Managing Weather Damaged Cotton in the Field and in the Gin

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Introduction

Microbial damage to raw cotton, sometimes referred to as weathering damage, is a common event in most parts of the world. Microbes, viz. bacteria and fungi, are omni-present in the environment. In the case of cotton production, microbes form an essential part of the biology and health of the soil in which the cotton plants grow. After the opening of the boll, wind-blown dust and soil components are deposited on the cotton fibres, carrying with them various bacteria and fungi. Thus the microorganisms are always present and only require favourable conditions for their growth [1]. Ideal conditions occur when rain delays the harvest.

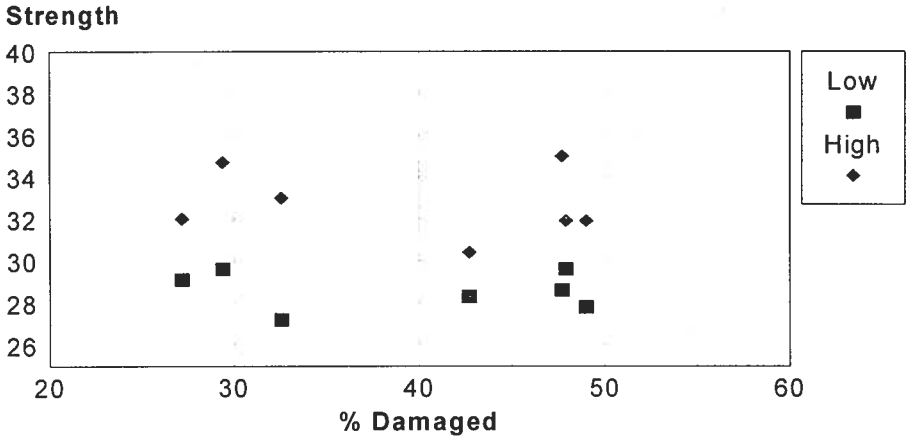
Studies on the seeds of cotton plants have isolated around twenty species of fungi. The majority of these species were present in under 1% of the samples studied with *Alternaria alternata, Colletotrichum gossypii, Fusarium equiseti* and *Fusarium pallidoroseum* being the only examples of species with an incidence greater than 10% [2]. Other species that are more associated with the infection of the boll of the cotton plant are those in the genus *Aspergillus* (in particular *A. flavus* and *A. niger*), the genus *Trichoderma* and the genus *Penicillium* (specifically *P. nigricans*). In particular, species of the genus *Aspergillus* produce aflatoxins in seed and seed products [3].

A major requirement for the growth of microorganisms is the presence of moisture at a minimum level of around 9% [4], although microbial damage has been detected with moisture levels as low as 7% [5-6]. The microorganisms responsible can be either fungi or bacteria, which are thought to contaminate the cotton from the soil [7], although not all fungi [8] or bacteria [9] are cellulolytic. This type of microbial damage can occur after boll opening, prior to or after harvest, and during storage in the module or the bale. Microbial deterioration does not necessarily result in a lowering of the grade [9].

In our work over the past several years we have found that microbial damage does not cause a significant change in the parameters measured by the HVI (High Volume Instrumentation) technique, viz. micronaire, length, strength, SFC%, etc. Figure 1 presents the HVI strength data for seven different cotton lots of varying microbial damage. The

"high" and "low" values represent the range of strength values for seven HVI tests made on random samples drawn from the lots. Clearly there is no correlation between strength and microbial damage. However, it has been reported that barre dyeing effects are observed in certain unbleached cottons, and that this barre dyeing effect has been ascribed to microbial damage in the cotton.

Figure 1
Strength -vs- Damage



Test Methods

Microbially damaged cotton can be detected by a variety of tests including microscopy after swelling in 18% sodium hydroxide, pH determination, water soluble reducing sugars (DNS), reaction with benzedrine and staining with selected dyes [10].

Of these, the most convenient test for use in the field is the pH determination using a Universal Indicator (Ajax Chemicals, diluted x20 in distilled water). The presence of microorganisms on the cotton decreases the organic acid content of the fibres, leading to a consequent increase in the pH of aqueous extracts from the fibres. This phenomenon has been attributed to the metabolic use of organic acids (probably malic acid) by the organisms present [8]. Normal undamaged cotton fibre would be expected to have a pH in the range 6.3-7.3, ie. near neutral pH, whereas microbially damaged cotton can have a pH in the range 8.2-9.5, with a pH of 10 indicating high microbial damage [8]. Whilst suitable for field work, it should be noted that the pH test is unreliable for cottons that have been held in storage for lengthy periods of time. Some samples decreased to nearly neutral pH over a period of 8-10 months [11].

On-Farm Strategies

As discussed above, microbial damage to cotton occurs when moisture levels are high, usually after late rains and/or a rain-affected harvest. In these circumstances the cotton fibres contain sufficient water to permit the microbes to grow. Since the cotton is stored in compacted modules prior to ginning, it is not feasible to dry the cotton and hence other protocols must be employed. It was noted in the literature [12] that treatment with acetic acid inhibits enzyme amylase in the genus *Aspergillus*. Other studies utilising propionic acid have also resulted in a lessened efficiency of *A. flavus* to infect the cotton plant and reduced the production of aflatoxins.

