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Ajay Kumar Pandey
Research Scholar, Seed Science and Technology, Department of G.P.B., SHUATS, Prayagraj, Uttar Pradesh, India

AK Chaurasia
Associate Professor, Seed Science and Technology, Department of G.P.B., SHUATS, Prayagraj, Uttar Pradesh, India

Anche Hareesh Babu
M. Sc. Seed Science and Technology, Department of G.P.B., SHUATS, Prayagraj, Uttar Pradesh, India

Dhananjay Tiwari
Research Scholar, Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Ajay Kumar Pandey
Research Scholar (Seed Science and Technology), Department of G.P.B., SHUATS, Prayagraj, Uttar Pradesh, India

Diversity of seed borne fungi associated with treated buckwheat (*Fagopyrum esculenum* Moench) seeds under storage conditions

Ajay Kumar Pandey, AK Chaurasia, Anche Hareesh Babu and Dhananjay Tiwari

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Abstract
Present paper deals with occurrence and diversity of fungi on treated seeds of buckwheat (*Fagopyrum esculenum* Moench) at storage conditions. Study consisted of 20 genotypes of buckwheat and three treatments. The seeds were treated with neem oil @ 5ml per kg (T_1) and Carbendezim @2g per kg (T_2). Un-treated seeds served as control (T_0). Four fungal species, namely *Aspergillus* spp., *Alternaria* spp., *Rhizopus* spp. and *Pencilium* spp. were found associated with the treated seeds of 20 genotypes. These were the most predominant fungi in terms of prevalence with increase in the storage period. The association of fungi varied with the treatments, genotypes and duration of storage periods. Among 20 genotypes, the association of fungi in buckwheat genotypes was noticed in seven genotypes. The total association of fungi was predominant in G_2 genotype when remained un-treated (T_0G_2) and the rest 13 genotypes showed no traces of fungi. On the other hand, the total fungal association of *Aspergillus* spp. was highest and *Penicillium* spp. was lowest.

Keywords: Buckwheat, genotypes, treatment, prevalence

Introduction
The *Fagopyrum* (Buckwheat), a genus belonging to family Polygonaceae, is native of Europe Asia, but most of the options concentrate on its origin being Central Asia. It is poor men's crop, representing an important food supply in remote places of tribal tract of the country. It is the best crop in higher altitude in terms of adaptation to climatic variables (Baniya, 2001) [1]. A well balanced amino acid profile and a good level of amino acid in buckwheat allow it to be used in food diets where some cereals are poor in lysine and other amino acids (Skrabanja *et al.*, 2001) [5].

The seeds are used in the alcoholic drinks and beverages and tender leaves as a leafy vegetable by the tribal. It is used as feed to the livestock, poultry, piggery and serve as bee hiving. The grain after maturity is made in to flour and used by the humans for chapathi, biscuits and noodles (Tummaramatti *et al.*, 2016) [6].

Fungi are the largest group of seed-borne pathogens, due to their capacity of multiplication and survival in nature (Neergard, 1977; Richardson, 1990) [3, 4]. Buckwheat is generally propagated by seeds and these are potential harbor of numerous micro-fungi which may impair seed germination resulting in the production of abnormal seedlings. Most diseases of buckwheat are transmitted through seeds which in most cases affect the quality of the seeds. Buckwheat seeds in storage carry field and storage fungi. Most of the storage pathogens are *Penicillium*, *Aspergillus* and *Rhizopus*.

Neem oil is a natural pesticide and has insecticidal properties due to which it has been used in the pest control in the stored seeds. It acts as oviposition deterrent i.e. by not allowing the female to deposit the eggs (Dialoke *et al.*, 2017) [7]. Carbendazim being a systemic fungicide controls the growth of fungi by hindering the movement of spindle fibres to the opposite ends in Anaphase stage of Mitosis. Carbdendazim is a broad spectrum systemic, protective and curative benzimadazole fungicide (Kishan et al., 2019) [8]. Seeds of buckwheat could also get fungal infection during storage; hence, in present study, effect of biocide/fungicide (neem oil and carbendazim) on occurrence of fungal species in buckwheat seeds during storage was assessed.

Materials and Methods
A lab experiment was conducted at Seed Testing Laboratory, Department of Genetics Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini,

Prayagraj. Twenty genotypes of buckwheat were used in the present investigation. Among them one genotype was procured from ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora (Uttarakhand), four from Mountain Agriculture Research and Extension Centre Sangla, (Kinnaur) (Palampur, Himachal Pradesh), five from ICAR-National Organic Farming Research Institute, Gangtok (Sikkim) and 10 from ICAR-National Bureau of Plant Genetics Resources (Delhi). Seed health testing for fungal infection was carried out using blotter technique for each sample.

Ten seeds in four replicates were placed equidistantly over a triple layered sterile blotter paper moistened with 0.2% 2, 4-D solution in sterile Petri plates. These Petri plates were then incubated at 20 ± 2 °C for a week with alternate cycles of 12 hours in near ultraviolet light range and for the remaining 12 h in dark. On the eighth day, the seeds were examined for the presence of fungal infection (spores, mycelia etc.) by electronic microscope. The number of infected seeds was counted and the mean was expressed in percentage (ISTA, 2010) [2].

Table 1: Prevalence of fungi (%) among the treatment combinations.

