज प्राप्त हुई।

राजस्थान के बीकानेर एवम् जयपुर जिलो, जो कि पूर्व 70.5522–73.3191 डिग्री, उतर 26.5538–28.0320 डिग्री एवम् 139.231 मीटर समुद्र तल से औसत ऊंचाई पर स्थित है, से फेलोरिनिया खुम्ब के 54 नमूने एकत्रित किए गए। इनके डी.एन.ए. अनुक्रमों के तुलनात्मक विशलेषण से इनकी 90 प्रतिशत समानता *फेलोरिनिया हरकुलिया* के साथ प्राप्त हुई। फेलोरिनिया खुम्ब की इन प्रजातियो की वृद्धि दर के अध्ययन हेतु 10 ठोस एवम् 11 द्रव्य माध्यम प्रयोग किए गए, जिनमे से माल्टअगर ठोस माध्यम प्रजाति 1/3 एवम् 5/19 के लिए तथा इलियट

द्रव्य माध्यम प्रजाति 1/3 के लिए सर्वश्रेष्ठ पाई गई। इन प्रजातियो के लिए उपयुक्त तापमान 40 डिग्री सेल्सियस एवम् पी.एच. 7.5 पाया गया। कार्बन स्रोतो मे मैनीटौल, सुक्रोज एवम् डेक्सट्रोज इन प्रजातियो के लिए सर्वोतम पाए गए। जबकि नाईट्रोजन स्रोतो मे सर्वाधिक वृद्धि कैल्सियम नाईट्रेट पर प्राप्त हुई। खनिज पदार्थो फेरस में सल्फेट (0.005 प्रतिशत), विटामिनो में थाईमिन (20 पी.पी.एम.) द्वारा सर्वाधिक वृद्धि प्राप्त की गई। वृद्धि के लिए सर्वश्रेष्ठ कार्बन नाईट्रोजन अनुपात 20:1 पाया गया। 5 पौषाधारों का मुल्यांकन भी विभिन्न प्रजातियो के लिए किया गया जिनमे पी–1/2 की सर्वश्रेष्ठ वृद्धि गेहूं के भूसे पर, पी–2/10 की धान के पुआल पर एवम् पी–5/19 की सोयाबीन के पुआल पर प्राप्त हुई। सभी प्रजातियो मे फलनकायो का निर्माण प्रजाति 1/3 में हुई परन्तु व्यस्क फलनकायो का निर्माण नही हो पाया।

शिटाके खुम्ब की 7 उपजातियो (ओई–8, ओई–16, ओई–20, ओई–21, ओई–22, ओई–38 एवम् ओई–388) को लकड़ी के बुरादे पर उपजाया गया तथा उपजाति ओई–388 सर्वाधिक जैविक क्षमता के साथ 107.29 प्रतिशत उपज तथा ओई–38 द्वारा 94. 79 प्रतिशत जैविक क्षमता प्रदर्शित की गई।

श्वेत बटन खुम्ब की विभिन्न उपजातियो मे तापीय मृत्यु बिंदु 39.4 से 48.4 डिग्री सेल्सियस, ऑयस्टर खुम्ब मे यह बिदुं 43.0–50.2 सेल्सियस एवम् शिटाके खुम्ब मे 46.6 से 50.2 डिग्री सेल्सियस पाई गई जबकि पराली खुम्ब मे यह बिदुं 44 से 54.8 डिग्री, ओरिकुलेरिया, एग्रोसाइब एवम् फलैमुलीना मे यह बिदुं क्रमशः 46.6 से 48.4, 44.8 एवम् 37.6 से 39.4 डिग्री सेल्सियस पाया गया।

मिल्की खुम्ब की 5 उपजातियो के मुल्यांकन मे सर्वाधिक उपज उपजाति ए.पी.के.–2 मे प्राप्त हुई। साथ ही साथ यह भी देखा गया कि मिल्की खुम्ब के उत्पादन मे सर्वाधिक उपज र्निजर्मीकृत केसिंग मिटटी द्वारा सभी उपजातियो मे प्राप्त हुई। मिल्की खुम्ब की सर्वाधिक रैखिक वृद्धि 62 प्रतिशत एवम् 60 प्रतिशत नमी पर प्राप्त हुई। जबकि 71 से 72 प्रतिशत नमी पर कवक जाल वृद्धि दर्ज नहीं की गई।

मैक्रोसाइब जिजैनटियम को एक बार फिर से गेहुं के भूसे पर सफलतापूर्वक उपजाया गया। *हिप्सीजाइगस अलमेरियस* खुम्ब के सुरूआती प्रयोगो मे 77 प्रतिशत जैविक क्षमता के साथ अच्छे परिणाम प्राप्त हुए।

इस वर्ष मिल्की एवम् बटन खुम्ब के 18 फार्म के दौरे हिमाचल प्रदेश एवम् हरियाणा राज्यो मे किए गए। इन दौरो के दौरान गीला–बुलबुला, हरी फफूंद एवम् फाल्स ट्रफल बीमारिया लगभग सभी फार्मो पर देखी गई।

ट्रेहलोज पर गीला बुलबुला बीमारी की फफूंद *माइकोगोन पर्नीसियोसा* के कोनिडीया का सर्वाधिक अंकुरण देखा गया। जबकि ग्लाईकोजेन, सुक्रोज एवम् जाइलोज पर यह अकुंरण बिल्कुल नहीं पाया गया। साथ ही साथ यह भी देखा गया कि माध्यम मे खुम्ब का सत्व डालने से 37 प्रतिशत तक अकुंरण दर्ज किया गया। *माइकोगोन* फफूंद के क्लेमाइडोस्पोर का अकुरंण सर्वाधिक 60 प्रतिशत डेक्सट्रोज पर, 50 प्रतिशत मैनिटोल पर, 40 प्रतिशत फ्रक्टोज पर तथा 20 प्रतिशत जाईलोज पर पाया गया। *माइकोगोन* के कवक जाल की सर्वाधिक वृद्धि दर 32 मि.मी., 6.0 पी.एच. पर तथा 25 डिग्री तापमान पर दर्ज की गई। गीला बुलबुला बीमारी के लक्षण 5 से 8 पी.एच. तक, 12 से 24 दिनों मे दिखाई देने लगे। जबकि पी.एच. 8.5 एवम् 9.0 पर बीमारी के लक्षण नही दिखाई दिए। फफूंदीनाशकों में कारबेन्डाजीम एवम् स्पोरगोन द्वारा बीमारी का 100 प्रतिशत नियंत्रण सभी सांद्रता पर पाया गया। जबकि बटन खुम्ब के कवक जाल पर इसका असर 10 से 17 प्रतिशत तक रहा। इन बीमारियों की पहचान के लिए विशेष प्राइमरों को बनाया गया तथा इनका सफलतापूर्वक प्रयोग किया गया।

विभिन्न खुम्बों के अपशिष्ट खादों में *पी. सेजोर काजु* की अपशिष्ट खाद मे सर्वाधिक बैक्टीरिया एवम् कवकों की विभिन्नता पाई गई। रंग विवर्णीकरण के लिए सक्षम 5 कवकों (*ए. फयूमीगेटस, पी.वेरीओटी, पी. गुलीरमोडी, साइजोफिल्म कम्यून* एवम् *पैजाइजोमाइकोटीना*) के 5.8 एस. जीन अनुक्रमों का विशलेषण किया गया और *पी. सेजोर काजु* की अपशिष्ट खाद मे पाये गए कवक *एस. कम्यून* की रंग विवर्णीकरण क्षमता चिकागो ब्लू के विवर्णीकरण के लिए सर्वश्रेष्ठ आंकी गई। इस कवक द्वारा अन्य रंगो जैसे कि स्टार्च एज्योर, रिएक्टीव ब्लू, रोडामाइन बी, ओरेन्ज–2 सोडियम एवम् मिथाइल ब्लू का भी विवर्णीकरण क्रमशः 100, 92.50, 81.60, 73.40 एवम् 67.80 प्रतिशत तक पाया गया। रंग विवर्णीकरण में सक्षम 6 बैक्टीरिया को 16 एस. जीन अनुक्रमो के विशलेषण द्वारा पहचाना गया। जिनमे से *पी. सेजोर काजु* की अपशिष्ट खाद से पृथककृत बैक्टीरिया *बी. लिचेनीफारमीस* द्वारा ओरेन्ज–2 सोडियम का सर्वाधिक विवर्णीकरण दर्ज किया गया। बैक्टीरिया *बी. लिचेनीफारमीस* द्वारा सर्वाधिक रंगविवर्णीकरण 25 डिग्री सेल्सियस एवम् पी.एच.–6.0 पर दर्ज किया गया।

वर्ष 2011 के दौरान निदेशालय द्वारा किसानों, महिलाओं, उद्यमियों, अधिकारियों एवम् कृषि विज्ञान केन्द्रों के अनुसंधानकर्ताओं के लिए कुल 8 प्रशिक्षण शिविरों का आयोजन किया गया। कुल मिलाकर 240 प्रशिक्षणार्थियों ने इन शिविरों मे भाग लिया। हर वर्ष की भांति इस वर्ष भी 10 सितम्बर, 2011 को खुम्ब मेले का आयोजन किया गया। जिसमें कि विभिन्न राज्यों से आयें 550 किसान, महिलाएं, मशरूम उत्पादक, अनुसंधानकर्ता, प्रसारकर्ता एवम् व्यपारियों ने भाग लिया। इस मेले के दौरान 7 प्रगतिशील खुम्ब किसानों को सम्मानित किया गया। इसके अलावा इस वर्ष 2 प्रादेशिक खुम्ब मेलों का होशियारपुर (पंजाब) एवम् मुरथल (हरियाणा) में क्रमशः 3 फरवरी एवम् 17 फरवरी, 2011 को आयोजन किया गया। इन मेलों मे खुम्ब किसानों की कठिनाईयों एवम् क्षेत्र में खुम्ब के खपत को ब.ाने के लिए किसान गोष्ठी का भी आयोजन किया गया।

इस वर्ष एक संसदीय समिति ने इस निदेशालय का भ्रमण किया। सलाहकार सेवाओं में खुम्ब उत्पादन के विभिन्न पहलुओं, प्रशिक्षण एवम् बाजारीकरण पर डाक चिटिटयों को भेजा गया। खुम्ब उत्पादन पर दुरभाष एवम् ई–मेल द्वारा भी जानकारी प्रदान की गई। औसतन 5 से 6 सवालों का प्रतिदिन जवाब दिया गया। इस वर्ष कुल 8 दूरदर्शन कार्यक्रम शिमला दूरदर्शन केन्द द्वारा कृषि दर्शन कार्यक्रम में प्रसारित किए गए। इसके अलावा दिल्ली दुरदर्शन द्वारा निदेशालय के निदेशक डा. मंजीत सिंह का साक्षात्कार भी प्रसारित किया।

वर्षपर्यन्त निदेशालय के वैज्ञानिकों के द्वारा कुल 19 शोघ पत्र राष्ट्रीय एवम् अतंराष्ट्रीय तकनीकी पत्रिकाओ में, 8 अध्याय एवम् 8 सारांश प्रकाशित किए गए।

EXECUTIVE SUMMARY

The Directorate of Mushroom Research has made significant progress in research, transfer of technology and human resource development. The achievements of Directorate of Mushroom Research during 2011 in area of Crop Improvement, Crop Production, Crop Protection, SMS, Transfer of Technology, Education and Training and Publications are summarized here.

A total number of 146 wild mushrooms were collected, preserved and tentatively identified from Arunachal Pradesh and Himachal Pradesh.The gene bank of DMR has been enriched by 112 tissue cultures of wild edible, non edible and poisonous mushroom species.

A total of 451 single spore isolates of white button mushroom have been made from the strains U-3, A-6, A-94, A-4, S 11, NCS-101, S-465, A-15, A-2, WI-1, Delta, S-130, BS-419, S-454 and a wild strain. Out of 394 single spore isolates tested, a total of 34 single spore selections were made based on cultivation trials and four single spore selections from each white and brown strains are made on the basis of yield performance and quality attributes i.e. colour, pileus diameter, stipe diameter, gill size and gill colour. The eight single spore selections are recommended for AICRP trials. A total of 37 non-fruiting isolates could be identified. These isolates belonged to seven strains viz. U-3, A 94, S-465, A-15, WI-1, S-130 and S-11. Till date a total of 48 inter-strainal crosses have been made between U-3 and A-94. The fertility status of the crosses is under evaluation at small scale. The successful crosses will be tested for their yield performance and quality attributes. RAPD analysis of 18 fertile and non-fertile single spore isolates has been done using 30 random primers. A total of 5 primers could amplify a marker band in the fertile isolates whereas 2 primers could amplify a marker band in non-fertile isolates. The fertility marker in must be validated in larger populations before it can be used for identification of fertile and non-fertile isolates. Further analysis for validation of DNA markers with 39 non-fruiting and 93 fertile isolates is under progress. For searching of SNP makers, ITS 5.8S region of 18 single spore isolates were sequenced. Out of the 18 SSIs, 10 SSIs were fertile and 8 were non-fertile. The analysis using Clustal x and Mr Bays showed that the fruiting and non-fruiting isolates made separate clusters but the third group consisted of both fertile and non-fertile isolates. The possible reason for grouping of non-fertile and fertile isolates may be due to that the non-fertile isolates carried two nuclei of same mating type. Further analysis on SNP markers is under progress.

The experiments on strain evaluation of button mushroom have been laid out twice during the year. The results of the first trail indicated that ABS-2 and ABS-7 are performing better on short method compost while ABL-1 and ABL-6 are performing better on long method compost. Eight single spore selections have been recommended for evaluation under AICRP. The pooled analysis of data from all centres along with DMR centre identified SSI-3 followed by SSI-2 to be the best performing strain amongst white strains while SSI-6 and SSI-8 was found to be the best perfoming strain amongst brown strains.

Out of 6 laccase genes, partial sequences of laccase 1, 2, 3 and 6 in the heterozygotic strain Vv-01 and partial sequence of laccase 3 in homozygotic strain BBSR-003 were obtained. The lcc 3 sequences of two strains, Vv-01 and BBSR-003 have been submitted to NCBI GenBank with accession numbers HQ687205 and JF313903, respectively and they showed differences at 10 different base positions. In lcc 1, 16 different introns have been recorded and the amino acid sequence of Vv-01 strain differed by one amino acid less than the published sequence of lcc1. No evidence of heterozygocity has been recorded in this sequence. The lcc 2 sequence also revealed 16 different introns. Although only a small portion of sequence could be validated but evidence for heterozygocity was

found in strain Vv-01. The small sequence of lcc 2 in strain BBSR-003 also differed at some bases from strain Vv-01. The sequence of lcc 6 helped in identifying 5 introns. The positions of introns in different laccase genes (lcc 1, lcc 2 and lcc 3) of grouped them to sub-family A. The seventeen strains were compared for their mycelial growth characteristics on malt extract agar media and downward mycelial growth on pounded paddy straw. Majority of strains showed fast growth rate and brownish chlamydospores colour on MEA medium. In order to select a superior colonizer of paddy straw and fructification ability, sixteen strains were tested for their extracellular lignocellulolyic enzyme activity. The cellulolytic and xylanolytic activity was higher in strain Vv-1 (v), followed by OE-272. The ligninolytic activity was highest in OE-272, followed by WV-3. In molecular weight profile of ITS regions of 5.8S rDNA region of different strains, the ten strains formed bands almost at same level (720 bp), while the rest four formed in the molecular weight range of 600 bp or less. The two strains designated as WV-2 and WV-3 were identified as , a new species separated from since January 2011.

Mycoflora was isolated from compost samples collected from different location of Solan at different stages of button mushroom compost production. and were dominantly isolated from different samples. These fungi showed varied diversity. Compost was prepared using total indoor compost production technique using (X-21 strain) and (I-33 strain) and a total of 3.78 tons of compost was produced giving average yield of 8.82 kg/q compost. Both these fungi along with and their consortium were also tried to see their effect on compost production using SMC. The highest yield in the experiment was obtained on followed by consortium of above fungi treatment. Cotton waste, spent compost and chicken manure were treid in compost production under SMC. Both these materials were successfully employed and highest yield was obtained in cotton waste (as N source) based compost. Chicken manure free compost yieled slightly lesser yield (4.2 kg/100kg compost) over the 100% chicken manure compost. Application of gypsum in casing soil (SMS: FYM in the ratio of 1:1) increased the yield slightly. Urea content in harvested button mushroom increased up to 1.07% in 11 days under room temperature storage in winter season.

Two wild spp. gave fruiting in 10-12 days with very high yield. bags with only 13 X 63 strips for fructification gave better yield than fully opened bags.

Fifty four samples of mushroom were collected from Bikaner and Jaisalmer area ranging from E 70.5522-73.3191°, N 26.5538-28.0320° and MSL139-231m elevation. Nucleotide sequence comparisons showed 90 percent identity with Malt extract agar medium was found to be the best for 1/3 and 5/19 isolates among 10 solid media whereas Elliot's medium was the best for 1/3 isolate among eleven liquid media tested.Optimum temperature for the three distinct isolates (1/3, 2/10 and 5/19) was found to be 40ºC and a pH 7.5 was the best for all the three isolates. Among carbon sources manitol, sucrose and dextrose were found to be the best for 1/3, 2/10 and 5/19 isolates, respectively. In nitrogen sources calcium nitrate supported maximum growth of all the three isolates of . $FeSO_4$ (0.005%) supported the maximum growth of all the three isolates among the four trace elements tested. Thiamine at 20 ppm concentration was the best vitamin to support the growth of all the three isolates. 20:1 is the best C: N ratio to support the mycelial growth of all the three isolates. Among 5 substrates (wheat, paddy and soybean straw, saw dust and coir pith), wheat straw supported the maximum growth of P-1/2 isolate, paddy straw for P-2/10 isolate and soybean straw for P-5/19 isolate.Primordia develops in 1/3 isolate but did not develop to mature fruit bodies nor showed any differentiation.

Seven strains of shiitake (OE-8, OE-16, OE-20, OE-21, OE-22, OE-38, OE-388) cultivated on sawdust were evaluated for yield. OE-388 strains proved to be the highest yielder with a biological efficiency of 107.29 % followed by OE-38 94.79 % (BE).

Thermal death point of different strains of was observed between 39.4 - 48.4 ºC. In spp it ranged between 43.0-50.2 ºC and in shiitake it was 46.6 - 50.2 ºC. showed a lot variation in thermal death point and it varied between 44-54.8ºC. and had 46.6-48.4, 44.8 and 37.6-39.4 ºC thermal death point temperature, respectively.

Evaluation trial on five strains (OE-46, APK-2, OE-334, OE-335 and OE-345) of revealed that strain APK-2 is the highest yielder followed by OE -334 and OE-335. Autoclaved casing soil proved to be the best giving the highest yield followed by pasteurized and chemical treatments for all the five strains (OE-46, APK-2, OE-334, OE-335 and OE-345) used in the study. Maximum linear growth of was recorded at 62% and 60% moisture content followed by 58%. There was no spawn run when substrate was filled after 2-4 h of chemical sterilization having 71-72% moisture contents. The spawn run took place only in bags filled after 18h with moisture content of 64% or lower.

an edible mushroom species was again cultivated on wheat straw. Initial cultivation experiment with were encouraging and gave 77 % BE.

During the year 18 farms of milky and button mushroom were visited in Haryana and Himachal Pradesh. Wet bubble, olive green mould and false truffle were recorded in button mushroom.

Trehalose supported the maximum (88%) conidial germination of after 24h. There was no germination in Glycogen, sucrose and Xylose. Mushroom juice resulted in 37% conidial germination. Dextrose resulted in maximum (60%) germination of chlamydospres followed by manitol (50%), fructose (40%) and xylose (20%). growth was the maximum (32mm) at pH 6.0 and temperature 25ºC after 7 days followed by pH 7.0 and 8.0 at the same temperature. Symptom of wet bubble developed at pH 5.0- 8.0 after 12-24 days. There was no disease development at pH 8.5 and 9.0. Carbendazim and sporgon gave 100 per cent inhibition of at all the concentrations tried (20-200 ppm) whereas it resulted just 17 and 10% inhibition of respectively. Sporgon resulted in maximum reduction in disease in mushroom house followed by carbendazim. Specific primers designed to target were tested for and gave satisfactory results.

Among SMS of different mushrooms, the SMS from exhibited highest population along with variability of both fungi and bacteria. Five fungi viz., , , , and sp. with potential dye decolourization potential have been recorded to thrive on SMS of different mushrooms by using 5.8S rRNA gene sequencing and BLASTn techniques. Out of these from SMS has been recorded to exhibit highest decolourization potential (95%) with in 10 days against Chicago sky blue. This fungus also exhibited dye decolourization potential of 100, 92.50, 81.60, 73.40 and 67.80% against other dyes like Starch Azure, Reactive blue, Rhodamine B, Orange II sodium salt and Methyl blue, respectively. Similarly, by using 16S rRNA gene sequencing and BLASTn, six potential bacteria viz., , , , , and have also been identified, out of which isolated from SMS, exhibited highest decolourization potential of 66.10% against Orange II sodium salt, followed by (57.7%). Temperature and pH optima of 25ºC and 6.0 respectively, have been recorded for achieving highest level of decolourization

through . The study highlights the utility of SMS for unconventional activities like dye decolourization, which indirectly supports its use in bioremediation activities. Runoff water from SMS site was characterized and found that it is moderately rich in organic load and nutrient content. SMS was recycled as manure by using cow dung and Vermiworm in a period of 70 – 120 days compared to regular SMS composting which took more than one-year period.

During 2011, the Directorate organized eight on and off campus training programmes for farmers, farmwomen, entrepreneurs, officers and scientists of KVKs. A total of 240 trainees got benefited in all these trainings during 2011. One day Mushroom Mela was organized on 10th September 2011. About 550 farmers, farmwomen, mushroom growers, researchers, extension workers and businessmen attended it from various states. During the Mushroom Mela, the center awarded seven (7) progressive/ innovative mushroom growers for adopting innovative practices in mushroom cultivation technology. Two regional mushroom mela and consumption fairs were held at Hoshiarpur in Punjab on 3rd Feb 2011 and Murthal I7th Feb 2011 in Haryana to address the problems faced by mushroom growers and to promote mushroom consumption among common public.

The Parliamentary Standing Committee on Commerce visited the Directorate of Mushroom Research, Solan. Advisory services through postal extension letters on various aspects of mushroom cultivation, training and marketing were provided. Queries on mushroom cultivation, training were replied through telephone and e-mail. On an average 5-6 queries per day were received either by phone/ mail/ letters and were replied. Eight (08) Phone-in and field based programmes were telecast on Doordarshan Kendra from Shimla on Krishi Darshan. During the year, the scientists of the DMR have published 19 research papers in referred national and international journals, 8 book chapters and 8 abstracts.

1. INTRODUCTION

Mushroom cultivation is gaining momentum in India and more and more farms are added every year in different parts of the country. Mushroom is such a commodity that not only imparts diversification but also help in addressing the problems of quality food, health and environmental sustainability. Nutritionally, mushrooms are high proteins diet with good quality proteins compared to plants. Mushrooms are low fat and high fibre foods with rich essential amino acids content and contain all-important minerals except iron. In fact, Mushrooms are the only source of Vitamin D and on exposure to UV-light the concentration of vitamin D increases manyfold. In light of the growing incidences of cancer in today's world, it is high time for people to wake up to the beneficial effects of mushrooms and utilize their cancer-fighting qualities. Our per capita consumption of the proteins is lowest in the world. Increased mushroom production can address this issue up to some extent and achieve these increased goals we may have to utilize our resources in the most judicious manner.

Directorate of Mushroom Research is located in Solan 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 Research Project on Mushroom (AICRP) has been initiated 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. Presently, coordinating Centres of AICRP are located at Ludhiana (Punjab), Pantnagar (UP), Coimbatore (Tamil Nadu), Pune (Maharashtra), Raipur (Chhattisgarh) Faizabad (UP), Udaipur (Rajasthan), Vellayani (Kerala), Hisar (Haryana), Pasighat (AP), Bhubaneswar (Orissa), Samastipur (Bihar), Barapani (Meghalya), Ranchi (Jharkhand) along with two Co-operating Centres at Nauni, Solan (HP) and Murthal (Haryana).

Achievements

The gene bank of DMR has been enriched by 112 tissue cultures of wild edible, non-edible and poisonous mushroom species. In all 394 single spore isolates of were tested and out of which 34 single spore selections were made based on cultivation trials. Further eight single spore selections four each from white and brown strain were also made on the basis of yield performance and quality attributes. These single spore selections are recommended for AICRP trials. Although all the eight SSIs performed well over controls but SSI-3 followed by SSI-2 were found to be the best performing strain amongst white strains while SSI-6 and SSI-8 among brown strain. Five marker band could be identified in fertile isolates while two in non-fertile isolates. Strain evaluation trial of button mushroom revealed that ABS-2 and ABS-7 performed better on short method compost while ABL-1 and ABL-6 performed better on long method compost.

In , partial sequences of laccase 1, 2, 3 and 6 in the heterozygotic strain Vv-01 and partial sequence of laccase 3 in homozygotic strain BBSR-003 were obtained. The lcc 3 sequences of two strains, Vv-01 and BBSR-003 have been submitted to NCBI GenBank with accession numbers HQ687205 and JF313903, respectively and they showed differences at 10 different base positions, Sixteen strains were evaluated for their extracellular lignocellulolyic enzymes activity to select a superior colonizer of paddy straw and fructification ability. The cellulolytic and xylanolytic activity was higher in strain Vv-1(v), followed by OE-272. The ligninolytic activity was highest in OE-272, followed by WV-3.

