South African Experience with Bt Cotton

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Introduction

The bollworm is a major pest in South Africa. The last three seasons Bt cotton cultivars were registered in South Africa and were tested extensively in different cotton-production areas. During the 1998 planting season, the first cotton seed with the Bollgard™ gene, produced by Monsanto, was commercially released by Delta & Pine Land Inc. South Africa. The cultivars were NuCotn 35B and NuCotn 37B.

Adaptability

South Africa is divided into eight (Fig 1) cotton-production areas. This division is based on climatic differences. The evaluation program showed that the Bt cultivars were well adapted to all the production areas. At present, Bt cotton is planted successfully in all the production areas under widely different climatic conditions.

Among commercial cotton farmers, 195 bought licenses. However, the level of acceptance was lower among those commercial producers who planted cotton under rainfed conditions. By contrast, the number of small-scale farmers who planted Bt cotton increased phenomenally from 76 in the first season to 411 the following year. During the 2000/2001 season, 1,184 small-scale farmers bought licenses. In this sector, the yield increased from 40-300%. The lower the management skills, the higher the percentage yield obtained.

These farmers saw the following advantages:

- Safety: Families were no longer exposed to highly toxic

chemicals throughout the season.

- Convenience: Since water was not readily available for mixing chemicals, Bt cotton was more convenient to handle.
- Profitability: higher yields and reduced costs meant more money.

Yield

Bt and non-Bt cotton cultivars were used in trials conducted under widely different climatic conditions. These trials were done over three seasons under irrigated and rainfed conditions.

Figure 2 represents the seed cotton yield of Bt and non-Bt cultivars under irrigation. The results indicate that, over the three seasons, the Bt cultivars produced significantly higher seed cotton yields than the non-Bt cultivars.

The seed cotton yield under rainfed conditions over three seasons was 2,308 kg/ha for Bt cultivars and 1,949 kg/ha for non-Bt cultivars. The data in Figure 3 also demonstrate that the yield of Bt cotton was higher, but not significantly higher, than that of non-Bt cotton.

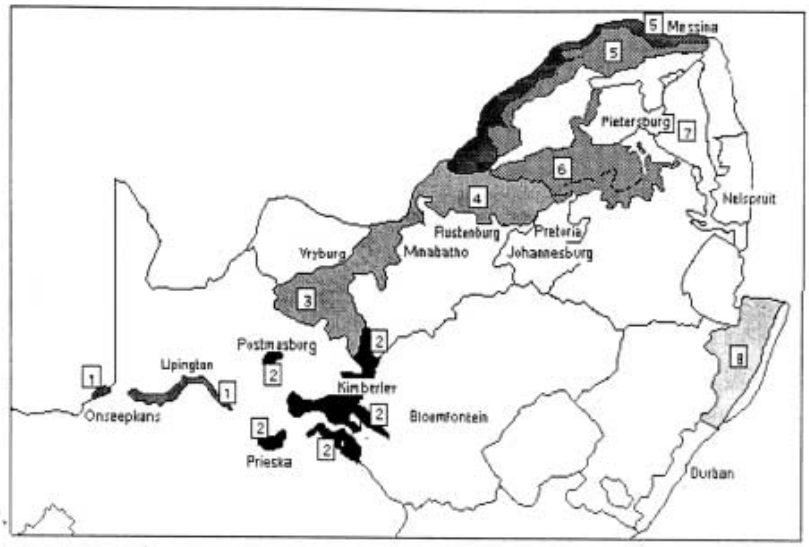


FIG. 1. Cotton Areas in the RSA (areas 1 to 8)

1. Lower Orange River (Irrigation)
2. Griqualand-West (Irrigation)
3. North-West – Vryburg
4. North-West – Rustenburg
5. Limpopo Valley
6. Loskop – Springbok Flats
7. Lowveld (Irrigation)
8. KwaZulu-Natal

Fiber Properties

Many samples of Bt cotton were analyzed and, in general, the fiber properties of Bt cotton were more acceptable than those of non-Bt cotton. Figure 4 represents the ginning outturn (GOT) data of Bt cotton planted under irrigation over three seasons. The GOT of Bt cotton was higher than that of non-Bt cotton and the difference was significant for the 1999/2000 and 2000/2001 seasons. Under rainfed conditions, the Bt cotton produced a significantly higher GOT during the 1999/2000 season (Fig 5).