	***Aspergillus* spp.**		***Alternaria* spp.**		***Rhizopus* spp.**		***Penicillium* spp.**	
Treatment	**6 MAS**	**12 MAS**	**6 MAS**	**12 MAS**	**6 MAS**	**12 MAS**	**6 MAS**	**12 MAS**
T_0G_1	-	-	-	-	-	-	-	-
T_1G_1	-	-	-	-	-	-	-	-
T_2G_1	-	-	-	-	-	-	-	-
T_0G_2	5.75	10.5	10	14.5	-	-	-	15.5
T_1G_2	-	-	5.5	10.25	-	-	-	-
T_2G_2	-	-	-	-	-	-	-	-
T_0G_3	-	-	-	-	-	-	-	-
T_1G_3	-	-	-	-	-	-	-	-
T_2G_3	-	-	-	-	-	-	-	-
T_0G_4	-	-	-	-	-	-	-	-
T_1G_4	-	-	-	-	-	-	-	-
T_2G_4	-	-	-	-	-	-	-	-
T_0G_5	-	-	-	-	-	-	-	-
T_1G_5	-	-	-	-	-	-	-	-
T_2G_5	-	-	-	-	-	-	-	-
T_0G_6	-	-	-	-	-	-	-	-
T_1G_6	-	-	-	-	-	-	-	-
T_2G_6	-	-	-	-	-	-	-	-
T_0G_7	-	-	-	-	-	-	-	-
T_1G_7	-	-	-	-	-	-	-	-
T_2G_7	-	-	-	-	-	-	-	-
T_0G_8	-	-	-	-	-	-	-	-
T_1G_8	-	-	-	-	-	-	-	-
T_2G_8	-	-	-	-	-	-	-	-
T_0G_9	-	-	-	-	-	-	-	-
T_1G_9	-	-	-	-	-	-	-	-
T_2G_9	-	-	-	-	-	-	-	-
T_0G_{10}	-	-	-	-	-	-	-	-
T_1G_{10}	-	-	-	-	-	-	-	-
T_2G_{10}	-	-	-	-	-	-	-	-
T_0G_{11}	-	-	-	-	-	-	-	-
T_1G_{11}	-	-	-	-	-	-	-	-
T_2G_{11}	-	-	-	-	-	-	-	-
T_0G_{12}	-	-	-	-	-	-	-	-
T_1G_{12}	-	-	-	-	-	-	-	-
T_2G_{12}	-	-	-	-	-	-	-	-
T_0G_{13}	7.5	15.75	10	13.5	-	-	-	-
T_1G_{13}	-	-	-	-	-	-	-	-
T_2G_{13}	-	-	-	-	-	-	-	-
T_0G_{14}	-	-	-	-	-	-	-	-
T_1G_{14}	-	-	-	-	-	-	-	-
T_2G_{14}	-	-	-	-	-	-	-	-
T_0G_{15}	-	-	-	-	-	-	-	-
T_1G_{15}	-	-	-	-	-	-	-	-
T_2G_{15}	-	-	-	-	-	-	-	-
T_0G_{16}	-	-	-	-	-	-	-	-
T_1G_{16}	-	-	-	-	-	-	-	-
T_2G_{16}	-	-	-	-	-	-	-	-
T_0G_{17}	-	15.56	-	-	-	-	-	12.26
T_1G_{17}	-	-	-	-	-	-	-	-
T_2G_{17}	-	-	-	-	-	-	-	-
T_0G_{18}	-	-	-	-	-	-	-	-
T_1G_{18}	-	10.39	-	-	-	15.75	-	-

T_2G_{18}	-	-	-	-	-	-	-	-
T_0G_{19}	-	-	-	-	-	-	-	-
T_1G_{19}	-	-	-	-	-	-	-	-
T_2G_{19}	-	-	-	-	-	-	-	-
T_0G_{20}	-	12.25	-	-	6.5	14.25	-	-
T_1G_{20}	-	-	-	-	-	-	-	-
T_2G_{20}	-	-	-	-	-	-	-	-

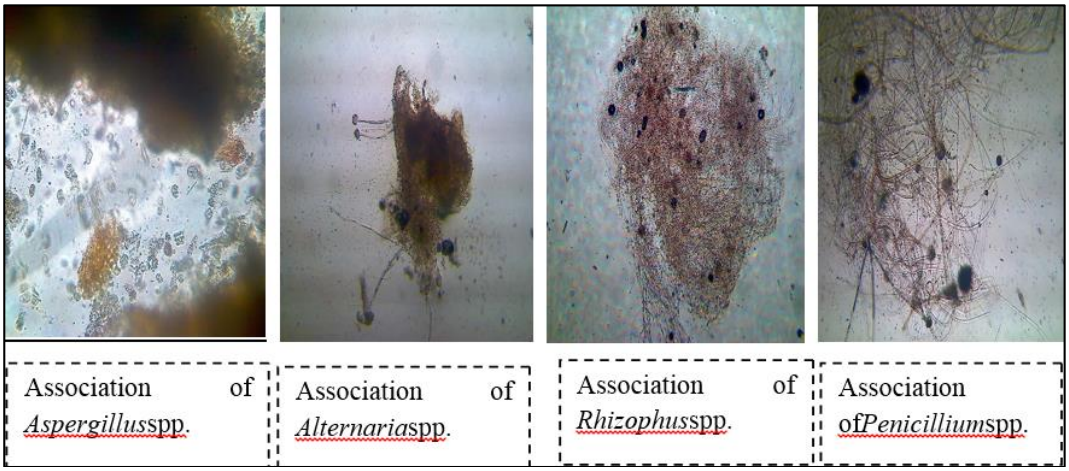

Fig 1: Fungi associated with the seeds of different buckwheat genotype

Conclusion

Storage fungi deteriorate the quality and quantity of seeds in the storage. The occurrence and abundance of fungi were different with duration of storage period. The present findings suggest that there is a need for proper storage of buckwheat seeds to minimize the fungal growth, Present findings will be helpful for designing the management of mycoflora of buckwheat in storage.

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