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# The effect of short fibre and neps on Murata vortex spinning

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Murata vortex spinning was introduced at the 1997 Osaka International Textile Machinery Show. Murata impressively demonstrated the economic potential of the MVS by spinning a 15 tex yarn in 100 per cent cotton at 400 metres per minute. By way of comparison, open end rotor spinning delivers the same yarn at around 150 metres per minute. In addition the yarn and fabric properties of MVS are comparable to those of ring spun yarn — that is, fabric can be as smooth and soft as ring spun fabrics and with enhanced wear properties.

But for MVS to achieve these high outputs, fibre must be clean and strong, have a staple length of at least 28 mm (more than 13/32 inches) and be uniform in length.

The air vortex spinning method used by the MVS takes drawn cotton sliver and drafts it to the desired yarn count (fineness) using a four roller/ apron drafting system. The drafted fibres are then sucked into a nozzle where a high speed 'vortex' air current wraps the fibres around the outside of a hollow stationary spindle.

A vacuum around the base of the spindle acts to 'comb' out shorter fibres and neps. Fibres are pulled down a shaft that runs through the middle of the spindle. Yarn twist is inserted as the fibres swirl around the apex of the spindle before being pulled down the spindle shaft.

The productivity of the MVS system comes through its delivery speed, the fact that it spins yarn directly from sliver, rather than 'roving', and the fact that yarn is wound and cleared directly onto a package that can be sold by the mill.

FIGURE 1: HVI staple length

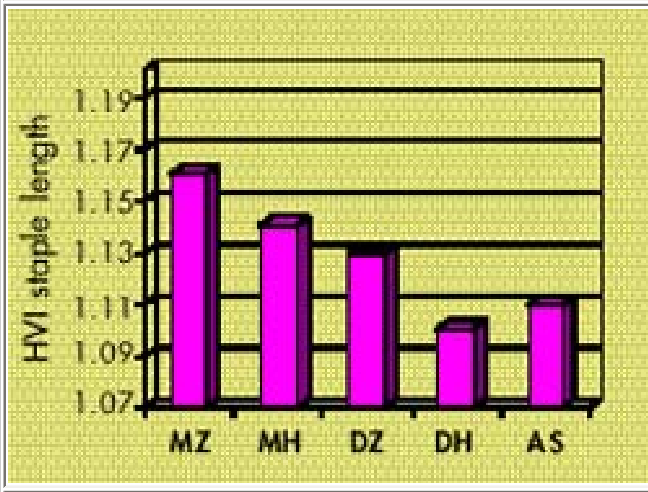



FIGURE 2: HVI length uniformity

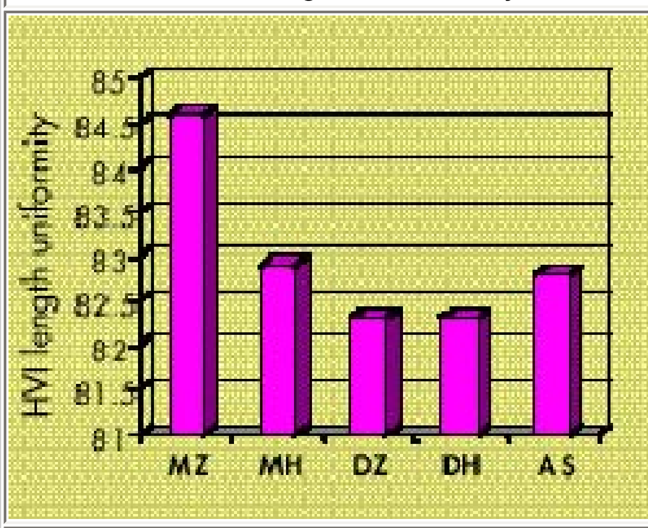



FIGURE 3: HVI short fibre index

## GIN TREATMENTS

Five bales of irrigated Darling Downs cotton (Sicala 40) each with different fibre length distributions and nep levels were obtained through the National Centre for Engineering in Agriculture's (NCEA) Field to Fabric gin study. This was conducted at Queensland Cotton's Dalby gin in July 2000.

A module was divided into three parts with each part stored at different moisture conditions before ginning to produce the different fibre length and nep characteristics. Each part was then subjected to one of three different heat settings in the gin.

This gave nine lots of the same cotton — each lot with different length and nep characteristics. Of these, four extreme treatments and the standard treatment (ambient storage conditions and standard heat in the gin) were used for the MVS study (see Table 1).