No significant differences in length and strength were found between Bt and non-Bt cotton under irrigated and rainfed conditions. There were also no significant differences in micronaire between Bt and non-Bt cotton under irrigated and rainfed conditions, but there were some indications that the micronaire values of both Bt and non-Bt cotton were lower under rainfed conditions (Fig 6).

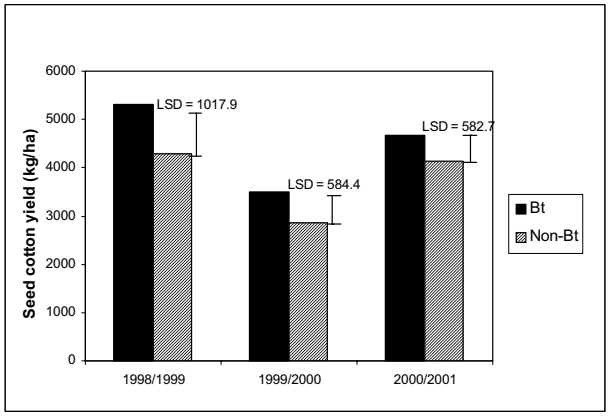
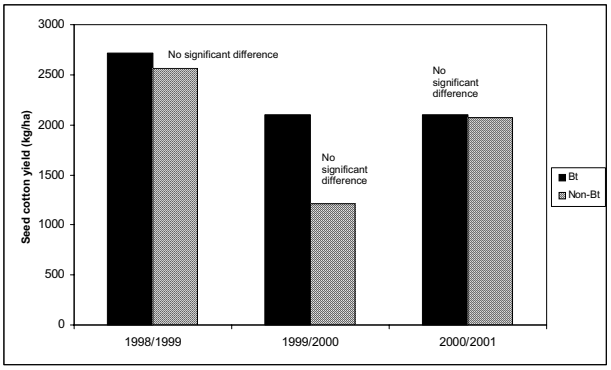


Fig. 2. A comparison of the seed cotton yield of Bt and non-Bt cotton under irrigation over three years



1998/99 - Localities: Rustenburg, Makhathini and Towoomba
1999/00 - Localities: Potgietersrus, Makhathini and Towoomba
2000/01 - Localities: Rustenburg and Makhathini

Fig. 3. A comparison of the seed cotton yield (kg/ha) of Bt and non-Bt cotton under rainfed conditions for different season

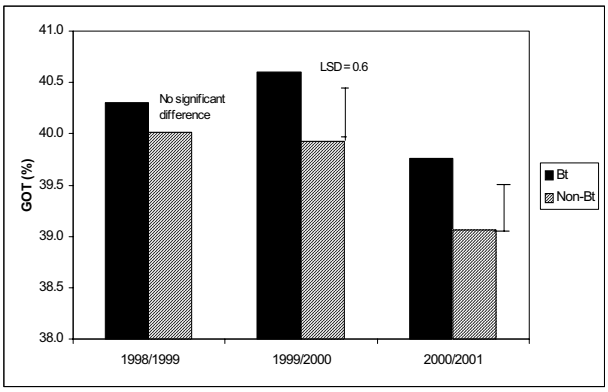


Fig. 4. A comparison of the GOT (%) of Bt and non-Bt cotton under irrigation over three years

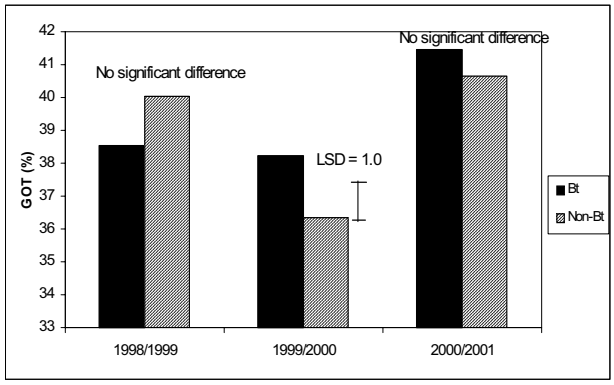


Fig. 5. A comparison of the GOT (%) of Bt and non-Bt cotton under rainfed conditions over different seasons

