AICRP ON MUSHROOM

Objectives

1. To conduct survey of naturally occurring wild mushroom, catalogue and explore possibilities of cultivation of promising species.
2. To evaluate the promising and high yielding strains for suitability in Uttarakhand condition.
3. To carry trial for standardization of production techniques of different mushroom.
4. To explore possibility of selection of cheaper locally available substrates for mushroom cultivation.
5. To supply good quality spawn to the mushroom growers.
6. Popularization of mushroom cultivation in different agro- eco- regions

1. Significant Achievements:

A. Crop improvement:

1. Pantnagar Centre collected 323 germplasms of wild mushrooms from more than 20 different places covered about all the districts of Uttarakhand State. Out of which DMR has allotted accession numbers of 31 wild collections. *Calocybe, Lentinus, Auricularia, Ganoderma, Coprinus,* Katarwa, *Polyporus* spp, *Tuber* spp., *Rossula* spp., *Amanita* spp., *Boletus* spp.,*Tremates versicolar*, Jelly fungus, *Flammulina* spp., *Pleurotus djamor*, *Volvareilla* spp., *Scleroderma* sp, *Pleurotus* sp., *Agaricus* sp., *Geastrum triplex*, *Mycena* spp., *Suillus luteus, Lactarius indigo*, *Entoloma corvinum, Conocybe* spp, *Clavicorona pyxidata, Daldinia* spp, *Termytomyces* spp., Puffball, *Fomes*, *Marasmius*, *Ramularia* sp and *Lepiota* were the major identified genus.
2. out of the collected mushroom five isolates of *Aruicularia*,two species of *Pleurodtus* and twenty isolates of Ganoderma *lucidum* have been brought under cultivation
3. The centre has evaluated hundreds of strains of button mushroom,oyster mushroom,milky mushroom & shiitake mushroom for resistance aginst majaor diseases and their yield performance . The data genrated is beeing used for the breeding of high yielding stranis of different mushrooms. Among them, AVT-04, AVT-1, AVT-05, AVT-3, AVT-04 of white button and AVT-09 of brown button produced highest yield of 19.23-23.23 kg/qtl compost. In milky mushroom it was found that the strains, CI-14-04, strain CI-15-01 and strain CI-16-01 were stood with highest 95.43, 79.17 and 78.63 kg yield of fresh mushroom/ qtl dry wheat straw. However, strain of *Lentinula edodes* LE-15-06 produced 76.94 kg and 66.89 kg fresh mushroom / quintial wheat straw and sawdust under its IVT**.** The high yielding strains of *Pleurotus* PL-16-02 was highest yielder that is 78.52kg /qtl dry substrate. In case of *Lnetinula edodes* strain OE 388 was one of the best strain as it produced 103.34 kg yield/ qtl dry wheat straw from 30 days harvesting.
4. Associated with multilocational testing and release of strains NCS-100 NCS-102 NCH-102 of *Agaricus bisporus* (Button mushroom)
5. Developed twenty three inter – specific and inter-generic hybrids of oyster mushroom *(Pleurotus spp.)* and blue oyster mushroom *(Hypsizygus ulmarius)* .Some of them are performing much better than their parents.

B. Crop Production:

1. The production potentialities of three strains of *Macrocybe giganteum* MA-1, MA-2 and

MA-3 on paddy and wheat straw and their mixture was tested. Among them, the paddy straw resulted highest 56.42% and 59.82% biological efficiencies of strain MA-1 and MA-2, respectively. In another trial, the productivity of the compost as prepared using thermophillic fungi was studied and found that the normal compost (check) was found superior than to that of compost imprignated with inoculum of thermophilic fungi for both consequtive years 2013-14 and 2014-15 as evaluated with the yield of button mushroom.