Gin cleaning equipment consisted of hot air, inclined seed-cotton cleaners and TrashMaster before ginning, followed by one lint cleaner after ginning.

## MILL PROCESSING

Fibre from each treatment was thoroughly characterised in fibre tests involving high volume instrumentation and individual laboratory instruments.

Then each bale was opened, cleaned, carded and drawn to second passage sliver at the International Fibre Centre in Melbourne. About 40 kg of sliver from each treatment was packaged and freighted to the Murata research and development centre in Kyoto, Japan for final drawing and spinning. Spinning was conducted on a MVS machine at high speed to gauge the effect of high short fibre content on yarn quality and spinning efficiency.

The yarns from each treatment were evaluated in terms of physical and appearance characteristics, processing behaviour and fibre loss. Two yarn counts were spun to observe any distruptive effect from high short fibre content. Yarns were knitted into fabric samples at CSIRO Textile and Fibre Technology (CTFT) and

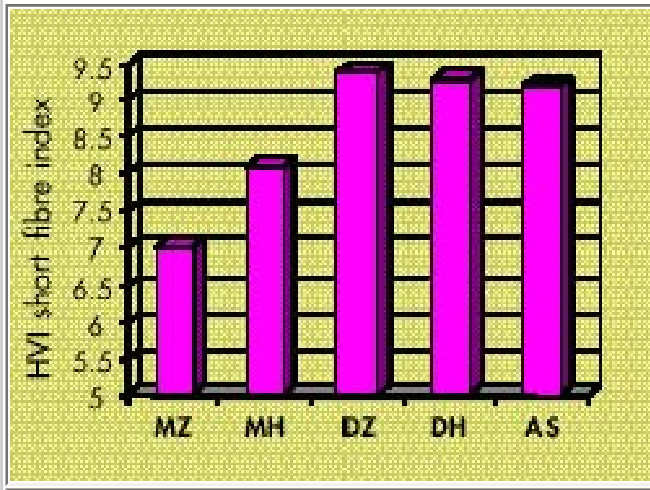



FIGURE 4: AFIS neps (raw fibre)

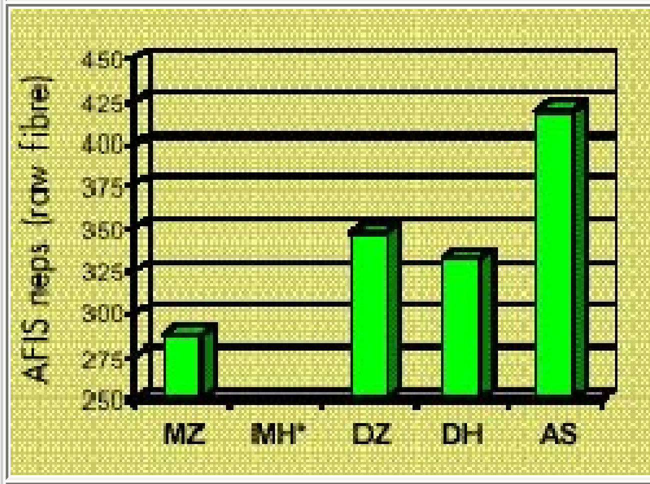
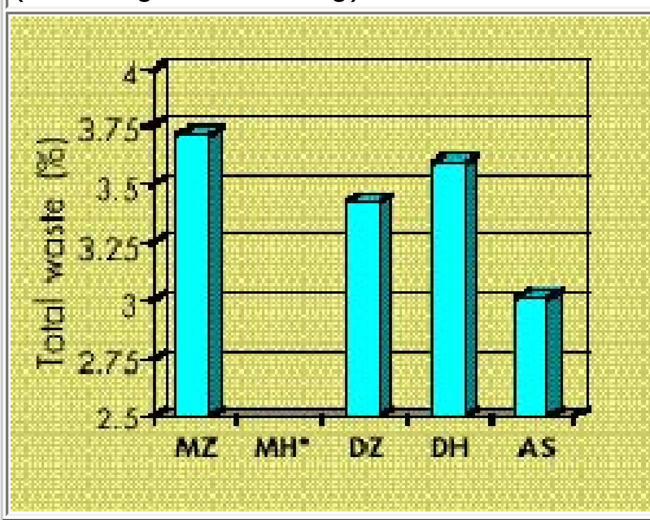



FIGURE 5: Total processing waste (cleaning and carding)



subjected to extended pilling tests to again highlight the effects of elevated short fibre.

