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अखिल भारतीय समन्वयित खुम्ब उन्नयन परियोजना  
All India Co-ordinated Mushroom Improvement Project



राष्ट्रीय खुम्ब अनुसंधान केन्द्र  
NATIONAL RESEARCH CENTRE FOR MUSHROOM

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

चम्बाघाट, सोलन - 173 213 (हि.प्र.), भारत  
Chambaghat, Solan-173 213 (H.P.) India

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### All India Co-ordinated Mushroom Improvement Project

#### National Research Centre for Mushroom

Solan - 173213, India

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*Cover Photograph* : Domestication of Oyster Mushroom (forest to farm)

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## PREFACE

The report contained in this document pertains to the achievements made during the financial year 2004-05 by the ten Coordinating Centres working under the aegis of the All India Coordinated Mushroom Improvement Project (AICMIP) with the Headquarters at NRC for Mushroom, Solan (HP). The Centres are located each at Punjab Agricultural University, Ludhiana (Punjab), G.B. Pant University of Agriculture and Technology, Pantnagar (Uttaranchal), Maharana Pratap University of Agriculture and Technology, Udaipur (Raj.), Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (Chattisgarh), Mahatma Phule Agricultural University, Pune (MS), Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu), Kerala Agricultural University, Thrissur (Kerala), ICAR Research Complex for NEH Region, Barapani (Meghalaya) and Horticulture and Agro forestry Research Programme (ICAR Research Complex for Eastern Region), Ranchi (Jharkhand). All the Coordinating Centers along with Headquarters, NRCM, Solan conducted a total of 16 experiments following a common package of practices finalized and adopted at IXth Biennial Group Meeting of Workers of AICMIP held on 25-26 October, 2004 at NRCM, Solan.

During the year under report, attempts were made to bring out better strains of white button mushroom, paddy straw mushroom, and milky mushroom, evaluation of locally available agro-industrial wastes as casing materials, post harvest technology and cultivation of specialty mushrooms which are needed to diversify the mushroom cultivation scenario in the country. Attempts were also made to optimize the yield of oyster, button, shiitake and black-ear mushrooms by way of using varying rate of supplements. Safer chemicals (EDTA-DiNa) were tried for improving shelf-life of button mushroom in replacement of potassium metabisulphite which is already in use. Some new experiments especially on packaging and drying of mushrooms were also taken up. Emphasis was also laid on germplasm collection, conservation, survey and surveillance for diseases and insect-pests of mushrooms in specific areas.

Strainal evaluation trials at multilocations have helped in identification of some better strains like CM-5 and CM-7 of *Agaricus bisporus*, Vv-7 and Vv-6 of *Volvariella volvacea*, C.I-3 and C.I-9 of *Calocybe indica*. Casing mixture prepared from coir pith + FYM (1:1, v/v) and 2 years old spent compost gave maximum yield of *A.bisporus*. The EDTA washing treatment has also provided a safer alternate to KMS for increasing shelf-life of button mushroom. Packaging of button mushroom in 100 gauge PP bags also increased the keeping quality of mushrooms.

In case of oyster mushroom spray application of different chemicals invariably increased the yield at different Centres. The better yield with *P.fossulatus* and blue oyster (*Hypsizygus ulmarius*) has also improved the scope of introduction of new species in oyster mushroom scenario. The results obtained in drying experiment has also opened the gate for post harvest management of oyster mushroom.

Use of different types of beds and different substrates have also opened up options for the introducing tropical mushrooms like paddy straw and milky mushrooms. The achievements made in obtaining good yield of shiitake and black ear mushrooms are also a boon in diversification. The other aspects like germplasm collection and conservation, survey and surveillance of diseases and insect-pests and transfer of technology have also gained the requisite momentum, which is the need of the hour to boost the overall production of mushrooms in the country.

**R.P. Tewari**  
Project Coordinator

## सारांश

वर्ष 2004-05 के दौरान मुख्यालय राष्ट्रीय खुम्ब अनुसंधान केन्द्र, सोलन (हि0प्र0), सहयोगी केन्द्र डा0 यशवन्त सिंह परमार औद्योगिकी एवं वानिकी विश्वविद्यालय, नौणी, सोलन (हि0प्र0) तथा विभिन्न राज्यों में स्थित सभी अखिल भारतीय समन्वयित मशरूम उन्नयन परियोजना केन्द्रों पर वर्ष 2004 में आयोजित द्विवर्षीय कार्यशाला में तय किये गये तकनीकी कार्यक्रम के अनुसार प्रयोग किये गये।

विभिन्न केन्द्रों पर श्वेत बटन मशरूम (*एगोरिकस बाइसपोरस*) के कुल चार बिन्दुओं, प्रजाति मूल्यांकन, केसिंग मिश्रण मूल्यांकन, कटाई उपरांत मशरूम का उपचार तथा पैकिंग मैटिरियल मूल्यांकन पर प्रयोग किये गये।

श्वेत बटन मशरूम के प्रजातिय मूल्यांकन पहलू पर सात परियोजना केन्द्रों पर प्रयोग किये गये। इन प्रयोगों के दौरान पाया गया कि सी0एम0-7, सी0एम0-13 तथा सी0एम0-14 प्रजातियों ने पुणे केन्द्र पर सार्थकतापूर्वक अधिक उपज दी। जबकि लुधियाना केन्द्र पर सी0एम0-5, रायपुर केन्द्र पर सी0एम0-3, फैजाबाद केन्द्र पर सी0एम0-13, पंतनगर केन्द्र पर सी0एम0-10 एवं 5, कोयम्बटूर केन्द्र पर एस0-11 तथा सोलन मुख्यालय पर सी0एम0-18 प्रजातियों ने अन्य प्रजातियों की तुलना में अच्छी पैदावार दी। सी0एम0-10 प्रजाति द्वारा लिया गया प्रथम तुड़ान समय कोयम्बटूर, लुधियाना व पंतनगर केन्द्रों पर सबसे कम पाया गया।

विभिन्न केसिंग अवयवों के मूल्यांकन संबंधी प्रयोगों में पाया गया कि क्वायरपिथ व गोबर की खाद को बराबर हिस्सों में मिलाकर तैयार की गई केसिंग मिट्टी को प्रयोग में लाया गया तो पुणे व लुधियाना केन्द्रों पर प्रति क्विंटल कम्पोस्ट क्रमशः 13.35 किलोग्राम व 11.68 किलोग्राम अधिकतम उपज पायी गई। तुड़ई उपरांत श्वेत बटन मशरूम की गुणवत्ता बनाये रखने व अधिक समय तक भण्डारण करने के उद्देश्य से मशरूम को जब 100 पी0पी0एम0 सांद्रता के ई0डी0टी0ए0 घोल को 2 प्रतिशत पोटेशियम मेटाबाईसल्फाइड (के0एम0एस0) घोल के साथ मिलाकर तैयार किये गये घोल से धोया गया तो लगभग सभी केन्द्रों पर 5° सेल्सियस तापमान पर 48 घण्टों तक मशरूम का भण्डारण किया जा सका तथा सबसे अधिक सफेद मशरूम प्राप्त हुई।

सामान्य तापमान व रेफ्रिजरेटिड दशाओं में मशरूम की सफेदी, वजन में कमी व कैप का खुलना मानको को आधार मानकर किये पैकेजिंग के प्रयोग में कोयम्बटूर, फैजाबाद, पुणे व रायपुर केन्द्रों पर 100-125 गेज की पॉलीप्रोपाइलीन बैग में पैक की गई मशरूम उपरोक्त मानकों पर खरी उतरी।

आयस्टर (ढींगरी) मशरूम वर्ग में रसायनों का छिड़काव, *फ्लूरोटस फोस्फोलेटस* व *हार्पजीजाईगस अलमेरियस* प्रजातियों की उत्पादन क्षमता का मूल्यांकन, सम्पूरकों को उपज पर प्रभाव तथा मशरूम को सुखाना बिन्दुओं पर चार प्रयोग किये गये।

रसायन छिड़काव का आयस्टर मशरूम की उपज वृद्धि पर प्रभाव जानने हेतु किये गये प्रयोगों में पाया गया कि कोयम्बटूर, फैजाबाद व पंतनगर केन्द्रों पर *फ्लूरोटस फ्लोरिडा* व *फ्लू0साजोर-काजू* की फसल पर 0.1 एम0 सांद्रता के  $K_2HPO_4$  के घोल का छिड़काव करने से उपज में वृद्धि पाई गई। जबकि सोलन केन्द्र पर *फ्लूरोटस फ्लोरिडा* की फसल पर 0.1 प्रतिशत सांद्रता का यूरिया के घोल के छिड़काव से अधिक उपज प्राप्त हुई।

प्लूरोटस फोस्यूलेटस व हाईपजीजाईगस अलमेरियस प्रजातियों की उत्पादन क्षमता के मूल्यांकन हेतु सात केन्द्रों पर अध्ययन किया गया। कोयम्बटूर केन्द्र पर हाईपजीजाईगस अलमेरियस प्रजाति की जैव परिवर्तन क्षमता प्लूरोटस फ्लारिडा (94:) व प्लूरोटस साजोर काजू (87:) की तुलना में बहुत ही ज्यादा (124:) पायी गई।

विभिन्न तरीकों के सुखाने का प्रभाव आयस्टर मशरूम की गुणवत्ता पर परखा गया। रसायनिक उपचार उपरांत धूप में सुखाना तथा साधारण धुलाई उपरांत धूप में सुखाना विधियों ने सफेदी, कड़कपन व तीन महीने बाद भण्डारण गुणवत्ता मानको के आधार पर अच्छे परिणाम दिये।

पराली मशरूम वर्ग में प्रजाति मूल्यांकन व उत्पादन तकनीकी में सुधार हेतु अध्ययन किये गये। प्रजाति Vv-6 व Vv-7 ने विभिन्न केन्द्रों पर अन्य प्रजातियों की तुलना में अधिक पैदावार दी।

उत्पादन तकनीकी में सुधार हेतु किये गये अनुसंधान में पाया गया कि पराली से तैयार किये गये गोलाकार टोस शैय्या से सबसे अधिक उपज (22.4 कि0ग्रा0/100 कि0ग्राम शुष्क माध्यम) मिली। इसके निकटतम पैदावार वर्गाकार टोस शैय्या की रही।

दूधिया मशरूम प्रजाति मूल्यांकन अध्ययन सात केन्द्रों पर किये गये। अध्ययन के दौरान पाया गया कि प्रजाति सी0आई-06 ने कोयम्बटूर व उदयपुर केन्द्रों पर सबसे अधिक पैदावार दी जबकि प्रजाति सी0आई0-1 ने फैजाबाद और पंतनगर केन्द्रों पर, प्रजाति सी0आई0-3 ने लुधियाना केन्द्र पर तथा प्रजाति सी0आई0-07 ने विल्लयानी केन्द्र पर अधिक पैदावार दी। दूधिया मशरूम उत्पादन पोषाधार मूल्यांकन अध्ययन से पाया गया कि भूसे से तैयार पोषाधार से पुआल से तैयार पोषाधार की तुलना में अधिकतम उपज प्राप्त हुई।

शिटाके मशरूम (लेन्टीनुला इडोडस) की उत्पादन तकनीकी का मानकीकरण करने हेतु किये गये प्रयोगों से ज्ञात हुआ कि पंतनगर केन्द्र पर बुरादे में 20 प्रतिशत की दर तथा कोयम्बटूर केन्द्र पर 10 प्रतिशत की दर गेहूं का चोकर मिलाने पर शिटाके मशरूम की सबसे अधिक उपज मिली।

काले कनचपड़े (ऑरिकुलेरियेला पॉलीट्राइको) मशरूम की उत्पादन तकनीकी मानकीकरण अध्ययनों में पाया गया कि उदयपुर केन्द्र पर गेहूं के भूसे में 2 प्रतिशत की दर तथा पंतनगर केन्द्र में 10 प्रतिशत की दर से गेहूं का चोकर मिलाकर तैयार किये गये पोषाधार से अधिकतम उपज प्राप्त हुई। जबकि कोयम्बटूर केन्द्र पर पराली में 5 प्रतिशत की दर से गेहूं का चोकर मिलाकर तैयार किये गये पोषाधार से अधिकतम पैदावार मिली।

खाद्य कवकों को एकत्र करने, उन्हें पहचानने व संरक्षित करने के उद्देश्य से सभी परियोजना केन्द्रों पर सर्वेक्षण किये गये। जंगलों से कोयम्बटूर केन्द्र ने 22, फैजाबाद केन्द्र ने 4, पंतनगर केन्द्र ने 23, पुणे केन्द्र ने 13, रायपुर केन्द्र ने 20, रांची केन्द्र ने 4, उदयपुर केन्द्र ने 113, विल्लयानी केन्द्र ने 4 तथा सोलन केन्द्र ने 319 गुद्देदार कवकों के नमूने एकत्र किये गये। ज्यादातर केन्द्रों ने अपने स्तर पर इन कवकों की पहचान कर अपने केन्द्र पर ही संरक्षित किया जबकि कुछ केन्द्रों ने कुछ नमूने राष्ट्रीय खुम्ब अनुसंधान केन्द्र स्थित जिन बैंक में संरक्षित कराने हेतु जमा कराये।

लगभग सभी परियोजना केन्द्रों द्वारा अपने-अपने क्षेत्रों में बीमारियों व कीड़े-मकोड़ों के अध्ययन हेतु सर्वेक्षण व निरीक्षण कार्य किया गया। कोयम्बटूर केन्द्र पर कोप्राईनस स्पीसीज व टी0स्यूडोकोननजाई बीमारियों का प्रकोप पाया गया। पेनिसीलियम स्पीसीज, ट्राइकोडर्मा स्पीसीज, अल्टर्नेरिया अल्टर्नाटा, कोप्राईनस सपीसीज व राईजोपस

स्पीसीज नामक बीमारियां फैजाबाद केन्द्र पर पाई गयी। लुधियाना केन्द्र पर *ट्राइकोडर्मा* स्पीसीज, *कोप्राईनस* स्पीसीज व *स्कॉपूलारियोपसिस फीमीकोला* नामक संक्रमण पाये गये। पंतनगर केन्द्र पर *ट्राइकोडर्मा* स्पीसीज, *डेहलियोमाइसिस माइक्रोस्पोरस*, *पापुलास्पोरा बाईसीना*, *वर्टीसीलियम फंजीकोला* व *कीटोमियम ग्लोबोसम* बीमारियों का प्रकोप मिला। पुणे केन्द्र पर वैक्टीरियल ब्लॉच, सूखा बुलबुला, कोप्राईनस स्पीसीज, हरा फफूंद, कॉब वेब, भूरा प्लास्टर व पीला फफूंद बीमारियां पाई गई। रायपुर केन्द्र पर *ट्राइकोडर्मा* स्पीसीज, *स्केराषियम रोल्फसाई*, *कोप्राईनस* स्पीसीज व यलो ब्लॉच बीमारियों का प्रकोप देखने को मिला। उदयपुर केन्द्र पर कोप्राईनस स्पीसीज व स्कलेरोशियम स्पीसीज तथा सोलन केन्द्र पर वेट बबल बीमारियां पाई गई।

कीड़े-मकोड़ों में, स्केपीसोमा पिकटम व *एसओ नाइग्रोफेशियटम* का प्रकोप कोयम्बटूर केन्द्र पर पाया गया। सियारिड व फोरिड मक्खियों का संक्रमण सामान्य रूप से सभी केन्द्रों पर देखा गया। विभिन्न परियोजना केन्द्रों पर फलनकाय त्वचा चटकन, कलिकाओं का भूरा पड़ना तथा मशरूम का जल्दी खुलना अजैविक विषमतायें पाई गई।

सभी परियोजना केन्द्रों ने राष्ट्रीय/राज्य स्तरीय प्रदर्शनियों तथा मेलों में अपना प्रतिनिधित्व किया, आकाशवाणी व दूरदर्शन पर वातयें प्रसारित की गई। किसानों व मशरूम उत्पादकों को पत्रों, फोन व फार्म भ्रमण द्वारा सलाह मशवरा दिया गया। कुछ केन्द्रों द्वारा मशरूम पर फोल्डर व पत्रिकायें प्रकाशित की गई। सभी केन्द्रों द्वारा बेरोजगार युवकों, किसानों, उद्यमियों व महिलाओं के लिये प्रशिक्षण कार्यक्रम आयोजित किये गये। केन्द्रों द्वारा मशरूम के शुद्ध संवर्धन व स्पॉन विभिन्न प्रयोगशालाओं व उत्पादकों को प्रदान कराया गया।

मुख्यालय सोलन पर वर्ष के दौरान कुल 12 प्रशिक्षण कार्यक्रम विभिन्न वर्ग के लिये आयोजित किये गये जिसमें पांच प्रशिक्षण शिविर वाह्य परिसर, चार प्रायोजित और तीन नियमित कार्यक्रम थे। सोलन केन्द्र पर 'राष्ट्रीय मशरूम मेला' का भी आयोजन 10 सितम्बर, 2004 को किया गया जिसमें पिछले वर्षों की भांति इस वर्ष भी हिमाचल प्रदेश व उसके पड़ोसी राज्यों से लगभग 500 किसानों, मशरूम उत्पादकों व विस्तार कार्यकर्ताओं ने भाग लिया।



## SUMMARY

During the year under report (2004-05), research trials were conducted at all ten Coordinating Centres, one Cooperating Centre and the Headquarters at the National Research Centre for Mushroom, Solan (HP) based upon the technical programme finalized at the IXth Biennial Group Meeting of the Workers of All India Coordinated Mushroom Improvement Project (AICMIP) held on 25<sup>th</sup>-26<sup>th</sup> October, 2004 at NRCM, Solan (HP).

Altogether 4 experiments were laid on white button mushroom, *Agaricus bisporus* at various Centres. In strain testing trials conducted at seven Centres, strains CM-7, CM-13 and CM-14 gave significantly higher mushroom yield at Pune, while strain CM-5 at Ludhiana, strain CM-3 at Raipur, strain CM-13 at Faizabad, strain CM-10 and CM-5 at Pantnagar, strain S-11 at Coimbatore and strain CM-18 at Solan performed better than other strains. The time taken for the first harvest (days post-casing) was lowest in strain CM-10 at Coimbatore, Ludhiana and Pantnagar. In casing material evaluation trial, Coir pith in combination with FYM in the ratio of 1:1 (v/v) gave highest mushroom yield of 13.35kg and 11.68kg/100kg compost, respectively at Pune and Ludhiana Centres. In button mushroom washing treatment, combined washing treatment of 100 ppm EDTA with 0.2% KMS gave whitest mushrooms just after washing and 48 hours of storage at 5°C at almost all the Centres. In case of packaging treatment mushroom packed in 100-125 gauge polypropylene bags gave better results with respect to whiteness, weight loss and veil opening on their storage both at refrigerated and ambient temperature conditions at Coimbatore, Faizabad, Pune and Raipur Centres.