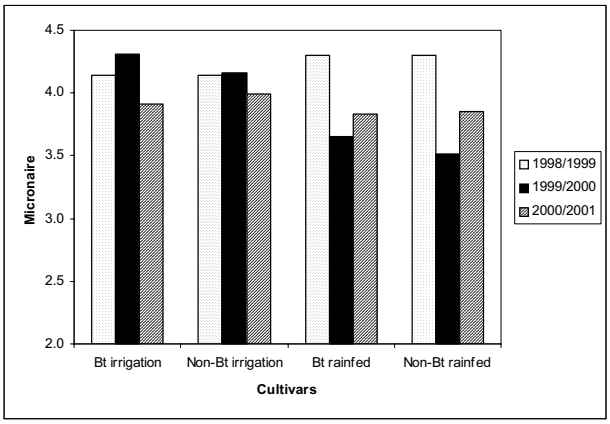


Fig. 6. Micronaire of Bt and non-Bt cotton under irrigated and rainfed conditions for three seasons

Plant Diseases

Since their introduction into South Africa, Bt cotton cultivars have been included for evaluation in our annual national cotton cultivar trials. This has enabled us to evaluate these cultivars extensively for their reaction to the various cotton diseases that occur in different cotton-growing areas. A wide range of fungal and bacterial diseases occur in all the cotton-growing areas of South Africa. However, not all these diseases are of economic importance. The following diseases are found:

- Verticillium wilt (*Verticillium dahliae* – two pathotypes of the defoliating strain)
- Seedling diseases (*Rhizoctonia solani, Fusarium* spp. *Pythium* spp. *Thielaviopsis basicola*)
- Alternaria leaf spot (*Alternaria* spp.)
- Bacterial blight (*Xanthomonas campestris* pv. *malvacearum* – races 2, 4, 5, 8, 9, 11, 12, 15, 18, 18, 19, hyper-virulent)
- False mildew (*Ramularia gossypii*)
- Various primary boll rots (*Alternaria* spp., *Xanthomonas campestris* pv. *malvacearum*, *Fusarium* spp., *Glomerella* spp.).

The occurrence of these diseases on cotton is highly dependent on environmental and seasonal conditions as well as on the inoculum potential of the pathogen. Fortunately, at this stage, Fusarium wilt (*Fusarium oxysporum* fsp. *vasinfectum*) and viral diseases do not occur in South Africa.

Except for bacterial blight and false mildew, all of the cotton diseases mentioned above have been isolated from Bt cotton cultivars and non-Bt cultivars currently grown in South Africa. The Verticillium wilt tolerance of these Bt cultivars compares well with the level of tolerance expressed by the Verticillium wilt-tolerant non-Bt cultivars grown in South Africa.

The results indicate that the Bt cotton cultivars currently released in South Africa react almost in the same way as non-Bt cotton cultivars to the cotton diseases that occur in various cotton-growing areas.

Pests

The Bt gene is used specifically for the control of the three bollworm species. This fact was explained to growers repeatedly and at length. Despite this effort, individuals had the mistaken perception that all spraying was now something of the past. Experience has taught us to be on the alert for jassids, stink bugs and stainers. These pests should still be sprayed when thresholds are exceeded. Aphids and mites are normally controlled biologically on Bt cotton, but that does not mean they cannot get out of hand. The message remains clear: scouting is still vitally important in cotton production, only the emphasis has shifted.

As is to be expected, the number of bollworms found in Bt cotton is low. In controlled experiments, an average of 0.075 to 3.9 bollworm larvae per 24 plants were found on Bt cotton during weekly scouting, compared with up to 18 larvae per 24 plants on normal cultivars. The number of larvae still found on Bt cotton should not cause too much concern because the integrated pest management system recommended to farmers is based on a spraying threshold of 5 larvae per 24 plants.

In addition, it is mandatory that growers plant a refugia of either 5% unsprayed or 20% sprayed non-Bt cotton. However, the implementation of refugia in small-scale farmer situations may be difficult.

Of great concern is the possibility that previously minor pests, or other little-known pests, may increase and attain major-pest status in the absence of adequate chemical control. In this regard, jassids pose a serious threat, while the green vegetable stink bug, which had gone unnoticed for nearly 50 years, reappeared during the last two seasons. The appearance of the green vegetable stink bug was, however, not confined only to Bt cotton.

The variation in the pest spectrum brought about by the planting of Bt cotton differed in different production areas, but the pest pressure also varied over different seasons.