## FIBRE QUALITY CHARACTERISTICS

Since growing location and conditions including harvesting were identical, the differences in fibre properties can be attributed to module storage and gin heat. As expected, micronaire, fibre fineness and maturity were unaffected by the gin treatments. But length, strength, trash and nep characteristics were significantly affected by the combination of storage moisture and gin heat conditions.

### Fibre length characteristics

There were pronounced differences in staple length, short fibre index and length uniformity between gin treatments (see Figures 1, 2 and 3). In general, seed cotton ginned with no heat in the gin produced longer, more even cotton. Moist seed cotton ginned with no heat (MZ) produced the longest, most even cotton followed by dry seed cotton treated with zero heat (DZ). On the other hand, dry seed cotton treated with high heat (DH) and seed cotton stored under ambient conditions and treated to standard heat (AS) produced lint with reduced staple length and higher short fibre contents.

### Strength

Fibre strength is a fundamental fibre property that decides both yarn and fabric quality and processing efficiency. Fibre strength across all treatments was generally very good (more than 29 grams per tex) and in keeping with the grade of the cotton ginned. As expected, fibre strength did not vary greatly between gin treatments, although measurements were higher for treatments stored under moist conditions (MZ and MH).

### Trash and neps

Trash and fibre entanglements, such as neps, disrupt the spinning processes and damage both yarn and fabric appearance. These contaminants may be less of a problem in MVS spinning because of the suction around the MVS stationary spindle. As well as removing shorter fibres, the vacuum removes neps before they are

**TABLE 1: Combinations used**

| Treatment | Storage moisture | Gin heat |
|---|---|---|
| MZ | Moist | Zero |
| MH | Moist | High |
| DZ | Dry | Zero |
| DH | Dry | High |

FIGURE 6: MVS yarn tenacity

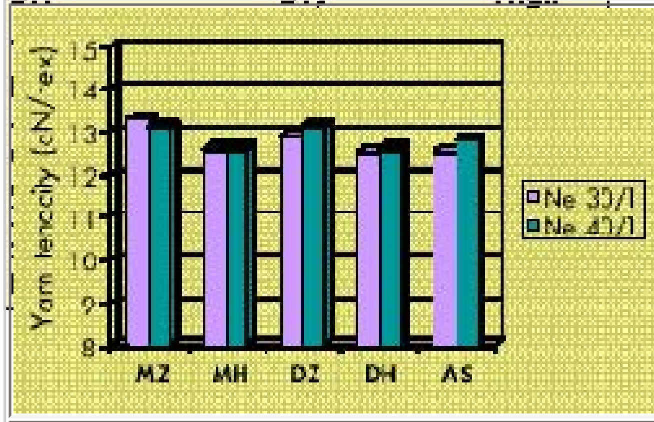



FIGURE 7: MVS yarn imperfections (Ne 30/1 only)

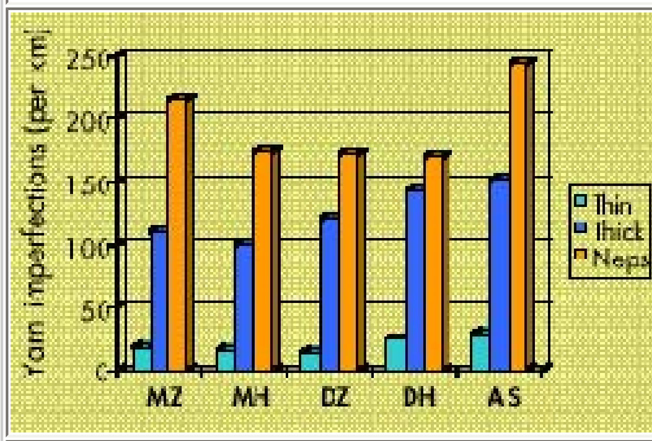



FIGURE 8: MVS yarn hairiness

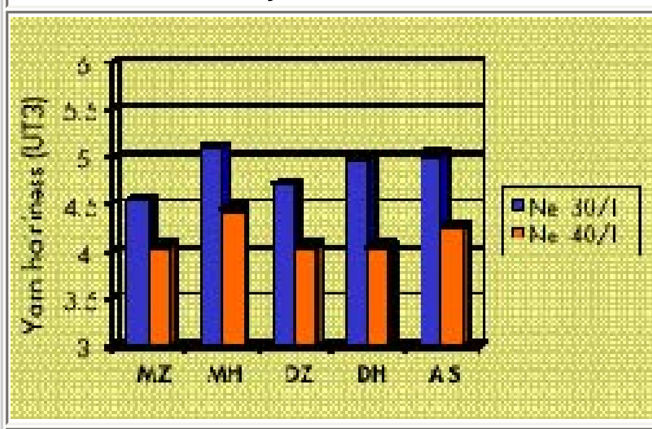



FIGURE 9: Fibre lost during spinning

incorporated into the yarn.