Four experiments were laid on oyster mushroom cultivation aspect, which includes effect of chemical spray on yield of *Pleurotus* spp., evaluation of yield potential of *P.fossulatus* and *Hypsizygus ulmarius*, effect of supplementation on mushroom yield and drying. In effect of chemical spray experiment, spray of 0.1M  $K_2HPO_4$  significantly enhanced the yield of *P.florida* at Faizabad, Pantnagar and Coimbatore Centres. However, spray application of 0.1% Urea gave significantly higher yield at Solan. Effect of chemical spray treatments on the yield of *P.sajor-caju* was also conducted at 4 Centres. Enhanced yield of *P.sajor-caju* was obtained by spraying of 0.1M  $K_2HPO_4$  on mushroom beds at Coimbatore, Faizabad and Pantnagar Centers. Evaluation of yield potential of *P.fossulatus* and *Hypsizygus ulmarius* was conducted at seven different Centres. At Coimbatore Centre very high biological efficiency of 124.0% was recorded in comparison to 94.0 and 87.0% in *P.florida* and *P.sajor-caju*, respectively. Effect of different drying methods on the quality of oyster mushroom revealed that chemical treatment with sun drying and simple washing with sun drying gave better results with respect to whiteness, brittleness and keeping quality after 3 months of storage.

Experiments were also conducted on paddy straw and milky mushrooms to evaluate best strains and refine the cultivation technology. In the strain evaluation trial

on *V.volvacea*, strain Vv-06, Vv-07 gave highest yield as compared to other strains at different Centres. Compact round bed prepared out of paddy straw gave highest mushroom yield of 22.4kg/100kg dry substrate which was closely followed by compact square bed. Strain evaluation trial on milky mushroom was laid out at seven Centres. Strain C.I-06 gave highest yield at Coimbatore and Udaipur Centres, while strain C.I-1 at Faizabad and Pantnagar, strain C.I-03 at Ludhiana and C.I-07 at Vellayani Centre. Among different substrates evaluated, highest mushroom yield was obtained on wheat straw as compared to paddy straw.

Experiments were also conducted on standardization of cultivation technology of shiitake (*L.edodes*) and black ear (*A.polytricha*) mushrooms. In case of shiitake, saw dust substrate supplemented with 20% and 10% wheat bran gave highest mushroom yield at Pantnagar and Coimbatore Centres, respectively. In case of black ear mushroom, 2% wheat bran supplemented wheat straw gave highest yield at Udaipur, while 10% wheat bran supplemented wheat straw at Pantnagar and 5% wheat bran supplemented paddy straw at Coimbatore.

Survey for collection, identification and preservation of wild fleshy fungi were conducted by various Centres. A total number of 22 fleshy fungi were collected at Coimbatore, four at Faizabad, 23 at Pantnagar, 13 at Pune, 20 at Raipur, 4 at Ranchi, 113 at Udaipur, 4 at Vellayani and 319 specimens at Solan Centre. Most of the Centres identified and preserved the cultures at their own level, while some Centres submitted few specimens at NRCM, Gene Bank at Solan. Survey and surveillance of diseases and insect-pests was also done by almost all the Centres. Among the common fungal pathogens/competitors, *Coprinus* sp., *T.pseudokoningii* were recorded at Coimbatore, *Penicillium* spp., *Trichoderma* spp., *Alternaria alternata*, *Coprinus* sp, and *Rhizopus* spp. at Faizabad, *Trichoderma* spp., *Coprinus* spp., *Scopulariopsis fimicola* at Ludhiana, *Trichoderma* spp., *Deihliomyces microsporus*, *Papulaspora byssina*, *Verticillium fungicola* and *Chaetomium globosum* at Pantnagar, bacterial blotch, dry bubble, *Coprinus* spp. and green mould, cobweb, brown plaster and yellow mould at Pune, *Trichoderma* spp., *Sclerotium rolsii* and *Coprinus* sp., yellow blotch at Raipur, *Coprinus* spp., *Sclerotium* spp. at Udaipur and wet bubble at Solan. Among insect-pests, *Scapisoma pictum* and *S.nigrofaciatum* were recorded at Coimbatore, while sciarid and phorid flies were common at most of the farms surveyed by different Centres. Browning, scaling and gill opening in button mushroom were also recorded at different Centres.

All the Centres carried out the extension activities by participating in State/National level Exhibitions, Melas, Kisan Gosthies, and through AIR's. Advisory services were also provided by replying letters, telephones, e-mails and on the spot guidance during farm visits. Almost all the Centres conducted training programmes of various durations for farmers, farm women, unemployed youths and the entrepreneurs of their areas. The Centres also supplied pure culture and commercial spawn to different growers. At headquarters, a total of 12 training programmes of 2 to 10 days duration were conducted out of which five were off-campus, four sponsored and rest three were under regular institutional activities.

## I. INTRODUCTION

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

- Punjab Agricultural University, Ludhiana (Punjab).
- Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu).
- G.B. Pant University of Agriculture and Technology, Pantnagar (Uttaranchal)

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

All the Co-ordinating Centres and HQrs. at NRCM, Solan work in coordination on common objectives and mandate. The technical programme for conducting participatory research at all the Centres and the HQrs. is finalized in a biennial workshop organised at any of the Centres or HQrs. During the biennial workshop the progress reports for the previous years are presented and discussed to monitor the progress made in the project during the previous years and the technologies generated are assessed for release and their adoption at all India level. The last Group meeting of workers of AICMIP was held on 25<sup>th</sup>

and 26<sup>th</sup> October, 2004 at National Research Centre for Mushroom, Solan (HP) under the Chairmanship of Dr. H.S. Sohi FNA and Ex-Director National Research Centre for Mushroom, Solan. During the meeting the progress of last two years was read out and technical programme for 2002-2004 was finalized. The objectives of the AICMIP are also identified during the workshop and presently AICMIP is working on the following objectives:

**Objectives:**

1. Survey, collection and identification of fleshy fungi in the area of respective co-ordinating Centre for exploitation and cultivation of new species/strains suited to different regions.
2. Regional adaptability trials for growing the promising strains/species of different edible fungi.
3. Selection of cheap and locally available agro/industrial wastes for composting, supplementation of substrate and casing.
4. Standardization of cultivation techniques for optimization of yields of different mushrooms.
5. Survey and surveillance of diseases and pests during different seasons in various regions.
6. Transfer of proven technology to mushroom growers and to impart training on mushroom cultivation.

## II. TECHNICAL PROGRAMME OF WORK

### I. CROP IMPROVEMENT

#### Expt. No.1: Testing of different strains of *Agaricus bisporus*

##### a) Participating : Centres

Pune, Pantnagar, Solan (Pasteurized compost using wheat straw)

Ludhiana, Raipur, Faizabad (Long method compost using wheat straw)

Coimbatore (Long method compost using paddy straw)

##### b) Substrate

###### i) Compost formula:

|               |   |         |
|---------------|---|---------|
| Wheat straw   | - | 1000 kg |
| Poultrymanure | - | 500 kg  |
| Urea          | - | 16kg    |
| Wheat bran    | - | 120 kg  |
| Gypsum        | - | 30 kg   |

ii) Substrate quantity - 10 kg compost wt./bag

iii) No. of replications - 8 for each strain in RBD.

##### c) Strains to be evaluated

i) CM-1, CM-3, CM-5, CM-6, CM-7, CM-10, CM-11, CM-12, CM-13, CM-14 and S-130 at Pune, Pantnagar and Solan.

ii) CM-3, CM-5, CM-10, S-130 and S-11 to be used at rest of the Centres by using long method of composting.

##### d) Methodology to be adopted

i) Preparation of compost by short method in 2 phases - phase-I and phase-II following standard procedure (-6, -4/0, 2,4,6,8 (fill)/phase-II (6-7 days).

Compost will be ready in 18 days.

Compost should be tested for N (2.2-2.4%), colour (dark-brown), pH (6.8-7.2), moisture (67-69%), ammonia (less than 2 ppm), bulk density 80-90kg per m<sup>3</sup> (6-7" depth)

ii) **Spawning rate:** 0.7% of wet weight of compost.

e) i) Long method compost to be prepared in single phase outdoors (without steam pasteurization) in 18-20 days (0,4,7,9,11,13,15,17 and spawn).

Ingredients to be used are wheat/paddy straw 1000kg, wheat bran 150kg, Urea-18kg, Gypsum-35kg. The compost prepared should be tested for N (1.6-1.7%), moisture (65-67%), pH (6.8-7.2), colour (dark brown), ammonia (less than 3 ppm), bulk density 80-90kg per m<sup>3</sup> bed area @ (6"-7" depth).

ii) Spawning rate to be used: 0.7% of wet weight of compost

##### f) Data to be recorded during days taken cropping

- |                                                                                                                                                                                                                      |   |                                                                                                                                                                                                                                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| i) Spawn run at 24+1°C, RH 90-95% CO <sub>2</sub> - above 10,000ppm                                                                                                                                                  | = | before weighing. Do not discard the weight of open mushrooms, but the number of mushrooms opened in each harvest should be recorded to determine the quality of the fruitbody produced by a particular strain.                        |
| ii) Case run.....do.....                                                                                                                                                                                             | = |                                                                                                                                                                                                                                       |
| iii) Days taken to pin after ventilation (Temp. 15-17°C, RH 80-85%, CO <sub>2</sub> - below 1500ppm)                                                                                                                 | = |                                                                                                                                                                                                                                       |
| iv) First harvest (days taken after casing)                                                                                                                                                                          | = | - Average fruitbody weight to be recorded in each treatment (Total weight of mushrooms harvested divided by No. of mushrooms harvested) to determine the quality of mushrooms produced and ultimately the dry weight of the mushroom. |
| v) Last harvest                                                                                                                                                                                                      | = |                                                                                                                                                                                                                                       |
| (Data for total cropping days of 6 weeks only to be recorded)                                                                                                                                                        |   |                                                                                                                                                                                                                                       |
| vi) Disease/pest encountered causing economic losses                                                                                                                                                                 | = | - Every effort should be made to strictly adhere to the above instructions for this experiment. This will facilitate generation of uniform data for assessment and final recommendation.                                              |
| Bag size-18"x24" (polythene - 150 gauge)                                                                                                                                                                             |   |                                                                                                                                                                                                                                       |
| - The yield data should be recorded in tabulated form replication wise.                                                                                                                                              |   |                                                                                                                                                                                                                                       |
| - The replicates should be randomised in cropping rooms in different tiers in RBD.                                                                                                                                   |   |                                                                                                                                                                                                                                       |
| - Watering should be restricted to wetting of casing material. Humidifier to be used for RH maintenance.                                                                                                             |   |                                                                                                                                                                                                                                       |
| - Use standard casing material recommended, i.e., spent compost/FYM (both 2 years old - well decomposed in a pit).                                                                                                   |   |                                                                                                                                                                                                                                       |
| - The casing material should be water leached for 8 hours before treatment with steam/chemicals. Uniform layer of casing to be applied on mycelia impregnated compost, with use of 4cm wide metal rings (4cm thick). |   |                                                                                                                                                                                                                                       |
| - Harvest mushrooms in button form, removing the solid stem end with knife                                                                                                                                           |   |                                                                                                                                                                                                                                       |

### Expt. No.2: Strainal evaluation of Milky mushroom, *Calocybe indica*

**a) Participating Centres:** All Centres

#### **b) Substrate**

- |                          |                                                                    |
|--------------------------|--------------------------------------------------------------------|
| i) Substrate quantity    | - 5 kg wet wt. (each bag to be cut into 2 halves)                  |
| ii) Bag size             | - 30 x 90 cm                                                       |
| iii) No. of replications | - 8 for each strain.                                               |
| iv) Substrate treatment  | - Hot water treated (70°C for 30 minutes) paddy straw/ wheat straw |

**c) Strains** : 9 strains C.I-1, C.I-2, C.I-3, C.I-

4, C.I-5, C.I-6,  
C.I-7, C.I-8 and  
CI-9.

**d) Spawn rate** : 5% wet wt.  
basis

**e) Observations to be recorded**

- Number, weight and size of the mushroom viz., pileus diameter and stipe length are also to be observed

**Expt. No.3: Strainal evaluation of Paddy straw mushroom (*Volvariella volvacea*)**

**a) Participating - Centre** - Ludhiana, Faizabad, Coimbatore, Raipur, Ranchi, Barapani, Vellayani

**b) Substrate**

Observations and methodology as per Expt. No.8 by using 5 bundles x 4 layers + 2 bundles opened at top.

**c) Strains** : All *Volvariella* strains except VV-5 & VV-3.

**II. CROP PRODUCTION**

**1. Button Mushroom**

**Expt. No.4: To test the locally available agro-industrial wastes for feasibility as casing materials**

**a) Participating : Centres** : Solan, Ludhiana, Pune and Udaipur

**b) Substrate treatment**

i) FYM+spent compost (1:1) (v/v)

ii) Spent compost (2 years old)

iii) Coirpith

iv) Coirpith+FYM (1:1) (v/v)

v) Coirpith + FYM (1:4) (v/v)

vi) Coirpith + spent compost (1:1) (v/v)

vii) Burnt rice husk + FYM (1:1)

viii) Burnt rice husk +FYM (1:2)

ix) FYM+coirpith+burnt rice husk (4:1:1) (v/v)

x) FYM+garden soil (1:1) (v/v) – (control-1)

xi) FYM (control-2)

**c) No. of replications** : 10 of 10 kg compost/  
bag

**d) Design** : RBD

**e) Physical parameters to be analysed at NRCM, Solan**

**f) Brief description of : methodology** : Cultivation method same as for Expt. No. 1.

Data to be recorded:

1. pH
2. Water holding capacity
3. Conductivity
4. Density
5. Yield (No. and weight of mushroom).

## 2. Oyster Mushroom

### Expt. No.5: Effect of chemical spray on yield of *Pleurotus* spp.

- a) **Participating Centres:** All Centres
- b) **Species to be used:** *P.florida*,  
*P.sajor-caju*
- c) **Substrate treatment:** Hot water treatment (80°C and above for 30 minutes)
- d) **Containers** : Polybags (60x30cm)

### Spraying mushroom beds at pinning

- i) with 0.1M Dipotassium hydrogen phosphate ( $K_2HPO_4$ )
- ii) with Urea 0.1%

\* Second and third spray after 1st harvest and 15 days later, respectively

- f) **No. of replications:** 15 bags each of 1.0kg dry wt. treatment

### g) **Data to be recorded** :

1. No. of pinheads appeared
2. No. of mushrooms harvested
3. Yield data (kg/100kg dry weight basis upto 4 weeks)
4. Time taken for I, II and III flush
5. Contamination of beds (%)
6. Type of contamination
7. Daily bed temperature

8. Cropping room temperature (max. and min.) and RH (%).

### Expt. No.6: Evaluation of the yield potential of *Pleurotus fossulatus*

- a) **Participating Centres** : Solan, Udaipur, Coimbatore, Ludhiana, Raipur, Barapani, Faizabad, Ranchi, Pantnagar
- b) **Species to be used** : *P. fossulatus* and *P. florida* (low temperature strain)
- c) **Substrate treatment** : Hot water treatment (80°C and above)
- d) **Substrate quantity** : 1 kg dry substrate/ bag
- e) **Containers** : Polybags (60x 30cm)
- f) **No. of replications** : 15 bags each of 1.0 kg dry weight

### g) **Data to be recorded:**

1. Days taken for spawn run
2. Days taken for pinhead formation
3. Yield data (number and weight of fruitbodies upto 4 weeks)
4. Time taken for I, II and III flush
5. Pest and disease incidence (as per proforma)
6. Cropping room temperature (°C) and RH (%).

### Expt. No.7: Evaluation of the yield potential of blue oyster mushroom (*Hypsizygus ulmarius*)

a) **Participating Centres:** All Centres

b) **Species to be used :**

i) *Hypsizygus ulmarius*

ii) *Pleurotus florida*

iii) *P. sajor-caju*

c) **All other details as per Experiment No.6.**

### 3. Paddy straw mushroom

### Expt.No.8: Cultivation of Paddy Straw Mushroom (*Volvariella volvacea*)

a) **Participating Centres :**

Coimbatore, Ludhiana, Faizabad, Raipur, Vellayani, Solan and Barapani

b) **Substrate Treatments**

1. Hollow bed (6" hollow dia)
2. Compact bed (square)
3. Compact bed (round)
4. Bundle method (hollow) (4 bundles x 5 layers + 2 bundles opened at top)
5. Bundle method (5 bundles x 4 layers + 2 bundles opened at top)

c) **Replication :** 5

d) **Design :** RBD

e) **Supplementation :** 2 % Horse gram powder

f) **Substrate treatment :**

- Pre wetting -20 h
- Drain excess moisture/squeeze until 70 % moisture is retained

g) **Substrate quantity**

h) **Spawn rate :** 1.5 % to dry weight of straw

i) **Harvesting at egg stage**

j) **Observations to be recorded**

1. Daily room temperature & RH
2. Substrate moisture at spawning by oven dry method.
3. Daily bed temperature after spawning till end of crop
4. Days for spawn run
5. Days for pinhead formation
6. No. of fruit bodies
7. Yield data (number and weight I, II, III week)
8. Average fruit body weight
9. Biological efficiency (kg fresh mushroom per 100 kg dry straw)
10. Incidence of competitor moulds as per the scale decided in the VIIIth Mushroom Group Worker's Meet.