2. Compost formulation with Sugarcane baggases + Wheat Straw, 2:a developed resulting in reduced cost of cultivation *of Agaricus bisporus.*

3. Standarized cultivation of Calocybe indica using wheat straw as a substrate with casing of FYM+Spent Compost + Sand (2:1:1)

4. A relay cropping Schedule developed for Tarai region of Uttarakhad: two crops af Agaricus bisporus from

5. Standaridized cultivation technology of Gypsizygus ulmarius using wheat straw sipplemented with wheat bran.

6. Standaridized cultivation technology of Ganoderma lucidum, using sterilized wheat straw bran (5%)

7. Extracted and determined the presence of polysaccgarides and Ganoderic acids A, c2 and H from the fruiting bodies of Ganoderma lucidum.

8. Standaridized cultivation of Lentinula edodes with substrate wheat straw and popular sawdust supplemented with 20% wheat bran.

9. Cultural growth of Cordyceps found to be initially white to light cream changing orange or pink to light purple and revers purplish red or dark tan or blood red colour of different medial.

C. Crop Protection:

1. In the year 2014-15 seven bacterial isolates were tested for the management of *Mycogone perniciosa.* As a result it was observed that none of the bacterial isolates could manage the *Mycogone***.** However, the combination of isolates B18 and B19 was found 3.90% superior in comparison to check.

2. Developed chemical treatment (Formalin 15ml + *Bavitin* 0.5g/10kg compost) of long method compost to avoid the moulds in cultivation of A. *bisporus.*

3. Pseudomonas fluorescence proved effective in controlling mushroom diseases caused by *Verticillium, Sepedonium, Trichoderma* and *Fusarium.*

4. Botanicals *Aegle mormelos* (0.5%) and Cleome viscose (1.0%) were found effective in control of *Mycogone perniciosa* and *Trichoderma viride,* respectively.

5. Chemical control of pathogens *Mycogone perniciosa and Verticillium fumgicola* by *sporgone*(0.075%) and *Hypomyces rosellus*, *Fusarium moniliformae* and *Sepedonium chryosporium* by *Bavistin* (0.025%) + Formalin (0.2%) have been worked out.

6. Of twenty isolates of Ganoderma collected, three were examined and characterized biochemically.

D. Post Harvest Technology:

Developed and promoted the mushroom based recipies in form of Matar Mushroom, Mushroom Pakora ,Mushroom warian ,Mushroom papad, Mushroom soup powder and Mushroom Pickle. Another successful attempt was made in which instantly prepared value added recipe of fresh button mushroom with the Chaat masala, salt and lemon juice in from of salad was successfully introduced among the beneficiaries during demonstrations on the post harvest use of mushroom.

E. Extension:

More than 50 villages encampassed in even all districts of Uttarakhand in form of trainings and demonstrations on mushroom cultivation techniques. In which More than 2195 people were trained in mushroom cultivation, 173 demonstrations on mushroom cultivation were successfully led with presently > 60 viable seasional units of button mushroom are working.

Pantnagar Center supplied more than 23874 kg commercial spawn, 550 bottles of master spawn, 458 mother culture, 4552 kuntal quntle compost and 20742 kg casing mixture.

Mushroom cultivation related awarness and problems were also addressed to the people through radio talk, telivision talk, newspaper, phone, whatsapp, postal letters, visits, kishan mela, kishan gosthi and mushroom day.

During 2012-17 Pantnagar Centre was also developed the eight sustainable mushroom houses in the Villages for the benefit of the mushroom growers in Chakarata and Kalsi block, Dehradun.

F. Patent: The following patents are filled

1. PANT MUSHROOM COMPOSTING ASSEMBLY application number 201811004765 dated 2018/02/08

2. BIOFORTIFICATION OF WHITE OYSTER MUSHROOM (*PLEUROTUS FLORIDA*) WITH IRON USING SULPHIDE NANOPARTICLES application number 201811029588 dated 2018/08/07

2. Research Publication :

1. Singh, M.,H.S Chaube and R.P Singh (2001). Changes in physico- chemical properties of casing soil during growth and devlopment of Agaricus bisporus (Lange) Imbach. Indinan J. of Mushroom. 19 (1&2): 24-27

2. Batt, N and R.P Singh (2002). Cobweb disease of Agaricus in bisporus: Incidence, lossess and effective management. *Mushroom Biology and Mushroom Products* (3) : 161- 169