Thermophilic fungi namely, and fungi were successfully used for the production of short method compost. Cotton waste, spent compost and chicken manure were treid in compost production under SMC. Both these materials were successfully used and highest yield was obtained in compost based on cotton waste as nitrogen source. Chicken manure free compost yielded slightly lesser yield (4.2 kg/100kg compost) over the chicken manure based compost. Application of gypsum in casing soil (SMS: FYM in the ratio of 1:1) increased the yield slightly.

Two wild spp. gave fruiting in 10-12 days with good yields. It was observed that

pasteurized straw is not suitable for growing oyster mushroom spp. bags with only 13 X 63 stripes for fructification gave better yield than fully opened bags. , an edible mushroom species, was again cultivated on wheat straw. Results of initial cultivation experiment on were encouraging and gave 77 % BE.

Physiological studies on were done. Among seven high temperature strains of shiitake, OE-388 strains proved to be the highest yielder with a biological efficiency of 107.29 % followed by OE-38 94.79 % (BE). In strain APK-2 was the highest yielder followed by OE -334 and OE-335. Autoclaved casing soil gave maximum yield followed by pasteurized and chemical treatments in Maximum linear growth of was recorded on 62% and 60% moisture content followed by 58%.

Wet bubble, olive green mould and false truffle were recorded as the main problems during button mushroom cultivation. Carbendazim and Prochloraz manganese gave 100 per cent inhibition of at all the concentrations tried (20-200ppm) with just 10-17% inhibition of . Sporgon resulted in maximum reduction in disease in mushroom house followed by carbendazim. Specific primers designed to target were tested for two primers gave satisfactory results. Among Spent Mushroom Substrate (SMS) of different mushrooms, the SMS from exhibited highest population along with variability of both fungi and bacteria.

The Directorate organized eight on and off campus training programmes for farmers, farmwomen, entrepreneurs, officers and scientists of KVKs. A total of 240 trainees got benefited in all these trainings during 2011. Two regional mushroom mela and consumption fairs were held at Hoshiarpur on 3rd Feb and Murthal on 7th Feb and one day National Mushroom Mela was organized on 10th September, 2011 at DMR, Solan to address the problems faced by mushroom growers and to promote mushroom consumption among common public. The Parliamentary Standing Committee on Commerce visited the Directorate of Mushroom Research, Solan. Advisory services through postal extension letters on various aspects of mushroom cultivation, training and marketing were provided. Eight (08) Phone-in and field based programmes were telecast on Doordarshan Kendra from Shimla on Krishi Darshan.

The Directorate 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 Centre.

Staff and Finance

The Directorate has a sanctioned strength of 1 Director + 16 scientists, 14 Technical, 14 administrative and 10 supporting staff. The staff in position on 31.12.2011 was 10 scientists, 13 technical, and 15 administrative and 8 supporting staff. The annual budget of the centre for the year 2011-2012 was Rs.130.00 Lakh (Plan) and Rs. 292.50 Lakh (Non Plan), which was fully utilized. The Directorate earned Rs.19.00 Lakhs as revenue during the year by sale of literature, mushroom cultures, spawn, fresh mushrooms, pickles, consultancy, training and other services.

Facilities

Thirteen environment controlled cropping rooms.

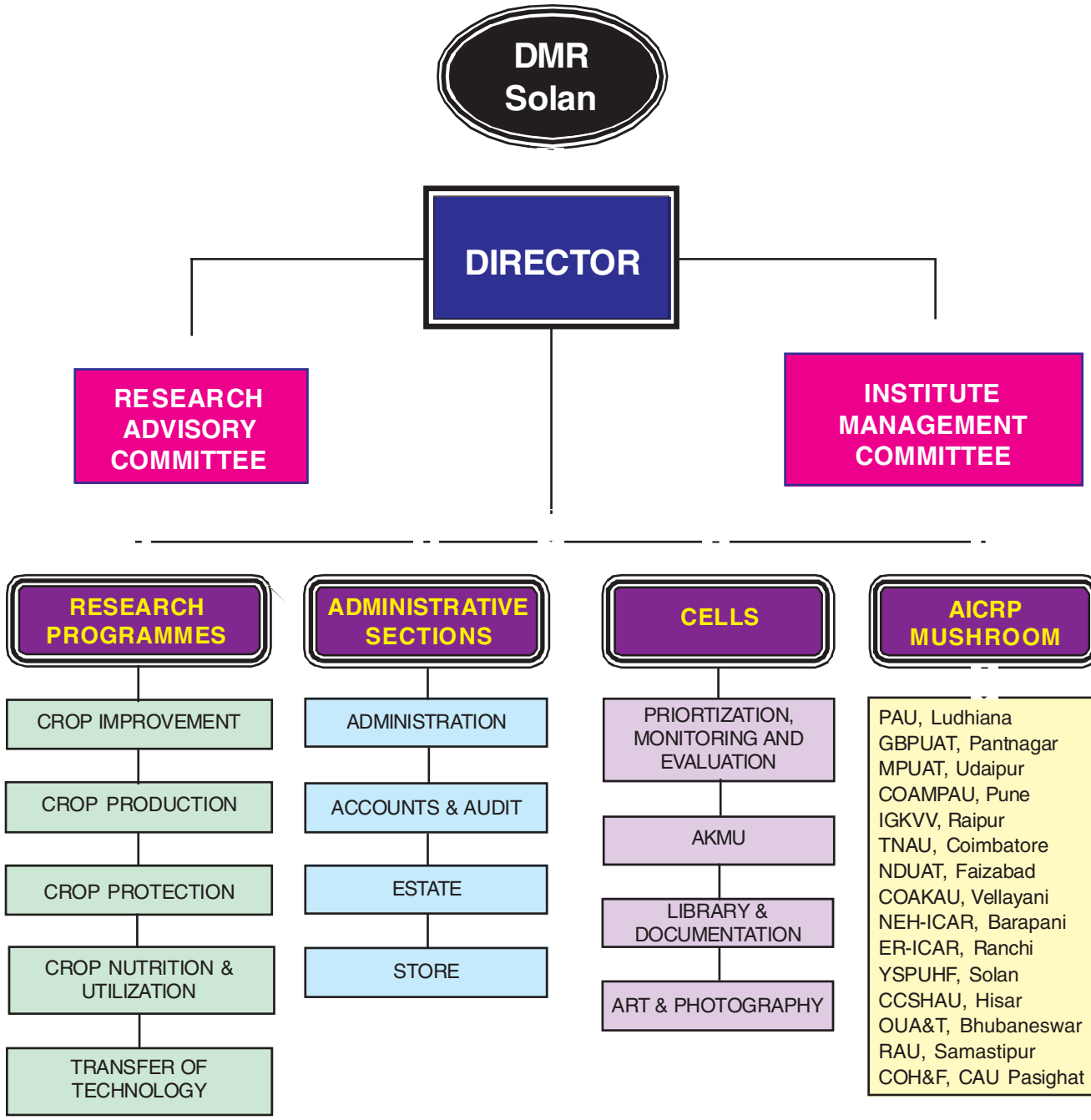
One poly house

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.

ORGANOGRAM OF DMR, SOLAN



2. RESEARCH ACHIEVEMENTS

A. Crop Improvement

i. Mushroom Genetic Resources

Survey, collection and identification of wild fleshy fungi

During rainy season forays were undertaken in the forest areas of Himachal Pradesh and Arunachal Pradesh. A total 146 specimens were collected and 130 specimens identified upto genus level. All the specimens have been preserved in the Herbarium of DMR, Solan. Pure tissue cultures of 116 wild edible, non edible and poisonous specimens were obtained and deposited in the Gene Bank of DMR, Solan, which included spp spp spp sp sp and spp. Some collections like and were identified up to species level.

The number of specimens in each genus are as follows:

The detailed anatomical description of is mention below:

Locq. Ex Bon **11**(43): 73. 1981 (Fig.1(A-E).

Fructifications up to 14.5 cm in height, Pileus upto 9.2 cm in diameter, convex to hemispherical, surface dry, applanate with short umbo, greyish orange (5B4) near the center, covered by grayish orange (5B4) appressed fibrillose scales soon cracking into small pieces, dense towards the center and scattered towards the margin over orange white (4A2) background, margin feebly striate, reflexed; splitting at maturity; cuticle fully peeling; flesh 0.6 cm thick, off white, unchanging. Taste and odour honey like. Lamellae free, collariate, unequal of 2 lengths, subdistant to crowded, ventricose, 0.5cm broad, yellowish white (4A2) in young specimens, brownish on bruising, gill edges minutely serrate. Stipe central up to 12 cm long, 0.8 cm broad, 2cm near the base, obclavate with distinctly bulbous base, and silky shining white with very tiny scales. Annulus persistent, simple, attached.

Spores 11.5-16 x 7-10 µm (Q=1.63), broadly ellipsoid to amygdaliform, dextrinoid, congophilous, cyanophilous, dextrinoid, weakly metachromatic in cresyl blue, apically truncated by a germpore, covered by a hyline cap, roghned inside. Basidia 25-36 x10-15µm, clavate, tetrasporic, sterigmata up to 2.5 µm long in size, Gill edges sterile. Cheilocystidia versiform varying from pyriform, clavate, lageniform to shortly subcapitate 22-48x7-18µm in width, crowded. Pleurocystidia absent.

Pileus surface composed of loosely arranged thin long cylindrical, septate hyphae arising from the context, not compactly arranged up to 4 µm in width. Stipe regular, hyphae running parallel through out measuring up to 20 µm in width with some projecting cylindrical elements. Pileus context homoiomerous, subhymenium pseudoparenchymatous, well developed. Hymenophoral trama are regular, Tramal hyphae up to 15 µm in width. Clamp connections present throughout.

(Fr.) M. M. Moser 1967.

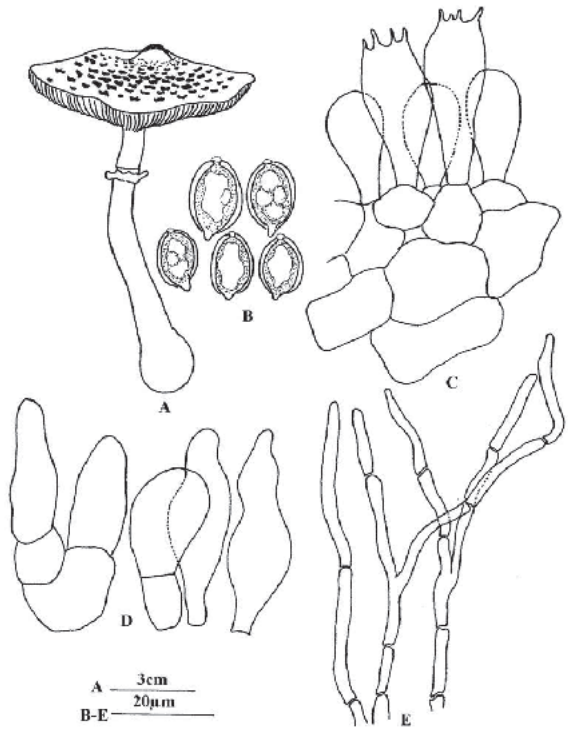


Fig. 1 (A-E). A) Carpophore, B) Basidiospores, (C) Basidia, (D) Cheilocystidia & E) Pileus trichodermia elements

Carpophores up to 10 cm in height, Pileus 6.5 cm in diameter, applanate with broad umbo; surface whitish to orange white (5A2) with brownish orange (5C4) centre, moist; covered with thick long brownish orange (5C4) appressed fibrillose to recurrved scales which are concentrically arranged around umbo region; cuticle fully peeling, margin striate, irregular, splitting at maturity; cuticle ½ peeling; flesh off white, changing, pinkish red on bruising, up to 0.5 cm thick; taste mild and odour sweet. Lamellae free, collariate, fragile, crowded, ventricose, unequal of 3 lengths, up to 0.5-0.7cm broad, whitish becomes orange grey (5B2) on maturity; gill edges serrate, finely brown layered. Stipe central, 9.2 cm long white, hollow, annulus white and brownish underneath, double, covered by thick squamules of veilar remains scattered in annulate fashion down the stipe; or patchy type scales remaining on lower portion of stipe; annulus persistant.

Spores 7.5-11 x 5-6.5 µm (Q=1.6), broadly ellipsoid, double walled, dextrinoid, congophilous, cyanophilous. Basidia are 23-35 x 9.5-14.5µm clavate, tetrasporic, sterigmata up to 2.5 µm long. Gill edges sterile, cheilocystidia 26-57(80) x 8-17 µm, versiform, lageniform, pyriform, subcapitate, cylindrical with broad apex. Pleurocystidia absent.

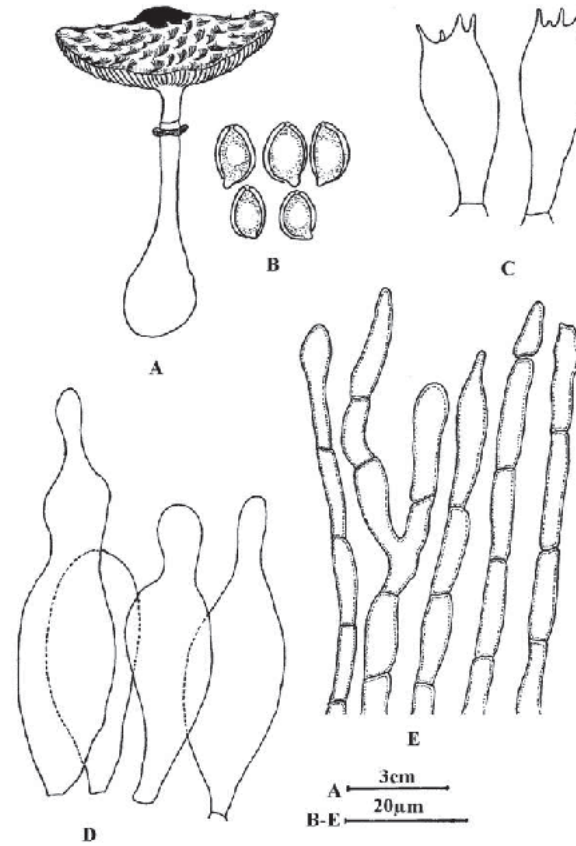


Fig. 2 (A-E). A) Carpophore, B) Basidiospores, (C) Basidia, (D) Cheilocystidia & (E) Pileus trichodermial

Pileus surface a loose trichoderm of long multiseptate, branched, thick walled, obtuse to cylindrical elements without clamp connections. Pileus context homoiomerous, Gill trama almost regular, composed of 24 µm broad hyphae. Stipe surface hyphae running parallel throughout, with some dark stained cylindrical septate elements, thick walled measuring 4-25 µm. Clamp connections present.

b. Genetic Improvement

i. :

Initial evaluation of fertile isolates/hybrids of button mushroom ( )

A total of 451 single spore isolates have been made from the strains U-3, A-6, A-94, A-4, S 11, NCS-101, S-465, A-15, A-2, WI-1, Delta, S-130, BS-419, S-454 and a wild strain. Out of 394 single spore tested, a total of 34 single spore selection have been made based on cultivation trials. Out of 34, four single spore selections from each white and brown strains are selected on the basis of yield performance (Table 1) and quality attributes i.e. colour, pileus diameter, stipe diameter, gill size and gill colour. The eight single spore selections are recommended for AICRP trials.

Table 1. Average yield of selected good quality and high yielding SSIs of

Strains	Yield (kg/100kg compost)	Average fruit body wt (g)	Quality (scale 1-5)
A-6-1	16.47	12.6	4.0
A-6-5	15.16	10.8	4.5
A-6-9	13.82	13.6	3.0
A-6-Cont	12.17	13.3	3.0
A-94-1	19.16	10.5	4.0
A-94-10	17.95	11.5	2.0
A-94-11	13.84	11.0	2.5
A-94-12	15.50	9.7	3.5
A-94-15	15.36	12.7	4.0
A-94-22	17.13	14.3	2.5
A-94-4	16.34	13.9	4.0
A-94-5	19.29	15.3	3.5
A-94-8	16.73	15.9	4.0
A-94-9	14.49	9.8	4.0
A-94-Cont	13.96	10.6	4.0
S-11-10	16.29	13.2	3.0
S-11-11	15.32	12.3	4.0
S-11-12	18.97	11.2	3.0
S-11-13	14.79	11.4	3.5
S-11-2	17.34	17.1	3.5
S-11-3	18.06	11.5	4.5
S-11-5	17.32	13.9	4.0
S-11-Cont	16.77	11.6	3.0
U-3-39	13.93	12.9	4.0
U-3-43	18.95	14.7	4.5
U-3-5	20.03	11.8	4.0
U-3-50	16.48	13.0	4.0
U-3-54	20.03	11.9	3.5
U-3-57	16.05	14.1	4.5
U-3-58	18.49	11.2	4.5
U-3-59	13.43	14.0	4.5
U-3-Cont	13.98	11.9	4.0

Fig. 3. Morphological Variability amongst SSIs of white button mushroom

Inter-mating of non-fertile isolates for production of hybrids in button mushrooms

Out of a total of 394 single spore isolates tested for fruiting attribute, a total of 37 non-fruiting isolates from could be identified. These isolates belonged to seven strains viz. U-3, A 94, S-465, A-15, WI-1, S-130 and S-11. Till date a total of 48 inter-strainal crosses have been made between U-3 and A-94. The fertility status of the crosses is under evaluation at small scale. The successful crosses will be tested for their yield performance and quality attributes.

Molecular /biochemical characterization of parents/homokaryons/hybrids

RAPD analysis of 18 fertile and non-fertile single spore isolates has been done using 30 random primers. A total of 5 primers could amplify a marker band in the fertile isolates whereas 2 primers could amplify a marker band in non-fertile isolates. The fertility marker in must be validated in larger populations before it can be used for identification of fertile and non-fertile isolates. Further analysis for validation of DNA markers with 39 non-fruiting and 93 fertile isolates is under progress.

For searching of SNP makers, ITS 5.8S region of 18 single spore isolates were sequenced. Out of the 18 SSIs, 10 SSIs were fertile and 8 were non-fertile. The analysis using Clustal x showed that the fruiting and non-fruiting isolates made separate clusters but the third group consisted of both fertile and non-fertile isolates. The possible reason for grouping of non-fertile and fertile isolates may be due to that the non-fertile isolates carried two nuclei of same mating type. Further analysis on SNP markers is under progress.

Spawn of hybrids of button mushroom and initial trials for screening of strains of button mushroom for morphological attributes

A total 48 hybrid made by the inter mating of U-3 (white strain) SSIs and A-94 (brown strain) SSIs are under initial trail for identification of their hybrid status. Once the hybrid status is confirmed, we will go for large-scale trials for yield and quality attributes.

ii. Paddy straw mushroom ( )

Positioning of introns in different laccase genes and its relevance to phylogenetic ambiguity of

strains and laccase genes amplification: The strains Vv-01 and BBSR-003 were used in the study. DNA was extracted by using Illustra DNA extraction Kit from GE Healthcare, UK by following the protocol provided

Table 2. Correlation matrix of different traits of SSIs of

	Downward linear growth	Linear growth on MEA	Gill Size	Pileus Size	Stipe Size	Yield
Downward linear growth	1.000	-0.097	0.301*	-0.082	0.424**	0.771**
Linear growth on MEA		1.000	-0.381**	-0.010	-0.310*	-0.124
Gill size			1.000	-0.161	0.672**	0.467**
Pileus size				1.000	-0.212	-0.073
Stipe size					1.000	0.618**
Yield						1.000

* p< 0.05, ** p<0.01

Table 3. Inter-relationship between downward linear growth with gill & stipe size and yield in white button mushroom

	Downward linear growth	Gill Size	Stipe Size	Yield
Downward linear gr.	1.000	0.301*	0.424**	0.771**
Gill size		1.000	0.672**	0.467**
Stipe size			1.000	0.618**
Yield				1.000

* p< 0.05, ** p<0.01

by the manufacturer. The primer pairs for six laccase genes(lcc1, lcc2, lcc3, lcc4, lcc5 and lcc6) of were designed based on the mRNA sequences of these genes available in NCBI nucleotide database using Primer 3.0 (version 0.4.0) free software available on internet. These primers (Table 4) were synthesized from Sigma Life Science, France.

Out of the six pairs of primers corresponding to the six different laccase genes of strain Vv-1, unique single bands of desired sizes were obtained only for laccase genes 1 and 3. For laccase 2, only low molecular weight fragments (probably primers dimers) were obtained, while in the case of laccase 4, multiple amplicons were obtained, which indicates non-specificity of the primers. For laccase 5 and 6 genes, the amplicons of desirable size were obtained but were in very low concentration. In order to improve the amplification efficiency, the PCR was performed at an annealing temperature of 57 ± 2°C and amplicon's band intensities increased with the increase in the annealing temperature (Fig 1). Similarly, attempts were made for laccase 4 and 5 genes at annealing temperatures of 57 ±

Table 4. Source and sequences of primers designed for different laccase genes

Laccase gene	mRNA Accession No. in NCBI GenBank	mRNA GI No. in NCBI GenBank	Primer	Sequence (5´ to 3´)
Laccase 1	AY249052.1	37732219	Vv1FL1	CCGATGAAGTTGGGACATTC
			Vv4RL1	TCGCAATCACAATCACAGTTC
Laccase 2	AY338483.1	37791150	Vv1FL2	CCTTGCTCAACACCCTTACC
			Vv4RL2	GCCAGAGACTGGGTTAGACG
			Vv12FL2	CTGCTGCACAACAGAGCTTC
			Vv42RL2	AATACCAGAGGACGCGAGAC
Laccase 3	AY338484.1	37791152	Vv1FL3	TGCGAGCGTAACTCAATGTC
			Vv4RL3	GCAAAGCTCATCCCAAGAAG
Laccase 4	AY338486.1	37791156	Vv1FL4	ATATCTGCTCGGCCATCTTG
			Vv4RL4	GACAGAGCTGCTTCCATTCC
			Vv15FL4	TCATTCTGGGGGTTATCCTG
			Vv45RL4	TAGAAGCGGGTTTCTCCTTG
			Vv05FL4	CTCGTCGCGGGTAAAATATC
Laccase 5	AY338485.1	37791154	Vv1FL5	CAGTGCAATTTTGGTCAACG
			Vv4RL5	AAGTGTCCGATCCACTGTCC
Laccase 6	AY338487.1	37791158	Vv1FL6	TGGAACAGCCTCTCACACAC
			Vv4RL6	ATTCGACACCAGGTCTGAGG
			Vv01FL6	CAACACCCTCACTGTCGTTC
			Vv35RL6	CACAAAGGTCATCCCACTCC
Laccase 3 (for remaining portion)	Received genome sequence of lcc3	NA	Vv2FL3	AGCCCGTTGACAACTACTGG
			Vv3RL3	GGGACGGCATTTTCTATGAG
			Vv2RL3	AGTTGTCAACGGGCTGATTG
			Vv3FL3	TTGATTGGGATATGCTGCAC
Laccase 1 (for remaining portion)	Received genome sequence of lcc1	NA	Vv18FL1	GGCTGATTTCGATCTCTTGC
			Vv2FL1	CCGTTATCAATAGGCCAACG
			Vv18RL1	AATCAGCCTCATGCGATACC
			Vv2RL1	TTGATAACGGAATGCGTCAG
			Vv3RL1	CCTAGGGTCTTGCTCGAGTTC
			Vv08FL1	TTGAGCTCGCATACGTTGAC
			Vv45RL1	TCTGAAGCGGGGATAGAAAA

Fig. 4. Some high yielding SSIs of during large-scale trials

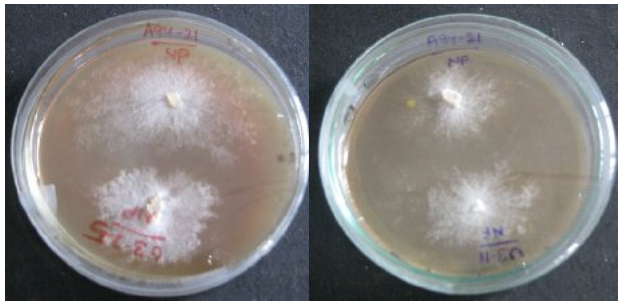


Fig. 5. Hybridization experiments between SSIs of U-3 and A-94

2°C and 54 ± 1°C, respectively but no further improvement in amplicon quality (intensity /purity) was recorded, hence the primer pairs were rejected due to low specificity. The redesigned primers of laccase 2 and 6 genes were tried at annealing.

Sequencing of PCR amplicons, their analysis and annotation for intron positioning: The amplicons along with the corresponding primer pairs (forward and reverse) were sent to BECKMAN COULTER GENOMICS, UK for sequencing and the received sequences were further processed.

The received sequences were edited using the BioEdit free software. The poor quality sequences were first deleted, followed by blast searches to verify the genes. The confirmed cleaned sequences were saved and compared with the available mRNA sequence using CAP contig. The sequences obtained from both forward and reverse primer were matched with the sequence of mRNA to identify the location of different introns in the laccase genome. Further annotations for finding amino acid sequences and the intron positions at the amino acid level were performed using the Artemis free Software. The annotated nucleotide and amino acid sequence obtained from different laccase genes were prepared in Sequin for their submission to NCBI database as the new sequences.