11. Incidence of pests as per the scale decided in the VIIIth Mushroom Group Worker's Meet.

#### 4. Milky Mushroom

##### Expt. No.9: Cultivation of milky mushroom, *Calocybe indica*

a) **Participating Centres** : Ludhiana, Faizabad, Pune, Raipur, Udaipur, Pantnagar, Vellayani, Ranchi and Barapani.

b) **Species to be used** : *Calocybe indica* var. APK2

c) **Substrate** : i) Wheat straw alone  
ii) Paddy straw alone and in combination with wheat straw 1:1, 1:2, 2:1

d) **Method of substrate** : CST, hot water, preparation solar pasteurization, Autoclaving

e) **Spawn rate** : 4%

f) **No. of replication** : 20 each (5kg/bag)

g) **Observation to be**: Time taken for recorded spawn run and total yield

h) **Size of bag** : 90cm x 30cm

i) **Casing soil** : Clay loam or sandy loam with a standard pH of 8.0 to 8.5 (In case the pH of the soil is less, add  $\text{CaCO}_3$ ) casing soil is to be steamed for 1 h at 10 psi pressure

j) **Casing layer** : 2 cm thick

\* Cropping should preferably be conducted in polyhouse lined with blue HDP silpaulin sheet as roofing material.

k) **Observations to be recorded** : As per Experiment No. 2

#### 5. Shiitake Mushroom

##### Expt. No.10: Cultivation of shiitake mushroom, *Lentinula edodes*

a) **Participating Centres** :

Pantnagar, Coimbatore, Pune, Udaipur, Solan, Ludhiana and Raipur

b) **Strain** : Malaysian

c) **Substrate** : i) Saw dust

- ii) Wheat straw
- d) Supplement** : Wheat bran 5, 10 and 20% dry weight basis
- e) Method of substrate preparation** : Auto claving
- f) Spawn rate** : 5%
- g) No. of replication** : 20 each (2kg/bag)
- h) Observations to be** : Time taken for recorded spawn run and total yield

**i) Production technology to be followed:**

Take 40kg saw dust of hard wood broad leaved trees



Add water (65%) for thorough overnight wetting



Add wheat bran and mix thoroughly



Fill 2kg each in polypropylene bags and put ring and cotton plug



Autoclave at 121°C for 1/2 hours



On cooling spawn aseptically @ 2% on wet weight basis.

↓  
Incubate at 24°C



After completion of spawn run (about 60 days) allow them to turn brown



Remove the PP bags and dip the blocks in chilled water (4-5°C) for about 5 minutes



Keep the block for fruiting at 20-23°C

## 6. Jew's Ear Mushroom

**Expt. No.11: Cultivation of Black ear mushroom, *Auricularia polytricha***

### a) Participating Centres :

Pantnagar,  
Coimbatore,  
Raipur, Ludhiana,  
Udaipur and  
Barapani

**b) Substrate** : i) Wheat straw

ii) Paddy straw

**c) Supplement** : Wheat bran @ 2, 5 and 10% on dry weight basis

**d) Method of substrate:** Autoclaving, hot preparation water, solar pasteurization

**e) Spawn rate** : 2%

**f) No. of replication** : 20 each  
(2kg/bag)

**g) Observations to be** : Time taken for  
recorded  
spawn run  
and total yield

**h) Production technology to be followed:**

**a)** Substrate preparation



Wet the substrate for 20 h



Supplement with wheat bran (if required  
as per treatments)



Fill in autoclavable PP bags (30 x 60  
cm) @ 2 kg (wet weight) per bag



Autoclave at 15 psi for 1 hour



Cool the bags and spawn (preferably  
aseptically) @ 2 % on wet weight basis



Incubate at 25 to 28 °C



After 3-4 weeks give vertical slits and  
maintain high RH (80-85%) in the  
cropping room

**b) Design** : RBD

**c) Observations to be recorded:**

1. Daily room temperature & RH
2. Substrate moisture at spawning
3. Days for spawn run
4. Days for pinhead formation
5. No. of fruitbodies
6. Average fruitbody weight
7. Yield data (I, II, III week)
8. Biological efficiency
9. Incidence of pests, diseases and  
abiotic disorders as per proforma

### III. POST HARVEST TECHNOLOGY

**Expt. No.12: Washing treatment for  
button mushroom, *A.  
bisporus***

**a) Participating Centres** : All Centres  
doing  
Experi-  
ment on *A.  
bisporus*

**b) Strain** : Most popular  
strain in the  
r e g i o n  
S-11 or U-3 of  
white button  
mushroom

**c) Treatment** : 100 ppm EDTA  
– Di Na 150 ppm  
200 ppm 100 +  
0.02% KMS  
500 ppm  
Unwashed

**d) Storage** : 5°C, Ambient  
(only upto 48 h)

3. Veil opening (%  
m u s h r o o m s  
opened)

**e) Observations to be:** Whiteness  
only  
recorded  
(either %  
reflectance or  
++, +++,  
+ + + + )  
Before  
washing  
  
After  
washing  
  
After 24 h  
  
After 48 h

#### Expt. No.14: Drying of oyster mushroom

**a) Participating Centres** : Raipur, Ludhiana,  
U d a i p u r ,  
Coimbatore and  
Vellayani

**b) Strain/species** : Most popular in  
the region

**c) Treatments** : Blanched (0.2%  
salt + 0.1% citric  
acid for 2 minutes)

U n b l a n c h e d  
(0.2% salt + 0.1%  
cetric acid for 2  
minutes)

#### Expt. No.13: Packaging for button mushroom (washed with 0.05% KMS)

**a) Participating Centres:** All Centres  
d o i n g  
experiments  
on button  
mushroom

Sun drying

Cabinet drying  
(60°C till 7%  
moisture)

#### b) Treatments

i) Uniform size, 75 gauge PP, 100  
gauge PP, 125 gauge and 100 PE  
control

ii) No holes: 10 allpin holes

**c) Storage** : Refrigerator,  
Ambient

**d) Observation** : 1. Weight loss  
  
2. Whiteness (%  
reflectance or ++,  
+++,++++)

**d) Observations:** 1. Weight gain/loss  
to be recorded

2. Whiteness/  
yellowness

3. Brittleness

4. Keeping quality  
in pack of 100  
gauge PP (3  
months–rottag, insect attack, off-  
flavour)

**Expt. No.15: Wild germplasm  
collection, identification  
and conser-vation**

**Data Recording :** As per the  
p r o f o r m a  
supplied in  
proceedings  
of the VIIIth  
B i e n n i a l  
Workshop of  
AICMIP

**Expt. No.16: Survey and Surveillance  
of diseases and insect  
pests in mushroom  
farms in different regions**

**Data Recording :** As per the  
p r o f o r m a  
supplied in  
proceedings  
of the VIIIth  
B i e n n i a l  
Workshop of  
AICMIP

### III. RESEARCH PROGRESS

#### 1. Crop Improvement

##### 1.1 Testing of strains of white button mushroom, *A. bisporus*

The trial was assigned to seven Centres including the Headquarters by using compost prepared both by long and short method of composting. At Coimbatore Centre highest yield (18.50kg) was recorded in strain CM-10 followed by strain CM-15. At Faizabad Centre highest yield of 13.42kg/100kg compost was recorded in strain CM-13, followed by 12.61kg in strain S-11. At Ludhiana Centre strain CM-5 out-yielded other strains, while strains CM-7 and CM-13 at Pune, strains CM-1 and CM-5 at Pantnagar and CM-3 at Raipur gave higher yield

than other strains tested. At Headquarters, strain S-11 gave highest yield (18.26kg) and it was followed by strain CM-5 and CM-10 (Table-1). In overall average basis strain S-11 out performed others.

The time taken for first harvest (days post casing) was lowest in strain CM-10 at Coimbatore, Ludhiana and Pantnagar, while it was lowest in strains CM-12 and CM-1 at Raipur Centre. On overall basis lowest time for first harvest was 12 days in strain CM-12 at Raipur in comparison to highest of 27 to 32 days both at Ludhiana and Coimbatore Centres. The average fruiting body weight was also higher at Raipur and Coimbatore Centres, where it ranged between 12.27 to 17.76g in comparison to range of 8.63g to 12.87g at Ludhiana

Table 1. Yielding potential of different strains of white button mushroom, *A.bisporus*

| <i>A.bisporus</i><br>Strain | Mushroom yield (kg/100kg of compost) at different Centres |          |        |          |            |                 |       |       |
|-----------------------------|-----------------------------------------------------------|----------|--------|----------|------------|-----------------|-------|-------|
|                             | Pune                                                      | Ludhiana | Raipur | Faizabad | Pant-nagar | Coimb-<br>atore | Solan | Av.   |
| CM-1                        | 13.53                                                     | -        | 6.47   | -        | 17.2       | -               | 11.21 | 12.10 |
| CM-3                        | 14.04                                                     | 9.62     | 7.64   | 11.91    | 15.20      | 14.60           | 12.86 | 12.27 |
| CM-5                        | 10.15                                                     | 12.10    | -      | 10.62    | 16.56      | 15.20           | 15.45 | 13.35 |
| CM-6                        | 14.03                                                     | -        | -      | -        | 6.38       | -               | 11.65 | 10.69 |
| CM-7                        | 17.89                                                     | -        | 5.91   | -        | 14.06      | -               | 14.98 | 13.21 |
| CM-10                       | 13.91                                                     | 10.14    | 3.40   | 10.21    | 15.24      | 18.50           | 15.01 | 12.34 |
| CM-11                       | 13.04                                                     | -        | 1.91   | -        | 13.09      | -               | 14.94 | 10.75 |
| CM-12                       | 13.09                                                     | -        | 3.02   | -        | 10.99      | -               | 14.15 | 10.31 |
| CM-13                       | 16.88                                                     | -        | 3.58   | 13.42    | 13.67      | -               | 12.43 | 12.00 |
| CM-14                       | 15.84                                                     | -        | 3.42   | -        | 10.97      | -               | 10.64 | 10.22 |
| S-11                        | -                                                         | 10.32    | -      | 12.61    | -          | 15.8            | 18.26 | 14.25 |
| CM-15<br>control            | 13.99                                                     | -        | -      | -        | 11.92      | 16.0            | 11.06 | 13.24 |
| CD                          | 1.12                                                      | 1.44     | -      | 1.18     | 0.83       | 2.40            | 2.52  |       |



Fig. 1: White button mushroom cultivation trial by using different agro-industrial wastes as casing materials (Courtesy: Dr. B.L. Dhar, NRCM, Solan)

and Pantnagar Centres. At Solan Centre, the time taken for first harvest ranged between 17.9 to 23.4 days. Except strain CM-5, the difference in time taken for first harvest was insignificant. The average fruiting body weight also did not show much variations

and it ranged between 12.8g to 14.4g. On overall average basis the time taken for first harvest was lowest in strains CM-1, CM-12 and CM-7, while the average fruitbody weight did not show much variation in different strains (Table-2).

Table 2: Time taken for first harvest and average fruitbody weight in different strains of *A.bisporus*

| <i>A.bisporus</i><br>strain | Time taken for first harvest (days post-casing)/fruitbody weight/Centre |      |        |       |           |       |            |       |       |      |         |       |
|-----------------------------|-------------------------------------------------------------------------|------|--------|-------|-----------|-------|------------|-------|-------|------|---------|-------|
|                             | Ludhiana                                                                |      | Raipur |       | Pantnagar |       | Coimbatore |       | Solan |      | Average |       |
|                             | a                                                                       | b    | a      | b     | a         | b     | a          | b     | a     | b    | a       | b     |
| CM-1                        | -                                                                       | -    | 12.3   | 12.22 | 16        | 8.71  | -          | -     | 17.9  | 13.1 | 15.4    | 11.34 |
| CM-3                        | 28                                                                      | 11.2 | 13.9   | 14.31 | 16        | 8.63  | 32         | 12.37 | 18.6  | 14.4 | 21.7    | 12.18 |
| CM-5                        | 29                                                                      | 11.0 | -      | -     | 16        | 9.17  | 28         | 13.82 | 23.4  | 13.2 | 24.1    | 11.80 |
| CM-6                        | -                                                                       | -    | -      | -     | 18        | 12.87 | -          | -     | 19.9  | 14.1 | 18.95   | 13.48 |
| CM-7                        | -                                                                       | -    | 13.5   | 13.43 | 16        | 9.32  | -          | -     | 18.9  | 13.7 | 16.1    | 12.15 |
| CM-10                       | 27                                                                      | 9.6  | 16.2   | 16.27 | 16        | 11.21 | 27         | 14.02 | 19.1  | 13.6 | 21.06   | 12.94 |
| CM-11                       | -                                                                       | -    | 14.8   | 16.09 | 16        | 11.58 | -          | -     | 19.0  | 14.2 | 16.6    | 13.96 |
| CM-12                       | -                                                                       | -    | 12.0   | 13.25 | 16        | 11.83 | -          | -     | 18.6  | 14.1 | 15.53   | 13.06 |
| CM-13                       | -                                                                       | -    | 15.9   | 15.40 | 17        | 9.92  | -          | -     | 18.0  | 13.5 | 16.97   | 12.94 |
| CM-14                       | -                                                                       | -    | 18.9   | 17.76 | 17        | 12.35 | -          | -     | 18.9  | 12.8 | 18.27   | 14.30 |
| S-11                        | 28                                                                      | 11.7 | -      | -     | -         | -     | 28         | 13.74 | 19.3  | 13.5 | 25.1    | 12.98 |
| CM-15                       | -                                                                       | -    | -      | -     | 17        | 11.06 | 30         | 13.33 | 18.9  | 13.9 | 21.97   | 12.76 |
| CD                          | NC                                                                      | NS   | -      | -     | -         | -     | NS         | 0.68  |       |      |         |       |
| 0.05%                       |                                                                         |      |        |       |           |       |            |       |       |      |         |       |

a = Time taken for first harvest (days post-casing)

b = Average fruitbody weight (g)

## 1.2 Testing of strains of milky mushroom, *Calocybe indica*

The trial was laid out at seven Centres by including 9 different strains. The mushroom yield obtained at different Centres varied in different strains. Strain C.I-06 gave highest yield at Coimbatore and Udaipur Centres, while strain C.I-1 at Faizabad and Pantnagar, strain C.I-03 at Ludhiana and C.I-07 at Vellayani Centre (Table-3). Highest biological efficiency of 182 per cent was obtained at Coimbatore, while lowest of 20.6% at Raipur Centre.

## 1.3 Testing of strains of paddy straw mushroom, *Volvariella volvacea*

The trial was laid out at 4 different Centres and highest biological efficiency in the range of 20.3 to 23.2% was recorded at Coimbatore followed by Ludhiana Centre. Strain Vv-07 gave highest yield of 23.2kg/100kg dry substrate at Coimbatore, while strain Vv-04 at Ludhiana, Vv-03 at Faizabad and Vv-06 at Vellayani Centre (Table-4). On overall average basis strains Vv-06 and Vv-07 gave higher yield than other strains.

**Table 3: Strainal evaluation of milky mushroom, *C.indica***

| Strain  | Yield (kg/100kg dry substrate) at different Centres |          |        |         |          |           |                 |      |
|---------|-----------------------------------------------------|----------|--------|---------|----------|-----------|-----------------|------|
|         | Vellayani                                           | Ludhiana | Raipur | Udaipur | Faizabad | Pantnagar | Coimbatore<br>a | b    |
| C.I-1   | -                                                   | 41.0     | -      | 18.33   | 36.5     | 42.6      | 168             | 42.8 |
| C.I-2   | -                                                   | 49.5     | -      | 38.13   | 20.2     | 31.46     | 176             | 44.0 |
| C.I-3   | 52.3                                                | 62.9     | -      | 34.13   | 25.8     | 26.89     | 162             | 42.0 |
| C.I-4   | -                                                   | -        | -      | 40.26   | -        | -         | 156             | 47.6 |
| C.I-5   | 52.6                                                | -        | -      | 40.86   | -        | -         | 170             | 48.0 |
| C.I-6   | -                                                   | 42.2     | -      | 51.33   | -        | -         | 182             | 42.0 |
| C.I-7   | 52.8                                                | 32.6     | 23.0   | -       | -        | -         | 164             | 43.4 |
| C.I-8   | 47.5                                                | 38.6     | -      | -       | -        | -         | 158             | 46.2 |
| C.I-9   | -                                                   | 58.0     | 20.6   | 23.66   | -        | -         | 172             | 46.0 |
| C.I-10  | -                                                   | -        | 27.3   | 27.33   | -        | -         | -               | -    |
| CD (5%) | 17.81                                               | 3.4      | -      | 1.72    | 3.41     | 7.53      | 12.96           | NS   |

a) mushroom yield; b) average fruitbody weight (g)

**Table 4: Strainal evaluation of paddy straw mushroom, *Volvariella volvacea***

| Strain | Yield (Kg/100kg of dry substrate) at different Centres |          |          |                  |      |           |
|--------|--------------------------------------------------------|----------|----------|------------------|------|-----------|
|        | Ludhiana                                               | Barapani | Faizabad | Coimbatore<br>a) | b)   | Av. Yield |
| Vv-1   | 7.8                                                    | 0.19     | —        | 21.0             | 20.2 | 9.6       |
| Vv-2   | 15.8                                                   | 0.14     | 10.6     | —                | —    | 8.84      |
| Vv-3   | 4.3                                                    | —        | 14.7     | —                | —    | 9.5       |
| Vv-4   | 16.2                                                   | 0.14     | 7.97     | —                | —    | 8.10      |
| Vv-5   | 15.6                                                   | —        | 8.39     | —                | —    | 11.99     |
| Vv-6   | 13.2                                                   | 10.5     | —        | 20.3             | 21.7 | 14.67     |
| Vv-7   | 8.1                                                    | —        | —        | 23.2             | 2.0  | 15.65     |
| CD     | 0.5                                                    | —        | 1.37     | 0.972            |      |           |

a) Average mushroom yield; b) average fruiting body weight (g).

## 2. Crop Production

### 2.1 White button mushroom

#### 2.1.1 Evaluation of different agro-industrial wastes as casing material for white button mushroom, *A. bisporus*

The experimental trail was laid out at three Centres including the Headquarters. Coirpith in combination with FYM in the ratio of 1:1 (v/v) gave highest mushroom yield of 13.35kg and 11.68kg/100kg compost, respectively, at Pune and Ludhiana Centres. It was followed by mixture of coirpith with FYM in the ratio of 1:4 (v/v) at both the Centres. The fruiting bodies obtained from coirpith+FYM were also of good weight and it ranged between 10.1g to 10.4g (Table-5).