3. Bhatt, N. and R.P Singh (2002). Casing soil bacteria as biocontrol agents against the mycoparasitic fungi of *Agaricus bisporus Mushroom Biology and Mushroom Products* (3): 171-177

4. Sharma, G. and Singh R.P (2002). Variability among the single spore isolates of *Agarcius bisporus (Lange) Imbach strain S-11 J. Mush 20:9-13.*

5. Bhatt N. and R.P Singh (2002). Chemical control of mycoparasites of Button Muhroom. J Mycol. PI. Pathol: 32-45

6. Singh, V.; R.P Singh and N.K Singh (19998). Protein profiles of different Agaricus strains and effect of heat treatment on the protein banding pattern. Mush. Res 7 (1) : 13-18

7. Kushwaha, K.P.S; Bhanu, C. and Singh R.P (2004). Evaluation of different species and hybrids of *Pleusrotus in items of yield. Indian Phytopath* 57: 348-349

8. Kushwaha, K.P.S. (2005). Effect of different treatmentsand supplements of substrate on yield of Pleurotus species. *Progressvie Horticulture*. 37(1): 220-222.

9. Singh, M. and Singh, R.P. (2005) Management of mushroom pathogens through botanicals. *Indian Phytopath.* 58(2):189-193.

10. Mishra, K.K. and Singh R.P. (2006). Exploitation of indigenous *Ganoderma lucidum* for yield on different substrates. *J. Mycol. Pl. Path*. 36(2): 130-133.

11. Bhatt P., Kushwaha K.P.S., and R.P. Singh (2006). Physico chemical properties of different casing mixtures and its effect on yield of *Agaricus bisporus*. *Mushroom Research*. 15(1): 29-32.

12. Kushwaha K.P.S., Pratibha Bhatt and R.P. Singh (2006). Evaluation of different substrate for yield performance of *Auricularia polytricha* a medicinal mushroom. *Int. J. of Agri. Sci.* 2 (2). 389-391.

13. Kushwaha, K.P.S.; Verma, R.C.; and Singh, R.P. (2006). Yield performance of different strains of *Agaricus bisporus* (Lange) Imbach. *Int. J. of Pl. Sci*. 1(2): 264-265.

14. Bhatt P., K.P.S., Kushwaha and R.P. Singh (2007). Evaluation of different substrates and casing mixtures for production of *Calocybe indica*. *Indian Phytopath*. 60(1):128-130.

15. Singh R.P., K.K. Mishra, R.C. Verma, Shishir Tandon and Ashutosh Dubey. (2007). Anti-oxidative properties of *Ganoderma lucidum* and

Cordyceps sinensis. *Mushroom Research*. 16(1): 19-22.

16. Mishra K.K. and R.P. Singh. (2008). Evaluation of substrate for production of *Ganoderma lucidum* (W. Curt.: Fr.) P. Karst (Aphyllophoromycetideae). *Int. J. Med. Mushr.*10 (4): 379-383.

17. Arora R.K. Singh R.P. and Guru S.K. (2008). Determination of bio-active compounds in medicinal mushroom *Cordyceps sinensis*. *Mush. Res*. 17(2): 61-66.

18. Prakasham V. and Singh R.P. (2008) Diversity analysis in button mushroom by biochemical marker. *Mush. Res*. 17(2): 55-59.

19. Prakasham V. and Singh R.P. (2008) Cultural and morphological characterization of *Agaricus bisporus* strains. *Ann. Pl. Protec.Sci*. 16(2): 454-457.

20. Singh R.P., Pachauri, V, R.C. Verma and K.K. Mishra. (2008). Caterpillar fungus (*Cordyceps sinensis)*: A review. *J. Ecofriendly Agri*. 3(1): 1-15.

21. Singh R.P., Vinita Pachauri, R.C. Verma, K.K. Mishra, Ashutosh Dubey and Shishir Tandon. (2008). Extraction and quantification of glucosaminoglycan of *Ganoderma lucidum*. *J. Ecofriendly Agri*. 3(2):180-182.