The CAP contig of laccase 1 gene revealed a total of sixteen introns in addition to the possibility of additional introns at the beginning of the gene. The number of introns was also sixteen in laccase 2 gene. However, in same stretch of gene length, it had intron 12, which was absent in lcc 1. The three introns (70, 72 and 75), which existed in lcc1 were missing in this gene. Laccase 2 exhibited two introns (3 and 4) in the genome region, where sequence is missing in lcc1 and lcc3. A total of eleven introns could be documented in the same gene length of laccase 3 from strain Vv-1, out of which only six matched with the positions of introns in lcc1 and seven in lcc2 (Fig. 3). The small partial sequence of lcc6 we obtained

only five introns (position 72, 39, 73, 74 and 77, a new position between 62 and 75) and their location was not considered in laccase gene classification nor in the phylogenetic analyses between laccases of different mushroom species.

The position of introns in different laccase genes of different mushrooms was compared and the laccases belonging to sub-family A (Lcc3 and Lcc9) from exhibited a closer relationship with respect to positions of introns in their genes than laccase genes belonging to sub-family B or C (Fig. 6). The figure 3 presents the comparative sequence of laccase 2 gene of strain Vv-01 of with positions of 16 introns to the published mRNA sequence from some other strain. Some of the ambiguous results were due to the heterozygocity of this gene (two sequences of gene) in the heterokaryotic strain Vv-01. A gap underlined corresponds to a base pair defect in the published mRNA sequence, which might have arisen in consequence of frame shift resulting from a first gap in the sequence (probably localised 40 to 80 bp before in the sequence missing in this work). The amino acid translation of the sequence before the identified gap should be LGSLMPSGSYIEL (which is very similar to laccase 1 homologous sequence: VSSLLPSGSYIEL) instead of IRLAHAQRILYRV.

Eight most parsimonious cladograms deduced from the positions of introns in twelve laccase genes belonging to three sub-families from four different basidiomycetes, revealed formation of eleven different clades (Fig. 7). In this dendrogram, Lcc3 from occupied the same clade as Lcc3 from in 97% of the bootstraps Lcc1 and Lcc2 from also formed one clade with more than 98% of the bootstraps. Lcc9 from belonging to sub-family A formed a separate clade from Lcc3 from same mushroom. The four laccases (Pox1-2-4, Pox5, PoxA1b and Pox3) of belonging to sub-family A formed a clade in 97% of the bootstraps. All sub-family A laccase genes formed a clade supported by 92 bootstraps and sub-family A and C laccases formed clade supported by 94 bootstrap value. The only laccase (Lcc17) from belonging to sub-family B shared only 3 intron positions with genes of sub-family A and C. The results indicate high similarities between laccases of one sub-family belonging to a particular species and their distinctness from laccases of other sub-families either from the same or other related species. Laccases from share into two groups as already shown with protein sequences. In Fig. 4, VvLcc2 and VvLcc1 clustered outside of the clade along with CcLcc9, VvLcc3 and CcLcc3, but another of the eight most parsimonious cladograms obtained, have placed these two genes as the sister group of the remainder of the sub-family A laccases.

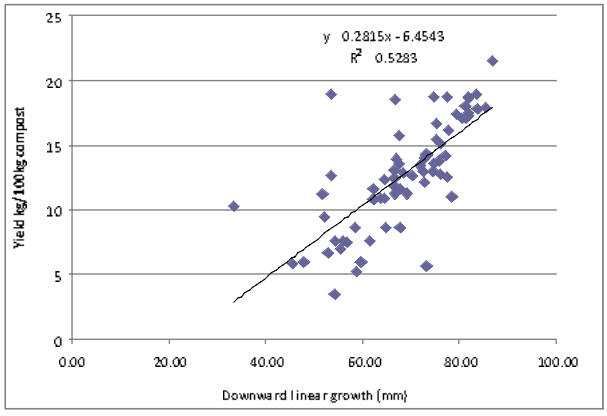


Fig. 6. Yield prediction equation using 143 single spore isolates of using downward linear growth

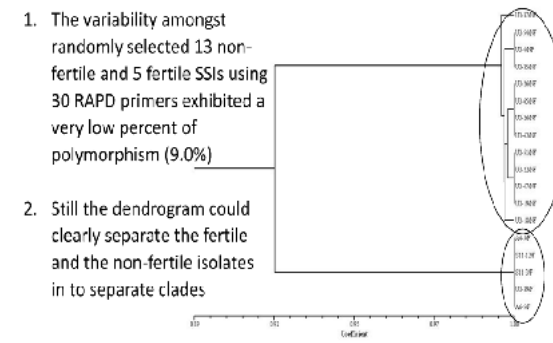


Fig. 7. DNA polymorphism using thirty RAPD primers and dendrogram separating fertile from non-fertile isolates of

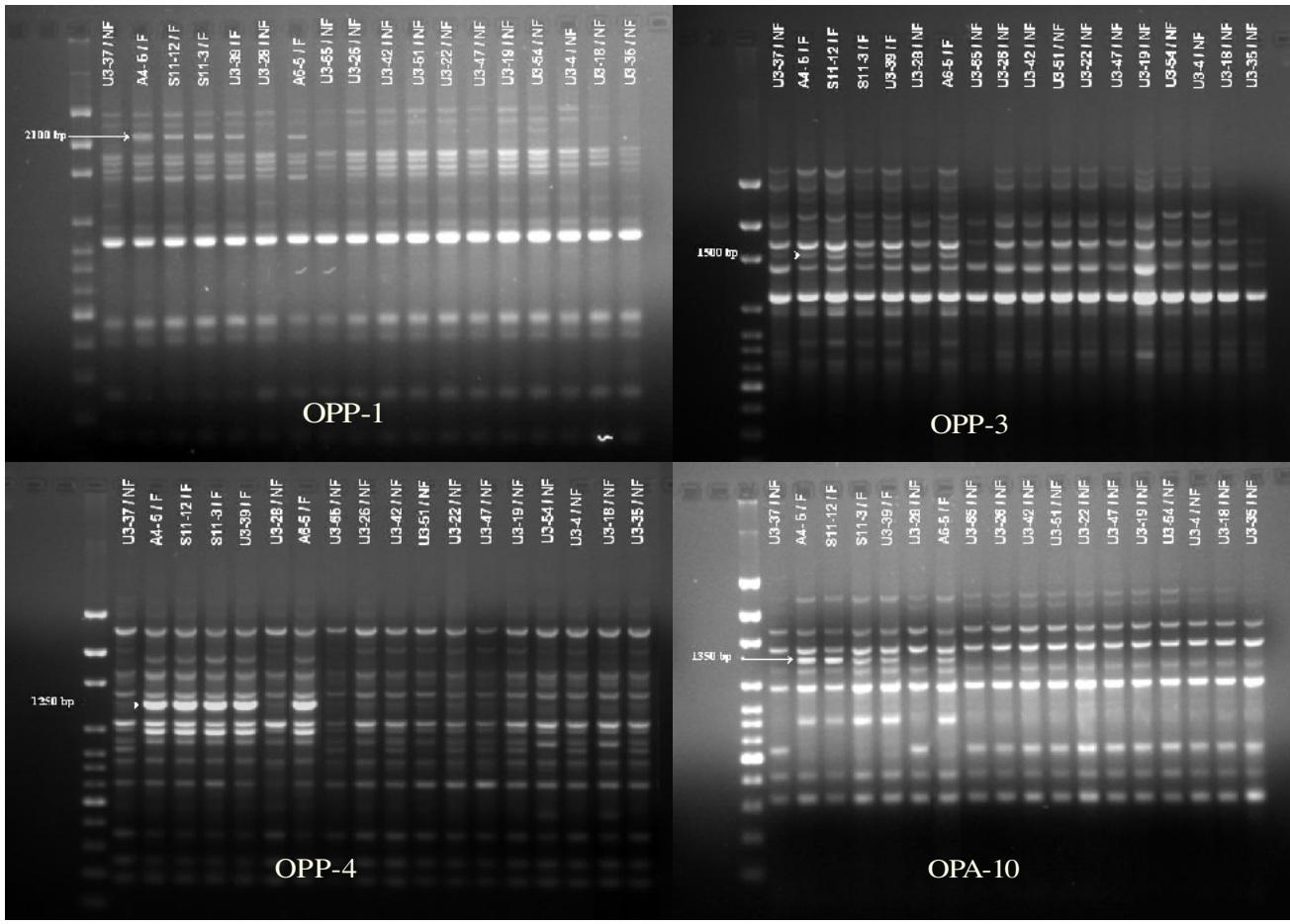


Fig. 8. Fertility marker bands developed by different RAPD primers in single spore isolates of

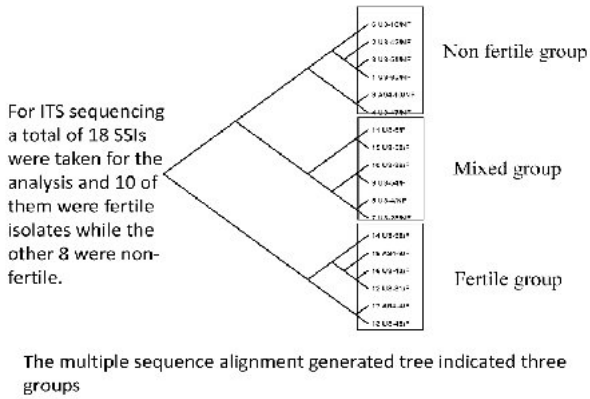


Fig. 9. SNP markers could separate fertile and non-fertile isolates of

The nucleotide sequence obtained for laccase 3 genes of two strains (Vv-01 and BBSR-003) varied at ten different nucleotide positions. Strain Vv-01 exhibited heterozygocity at 10 different places, which are presented as R, Y, R, Y, R, Y, R, Y, R and Y, which mean A or G for R and C or T for Y. However, at these locations, the nucleotides in strain BBSR-003 were A, T, G, T, G, C, A, C, G and C respectively. This proves heterozygocity of the mushroom at the nucleotide level of this laccase gene. However, at the amino acid sequence level, there was only one difference; strain Vv-01 had D or N (i.e. Aspartic acid or Asparagine) noted X (i.e. any amino acid), while strain BBSR-003 had N means Asparagine.

The present study has mainly analyzed the variations in number and position of introns in different laccases of and compared that variation to other known laccases of , and . The study has generated some valuable information like the grouping of laccases (lcc1, lcc2 and

lcc3) in sub-family A and confirmation of clustering VvLcc3 with CcLcc3. In the present study, there was an intron 8, found earlier in lcc3 from but has not been spliced in the published mRNA sequence. This intron has to be spliced in strain Vv-01 to give a functional protein and by virtue of which, the published phylogenetic position of lcc3 in the laccase dendrograms is probably wrong. In lcc1, 16 different introns have been recorded and the sequence of Vv-01 strain differs by one amino acid from the published sequence of lcc1. No evidence of heterozygocity has been recorded in this sequence. The lcc2 gene also revealed 16 different introns. Although only a small portion of sequence could be validated but that also proved some heterozygocity in strain Vv-01. The small sequence of lcc 2 in strain BBSR-003 also revealed differences at some bases from strain Vv-01. At the protein sequence level, there were clearly 26 amino acids of the published mRNA, which were on the wrong reading frame. Maybe it is due to errors in sequencing, or the strain used had a pseudo gene or a very original allele for lcc 2. Due to these factors, the position of laccase 2 in the dendrogram will be changed. The sequence of lcc6 has helped in identification of 5 introns. The positions of introns in different laccase genes (lcc1, lcc2 and lcc3) of showed that they belong to sub-family A. Although not the main objective, the present study has proved heterozygocity in strain Vv-01 of , which has not been shown in earlier studies carried out on this species.

In present study we have compared intron positions present in sub-family A laccase genes in and from Agicoid clade (VI) and and from Pluteoid clade (III) From this comparison, it is clear that only intron position 2 was shared exclusively by and the Agaricoid clade laccases. However, data in the present study is insufficient to indicate whether this intron position is present in . In contrast, intron positions 5, 6 and 10 are shared exclusively by and Agaricoid clade laccases. VvLcc3 clustered with Agaricoid clade VI sub-family A genes while laccase genes formed a sister clade. This could indicate that ancestor genes from sub-family A laccases from and Agaricoid species could have diverged more recently than from ancestor genes of sub-family A laccases. However VvLcc1 and VvLcc2 share intron position 37 and 39, which are present in laccase sub-family C and in Polyporus sub-family A laccases. Then they could belong to the clade containing Polyporus laccase in sub-family A. Moreover, positions of these two genes vary in the different cladograms we have obtained. Present finding is not sufficient to elucidate the respective phylogenetic positions of , and Agaricoid clade species. To build further species phylogenetic trees, it is important to use sequences from and from , since they don't cluster together.

Evaluation of different strains of paddy straw mushroom ( )

A total of 17 strains were used for the strainal evaluation. The strains were observed for mycelial growth rate, type of growth and formation of aerial hyphae as well as intensity of chlamydospores on malt extract agar medium and pounded paddy straw.

The data depicted in table 5 reveal that out of 17 strains, 4 completely colonized the medium in petridishes within 5 days of inoculation and the mycelial spread was different in different strains. Some strains OE-295, WV-2 grew very slowly. The strains also varied in density and extent of aerial mycelial growth, which is also considered as a criterion of a potential high yielding strain. Strain, WW-10 exhibited highest growth and density of the aerial mycelium, followed by Vv-2(v) and Vv-4(v). Five strains, OE-272, OE-274, BBH-05, OE-305 and OE-153 exhibited similar type of mycelia growth pattern, growth rate, shape of margin and intensity of chlamydospores. Two strains, WV-2 and WV-3 showed thick, dense and little cottony type of growth. The aerial mycelia were almost completely absent in strain Vv-3(v). Some strains exhibited purple, pinkish and orange coloured chlamydospores, which are not generally found in culture.

Table 5. Mycelial growth characteristic of different strains deposited as of spp. on malt extract media

Strain	Mycelial growth characteristics					
	Radial growth	Aerial mycelia		Form and margin	Type of growth	Chlamydo-spores
		Density	Growth			
OE-272	40	+++	+++	Filliform and Curled	Creturing	Brownish Circle
OE-273	38	+++	+	Filamentous	Raised	_
OE-274	30	++	++++	Filliform	Creturing	Brownish Circle
OE-55	21	+	++	Filliform, Curled	Creturing	-
BBH-05	35	++	++	Circular, Filliform	Raised	Brownish Circle
WW-10	70	++++	+++++	Irregular, Undulase	Raised	-
GV-1	56	+++++	++	Undulase, Curled	Creturing	Light Orange
Wv-2	19	++++	+++	Undulase, Filliform	Umbonate	-
Wv-3	43	++	+	Undulase, Filliform	Umbonate	-
Vv-1(v)	41	+++	+	Irregular, Filliform	Creturing	Purplish outer circle
Vv-2(v)	68	++	+++	Filliform	Creturing	Light brownish
Vv-3(v)	43	_	_	Irregular, curled	Flat	-
Vv-4(v)	68	++	+++	Filliform	Creturing	Light brownish
OE-295	19	+++++	++	Irregular, Lobate	Star like	-
OE-305	54	+	++	Filliform	Flat	Dark brownish circle
OE-153	33	++	++	Filliform, Curled	Creturing	Yellowish Circle
OE-294	43	++++	+	Undulase, Curled	Creturing	Dark pink and Purplish circles

+ Scare, ++++++ highest, - absent

The data presented in table 6 reveal that strain WW-10 exhibited highest growth on Paddy Straw, followed by strains OE-305, OE-153, BBH-05, OE-274, OE-272, Vv-4(v) and Vv-2(v). The poorest growth was recorded in strain Vv-3(v). The aerial mycelial growth was highest in case of strain WW-10, while the mycelia density was high in strains OE-295, OE-294, Vv-1(v). Seven strains produced the chlamydospores. In flasks, almost all the strains completely colonized the substrate. Two strains WV-2 and WV-3 exhibited distinct type of growth.

Extracellular lignocellulolytic enzymes activity profile of different strains

The activity of six different extracellular lignocellulolytic enzymes was assayed first by growing all the strains on pounded paddy straw and the extracellular enzyme extract was obtained using standard protocol. Activity of different enzymes was recorded again by following standard protocol (Table 7).

Exoglucanase activity was highest in strain Vv-1(v), followed by WV-2 and least in Vv-4(v) strain. Endoglucanase activity was also highest in strain Vv-1(v), followed by OE-295 and least in Vv-3(v) and WW-10 strains. â-glucosidase activity was similar in most strains. It was highest in strain OE-294, followed by OE-295 and least in Vv-3(v). Xylanase activity was highest in strain Vv-1(v), followed by OE-294 and least OE-274. Laccase activity was absent in half of the strains. It was highest in strain OE-272, while lowest in strain OE-153. Polyphenol oxidase activity was

Table 6. Mycelial growth characteristics of different strains deposited as spp. on Paddy straw based spawn substrate

Strain	Mycelial growth characteristics				
	Downward growth in test tubes (mm)	Radial growth in flasks(mm)	Aerial mycelia		Chlamydospores
			Density	Growth	
OE-272	39	70	+++	++	Light brownish
OE-273	11	39	++	+	Light yellowish
OE-274	55	70	++	+++	-
OE-55	19	70	+	+	Yellowish
BBH-05	59	70	++	+++	-
WW-10	92	70	++++	++++++	-
GV-1	5	70	+	+	Brownish circle
Wv-2	2	31	+	++	-
Wv-3	7	37	+	++	-
Vv-1(v)	13	6	++++	++	Yellowish in mid
Vv-2(v)	25	70	++	++	-
Vv-3(v)	-	-	-	-	-
Vv-4(v)	28	60	++	++	-
OE-295	3	28	++++++	++	-
OE-305	70	70	+++	+++	-
OE-153	57	70	+++	+++	Light brownish
OE-294	15	70	++++	+	Light brownish

+ Scare, ++++++ highest, - absent

Table 7. Extracellular lignocellulolytic enzymes activity of strains received as spp.

Strain	Enzyme activity					
	Exo-glucanase	Endo-glucanase	-glucosidase	Xylanase	Laccase	Polyphenol oxidase
OE-272	0.4355	1.0457	0.4954	0.7098	5.1990	1.0052
OE-273	0.3540	0.8836	0.4962	0.3890	-	-
OE-274	0.0519	0.7733	0.4834	0.0591	0.0677	-
OE-55	0.1436	0.7527	0.4920	0.2242	-	0.0677
BBH-05	0.2143	0.8020	0.4815	0.5084	-	-
WW-10	0.0715	0.1204	0.5021	1.0369	-	0.0156
GV-1	0.3262	1.3957	0.5076	0.6571	-	0.0312
Wv-2	0.6087	0.5281	0.2873	0.3768	0.1531	0.2153
Wv-3	0.1787	0.2418	0.4838	0.1655	2.5851	0.7326
Vv-1(v)	0.8249	1.6748	0.5143	1.6470	0.1996	0.2517
Vv-2(v)	0.3722	0.8891	0.5408	0.4694	0.2222	0.1006
Vv-3(v)	NA	0.0647	0.0033	1.2903	-	0.0295
Vv-4(v)	0.0394	0.2298	0.5280	0.1217	0.1927	0.1788
OE-295	0.1462	0.2966	0.5414	0.2807	-	0.0260
OE-305	0.1479	0.1702	0.4798	0.2353	-	0.0642
OE-153	0.0570	0.2983	0.5196	0.1980	0.0364	0.0364
OE-294	0.1830	1.4030	0.5456	1.3083	0.2100	0.1823

- Absent

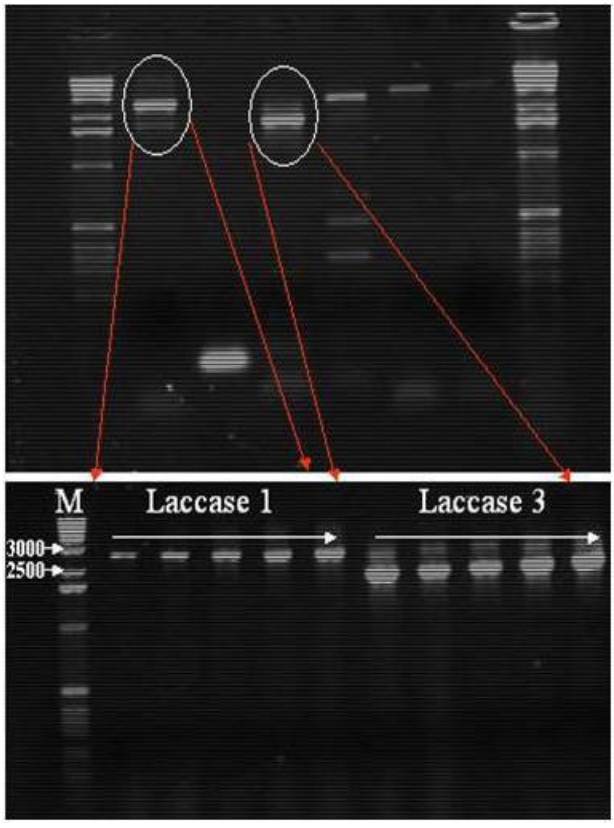


Fig. 5. PCR amplification of different laccase genes of . a) From left to right, surrounded by 1 Kb ladder (Life Technologies), Laccase 1 to 6. b) DNA ladder, Laccase 1 annealing temperature from 55 to 59ºC, Laccase 3 annealing temperature from 55 to 59ºC. temperatures of 58 ± 2°C and laccase 2 exhibited fairly good amplification at almost all temperatures (56-60°C), while laccase 6 gene exhibited amplification at only 59 and 60ºC annealing temperatures. In case of homozygotic strain BBSR-003, out of 4 pair of primers (laccase1, 2, 3 & 6) attempted at 57 ± 1°C annealing temperatures, appropriate amplification were obtained only for laccase 3 gene.

highest in strain OE-272, followed by WV-3 and absent in 3 strains, OE-273, OE-274, and BBH-05.

Vv-1(v) exhibited appreciable activity of Exoglucanase, Endoglucanase and Xylanase, which suggests that it is highly capable of degrading and utilizing cellulose and hemicellulose. OE-272 also exhibited appreciable activity of all 6 Enzymes. Very low enzymatic activity was shown by strains, Vv-3(v) and WW-10.

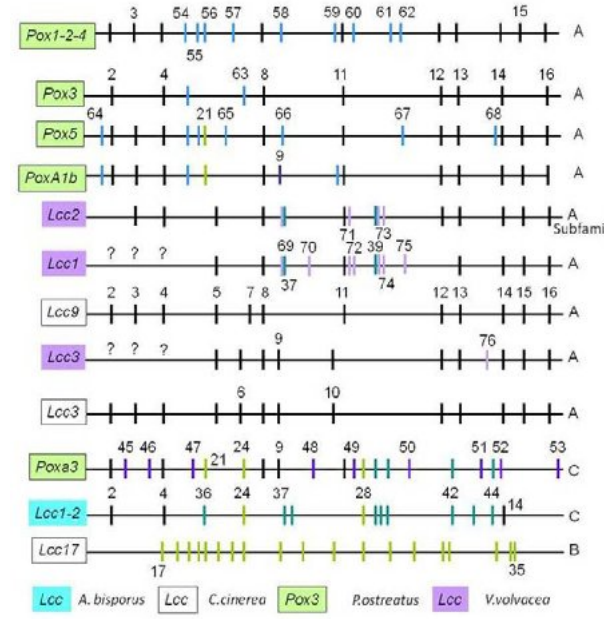


Fig.6. Relative positions of introns in different laccase genes of different sub-families. Nomenclature of introns 2 to 35 [23], 36 to 44 (lcc1 and lcc2), 45 to 68 (Poxa3, Pox1-2-4, Pox3, Pox5), 69 to 76 (lcc1 and lcc3). gene nomenclature corresponds to: Pox1(LACC9), Pox2 (LACC10), Pox3 (LACC4), Pox4 (LACC1), Pox5 (LACC11), PoxA1b (LACC6) and Poxa3 (LACC2)

Units of measurement: Exo and Endo-glucanase/ Xylanase**:** ì mole glucose released/ hr/ml of filtrate. PPO/Laccase: change in absorbance by 0.001/min/ml of filtrate. â - Glucosidase: ì mole p-nitrophenol released/hr/ml of filtrate.

Profiling and sequencing of the ITS region of 5.8S rDNA of different strains deposited as spp.

