

Fungal Degradation of Cotton Cordages under Outdoor Weathering

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Abstract. Fungal degradation of Indian cotton cordages has been studied during outdoor monsoon exposure. The rate of degradation was found to be inversely related to the thickness of the cordages. Successional pattern of fungi incident on exposed cordages was also studied.

1. Introduction

The Indian tropical climatological conditions are ideal for generating optimum fungal activity and all types of Service Stores made from cotton have been found to suffer fungal attack resulting in their unserviceability and loss of materials. Under tropical conditions the fungal degradation in cotton cordages is both intensive and extensive. Apart from few sporadic reports (Siu¹, Freitas & Bhat², Greathouse & Wessel³, and Radhelakshmi & Kurian⁴,) on microbial deterioration of cordages, no systematic work has been carried out in India on fungal degradation of cotton cordages. Some work has been done on protective treatment of cordages against micro-organisms, but the cordages receiving mildew resistant treatment again deteriorated badly after a short period of use. Keeping in view these facts and considering wide uses of cotton cordages, a detailed investigation has been undertaken to study the rate and pattern of fungal degradation as well as sequence cum succession of fungi attacking cordages made from Indian cotton under outdoor weathering conditions. These studies will be of great help in formulating adequate preventive measures for both physical and chemical applications on cordages.

2. Material and Method

The Indian Cordages of three different circumference were taken: (i) Cordage cotton grey white, 0.625 cms circumference, ply 3, singles 8. (ii) Cordage cotton

grey white, 1.25 cms circumference, ply 4, singles 7 (iii) Cordage cotton grey white, 2.5 cms circumference, ply 4, singles 190.

1.5 metre length sample pieces of cordages were continuously exposed to outdoor weathering at Kanpur for four months commencing from 15th June 1975 as per Indian specification number ISO/TC-38/SC-1 (1961). The period of exposure was so chosen as to include whole monsoon period. The samples were drawn for tests in a random order initially and every month of exposure. The extent of deterioration was assessed by subjecting the samples to breaking strength test. For determining the breaking strength, the samples were dipped in ethyl alcohol and then dried at room temperature for 24 hours. These were then conditioned at $27 \pm 2^\circ\text{C}$ temperature and $65 \pm 2\%$ relative humidity for 48 hours and were broken (50 cms between grip) in a Goodbrand rope tensile tester in which the test pieces were stretched at a constant rate of 45 cms per minute. The samples were examined visually and with the aid of microscope for fungal growth. Isolation of fungi from exposed cordage samples was made on PDA, CDA and Thorton's media by standard isolation techniques. The cellulose destroying power of fungi was determined by fabric test method⁵.

3. Results

The cotton cordages exposed for first two months during monsoon period did not show apparent mildew symptom. The appearance of fungi on cordages was noticeable in the third month, almost in the middle of monsoon period. The fungal

Weather data

Month	Max. temp. °C	Min. temp. °C	R.H. %
June	39.9	28.7	54
July	33.7	26.6	61
August	32.1	25.8	86
September	32.7	24.9	81
October	32.7	19.6	69

attack was not found uniform on cordages and the incidence was localised. The incipient fungal attack began with slight reddish colouration of the surface and finally the fungal growth sprouted and fructification appeared mainly in the twists of the cordages. These visual observations along with decreasing trend of the breaking strength of the cordages (Fig. 1) clearly indicated that fungal degradation of cordages has taken place. The statistical analysis of the percentage loss of breaking strength of experimental cordages revealed significant variations in different days of exposure. The percent loss of breaking strength showed progressive increase with the increase in the duration of exposure. Among the cordages maximum degradation was noticed in cordage of 0.625 cms and minimum in cordage of 2.5 cms.

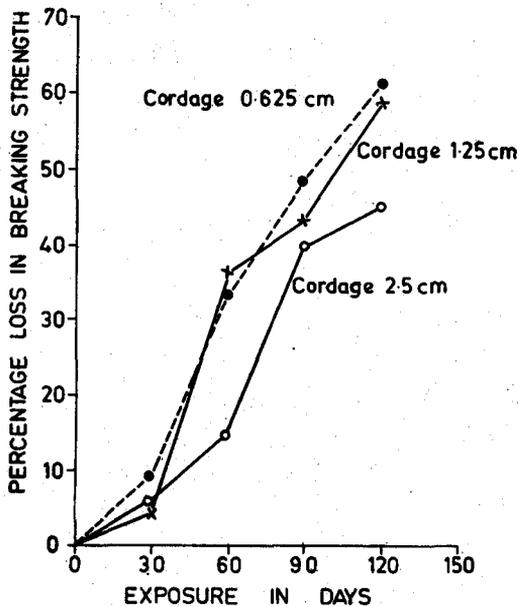


Figure 1. Strength loss of cotton cordages during outdoor exposure.