22. Verma R.C., K.K. Mishra and R.P. Singh. (2008). Evaluation of locally available substrates and grains spawn for production of *Pleurotus sajor-caju. Int. J. Agric. Sci.* 4(2): 450-452.

23. Arora, R.K. and Singh R.P. (2008). Biochemical characterization of caterpillar mushroom (*Cordyceps sinensis*) *Mushroom Research* 18(1):39-

24. Arora R.K. and Singh R.P. (2009). Effect of nutritional sources on mycelial growth of caterpillar mushroom *Cordyceps sinensis* (Berk) Sacc.. *J. Mycol Pl. Pathol*. 39(1):114-117.

25. Singh, R.P.; Mishra K.K.; Verma, R.C.; Pachauri V.; Tandon S. and Dubey A. (2010). Medicinally important terpenoids of *Ganoderma lucidum* isolates from Uttarakhand, India. *Indian Phytopath.* (Accepted).

26. Mishra S.K. and Singh R.P. (2010) Interaction of bioformulations and pathogenic fungi over case run and yield of *Agaricus bisporus* (Lange) Imbach. *Mushroom Research* 19(1):16-21.

27. Bhatt P., Singh R.P. and Sati S.C. (2010) Evaluation of different pleurotus hybrids for their growth requirements *in-vitro*. *Indian Phytopathology*. 63(4):424-426.

28. Mishra, K.K. and Kushwaha, K.P.S. (2011). Evaluation of locally available agro-wastes for cultivation of medicinal mushroom *Lentinula edodes*. *J. Mycol. Pl. Pathol*. 41(1): 129-131.

29. Kushwaha, KPS, Singh PK, Mishra, KK and Bhardwaj, S.B. 2011. Cultural and morphological studies of *Hypsizygus ulmarius*, blue oyster mushroom. *Pantnagar Journal of Research*. 9(2):202-205.

30. Mishra K.K., Mishra Prachi, and Kushwaha K.P.S. (2012). Cultural, morphological and yield attributes of winter mushroom *Flammulina velutipes* (Curt. Fr.) Sing. J. Mycol. Plant. Pathol. 42(1):167-171.

31. Gajendra Singh Jeena, H. Punetha, Om Prakash, Dinesh Pandey and KPS Kushwaha (2013). Investigation of nutritional characterization and element profiling of some *Pleurotus* species (Dhingri Mushroom). *Pantnagar Journal of Research* 11(3): 405-408.

32. Gajendra Singh Jeena, H. Punetha, Om Prakash, Mahesh Chandra and KPS Kushwaha (2014). Study on *in-vitro* antioxidant potential of some cultivated *Pleurotus* species (Oyster mushroom). *Indian Journal of Natural Products and Resources*.5(1):56-61.

33. Neelam, Vinod Upadhyay and KPS Kushwaha (2014). Effect of *Alcaligens faecalis* supplementation to different casing mixture on its physic-chemical properties and yield stimulation of *Agaricus bisporus*. *The Bioscan. 9(2): 659-661.*

34. Mishra KK, Prachi Mishra and KPS Kushwaha (2014). Biochemical characterization of winter mushroom Flammulina velutipes (Curt. Fr.) Sing. *Indian Journal of Mushroom*. 32(1) 4-6.

35. Gajendra S Jeena, H Punatha, Om Prakash, Mahesh Chandra, KPS Kushwaha (2016). Study on in vitro antioxidant potential of some cultivated *Pleurotus* species (Oyster mushroom). *Indian Journal of Natural Products and Resources*. 5(1):56-61.

36. KPS Kushwaha, Arun Kushwaha and SK Mishra (2016). Yield Evaluation of Macrocybe gigantean (Massee) Pegler & Lodge (Giant Mushroom) on locally available different agro-wastes. *Advances in Life Sciences*. 5(24): 11277-11278

37. SK Mishra, Sanjeev Ravi and KPS Kushwaha (2016). Post-composting supplementation of wheat bran and dal powder at spawning of *Agricus bisporus*. Advances in Life Sciences 5(17), 6887-6888.