Out of sixteen strains used from the beginning of the study, good and pure DNA could be extracted from fourteen strains only, leaving strains OE-273 and WW-10. Out of fourteen strains, ten got amplicons of almost save length (720 bp), while the rest four got amplicons of less than 600 bp and lowest of nearly 400 bp in strain Vv-3(v) (Fig. 8). The strains with amplicons of nearly 720 bp were later identified as or while the rest with amplicons of near or less than 600 bp were

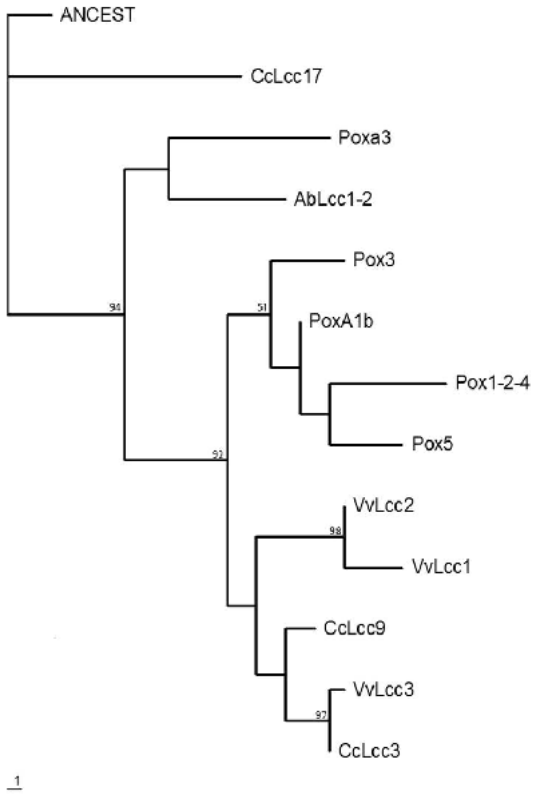


Fig. 7. One of the eight most parsimonious cladograms obtained by Dollo parsimony deduced out of 75 introns positions in laccases genes of three subfamilies of four basidiomycetes. Thirty intron positions were parsimony-informative characters. Bootstrap values are from 50 % majority-rule consensus tree. Sub-family B - CcLcc17, sub-family C- Poxa3 and AbLcc1-2, sub-family A – all other genes, ANCEST – hypothetical ancestor gene with no intron

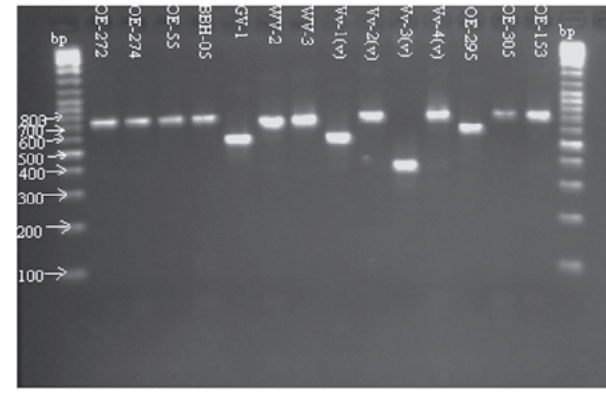


Fig. 8. ITS profile of different strains with primer ITS-1 and ITS-4

identified other than or (Table 8). Two strains WV-2 and WV-3, which were deposited as white strains of spp., were identified as a new name given only in January, 2011. The four unrelated species identified were sp. for (GV-1), for Vv-1(v), for Vv-3(v), both strains received from Vellayani Centre of AICRP-Mushroom and for OE-295 received from DMR culture bank.

Table 8. Results of Nucleotide BLAST of ITS region of 5.8S rDNA of strains received as spp.

Sl. No.	Strain code	Strain identified
1.	OE-272	strain Vv-34
2.	OE-274	strain Vv-34
3.	OE-55	strain NIH1001
4.	BBH-05	strain Vv-34
5.	GV-1	sp. 172NL/R
6.	WV-2	voucher Mamet7
7.	WV-3	voucher Mamet7
8.	Vv-1(v)	f. sp. lycopersici isolate ED-3
9.	Vv-2(v)	strain Vv-34
10.	Vv-3(v)	
11.	Vv-4(v)	strain Vv-34
12.	OE-295	strain Dzf16
13.	OE-305	strain Vv-34
14.	OE-153	strain Vv-34

Results of CLUSTAL W multiple alignment

The NJ Bootstrap consensus tree by using the ITS sequences of 5.8S rDNA region of fourteen strains received as spp. was drawn by using MEGA 5.05 free online software. Strains OE-272, OE-274 and OE-305 formed one clade with bootstrap value of 99. The other two strains received from Vellayani Centre again formed one clade with bootstrap value of 100, means two strains have evolved together and are almost same. The two strains (WV-2 and WV-3) identified as have shown very high level of divergence, which is also true as these two have been collected from two completely different as well separated places (Gujarat and Andaman & Nicobar Islands). The placement of OE-55, WV-3 and OE-153 identified as or between Vv-3(v), Vv-1(v), Gv-1 and OE-295, identified as contaminants is quite surprising (Fig 9).

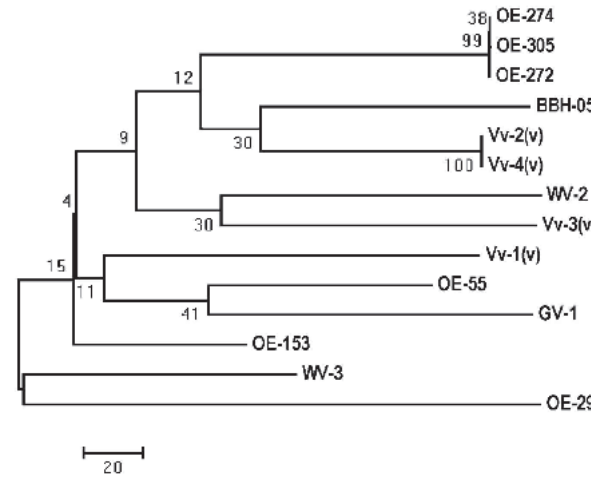


Fig. 9. Neighbor Joining Tree showing the phylogenetic distance between different strains received as spp.

Submission of sequences to NCBI Genbank

The improved and annotated sequences of laccase 3 genes from heterozygotic strain Vv-01 and homozygotic strain BBSR-003 were submitted to NCBI Genbank as direct submissions and the accession Nos. received as per table 5. Similarly the improved sequences of ITS 1-5.8S rDNA-ITS-2 region belonging to 23 different parent strains and SSIs were submitted to NCBI Genbank as direct submissions.

2)

B. Crop Production

i.

Isolation of thermophilic mycoflora from different compost Samples

A large number of thermophilic fungi were isolated from samples collected across the country. and were dominantly isolated from different samples.

Total indoor compost production using thermophilic fungi.

The compost was prepared using wheat straw (1000 kg), poultry manure (700 kg), wheat bran (70 kg), urea (12 kg) and gypsum (40 kg) with cold N level at 1.5%. Inoculum of (X-21 strain) + (I-33) was added @ 0.3 % on dry wt. basis of the straw i.e 1.5 kg each in two spilt doses. Inoculum was grown on wheat grains (usual spawn bottles with sterilized wheat grains) and incubated at 45C for 7- 10 days. Later both the inoculum were mixed on a polythene sheet and mixed in two buckets of water, stirred properly with hand so that spores of the fungi are disbursed in water properly. Following schedule was used during compost preparation.

0 day : Properly wet wheat straw and bring it up to 75% moisture level. Later thoroughly mix all the ingredients into it along with inoculum. (thorough mixing is very important) and make a heap

+1 day : Break open the heap, add water if required, mix the ingredients properly, again make a heap (temp around 58-60°C)

+2 day : Again turn the compost ingredients and make a heap (temp 62-65°C)

+3 day : Again turn the compost ingredients and make a heap (temp around 70°C)

+4 day : Transfer the entire mass to the phase-II tunnel and equalize at 45-48°C

+5 day : Maintain the compost temp at 45-52°C (pre pasteurization conditioning)

+6 day : Maintain the compost temp at 45-52°C (pre pasteurization conditioning)

+7day : Kill at 59°C for 6 hours (either through self-heat generation or through steam), later Post pasteurization conditioning (POPC) at 48-52°C

+8 day : Post pasteurization conditioning (POPC) continued

+9 day : POPC

+10 day : POPC and cool down at night

+11day : Spawning

Compost was prepared following above schedule and methodology. Physical and biological parameters obtained are presented in table 1 and 2, respectively. Nitrogen percentage at spawning was 2.4 while CN ratio at beginning of composting was 19.2 which came down to 13.4 at spawning. All other parameters showed decline trend and their values were minimum at spawning (table-1a). and were dominantly isolated from the

Table 1. Physical parameter of indoor compost

Turnings	Cellulose (%)	pH	C (%)	N (%)	C:N	N.D.F. (%)	A.D.F. (%)	A.D.L (%)	Moisture (%)	Hemicellulose (%)
Ist day	42	9.2	54	2.8	19.2	72.1	45.2	22.6	71	26.9
4th day	32	8.2	42	2.5	16.8	57.2	38.1	38.4	68	19.0
At spawning	28	7.7	32	2.4	13.4	42.3	30.2	38.0	67	12.0

Table 2. Mycoflora of indoor composting

Turnings	Av. C.F.U.	Dominant mycoflora
Ist day	8.3	As>St>Hi
4th day	12.6	St>Hi>As
At Spawn.	13.0	Si>Hi

As - *A. fumigatus*; St - *S. thermophilum*; Hi - *H. Insolense*

compost at various stages. At spawning and were dominantly present and their CFU was maximum at this stage (Table 2).

A total of 3.76 tons of compost was produced giving average yield of 8.82 kg/ 100 kg compost. The yields were lower this time as the experiment was conducted in September and temperature in the growing rooms could not be controlled properly.

Utilization of spent compost and cotton waste in button mushroom compost production under short method of composting

These three ingredients were evaluated for compost production under short method of composting taking 600 kg wheat straw as the base material (Table 3). A total of 20.0, 28.9 and 17.4 qtls. of final compost was produced using chicken manure, SMS and cotton waste respectively as the principal N source.

Physical parameters viz. cellulose, hemicellulose, C:N ratio, NDF, ADF, ADL , pH, and moisture % were also analyzed in detail at each of the three turnings and at spawning for all the three piles (Table 4,6,8). Besides above biological parameters in terms of CFU and numbers of fungi for each pile for above periods were also determined. In general all the parameters showed decline trend as composting proceed and were lowest at spawning.

and were dominantly isolated from different composts (Table 5,7,9) at various intervals. P-3 pile where cotton waste was added showed the dominance of and .

Good spawn run was observed in all the three treatments even with SMS. Cotton waste treatment performed very well and gave highest yield (16.77kg/100kg compost). Lowest yield,

Table 3. Formulations used

Ingredients	Pile-1 (kg)	Pile-2 (kg)	Pile-3 (kg)
Wheat straw	600	600	600
Chicken manure	480	0	300
Cotton seed meal	24	24	24
Cotton waste	0	0	120
SMS	0	480	0
Urea	8	12	11
Gypsum	30	30	30
Cold N %	1.56	1.51	1.55

Table 4. Physical parameters of P-1 compost. at different turnings

Turnings	Cellulose (%)	pH	C:N	N.D.F. (%)	A.D.F. (%)	A.D.L. (%)	Moisture (%)	Hemicellulose (%)
I	48.0	9.2	20.7	77.8	60.2	27.6	71.0	17.5
II	40.0	8.5	20.4	69.8	54.3	27.6	71.0	15.5
III	38.0	8.3	20.0	67.2	52.1	27.6	68.0	15.1
At spawning.	28.0	7.7	16.5	55.3	45.1	27.6	63.0	10.1

Table 5. Mycoflora of P-1 compost at different turnings

Turnings	Av. C.F.U.	Dominant mycoflora
1	6.0	As>St > Hi
II	10.3	St > Hi > As
III	13.3	St >Hi > As
At Spawning	13.3	St > Hi > As

however was obtained with SMS (13.85 kg) which was slightly lesser than chicken manure (14.02 kg) (Table 10). Experiment gave indication that cotton waste and SMS can well be utilized in compost production for button mushroom. Another trial to confirm the data is in progress.

Table 6. Physical parameter of P-2 compost at different turnings.

Turnings	Cellulose (%)	pH	C:N	N.D.F. (%)	A.D.F. (%)	A.D.L. (%)	Moisture (%)	Hemicellulose (%)
I	52.0	9.0	21.4	77.9	63.1	28.4	73.0	14.8
II	48.0	8.2	20.8	72.3	61.2	28.4	72.0	11.0
III	38.0	8.0	20.4	62.1	53.2	28.4	68.0	8.9
At spawning	28.0	7.5	19.4	52.3	43.2	28.4	62.0	9.0

Table 7. Mycoflora at different turnings of P-2 compost.

Turnings	Av. C.F.U.	Dominant mycoflora
1	9.6	As > St> Ht
II	14.0	St> Hi> As
III	14.0	St > Hi> As
At Spawn	16.6	St > Hi

Utilization of thermophiles in short method compost

Above experiment was taken with a view to screen
and their consortium for improving the yield in short method compost when inoculated in the compost piles at stacking. The compost for the

Table 8. Physical parameters of P-3 compost at different turnings

Turnings	Cellulose (%)	pH	C:N	N.D.F. (%)	A.D.F. (%)	A.D.L. (%)	Moisture (%)	Hemicellulose (%)
I	54.0	9.5	24.8	77.8	63.3	28.1	72.0	14.5
II	52.0	9.2	24	72.3	61.1	28.1	72.0	11.1
III	45.0	8.8	22.6	63.2	53.1	28.2	68.0	10.1
At spawning	32.0	7.8	15.0	52.1	43.2	28.2	63.0	8.8

Table 9. Mycoflora at different turnings of P-3 compost

Turnings	Av. C.F.U.	Dominant mycoflora
1	12.0	St>As> Hi
II	15.0	St>Hi >As
III	26.6	St>Hi>As.>Spt>Hg.
At Spawning	16.6	St > Hi >Hg

St. – ,Hi- , Hg- , As- Spt-

experiment was prepared using wheat straw (200 kg), poultry manure (20 kg), wheat bran (80 kg), urea (3 kg) and gypsum (6 kg). Cold nitrogen was 1.47 %.

Five such piles were prepared and three piles were inoculated with each fungus, 4th pile was inoculated with their consortium while 5th pile served as control (uninoculated).

Table 10. Yield obtained with different piles

Pile	Total compost Produced (Kg)	Total yield Kg	Kg/ 100 kg compost
P-1	2008	281.6	14.02
P-2	2104	289.3	13.85
P-3	1720	285.8	16.77

The inoculums was added in the piles @ 0.5% dry wt. of the straw. Physical parameters obtained for all the piles were within permissible limit and all the studied parameters showed decline trends as composting progressed and their values were lowest at spawning. Only and were dominantly isolated from different piles (Tables 11-20).

Table 11. Physical parameters of P-1 ( ) compost at different turnings

Turnings	Cellulose (%)	pH	C:N	N.D.F. (%)	A.D.F. (%)	A.D.L. (%)	Moisture (%)	Hemicellulose (%)
I	45	9.2	19.2	78.3	62.4	28.6	71.0	15.8
II	38	8.5	20.4	74.2	60.4	27.6	71.0	13.8
III	35	8.3	19.5	67.4	54.3	27.6	68.0	13.1
At spawning	24	7.7	19.0	55.4	45.3	27.6	63.0	10.1

Table 12. Mycoflora at different turnings of P-1 ( ) compost

Turnings	Av. C.F.U.	Dominant mycoflora
1	8.0	
II	10.0	
III	12.3	
At Spawn	10.6	

Physical , biological parameters and yield was recorded for all the treatments. Very good spawn run and highest yield (Table 21) was offered by treatment (15.14 kg) followed by consortium treatment (14.97kg). Control treatment yielded only 10.13 kg mushrooms.

Table 13. Physical parameters of P-2 (ST) compost at different turnings

Turnings	Cellulose (%)	pH	C:N	N.D.F. (%)	A.D.F. (%)	A.D.L. (%)	Moisture (%)	Hemicellulose (%)
I	52	9.0	21.4	77	62	28.4	73	15
II	45	8.2	20.8	74	60	28.5	72	14
III	33	8.0	20.4	65	55	28.5	68	10
At spawning	27	7.5	15.9	54	43	28.6	62	9

Table 14. Mycoflora P-1 ( ) compost at different turnings

Turnings	Av. C.F.U.	Dominant mycoflora
1	8.3	
II	12.6	
III	16.0	
At Spawn	13.3	

Utilization of different agriculture wastes for compost production under LMC

For this particular study three compost piles were prepared using a combination of soybean, paddy straw, wheat straw and cotton wastes. Compost was prepared by LMC in 28 days time. Physical and biological parameters of all the three composts were studied. Erratic/ poor and delayed

Table 15. Physical parameters of P-3 ( ) compost at different turnings

Turnings	Cellulose (%)	pH	C:N	N.D.F. (%)	A.D.F. (%)	A.D.L. (%)	Moisture (%)	Hemicellulose (%)
I	55	9.5	21.4	78.8	63.2	28.5	71	15.59
II	53	9.2	20.8	72.3	57.7	28.5	72	14.60
III	45	8.8	20.0	62.8	53.1	28.6	67	9.73
At spawning	35	7.8	15.8	52.2	43.2	28.6	62	8.98

Table 16. Mycoflora of P-3 ( ) compost at different turnings

Turnings	Av. C.F.U.	Dominant mycoflora
1	12.0	
II	12.6	
III	13.3	
At Spawn.	16.0	

spawn run was observed in a combination of soybean and paddy straw treatment resulting in no harvest in such treatment. Other treatments utilizing wheat straw and cotton waste and wheat straw and wheat bran also offered low yields, experiment however gave indication that cotton waste can be utilized in compost production for button mushroom.

Table 17. Physical parameters of P-4 (consortium) compost at different turnings

Turnings	Cellulose (%)	pH	C:N	N.D.F. (%)	A.D.F. (%)	A.D.L. (%)	Moisture (%)	Hemicellulose (%)
I	52	9.5	21.4	78.2	62.3	28.4	73	15.9
II	47	9.2	20.8	70.3	58.2	28.4	72	1212.0
III	42	8.8	20.0	63.4	52.3	28.4	68	11.0
At spawning	28	7.5	17.3	496	39.7	28.4	62	9.9

Table 18. Mycoflora at different turnings of P-4 (Consortium) Compost

Turnings	Av. C.F.U.	Dominant mycoflora
1	12.6	
II	16.3	
III	16.0	
At Spawning	18.3	

Chicken manure free compost formulation trial

Three compost formulation viz., recommended Chicken Manure (CM) dose, half dose and without chicken manure was attempted in button mushroom cultivation. It was found that 100% CM yielded 17.3% yield whereas CM free compost yielded 13.1% for 100 kg compost.

Table 19. Physical parameter at different turnings of P-5 (Control) Compost

Turnings	Cellulose (%)	pH	C:N	N.D.F. (%)	A.D.F. (%)	A.D.L. (%)	Moisture (%)	Hemicellulose (%)
I	54	9.5	24.8	77.8	63.4	30.4	73	14.4
II	52	9.2	24.0	72.3	61.1	31.4	72	11.1
III	45	8.8	22.6	62.7	53.4	31.4	68	9.3
At spawning	32	7.8	17.5	52.3	43.4	34.5	62	8.8

Table 20. Mycoflora at different turnings of P-5 (Control) Compost.

Turnings	Av. C.F.U.	Dominant mycoflora
1	1.6	
II	16.0	
III	17.6	
At Spawn.	16.6	

Table 21. Total final compost and yield obtained with different composts:

Pile	Total compost Produced (kg)	Spawn run	Yield kg/ qt. compost
1)	420	++++	14.37
2( )	430	++++	15.14
3( )	410	++	10.17
4 (Cosortium.)	500	++++	14.97
5 (control)	470	+++	10.13

Evaluation of different materials for casing worthiness

Confirmation trial on evaluation of six different materials such as lime, gypsum, vermiwash, button SMS and FYM was conducted. In this experiment gypsum @ 10 % gave better yield (10.97 kg/100 kg compost), followed by vermiwash treatment (8.85 kg/100 kg compost). Increasing dose of lime application resulted in decreasing yield. Confirmation trial on evaluation of particle size was carried out and found that medium size particle showed better yield over fine particle size.

ii. spp

Improvement in cultivation technology of oyster mushroom

Eight wild spp. collected from the forests were evaluated for their large scale evaluation on pasteurized wheat straw during July and August. The strains evaluated were DMRP-150, DMRP-197, DMRP-200, DMRP-214, DMRP-219, DMRP-229, DMRP-231 and DMRP-244. All the strains have four replications with 3 bags each in each replication. All the strains gave good mycelial growth, however the mycelial growth in two strains namely DMRP-197 and DMRP-200 was fastest and it took only ten days for complete mycelial growth. Both strains gave 80-85 % Biological efficiency in 30 days. Moreover the fruit bodies are pure white, short stalked and infundibuliform. The experiment was repeated two times in polythene bags as well as in plastic trays.

Evaluation of hybrid strains of spp. for yield.

Six strain of spp. (V-1 to V-6) were evaluated on pasteurized wheat straw. Each

Table 22. Yield data of various strain of hybrid strain on pasteurized wheat straw

S. No.	Strain	B.E. (%)
1	V-1	52.6
2	V-2	49.6
3	V-3	55.3
4	V-4	55.3
5	V-5	25.6
6	V-6	25.2

strain had four replications and each strain had three bags per replications. Yield data were recorded for 35 days. Strain No. V-3 and V-4 gave highest yield of 55.3 % B.E. followed by V-1 and V-2. The yield data are presented in table 22.

Effect of bag opening on yield in

Pasteurized wheat straw was spawned with 25 days old spawn of . The mycelial colonized bags were opened differently for fruiting to find out the effect on total yield. The different treatments evaluated were as follows: - T1= small holes of 2" dia (6 no.), after first flush slits of 1" X 6" and in 3rd flush bags were fully opened, T2 = holes of 2" dia (6nos.), T3 = strips of 1" X 6 " (6 nos. on both sides.) T4 = only top surface exposed. T5 = bags fully opened. It was observed that treatment T3 and T1 gave significantly higher yield.

Pasteurized straw for spp. for cultivation of King oyster mushroom spp.

Four different strains of King oyster were evaluated using pasteurized straw supplemented with 10 % of wheat bran, cotton seed cake and soybean meal. It was observed that there was good mycelial growth but no fructification was observed in any of the strain. It shows that for king oyster it required autoclaved substrate or the tunnel temp. should be more than 65ºC for longer duration.

Collection, isolation, identification and cultivation of

In an effort to enrich the collection and domestication of oyster mushroom species, surveys were conducted especially in the upper reaches of HP for collection of different macro-fungi during the month of June-July (2011). Mature fruit bodies growing on willow tree stump (10-30^{0}C; < 45%RH) were collected. The geographical location of the place was 32.58° N 77.03° E located at an altitude of 3,080 meters from mean sea level. There is little or no rain fall. The climatic conditions are extremely cold. Fruiting bodies were sterilized for 1 minute with mercuric chloride (0.1%) under aseptic conditions. Small tissue of the fruit body was taken from the junction of stipe and pileus. and placed in petri plates containing PDA.

Genomic DNA from the isolates were extracted using approximately 100 mg mycelial cultures raised in malt extract broth (Malt extract-10g L^1; Glucose- 5g L^{-1}) for 10 days at 25$\pm$1°C as stationary culture. Universal primers ITS-1 (5'-TCC GTA GGT GAA CCT GCG G-3') and ITS-4 (5'-TCC TCC GCT TAT TGA TAT GC-3') developed by White . were used for PCR-amplification of the internal transcribed spacer (ITS) region of ribosomal DNA, including the 5.8S rRNA gene, ITS-1, and ITS-2 regions. Nucleotide sequence comparisons were performed by the basic local alignment search tool (BLAST) network services against the National Centre for Biotechnology Information (NCBI) database. The mushroom species were designated to the sequenced cultures and analyzed based on similarity with the best-aligned sequence of BLAST search. 5.8S rRNA gene sequence alignments were performed using Clustal X 1.83 software. Comparison of sequences confirmed the identity as . This mushroom was cultivated on sawdust (Mixture of different woods) supplemented with wheat bran. Spawn run was completed in 25-30 days at 25-28°C. Pinning started after 10days of opening the bags. First flush was harvested after 15 days when blocks were placed at a temperature range of 10-25°C. Contributed cultures of and to gene bank of DMR under the acc. No DMRO 422 and DMRP 256, respectively.

Physiological studies on

Among the different medium tested, best growth was recorded on MEA medium (Table 23). A temperature of 25°C and pH 7 (Table 24) supported the maximum growth of the fungus.

Table 23. Evaluation of different media for

Medium	Av. Growth (mm)
Malt extract	75.0
Asthana & Hawker	40.0
Brown's medium	35.0
Czapekdox	20.0
Dextrose nitrate agar	48.0
Ellitos agar	50.0
Malt extract peptone dextrose agar	45.0
Martins rose Bengal streptomycin agar	70.0
Walksman agar	45.0
Sabourands medium	28.0
Glucose peptone agar	35.0
Joffers medium	40.0

Table 24. Evaluation of different temperatures for

Temp (°C)	Av. Growth (mm)	pH	Av. Growth (mm)
15	48.0	5	72
20	46.8	6	70
25	59.8	7	68
30	58.0	8	68
—	—	9	60

iii. Specialty mushrooms

Survey for

Survey of different sites of Rajasthan to collect : Survey of different sites in Rajasthan was conducted (Table 25). In all 54 samples of were collected from Bikaner and Jaisalmer area ranging from Long 70.5522-73.3191E and Lat 26.5538-28.0320 N. cap diameters varied from 1.8 to 3.3 cm.

Physiological studies on different isolates of

The temperature preferences of all the strains under investigation were found to be 40°C (Table 26). Since temperature range of only 20°C to 40°C was under study and the growth was found to be continuously increasing with the temperature hence it may be possible that best growth of the fungus may be obtained at further high temperatures. Studies are going on the growth rate of the test fungus at higher temperatures.