#### 2.1.2 Physico-chemical properties of agro-industrial wastes evaluated as casing materials for white button mushroom, *A. bisporus*

The experiment was laid out at 4 different Centres including the Headquarters. The pH, water holding capacity and conductivity were recorded highest in coirpith and its combination with FYM at Ludhiana, Udaipur and Pune Centres, while the particle density was in lower range and the highest particle density was of casing material prepared with FYM+garden soil (1:1, v/v). The pH of better performing casing material (coirpith, coirpith+FYM (1:1, v/v) and coirpith + FYM (1:4 v/v) was in alkaline range and it varied from 7.15 to 8.1. The conductivity varied between 0.52 mmho in coirpith to maximum of 3.05 in coirpith+FYM (1:4 v/v). Similarly the

**Table 5: Effect of different casing materials on the yield and fruitbody weight of *A.bisporus***

| Treatment                                              | Mushroom yield (kg/100kg compost) at different Centres |                      |       |
|--------------------------------------------------------|--------------------------------------------------------|----------------------|-------|
|                                                        | Pune<br>a                                              | Ludhiana<br>a      b | Solan |
| Farm yard manure (FYM) + spent compost (SC) (1:1, v/v) | 10.04                                                  | 9.88                 | 9.9   |
| SC (2 years old)                                       | 10.60                                                  | 7.80                 | 9.8   |
| Coirpith (CP)                                          | 13.02                                                  | 8.60                 | 10.2  |
| CP+FYM (1:1, v/v)                                      | 13.35                                                  | 11.68                | 10.4  |
| CP+FYM (1:4, v/v)                                      | 13.01                                                  | 9.68                 | 10.1  |
| CP+SC (1:1, v/v)                                       | 12.40                                                  | 8.52                 | 10.7  |
| Burnt rice husk (BRH)+FYM (1:1, v/v)                   | 12.11                                                  | 8.64                 | 10.8  |
| BRH+FYM (1:2, v/v)                                     | 12.88                                                  | 8.80                 | 11.0  |
| FYM+CP+BRH (4:1:1 v/v)                                 | 12.56                                                  | 8.98                 | 11.8  |
| FYM+Garden soil (1:1, v/v) Control-I                   | 11.74                                                  | 7.48                 | 11.0  |
| FYM control-II                                         | 10.65                                                  | 8.40                 | 11.9  |
| CD (5%)                                                | 0.87                                                   | 1.62                 | NS    |

a = Total yield, b = Average fruitbody wt.

water holding capacity ranged between lowest of 40.18 in coirpith+FYM (1:4, v/v) to highest to 450 in coirpith. The particle density increased with increased proportion of FYM in the casing material (Table-6).

## 2.2 Oyster mushroom

### 2.2.1 Effect of spray of different chemicals on yield of *Pleurotus florida* and *P.sajor-caju*

The experiment was conducted at 5 different Centres. Two chemicals viz; dipotassium hydrogen phosphate ( $K_2HPO_4$ ) and Urea were applied @ 0.1M and 0.1%, respectively on mycelium colonized substrate bags of *P.florida* and

*P.sajor-caju*. The spray of 0.1M  $K_2HPO_4$  significantly enhanced the yield of *P.florida* at Faizabad, Pantnagar and Coimbatore Centres. At Ludhiana and Raipur Centres, the control treatment gave significantly higher yield than chemical sprayed substrate bags (Table-7). The spray treatment with 0.1% Urea gave significantly higher yield at Solan. However, the overall average did not show much variations in yield in different treatments.

The experiment with *P.sajor-caju* was conducted at 4 Centres. Enhanced yield of *P.sajor-caju* was obtained on spraying 0.1M  $K_2HPO_4$  on mushroom beds at Coimbatore, Faizabad and Pantnagar Centres, while the

**Table 6: Different quality parameters of casing materials**

| Treatment                  | Centres  |     |       |      |      |     |       |      |         |       |       |       |
|----------------------------|----------|-----|-------|------|------|-----|-------|------|---------|-------|-------|-------|
|                            | Ludhiana |     |       |      | Pune |     |       |      | Udaipur |       |       |       |
|                            | pH       | WHC | Cond. | Den. | pH   | WHC | Cond. | Den. | pH      | WHC   | Cond. | Den.  |
| FYM+SC (1:1, v/v)          | 7.66     | 89  | 0.45  | 0.92 | 6.9  | 73  | 0.56  | 0.59 | 7.6     | 43.87 | 3.77  | 0.605 |
| SC (2 year old)            | 6.97     | 110 | 0.60  | 0.74 | 6.7  | 70  | 0.82  | 0.55 | 6.91    | 62.89 | 3.37  | 0.662 |
| Coirpith (CP)              | 7.15     | 450 | 0.52  | 0.13 | 7.5  | 80  | 1.56  | 0.39 | 7.94    | 35.67 | 1.03  | 0.387 |
| CP+FYM (1:1, v/v)          | 7.50     | 248 | 1.55  | 0.37 | 7.3  | 75  | 1.40  | 0.46 | 7.87    | 94.95 | 2.58  | 0.457 |
| CP+FYM (1:4, v/v)          | 7.70     | 123 | 2.50  | 0.66 | 7.0  | 73  | 1.38  | 0.47 | 8.1     | 40.18 | 3.05  | 0.581 |
| CP+SC (1:1, v/v)           | 6.62     | 223 | 1.45  | 0.59 | 7.2  | 72  | 1.52  | 0.42 | 7.27    | 52.66 | 2.64  | 0.304 |
| BRH+FYM (1:1, v/v)         | 7.24     | 184 | 1.00  | 0.48 | 7.2  | 63  | 0.40  | 0.37 | 8.33    | 62.09 | 2.62  | 0.731 |
| BRH+FYM (1:2, v/v)         | 7.46     | 180 | 2.55  | 0.54 | 7.3  | 65  | 0.38  | 0.39 | 8.35    | 67.21 | 2.84  | 0.628 |
| FYM+CP+BRH (4:1:1, v/v)    | 7.53     | 160 | 2.00  | 0.54 | 7.1  | 68  | 0.89  | 0.42 | 8.05    | 75.25 | 2.64  | 0.325 |
| FYM+Garden soil (1:1, v/v) | 7.77     | 48  | 1.75  | 1.09 | 7.4  | 69  | 0.50  | 0.80 | 8.26    | 52.66 | 1.87  | 0.804 |
| Control-I                  |          |     |       |      |      |     |       |      |         |       |       |       |
| FYM Control-2              | 7.61     | 95  | 2.85  | 0.77 | 7.2  | 71  | 0.45  | 0.55 | 8.29    | 44.25 | 2.69  | 0.714 |

Table 7: Effect of chemical spray on yield of *Pleurotus florida*

| Treatment                              | Yield (kg/100kg dry substrate) at different Centres |        |          |           |            |       | Average |
|----------------------------------------|-----------------------------------------------------|--------|----------|-----------|------------|-------|---------|
|                                        | Ludhiana                                            | Raipur | Faizabad | Pantnagar | Coimbatore | Solan |         |
| K <sub>2</sub> HPO <sub>4</sub> (0.1M) | 46.4                                                | 116.0  | 48.13    | 83.8      | 92.0       | 68.1  | 75.74   |
| Urea (0.1%)                            | 42.2                                                | 133.0  | 47.14    | 73.4      | 87.0       | 81.4  | 77.36   |
| Control                                | 65.0                                                | 151.5  | 41.67    | 72.2      | 84.0       | 58.4  | 78.80   |
| CD (5%)                                | 3.5                                                 | NS     | 3.91     | 9.82      | 5.68       | 17.46 | -       |

mushroom yield at Ludhiana Centre was significantly less in chemical sprayed treatments in comparison to control (Table-8). There were minor variations at average mushroom yield data calculated after summing up of yield obtained at different Centres.

### 2.2.2 Evaluation of yield potential of *Pleurotus fossulatus* and *Hypsizygus ulmarius*

The experiment was conducted at 7 different Centres including the

Headquarters. Blue oyster mushroom, *Hypsizygus ulmarius* gave higher yield at Pantnagar and Coimbatore Centres. At Coimbatore Centre very high biological efficiency of 124.0% was recorded in this mushroom in comparison to 94.0 and 87.0% in *P.florida* and *P.sajor-caju*, respectively. At Ludhiana, Raipur, Faizabad and Vellayani, the control *Pleurotus* spp. (*P.florida* and *P.sajor-caju*) out-yielded the test species (Table-9).

Table 8: Effect of chemical spray on yield of *P.sajor-caju*

| Treatment                              | Yield (kg/100kg dry substrate) at different Centres |        |          |           |            | Average Yield |
|----------------------------------------|-----------------------------------------------------|--------|----------|-----------|------------|---------------|
|                                        | Ludhiana                                            | Raipur | Faizabad | Pantnagar | Coimbatore |               |
| K <sub>2</sub> HPO <sub>4</sub> (0.1M) | 38.6                                                | 116.0  | 52.72    | 91.33     | 88.0       | 77.33         |
| Urea (0.1%)                            | 42.2                                                | 133.0  | 50.38    | 75.26     | 83.0       | 76.77         |
| Control                                | 56.7                                                | 151.5  | 46.34    | 71.6      | 82.0       | 81.63         |
| CD (5%)                                | 8.7                                                 | NS     | 4.13     | 3.14      | NS         |               |

Table 9: Evaluation of yield potential of *P.fossulatus* and *Hypsizygus ulmarius*

| Centres    | Biological efficiency (%) |                   |                    |                      | CD (5%) |
|------------|---------------------------|-------------------|--------------------|----------------------|---------|
|            | <i>P. fossulatus</i>      | <i>P. florida</i> | <i>H. ulmarius</i> | <i>P. sajor-caju</i> |         |
| Pune       | -                         | 54.5              | 50.2               | 55.1                 | 3.80    |
| Raipur     | -                         | 87.00             | 73.64              | 78.3                 | NS      |
| Faizabad   | 26.33                     | 42.13             | 29.13              | 45.31                | 3.12    |
| Pantnagar  | 51.5                      | 47.7              | 57.2               | 52.13                | 8.70    |
| Coimbatore | 82.0                      | 94.0              | 124.0              | 87.0                 | 11.55   |
| Barapani   | -                         | 56.0              | 33.0               | -                    | -       |
| Solan      | 28.0                      | 56.0              | -                  | -                    | -       |



Fig. 2: Cultivation trial of Blue Oyster mushroom, *Hypsizygus ulmarius* at Udaipur and Pantnagar Centres

### 2.2.3 Effect of supplementation with organic N-rich supplements in substrate on yield of *P.florida* and *P.sajor-caju*

This experiment was conducted at 5 Centres under the 2002-03 and 2003-04 technical programme. At Pune Centre supplementation with 4% rice bran significantly enhanced the yield in both *P.florida* and *P.sajor-caju*, while at Raipur and Vellayani Centres higher yield was recorded with 4% and 2% neem cake as supplement, respectively in *P.florida*. Wheat bran supplementation @ 2%

enhanced the yield of *P.sajor-caju* at Raipur, Udaipur and Ranchi. Supplementation with 4% rice bran gave higher yield, in *P.sajor-caju* at Raipur and in *P.florida* at Udaipur Centre, respectively (Table-10).

### 2.3 Paddy straw mushroom

#### 2.3 Cultivation trial of paddy straw mushroom, *Volvariella volvacea*

The trial could only be laid out at two Centres. At Coimbatore Centre the compact round bed prepared out of

Table 10: Effect of supplementation on yield of *Pleurotus florida* and *P.sajor-caju*

| S.No. Treatment         | Pune             |                     | Raipur           |                     | Udaipur                   |                     | Vellayani        |                  | Ranchi              |  |
|-------------------------|------------------|---------------------|------------------|---------------------|---------------------------|---------------------|------------------|------------------|---------------------|--|
|                         | <i>P.florida</i> | <i>P.sajor-caju</i> | <i>P.florida</i> | <i>P.sajor-caju</i> | <i>P.citrino-pileatus</i> | <i>P.sajor-caju</i> | <i>P.florida</i> | <i>P.florida</i> | <i>P.sajor-caju</i> |  |
| 1. Neem cake 2%         | 62.4             | 62.5                | 56.20            | 20.00               | 56.57                     | 62.59               | 116.67           | -                | -                   |  |
| 2. 4%                   | 65.7             | 64.2                | 61.40            | 21.30               | 55.57                     | 57.00               | 83.08            | -                | -                   |  |
| 3. Wheat bran 2%        | 57.6             | 55.6                | 38.37            | 34.75               | 56.15                     | 71.25               | 83.33            | 175.36           | 157.26              |  |
| 4. 4%                   | 62.0             | 59.3                | 22.30            | -                   | 63.84                     | 59.28               | 51.83            | 153.33           | 138.63              |  |
| 5. Rice bran 2%         | 70.2             | 68.0                | 37.30            | 27.00               | 63.56                     | 60.14               | 100.33           | 141.46           | 132.33              |  |
| 6. 4%                   | 74.2             | 70.5                | 40.00            | 33.40               | 75.53                     | 65.55               | -                | 122.20           | 114.66              |  |
| 7. Deoiled meal soybean | 66.6             | 65.0                | -                | 12.00               | 63.27                     | 59.00               | -                | 104.66           | 122.66              |  |
| 8. 1+3+5+7              | 56.2             | 54.3                | 39.40            | 36.50               | 48.48                     | 59.85               | -                | 107.20           | 112.20              |  |
| 9. Control              | 54.2             | 53.2                | -                | 29.00               | 49.59                     | 53.01               | 79.67            | 102.06           | 105.46              |  |
| 10. CD @ 5%             | 4.5              | 3.0                 | -                | -                   | 3.51                      | 4.57                | -                | 25.04            | 27.41               |  |

paddy straw gave highest mushroom yield of 22.4kg/100 dry substrate. It was closely followed by compact square bed. At Ludhiana again the highest mushroom yield was obtained on

compact round bed and it was followed by bundle method (Table-11). Average fruiting body weight was also highest (32.0gm) from compact round bed and it was followed by compact square bed.

**Table 11: Cultivation of paddy straw mushroom, *Volvariella volvacea***

| Type of Bed                                                                             | Mushroom yield<br>kg/100 kg dry substrate | Coimbatore             |                                |
|-----------------------------------------------------------------------------------------|-------------------------------------------|------------------------|--------------------------------|
|                                                                                         |                                           | No. of fruiting bodies | Av. Wt. of fruiting bodies (g) |
| Hollow bed<br>(6" dia)                                                                  | 15.4                                      | 600                    | 25.5                           |
| Compact bed<br>(square)                                                                 | 18.6                                      | 590                    | 31.5                           |
| Compact bed<br>(round)                                                                  | 22.4                                      | 700                    | 32.0                           |
| Bundle method 4<br>(hollow – bundles x<br>5 layers + 2<br>bundles opened at<br>the top) | 17.0                                      | 640                    | 24.5                           |
| Bundle method<br>(5 bundlesx4 layers<br>+ 2 bundles opened<br>at the top)               | 16.2                                      | 610                    | 26.5                           |
| CD (5%)                                                                                 | -                                         | NS                     | 4.40                           |



**Fig. 3: Paddy straw mushroom cultivation trial at Ranchi Centre**

## 2.4 Milky mushroom

### 2.4.1 Evaluation of different substrates for cultivating of milky mushroom, *Calocybe indica*

The experimental trial was conducted at 5 Centres and at all the Centres highest mushroom yield was obtained in wheat straw as substrate in comparison to paddy straw and 1:1 (v/v) mixture of wheat straw and paddy straw. The mushroom yield varied from lowest of 26.0kg/100kg dry substrate at Faizabad to highest of 65.68 kg at Udaipur Centre. The yield levels obtained at Ranchi, Ludhiana and Udaipur were comparable, while it was low at Pantnagar and Faizabad Centres (Table-12).

## 2.5 Black ear mushroom

### 2.5.1 Cultivation trial on black ear mushroom, *Auricularia polytricha*

The experiment was conducted at 4 Centres by using wheat straw and paddy straw as substrates and 2%, 5% and 10% supplementation of wheat bran. The 2% wheat bran supplemented wheat straw gave highest yield at Udaipur, while 10% wheat bran supplemented wheat straw at Pantnagar and 5% wheat bran supplemented paddy straw at Coimbatore. Only one treatment i.e. 2% wheat bran supplemented wheat straw was tried at Ranchi and very low mushroom yield (8.2g/2kg substrate) was recorded (Table-13).

Table 12: Cultivation of *C.indica* on different substrates

| Substrate        | Yield (kg/100kg dry substrate) at different Centres |          |           |          |         |
|------------------|-----------------------------------------------------|----------|-----------|----------|---------|
|                  | Ranchi                                              | Ludhiana | Pantnagar | Faizabad | Udaipur |
| Wheat straw (WS) | 59.10                                               | 62.9     | 31.91     | 26.0     | 65.68   |
| Paddy Straw (PS) | -                                                   | -        | 19.10     | 18.0     | 55.30   |
| WS+PS (1:1)      | -                                                   | -        | 28.51     | 20.5     | 63.12   |
| CD               | -                                                   | -        | 11.08     | 2.27     | 2.49    |



Fig. 4: Milky mushroom (*Calocybe indica*) cultivation trial at Vellayani and Pantnagar Centres

Table 13: Evaluation of different substrates for the cultivation of *A. polytricha*

| Substrate   | Average yield (g/2kg substrate) at different Centres |         |           |            |
|-------------|------------------------------------------------------|---------|-----------|------------|
|             | Ranchi                                               | Udaipur | Pantnagar | Coimbatore |
| WS+WB (2%)  | 8.24                                                 | 65.90   | 57.4      | -          |
| WS+WB (5%)  | -                                                    | 65.07   | 82.8      | -          |
| WS+WB (10%) | -                                                    | 63.91   | 102.4     | -          |
| PS alone    | -                                                    | 60.59   | -         | 36.00      |
| PS+WB (2%)  | -                                                    | -       | 44.00     | 43.02      |
| PS+WB (5%)  | -                                                    | -       | 62.6      | 44.25      |
| PS+WB (10%) | -                                                    | -       | 87.8      | 42.53      |

WS – wheat straw, WB- wheat bran; PS – paddy straw

Fig. 5: Black ear (*Auricularia polytricha*) cultivation trial at Pantnagar Centre

## 2.6 Shiitake mushroom

### 2.6.1 Cultivation trial on shiitake mushroom, *Lentinula edodes*

The experimental trial was conducted at 3 Centres only. Out of different substrates and supplements, the 20% and 10% wheat bran supplemented saw dust gave highest mushroom yield at Pantnagar and Coimbatore Centre,

respectively. The wheat straw supplemented with different ratio of wheat bran gave comparatively good yield at Pantnagar Centre, while the yield obtained at Coimbatore was almost half than the yield obtained in wheat bran supplemented saw dust (Table-14). Average fruiting body weight (25.25 to 33.88g) was comparatively higher at Pantnagar than at Coimbatore Centre (14.8 to 18.4 gm).