38. Tanvi Gaur, PB Rao, and KPS Kushwaha (2016). Nutritional and anti-nutritional components of some selected edible mushroom species. Indian Journal of Natural Products and Resources. 7(2): 155-161.

39. Geeta Sharma, Prachi Mishra, KPS Kushwaha, SK Mishra (2014). Estimation of protein and phenol biochemical from sporocarps of *Flammulina velutips* (Curt. Fr.) Sing. Indian Journal of Hill Agriculture. (5)1:83-85.

40. Geeta Sharma, SK Mishra and KPS Kushwaha (2014). Genetic characterization of single spore isolates o Agaricus bisporus (Lange) Imbach. Proceedings of the 8th International Conference on Mushroom Biology and mushroom products (ICMBMP8). Vol. I. 145-150.

41. Rakesh Kumar and KPS Kushwaha (2014). Evaluation of different strains of oyster mushroom for their cultural morphological and yield attributes. Proceedings of the 8th International Conference on Mushroom Biology and mushroom products (ICMBMP8). Vol. I. 351-355.

42. Neelam, KPS Kushwaha and SK Mishra (2014). Yield performance and element profiling of different strains of *Lentinula edodes* (Berk.) Pegler. Proceedings of the 8th International Conference on Mushroom Biology and mushroom products (ICMBMP8). Vol. I. 365-368.

43. SK Mishra, Geeta Sharma, Neelam and KPS Kushwaha (2014). Technological and marketing fissures of button mushroom at traditional and scientific know-how in mid hills of Uttrakhand State, India. Proceedings of the 8th International Conference on Mushroom Biology and mushroom products (ICMBMP8). Vol. II. 635-639.

44. SK Mishra and Rajbir Singh (2015). Techniques of spawn preparation and types of spawn. Proceedings of UGC sponsored National Seminar on Innovative Approaches for sustainable Agriculture, Livelihood and environment Security. Deptt. of Plant Pathology, Gochar Mahavidyalaya, Rampur Maniharan, Saharanpur (UP). P.39-51.

45. Gajendra S Jeena, H Punatha, Om Prakash, Mahesh Chandra, KPS Kushwaha (2016). Study on in vitro antioxidant potential of some cultivated *Pleurotus* species (Oyster mushroom). *Indian Journal of Natural Products and Resources*. 5(1):56-61.

46. SK Mishra, Sanjeev Ravi Omveer Singh, KPS Kushwaha and RK Sharma (2016). Adaption of buttion mushroom cultivation and value addition techniques by the Tribal rural women of Uttarakhand State. IJM. 34(1):28-33

47. Arun Kushwaha, Vaibhav Singh, LB Yadav, SK Mishra, Satya Kumar and KPS Kushwaha. (2017). Impact of Training on Knowledge Level and Adoption of Mushroom Production as Additional Source of Income Among Tribal's of Uttarakhand. *Trends in Biosciences* 10(22): 4565-4567

3. Thesis research:

I. M.Sc. degree

1. Tiwari, HC (1989) Thermophilic fungi of mushroom compost and their enzymatic

activity.Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. B.N. Johari.

2. Tewari, AK (1989) Thermophilic fungi of mushroom compost and their enzymatic activity. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. Dr. R.P. Singh.

3. Rakwal, R. (1992) Chemical control of *Fusarium moniliforme* and *Neurospora* species encountered during cultivation of *Agaricus bisporus* (Lange) Sing. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. R.P. Singh.

4. Singh, A.K. Singh, (1994) Studies on variability among strains of *Agaricus bisporus* (Lange) Sing. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. R.P. Singh.

5. Rajni (1994) Influence of thermophilic fungi on *Agaricus bisporus*. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. B.N. Johri.

6. Singh, R.K. (1996) Studies on persistence of carbendazim in the carpophores of *Agaricus bisporus* (Lange) Sing. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr.R.P Singh.

7. Shikha, Rastogi (1997) Population Dyanmics of mycorrhizal flora in compost and Casing soil. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. B.N. Johari.