The optimum pH for all the test strains was observed to be 7.5. Although in strain 1/3 the growth declined sharply after pH 7.5 while in other strains it remained constant up to pH 8.5 (Table 27). The results indicated that the fungus requires high temperature and slight alkaline pH, which is normally found in the deserts of Rajasthan (India). One earlier study on soil conditions mushroom natural sites revealed that it grows in coarse, well-aerated sandy soil with poor nutrients and high pH (Manikandan 2011).

For further physiological studies, eleven liquid and ten solid media were evaluated to identify a basal medium. For the media preference the strains differed from each other. Strain 1/3

Table 25. Survey for

Location	Long-lat	No of samples	Cap.dia (cm)	Stipe dia (cm)	Wt (g)	Length (cm)
Road side (El=157m) (70KM before Jaisalmer)	27.0176N 71.3939 E	9	1.8	1.3	11.5-58.0	7.5-18
Road side (El=139m) (50KM before Jaisalmer)	26.9826N 71.2959 E	2	2.1	1.1	16.8-46.6	9-13
Bikaner market (El=150m)	28.0320N 73.3191 E	23	3.3	1.5	19.1-84.3	8-19
Jaisalmer market (El=231m)	26.5538N 70.5522 E	20	2.8	1.3	21.0-60.2	6-16

Table 26. Radial growth of strains at different temperatures

Strains	Average mycelial growth (mm) after 15 Days				
	20°C	25°C	30°C	35°C	40°C
1/3	20.3	23.3	35.0	39.0	41.0
2/10	18.6	21.3	23.0	35.0	39.3
5/19	10.0	23.0	27.3	40.0	45.6
CD (0.05)	0.6	0.8	0.6	0.5	0.4

Table 27. Radial growth of strains at different pH

Strains	Average mycelial growth (mm) after 15 Days								
	5.0	6.0	6.5	7.0	7.5	8.0	8.5	9.0	10
1/3	42.6	45.0	66.5	74.9	82.3	68.0	64.0	65.3	57.5
2/10	43.4	46.8	59.3	64.2	67.4	64.8	62.0	60.0	57.0
5/19	44.5	47.0	55.6	57.9	65.0	64.0	60.0	57.4	55.8
CD (0.05)	1.94	1.42	0.76	1.03	1.01	1.47	1.44	1.56	1.35

preferred Elliott's medium while strains 2/10 showed best growth in Czapek's dox medium and 5/19 grew best on malt dextrose peptone medium (Table 28 and 29). To perform the physiological studies a synthetic medium was required and all the test strains showed good growth on Czapek's dox medium hence used for all physiological studies.

Table 28. Evaluation of liquid media for the growth of isolates

Isolate	Dry mycelial weight (mg) after 15 days									
	1	2	3	4	5	6	8	9	10	11
1/3	15	151	9	10	312	129	8	101	8	10
2/10	39	22	169	15	29	10	9	11	10	10
5/19	33	12	170	90	28	234	50	10	11	14
CD (0.05)	3.97	5.63	18.1	5.25	12.07	21.99	6.13	8.09	6.34	1.66

1- Asthana & Hawkers; 2 - Browns; 3 - Czapek's dox; 4 - Dextrose nitrate; 5 - Elliot's; 6 - Malt extract peptone dextrose; 8 - Walksman; 9 - Sabouraud's; 10 - Glucose peptone; 11- Joffer's medium

Table 29. Evaluation of different solid media for the growth of isolates

Isolates	Average mycelial growth (mm) after 15 Days									
	1	2	3	4	5	6	7	8	9	10
1/3	37.0	48.3	0.0	42.0	45.6	90.0	30.0	57.6	37.0	51.6
2/10	33.3	21.0	12.0	24.6	33.6	28.3	25.0	59.0	28.0	23.0
5/19	37.6	29.3	15.0	37.0	42.6	59.6	24.3	25.6	32.6	43.3
CD (0.05)	1.2	2.7	-	3.2	2.1	5.4	3.34	2.7	2.6	4.6

1- Asthana & Hawkers; 2 - Browns; 3 - Czapek's dox; 4 - Dextrose nitrate; 5 - Elliot's; 6 - Malt extract peptone dextrose; 8 - Walksman; 9 - Sabouraud's; 10 - Glucose peptone; 11- Joffer's medium

To study the physiological requirement, carbon and nitrogen source preference of the test fungi was studied. Also the trace element i.e. Copper, iron, manganese and zinc requirement of strains under study were studied. The results indicated that all the three strains differed in their carbon source preference. The strain 1/3 showed the maximum growth on sugar alcohols while strain 2/10 grew the maximum on sucrose as well as the sugar alcohols. The maximum growth amongst all the three strains were recorded in the strain 5/19 and the most preferred carbon source by the strain was found to be dextrose. The strain 5/19 was found to be the most potent strain and could grow on almost all the carbon sources (Table 30).

The results on the nitrogen source utilization also showed that the strains are different in their physiological requirement (Table 31). The strain 1/3 and 2/10 showed the maximum growth on calcium nitrate while the strain 5/19 grew the maximum on ammonium sulfate. The difference in the physiological requirement of the test fungi also indicates that the specimens collected may belong to different species.

The trace element required by the test fungal strains were tested and results are given in the table 32. The strain 1/3 showed very low growth on the copper supplemented media. All the test strains showed equal preference for the iron concentration and the maximum growth of the test strains was observed to be on 0.05% concentration of iron. All test strains have showed same growth rate on all the manganese concentrations tested. However, different strains showed different growth rates on manganese concentrations. The maximum growth of all the strains has been recorded on the 0.05% concentration of Zinc. However, maximum growth rate was recorded in strain 5/19 in all the treatments.

Effect of different C:N combination on the mycelia growth of : Among the different C:N ratios (10:1, 10:2, 10:3, 10:4, 20:1, 20:2, 20:3, 20:4, ,30:1, 30:2, 30:3, 30:4, ,30:1, 30:2, 30:3, 30:4) tried for maximum growth for all the strains/isolates 1/2, 4/17 and 5/23 recorded in 40:2.

Table 30. Carbon source utilization by different isolates of

Isolate	Dry mycelial weight (mg) after 15 days									
	1	2	3	4	5	6	7	8	9	Control
1/3	43.6	39.9	43.9	24.3	23.9	51.8	19.3	22.5	49.3	18.4
2/10	36.1	35.2	35.0	32.8	45.2	42.1	42.3	30.2	44.3	23.2
5/19	84.7	74.2	55.7	42.0	42.8	22.6	23.4	53.8	44.5	22.6
CD (0.05)	3.12	5.62	4.63	3.23	2.12	4.26	3.09	4.24	3.23	

1-Dextrose; 2-Lactose; 3-Maltose; 4- Starch; 5-Sucrose; 6- Sorbitol; 7-Citric acid; 8-Cellulose; 9 Manitol

Table 31. Nitrogen source utilization for the growth of isolates

Isolate	Dry mycelial weight (mg) after 15 days						
	1	2	3	4	5	6	Control
1/3	5.6	4.9	16.8	23.5	41.7	27.6	3.8
2/10	2.2	7.8	14.2	11.3	35.8	14.3	4.0
5/19	11.5	22.1	14.2	20.5	22.6	19.6	2.2
CD (0.05)	0.23	2.12	2.25	3.23	3.63	2.09	

1-Urea; 2-Ammonium sulfate; 3-Ammonium chloride; 4-Sodium Nitrite; 5-Calcium Nitrate; 6-Sodium Nitrate

Table 32. Effect of different concentration of trace elements on isolates

Trace elements	Concentration (%)	Dry mycelial wt (mg) after 15 days			
		Isolates			
		1/3	2/10	5/19	CD (0.05)
$CuSO_4$	0.025	2	21	41	2.23
	0.05	3	21	42	4.62
	0.075	3	21	43	3.25
	0.1	3	22	41	6.28
$FeSO_4$	0.025	34	18	60	5.24
	0.05	70	31	67	4.62
	0.075	60	30	59	3.23
	0.1	60	30	61	6.37
$MnSO_4$	0.025	46	13	50	3.26
	0.05	40	14	51	4.21
	0.075	47	14	50	3.23
	0.1	40	13	50	4.86
$ZnSO_4$	0.025	26	18	49	3.17
	0.05	28	22	50	2.26
	0.075	25	19	43	3.12
	0.1	25	19	44	3.21
Control	NTE	20	14	48	3.67

Effect of different vitamins on different isolates of : Three (10,20 and 50ppm) concentrations of four vitamins (Riboflavin, biotin, folic acid and nicotinic acid) were tried against four isolates of . It is clear from the data that thiamine supported the maximum growth of all 1/2, 4/17, 5/19 and 5/23 isolates at 20ppm concentration.

Linear growth of isolates on different substrates: Among the different isolates of , highest mycelial growth of isolate P-1/2, P-1/3, P-4/10 and P-5/23 took place in paddy straw whereas for isolate P-4/17 and P-5/19 it was soybean straw which supported the maximum growth (Table 33). Sawdust and peat moss supported some growth of P-1/3 isolate whereas soybean straw failed to support the growth of P-1/3 isolate.

i) Primordial Development of Phellorinia.

Inoculation of wheat and paddy straw with diffent isolates of Phellorinia was done. The bags were incubated at 35°C. The substrate was fully colonized in 10-15 days. Primodia were formed in two isolates but failed to develop into mature fruitbodies.

Table 33. Linear growth of isolates on different substrates

isolate	Linear growth of Phellorinia on different substrates (mm) after 10 days				
	Wheat straw	Paddy straw	Soybean straw	Saw dust	Peat moss
P-1/2	45	50	22	—	—
P-1/3	32	44	—	14	18
P- 2/10	44	54	—	—	—
P-4/17	10	34	45	—	—
P-5/19	12	16	36	—	—
P - 5/23	10	46	30	—	—

ii) Standardization of the moisture content of substrate on the productivity of

The data presented in table 34 revealed that maximum growth of *Calocybe indica* is at 60 7 62 % moisture contents followed by 58% and 64 and 66%. At 72% and above and 52% and below

Table 34. Effect of substrate moisture content on the linear growth of

S.N.	MCS (%)	DLG (mm)
1	48	10
2	50	10
3	52	10
4	54	15
5	56	30
6	58	45
7	60	48
8	62	48
9	64	35
10	66	35
11	68	32
12	70	20
13	72	8
14	74	8

MCS-Substrate moisture content; DLG- Downward linear growth

Table 35. Effect of moisture content of substrate on the productivity of

Filling stage	MC (%)	DSR	Yield (g/ kg dry bag)
After CST	74	NSR	-
2h	72	NSR	-
4h	71	NSR	-
12h	68	NSR	-
18h	64	18 days	310
24h	62	15 days	318

MC-Substrate moisture content; DLG- Downward linear growth

moisture content the growth rate was very poor. The substrate was chemically sterilized and filled after 2,4,6,12,18 and 24h. The moisture percentage was 72, 71, 68, 64 and 62%. It is clear from the data (Table 35) that there was no spawn run upto 68% moisture content. The substrate was colonized only when the moisture content was 64% or 62%.

Maximum growth of *Calocybe indica* was recorded on 62%and 60% moisture content followed by 58%. There was no spawn run when substrate was filled 2-4 h after chemical sterilization having 71-72% moisture contents. The spawn run took place only in bags filled after 18h with moisture content of 64% or lower.

It is clear from the data (Table 36) that autoclaved casing soil resulted in the highest yield of all the five tested strains followed by pasteurized treatment. The lowest yield was recorded in chemically treated soil. In this treatment also fruitbodies developed late by one day as compared to autoclaved or pasteurized treatments. Autoclaved casing soil proved to be the best giving the highest yield followed by pasteurized and chemical treatments for all the five strains (OE-46, APK-2, OE-334, OE-335 and OE-345) used in the study.

Evaluation trial on five putative strains (OE-46, APK-2, OE-334, OE-335 and OE-345) of revealed that strain APK-2 is the highest yielder followed by OE -334 and OE-335 (Table 37).

Evaluation of different strains of shiitake

Seven strains of shiitake (OE-8, OE-16, OE-20, OE-21, OE-22, OE-38, OE-388) cultivated on sawdust were evaluated for yield (Table 38). OE-388 strains proved to be the highest yielder with a biological efficiency of 107.2 % followed by OE-38 with 94.7% (BE).

Thermal Death point of some edible fungi:

Thermal death point of forty six cultures of different edible mushrooms ((, ,

Table 36. Effect of different casing treatment on the productivity of

Treatment Method	Strain	Days for primordial formation	Yield (g/kg dry)	Wt of fruit body
Pasteurized	OE-335	12	436	75
	OE-345	12	351	75
	Oe-334	12	325	65
	OE-46	12	105	70
	APK-2	12	270	68
Autoclaved	OE-335	12	535	76
	OE-345	12	438	65
	Oe-334	12	796	88
	OE-46	12	150	51
	APK-2	12	423	65
Chemical	OE-335	13	298	60
	OE-345	13	237	69
	Oe-334	13	327	75
	OE-46	13	195	65
	APK-2	13	347	69

Table 37. Evaluation of different strains of

Strain	Days for spawn run	Days for Primordial formation	Number of fruit bodies/bag	Yield (1.5kg/bag)dry
OE-334	17	28	15	921
OE-335	17	30	12	743
OE-345	25	34	5	310
OE-46	21	32	5	284
APK-2	18	28	14	929

Table 38. Evaluation of different strains of shiitake

Strain	Days for spawn run	Days for Primordial formation	Number of fruit bodies	Yield (kg/bag*)	BE (%)
OE-8	68	18	38	0.221	27.6
OE-16	62	21	52	0.725	90.6
OE-20	62	22	41	0.312	39.0
OE-21	64	21	42	0.504	63.0
OE-22	67	20	47	0.592	74.0
OE-38	61	22	45	0.758	94.7
OE-388	61	21	41	0.858	107.2

*Bag= 800g dry substrate

and
was investigated (Table 39). Thermal death point of different strains of was observed between 39.4-48.4ºC. In spp it ranged between 43.0-50.2 ºC and in shiitake it was 46.6 -50.2ºC. showed a lot variation in thermal death point and it varies between 44-54.8 ºC.
and had 46.6-48.4, 44.8, and 37.6-39.4 ºC thermal death point temperature, respectively.

Studies on

Collection, isolation and influence of different media on the growth of entomopathogenic and medicinal fungus

Entomopathogenic fungi parasitizing beetles were collected from the mid hills of HP (Fig.1). Isolation of pure culture and subsequent molecular characterization revealed it as , a highly prized medicinal

Table 39. Thermal death point of different mushroom strains

Edible fungi	Different strains	Thermal death point (°C)		Edible fungi	Different strains	Death point (°C)	
		Dry	Wet			Dry	Wet
	BBH-01	54.8	53.0		A-15	46.6	46.6
	BBH-05	53.0	53.0		A-17	48.4	48.4
	BBSR-007	49.4	49.4		A102	48.4	44.8
	GVV-2	49.4	49.4		A-104	39.4	39.4
	OE-210	49.4	49.4		A(US)	39.4	39.4
	OE-272	54.8	54.8		Delta	48.4	46.6
	OE-274	53.0	53.0		M-56	46.6	46.6
	Vb	54.8	53.0		S-11	44.8	44.8
	Vv-01	47.6	47.6		U3	39.4	39.4
	Wv-01	44.0	44.0		Xb-13	41.2	41.2
spp.	PI-1140	50.2	50.2		OE-2	48.4	48.4
		50.2	48.4		OE-8	48.4	48.4
		43.0	43.0		OE-9	48.4	48.4
		46.6	46.6		OE-16	46.6	44.8
		43.0	43.0		OE-24	46.6	46.6
		48.4	46.6		OE-28	48.4	48.4
		48.4	48.4		OE-45	48.4	48.4
	X-375	48.4	48.4		OE-142	50.2	50.2
	OE-283	39.4	37.6		OE-329	50.2	50.2
	OE-289	37.6	37.6		OE-388	48.4	48.4
	OE-6	44.8	44.8		DMR-98	48.4	46.6
	OE-47	44.8	44.8		DMR-106 46.6	44.8	
	OE-56	44.8	44.8				

mushroom. Among the different media tested, starch beef extract medium supported maximum (Table 40) mycelial growth. A temperature (Table 41) of 25^{0}C and pH 9 favoured maximum growth of the fungus. Among the different carbon sources

Fig. 1. beetle infected with

Table 40. Evaluation of different media for

Medium	Av. Growth (mm)
Malt extract	43.0
Asthana & Hawker	43.8
Brown's medium	29.0
Czapekdox	40.0
Dextrose nitrate agar	51.2
Ellitos agar	50.0
Malt extract peptone dextrose agar	35.5
Martins rose Bengal streptomycin agar	43.6
Walksman agar	37.2
Sabourands medium	50.0
Glucose peptone agar	52.0
Joffers medium	51.2
Richards synthetic agar	56.2
Starch beef extract agar	65.0

Table 41. Evaluation of different temperature and pH for

Temp (°C)	Av. Growth (mm)	pH	Av. Growth (mm)
20	33.0	5	48.4
25	45.0	6	46.6
30	0.0	7	54.4
35	0.0	8	48.8
		9	51.2

tested, starch proved best. This mushroom is being reported for the first time from India.

xi) Cultivation of

The indigenous new spp. was successfully cultivated (Fig.2) during summer on wheat straw treated chemically with carbendazim + formalin, in hot water, pasteurized as well as partial composted substrate.

Fig.2. Cultivation of on wheat straw

xi) Cultivation of on pasteurized wheat straw during winter

(Blue oyster mushroom) which is gaining popularity due to its thick and fleshy basidiocarps and blue colored cap, during young stages, was attempted for its artificial cultivation in March and April when the maximum and minimum temperature ranged between 14-18ºC in the cropping rooms. Pasteurized wheat straw was spawned using 20 days old spawn prepared on wheat grains. It was observed that is a very good variety and gave 77.8 % B.E. the average yield varied from 700-850g fresh fruit bodies per kg of dry wheat straw. There is big scope to get better yield by using various supplements.

i) Morel mushroom collected from plain land

An interesting morel mushroom was collected from a plain land location situated at Kathua, Jammu & Kashmir during October. The morel fruit bodies were associated with a dry irrigation channel. This channel was used for irrigating adjoining paddy field during kharif season (Fig. 3). It was a yellow morel with characteristic cream coloured stipe and yellowish-brown pileus. The mushrooms were brought to laboratory and used for isolation by tissue culture method. Two pure cultures were developed and these are being maintained.

Fig.3. growing on dry irrigation channel

Since morels collected from Kathua appeared at higher temperature, culture established from this place was checked for identity by ITS sequence comparison. GenBank sequence search using consensus aligned sequence suggested that the morel belonged to

.

C. Crop Protection

i. Diseases

Survey of pests and diseases

Survey of mushroom farms at Murthal, Shersaw, Khubru and Gannour revealed that every farm was using its own compost formulations. Yellow mould, green mould , brown plaster mould, false truffle and hardening of casing mixture was common in all the farms visited. Sciarid flies were common in almost all the farms visited. Most of the farms were using non recommended pesticides. Severe incidence of wet bubble was recorded at one of the farm at Mamlig (HP). Poor environmental (aeration and RH) conditions were prevalent in different milky mushroom farms visited in Sonepat district of Haryana.

Effect of different carbon sources on the spore germination of

Various (Table 1) saccharides (Trehalose, fructose, dextrose, mannose, galactose, rhamnose, mannitol, glucose and sucrose) that annulled in casing fungistasis were evaluated for the spore (conidia and chlamydospore) germination of . Trehalose fructose, dextrose, mannose, galactose, rhamnose and mannitol supported the conidial germination in descending order. Trehalose supported the maximum (88%) conidial germination after 24h. There was no germination in r Glycogen, sucrose and Xylose as well as in water. Mushroom juice also resulted in 37% conidia germination.

Similarly, dextrose resulted in maximum (60%) germination of chlamydospres followed by manitol (50%), fructose (40%) and xylose (20%). There was 20% germination of chlamydospores in mushroom juice and no germination in rest of the sugars and water after 96 h.

Development of at different pH

The data presented in table revealed (Table 2) that pH 6.0 supported the maximum growth (32mm) at 25^{0}C after 7 days followed by 7.0 and 8.0 pH. However there was reduction in growth at pH 9.0, where only 24mm growth was recorded. Similarly at pH 5.0 there was also reduced growth as compared to pH 6.0.

After the compost was fully colonized by mycelium, casing mixture of

Table 1 . Evaluation of different saccaharides for conidia germination of

S.N.	Carbon sources	Conidia germination (%) after h		Chlamydospore germination (%) after h		
		12	48	48	72	96
1	Dextrose	23	68	48	72	96
2	Sucrose	0	0	10	24	60
3	Fructose	24	76	0	0	0
4	Manitol	0	5	6	18	40
5	Xylose	0	0	9	22	50
6	Trehalose	33	88	0	8	20
7	Rhammose	0	9	0	0	0
8	Mannose	3	27	0	0	0
9	Galactose	0	9	0	0	0
9	Mushroom Juice	3	37	0	0	0
10	Glycogen	0	0	0	11	20
11	Plain water	0	0	0	0	0

Table 2. Effect of different pH on the mycelial growth of

pH	Growth of	at different pH after days	
	15	20	25
5.0	18	24	26
6.0	22	28	32
7.0	22	24	28
8.0	21	24	28
9.0	16	22	24

different pH was applied followed by inoculation @ 14mm bit of actively growing mycelium. A temperature of 16^{0}C and relative humidity of 85-90% were maintained. Data on disease development was recorded. It is evident from table 3 that first symptom of the disease developed at pH 8.0 after 12 days. In fact in this treatment initially only the bubble structure developed. After 24 days the disease developed in all thwe treatments except pH 8.5 and 9.0.

Table 3. Effect of different pH on the Mycogone disease development

S.N.	pH	Time for disease development (days after casing application)		
		12	18	24
1	5.0	-	-	+
2	5.5	-	+	+
3	6.0	-	+	+
4	6.0	-	-	+
5	7.0	-	-	+
6	7.5	-	+	+
7	8.0	+	+	+
8	8.5	-	-	-
9	9.0	-	-	-

Evaluation of different fungicides against

Evaluation (Table 4) of different fungicides (Delan, carbendazim, Chlorothalonil, Sporgon,

Table 4. Evaluation of different fungicides against

Fungicide	Concentration	% inhibition of	% inhibition of
Delan	20	26 (10)	46(27)
	50	26(10)	25(60)
	100	24(17)	22(65)
	200	24(17)	19(70)
Carbendazim	20	24(17)	0(100)
	50	22(24)	0(100)
	100	18(37)	0(100)
	200	18(37)	0(100)
Chlorothalonil	20	22(24)	11 (82)
	50	22(24)	10(84)
	100	20(31)	0(100)
	200	20(31)	0(100)
Sporgon	20	26(10)	0(100)
	50	26(10)	0(100)
	100	9(69)	0(100)
	200	9(69)	0(100)
Indofil Z-78	50	29 (0)	32(50)
	100	26(10)	26(59)
	200	8(72)	16(75)
	500	0(100)	12(81)
Indofil M-45	50	22(24)	26(49)
	100	16(44)	22(65)
	200	10(65)	16(75)
	500	0(100)	10(84)
Control		29	63

Indofil Z-78, Indofil M-45) against and revealed that carbendazim and sporgon gave 100 per cent inhibition of at all the concentrations tried (20-200ppm) whereas it resulted just 10 and 17% inhibition of respectively. Chlorothalonil also resulted in 100 per cent inhibition at 100 and 200ppm of and it gave 31% inhibition of at this concentration. Both Indofil Z-78 and Indofil M-45 were more toxic to at 500ppm as compared to

Evaluation of different fungicides for controlling wet bubble disease

Different fungicides namely (Delan, Carbendazim, Chlorothalonil, Sporgon, Indofil Z-78, Indofil M-45) were evaluated in the mushroom house by giving two sprays. Data on disease development was recorded (Table 5).

Table 5. Evaluation of different fungicides against

Fungicide	Concentration	Yield (kg/10kg)	Weight (kg) of sclerodermoids
Delan	0.1	0.650	0.078
Carbendazim	0.1	1.110	0.071
Chlorothalonil,	0.1	0.905	0.082
Sporgon	0.1	1.220	0.067
Indofil Z-78	0.15	0.650	0.098
Indofil M-45	0.15	0.660	0.100
Hexaconazol	0.1	0.480	0.058
Control	-	1.530	0.130
CD (0.05)		0.280	

disease of button mushroom

A disease was found to occur at DMR during summer season. It was characterised by tightening of casing layer. As a result, button mushroom production was greatly affected, often leading to crop failure. A fungus with cottony growth usually appeared later on the casing. This was cultured on artificial medium and pure culture was obtained. ITS based identification study suggested that the cottony growth from casing and isolated fungus were members of spp.

ii. Pests

Evaluation of different coloured light traps

In order to assess the effectiveness of different coloured light traps, traps were placed (Fig.1) in a circular fashion above the heavily infested bags. Distance between the bulbs was 2ft. To nullify the effect of direction and time, position of bulbs were changed randomly. Traps were operated during different times of the day. It was observed that irrespective of time and position of bulbs, yellow bulb proved highly effective in trapping mushroom flies.