Table 14: Evaluation of different substrates for the cultivation of *Lentinula edodes*

| Substrate         | Average yield (g/2kg substrate) at different Centres |                          |            |                          |
|-------------------|------------------------------------------------------|--------------------------|------------|--------------------------|
|                   | Pantnagar                                            |                          | Coimbatore |                          |
|                   | Yield                                                | Av. Fruiting body wt./kg | Yield      | Av. Fruiting body wt./kg |
| SD alone          | -                                                    | -                        | 183.5      | 18.4                     |
| SD+WB (5%)        | 210.00                                               | 52.5                     | 195.5      | 16.3                     |
| SD+WB (10%)       | 246.25                                               | 25.25                    | 272.0      | 16.0                     |
| SD+WB (20%)       | 422.50                                               | 28.64                    | 210.0      | 15.0                     |
| Paddy straw alone | -                                                    | -                        | 81.5       | 14.8                     |
| WS+WB (5%)        | 220.25                                               | 33.88                    | 115.5      | 16.5                     |
| WS+WB (10%)       | 321.25                                               | 29.20                    | 112.0      | 16.0                     |
| WS+WB (20%)       | 367.50                                               | 28.26                    | 159.5      | 14.5                     |
| CD (5%)           | 31.66                                                | -                        | -          | -                        |

SD – saw dust, WB – wheat bran; WS – wheat straw

Fig. 6: Shiitake mushroom (*Lentinula edodes*) cultivation trials at Udaipur and Pantnagar Centres

### 3. Post harvet technology

#### 3.1 White button mushroom

##### 3.1.1 Effect of washing treatment with different chemicals on whiteness of fresh and stored white button mushroom fruiting bodies

The experiment was conducted at 7 Centres by using washing treatment of button mushroom fruiting bodies with 100, 150, 200 and 500ppm of EDTA, 100

ppm EDTA +0.2% KMS and unwashed mushrooms as control. The combined washing treatment of 100ppm EDTA with 0.2% KMS gave highest whiteness just after washing and 48 hrs. of storage at 5°C at almost all the Centres. The second best treatment at Coimbatore, Raipur and Pantnagar was 500ppm EDTA, while 200 ppm EDTA at Faizabad, Ludhiana, Pune and Udaipur (Table-15).

The results were different after storing the mushrooms at ambient temperature conditions and washing with

Table 15: Effect of washing treatment followed by storage at 5°C on whiteness of button mushroom, *A.bisporus*

| Dipping Treatment     | Coimbatore |    |    |    | Faizabad |    |    |    | Ludhiana |    |    |    | Pantnagar |    |    |    | Pune |    |    |    | Raipur |    |    |    | Udaipur |    |    |   |
|-----------------------|------------|----|----|----|----------|----|----|----|----------|----|----|----|-----------|----|----|----|------|----|----|----|--------|----|----|----|---------|----|----|---|
|                       | a          | b  | c  | d  | a        | b  | c  | d  | a        | b  | c  | d  | a         | b  | c  | d  | a    | b  | c  | d  | a      | b  | c  | d  | a       | b  | c  | d |
| EDTA 100ppm           | 2+         | +  | +  | -  | 4+       | 4+ | 3+ | 2+ | +2       | +3 | +3 | +2 | 2+        | 2+ | +  | 3+ | 3+   | 3+ | 3+ | 3+ | 3+     | 3+ | +  | 3+ | 4+      | 4+ | 3+ | + |
| EDTA 150ppm           | 2+         | 2+ | 2+ | 2+ | 4+       | 4+ | 3+ | 3+ | +2       | +3 | +4 | +2 | 2+        | 2+ | +  | 3+ | 3+   | 2+ | 2+ | 3+ | 3+     | 3+ | +  | 3+ | 4+      | 4+ | 4+ | + |
| EDTA 200ppm           | 2+         | 2+ | 2+ | 2+ | 4+       | 4+ | 3+ | 3+ | +2       | +4 | +4 | +3 | 2+        | 2+ | 3+ | 2+ | 2+   | 3+ | 3+ | 2+ | 3+     | 3+ | ++ | 3+ | 4+      | 4+ | 4+ | + |
| EDTA 100 ppm+0.2% KMS | 2+         | 3+ | 3+ | 3+ | 4+       | 4+ | 4+ | 3+ | +2       | +4 | +4 | +4 | 2+        | 2+ | 5+ | 5+ | 3+   | 3+ | 3+ | 3+ | 3+     | ++ | 3+ | 4+ | 4+      | 4+ | 4+ | + |
| EDTA 500 ppm          | 2+         | 3+ | 2+ | 2+ | 4+       | 4+ | 3+ | 2+ | +2       | +3 | +4 | +3 | 2+        | 2+ | 4+ | 4+ | 3+   | 2+ | 2+ | 3+ | 3+     | 3+ | 3+ | 4+ | 4+      | 4+ | 4+ | + |
| Unwashed              | 2+         | +  | +  | +  | 4+       | 4+ | 2+ | 2+ | +2       | +2 | +1 | +1 | 2+        | 2+ | +  | 3+ | 3+   | 2+ | 2+ | 3+ | 2+     | 2+ | +  | 3+ | 3+      | 3+ | 3+ | + |
| Water washed          | -          | -  | -  | -  | -        | -  | -  | -  | +2       | +3 | +3 | +3 | -         | -  | -  | -  | -    | -  | -  | -  | -      | -  | -  | -  | -       | -  | -  | - |

a) whiteness before washing; b) whiteness after washing; c) whiteness after 24 hrs. of storage; d) whiteness after 48 hrs. of storage.



UNWASHED



100 PPM EDTA + 0.02%

Fig. 7: Effect of different washing treatments on quality and shelf life of button mushroom (*Agaricus bisporus*) at Pantnagar Centre

200 ppm EDTA gave whiteness at par with that of washing with 100ppm EDTA + 0.2% KMS at Coimbatore, Faizabad, Ludhiana, Pune and Raipur Centres. It was only the Pantnagar Centre, where better whiteness was retained in 100 ppm EDTA + 0.2% KMS treatment than other EDTA washing treatments and the second best treatment was recorded as 500 ppm EDTA (Table-16).

### 3.1.2 Effect of different packaging treatments on the shelf-life of white button mushroom, *A.bisporus*

The experiment was conducted at 7 Centres by using polypropylene bag of 75, 100 and 125 gauge thickness and polythene bag of 100 gauge thickness. The packed mushrooms were stored both at ambient and refrigerated temperature conditions and the loss in whiteness, weight and opening of veil were recorded. At Coimbatore, Faizabad, Pune and Raipur Centres, the mushrooms packed in 100 gauge polypropylene gave better results with respect to whiteness, weight loss and veil opening on their storage both at refrigerated and ambient temperature conditions. At Ludhiana and Raipur Centres better results were obtained on packaging mushrooms in 125 gauge thick polypropylene, while at Pantnagar Centre no significant differences were recorded in either of the packaging treatment (Table-17). When the mushrooms were stored in different packaging materials without any hole, the 75 gauge polypropylene gave better results than other materials at Faizabad Centre, while 100 gauge polypropylene at Pune (Table-18).

## 3.2 Oyster mushroom

### 3.2.1 Effect of different drying methods on quality of dried oyster mushroom, *Pleurotus* spp.

The experiment was conducted at 4 Centres and four methods viz; blanching followed by sundrying, no blanching followed by sun-drying, simple washing followed by sun-drying and cabinet drying were employed. The results obtained at different Centres varied and keeping quality after 3 months of storage was recorded to be better in treatment involving blanching followed by sun-drying method at Coimbatore and Raipur Centres. However, at Udaipur and Ludhiana, the chemical treatment with sundrying and simple washing with sundrying gave better results with respect to whiteness, brittleness and keeping quality after 3 months of storage (Table-19).

## 4. Survey of wild fleshy fungi

### Coimbatore Centre:

A total number of 22 fleshy fungi were collected during the survey. Among them one each of *Agaricus*, *Calocybe*, *Ganoderma* and *Schizophyllum* were pure cultured. The potentiality for the collection of several species of wild mushrooms in the Western Ghats and plains of Tamil Nadu is great and it would yield wrathful specimen. However, rapid survey covering larger areas during rainy months could not be taken up for want of vehicle for transport. As many of the species had poor shelf life, they got contaminated before reaching the laboratory. So, they could not be pure cultured.

Table 16: Effect of washing treatment followed by storage at ambient temperature conditions on whiteness of button mushroom, *A. bisporus*

| Dipping Treatment     | Coimbatore |    |    |   | Faizabad |    |    |    | Ludhiana |    |    |    | Pantnagar |    |    |    | Pune |    |    |    | Raipur |   |   |   |
|-----------------------|------------|----|----|---|----------|----|----|----|----------|----|----|----|-----------|----|----|----|------|----|----|----|--------|---|---|---|
|                       | a          | b  | c  | d | a        | b  | c  | d  | a        | b  | c  | d  | a         | b  | c  | d  | a    | b  | c  | d  | a      | b | c | d |
| EDTA 100ppm           | 2+         | +  | +  | + | 4+       | 4+ | 2+ | +  | 2+       | 3+ | 2+ | 2+ | 2+        | +  | +  | 3+ | 3+   | 2+ | 2+ | 3+ | 2+     | + |   |   |
| EDTA 150ppm           | 2+         | 2+ | +  | + | 4+       | 4+ | 3+ | 2+ | 2+       | 3+ | 3+ | 3+ | 2+        | +  | +  | 3+ | 3+   | 2+ | 2+ | 3+ | 2+     | + |   |   |
| EDTA 200ppm           | 2+         | 2+ | 2+ | + | 4+       | 4+ | 3+ | 2+ | 2+       | 4+ | 3+ | 3+ | 2+        | 2+ | +  | 3+ | 3+   | 2+ | 2+ | 3+ | 2+     | + |   |   |
| EDTA 100 ppm+0.2% KMS | 2+         | 2+ | 2+ | + | 4+       | 4+ | 3+ | 2+ | 2+       | 4+ | 3+ | 3+ | 2+        | 4+ | 3+ | 3+ | 3+   | 2+ | 3+ | 3+ | 2+     | - |   |   |
| EDTA 500 ppm/kms      | 2+         | 2+ | 2+ | + | 4+       | 4+ | 2+ | +  | 2+       | 3+ | 2+ | 2+ | 2+        | 3+ | 3+ | 3+ | 2+   | 2+ | 2+ | 3+ | 2+     | + |   |   |
| Unwashed              | 2+         | +  | +  | + | 4+       | 4+ | 2+ | +  | 2+       | 2+ | +  | +  | 2+        | +  | +  | 3+ | 3+   | 2+ | 2+ | 3+ | 2+     | + |   |   |
| Water washed          | -          | -  | -  | - | -        | -  | -  | -  | 2+       | 3+ | 2+ | +  | -         | -  | -  | -  | -    | -  | -  | -  | -      | - | - | - |

a) before washing; b) after washing; c) after 24 hrs. of washing; d) after 48 hrs. of washing

Table 17: Effect of different packaging treatments with holes on whiteness, weight loss and veil opening of button mushroom on storage for 48 hrs. at refrigerated and ambient temperature conditions

| Treatment       | Coimbatore |      |    | Faizabad |      |     | Ludhiana |     |      | Pantnagar |     |     | Pune |      |      | Raipur |      |    | Udaipur |      |      |
|-----------------|------------|------|----|----------|------|-----|----------|-----|------|-----------|-----|-----|------|------|------|--------|------|----|---------|------|------|
|                 | a          | b    | c  | a        | b    | c   | a        | b   | c    | a         | b   | c   | a    | b    | c    | a      | b    | c  | a       | b    | c    |
| 75 gauge PP (R) | +          | 7.5  | 10 | 4+       | 5.8  | 0.0 | 2+       | 5.0 | 0.0  | 2+        | 0.0 | 0.0 | -    | -    | -    | 2+     | 4.17 | +  | 3+      | 0.15 | 0.0  |
| (A)             | +          | 14.0 | 32 | 2+       | 15.3 | 2.6 | 2+       | 2.0 | 10.0 | 2+        | 0.0 | 0.0 | -    | -    | -    | +      | 0.37 | ++ | 3+      | 0.13 | 0.0  |
| 100 gauge PP(R) | 2+         | 6.0  | 8  | 4+       | 5.3  | 0.0 | 3+       | 2.0 | 0.0  | 2+        | 0.0 | 0.0 | 3+   | 0.67 | 0.00 | 3+     | 0.97 | +  | 3+      | 0.06 | 0.0  |
| (A)             | 2+         | 15.0 | 24 | 3+       | 14.7 | 2.8 | 2+       | 2.0 | 10.0 | 2+        | 0.0 | 0.0 | 3+   | 0.64 | 0.00 | +      | 0.20 | ++ | 3+      | 5.67 | 0.0  |
| 125 gauge PP(R) | 2+         | 8.0  | 8  | 4+       | 5.5  | 0.0 | 4+       | 0.0 | 0.0  | 2+        | 0.0 | 0.0 | -    | -    | -    | 2+     | 1.26 | +  | 3+      | 0.00 | 0.0  |
| (A)             | 2+         | 11.0 | 28 | 3+       | 15.2 | 2.1 | 3+       | 0.0 | 10.0 | 2+        | 0.0 | 0.0 | -    | -    | -    | +      | 0.86 | ++ | 3+      | 0.00 | 0.00 |
| 100 gauge PE(R) | 2+         | 6.5  | 10 | 3+       | 5.6  | 0.5 | 3+       | 0.0 | 0.0  | 2+        | 0.0 | 0.0 | 2+   | 0.69 | 0.0  | 2+     | 1.37 | +  | 3+      | 0.02 | 0.0  |
| (A)             | 2+         | 10.0 | 30 | 2+       | 16.0 | 2.5 | 2+       | 0.0 | 30.0 | 2+        | 0.0 | 0.0 | 2+   | 0.33 | 0.0  | +      | 0.70 | ++ | 3+      | 0.08 | 0.0  |

PP, polypropylene; PE, Polyethylene; R, refrigerated; R, ambient; a, whiteness; b, percent weight loss; c, percent veil opening.

**Table 18: Effect of different packaging treatments without hole on whiteness, weight loss and veil opening of button mushroom on storage for 48 hrs. at refrigerated and ambient temperature conditions**

| Treatment    | Faizabad |       |       | Pune |       |          |
|--------------|----------|-------|-------|------|-------|----------|
|              | a        | b (%) | c (%) | a    | b (%) | c (%)    |
| 75 gauze PP  | (R)      | 4+    | 3.2   | 0.0  | -     | - -      |
|              | (A)      | 2+    | 12.3  | 2.3  | -     | - -      |
| 100 gauze PP | (R)      | 4+    | 3.4   | 0.0  | 3+    | 0.53 0.0 |
|              | (A)      | 2+    | 12.9  | 3.0  | 3+    | 0.26 0.0 |
| 125 gauze PP | (R)      | 4+    | 3.5   | 0.0  | -     | - -      |
|              | (A)      | 2+    | 13.7  | 2.8  | -     | - -      |
| 100 gauze PE | (R)      | 3+    | 3.3   | 0.0  | ++    | 0.34 0.0 |
|              | (A)      | +     | 14.4  | 3.3  | ++    | 0.53 0.0 |

a, whiteness; b, weight loss; c, veil opening

**Table 19: Effect of different drying treatments on quality of dried oyster mushroom, *Pleurotus* spp.**

| Treatment                         | Coimbatore |    |    |      | Ludhiana |    |    | Raipur |    |    |      | Udaipur |    |
|-----------------------------------|------------|----|----|------|----------|----|----|--------|----|----|------|---------|----|
|                                   | a          | b  | c  | d    | a        | b  | c  | a      | b  | c  | d    | a       | b  |
| Blanching and sun drying          | 2+         | 2+ | 2+ | 12.0 | +        | 4+ | 3+ | +      | +  | 2+ | 2.12 | +       | 3+ |
| Chemical treatment and sun drying | +          | 2+ | +  | 14.5 | 3+       | 4+ | 4+ | 2+     | 2+ | +  | 2.80 | 3+      | 3+ |
| Simple washing and sun drying     | +          | 3+ | +  | 11.0 | 3+       | 4+ | 4+ | 2+     | 2+ | +  | 1.46 | 3+      | 3+ |
| Cabinet drying                    | +          | 3+ | +  | 14.0 | 4+       | 4+ | 3+ | 2+     | 2+ | +  | 3.12 | +       | 3+ |

a) whiteness, b) brittleness, c) keeping quality after 3 months, d) weight loss (%)

**Fig. 8: Effect of different blanching and drying treatments on keeping quality of oyster mushroom (*Pleurotus* spp.) at Udaipur Centre**

### Faizabad Centre:

Survey were carried out during the month of July to September in Faizabad. Areas of Faizabad district and adjoining places of University Campus were surveyed to collect the wild mushroom flora. The large area of plains where mushroom flora are in abundance were not surveyed due to heavy rainfall and flood. Species of *Volvariella*, *Termitomyces*, *Calocybe* and *Agaricus bitorquis* were collected and identified.

### Pantnagar Centre:

Surveys were conducted during rainy season in the forest areas of Nainital, Udham Singh Nagar and Pithoragarh districts of Uttaranchal.

A total of twenty three specimens were collected out of which, 14 were identified tentatively. Some of the collections included *Hericium* sp., *Geastrum* sp., *Termitomyces* sp., *Grifola sulphurea*, *Cordyceps sinensis*, *Pleurotus* sp., *Coriolus* sp., *Ganoderma*

*lucidum*, *Russula* sp. and *Amanita* sp.

### Pune Centre:

A total of 13 samples of wild fleshy fungi were collected from Mahabaleshwar area of Maharashtra during monsoon season. These samples were then studied for their mycological characters as per the NRCM guidelines and identified up to genus level. A total of 6 samples were successfully isolated and purified. Some of the collections included *Coprinus* sp., *Tuber* sp., *Polyporus* sp., *Agaricus* sp. (2), *Macrolepiota* sp., *Copelandia* sp., *Lactiporus* sp., *Leucoagaricus* sp., *Clitocybe* sp., *Hygrophorus* sp. and *Nematoloma* sp. were collected and identified upto genus level. Out of the 12 species collected pure culture of only five species could be raised.