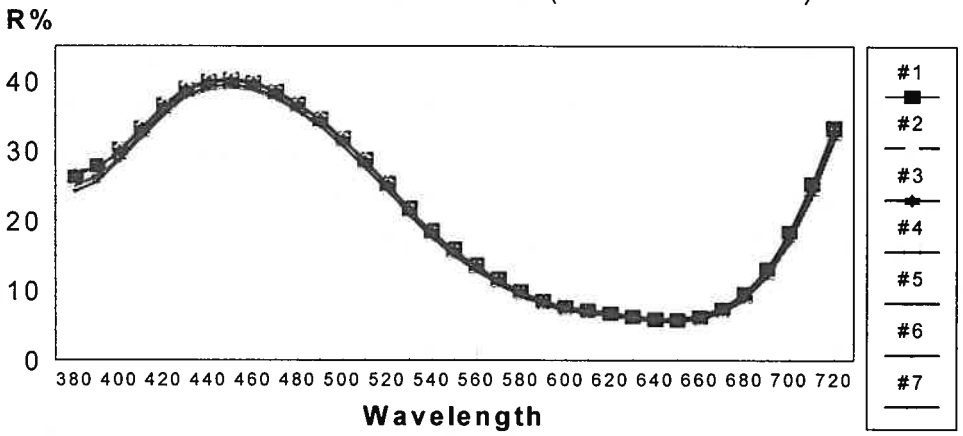
Mini-bales were prepared at the ACRI using undamaged (DRY) and weathered (WET) cotton, at three moisture contents (5%, 10% & 15%) and stored for six weeks. Mini-bales were also prepared from the WET cotton after pre-treatment with acetic acid and hydrogen peroxide. After the six week storage period the bales were opened and analysed for microbial damage. The results are given in Table 1.

Table 1 : Microbial Damage Results

Conditions	Sample ID Numbers	Moisture (%)	Cotton DNS (±0.1)	pH (±0.1)	Damaged (%)
DRY	1-6	5	1.0	6.8	
	7-12	10	0.8	7.6	
	13-18	**15**	**0.2**	**10.2**	**28**
WET	19-24	5	0.9	8.0	
	25-30	10	0.8	8.0	
	31-36	**15**	**0.2**	**10.4**	**49**
WET PEROXIDE	37-42	5	0.9	4.6	
	43-48	10	0.6	8.2	
	49-54	**15**	**0.1**	**10.7**	**24**
WET ACETIC ACID	55-60	5	0.9	6.8	
	61-66	10	1.0	6.4	
	67-72	**15**	**1.1**	**7.1**	**25**

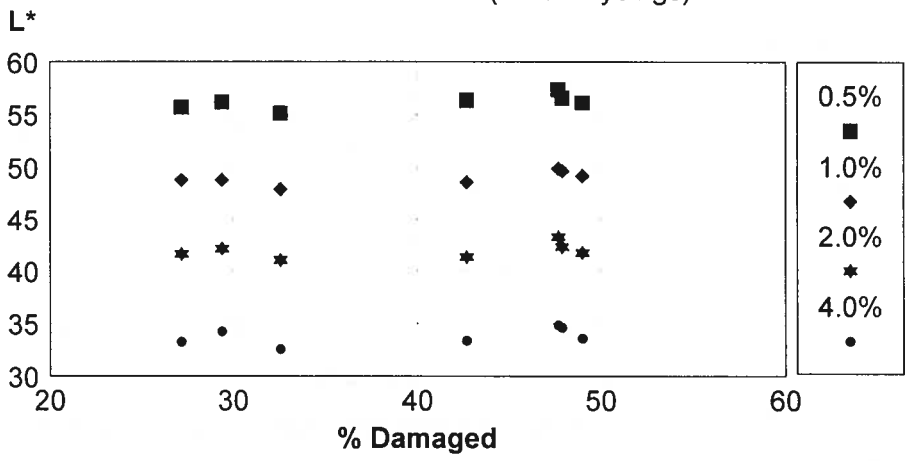
These results clearly demonstrate that microbial damage increases dramatically when the moisture content exceeds 10% and, further, that the acetic acid treatment prior to compression into bales effectively curtails microbial damage during storage.

Figure 2
Reflectance Data (Run #1)
1.0% Evercion Blue HEGN (Bleached Cotton)



As shown in Figure 3, for the same dyestuff, there is no correlation between fibre damage and the lightness/darkness (CIE L*) of the dyeings. Again, the total differences are small, but would be noticeable if two lots were knitted into the same fabric structure. The net effect would be the barre observed in commercial production.

Figure 3
Lightness (L*) - vs - % Damaged
Evercion Blue HEGN (Union Dyeings)



Thus, control strategies at the mill would include:

- better blending protocols,
- bleaching of the cotton (if necessary),
- quality assurance protocols that avoid mixing different yarn lots (on the same knitting machine), and,
- the development of dyeing assistants for use in the dyehouse.

Conclusions

In Australia, microbial damage to cotton is a relatively rare event and, in general, results from rain-affected harvests. In this paper we have suggested possible control protocols for on-farm, gin and mill situations. However, the problem of microbial damage in rain-affected cotton can largely be minimised by the careful monitoring of moisture contents of modules and bales and by better blending protocols at the mill.

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