Fig.1. Traps placed in a circular fashion

Evaluation of Thiamethoxam against

Thiamethoxam, an insecticide in the class of neonicotinoids was tested against at different concentrations under conditios. However, no inhibitory effect was recorded in any of the concentation tested (Table 6).

Table 6. Evaluation of Thiamethoxam against

Conc. (%)	Av. Growth (mm)
0.1	30
0.01	30
0.05	32
0.03	30
0.001	30
Control	30

D. Spent Mushroom Substrate

i. Spent mushroom substrate for dye decolorization

Isolation and identification of spent substrate microflora: Spent substrate from button ( ), oyster ( ) and paddy straw mushroom ( ) collected from Directorate of Mushroom Research, Solan (HP), India was used for isolation of fungi and bacteria. Fungi and bacteria were isolated using the serial dilution and plating method on Potato Dextrose Agar and Nutrient Agar medium, respectively and incubating at 30±2ºC for 5 days. Purified fungi and bacteria were identified using 5.8S rRNA and 16S rRNA gene sequencing, followed by Nucleotide Basic Local Alignment Search Tool (BLASTn) techniques.

Spent substrate from three different mushrooms varied both in their quantitative and as well as qualitative fungal population. SMS from harboured highest fungal population, dominated by , followed by and sp. (Table 1). SMS of , harboured next highest population exclusively dominated by . SMS from although harboured three dominating fungi like SMS, but it exhibited two very distinct fungi (and) along with a common fungus ( ).

SMS of did harbour highest population as well as diversity of bacteria comprised of four different species (, , and) compared with SMS of and , which harboured three and one species, respectively (Table 2). SMS harboured second highest bacterial population, dominated by only one species ( ). The present findings also prove the dominance of sp. in SMS of and , while and

Table 1. Fungal population in spent substrate of different mushrooms

Spent substrate	Fungus (5.8S rDNA sequencing)	CFU (×10^4)
		5.0
		8.5
		3.0
	sp.	3.0
		1.0
		2.0
		1.0

Table 2. Bacterial population in spent substrate of different mushrooms

Spent substrate	CFU (×10^7)
	9.0
	2.1
	4.0
	1.0
	0.6
	0.2
	14.9
	10.0
	10.0
	0.6
	29.0

in SMS. The presence of in SMS has also been presented

Dye decolorization potential of different fungi: First of all seven fungi belonging to 5 different genera [(Ab), (Ps), Schizophyllum commune (Ps), Pezizomycotina sp. (Ps), Aspergillus fumigatus (Vv), Paecilomyces variotii (Vv) and Pichia guilliermondii (Vv)] and isolated from three different spent substrates (given in parenthesis) were screened for their dye decolourization potential against Chicago sky blue. The dye decolourization potential was studied against 100 ppm concentration of the dye in Potato Dextrose Broth at 25 ± 1°C for 12 days. The decolourization was measured as decrease in OD at l_{max} of Chicago sky blue against zero time control.

Similarly the potential fungus ( ) isolated from spent substrate was further studied for its dye decolourization potential against 6 different dyes (Table 3) (Methyl blue, Orange II Sodium salt, Rhodamine B, Azure B, Reactive blue and Starch Azure).

Out of seven fungi from SMS of three different mushrooms, highest decolourization of Chicago sky blue (95.0%) after 12 days of incubation was recorded with isolated from SMS, followed by sp. again from the same SMS (Table 4). It was followed by three isolates of isolated from three different SMSs (33.6 to 49.0%). Decolourization was completely absent in isolated from SMS. Decolourization increased with time of incubation and become near static after 10 days of incubation.

The potential dye decolourizer fungus, was further evaluated for its decolourization potential against 6 additional dyes for 18 day of incubation. This fungus exhibited significantly higher decolourization of Starch Azure (100%), followed by Reactive blue

Table 3. Details of different dyes used in study

Dye	Chemical formula	CAS No.	max (nm)
Rhodamine B	$C_{28}H_{31}N_2O_3Cl$	81-88-9	543
Methyl Blue	$C_{16}H_{18}ClN_3S$	61-73-4	655
Orange II sodium salt	$C_{16}H_{11}N_2NaO_4S$	633-96-5	550
Azure B	$C_{15}H_{16}N_3S^+$	531-55-5	648
Reactive Blue	$C_{22}H_{16}N_2Na_2O_{11}S_3$	2580-78-1	550
Starch Azure	$C_{36}H_{55}NO_{28}$	66068-38-0	650
Chicago Sky Blue 6B	$C_{34}H_{24}N_6Na_4O_{16}S_4$	2610-05-1	650

Table 4. Decolourization of synthetic dye Chicago sky blue with different fungal isolates isolated from spent substrate of different mushrooms

Fungus	Dye decolourization (%) at different interval of time (days)						
	0-day	2-day	4-day	6-day	8-day	10-day	12-day
(Ab)	0	6.7	22.9	28.7	30.3	31.8	33.6
(Vv)	0	12.3	37.0	41.8	43.7	47.1	49.0
(Vv)	0	0.0	11.2	25.7	27.3	29.4	29.7
(Vv)	0	0.0	0.0	0.0	0.0	0.0	0.0
(Ps)	0	11.0	32.1	36.0	34.9	36.2	40.5
Schizophyllum commune (Ps)	0	0.0	60.4	79.8	90.7	95.3	95.0
sp. (Ps)	0	0.0	53.5	54.7	73.8	87.8	92.0
$CD_{0.05}$	-	0.09	0.06	0.07	0.14	0.03	0.08

(92.5%), Rhodamine B (81.90%), Orange II sodium salt (73.40%) and Methyl Blue (67.8%). Negligible decolourizarion was recorded in case of Azure B (Table 5).

Dye decolorization potential of different bacteria: Eight bacterial isolates belonging to 5 different genera [-1 (Ab), -2 (Ab), (Ab), (Ps), (Ps), (Ps), -1 (Vv) and -2 (Vv)] and isolated from three different spent substrates (given in parenthesis) were screened for their dye decolourization potential against 100 ppm concentration of Orange II Sodium salt in PDB at 25 ± 1°C for 8 days. Decolourization was recorded like in case of earlier steps.

The potential bacteria (and) isolated from spent substrate were evaluated for their dye decolourization potential against 2 additional dyes (Azure B and Methyl blue).

Out of eight different bacteria studied for their dye decolourization potential against Orange II sodium salt for 8 days of incubation, highest decolourization (66.1%) after 8 days of incubation was with isolated from SMS, followed by (57.0%) isolated from SMS (Table 6). Lowest decolourization was with and both isolated from SMS. The three isolates of isolated from SMS of three different mushrooms also varied in their dye decolourization potential.

Table 5. Decolorization of different dyes by a promising fungus isolated from oyster mushroom spent substrate

Dye	Dye decolourization (%) at different interval of time (days)						
	0-day	3-day	6-day	9-day	12-day	15-day	18-day
Methyl blue	0	0	15.9	29.6	46.2	67.2	67.8
Orange II Sodium salt	0	0	16.9	34.4	59.7	73.1	73.4
Rhodamine	0	0	13.6	14.3	18.6	27.8	81.6
Chicago sky	0	0	2.2	2.5	2.2	2.2	2.2
Azure B	0	0	4.1	3.4	4.1	4.0	4.0
Reactive blue	0	0	20.5	22.5	44.6	81.0	92.5
Starch Azure	0	0	100	100	100	100	100
$CD_{0.05}$	-	-	0.07	0.04	0.06	0.06	0.07

Table 6. Decolourization of synthetic dye Orange II sodium salt with different bacteria isolated from spent substrate of different mushrooms

Bacterium	Dye decolourization (%) at different interval of time (days)				
	0-day	2-day	4-day	6-day	8-day
(Vv)	0	0.0	48.4	57.7	57.0
-1 (Ab)	0	10.0	30.4	32.9	30.2
(Vv)	0	22.0	28.6	44.7	45.9
-2 (Ab)	0	23.1	40.5	41.0	42.1
(Ps)	0	12.7	15.9	11.6	10.0
(Ab)	0	26.8	44.3	40.2	40.0
(Ps)	0	17.3	17.8	62.7	66.1
(Ps)	0	1.1	1.3	1.4	0.0
$CD_{0.05}$	-	0.146	0.228	0.129	0.109

In majority of the dyes, highest decolourization was achieved up to 6 days of incubation, after which it remained almost static.

The two potential bacteria, and isolated from SMS were restudied from their decolourization potential against two more recalcitrant dyes (Azure B and Methyl blue), where in decolourized two dyes up to 44.6 and 91.3%, respectively. Decolourization of these two dyes was comparatively lower (15.0 and 75.8%) in case of (Table 7).

Temperature and pH optima of for dye decolourization: pH range of 4.0 to 10.0 was used for studying the pH optima of Orange II sodium salt decolourization by the potential bacterium, . The pH optima were studied at 100 ppm concentration of dye with 0.1 ml of two day old bacterial broth ($\times 10^{-6}$) at 25 ± 1°C for next 8 days. Decolourization was recorded like in case of earlier steps.

Five different incubation temperatures (20, 25, 30, 35 and 40°C) were used for studying the temperature optima of Orange II Sodium salt decolorization with potential bacterium, . Protocol for media preparation and setting up of experiment was same as was for pH studies, excepting medium pH, which was kept 7.2.

The test bacterium was studied for its decolourization potential against Orange II Sodium salt at seven different pH levels, where in highest decolourization (85.6 and 81.1%) was recorded against pH levels of 6.0 and 7.0, followed by 8.0. Decolourization was almost similar at pH 5.0 and 9.0, while lowest at 4.0 (Table 8). The decolurization was almost negligible up to first 4 days of inoculation, which suddenly increased on day 6 of incubation.

Like pH, temperature of incubation has direct role is sustaining enzymatic activities and growth of different microorganisms in a cultural medium,

Table 7. Decolourization of Azure B and Methyl blue with two potential bacteria and . isolated from SMS of under nutrient deficient conditions

Bacterium	Dye	Dye decolourization (%) at different interval of time (days)				
		0-day	2-day	4-day	6-day	8-day
	Azure B	0	1.7	24.2	15.1	15.0
	Methyl blue	0	9.8	43.1	52.9	75.8
	Azure B	0	2.5	36.4	40.3	44.6
	Methyl blue	0	43.7	58.0	66.0	91.3
$CD_{0.05}$	-	0.045	0.064	0.194	0.113	

Table 8. Effect of pH of the growing medium on decolourization of Orange II sodium salt with potential bacterium isolated from spent mushroom substrate

pH	Dye decolourization (%) at different interval of time (days)				
	0-day	2-day	4-day	6-day	8-day
4.0	0	0.0	0.0	56.6	74.1
5.0	0	3.0	5.5	3.0	75.4
6.0	0	1.6	1.9	78.0	85.6
7.0	0	0.0	1.4	71.8	81.1
8.0	0	0.0	0.0	62.6	79.4
9.0	0	0.0	3.5	74.1	75.9
10.0	0	0.0	0.0	43.2	59.9
$CD_{0.05}$	-	0.026	0.053	0.089	0.064

which ultimately influences the dye decolourization process. The temperature optima of test bacterium for decolourization of Orange II Sodium salt were studied at 5 different temperatures. Highest decolourization (62.2% and 61.7%) was recorded at 25°C, closely followed by 20°C. The decolourization level decreased with increasing temperature of incubation (Table 9).

In present study, variation in temperature optima for decolorization of Orange II sodium salt through was mainly because of variation in bacterium and the dye used in study. Decolourization was higher at 25 and 20°C, because of 20-25°C is the optimum temperature for mycelial growth and fruiting of . Accordingly, the SMS of will also supports the microorganisms with their temperature optima in this temperature range. In few earlier studies, the decolourization has been reported at par at 15, 25 and 35°C, which is attributed to 15°C as the optimum temperature for fruiting of and .

ii. SMS runoff water

Characterization of SMS runoff water

Three polythene-lined pits of one cubic feet size were made to collect runoff water from SMS site. Four runoff samples were collected during last year and characterized for its organic matter, salt and nutrient contents. This characterization will leads to the assessment of impact of SMS runoff on surrounding land and soil. The characteristics of two-runoff water sample are given in table 10.

Table 9. Effect of temperature of incubation on decolourization of Orange II sodium salt with potential bacterium B. licheniformis isolated from SMS of P. sajor-caju under nutrient deficient conditions

Temperature (°C)	Dye decolourization (%) at different interval of time (days)					
	0 day	2-day	4-day	6-day	8-day	10-da
20	0	33.9	45.7	57.7	58.4	61.7
25	0	35.9	51.3	60.0	58.4	62.2
30	0	43.3	53.4	56.0	53.0	51.0
35	0	48.3	43.3	54.7	50.0	45.0
40	0	49.6	49.0	44.1	39.0	35.0
CD0.05	-	0.149	0.071	0.067	0.194	0.081

Table10. Run off water characteristics of SMS composting site

Parameter	27.06.2011			20.01.12		
	Pit I	Pit II	Pit III	Pit I	Pit II	Pit III
OC %	0.0	0.0	0.0	0.0	0.0	0.0
pH	7.0	6.9	7.0	6.9	7.0	7.6
EC (dS m^{-1})	0.0	0.0	0.0	0.04	0.0	0.0
N (ppm)	38.5	19.2	28.9	15.9	11.3	7.9
K (ppm)	3.2	0.5	0.1	3.2	0.5	0.1
HCO_3^- (meq L^{-1})	6.1	3.6	2.4	9.7	7.3	4.8
CO_3^- (meq L^{-1})	-	-	-	-	-	-

Improvement of SMS composting

SMS in combination with cow dung slurry in alternate layer was compared with SMS composting alone. It was found that SMS along with cow dung slurry was composted in 90-110 days period whereas SMS alone needs more than four-month time. The SMS in combination with cow dung evaluated for vermicomposting and found suitable. The characteristics of different compost obtained are given in table 11.

Table 11. Characteristics of different compost

Composting Method	pH	dS m^{-1}	Maturity time (days)
VC Conventional	6.87	1.35	70-80
Cow dung combination	6.59	2.12	100 – 120
Natural weathering	7.31	6.24	> 120

3. TRANSFER OF TECHNOLOGY

a. Training programmes conducted

During 2011, the center organized eight On and Off campus training programmes (Table.1) for farmers, farmwomen, entrepreneurs, officers and scientists of KVKs.

b. Mushroom Mela-2011

One day Mushroom Mela was organized on 10th September, 2011 as regular activity of the center. It was inaugurated by Dr K.R Dhiman Hon'ble vice chancellor, YSP UH&F, Nauni, Solan. Dr Jag Mohan Singh, former Vice Chancellor was the guest of Honour. It was attended by about 550 farmers, farmwomen, mushroom growers, researchers, extension workers and businessmen from various states viz, Himachal Pradesh, Haryana, Punjab, Uttar Pradesh, Maharashtra, Madhya Pradesh, Chattisgarh, Bihar, Jharkhand, Delhi, Uttarkhand, Assam, Gujarat, Tamilnadu and Orissa. The representatives from more than 20 states of India attended the mela.

An exhibition on improved mushroom cultivation technologies and other related aspect was organized in which various Govt. Organisation, ICAR Institutes/Universities, Govt. financial organization, compost and spawn producers, mushroom product manufacturer, seed and pesticides and chemical producers and NGOs displayed their valuable information/ technologies/products and provided their services to the participants of the Mushroom Mela. The Exhibition was inaugurated by chief guest Dr. K. R. Dhiman.

In order to create awareness to the participants, various improved technologies/ practices of mushroom cultivation, farm visit of the growing units of the Center 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 mushroom growers and farmers were replied by panel of experts in a very systematic manner.

During the Mushroom Mela, the center awarded seven (7) progressive/ innovative mushroom growers for adopting innovative practices in mushroom cultivation on larger scale and mobilizing other farmers to adopt mushroom cultivation as source of income. The farmers mentioned below were selected across India.

Sh. Nitin Rawat, Chhattisgarh
Sh. Santosh Kumar Mishra, Orissa
Sh. S.S.T. Rajenthran,Thuraiyur, Dt Trichy
Mrs Geetanjali Mohanty, Odisha
Ashok Pal, West Bengal
Sh. A.R. Subramanian, Tamil Nadu
Sh. Sunil Mallik, Haryana

c. Participation in national/state level exhibitions

In order to create awareness about mushroom cultivation and its health benefits the center has participated in eight state and national level

SN.	Exhibition/ Fair	Date
1	North Zone Agriculture Trade Fair 2011 at Hamirpur (HP)	23-26th February, 2011
2	PUSA Krishi Vigyan Mela 2011	03-05th March, 2011
3	Aloo mela and Exhibition 2011 at CPRS Modipuram, Meerut (UP	05-6th, March, 2011
4	National Conference on "HortiBusiness - Linking Farmers with Market" during 3rd "Swadesh Prem Jagriti Sangosthi-2011" held at Dehradun (Uttarakhand)	28-30th May, 2011
5	Destination Punjab at Amritsar (Ranjit Avenue ground) Organised by CII	5 – 10th October, 2011
6	Dushehra Mela at Krishan Garh, Kuthar, Solan (HP)	5– 6th October, 2011
7	Regional mushroom mela and Kissan goshthi at Talab Tillo, Jammu (J&K)	20th October
8	National KVK conference on 'enabling farmers for second green revolution' held at JNKVV, Jabalpur (MP)	3-5th December, 2011

exhibitions and fairs by establishing a stall and by distributing the free literature of the Center.

d. Promotion of Mushroom Consumption

Two regional mushroom mela and consumption fairs were held at Hoshiarpur in Punjab and Murthal in Haryana to address the problems faced by mushroom growers and to promote mushroom consumption among common public. A regional mushroom mela and the mushroom consumption fair was held for the first time in Punjab state by the Directorate. The fair was held on 3rd February, 2011 at Thiara Mushroom Estate, Village Khanpura, Jallandhar road, near Hoshiarpur. More than 200 farmers, farm women, youth and more than 30 officials from different departments and financial institutions participated in the mela. A kisan goshthi was held on the occasion to facilitate on the spot solution to the problems of mushroom growers. Director, DMR, Solan, Scientists from DMR, Solan, PAU, Ludhiana, KVK, Hoshiarpur, officials from Department of Agriculture, Horticulture, State Bank of India and NHB participated in the Goshthi to answer to the queries of farmers.

Another regional mushroom mela and consumption fair was organized at Haryana Agro Industries Corporation (HAIC), Murthal in Sonepat district of Haryana on 7th February, 2011. Sh. Roshan Lal, IAS, Finance Commissioner and Chief Secretary to Government of Haryana was chief guest of the function, Engineer Sh. H. S. Chahal, Honourable Vice Chancellor, DBCRUST, Murthal was guest of honour and Dr Manjit Singh, Director, DMR presided over the function. Over 300 farmers and mushroom growers attended the mela. A Kisan Goshthi was held in the presence of Scientists from DMR, Solan, HAU, Hisar, HAIC, Murthal, KVK, Panipat, officials from NABARD, Dept. of Horticulture, NHB, Punjab National Bank. The farmers problems were addressed on the spot in the Kisan goshthi.

In order to bring awareness about the mushrooms among common people, several posters were displayed to show the health benefits of mushroom, variety of value added products from different types of mushrooms, cultivation technologies of different mushrooms, spawn production technology etc in both the melas. A registration kit containing all the complementary literature of DMR, Solan, a writing pad and a pen was given to all the people attending the mela. A special folder on mushroom recipes in Hindi was also given to popularize the consumption of mushrooms by Indianisation of mushroom recipes. All the priced publications of DMR including the mushroom recipes were kept for sale in the stall on both the melas. Mushroom biscuits and mushroom pickle were kept for sale for the visitors. A mushroom dish was served in the lunch for all the people attending the mela. Both the events were widely covered by Doordarshan national network, Doordarshan Jallandhar, various local electronic and press media.

e. Advisory service to farmers/ Mushroom growers/ Businessman/ unemployed youths

Advisory services through postal extension letters on various aspects of mushroom cultivation, training and marketing were provided. Queries on mushroom cultivation, training were replied through telephone and e-mail. On an average 6 queries per day were received either by phone/ mail/ letters and were replied. The farmer groups from different states and students of various colleges visiting the institute were briefed regularly about the various facilities and services rendered by DMR, Solan

Facilitated the visit and explained the research and extension activities of the Directorate to Sh. N. Vijayan, CEO of Vegetable and Fruit Promotion Council Keralam and Sh. Jose Joseph Director of Horticulture resource center, Govt. of Kerala on 05-04-2011. Nine (08) Phone-in and field based programmes were telecast on Doordarshan Kendra from Shimla on Krishi Darshan.

f. Visit of Parliamentary Standing Committee on Commerce at DMR Solan

The Parliamentary Standing Committee on Commerce visited the Directorate of Mushroom Research, Solan on 29th June, 2011. The committee consisting of 10 Members of Parliament under the Chairmanship of Sh. Shanta

Kumar, Honourable MP visited the Directorate as part of their visit to study the country's potential and opportunities of various agriculture and horticulture commodities for export. The Chairman and members of the committee were apprised about the research achievements of the Directorate and the mushroom scenario in the country by Director Dr. Manjit Singh and were shown the different mushroom varieties suitable for different agro climatic regions of the country. The Committee lauded the research achievements of the Directorate and appreciated the initiatives for popularization of mushroom consumption in the country. The Chairman of the committee advised the scientists to promote mushroom cultivation as a small scale industry to address the problems of rural unemployment and a tool of poverty alleviation.

Fig. 1. Dr K.R.Dhiman, Hon'ble Vice Chancellor, University of Horticulture and Forestry, Solan inaugurating the exhibition mushroom mela-2011

Fig. 2. Dr K.R.Dhiman, Hon'ble Vice Chancellor, University of Horticulture and Forestry, Solan felicitating a progressive grower during mushroom mela-2011

Fig. 3. Dr K.R.Dhiman, Hon'ble Vice Chancellor, University of Horticulture and Forestry, Solan visiting the exhibition stalls during mushroom mela-2011

Fig. 4. National Science day was celebrated on 28th Feb. 2011

4. TRAINING COURSES

Farmers and Entrepreneurs

Date	Training	Number of trainees	Course Director and Coordinator
10-15th January, 2011	Refresher Training for the District Horticulture officials, and Extension functionaries of H. P State Dept. of Horticulture - II	20	Dr. B. Vijay Sh. Mahantesh Shirur
04th April, 2011	Collaborated for a 3 day training for entrepreneurial skill development for youth organized by MSME, Chambaghat	30	Sh. Mahantesh Shirur
25th April- 4th May, 2011	Training programme on mushroom cultivation technology for entrepreneurs	34	Dr. O. P. Ahlawat Sh. Mahantesh Shirur
11-17th May, 2011	Training programme on mushroom cultivation technology for farmers	60	Sh. Mahantesh Shirur Dr. Goraksh C. Wakchaure
21-27th July, 2011	Training programme on mushroom production technology for Scientists and SMS of Subject Matter Specialists of KVKs and SAUsand for Officials of state Dept. of Horticulture, Govt. Of Orissa	21	Sh. Mahantesh Shirur Dr. K. Manikandan
16-20th August, 2011	Five day training programme on spawn production and mushroom cultivation technology for the officials of state department of Horticulture of Arunachal Pradesh sponsored by TMNE	5	Sh. Mahantesh Shirur
20-26th September, 2011	Training programme on mushroom cultivation technology for farmers –II	60	Dr. Kunal Mandal Dr. Goraksh C. Wakchaure
20-23rd December, 2011	Training programme on spawn production and mushroom cultivation technology for farmers from Sikkim sponsored by TMNE	10	Dr. B. Vijay Sh. Sunil Verma

Scientists and students

Summer Training of Students: During the year under report 8 students as listed below completed their Summer Projects from the Directorate.

Mr. Ramniwas Banjare, M.Sc.(Genetic Engineering), School of Biotechnology, Devi Ahiliya Vishwavidyalaya, Indore (MP)

Mr. Gaurav Chaudhary, M.Sc.(Applied Microbiology), VIT Vellore (TN)

Jaspreet Kaur Mann, M.Sc.(Applied Microbiology), VIT Vellore (TN)

Ms. Megha Jivanramjiwala, M.Sc.(Applied Microbiology), VIT Vellore (TN)

Mr. Govind Prasad Maheshwari, M.Sc. (Biotechnology), MIMT, Greater Noida (UP).

Mr. Dilip Ranakawat, M.Sc.(Integrated Biotechnology), School of Life Sciences, Jaipur National University, Jaipur (Rajasthan)

Fig. 1. Trainees learning to cultivate milky mushroom cultivation during a training course

Fig. 2. Trainees learning to prepare mushroom pickle during a training course

Mr. Gaurav Kumar, M.Sc.(Biotechnology), HNB Garhwal Central University, Srinagar, Garhwal (Uttarakhand).

Ms. Rachana Kumari, M.Sc.(Microbiology), Uttaranchal College of Science & Technology, Dehradun - 248001(Uttarakhand).