Cotton stored under moist conditions had higher trash contents than cotton stored under dry or ambient conditions.

It is notable that all seed cotton treatments had nep contents exceeding 250 neps per gram (see Figure 4). Uster Statistics rank cotton with this level of neps in the upper half of cotton tested.

## FIBRE PREPARATION AND SLIVER QUALITY

The five gin treatments were opened, cleaned, carded and drawn under identical conditions using Trützschler equipment.

The main measures of an opening, cleaning and carding system’s ability to process and clean cotton efficiently include trash content and the number of neps in the sliver produced from it. Waste reduction by fractions of a per cent are significant to most cotton spinners if the amount of fibre purchased annually is considered.

Each of the samples used was relatively clean (middling grade with leaf grade of one) and total waste produced during opening, cleaning and carding did not exceed 3.7 per cent for any of the treatments (see Figure 5).

The trash and nep contents of second draw sliver from each gin treatment were tested. The moist gin treatments (MZ and MH) were the cleanest in terms of trash content and percentage of fibre fragments and the zero heat gin treatments (MZ and DZ) had the best length characteristics.

The results demonstrated that traditional cotton grades for trash and leaf content do not necessarily describe a cotton’s processing ability or quality of the end product. It was also notable that the nep content of each sliver sample was low with no trend associated with gin treatments.

## SPINNING AND YARN QUALITY

The drawframe sliver sent to Murata was drawn for a third time at the Murata R&D Centre in preparation for spinning on the MVS frame. A medium twist level was selected so as to reflect the quality of yarn for both knitting and weaving

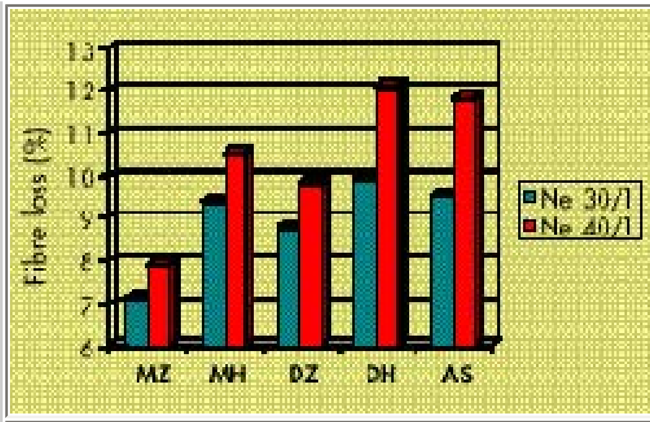
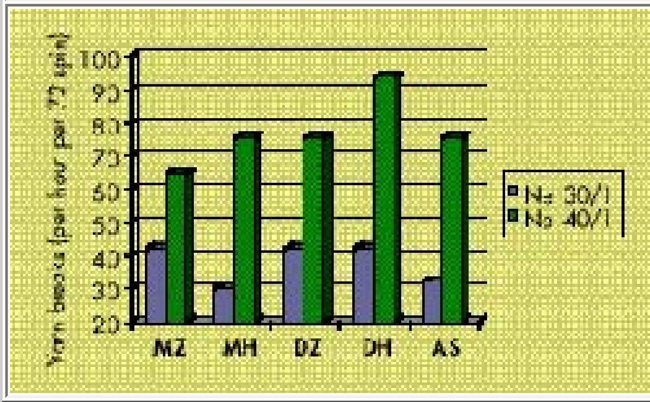



FIGURE 10: Yarn breaks per hour per frame



end uses.

Two yarns counts were spun (Ne 30/1 and Ne 40/1). Murata vortex spinning frames can spin yarn counts from carded sliver in the range from Ne 10/1 to Ne 50/1. Yarn was spun in sufficient quantities for thorough yarn and fabric testing and calculation of spinning efficiencies and fibre loss.

## Yarn tenacity

Yarn tenacity is determined by a combination by fibre fineness, fibre length and fibre strength. As fibre fineness was constant in this trial, the yarn tenacity results reflect the gin treatments and their effect upon fibre length and strength.