8. Singh, S.K. (1997) Fluidized bed drying behaviour of Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. M. Narain.

9. Singh, Vineeta (1998) Variation in strains of *Agaricus bisporus* (Lange) Imbach with particular reference to protein profiles Variation in strains of *Agaricus bisporus* (Lange) Imbach with particular reference to protein profiles Dr. R.P. Singh.

10. Rawat, Seema (1998) Production and characterization of amylases from *Scytalidium thermophilum* Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. B.N. Johri.

11. Tomar P. (1998) Optimization of process parameters for preparation of mushroom powder. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. Dheer Singh.

12. Day A. (1998) Osmo-air drying characteristics of button mushroom. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. R.K. Pandey.

13. A. Kar (1999) Mathematical modeling of thin layer drying characteristics of mushroom (*Agaricus bisporus*) Dr. Y.C. Agarwal.

14. Sethi, Shruti (1999) Development of process for the preparation of mushroom pickle and ketchup Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. Dheer Singh P.H.T.

15. Tiwari, Pooja (2000) Thermophilic fungi from Mushroom compost and their polysaccrolytic activities. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. R.P. Singh.

16. Bhanu, C. (2000) Collection and domestication of some wild edible fungi with particular reference to *Auricularias* - the black ear mushroom. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of R.P. Singh.

17. Neetu (2001) Development of mushroom based 'warian' Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. N. Nath.

18. Kumar, Naveen(2002) Development of mushroom –based 'sev' and 'warian' Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. N. Nath.

19. Rakhi, (2002) Studies on preparation of

instant mushroom soup. Studies on preparation of instant mushroom soup. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. Dheer Singh.

20. Kumar Sanjeev (2004) Development and evaluation of mushroom based 'Mathri'. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. N. Nath.

21. Joshi H.C. (2004) Studies on Interspecific hydridization of *Pleurotus* species for yield and quality. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. K.P.S. Kushwaha, Mishra,Deepika (2004) Development of process of freeze texturization of mushrooms Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. N. Nath.

22. Singh, Ajayveer (2004)Bacterial diversity of early stages of mushroom compost Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. B.N. Johri.

23. Sharma, Abhinay (2004) Studies on preparation of instant mushroom soup Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. B.N. Johri.

24. Singh, P.K.(2006) Studies on *Hypsizygus ulmarius* edible Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. K.P.S. Kushwaha.

25. . Prakasam, V (2006) Morphological and molecular diversity among strains of *Agaricus bisporus* (Lange) Imbach Plant Pathology Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. R.P. Singh.

26. Chaudhary, Aditi (2006) Studies on hybridization of oyster mushroom Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. R.R. Dwivedi.

27. Puri, Smita (2006) Studies on cultural, biochemical characterization and production technology of *Lentinula edodes* (Berk) Pegler Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. R.R. Dwivedi.

28. . Varshney, Anjum, (2007) Variability among different strains of *Calocybe indica* P. & C. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. K.P.S. Kushwaha.

29. Prasad, Meenakshi (2008) Morphological and genetic characterization of hybrids of oyster mushroom and blue oyster mushroom Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. R.P. Singh.

30. Pandey, Vandana (2009) Impact of physico-chemical properties and microbial dynamic of casing on sporophore development and yield of *calocybe indica* P&C Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. K.K. Mishra, Plant Pathology.

31. Shradha S. Arya, (2009) *Ganoderma lucidum*-Cultivation, Characterization and extraction for medicinal use Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. Laxmi Tewari.

32. Singh, Deepali (2010) Biology and cultivation technology of *Agrocybe aegerita* with special reference to biochemical characterization Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. K.K. Mishra

33. Eshetu, Mitiku (2010) Supplementation of oyster mushroom to pig ration as a source of phytase and its effect on phosphorus utilization, blood biochemical profile and carcass traits Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. D.V. Singh.

34. Mishra , Prachi, (2011) Biology and cultivation technology of *Flammulina velutipes* (star mushroom) Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of. Dr. KPS Kushwaha

35. Jeena, Gajendra Singh (2012) Biology and cultivation technology of *Flammulina velutipes* (star mushroom) Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. Himanshu Punetha.