5. AICRP CENTRES

The All India Coordinated Research Project (AICRP) on Mushroom came into existence during VIth Five-Year Plan on 01.04.1983 with its Headquarters at Directorate of Mushroom Research, Solan (HP). The Director of DMR, Solan (HP) also functions as the Project Co-ordinator of the project. Initially the AICRP 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, 14 Co-ordinating and two co-operating Centres are working under AICRP programme with its Headquarters at DMR, 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 (Uttarakhand)

College of Agriculture, Mahatma Phule Agricultural University, Pune (Maharashtra)

N.D.University of Agriculture and Technology, Faizabad (UP)

Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (Chhattisgarh)

Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan)

College of Agriculture, Kerala Agricultural University, Vellayani (Kerala)

CCS Haryana Agricultural University, Hisar (Haryana)

College of Hort. & Forestry, CAU, Pasighat (Arunachal Pradesh)

Orissa University of Agriculture & Technology, Bhubaneswar (Orissa)

Rajendra Agricultural University, Samastipur (Bihar)

ICAR Research Complex for NEH Region, Barapani (Meghalya)

ICAR Research Complex for Eastern Region, Ranchi (Jharkhand)

Cooperating Centres

Dr. Y.S.P. UHF, Nauni, Solan

HAIC Agro R&D Centre, Murthal (Sonepat), Haryana

6. PUBLICATIONS

A. Research Papers

1. Ahlawat, O.P., Singh, R. and Kumar, S. 2011. Evaluation of strains for yield and diseases/ insect-pests resistance using composted substrate of paddy straw and cotton mill waste. 52(2): 200-205

2. Ahlawat O.P., Gupta Pardeep, Kumar Satish and Sharma, D.K. 2010. Bioremediation of fungicides by spent mushroom substrate and its associated microflora. 50(4): 390-395.

3. Ahlawat, OP, Manikandan, K, Sagar, MP, Rai Dev and Vijay, B. 2011. Effect of composted button mushroom spent substrate on yield, quality and disease incidence of Pea ( ). 20 (2) : 87-94.

4. Aparajita Das, Kamal Shwet, Shakil, N.A. Sherameti Irena, Oelmüller Ralf, Dua Meenakshi, Tuteja Narendra, Johri, Atul Kumar and Varma, Ajit. 2012. The root endophyte fungus leads to early flowering, higher biomass and altered secondary metabolites of the medicinal plant, . . 7, (1): 103-112.

5. Kumari Deepika, Reddy, M. S. and Upadhyay R.C. 2011. Nutritional composition and antioxident activities of 18 different wild mushrooms of North-Western Himalayas. 17(6): 557-567

6. Kumar, Y., Samanta, J. N., Mandal, K. and Gajbhiye, N. A. 2011. Phenotypic, pathogenic, molecular and phylogenetic comparisons of bacteria causing Aloe rot from three countries. 64: 329-334.

7. Mandal, K. and Kothari, I.L. 2011. Reaction of accessions and other spp. against downy mildew. 41: 146-147.

8. Mandal, K., Samanta, J. N., Maiti, S. and Kamboj, R. D. 2011. Myths and facts of guggal gum tapping. 137: 1346-1347.

9. Manikandan, K., Natarajan, S Sivasamy, R. Sankar, M. and Padwal, K.S. 2011. Evaluation of Soil Resources for Productivity through Remote Sensing in GIS Environment. 137 (2): 175-183.

10. Manikandan, K., Natarajan, S., Sivasamy, R., Sankar, M. and Padwal, K.S. 2011. Spatial and temporal variation in groundwater characteristics of the coastal region of Tamil Nadu. 137 (2): 1009-1014.

11. Manikandan, K., Natarajan, S., Sivasamy, R.. 2011. Hydro-chemical grouping of ground water in coastal region of Cuddalore District, Tamil Nadu using cluster analysis. 5: 763-771.

12. Manikandan, K., Sharma, V.P. Kumar, Satish, Kama, Shwet and Shirur, Mahantesh. 2011. Edaphic conditions of Morchella and Phellorinia in natural site conditions. 20 (2): 117-120.

13. Mahantesh Shirur, Vijay, B., Manikandan, K., Goraksha W.C, Verma, Sunil, Bhatia, Reeta and Taank Vikas 2011. Impact assessment of National Mushroom Mela. 20 (2): 95-102.

14. Sharma, V.P. and Kumar, S. 2010. Studies on causing olive green mould in white button mushroom. . Vol. XXVIII : 17-22

15. Sharma, V.P. Singh, Rajender, Kumar, S. and Ahlawat, O.P. 2011. Thermal death points of some edible mushrooms mycelium under dry and wet conditions. 29 (2): 29-33.

16. V.P. Sharma, Kumar, S., Kamal, Shwet and Singh, S.K.. 2011. Etiology and molecular

characterization of wet bubble disease causing fungus (Hypomyces perniciosus) in

20(1): 21-25.

17. Sharma, V.P. and Kumar, S. 2011. Present status of wet bubble ( ) disease. . 29 (1):36-43.

18. Singh, Manjit, Kamal, S. and Wakchaure, Goraksha C. 2011. Earning more through exporting mushrooms. 56(3): 41-43.

19. Tripathi, A., Upadhyay R.C. and Singh S.K. 2010. Mineralization of nitro phenols by and and ligninolytic enzymes. 51:635-649.

Book Chapters

1. Mandal, K. 2011. Diseases of Isabgol (Plantago ovate Frosk.) and their Management.. In Sustainable Disease Management of Agricultural Crops Biswas, (S.K. and Singh, S.R., Eds.). Daya Publishing House, New Delhi. Pp. 303-311.

2. Kumar, S and Sharma, V.P. 2011. Biology and management pf insect-pests and mites of mushrooms. In Mushrooms-Cultivation, Marketing and Consumption (M. Singh, B. Vijay, S. Kamal and GC Wakchaure eds) DMR, Solan. Pp 175-182.

3. Kumar, S and Sharma, V.P. 2011. Nematode pests of mushrooms and their management. In Mushrooms-Cultivation, Marketing and Consumption (M. Singh, B. Vijay, S. Kamal and GC Wakchaure eds) DMR, Solan. Pp. 183-188.

4. Sharma, V.P. and Kumar, S. 2011. Spawn production technology. In Mushrooms-Cultivation, Marketing and Consumption (M. Singh, B. Vijay, S. Kamal and GC Wakchaure eds) DMR, Solan. Pp. 31-42.

5. Sharma, V.P. and Kumar, S. 2011. Competitor moulds and diseases in mushroom production. In Mushrooms-Cultivation, Marketing and Consumption (M. Singh, B. Vijay, S. Kamal and GC Wakchaure eds) DMR, Solan. Pp. 155-174.

6. Sharma, V.P. and Kumar, S. and Sharma, S.R. 2011. Cultivation of shiitake. In Mushrooms-Cultivation, Marketing and Consumption (M. Singh, B. Vijay, S. Kamal and GC Wakchaure eds) DMR, Solan. Pp. 207-212.

7. Sharma, V.P. and Kumar, S. 2011. Cultivation of specialty mushrooms- , , and . In Mushrooms-Cultivation, Marketing and Consumption (M. Singh, B. Vijay, S. Kamal and GC Wakchaure eds) DMR, Solan. Pp. 213-220.

8. Sharma, V.P. and Kumar, S. 2011. Cultivation of medicinal mushroom- . In Mushrooms-Cultivation, Marketing and Consumption (M. Singh, B. Vijay, S. Kamal and GC Wakchaure eds) DMR, Solan. Pp. 221-230 DMR, Solan

Reports

1. Kamal Shwet. 2011. Compiled and edited AICRPM Annual Report 2010-11, DMR, Solan (HP) Pp-67.

2. Sharma, V.P. and Kumar, Satish. 2010. Compiled and edited DMR's Annual Report 2010. DMR, Solan, Pp- 74

Abstracts

1. Ahlawat, O.P. and Billette, C. 2011. Positioning of introns in different laccase genes, a relevant tool for solving phylogenetic position ambiguity of laccase genes. In Proceedings of 7th International Conference on Mushroom Biology and Mushroom Products, Pp. 100-112, Oct. 4-7, 2011, Arcachon, France.

2. Ahlawat OP and Singh R. 2011. Spent substrate from mushroom industry, a potential dye decolourizing agent. . In Proceedings of 7th International Conference on Mushroom Biology and Mushroom Products, Pp. 366-376, Oct. 4-7, 2011, Arcachon, France.

3. Atri, N.S., Kumari Babita and Upadhyay, R.C. 2011. New taxa of the genus from North west India. Annual Meeting of the Ind Phytopathological Society(NZ), CSKVV, Palampur, 24th and 25th Nov,2011.

4. Kamal , Shwet. 2011. Effect of nutrient sources and plant hormones on mycelial morphology of the black perigord truffle . Proceedings of the 7th International Conference on Mushroom Biology and Mushroom Products (ICMBMP7) at Arcachon, France 4-7 Oct 2011. pp 514-520.

5. Singh, Manjit and Kamal Shwet. 2011. Conventional and molecular approaches for breeding button mushroom. Proceedings of the 7th International Conference on Mushroom Biology and Mushroom Products (ICMBMP7) at Arcachon, France 4-7 Oct 2011. pp 35-42.

6. Singh, Manjit and Kamal Shwet .2011. Validity of mycelial growth on malt extract agar and compost as selection criteria for initial screening of genotypes for yield and quality in . Proceedings of the 7th International Conference on Mushroom Biology and Mushroom Products (ICMBMP7) at Arcachon, France 4-7 Oct 2011. pp 71-76.

7. Upadhyay, R.C. and Babita Kumari. 2011. Some mucological observations on family Tricholomataceae Roze. Annual Meeting of the Ind Phytopathological Society (NZ), CSKVV, Palampur, 24th and 25th Nov, 2011.

8. Upadhyay, R.C. and Manjit Singh. 2011. Evaluation of substrates and supplements for cultivating king oyster mushroom. National conference on Horti Business linking farmers with market ,28th May-31st May,2011, Dehradun.

7. APPROVED ON-GOING RESEARCH PROJECTS

On-going Research Projects of DMR

Institute Code	Title	Researchers		Period
DMR-1	Survey, collection and identification of fleshy fungi	Dr. R.C. Upadhyay Dr.O.P. Ahlawat Dr. Satish Kumar	PI Co-PI Co-PI	January, 1998 till date
DMR-2	Genetic Improvement of , and mushrooms	Dr. Manjit Singh Dr. R.C. Upadhyay Dr. O.P. Ahlawat Dr. Kunal Mandal Dr. Shwet Kamal Dr. K. Manikandan	PI (Button) PI ( ) PI ( ) Co-PI Co-PI Co-PI	April, 2010 to March, 2013
DMR-3	Improvement in cultivation technology of white button mushroom & effective utilization of spent substrate	Dr. B. Vijay Dr. O.P. Ahlawat Dr. K. Manikandan	PI Co-PI Co-PI	April, 2010 to March, 2013
DMR-4	Cultivation technology of oyster mushroom	Dr. R.C. Upadhyay Dr.V. P. Sharma	PI Co-PI	Januay, 2007 to December, 2011 NCM-38 with title change only
DMR-5	Integrative use of cultivation technologies for enhancing yield and quality of paddy straw mushroom	Dr. O.P. Ahlawat Dr. V.P. Sharma Dr. Satish Kumar	PI Co-PI Co-PI	Januay, 2007 to December, 2011 NCM-40 with title change only
DMR-6(a)	Developing cultivation technologies for Indigenous edible mushrooms, , , and	Dr. V.P. Sharma Dr. Manjit Singh Dr. Satish Kumar Dr. Shwet Kamal Dr. K. Manikandan	PI Co-PI Co-PI Co-PI Co-PI	April, 2010 to March, 2015
DMR-6(b)	Basic studies on cultivation technology of morel mushroom	Dr. Kunal Mandal Dr. VP Sharma Dr. Shwet Kamal Dr. K Manikandan	PI Co-PI Co-PI Co-PI	January 2012 to September, 2012
DMR-7	Modified Atmosphere Packaging for safe storage of Mushrooms	Dr. Goraksha C. Wakchaure Dr. B. Vijay	PI Co-PI	February, 2010 to June, 2014
DMR-8	Integrated Pest and Disease Management in Mushrooms	Dr. Satish Kumar Dr. V.P. Sharma	PI Co-PI	April, 2010 to October, 2012
DMR-9	Development of Web based Mushroom Expert System	Sh. Mahantesh Shirur	Principal Investigator	April, 2011 to 30th September, 2012

Externally Funded Projects

Title of the Project	PI of the Project	Duration	Funding Agency
Agrowaste Management, Bioremediation and Microbes in Post Harvest Processing i) Refinement in indoor compost technology for white button mushroom using thermophilic organisms.	Dr. B. Vijay	01.08.2006 to 31.07.2011	ICAR (AMAAS)
Microbial diversity and Identification i) Strengthening, authentication and exploitation of mushroom biodiversity at the National Mushroom Repository for human welfare.	Dr. R.C. Upadhyay	01.08.2006 to 31.07.2011	ICAR (AMAAS)
Screening and evaluation of ascomycetous and basidiomycetous macro-fungi of Uttarakhand and Himachal Pradesh for new drug discovery and ligninolytic enzymes.	Dr. R.C. Upadhyay	01.02.2009 to 31.01.2011	CSIR, HRDG, New Delhi.

8. CONSULTANCY PROVIDED BY DMR

The Consultancy to the following organizations was given during the period under report.

Consultancy in the form of preparation of Techno Economic Feasibility Report **(TEFR)** and advise on mushroom cultivation during the year 2011-12 was provided to the following persons/ units.

1. Sh. T. Lakshaminarayan, 23, Marutham Nagar, Sundar Kamuthur, Coimbatore – 641010 (TN).

2. Sh. Zubin Khurana C/o MRZ Honda, G.T. Road, Ram Talai, Amritsar (Punjab).

3. Sh. Rawta Ram S/o Sh. Bhura Ram Jat & Sh. Jasa Ram S/o Sh. Rawta Ram, 81, Godaro Ka Tala Sampuran Revenue Gram, P.O. Leelashr, Tehsil-Chouhtan, Distt. Barmar, Rajasthan-344708.

4. Sh. Anil Kumar S/o Sh. Jagmal Singh, Village and P.O. Bucholi, Tehsil & Distt. Mahendragarh, Haryana-123032.

5. Sh. Kamlesh Kumar Bhatnagar, Plot No.1, H.No.4004/2, Mohalla Soot Battan, Patiala (Punjab).

6. Sh. Srikant Singh S/o Late Sh. Ram Parikhan Singh, Village Naiyapar Bujurg, P.O. Naiyapar Khurd, Tehsil Sadar, Block Piprach, Distt. Gorakhpur – 273152 (U.P.).

7. M/s. Krishna Associates, 27, Industrial Area, Gurdaspur (Punjab).

8. Dr. Vivek Gupta C/o Gupta Nursing Home, Rairpur Rani, Panchkula (Haryana).

9. Shri Anand Agro and Food Product, SBS Nagar, Punjab – 144514.

10. M/s. Sai Mushroom Farm, Village Brahman Majra, P.O. Bhatian, Nalagarh, Distt. Solan (H.P.).

11. Mrs. Shradha Suri W/o Mr. Manish Suri, Star Cottage, Shilly Road, Solan (H.P.).

12. Sh. Akhil Angirish, M/s. Dev Bhoomi Foods, 26, MDDA Colony, Chander Road Dolah, Wala, Dehradun (Uttarakhand).

13. Sh.S.N.Chottray, M/s. Krishna Mushrooms Private Limited, Bhubaneswar(Orissa)-751007.

14. Sh. Krishan Chander, Village Rajna Kalan, Tehsil-Safidon, Distt. Jind, Haryana-126113. Dr. Jasphool Singh, Village & Tehsil Meham, Distt. Rohtak, Haryana.

15. Dr. Jasphool Singh, Village & Tehsil Meham, Distt. Rohtak, Haryana.

16. M/s. Vista Agriculture & Farming Private Limited, Plot No.4, Beside Jyoti Service Station, Near Flyover Cuttack Road, Bhubaneswar-751006.

17. Sh. Muni Lal, Village Seri, P.O. Galange, Tehsil & Distt. Solan (HP)-173212.

18. Sh. Kamlesh Kumar, Plot No.1, H.No.4004/2, Mohalla Soot Battan, Patiala (Punjab).

19. Sh. Rajiv Jalan, 8/2-B, Arya Nagar, Kanpur-208002 (Uttar Pradesh).

20. Sh. Rajbir Singh, Village Bhandura, Distt. Guna (MP).

21. Sh. Rajbir Singh, Village Bhandura, Distt. Guna (MP).

22. Sh. Shiv Nath Prasad, M/s. Bharati Mushroom Farm, Village Rajiv Nagar, P.O. Kesari Nagar, Patna Sadar, Thana Rajiv Nagar, Jan Shakti Colony, Road No.24, Patna, Bihar-800024.

23. Sh. Sunil Dahiya, M/s. Divine Mushroom Farm (P) Ltd., Divine Bless, H.No.2728, HBC, Sector-3, Rohtak(Haryana).

24. Sh. Keshav Ram Sharma, S/o Sh. Milkhi Ram, Village Anji Shalumna, P.O. Dharot, Tehsil & Distt. Solan (HP) – 173213.

25. Sh. Puran Chand S/o Late Sh. Tula Ram, Village Sadhnaghat, P.O. Naina Tikar, Tehsil Pachad, Distt. Sirmour (HP) – 173229.

26. Sh. Sanjay Kumar, S/o Sh. Laiq Ram, Village & P.O. Basal, Tehsil & Distt. Solan (HP) – 173213.

27. Sh. Sunil Dahiya, M/s. Divine Mushroom Farm (P) Ltd., Divine Bless, H.No.2728, HBC, Sector-3, Rohtak(Haryana) – (two Nos.).

28. Lt. Col. B. Kala & Partners, Flat No.64 B, Sector-20, Panchkula (Haryana).

29. M/s. Nisha Rani Agro Farm, Panchkula (Haryana).

30. Mr. Harpreet Singh, Village Manak Majra, Tehsil Khanna, Distt. Ludhiana (Pb) – 141401.

31. Mr. Amit A. Dhume, F-5, C.D. Good Earth, Dongarwarddo, Fatorda, Margao, Goa-403602.

32. Mr. Jagat Ram, Village Kashipur, P.O. Nihargarh, Tehsil Poanta Sahib, Distt. Sirmour (HP).

33. Sh. Vijay Sinh Moray, 1, Vishwas, Yeshwant Ghadge Nagar, Ganesh Khind Road, Pune-411007 (M.S.).

34. Sh. Prem Chand, Village Sandrol, P.O. Ghatti, Tehsil & Distt. Solan (HP).

35. Dr. Satya Prakash Banya, Director, M/s. Banjosh Associates, A-60, Sector-58, Gautam Budh Nagar, Noida-201301 (UP).

36. Sh. Dhanjay Kumar, Village & P.O. Bhojnagar, Tehsil & Distt. Solan (HP).

37. Smt. Kamlesh Thakur, Village & P.O. Dhari, Tehsil & Distt. Shimla (HP).

38. Smt. Reeta Devi, Village Ser Chirag, P.O. Jaunaji, Tehsil & Distt. Solan (HP) – 173213.

39. Smt. Raminder Kaur W/o Sh. Gurvinder Singh, H.No.10, Indra Puri, Sirhand Road, Patiala – 147001 (Punjab).

40. Sh. Charanjeet Singh S/o Sh. Partap Singh, H.No.1361, Street No.13, Gurbox Colony, Patiala (Punjab).

41. Sh. Amrik Singh S/o Sh. Babu Singh, Village Pabari, P.O. Khas, Tehsil Rajpura, Distt. Patiala (Punjab).

42. Sh. Joginder Singh S/o Sh. Arjun Singh, Village Nain Kalan, P.O. Khas, Tehsil & Dist. Patiala (Punjab) – 14700.

43. Sh. Krishan Chander S/o Sh. Sher Singh, Village Rajana Kalan, P.O. Budakhera, Tehsil Safidon, Distt. Jind (Haryana) -126113.

44. Sh. Tapan Malhotra, Bharati Airtel Limited, Plot No.21, Rajiv Gandhi Technology Park, Chandigarh – 160101.

45. Mr. Jaswant Singh M/s. Dhankhar Mushroom Farm, Khubru/Ganour City, P.O. Ganour, Tehsil Ganour, Distt. Sonepat (Haryana) – 131101.

46. Sh. Bharrat Bhushan Sharma, S/o Late Sh. Ravi Dustt Sharma, Village Baggar, P.O. Barog Railway Station, Tehsil & Distt. Solan (HP).

47. Smt. Sureshta Devi W/o Sh. Pritam Chand, Village Garh Basti, P.O. Malkod, Tehsil Palampur, Distt. Kangra (HP).

48. Sh. Vinod Kumar Thakur alias Sh. Budh Ram Thakur, Chambaghat, Solan (HP).

9. COMMITTEE MEETINGS

a) Institute Management Committee: one meeting of IMC was held on 5.2.2011 .

1.	Dr. Manjit Singh, Director, DMR, Chambaghat, Solan (H.P.).	Chairman
2.	Dr. Umesh Srivastava, Asstt.Director General (Hort. II), ICAR, Krishi Anusandhan Bhavan-II, Pusa, New Delhi-110012.	Member
3.	Dr. D.K. Arora, Director, National Bureau of Agriculturally Important Microorganisms (NBAIM), Kusmaur, MAU Nath Banjan (U.P.).	Member
4.	Dr. Gurdev Singh Shama, Director of Horticulture, Deptt. of Horticulture, Govt. of Himachal Pradesh, Shimla-2 (H.P.).	Member
5.	Dr. Ajay Yadav, Incharge, HAIC Agro Research & Development Centre Murthal (Haryana).	Member
6.	Director of Research, Dr. Y.S. Parmar University of Hort. & Forestry, Nauni, Solan(H.P.).	Member
7.	Sh. Vikas Benal, Vikas Mushroom, Vill. Shamlaich, P.O. Barog, Tehsil & Distt. Solan (H.P.).	Member
8.	Sh. Ram Dass Shinde, Tirupati Balaji Mushroom, Vill. Someshwarnagar(Nimbut), Tal. Baramati, Distt. Pune-412306(Maharashtra).	Member
9.	Dr. P.S Naik, Project Coordinator & Principal Scientist, CPRI, Shimla(H.P.).	Member
10.	Dr. Meera Pandey, Principal Scientist, IIHR, Bangalore.	Member
11.	Dr. V.P. Sharma, Principal Scientist, DMR, Chambaghat, Solan(H.P.)	Member
12.	Finance & Accounts Officer, Central Potato Research Institute, Shimla (H.P.).	Member
13.	Administrative Officer, DMR, Chambaghat, Solan(H.P.).	Member Secretary

(b) Research Advisory committee: One meeting was held on 21st May, 2011.

1.	Dr. S.M. Paul Khurana, Director General, Amity University Haryana, E-1101, Park View City II, Sohna Road, Gurgaon – 49 (Haryana)	Chairman
2.	Dr. R.P. Singh, Emeritus Scientist (Mushroom Project), F/61, Alliance Kingston Estate, Rudarpur – 263153.	Member

3. Dr. D.R. Sharma, Member
Dean, Shoolini Institute of Life Sciences &
Business Management,
Solan (H.P.) - 173212.

4. Dr. P.C. Trivedi, Member
Vice Chancellor,
Deen Dayal Upadhyay Gorakhpur University,
Gorakhpur (UP) – 273009, India.

5. Dr. J.C. Tarafdar, Member
National Fellow & Principal Scientist (Soil Chem/Fert),
Central Arid Zone Research Institute,
Jodhpur – 342 003 (Rajasthan).

6. Dr. Manjit Singh, Member
Director, Directorate of Mushroom Research,
Chambaghat, Solan(H.P.).

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

Fig.1. Members of QRT team visiting DMR

8.	Sh. Vikas Banal, Vikas Mushroom Farm, Vill. Shamlaich, Solan (H.P.).	Member
9.	Sh. Ram Dass Shinde, Tirupati Balaji Mushroom, Vill. Someshwar Nagar (Nimbut), Tal. Baramati, Distt. Pune – 412306 (MS).	Member
10.	Dr. R.C. Uapdhyay, Principal Scientist, Directorate of Mushroom Research, Chambaghat, Solan (H.P.) – 173213.	Member Secretary

(c) Institute Research Council (IRC)

Four meetings of Institute Research Committee (IRC) were held on 17.01.2011, 21.05.2011, 14.06.2011, 12.10.20110, and attended by all the Scientists under the Chairmanship of Dr. Manjit Singh, Director, DMR, Solan.

d) Core Committee:

1. Dr. Manjit Singh	Chairman
2. Sh. K.K. Sood	AO
3. Sh. Jiwan Lal	AFACO
4. Sh. R.K. Bhatnagar	Asstt.
5. Sh. Rajinder Sharma	Asstt.
6. Sh. Bhim Singh	Asstt
7. Sh. T.D.Sharma	Asstt
8. Sh. Dharam Dass	LDC

During the year six meetings were held on 25.01.2011, 25.02.2011, 25.03.2011, 27.05.2011, 27.06.2011, 25.08.2011,30.09.2011 and 26.12.2011.

e) Institute Joint Staff Council (IJSC)

Office Side

1. Dr. R.C. Upadhyay, Principal Scientist
2. Dr. Satish Kumar Sr. Scientist
3. Dr. K. Manikandan
4. Sh. K.K. Sood

5. Sh. Jiwan Lal, AFACO

6. Sh. R.K. Bhatnagar, AAO

Staff Side

1. Sh. N.P. Negi, Member CJSC

2. Sh. Roshan Lal Negi

3. Sh. Jia Lal Verma

4. Sh. Jeet Ram, Seceretary IJSC

5. Sh. Nika Ram, SSS

6. Sh. Tej Ram, SSS

During the year one meeting were held at this Directorate on 22.10.2011

f) Grievance Cell

1.	Dr. R.C. Upadhyay, Principal Scientist	Chairman
2.	Dr. B. Vijay, Principal Scientist	Member
3.	Dr. K. Manikandan, Scientist	Member
2.	Administrative Officer	Member
4.	Sh. Jiwan Lal, AFACO	Member
5.	Sh. Rajinder Sharma	Member
6.	Sh. Guler Singh, T-2	Member
7.	Sh. Raj Kumar, SSG-II	Member

Due to non-receipt of any grievance, no meeting was held.