Table 1. Incidence of fungi on cotton cordages during outdoor monsoon exposure (A-cordage of 2.5 cms cir., B-cordage of 1.25 cms cir. and C-cordage of 0.625 cms circumference).

Fungi	Days of Exposure											
	30			60			90			120		
	A	B	C	A	B	C	A	B	C	A	B	C
<i>Rhizopus nigricans</i>	+	+	+	+	-	-	-	-	-	-	-	-
<i>Phoma</i> sp.	-	-	-	-	-	-	-	-	-	-	-	+
<i>Trichoderma viride</i>	+	-	+	-	-	+	-	+	+	-	+	+
<i>Aspergillus flavus</i>	+	+	+	-	-	-	-	-	-	-	-	-
<i>A. fumigatus</i>	+	+	+	+	+	+	+	+	+	+	+	+
<i>A. niger</i>	+	+	+	+	+	-	-	-	-	-	-	-
<i>Paecilomyces varioti</i>	+	+	+	+	+	-	-	-	-	-	-	-
<i>Memnoniella echinata</i>	-	-	-	+	+	+	+	+	+	+	+	+
<i>Helminthosporium</i> sp.	-	-	-	-	-	-	-	-	+	-	-	-
<i>Fusarium chlamydosporum</i>	-	-	-	-	+	+	+	-	-	+	-	-
<i>F. moniliforme</i>	-	-	-	-	-	-	-	+	+	-	+	+
Total species	6	5	6	5	5	4	3	4	5	3	4	5

Fungi in serial number 1, 4, 6, and 7 are poorly cellulolytic

Fungi in serial number 2, 3, 5, 8-11 are highly cellulolytic.

Eleven species of fungi were isolated from exposed cordages (Table 1). The cellulolytic nature of the fungal isolates have also been assessed and given in Table 1.

The successional pattern of fungi incident on exposed cotton cordages was studied. *Rhizopus nigricans*, *Aspergillus flavus*, *A. niger* and *Paecilomyces varioti* appeared at early stage on the cordages and persisted upto 60th day. Late appearing species were *Memnoniella echinata*, *Fusarium chlamydosporum* and *F. moniliforme*. *Trichoderma viride* showed uneven distribution while *Phoma* sp. and *Helminthosporium* sp. showed restricted distribution. *A. fumigatus* was most common species present throughout the period of exposure on all types of cordages.

4. Discussion

During monsoon season, the temperature and humidity conditions are most congenial for optimum fungal growth and activity. The atmosphere during this period is replete with innumerable number of fungal spores. The aerial fungal flora has played vital role in the degradation of exposed cotton cordages. The pattern of fungal attack is, however determined by climatic effect coupled with actinic effect and the effect of atmospheric chemicals.

The extent of fungal degradation has been found to vary in the experimental cordages. It may be ascribed to the variation in the thickness of the cordages and physical characteristics of the fibres composing the cordages. The variation in degradation of cordages may also be attributed to the type and amount of cellulolytic mycoflora associated with the cordages.

Fungi occurring particularly on weathered cordages are physiologically specialized characterized by their ability to grow or survive under conditions of high light intensity, high and low temperature variations and minimum requirements of nutrition and water supply. These fungi include mostly the members of Deuteromycetes (Table 1).

The successional pattern of fungi on exposed cordages show that the cordages are first colonized by fungi having weak cellulolytic activity (Table 1). These are followed by species with higher cellulolytic activity. The fungi of latter group, in fact, initiate the active decomposition of cellulose in the cordages. These fungi during decomposition process release simpler forms of nutrition. These simpler forms are utilized by weak cellulolytic colonizers which persist for more time. When the substrate is again depleted off the simpler nutrition, the weak cellulolytic forms disappear. At this stage few more potent cellulose decomposing fungi appear and continue the decomposition of cotton cellulose in the cordages. The uniform distribution of *Aspergillus fumigatus* on cordages is due to its highly saprophytic ability to degrade cellulose and greater tolerance to varying environmental conditions. Moreover its ability to produce toxic substances⁶ helps in its survival under most competitive situations.

References

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