The MZ treated cotton produced the highest tenacity yarn in both Ne 30/1 and Ne 40/1 counts, while the AS and DH treated cotton produced the weakest yarns (Figure 6). Likewise, yarn elongation was better in the MZ treated cotton and worse in the drier, heat-treated samples.

The overall tenacity of the MVS yarns was better than that of comparative open-end rotor yarns but weaker than that of ring spun yarns.

## Yarn evenness and imperfections

The evenness of yarn spun on all short-staple spinning systems is directly affected by short fibre content. Evenness results followed a similar pattern to tenacity results, in that evenness was better in yarns spun from cotton treated to moist storage or zero heat. This was evident in both yarn counts and was also reflected in thick and thin place counts (see Figure 7).

But nep counts did not follow this pattern. DZ treated cotton had the lowest number of yarn neps in both yarn counts but AS cotton produced more neps in Ne 30/1 yarn and MZ produced more neps in Ne 40/1 yarn. It is interesting to note that nep levels in both yarn counts were at least 75 per cent better than yarn nep levels in carded ring spun yarns. Even yarns with the highest yarn nep measurements (MZ and AS) fell within the lowest 25 per cent of all Uster Statistic entries for carded ring spun yarn neps.

## Yarn hairiness

Yarn hairiness is significantly affected by short fibre and the trial results follow a similar pattern to the yarn tenacity and evenness results. Both MZ and DZ treated cotton, which had relatively low levels of short fibre, had the lowest hairiness values in both yarn counts, while AS and MH cotton produced the highest hairiness values in both yarn counts (see Figure 8).

## Fibre loss

Fibre loss at the MVS twist zone due to the vacuum around the base of the stationary spindle will be an important issue in the marketability of Australian cotton to MVS spinning mills. Fibre losses, expressed as a percentage of the total input weight, were significant and greater for the cottons exposed to dry storage and excessive heat during ginning.

Figure 9 illustrates the fibre loss for each yarn count due to each gin treatment. As expected, MZ cottons lost less fibre while cottons subject to harsher treatments — for example AS and DH cotton — lost more fibre. Different nozzle geometry and pressures can be used to reduce these figures although alteration of such spinning parameters may cause significant changes in yarn properties.

## Spinning breaks

Spin breaks are defined as the number of breaks per hour per spinning frame. Sixty breaks per hour is considered the cut off if a spinning efficiency of above 90 per cent is to be achieved. Spinning breaks for Ne 30/1 yarn were similar for all gin treatments. The high end-break rate with the DZ treatment was attributed to the condition of the sliver (see Figure 10).

Spinning breaks increased when the yarn became finer with all Ne 40/1 yarn exceeding 60 breaks per hour per machine. But the MZ treatment had the lowest number of end breaks (64) while the DH treatment had the highest (96). The high number of breaks is evidence that Ne 40/1 may effectively be the spin limit for carded Australian cotton and that to efficiently spin finer counts, combing may be required.

## FABRIC QUALITY

Ne 30/1 yarn from each gin treatment was knitted into single jersey fabric. These samples were then subject to a pilling resistance test. MVS fabrics are generally highly resistant to abrasive damage and pill formation, and consequently retain a fresh appearance even after many launderings.

All fabrics in this trial were rated as having no or little pilling.

## CONCLUSIONS

Treatment of seed cotton before and during ginning, especially with respect to fibre moisture and drying temperatures, has significant effects on fibre quality. Dry seed cotton and hot air in the gin lead to high short fibre content, shorter staple length, increased neps and reduced strength. These properties have adverse effects on both the quality of spun yarn and the efficiency with which the yarn can be spun.

With MVS yarn, higher short fibre contents lead to greater fibre loss around the MVS twist zone, which translates directly into lost production for the spinning mill.

High short fibre also contributes to poorer yarn tenacity, poorer yarn evenness, higher levels of imperfections, higher yarn hairiness and lower spinning efficiency. Conversely, elevated nep levels in fibre did not translate into higher yarn imperfections, because neps are removed at the twist insertion point during MVS spinning.

In terms of grade and trash content, the cotton investigated in this study would normally be described as a high quality growth. But for MVS (and ring) spinners the control cotton (AS) could only be described as being of reasonable quality. The AS treated cotton performed worst in almost all yarn quality indicators.

MVS spinners require better length characteristics to achieve the desired quality in their yarns. The results from this study show that cotton treated with more moisture and less heat in the gin performed better on MVS in terms of yarn quality, spinning efficiency and raw material cost savings.

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