### Raipur Centre:

Survey of wild fleshy fungi was conducted during rainy season of 2004 at Raipur, Mahasamund, Ambikapur and



Fig. 9: *Ramaria* sp. growing under forests conditions of Chattisgarh area (courtesy Raipur Centre)



Fig.10: *Schyzoplyllum commune* growing under forests conditions of Chattisgarh (courtesy Raipur Centre)

Barnavapara Wild Life Sanctuary. In all, twenty fleshy fungi were collected and identified. Some of them were deposited at NRCM, Solan. The species collected were *Pleurotus* spp. (3), *Podaxuis* sp., *Auricularia polytricha*, *V.volvacea* (2), *Tuber* sp., *Lycoperdon maximum*, *Canthrellus* sp., *Termitomyces* sp. (2), *Russula lepida*, *R.virginea*, *R.sp.*, *Tricholoma* sp., *Scleroderma* sp., *Coprinus* sp., *Ganoderma applanatum*, *G. suizi*, and *Polyporus* sp.

#### Ranchi Centre:

The survey was done in the monsoon season of 2004. The following fleshy fungi viz., *Agaricus* spp. (Button mushroom), *Boletus* spp. (Jamum Kukri), *Calocybe* spp. (Milky mushroom), *Termitomyces* spp. were collected and wet and dry preserved. Local culture of *Pleurotus* sp. and *Macrolepiota* sp. was made.

#### Udaipur Centre:

Total of 8 forays were made in the month of August 2004. This year rain were started late in the last week of July only. Therefore, the collection were done only in August month in different districts of Rajasthan such as Udaipur, Jaipur, Sirohi, Pali, and Chittorgarh. The major area surveyed were Badgoan, laswal, Gogunda, Madar, Oogna, Vas, Falasia, Jhadol, Pai, Peepalvas, Undri, Nai, Sisarma, Locing, Khamnoor, Kelwara, Jarga, Jaswanthgarh, Saira, Malgarh, Pindwara, Sai, Malva Ka Chora, Jobner, Amer and Jaipur. Total of 113 different wild specimens were collected. Their data base, culture, spore print were prepared. The specimens were preserved in dry form only. The most common occurring genera collected were *Agaricus* spp., *Auricularia*, *Podaxis pistallaris*, *Lepiota* spp., *Volvariella* spp., *Pleurotus* spp., *Ganoderma* spp.,



Fig. 11: *Melastiza chateri* growing in Rajasthan area (courtesy Udaipur Centre)



Fig.12: *Pleurotus ostreatus* growing in Rajasthan (courtesy Udaipur Centre)

*Schizophyllum commune*, *Geastrum* spp., *Pisolithus tintorius*, *Polyporus*, *Mycenia*, *Marasmius* spp., and *Phellorina* spp.

Some rare collection are *Melastiza chateri*, *Xylaria hypoxylon*, *Colocyble gambosa*, *Fuligo septica*, *Steccherium ochraceum*, *Entoloma caesiocinctus*,

*Hericium erinaceus*, *Sterum hirsutum*, *Polypores sulphureus*, *Calvatia cranniformis*, *Calvatia cyatheiformis*, *Ramaria fennica violaceibrunnea*, *Phellorina herculea* and *Microglossum viride*.

#### Vellayani centre:

As part of a PG programme, a collection of *Calocybe indica* was done locally. As a result 9 isolates were obtained which were further utilized for the strain evaluation. In addition to this *Pleurotus platypus*, *P. eous* and *Ganoderma* sp. etc were also collected from the wild and they were domesticated during the year.

#### Solan Centre:

Forays were conducted mainly during rainy season to collect wild mushrooms from the forest areas of Himachal Pradesh, namely, Karol, Nankheri, Narkanda, Kandaghat, Chail, Kufri, Chalanda, Koti, Basal, Matiana, Patti, Renuka, Nahan, Jarol Tikkar and Shilly. A total of 319 wild mushrooms were collected which includes gill fungi, tooth fungi, gelly fungi, polypores, gasteromycetes and Bolets. All the specimens were preserved in the NRCM Herbarium in dried and wet forms after recording their morphological characters and obtaining field photographs.

Following 27 specimens have been recorded for the 1st time from India: *Agaricus nivescens*, *A. rubronanus*, *A. rhopalopodius*, *Agrocybe putaninum*, *Collybia butyracea*, *Descolea flavo-annulata*, *Entoloma corneri*, *E. incanum*, *E. vulsum*, *E. verum*, *E. niphoides*, *Gomphus floccosus*, *Hygrophorus sordidus*, *H. russula*, *H. recurvatus*, *H. leucophaeus*, *H. crupidatus*,

*Hygrotrama microsporum*, *Lepiota erythrogramma*, *L. paradolita*, *L. oenocephola*, *L. fulvella*, *L. ventricospora*, *L. clypeolaria*, *L. metulisporeae*, *Melanoleuca tristis* and *Phaeocollybia christinae*.

#### 5. Survey and surveillance of diseases and insect-pests

##### Coimbatore Centre:

Both in oyster and milky mushroom beds *Coprinus* sp. was observed from spawn running till harvest in beds prepared with chemical substrate treatment method. In milky mushroom sporophores during the current season a disease was observed. The pathogen was *Trichoderma pseudokoningii* and it caused Gill spotting. Brownish necrotic lesions occur on the gills and the sporophore was totally rotten within a day. Further observations on the predisposing factors of the disease are being recorded. In paddy straw mushroom large number of beetles viz., *Scapisoma pictum* and *Scapisoma nigrofasciatum* were observed.

##### Faizabad Centre:

Surveys for recording of data on incidence of diseases and insect pests were carried out at farmer's units in Faizabad district. Studies indicated that competitor moulds are the major constraints in mushroom cultivation in the area. Few mycoparasitic nematodes and insects were also observed in or on substrate / fruiting bodies. *Penicillium* spp., *Trichoderma* spp. and *Alternaria alternata* were encountered in button mushroom farm alongwith presence of nematodes in manure. Cultivation of oyster mushroom was badly affected by

*Aspergillus* spp. and *Penicillium* spp., bacterial oozing was also observed from straw. Paddy straw and milky mushrooms were most affected by *Coprinus* spp., *Penicillium* spp. and *Rhizopus* spp. and infestation of insect phorids flies was also observed.

### Ludhiana Centre:

Survey and surveillance of pests and diseases was carried out at PAU campus by including 5 strains (CM-3, CM-5, CM-10, S-11, U-3) of *A.bisporus* grown on long method of compost. The incidence of *Trichoderma* spp. and *Coprinus* spp. was recorded on 3-8% of the beds. However, *P.byssina* was found to infest upto 5% of the bags. In case of *Scopulariopsis fimicola* less than 5% infection was observed on the casing surface. Among the abiotic disorder, incidence of stroma, open veil, rose comb, scales and brown discolouration was observed in 2-5% bags. Among the insect pests, 5% incidence of phorid fly was observed.

### Pantnagar Centre:

Marginal and small-scale mushroom farms located in the district U.S. Nagar of Uttaranchal were surveyed periodically during crop season 2004-05. It was observed that green mould caused by *Trichoderma* spp. prevailed to the extent of 60.00% in marginal scale mushroom growing under hut conditions. In the mushroom growing units surveyed, *Deihliomyces microsporus* and *Papulaspora byssina* were observed in 11.37% and 18.67% growing units, respectively in the month of Feb.-March, 2005. *Verticillium fungicola* and *Chaetomium globosum* were also observed at the extent of 4.38% and

5.59%, respectively, out of 116 marginal & small growing units visited. Infestation of sciarid and phorid flies were observed in 19.18% and 7.21%, respectively in last lag of the crop in most of the mushroom huts. During the month of March/April mushroom beetles were observed in 18.56% cropping rooms (huts) of *Pleurotus* spp. Browning of the pin heads and stroma was also observed in 14.95% and 2.25% cropping rooms, respectively.

### Pune Centre:

The incidence of pests and diseases was observed on button and oyster mushrooms. The commonly noticed diseases were bacterial blotch, dry bubble, *Coprinus* spp., green mould, cob web, brown plaster mould and yellow mould. Their incidence prevailed between 2.18%. Out of 625 bags of button mushroom observed, 75 bags were found to be infested by phorid flies, mites, sciarid flies, nematodes and springtails. The number of phorid flies infestation ranged between 10-13 per bed. In case of oyster mushroom out of 900 beds, 90 beds were found to be contaminated. Phorid flies were observed in the range of 5-10 per bed. About 5-15% infestation of green mould, *Coprinus*, bacterial rot and *Aspergillus* was noticed in beds.

### Raipur Centre:

The work on survey and surveillance of various diseases and insect pests of oyster mushroom was carried out in five mushroom farms at Durg district during kharif season (16<sup>th</sup> September, 2004). In all the cases, bags were contaminated with *Trichoderma* sp. (2-45%), *Sclerotium rolfsii* (3-10%), *Coprinus* sp. (12-65%), patchy growth (18-35%), yellow

blotch and one farm showed the infestation of phorid fly in traces. No infestation of insect pests was observed at polytechnic College.

Farms of oyster and milky mushrooms were visited and few farms were observed for presence of green mould and dipterian fly and inky caps. Button mushroom farms will be visited during January and February.

#### Udaipur Centre:

Total of 36 mushroom farms were visited for survey and surveillance of diseases and insect pests. Out of 36 farms maximum 22 farms of oyster mushroom were visited for occurrence of diseases and insect pests in Udaipur region specially in Tribal area. Whereas 2 farms of milky mushroom and 12 farms of button mushroom were visited.

It was observed that in tribal area no disease and insect pest were found.

Further, only at one farm *Coprinus* spp. and green mould were observed in traces. In Udaipur at one mushroom farm severe infection of *Coprinus* spp., *Sclerotium* spp. and infestation of dipterian flies were observed.

In winter season 12 button mushroom farms were visited around Udaipur region. At one mushroom farm heavy infection of *Coprinus* in Nai village was observed. In few farms cracks and veil opening were also observed.

#### Solan Centre

Survey of different mushroom farms located at Haryana and Himachal Pradesh revealed the wide spread incidence of wet bubble in Morni Hills (Haryana), Chambaghat and adjoining areas of Solan and Dharampur. Sciariid flies, mites and springtails were common in most of the farms.

## IV. EXTENSION ACTIVITIES

### Coimbatore Centre:

During the year 2004-2005 regular “**One day training programmes**” on mushroom cultivation were continued as usual on 5<sup>th</sup> of every month. Put together 266 such programmes have been conducted so far and more than twenty thousand people have been trained on oyster mushroom and milky mushroom production. The Centre also participated in three exhibitions.

### Faizabad Centre:

In order to promote mushroom cultivation in Eastern Uttar Pradesh concerted efforts were made through trainings, demonstrations, advisory services, participation in Kisan Mela and Gosthies; and most important, by supplying ready spawn for cultivation of

mushrooms. The Centre organised 4 training programmes wherein 88 persons were trained. In addition 5 goshties were also organized. Centre also participated in 3 Kisan Melas and demonstration trials in 10 villages were laid out.

### Pune Centre:

Training programme on mushroom cultivation technology was organised on first and third Saturday of every month. Training programme on spawn production technology was also organised at the Centre. In all 24 training programmes were organized in which 716 persons were imparted the training. The extension literatures like pamphlets and popular articles were also distributed. Awareness programmes were strengthened through exhibitions, farmers rallies, television and radio talks. The



Fig.13: Low cost white button mushroom (*A. bisporus*) cultivation farm in Faizabad area (courtesy: Faizabad Centre)

Centre also supplied 9883 spawn packets and 75 pure culture tubes to mushroom growers and spawn producers, respectively.

### Raipur Centre

Besides the research activities, the Centre is also working on transfer of

#### List of Training programmes organized

| S. No | Name of the Training                                         | Dates                  | Sponsoring Agency                                               | Place                                                 | No. of participants |
|-------|--------------------------------------------------------------|------------------------|-----------------------------------------------------------------|-------------------------------------------------------|---------------------|
| 1.    | Mushroom production technology to the women                  | 28.5.04 to 31.5.04     | Swa Shakti Project, Deptt. of Women and Child Development, C.G. | Mushroom Research Lab, College of Agriculture, Raipur | 5/25 men/women      |
| 2.    | Mushroom production technology to the women                  | 21.07.04 to 24.07.04   | Swa Shakti Project, Deptt. of Women and Child Development, C.G. | Mushroom Research Lab, College of Agriculture, Raipur | 4/27 men/women      |
| 3.    | Mushroom production technology to the women                  | 26.07.04 to 30.07.04   | In joint collaboration with Govt. Polytechnic, Durg             | Govt. Polytechnic, Durg                               | 29/3 men/women      |
| 4.    | Mushroom spawn production technology                         | 12.8.04 to 18.8.04     | Deptt. of Horticulture, Govt. of Chhattisgarh, Raipur           | Mushroom Research Lab, College of Agriculture, Raipur | 17/16 men/women     |
| 5.    | Mushroom spawn production technology                         | 24.11.04 to 30.11.04   | Deptt. of Horticulture, Govt. of Chhattisgarh, Raipur           | Mushroom Research Lab, College of Agriculture, Raipur | 17/7 men/women      |
| 6.    | Mushroom production technology to the women                  | 1.12.04 to 4.12.04     | Jointly organised by Swa Shakti Project, C.G. and IGAU, Raipur, | Mushroom Research Lab, College of Agriculture, Raipur | 2/28 men/ women     |
| 7.    | Mushroom spawn production technology                         | 7.9.2004 to 9.9.2004   | DBT Project, Govt. of India, New Delhi.                         | Mushroom Research Lab, College of Agriculture, Raipur | 0/14 men/ women     |
| 8.    | Mushroom processing technology (3 day) under DBT Project     | 17.12.04 to 19.12.04   | DBT Project, Govt. of India, New Delhi.                         | Tarra village                                         | 0/18 men/ women     |
| 9.    | Mushroom production technology to the Entrepreneurs          | 1.1.2005 to 4.1.2005   | Deptt. of Horticulture, Govt. of Chhattisgarh, Raipur           | Horticulture Nursery, Durg                            | 20/30 men/ women    |
| 10.   | Mushroom production technology to the Entrepreneurs          | 25.1.2005 to 31.1.2005 | Jointly organised by CCOST and IGAU, Raipur                     | Mushroom Research Lab, College of Agriculture, Raipur | 19/4 men/ women     |
| 11.   | Mushroom processing technology                               | 2.2.2005 to 5.2.2005   | DBT Project, Govt. of India, New Delhi.                         | Mushroom Research Lab, College of Agriculture, Raipur | 0/28 men/ women     |
| 12.   | Mushroom production technology to the women from Arang Block | 14.2.05 to 15.2.2005   | Trainees themselves                                             | Mushroom Research Lab, College of Agriculture, Raipur | 0/23 men/women      |
| 13.   | Mushroom processing technology                               | 17.2.05 to 21.2.2005   | DBT Project, Govt. of India, New Delhi.                         | Matia village                                         | 0/32 men/women      |
| 14.   | Mushroom production technology to the women                  | 16.2.05 to 22.2.05     | DBT Project, Govt. of India, New Delhi.                         | Dondekhurd village                                    | 0/25 men/women      |
| 15.   | Mushroom production technology to the Entrepreneurs          | 9.03.05 to 15.3.05     | Jointly organised by CCOST and IGAU, Raipur                     | Mushroom Research Lab, College of Agriculture, Raipur | 23/1 men/women      |



**Fig. 14: Visitors visiting the Mushroom Exhibition during Kisan Mela at Raipur**

mushroom growing technology to the rural as well as urban peoples through organizing training/kisan mela/kisan divas, live demonstrations cum training programme for extension workers, sale of mushroom spawn, mushroom pickle,

publicity through research articles, popular articles, folders, bulletins and coverage of the news in local newspapers, weekly magazines, All India Radio and Raipur Doordarshan, Sahara TV, E TV, etc.

### Udaipur Centre:

**a: Training program held from April, 2004 to March, 2005**

| S. No. | Date                 | Topics                                                          | No. of Trainees | Particulars                                             |
|--------|----------------------|-----------------------------------------------------------------|-----------------|---------------------------------------------------------|
| 1      | 06.04.04 to 18.06.04 | Mushroom cultivation                                            | 10              | Individual Training Program                             |
| 2      | 8.06.04 to 12.07.04  | Culture preparation, spawn preparation and mushroom cultivation | 7               | Modi Institute of Management & Technology, Kota (Raj.)  |
| 3      | 05.08.04             | Mushroom cultivation                                            | 25              | Participants of Agrclinic and Agribusiness in Rajasthan |
| 4      | 26.08.04 to 27.08.04 | Mushroom cultivation                                            | 13              | IVLP Farmers Training program in Udaipur (Raj.)         |
| 5      | 09.09.04             | Mushroom cultivation                                            | 25              | Farmers of KVK Barmer (Raj.)                            |

| S. No. | Date                 | Topics                                | No. of Trainees | Particulars                                        |
|--------|----------------------|---------------------------------------|-----------------|----------------------------------------------------|
| 6      | 29.09.04             | Mushroom cultivation                  | 25              | Farmers of Bhilwara, district (Raj.)               |
| 7      | 09.12.04 to 05.02.05 | Culture preparation, Spawn production | 3               | Mahatma Jyoti Rao Phoole, PG College Jaipur (Raj.) |
| 8      | 01.03.05             | Mushroom cultivation                  | 50              | Farmers of Jhalawar District (Raj.)                |
| 9      | 01.03.05             | Mushroom cultivation                  | 15              | Farmers of Udaipur District (Raj.)                 |
| 10     | 04.03.05             | Mushroom cultivation                  | 30              | Self Help Group, Udaipur (Raj.)                    |
| 11     | 15.03.05             | Mushroom cultivation                  | 15              | Prayas Sansthan NGO Udaipur (Raj.)                 |
| 12     | 28.03.05             | Mushroom cultivation                  | 25              | NATP, Home Science College MPUA&T, Udaipur (Raj.)  |



Fig.15: On campus mushroom cultivation training being organized at Udaipur Centre

#### b. Exhibition and Kisan Mela

| Date                 | Kisan Mela                                         | Participants | Sponsors                                                                     |
|----------------------|----------------------------------------------------|--------------|------------------------------------------------------------------------------|
| 24.02.05 to 27.02.05 | Western Region Krishi Vigyan Mela (National level) | 25000        | MPUA&T, Ministry of Agri. Department of Ag. and Cooperation, GOI, New Delhi. |
| 05.03.05             | Exhibition, Bhiluda village, KVK Dungerpur         | 4000         | MPUA&T                                                                       |

#### c. RAWE Program

| S.No. | Number of Student | Duration | Achievements                              |
|-------|-------------------|----------|-------------------------------------------|
| 1     | 12                | 15 Days  | Student were trained for entrepreneurship |



Fig. 16: Farmer demonstrating the spawn run bag of oyster mushroom at his farm in Rajasthan (courtesy Udaipur Centre)



Fig. 17: Participation in Exhibition by AICMIP Centre, Udaipur

#### d. Participation in Kisan Mela / Exhibition/ NSS Camp

1. Participated in 2-day Krishi Pradarshini and Kisan Mela being organised by IGAU and Department of Agriculture at College of Agriculture Campus, IGAU, Raipur on 12-13<sup>th</sup> March 2005. Mushroom exhibits related to production, protection, preparation of recipes were

displayed. A video CD on 'Mushroom Production Technology' was displayed during the whole day.

