CHAPTER 6

GENERAL DISCUSSION AND CONCLUSIONS

In this study the influence of selected pre-emergence herbicides on the growth and yield of ten dry bean cultivars was investigated. The potential of chlorophyll *a* fluorescence as a tool for timeous identification of differential cultivar tolerances was assessed, as well as the relationship between these responses and herbicide effects on the cell ultrastructural level. It is hoped that the findings will contribute towards more reliable identification of differences in herbicide tolerance between local dry bean cultivars. This work builds on that done earlier by De Beer (1988), Mennega *et al.* (1990) and Fouché (1996).

Effect of pre-emergence herbicides on the growth and yield of dry bean cultivars

The most important yield-reducing combinations are those cultivars (Helderberg, Kranskop, Enseleni, Monati, Cerrillos, Katberg, Mkuzi and Majuba) in combination with flumetsulam + metolachlor. All these herbicides, however, are very effective as regards to weed control and one might therefore consider accepting small losses in yield.

Tolerance of one dry bean cultivar to six pre-emergence herbicides on four soils

The only significant reductions in yield were caused by flumioxazin at both Lichtenburg and Reitz. Yield losses of 100% and 42% were recorded at Reitz and Lichtenburg respectively. It seems that flumioxazin application is dependent on the soil clay and organic material contents. This study confirms that organic matter and clay content influence the effect of herbicides on plants (Stevenson, 1972). It is suggested that the future use of flumioxazin in dry beans should be examined with close scruteny, since excessive crop injury was incurred at two of the four trial sites.

Chlorophyll *a* fluorescence screening

Changes in response to herbicide application of the two fluorescence parameters (Fo and Fv/Fm), as measured for the primary and trifoliate leaves, indicate that primary leaves are more likely to give a reliable indication of inherent tolerance to herbicides than older leaves. Measurements on older leaves would be influenced by the ability of the plant to recover from initial herbicide injury. Results indicate that the metabolism (photosynthetic electron flow) of the primary leaves of Kranskop is significantly influenced by flumetsulam + metolachlor, flumioxazin and metazachlor. This finding suggests that this cultivar is less tolerant than OPS-RS1.

Since selectivity cannot be considered an inherent feature of a particular chemical, being strongly dependent on the amount of herbicide applied under a given condition (e.g. plant species, soil type and climatic conditions) (Pfister & Urbach, 1983), the results presented underline the potential value of using chlorophyll *a* fluorescence to screen for herbicide tolerance. Further research regarding the influence of the degree of direction of change in the fluorescence parameters on dry bean yield should be conducted.

Morphological and cell-ultrastructural changes caused by selected herbicides

None of the herbicides caused drastic changes in the structure of the chloroplast. However, all of the herbicides, except imazethapyr, led to a reduction of the number of stroma and granum lamellae. Starch granules of treated plants, except for imazethapyr, appeared depleted and were rounder in shape than at control plants.

A comparison of mitochondria of control plants with those in treated plants revealed signs of degradation of the mitochondria, except for imazethapyr-treated plants. The arrangement of cristae in treated plants was chaotic and they were swollen.

The electronmicroscope photographs show definite differences between chloroplasts and mitochondria of treated and control plants. Similar differences were also reported for alachlor and metolachlor by De Beer (1988). These changes are probably

manifestations of acetyl-Co enzyme A (CoA) inhibition as reported by Molin, Anderson & Porter (1985). According to Bidwell (1974) CoA is needed in the formation of chlorophyll, and is an important part of the Krebs cycle which is based in the mitochondria. Changes in cristae suggest a slower respiration tempo in affected plants. Reinhardt & Nel (1986) did work with alachlor on grain sorghum earlier than 1988, and reported effects on chloroplasts. They found that alachlor not only influences the stroma lammelae but also causes disintegration of cell vacuole membranes, double membranes of chloroplasts and membranes of nuclei. This study did not show any influence on chloroplasts membranes. Effects on cloroplasts and mitochondria suggest that both photosynthesis and respiration efficiency will be influenced negatively, which in turn will have a negative influence on plant growth and yield.

This study indicated that the tested herbicides, except imazethapyr, could have a negative effect on photosynthesis although photosynthesis is not regarded as the mechanism of action of these herbicides. This and the results in Chapter 4 could indicate that some of the tested herbicides do have an effect on photosynthesis (secondary). According to Zimdahl (1993) the classification of the acetanilide group of herbicides can change since the primary mechanism of action has not yet been determined.

General

This study confirmed that dry bean cultivars vary in tolerance to selected pre-emergence herbicides. Chlorophyl *a* fluorescence meausurments could be used as a tool to establish differential tolerances at a very early stage. Since this is a non-destructive and inexpensive process it could be used as a routine assesment of the herbicide tolerance of different cultivars. Further research regarding the influence of the degree in direction of change in fluorescence parameters on dry bean yield should be conducted.

The responsibility of screening should primarily be the function of the seed and chemical companies. Ideally, prior to registration of a new herbicide, all the available cultivars should be screened by the relevant chemical company. On the other hand, it seems reasonable to expect that if a new cultivar is released after a particular herbicide has been registered, tolerance assessment must be the responsibility of the relevant seed company.