36. Kumar, Rakesh (2014) Studies on variability among different strains of oyster mushroom (Pleurotus spp.) Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. KPS Kushwaha.

37. Nadani, Sudha (2015) Characterization of laccase activities of *Lentinula edodes* (Shiitake mushroom) Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. SK Mishra.

38. Kumar, Shailendra (2015) Influence of organic and physical treatments of wheat straw on the growth of spawn of Lentinula (Berk.) Pegler Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. SK Mishra.

39. Suman,Megha (2015) Genetic variability of *Calocybe indica* and *Macrocybe gingantium* Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. Geeta Sharma.

40. Kaur, Manpreet (2018) Impact of Physical & Chemicals Treatments on the growth Field of Pleurotus spp. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. S.K Mishra.

41. Kumar, Varunesh (2018) Improving the Mycellation Process of Lentinula edodes (Berk) Pegler with organinc Substrates and Supplements. Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. S.K Mishra.

42. Dobhal,Prerna (2018) Preliniatire studies on thermophilic actionomcetes in relation to the mushroom and their green mould Thesis submitted for M. Sc. degree programme to GBPUAT under the guidance of Dr. S.K Mishra.

II. Ph.D. Degree

1. Dr. S.P. Singh (1997) Standardization of processes for dehydro-canning and pickling of button mushroom (*A. bisporus* Sing) Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. N.

2. Nath., F.S.T. Mandvi Singh (1998) Impact of physicochemical properties and microbes of casing on fructification and yield of *A. bisporus* (Lange) Imbach Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. H.S. Chaube.

3. Singh0 Mandvi (1999) Impact of physicochemical properties and microbes of casing on fructification and yield of *A. bisporus* (Lange) Imbach Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. H.S. Chaube.

4. Dr. Anjali Khokar (1999) Production and characterization of lipase from *Scytalidium thermophilum* Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. B.N Johri.

5. Nirmala Bhatt (1999) Biology and Management of some fungal pathogens of *Agaricus bisporus* (Lange) Imbach Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. R.P. Singh.

6. Sharma Geeta (2001) Variation in isolates of *Agaricus bisporus* (Lange) Imbach in terms of yield and Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. R.P. Singh.

7. Rawat Seema (2003) Microbial Diversity of mushroom compost Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. B.N Johri, Microbiology.

8. Mishra S.K. (2003) Development of mushroom based 'papad' using response surface methodology Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. R.P. Singh.

9. Tyagi . R.K. (2004) Development of mushroom based 'papad' using response surface methodology Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. N. Nath, FST.

10. Verma R.C. (1998) Genetic variation among different isolates of *Agaricus bisporus* (Lange) Imbach with surface to protein and DNA profiling Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. R.P. Singh.

11. Devendra (2005) Bacterial community analysis of casing soil Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. B.N Johri.

12. Pawan Agarwal (2005) Genotype characterization of microbial Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. B.N Johri.

13. .Mishr KK (2005) Biology and production technology of *Ganoderma lucidum* (W.Curt.:Fr.)P.Karst with special reference to Biochemical characterization Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. R.P. Singh.

14. Rawat, Shilpy (2007) Isolation and characterization of medicinal mushroom *Ganoderma lucidum* (W.Curt.:Fr.) P. Karst) Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. R.R. Dwivedi.

15. Arora, R.K. (2009) *Cordyceps sinensis* a medicinal mushroom of high altitudes: biochemical and molecular characterization Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. R.P. Singh.

16. Nayak Harapriya (2018) Development and Quality evaluation of pink oyster mushroom (Pleurotus djamor) and Barnyard Millet (Echincochloa frumentacea) Incoporated cutlet mix Thesis submitted for Ph.D. degree programme to GBPUAT under the guidance of Dr. Archana Kushwaha.

4. Future Thrust:

Conservation and maintenance of genetic resources, germplasms characterization and improvement, improvements in production technology, production technology of specialty and medicinal mushrooms, newer substrates, packaging and production system for spawn, integrated pest and disease management, improvements in storage, packaging and processing technologies, basic studies on mushroom biology and transfer of technology through trainings, demonstration and mass-media are the key programmes and thrust areas address to the future.