2. Participated in Kisan Mela being organised by water shed mission Dept of Agriculture at Tarera , Siliyari on 22<sup>nd</sup> July 2004. Hon'ble CM Dr. Raman Singh and Shri Brijmohan Agarwal Minister Chhattisgarh Govt Visited the

mushroom stall . Mushroom exhibits related to production, protection, preparation of recipies were displayed. A video CD on 'Mushroom Production Technology' was displayed during the whole day.

3. Participated in Rajyotsava 2005 being organised by Govt of chhattisgarh at Pt. RSU Campus Raipur from 1-7<sup>th</sup> November 2005, mushroom production technology was demonstrated through coloured charts.

#### e. Video CD on Mushroom

A documentary film of 10 minutes duration on cultivation of white button mushroom was prepared under overall technical guidance and direction of Dr. M.P. Thakur, PI, DBT Mushroom Project in the year, 2004-2005. The video CD is very much useful to the Farm Women interested in mushroom growing.

#### f. As Course Director

1. Dr. M.P. Thakur worked as 'Course Director' for Self Employment Generation Programme run by IGKV, Raipur on 'Mushroom Production, Processing and Marketing'

#### Pantnagar Centre:

##### 1. Training

- (a) 10 days training programme on different aspects of mushroom cultivation was organized from September 21-30, 2004 at the University. A batch of 45 trainees, from Uttaranchal, U.P. and M.P. got training on spawn preparation, composting,

cultivation and processing etc. of various mushroom.

- (b) Under **"SWARNJAYANTI GRAM SWAROJGAR YOJANA"** 589 BPLs (below poverty line) were trained in 22 batches each of 7 Days period from April 2004 to March 2005.

**2. Spawn supply:** Five thousand six hundred seventy kilogram (5670 kg) mushroom spawn, 62 bottles of master spawn and 95 culture tubes of different species/ strains were supplied to the growers and spawn producers in the year 2004 - 2005.

**3. Compost supply:** The Centre supplied 1148.6 quintal compost alongwith casing soil (230 quintal) to farmers in current year upto Feb. 2005. Besides, 10 MT compost prepared and used at Mushroom Research & Technology Centre.

**4. Field days and Front Line Demonstration:** Mushroom field days were organized at growers farm and front line demonstrations (FLD) of Dhingri and Milky mushroom were laid down in Naintal, U.S. Nagar and Almora districts of Uttaranchal.

#### Ludhiana Centre:

More than 117 persons were trained in 8 training programmes held at PAU, and KVK Kheri. In addition, 9 lectures cum demonstration programmes were conducted at PAMETI, Ludhiana, and PAU, Ludhiana, wherein more than 159 persons participated. The Centre also participated in 11 Kisan Melas at Ludhiana, Ballowal, Rauni, Bathinda and Gurdaspur. In addition delegates from

Kenya, Director Plant Protection Unit TANU, Coimbatore, Military officers and students from MD Public School visited the Centre.

### Vellayani Centre:

#### Technology developed:

A simple technique namely, stapler method- a modified spawn production technique has been perfected. In addition cultivation technique for *A. polytricha* using mango wood chips as substrate has been standardized.

#### Training programme:

1. Three batches of three day training programme on cultivation of oyster and milky mushrooms were organized at the Centre for the benefit of the unemployed youths and the house wives of the State. A total of 61 members participated in the training.
2. One day field training was conducted for the benefit of the members of the Kudumbasree connected to the Konni Gram Panchayat of the State in which 80 women participated. Followed by this campaign three self help groups have started mushroom growing.
3. Two batches of a total 80 VHSC students were given one day training on cultivation of oyster and milky mushrooms.
4. A batch of 65 farmers from Thirunelveli district of Tamil Nadu visited the Centre and they were given one day training on mushroom cultivation.

5. A total of 3880 mother spawn/ bed spawn packets were supplied to the growers during the year.

### Solan Centre:

#### Transfer of Technology

#### A) Training Programmes Conducted

During the year under report, the Centre has organised a total number of 13 training programmes for farmers & entrepreneurs. The training programmes conducted are listed below.

#### B) Mushroom Mela- 2004

The 8<sup>th</sup> one day Mushroom Mela was organised on 10<sup>th</sup> September, 2004 – the day on which Solan was declared as Mushroom City of India. It was inaugurated by Ex-Director NRCM, Dr.H.S. Sohi. It was attended by about 400 farmers, farm women, mushroom growers, researchers, extension workers and businessmen from various States viz; Himachal Pradesh, Haryana, Punjab, Uttar Pradesh, Jharkhand, Bihar, Maharashtra, Rajasthan, Delhi, Andhra Pradesh, J&K and West Bengal.

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

| S. No. | Name of Training Programm                                                                                                                                                                        | Sponsored by                                    | No. of Trainees    | CD & CC                              |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|--------------------|--------------------------------------|
| 1.     | Ten days training programme on mushroom production technology for Entrepreneurs w.e.f. 20 <sup>th</sup> to 29 <sup>th</sup> April, 2004.                                                         | Paid training programme of the Centre.          | 38                 | Dr. R.P.Tewari<br>Dr. M.P.Sagar      |
| 2.     | Seven days training on mushroom production for farmers w.e.f. 19 <sup>th</sup> to 25 <sup>th</sup> May, 2004.                                                                                    | NRCM, Solan                                     | 61                 | Dr. S.K.Singh<br>Dr. M.C.Yadav       |
| 3.     | Seven days training on mushroom production for farmers w.e.f. 4 <sup>th</sup> to 10 <sup>th</sup> August, 2004.                                                                                  | NRCM, Solan                                     | 67                 | Dr.O.P.Ahlawat<br>Er. Arumugathan    |
| 4.     | Seven days training programme on mushroom production technology for farmers & farm women of Sambal pur & Koraput (Orissa), w.e.f. 5 <sup>th</sup> -11 <sup>th</sup> October, 2004.               | ATMA Sambal pur & Koraput                       | 32+3(NS)           | Dr. R.C. Upadhyay<br>Sh. Sunil Verma |
| 5.     | Seven days training programme on mushroom production technology for the horticulture officers of Haryana w.e.f. 29 <sup>th</sup> Oct. to 4 <sup>th</sup> Nov., 2004.                             | Directorate of Horticulture, Haryana Government | 20                 | Dr. S.R. Sharma<br>Dr. M.P.Sagar     |
| 6.     | Seven days training programme on mushroom production technology for farmers & farm women of Bilaspur (H.P.), w.e.f. 14 <sup>th</sup> -20 <sup>th</sup> June, 2004.                               | ATMA, Bilaspur                                  | 27                 | Dr.B.L.Dhar<br>Sh. Sunil Verma       |
| 7.     | Three days off campus training programme on mushroom production technology for progressive farmers & officers of Shillong (Meghalaya), w.e.f.27 <sup>th</sup> Feb., – 1 <sup>st</sup> March 2005 | MM-I Scheme                                     | 52                 | Dr. B.Vijay<br>Dr. M.P.Sagar         |
| 8.     | Three days off campus training programme on mushroom production technology for progressive farmers & officers of Guwhati (Assam), w.e.f.2 <sup>nd</sup> – 4 <sup>th</sup> March 2005             | MM-I Scheme                                     | 40                 | Dr. B.Vijay<br>Dr. M.P.Sagar         |
| 9.     | Three days off campus training programme on mushroom production technology for progressive farmers & officers of Aizwal (Mizoram), w.e.f.17 <sup>th</sup> – 19 <sup>th</sup> March 2005          | MM-I Scheme                                     | 37                 | Dr. B.Vijay<br>Dr. M.P.Sagar         |
| 10.    | Two days off campus training programme on mushroom production technology for progressive farmers & officers of Imphal(Manipur), w.e.f.14 <sup>th</sup> – 15 <sup>th</sup> March 2005             | MM-I Scheme                                     | 50                 | Dr. B.Vijay<br>Dr. M.P.Sagar         |
| 11.    | Eight days training programme on mushroom production technology for Agril & Hort. Officers of NEH region, w.e.f. 20 <sup>th</sup> to 27 <sup>th</sup> Feb, 2005.                                 | MM-I Scheme                                     | 22+1<br>(Ind. Trg) | Dr. B.Vijay<br>Dr. M.P.Sagar         |
| 12.    | Two days off campus training programme on mushroom production technology for progressive farmers & officers of Agartala (Tripura), w.e.f.28 <sup>th</sup> – 29 <sup>th</sup> March 2005          | MM-I Scheme                                     | 30                 | Dr. B.Vijay<br>Dr. M.P.Sagar         |

Apart from this, participants purchased mushroom spawn, seed and pesticides, horticultural implements, literature on mushroom and finance and mushroom products.

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

Mushroom Mela, a Kisan Goshthi was held to sort out their queries related to mushroom cultivation faced by mushroom growers from all over the country. The problems raised by farmers and mushroom were replied by experts in a very systematic manner. Sh.Vinod Thakur was felicitated on this occasion for adopting innovative practices in mushroom cultivation. The function ended with vote of thanks to all the exhibitors, participants, and all the staff members of NRCM for successful organisation of Mushroom Mela.

### **C) Introduction and popularization of Milky Mushroom**

Keeping in mind the need of diversification in mushroom cultivation, milky mushroom crop was raised at the Centre during April to July, 2004. The temperature during this period was between 25-30°C. Substrate was prepared through chemical sterilization & pasteurization techniques. This crop was raised successfully and shown to the visitors at the Centre. As a result, the demand of spawn of milky mushroom have been increased. Many growers of H.P., Haryana, J&K and Punjab have started cultivation of milky mushroom.

### **D) Participation in National/ State level Kisan Melas and Exhibition**

In order to create awareness about mushroom cultivation, the Centre's stall was put up in the national & state level exhibitions in India at Shillong

(Meghalaya) From 9<sup>th</sup> to 11<sup>th</sup> March, 2005, Krishi Vigyan Mela at Maharana Pratap Agril. Uni. Udaipur from 24-27<sup>th</sup> Feb., 2005 & Agro Fair at Pune From 15-16<sup>th</sup> Dec., 2004.\

### **E) Visits**

Conducted visits of farmers, farm women, mushroom growers, extension workers and students at the Centre from all over the country. In all, a total number of 1025 persons were attended from April, 2004 to March, 2005.

### **F) Advisory service to farmers / Mushroom growers /businessman / unemployed youths**

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

## V. PUBLICATIONS

### Coimbatore Centre:

**Krishnamoorthy, A.S.** (2003). Management of mushroom nematodes. In: Proc. of ICAR winter School on "Ecological Control of Plant Parasitic Nematodes (Ed. G. Rajendran *et al.*, 2003). Dept. of Nematology, CPPS, TNAU, Coimbatore-3. pp-348-354.

**Krishnamoorthy, A.S., Thiribhuvanamala, G., Nakkeeran, S., Shanthi, K., Ramiah, M. and Marimuthu, T.** (2004). Co(OM)2 New oyster mushroom variety. Variety Release Bulletin – 2004. Directorate of Research, TNAU, Coimbatore-3.

**Manoharan, S., Devasenapathy, P., Thiribhuvanamala, G., Shanthi, K. and Krishnamoorthy, A.S.** (2004). Intercultivation of paddy straw mushroom (*Volvariella volvacea*) in maize. J.Farming Systems Research & Development 10: 106-107.

**Dilantha Fernando., W.G.D., Rajesh Ramarathnam, Krishnamoorthy, A.S. and Sarah Savchuk** (2005). Identification and use of potential bacterial organic antifungal volatiles in biocontrol. *Soil Biology & Biochemistry* 37: 955-964.

**Shanthi, K., Karuppiyah, R., Krishnamoorthy, A.S. and Ramiah, M.** (2004). Mushroom cultivation- Training and input supply from TNAU. In: Regional Consultation cum Workshop on Technologies Relevant to Farm and Non farm Sectors in Peninsular India, 15 –17 Sept., GRD

College of Science, Coimbatore, pp.147.

**K r i s h n a m o o r t h y , A.S.,Thiribhuvanamala, G., Shanthi, K. and Marimuthu, T.** (2004). Paddy straw mushroom as an inter crop in maize field. In: Regional Consultation cum Workshop on Technologies Relevant to Farm and Non farm Sectors in Peninsular India, 15 –17 Sept., GRD College of Science, Coimbatore, pp.147.

**K r i s h n a m o o r t h y , A.S.,Thiribhuvanamala, G., and Shanthi, K.** (2005). Cultivation of *Ganoderma lucidum*. In:National Seminar on Emerging Trends in Plant Pathology and their Social Relevance, 7-8 March., Annamalai University, Faculty of Agriculture, Dept. of Plant Pathology, Annamalai Nagar, Chidambaram, pp.148.

**K r i s h n a m o o r t h y , A.S.,Thiribhuvanamala, G., Shanthi, K, Nakkeran, S. and Ramaiah, M.** (2005). Commercial Prospects of *Hypsizygous ulmarius* Var. CO(OM)2. In:National Seminar on Emerging Trends in Plant Pathology and their Social Relevance, 7-8 March, Annamalai University, Faculty of Agriculture, Dept. of Plant Pathology, Annamalai Nagar, Chidambaram, pp.147.

**K r i s h n a m o o r t h y , A.S.,Thiribhuvanamala, G., and Shanthi, K.** (2005). Comparison of composted cotton waste with Paddy straw for the production of Paddy

straw Mushroom In: National Seminar on Emerging Trends in Plant Pathology and their Social Relevance, 7-8 March, Annamalai University, Faculty of Agriculture, Dept. of Plant Pathology, Annamalai Nagar, Chidambaram, pp.146

**Thiribhuvanamala, G., Krishnamoorthy, A.S., Shanthi, K. and Marimuthu, T.** (2005). Paddy straw mushroom as an inter crop in Integrated Farming System. In: National Seminar on Emerging Trends in Plant Pathology and their Social Relevance, 7-8 March., Annamalai University, Faculty of Agriculture, Dept. of Plant Pathology, Annamalai Nagar, Chidambaram, pp.133.

### Pantnagar Centre:

#### Research Paper:

- Mishra, K.K. and Singh, R.P.** (2004). Evaluation of substrates for the cultivation of different isolates of *Ganoderma* of Uttaranchal (Abstract). Souvenir with Abstracts of National Symposium organized by IPS (MEZ) on Dec. 31, 2004 at CISH, Lucknow.
- Mishra, S.K. and Singh, R.P.** (2004). Prospects for bio-management of major pathogenic fungi of *Agaricus bisporus* (Lange) Imbach. In: Souvenir with Abstracts. Symposium on Detection and Management of Plant Diseases using Conventional and Modern Tools on 31<sup>st</sup> Dec., 2004, 3:p2.
- Mishra, S.K. and Singh, R.P.** (2004). Management of pathogenic fungi of *Agaricus bisporus* using biocides. *Indian Phytopathology* 57 (3):343.
- Mishra, S.K. and Singh, R.P.** (2005). Bel va Hurhur se rukengi mushroom ki bimariyan. *Dainik Jagran* 261(1):1.
- Kushwaha, K.P.S., Bhatt, N. and Singh R.P.** (2004). Evaluation of different substrates for yield performance of *Auricularia polytricha*. Souvenir with Abstracts of National Symposium and IPS Zonal Meeting (MEZ). p. 60 (Awarded for best paper).
- Bhatt, N., Singh, R.P. and Kushwaha, K.P.S.** (2004). Evaluation of Substrates for production of *Lentinula edodes*- A medicinal Mushroom. Souvenir with Abstracts of National Symposium and IPS Zonal Meeting (MEZ). p.61.
- Verma, R., Bhatt, P., Kushwaha, K.P.S. and Singh, R.P.** (2004). Studies on variation among the single spore isolates of *Agaricus bisporus* with respect to yield and protein profiling. *Indian Phytopath* 57: 348
- Kushwaha, K.P.S., Bhanu, C. and Singh, R.P.** (2004). Evaluation of different species and hybrids of *Pleurotus* in terms of yield. *Indian Phytopath* 57: 348-349.
- Bhatt, P. and Singh, R.P.** (2004). Evaluation of different substrates for cultivation of *Ganoderma* species. *Indian Phytopath* 57: 349.
- Bhatt, N. and Rani, S.** (2004). Fleshy fungal flora from Uttaranchal. *Indian Phytopath* 57: 349.