(g) Consultancy Processing Cell (CPC)

One meetings of Consultancy Processing Cell (CPC) were held on 14.07.2011

(h) Complaint Committee at Institute for prevention of sexual harassement of women employees

1. Chairman — Smt. Reeta Bhatia

2. Members

i) Administrative Officer
ii) Mrs. Shailja Verma
iii) Mrs. Shashi Poonam

3. Member Secretary — Mrs. Sunila Thakur

Meeting of Women Complaint Committee

i) First meeting held on 19.01.2011

ii) Second meeting held on 30.06.2011

iii) Third meeting held on 22.12.2011

i) Rajbhasa Implementation Committee (Hindi Committee)

राजभाषा कार्यान्वयन समिति (हिन्दी समिति):

डा. मनजीत सिंह, निदेशक	अध्यक्ष
डा. आर.सी. उपाध्याय, प्रधान वैज्ञानिक	सदस्य
डा. के. मणिकंडन, वैज्ञानिक	सदस्य
श्री के.के. सूद, प्रशासनिक अधिकारी/प्रभारी राजभाषा कार्यान्वयन	सदस्य
श्रीमती रीता, तकनीकी अधिकारी	सदस्या
श्री सुनीला ठाकुर, निजी यहासक	सदस्या
श्री दीप कुमार ठाकुर, आशुलिपिक	सदस्य सचिव

राजभाषा कार्यान्वयन समिति द्वारा वर्ष 2011–12 के दौरान किये गए कार्यों का संक्षिप्त विवरण

भारत सरकार की राजभाषा नीति के कार्यान्वयन को सुनिश्चित करने तथा निदेशालय द्वारा संपादित किये जाने वाले कामकाज में हिन्दी का प्रयोग सुनिश्चित करने के उद्देश्य से निदेशालय में राजभाषा कार्यान्वयन समिति का गठन किया गया है। राजभाषा कार्यान्वयन के लिए निदेशालय में अलग से कोई अधिकारी व कर्मचारी न होने के बावजूद राजभाषा कार्यान्वयन समिति द्वारा किए गये प्रयासों के फलस्वरूप निदेशालय में हिन्दी के कामकाज व प्रचार–प्रसार में अपेक्षित सफलता प्राप्त हुई है। निदेशालय द्वारा वर्ष 2011–12 के दौरान किये गये कार्यों का संक्षिप्त विवरण निम्नानुसार है:–

राजभाषा वार्षिक कार्यक्रम पर कार्यान्वयन

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

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

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

तिमाही हिन्दी प्रगति रिपोर्ट का संकलन तथा समीक्षा

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

हिन्दी प्रोत्साहन योजना का कार्यान्वयन

राजभाषा विभाग द्वारा जारी निर्देशों के अनुरूप निदेशालय में सरकारी कामकाज मूल रूप में हिन्दी में करने के लिए प्रोत्साहन योजना सभी अधिकारियों व कर्मचारियों के लिए लागू की है। पूरे वर्ष में किए गए कार्यों को मध्य नजर रखते हुए एक मूल्यांकन समिति का गठन किया जाता है जो फाईलों व अन्य कार्यों का अवलोकन कर प्रथम, द्वितीय व तृतीय पुरस्कारों का निर्णय करती है।

त्रैमासिक बैठकों का आयोजन

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

त्रैमासिक राजभाषा कार्यशालाओं का आयोजन

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

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

हिन्दी सप्ताह का आयोजन

14–21 सितम्बर, 2011 तक 'हिन्दी सप्ताह' के दौरान हिन्दी में आयोजित प्रतियोगिताओं व वर्ष (अक्टूबर, 2010 से 13 सितम्बर, 2011) में सर्वाधिक कार्य करने वाले अधिकारियों/कर्मचारियों के दिनांक 21.09.2011 को नकद पुरस्कार दिए गए जिसका विवरण निम्नलिखित हैः–

1. श्रुतलेखन प्रतियोगिता (DICTATION) (कुल 5 प्रतिभागी)

   प्रथम – श्रीमति सुनीला ठाकुर, निजि सहायक
   द्वितीय – श्री दीप कुमार, आशुलिपिक
   तृतीय – श्री जीत राम, तकनीकी सहायक

2. सुलेख प्रतियोगिता (सुन्दर लिखाई) (कुल 10 प्रतिभागी)

   प्रथम – श्रीमती सुनीला ठाकुर, निजी सहायक
   द्वितीय – श्री जीत राम, तकनीकी सहायक
   तृतीय – श्री अर्जुन दास, (एस.एस.एस.)

3. निबंध प्रतियोगिता–(कुल 5 प्रतिभागी) (विषयः भ्रष्टाचार)

   प्रथम – डा. वी.पी. शर्मा, प्र. वैज्ञानिक
   द्वितीय – श्रीमति रीता, तकनीकी अधिकारी
   तृतीय – डा. सतीश कुमार, व. वैज्ञानिक

4. टिप्पणी प्रतियोगिता – (कुल 5 प्रतिभागी) (विषयः निदेशालय में पानी की कमी के मध्यनजर पानी का नया कुनैक्शन नगर परिशद सोलन से लेने के संदर्भ में टिप्पणी लिखना टिप्पणी लिखना)

   प्रथम – श्रीमती शशी पूनम, निम्न श्रेणी लिपिक
   द्वितीय – श्री दीप कुमार, आशुलिपिक
   तृतीय – श्री सुरजीत सिंह कवंर, निजि सचिव

5. सामान्य व तकनीकी ज्ञान प्रतियोगिता – (6 प्रतिभागी)

   प्रथम – श्री दीपक शर्मा, तकनीकी सहायक
   द्वितीय – श्री गुलेर सिंह, विघुतकार
   तृतीय – श्री परमानंद, तकनीकी सहायक

6. कम्प्यूटर पर टंकण प्रतियोगिता – (5 प्रतिभागी)

प्रथम – श्रीमती सुनीला ठाकुर, निजि सहायक
द्वितीय – श्रीमती शशी पूनम, क.लिपिक
तृतीय – श्री दीप कुमार ठाकुर, आशुलिपिक

7. पत्र लेखन प्रतियोगिता – (4 प्रतिभागी) (विषयः किसी कर्मचारी के धर पर अचानक बिमार पड़ जाने की स्थिति में कार्यालय में आवेदन भेजने के लिए आवेदन पत्र)

प्रथम – श्री विनय शर्मा (एस.एस.एस.)
द्वितीय – श्री अजीत कुमार (एस.एस.एस.)

8. वैज्ञानिक उपलब्धियां लिखना – (5 प्रतिभागी) यह प्रतियोगिता वैज्ञानिक के लिए थी जिसका विषय था निदेशालय की पिछले एक साल की वैज्ञानिक उपलब्धियां लिखना (सितम्बर, 2010 से अगस्त, 2011)।

प्रथम – डा. सतीश कुमार, वरिष्ठ वैज्ञानिक
द्वितीय – डा. गोरक्ष चिमाजी वाकचौरे, वैज्ञानिक
तृतीय – डा. वी.पी. शर्मा, प्र. वैज्ञानिक

9. क्वूज प्रतियोगिता– इस प्रतियोगिता में 37 प्रतिभागियों ने भाग लिया। इसमें शब्द अनुवाद, फोटो दिखाकार फोटो को पहचानना, मशरूम के बारे में प्रश्न, वैज्ञानिक व गैर वैज्ञानिक, खेलों संबंधी जानकारी, नवीनतम जानकारी इत्यादि संबंधी जानकारी प्रश्न पुछे जायेंगें।

सभी 37 प्रतिभागियों को सही उत्तर देने पर विजेताओं को नकद पुरस्कार दिए गए।

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

1. प्रथम पुरस्कार (2 पुरस्कार प्रत्येक 800/– रूपये)

1) श्रीमती शशी पूनम, निम्न श्रेणी लिपिक
2) श्री भीम सिंह, सहायक

2. द्वितीय पुरस्कार (3 पुरस्कार प्रत्येक 400/– रूपये)

1) श्री रोशन लाल नेगी, क. लिपिक
2) श्री एन.पी. नेगी, उच्च श्रेणी लिपिक
3) श्री दीप कुमार, आशुलिपिक

3. तृतीय पुरस्कार (5 पुरस्कार प्रत्येक 300/– रूपये)

1) श्रीमती तुलसी दास शर्मा, सहायक
2) श्री सतेन्दर कुमार ठाकुर, व. लिपिक
3) श्री धर्म दास, क. लिपिक
4) श्री संजीव शर्मा, क. लिपिक
5) श्री लेख राज राणा, तकनीकी सहायक

इन सबके फलस्वरूप निदेशालय के वैज्ञानिक/अधिकारियों/कर्मचारियों में हिन्दी में कार्य करने की प्रवृत्ति ब.ी है और वर्तमान में काफी प्रशासनिक कामकाज हिन्दी में संपादित हो रहा है। इसमें निदेशालय के वैज्ञानिकों, अधिकारियों व कर्मचारियों का सतत् सहयोग प्राप्त हुआ है जिसके परिणामस्वरूप हम लक्ष्य को प्राप्त करने की ओर अग्रसर हो रहे हैं। इसके लिए हमें निदेशक महोदय का उचित मार्गदर्शन तथा सहयोग हमेशा ही प्राप्त हुआ है।

निदेशालय की वार्षिक हिन्दी प्रगति संबंधी मुख्य गतिविधियाँ एवं उपलब्धियाँ

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

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

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

3. निदेशालय की अधिकतर बैठकों को कार्यवृत्त हिन्दी में तैयार किए गए।

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

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

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

7. निदेशालय के सभी 30 कम्पयूटरों में हिन्दी सॉफटवेयर को डाउनलोड किया गया है। इससे कम्पयूटर पर काम करने वाले प्रत्येक अधिकारी व कर्मचारी को अपनी इच्छानुसार हिन्दी में अथवा हिन्दी और अंग्रेजी दोनों में किसी भी भाषा में एक साथ काम कर सकते है।

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

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

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

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

12. निदेशालय के अधिकारियों तथा कर्मचाारियों के हिन्दी शब्द ज्ञान को ब ़ाने के उद्देश्य से पुस्तकालय में श्यामपट्ट (ब्लैक बोर्ड) पर तथा ई–मेल के माध्यम से कम्पयूटर पर 'आज का शब्द' शीर्षक के अन्तर्गत प्रतिदिन हिन्दी का एक शब्द उसके अंग्रेजी समानार्थ के साथ लिखा जाता है ताकि अधिकारियों व कर्मचारियों के शब्द ज्ञान में वृद्धि हो सके।

13. निदेशालय में प्रत्येक वर्ष की भांति इस वर्ष भी मशरूम मेले का आयोजन 10 सितम्बर, 2011 को आयोजित किया गया। इस अवसर पर मुख्य पंडाल के सभी चित्रों के शीर्षक, ग्राफ, हिस्टोग्राफ आदि हिन्दी में प्रदर्शित किए गए। मल्टीमीडिया के माध्यम से मशरूम संबंधी जानकारी आकर्षक ंग से प्रस्तुत की गई तथा किसानों, छात्रों व अन्य अंगतुकों को मशरूम साहित्य हिन्दी में उपलब्ध कराया गया।

14. हिन्दी पुस्तकों की खरीद के लिए एक समिति बनाई गई है जो हिन्दी पुस्तकालय के लिए पुस्तकें खरीदने की सिफारिश करती है। पुस्तकालय में प्रत्येक वर्ष राजभाषा विभाग द्वारा निर्धारित लक्ष्य के अनुसार पुस्तकें खरीदने का प्रयास किया जा रहा है। निदेशालय की पुस्तकालय में हिन्दी में उपलब्ध सभी प्रकाशनों की सूची में निदेशालय की वेबसाइट पर उपलब्ध कराई गई है।

15. दूरदर्शन तथा आकाशवाणी पर भी निदेशालय के वैज्ञानिकों व तकनीकी अधिकारियों की मशरूम विषय पर हिन्दी में वार्ताएं प्रसारित होती रहती है जिनसे मशरूम उत्पादकों की समस्याओं का समाधान होता है।

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

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

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

Dr. Manjit Singh

1. Participated in Innovation Educators Conference at ISB, Hyderabad on 29-30th April, 2011.

2. Participated in the Swadsh Prem Jagriti Sangosthi-2011 - National Conference on "Horti-Business – linking Farmers with Market" organized by Lt. Amit Singh Memorial Foundation, New Delhi in collaboration with Sardar Vallabh Bhai Patel University of Agriculture and Technology, Meerut, Amity University, Noida at Dehradun w.e.f. 28-30th May, 2011.

3. Participated in the 7th International Conference on Mushroom Biology and Mushroom Products from October 4-7, 2011 at Arcachon, France.

4. Attended and delivered a lead lecture in Symposium at Deptt. of Plant Pathology, CSK HP Agricultural University, Palampur (HP) on 24th – 25th November, 2011.

5. Attended the Annual Conference of KVKs jointly organized by ICAR and JNKV, Jabalpur (MP) fro 3rd - 5th December, 2011.

Dr. R.C.Upadhyay

1. Participated in the Bioinformatics Workshop on "Data Mining and Computational Methods in Bioinformatics for Microbial Research" w.e.f. 4th - 15th March, 2011 at National Bureau of Agriculturally Important Microorganisms, Mau, Uttar Pradesh.

2. Participated in the Workshop cum training on "Bio-informatics Application in Agricultural Sciences" on 14-16th December, 2011 at Unit of Simulation and Informatics, IARI, New Delhi.

3. Attended one day Protein purification workshop at Chandigarh on 4th April, 2011 organized by GE.

4. Participated in the annual Project review meeting of AMAAS at NBAIM, Mau on 14th and 15th April, 2011.

5. Attended Swadesh Prem Jagrati Sangosthi-2011 from 28th May to 31st May, 2011 at Dehradun.

6. Attended one day workshop on "Packaging of fresh and processed foods with special emphasis on mushrooms on 3rd June, 2011 and delivered lecture on recent developments in cultivation of oyster mushrooms.

7. Attended work shop on "Study of supply chain of mushroom business and development of business model" held at DMR, Solan on 17th Oct,2011 organized by NHB,Gurgoan.

8. Attended work shop on "Bioinformatics Application in Agricultural Sciences" from 14th to 16th Dec., 2011 at Unit of Simulation and informatics ,IARI, New Delhi

9. Attended Annual meeting of Ind Phytopathological Society(NZ) and National Symposium on Strategic issues in Plant pathological research on 24th Nova nd 25th Nov,2011 at SCK Himachal Pradesh , Palampur (HP).

Dr. V.P.Sharma

1. Attended "National Consultation-cum training on Diagnostics in Horticultural crops" on 16th April, 2011 at CPRI Shimla.

2. Attended the "ICAR-Zonal Technology Management & Business Planning and Development Meeting-cum-Workshop 2010-11" held at IARI, New Delhi w.e.f.17.03.2011 - 18.03.2011. I presented the ITMU assets of DMR, Solan.

Dr. O.P. Ahlawat

1. Attended training programme on Data Analysis using SAS at National Dairy

Research Institute, Karnal w.e..f. 12-17th September, 2011.

2. Attended the meeting for developing concept notes on "Health Foods" and "Waste Utilization" on 28th September, 2011 at IIHR, Bangalore.

3. Participated in the 7th International Conference on Mushroom Biology and Mushroom Products from October 4-7, 2011 at Arcachon, France.

4. Participated in ICAR-NAIP Interactive Meet with Scientists trained abroad in frontier areas of Agricultural Sciences from November 28-30, 2011 at NASC Complex, Pusa, New Delhi.

5. Participated in the Workshop cum training on "Bio-informatics Application in Agricultural Sciences" on 14-16th December, 2011 at Unit of Simulation and Informatics, IARI, New Delhi.

Dr. Kunal Mandal

1. Attended training programme on Data Analysis using SAS at National Dairy Research Institute, Karnal w.e..f. 12-17th September, 2011.

Dr. Satish Kumar

1. Attended workshop on packaging of fresh and processed food with special emphasis to mushrooms organized by Indian Institute of Packaging on June 3, 2011

2. AICRP on Mushrooms on 2.08.2011

3. Workshop on supply chain of mushroom business and development of business model sponsored by NHB at DMR Solan on 17.10.2011

Dr. Shwet Kamal

1. Attended training programme on Data Analysis using SAS at National Dairy Research Institute, Karnal w.e..f. 12-17th September, 2011.

2. Attended the National Conference on Horti-Business – Linking Farmers with Market Held at Dehradun on May 28-31, 2011.

3. Attended a two-day annual workshop of All India Coordinated Research Project on Mushroom on 1st and 2nd August 2011 at DMR, Solan

Dr. K. Manikandan

1. Attended workshop on "PME" at NAARM, Hyderabad (Sep 17-27, 2011) towards increasing work efficiency in PME cell.

2. Attended one day workshop on package of fresh and processed foods with special emphasis on mushrooms at Solan (HP) on 03-06-2011.

Sh. Mahantesh Shirur

1. Sh. Mahantesh Shirur, Scientist, participated in the International Confernece on "Innovative Approaches for Agricultural Knowledge Management: Global Extension Experiences" on 9th – 12th Novemebr, 2011 at NASC Complex, New Delhi.

11. DISTINGUISHED VISITORS

1. Maj. Gen. B.S. Dauthav along withTeam from National Defence College visited DMR on 04.02.2011.

2. Dr. K.D. Kokate, DDG (Agril. Extn.), ICAR, New Delhi and Dr. A.M. Narula, Zonal Project Director, ZPD-Z-I, Ludhiana (Pb.) visited DMR on 13.03.2011.

3. Dr. H.P. Singh, DDG(Hort.), ICAR, New Delhi visited DMR on 15.04.2011 & 2.06.2100.

4. Dr. Dinesh Parmar, MBBS, Ex-Minister, Govt. of Gujarat visited DMR on 28.04.2011.

5. Dr. S. Ayyappan, Director General & Secretary (DARE), ICAR, New Delhi visited DMR on 02.06.2011.

6. Sh. Shanta Kumar, Chairman Parliamentary Standing Committee on Commerce alongwith other members visited DMR on 29.06.2011.

Fig. 1. A Team from National Defense College visiting DMR

Fig. 2. Dr. S. Ayyappan, Director General & Secretary (DARE), along with Dr. HP Singh, DDG (Hort) ICAR, visiting DMR PHT Lab

Fig. 3. Sh. Shanta Kumar, Chairman Parliamentary Standing Committee on Commerce along with other members visiting DMR

Fig. 4. Dr. S. Ayyappan, Director General & Secretary (DARE), ICAR, releasing a mushroom book during his visit to DMR

12. PERSONNEL AND FACILITIES

SN	Name of employee	Designation
Scientific Staff		
1	Dr. Manjit Singh	Director
2	Dr. R.C. Upadhyay	Principal Scientist
3	Dr. B. Vijay	Principal Scientist
4	Dr. V.P. Sharma	Principal Scientist
5.	Dr. O.P. Ahlawat	Principal Scientist
6	Dr. Satish Kumar	Senior. Scientist
7	Dr. Shwet Kamal	Senior Scientist
8	Sh. Yogesh Gautam	Scientist (SS)
9	Dr. Goraksha Chimaji Wakchaure	Scientist
10	Sh. Mahentesh Shirur	Scientist
11	Dr. K. Manikandan	Scientist
Administrative Staff		
1	Sh. K.K. Sood	Administrative officer
2	Sh. Jiwan Lal	Asstt.Finance & Accounts Officer
3	Sh. Surjit Singh	PS
4	Sh. R.K. Bhatnagar	Assistant Administrative officer
5	Sh. Rajinder Sharma	Assistant
6	Sh. Bhim Singh	Assistant
7	Sh. T.D. Sharma	Assistant
8	Smt. Sunila Thakur	PA
9	Sh. Deep Kumar Thakur	Steno Gr.III
10	Sh. N.P. Negi	UDC
11	Sh. Satinder Thakur	UDC
12	Sh. Dharam Dass	LDC
13	Smt. Shashi Poonam	LDC
14	Sh. Roshan Lal Negi	LDC
15	Sh. Sanjeev Sharma	LDC
Technical Staff		
1	Sh. Sunil Verma	Technical Officer (T-6)
2	Smt. Reeta	Technical Officer (T-6)
3	Smt. Shailja Verma	Technical Officer (T-6)
4	Sh. Jia Lal	Technical Officer (T-5)
5	Sh. Gian Chand	T-4
6	Sh. Lekh Raj Rana	T-1-3
7	Sh. Ram Swaroop	T-3

SN	Name of employee	Designation
8	Sh. Parmanand	T-1-3
9	Sh. Dala Ram	Driver T-3
10	Sh. Ram Lal	Driver T-3
11	Sh. Jeet Ram	T-2
12.	Sh. Guler Singh Rana	Electrician T-2
13	Sh. Deepak Sharma	T-3
Skilled Supporting Staff		
1	Smt. Dayawanti	SSS
2	Sh. Naresh Kumar	SSS
3	Sh. Nika Ram	SSS
4	Sh. Tej Ram	SSS
5	Smt. Meera Devi	SSS
6	Sh. Raj Kumar	SSS
7	Sh. Ajeet Kumar	SSS
8	Sh. Arjun Dass	SSS
9	Sh. Vinay Sharma	SSS

Promotions

1. Sh.R.K. Bhatnagar, Assistant promoted as Asstt.Administrative Officer w.e.f. 28.03.2011 (FN).

2. Sh.Sunil Verma, Technical Officer (T-6) Promoted as Technical Officer T(7-8) w.e.f. 01.07.2010

3. Sh.Jeet Ram, Technical Assistant (T-2) promoted as Technical Assistant (T-3) w.e.f. 13.10.2010

4. Sh.Guler Singh, Electrician (T-2) promoted as Electrician (T-3) w.e.f. 27.10.2010

5. Sh.N.P. Negi, UDC promoted as Assistant w.e.f. 29.06.2011 (FN).

6. Sh.Dharam Dass, LDC promoted as UDC w.e.f. 30.06.2011 (FN).

Modified Assured Career Progression (MACP)

1. Sh.Bhim Singh, Asstt. granted financial upgradation in the pay band of Rs.9300-34800 + GP 4600/- w.e.f. 25.06.2011(FN).

2. Sh.Satinder Thakur, UDC granted financial upgradation in the pay band of Rs.5200-20200+ GP 2800/- w.e.f. 26.06.2011(FN).

3. Sh.Sanjeev Sharma, LDC granted financial upgradation in the pay band of Rs.5200-20200+ GP 2000/- w.e.f. 18.08.2011(FN).

4. Sh.Nika Ram, SSS granted financial upgradation in the pay band of Rs.5200-20200+ GP 2000/- w.e.f. 26.03.2011(FN).

5. Smt.Meera Devi, SSS granted financial upgradation in the pay band of Rs.5200-20200+ GP 1900/- w.e.f. 01.07.2010(FN).

6. Sh.Tej Ram, SSS granted financial upgradation in the pay band of Rs.5200-20200+ GP 1900/- w.e.f. 01.07.2010(FN).

7. Sh.Raj Kumar, SSS granted financial upgradation in the pay band of Rs.5200-20200+ GP 1900/- w.e.f. 01.07.2010(FN).

8. Sh.Ajeet Kumar, SSS granted financial upgradation in the pay band of Rs.5200-20200+ GP 1900/- w.e.f. 01.07.2010(FN).

9. Sh.Arjun Dass, SSS granted financial upgradation in the pay band of Rs.5200-20200+ GP 1900/- w.e.f. 01.07.2010(FN).

Transfers

1. Sh.Rishi Ram, Assistant Administrative Officer transferred from DMR, Solan to PDC Meerut on 26.03.2010(AN).

2. Sh.Yogesh Gautam, Scientist (SS) Computer Application transferred from DMR Solan to IASRI, New Delhi on 30.07.2011 (FN).

Retirement

1. Smt.Dayawanti, SSS superannuate from Council's services w.e.f. 31.01.2011(AN)

New Appointments

1. Sh. K.K. Sood joined at DMR, Solan on 07.01.2011(FN) as Administrative Officer.

2. Dr. Kunal Mandal joined at DMR, Solan on 07.03.2011(FN) as Principal Scientist.

Sports

The DMR contingent of 30 Nos. (28 men and 2 women) participated in ICAR Zonal Meet held at CSWRTI, Dehradun w.e.f. 18-21 April, 2011. In the men events, the Directorate participated in Volley ball (Smashing& shooting), badminton, Kabaddi, Chess, Tennis and Carrom Board. In the women events Ms Sunila thakur won first prize in long jump.

Gym facility developed

A well-equipped Gymnasium has been created in the campus for the benefit of DMR staff and their families.