**Popular article:**

11. **Singh, R.P. and Mishra, K.K.** (2004). The Medicinal Mushroom: *Ganoderma*. *Indian Farmer's Digest* 37 (12):28-29.
12. **Mishra, K.K. and Singh, R.P.** (2004). Uttaranchal Mein Mushroom Utpadan Ki Stithi Avam Sambhavanayen. *Kisan Bharti* 36(3) 38-10.
13. **Mishra, K.K. and Singh, R.P.** (2005). Fungal Biodiversity and food security. *Agrobiosh News letter* 3(9):12-13.
14. **Bhanu, Chandra and Kushwaha, K.P.S.** (2004) Mushroom Aushadhiyon Ka Khajana. *Krisak Devta* 1(1):4
15. **Bajaj, A., Kushwaha, K.P.S. and Bhatt, P.** (2004). Button Mushroom Ki Kheti Hetu Compost Kaise Banayen. *Kisan Bharti* 35(10): 11-14.
16. **Kushwaha, K.P.S. and Bhatt, P.** (2004). Mushroom Ke Achchhe Spawn (Beej) Ki Visheshtayen Avam Pahchan. *Kisan Bharti* 36(2): 20-21
17. **Mishra, S.K., Mishra, K.K., Kushwaha, K.P.S. and Singh, R.P.** (2004). Dudhiya Mushroom ki kheti. *Kisan Bharti* 36(3):11-12.
18. **Bhatt, P., Verma, R.C., Kushwaha, K.P.S. and Singh, R.P.** (2004). Dhingri Mushroom Ki Vyawharik Kheti Tatha Uska Arthik Vishleshan. *Kisan Bharti* 36(3): 13-15.
19. **Bhatt, P. and Kushwaha, K.P.S.** (2004). Mushroom Ki Kheti Hetu Achchhi Awaran Mrida Ke Gun Avam Karya. *Kisan Bharti* 36(3): 16-17.
20. **Mishra, K.K. and Kushwaha, K.P.S.** (2004). Button Mushroom Ke Pramukh Rog Tatha Unka Niyantran. *Kisan Bharti* 36(3): 18-21.
21. **Mishra, K.K. and Kushwaha, K.P.S.** (2004). Button Mushroom Ke Hanikarak Keet Avam Unka Prabandhan. *Kisan Bharti* 36(3): 23-24.
22. **Mishra, K.K., Mishra S.K. and Kushwaha K.P.S.** (2004). Mushroom Avam Unke Ausdheeya Gun. *Kisan Bharti* 36(3): 25-26.
23. **Bhatt, P., Kushwaha, K.P.S. and Singh, R.P.** (2004). Mushroom se Taiyar Karen Vibhinn Vyanjan. *Kisan Bharti* 36(3): 30-32.
24. **Bhatt, P., Verma, R.C., Kushwaha, K.P.S. and Singh, R.P.** (2004). Dhingri Mushroom ki Kheti Kyon Avam Kaise Karen. *Krishak Bharti* 5(6):3-4.
25. **Mishra, K.K., Kushwaha, K.P.S. and Singh, R.P.** (2004). Mushroom of medicinal importance. *Indian Farmer's Digest* 37(12): 30-32.

**Raipur Centre:****Research Papers:**

1. **Bhanwar, R. R. and Thakur, M. P.** (2005). Effect of bio-fertilizer recommended with microorganism

on vegetative growth and yield of oyster mushroom (*Pleurotus* spp.). *J. Mycol. Pl. Pathol.* (in progress).

2. **Bhanwar, R.R. and Thakur, M.P.** (2005). Management of competitor moulds using extracts of medicinal and weed plants and their influence on growth and yield of oyster mushroom. *J. Mycol. Pl. Pathol.* (in progress).

#### Extension bulletins:

1. **Shukla, C.S., Thakur, M.P., Sharma, R. and Taunk, S.K.** (2004). Gramin Star par Mushroom Utpadan Takneek. Extension Bulletin No. 3 published by Directorate of Extension, IGAU, Raipur. pp. 1-22.
2. **Sharma, R.L., Thakur, M.P., Shukla, C.S., Thapak, S.K. and Netam, R.S.** (2004). Bastar Mein Mushroom Utpadan. Extension Bulletin published by the Financial Assistance from Integrated Horticulture Development Project, Bastar and Printed at Shaheed Gundadhoor College of Agriculture and Research Station, IGAU, Bastar. ,pp 1-48.
3. **Thakur, M.P., Bhatt, Jyoti, Shukla, C.S. and Sinha, Alok** (2005). Mushroom ke vyanjan awam prasanskrit utpad. Extension Bulletin 3 published by Directorate of Research Services and printed by Information and Communication Centre, Directorate of Extension Services, IGAU, Raipur pp 1-24.

#### Multicoloured Folders:

1. **Thakur, M.P., Shukla, C.S. and Yadav, Vijay** (2005). Paira

Mushroom Utpadan Pradaugiki. Multicoloured Folder published by Directorate of Research, Indira Gandhi Agricultural University, Raipur. PP. 1-8.

2. **Thakur, M.P., Shukla, C.S. and Yadav, Vijay** (2005). Mushroom Beej (Spawn) Utpadan Pradaugiki. Multicoloured Folder No. 2 published by Directorate of Research, Indira Gandhi Agricultural University, Raipur. PP. 1-8.

#### Popular Articles:

1. **Thakur, M.P., Shukla, C.S. and Sinha, Alok** (2004). Mushroom Beej Utpadan Pradaugiki. Chhattisgarh Kheti, July-September, p. 30-32.
2. **Sinha, A., Shukla, C.S., Thakur, M.P., Toorray, N. and Tamrakar, D.** (2005). Safed Dudhari Mushroom Kee Utpadan Taknnek. Krishi Amrit, p.2.

#### Training Compendium:

1. **Thakur, M.P.** (2004). Mushroom Beej Utpadan Pradaugiki. Compilation of lectures during State level Training Programme on 'Mushroom spawn Production Technology to the Entrepreneurs', organised jointly by Department of Horticulture, Govt. of Chhattisgarh, Dept. of Plant Pathology and Directorate of Extension, IGKV, Raipur from 12-18<sup>th</sup> August, 2004, pp.1-57.
2. **Thakur, M.P.** (2005). Mushroom Utpadan Pradaugiki. Compilation of lectures during State Level Training Programme on 'Mushroom

Production Technology to the Entrepreneurs', organised jointly by Chhattisgarh Council of Science and Technology (CCOST), Mushroom Research Lab. of Department of Plant Pathology and Directorate of Extension, IGKV, Raipur from 25 to 31<sup>st</sup> January, 2005. 1-101 p.

3. **Thakur, M.P.** (2005). Mushroom Utpadan Pradaugiki. Compilation of lectures during State Level Training Programme on 'Mushroom Production Technology to the Entrepreneurs', organised jointly by Chhattisgarh Council of Science and Technology (CCOST), Mushroom Research Lab. of Department of Plant Pathology and Directorate of Extension, IGKV, Raipur from 9 to 15<sup>th</sup> March, 2005. 1-101 p.

## B. THESIS GUIDED

1. **Sawale, V. V.** (2004). Comparative studies on wild pink oyster mushroom, *Pleurotus spp.* and *P. eous*. M.Sc. thesis, Dept of Plant Pathology, IGAU, Raipur (submitted)
2. **Sharma, D.** (2004). Studies on Reishi Mushroom, *Ganoderma lucidum*. Ph.D. Thesis. Department of Plant Pathology, IGAU, Raipur (in progress).
3. **Sharma, R.L.** (2004). Studies on agronomic, physiological and enzymatic aspects of *Pleurotus florida* (oyster mushroom). Registered in Pt R.S. University, Raipur (In progress).
4. **Devangan, U.** (2004). Studies on Shiitake mushroom. M.Sc. thesis,

Dept of Plant Pathology, IGAU, Raipur (In progress)

## Udaipur Centre:

### Research Papers:

1. **Zacharia, Sunil and Doshi, Anila** (2004). Artificial indoor cultivation of *Tricholoma crassa* (Berk Sacc an ectomycorrhizal mushroom. *J. Mycol Pl. Pathol.* vol. 34 (1) : 125 - 126.
2. **Sharma, Manish, Shah, Rakesh and Doshi, Anila** (2004). Preliminary studies on casing soil bacteria of white button mushroom *Agaricus bisporus* (Lange) Sing. *Mushroom International*, 98 : 6-11.
3. **Yadav, Rakesh Kumar and Doshi, Anila** (2004). Role of spawn rate in the production of fruit bodies of *Tricholoma crassa* (Berk) Sacc. *Udyanika* 10 (11) : 40-41.

## Vellayani Centre:

1. **Das, Lulu, Balakrishnan, B. and Reeja, R.S.** (2003). Bioremediation use lignocellulolytic fungi, Proceedings of fifteenth Kerala Science Congress pp 467 – 470.
2. **Das, Lulu, Reeja, R.S. and Balakrishnan, B.** (2003). Macrofungi in bioremediation. Paper presented at the National Seminar on IPDMSA, Annamalai, Abstracts pp226.
3. **Pramod, R., Balakrishnan, B. and Das, Lulu** (2004). Evalaution of different methods of the substrate pasteurization for the cultivation of paddy straw mushroom (*Volvariella*

*volvacea*). *Mushroom Research* 13 (1) 29 – 30.

## Solan Headquarters

### i) Research papers

- 1) **Dhar, B.L., Ahlawat, O.P. and Gupta, Pradeep** (2004). Suitable casing materials as related to *Agaricus bisporus* productivity and quality. For presentation in Vth International Conference on *Mushroom Biology and Mushroom Products* from 8-12<sup>th</sup> April, 2005 at Shanghai, P.R. China.
- 2) **Dhar, B.L., Ahlawat, O.P., Dubey, J.K. and Nath, A.** (2005). Organic mushroom production: Pesticide residue analysis and quality produce. *National Conference on Organic Agriculture* from 8-9 Feb., 2005. Centre for Bharatiya Marketing Development, New Delhi (Invited paper).
- 3) **Gupta, P., Indurani, C., Ahlawat, O.P., Vijay, B. and Mediratta, V.** (2004). Physico-chemical properties of SMS of *Agaricus bisporus* and its utilization in improving soil fertility. *Mushroom Research* 13(2):84-91.
- 4) **Kumar, S., Sharma, S.R., Sharma, V.P. and Gautam, Y.** (2004). *Lasioderma serricorne* Fabr.-a new pest of dried mushroom. *Mushroom Research* 13(1):45.
- 5) **Kumar, S., Gautam, Y. and Sharma, S.R.** (2004). Mushroom mites and their management. *Mushroom Research* 13(2):46-52.
- 6) **Sagar, M.P. and Vijay, B.** (2004). Role of radio in transfer of mushroom cultivation technology. *Indian Jour. of Extension Education* 40(1&2 )
- 7) **Sagar, M.P.** (2005). Impact of integration of extension methods on farmers knowledge level about mushroom cultivation. *Indian Res. Jour. of Extension Education* , 5(1) : 56-58
- 8) **Sagar, M.P. and Vijay, B.** (2004). Impact of integration of extension methods on adoption of mushroom cultivation. *Maharashtra Jour. of Extension Education* (Communicated)
- 9) **Sagar, M.P. and Vijay, V.** (2005). Adoption of mushroom cultivation as correlated with selected characteristics of farmers in H.P. *Agricultural Extension Review* (Communicated).
- 10) **Sharma, V.P., Sharma, S.R. and Kumar, S.** (2004). Physiological requirements and cultivation of Black Popular mushroom, *Agrocybe aegerita* in India. *Mushroom Research* 13(2):66-70.

### ii) Popular Articles

- 1) **Ahlawat, O.P. and Verma, R.N.** (2004). Bacterial spoilage of spawn of white button mushroom (*Agaricus bisporus*) and its management. *Indian Farming* 53(10): 10-11&32.
- 2) **Ahlawat, O.P. and Rai, R.D.** (2004). Improving the quality and shelflife of the button mushroom (*Agaricus*

*bisporus*). Indian Horticulture 48(4): 12-13.

- 3) **Ahlawat, O.P. and Tewari, R.P.** (2004). Growth promoters spray: a handy method to improve the yield of white button mushroom. Indian Farming 54(3): 20-22.
- 4) **Sagar, M.P.** (2004). Mushroom utpadan- poshan suraksha va arthik samridhita ka aadhaar. *Dainik Bhaskar*, 20<sup>th</sup> Aug., 2004
- 5) **Sagar, M.P. and Vijay, B.** (2004). Mushroom utpadan – sapnoo ko saakar kare. *Niryatuk Kheti Bari, Varanasi*. (Communicated).
- 6) **Sagar, M.P. and Verma, R.N.** (2004). Dhingri mushroom ki kheti. *Phal Phool*, 27(3):25-27.
- 7) **Sharma, S.R. and Kumar, S.** (2005). Mushroom diseases and their management. (In press) UHF Publication.

### iii) Research Abstracts Published in Seminar/Symposia Proceedings

- 1) **Ahlawat, O.P., Gupta, Pradeep, Dev, Raj and Sagar, M.P.** (2004). Complete recycling of organic wastes for multiple purposes. National Symposium on *Management of Organic Wastes for Crop Production* from Jan. 19-20, 2005 at CCS Haryana Agricultural University, Hisar, Haryana.

- 2) **Indu, Rani, C., Sagar, M.P., Ahlawat, O.P., Gupta, Pradeep, Vijay, B. and Dhar, B.L.** (2004). Effect of button mushroom spent substrate of different age on yield and quality of Tomato (*Lycopersicon esculentum*). For presentation in XVIIIth Annual Conference of **National Environment Science Academy** in May/June, 2005 at Bangalore.

- 3) **Indu, Rani, C., Ahlawat, O.P., Sagar, M.P., Gupta, Pradeep, Vijay, B. and Dhar, B.L.** (2004). Effect of button mushroom spent substrate of different age on yield and quality of *Capsicum annum*. For presentation in XVIIIth Annual Conference of **National Environment Science Academy** in May/June, 2005 at Bangalore.

- 4) **Sagar, M.P. and Vijay, B.** (2005). Dimensions of impact assessment of mushroom cultivation, compendium of lead papers and abstract, National Seminar -2005 on Extension Methodological Issues in Impact Assessment of Agril. and Rural Development Programmes From 21<sup>st</sup> to 23<sup>rd</sup>, Jan., 2005 at Bangalore.

### iv) Books

Mushroom utpadan, Compiled by R. P. Tewari and M. P. Sagar. Pub., Directorate of Extension, Min. of Agril. Govt of India. New Delhi. (In press)

## PERSONNELIA

## Staff position at various AICMIP Centres during 2004-05

| Post                      | Coimbatore              | Ludhiana                              | Faizabad                        | Pantnagar                     | Pune            | Raipur          | Udaipur                     | Thrissur             |
|---------------------------|-------------------------|---------------------------------------|---------------------------------|-------------------------------|-----------------|-----------------|-----------------------------|----------------------|
| Mycologist                | Dr. A.S. Krishnamoorthy | Dr. (Mrs.) S. Dhanda (Sr. Mycologist) | Dr. S.K.S. Chauhan              | Dr. R.P. Singh Joint Director | Dr. T.K. Narute | Dr. M.P. Thakur | Dr. Anila Doshi             | Dr. B. Balakrishnan  |
| Asstt. Mycologist Lakshmi | Dr. R. Radhajeya        | Dr. H.S. Sodhi (Mycologist)           | Dr. P.K. Shukla Asstt. Director | Dr. K.P.S. Kushwaha           | Dr. S.S. Wange  | Sh. C.S. Shukla | Vacant                      | Dr. K.S. Meenakumari |
| Technical Assistant       | Th. M. Nagendran        | Sh. Jagnail Singh                     | Sh. G.P. Gautam                 | Ms. Pratibha Bhatt            | Vacant          | Vacant          | Vacant (Contractual)        | Sh.D. Sivaprasad     |
| Jr.Assistant/Fieldman     | —                       | Sh. Gurdev Singh                      | Sh. Vijay Kant                  | Sh. Ramakant Singh            | Sh.N.G. Desai   | Sh.B.L. Sinha   | Sh. Satya Narayan Choudhary | —                    |
| Lab. Asstt.               | Th. M. Munusamy         | —                                     | —                               | —                             | —               | —               | —                           | —                    |
| Typist cum Clerk          | Th. C.D. Ramadoss       | Mrs. H. Kaur                          | Sh. S.G. Yadav                  | Sh. Vishnu Ray                | Sh. S.C. Kashid | Sh. R.K. Panday | Sh. S. Bhatnagar            | —                    |
| Beldar                    | Th. P. Selvaraj         | Sh. Ram Kumar                         | Sh. G. Prasad                   | Sh. Deo Kumar                 | Sh. Y.S. Bhawe  | Sh. A.R. Sahu   | Sh. Behu Lal                | —                    |

## BUDGET

| Head                                  | Udaipur |      | Faizabad |      | Coimbatore  |      | Ludhiana |      | Pantnagar |      | Thrissur |   | Pune |      | Raipur |      | Ranchi |      | UHF, Nauni |   | Barapani |   |
|---------------------------------------|---------|------|----------|------|-------------|------|----------|------|-----------|------|----------|---|------|------|--------|------|--------|------|------------|---|----------|---|
|                                       | a       | b    | a        | b    | a           | b    | a        | b    | a         | b    | a        | b | a    | b    | a      | b    | a      | b    | a          | b | a        | b |
| Estt. Charges                         | 6.75    | 5.45 | 7.37     | 6.13 | 8.55        | 5.17 | 9.04     | 8.81 | 6.50      | 3.05 | 5.81     | - | 6.70 | 4.20 | 7.57   | 5.01 | -      | -    | -          | - | -        | - |
| T.A.                                  | 0.11    | 0.10 | 0.10     | 0.10 | 0.10        | 0.10 | 0.10     | 0.10 | 0.10      | 0.05 | 0.07     | - | 0.11 | 0.10 | 0.10   | 0.10 | 0.10   | 0.10 | 0.04       | - | 0.10     | - |
| Recurring contingencies including FLD | 0.60    | 0.60 | 0.60     | 0.60 | 0.60        | 0.60 | 0.60     | 0.60 | 0.60      | 0.30 | 0.30     | - | 0.60 | 0.60 | 0.60   | 0.60 | 0.19   | 0.09 | 0.14       | - | 0.19     | - |
| <b>Non-Rec.</b>                       |         |      |          |      |             |      |          |      |           |      |          |   |      |      |        |      |        |      |            |   |          |   |
| a) Equipments                         | 0.13    | 0.13 | 0.13     | 0.13 | 0.13        | 0.13 | 0.13     | 0.13 | 0.00      | 0.00 | -        | - | 0.13 | 0.13 | 0.13   | 0.13 | -      | -    | -          | - | -        | - |
| b) Vehicle                            | -       | -    | -        | -    | -           | -    | -        | -    | -         | -    | -        | - | -    | -    | -      | -    | -      | -    | -          | - | -        | - |
| c) Works                              | -       | -    | -        | -    | -           | -    | -        | -    | -         | -    | -        | - | -    | -    | -      | -    | -      | -    | -          | - | -        | - |
| Total                                 | 7.59    | 6.28 | 8.20     | 6.96 | 9.38        | 6.00 | 9.87     | 9.64 | 7.20      | 3.40 | 6.18     | - | 7.54 | 5.03 | 8.40   | 5.84 | 0.29   | 0.19 | 0.18       | - | 0.29     | - |
| a) Sanctioned                         | 65.12   |      |          |      | Amount      |      |          |      |           |      |          |   |      |      |        |      |        |      |            |   |          |   |
| b) Actual                             | 43.34   |      |          |      | expenditure |      |          |      |           |      |          |   |      |      |        |      |        |      |            |   |          |   |

A, sanctioned amount

B, actual expenditure