EFFECTS OF TEMPERATURE ON SEASONAL CHANGES IN GROWTH AND CARBOHYDRATE PHYSIOLOGY OF ASPARAGUS

(*Asparagus officinalis* L.)

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ABSTRACT

In a temperate climate, most of the visible, seasonal changes in asparagus growth are induced by or dependent on changing temperature regimes. Senescence of ferns in autumn occurred below 13C, but was prevented by 20C. Crowns required chilling at temperatures below 12.5C to release the internal dormancy which occurred during winter. Although budbreak was never completely suppressed, the minimum temperature at which budbreak could occur changed during winter dormancy. Budbreak did not occur at 12.5C in some cultivars at maximum dormancy. The optimum temperature for the growth of young plants was between 25C and 30C.

A model was developed which simulated seasonal changes in carbohydrate accumulation and utilisation, and the changing source-sink relationships within male and female plants. The model used temperature, indirectly, to determine the times at which seasonal changes in plant growth occurred.

The basic unit for carbohydrate production and allocation in cultivars with well defined rhizomes, e.g.'Rutger's Beacon', was a rhizome and it's attached developing axillaries. An axillary rhizome became independent very soon after it had developed fern. The basic unit may differ in cultivars such as 'UC157' which have less well defined rhizomes. The strength of correlative inhibition within a cultivar appears to affect both rhizome morphology and budbreak patterns during spear harvest.

In summer, young fern had a higher mobilising ability for assimilate than older fern or roots in male plants. In late summer-early autumn, roots became a stronger sink than the fern. On female plants, reproductive sinks (i.e, berries) had the highest competitive and mobilising ability.

Crown carbohydrate concentration appeared to reach a physiological maximum of 65% in late summer. Most of the carbohydrate pool was long chain fructans, i.e, with degree of polymerisation above eight. The size of the crown carbohydrate pool increased during autumn and senescence as crown dry weight increased. The concentration of disaccharide increased during senescence indicating that it may have a role in cold tolerance. There was little change in crown dry weight or carbohydrate concentration of chilled plants until after the plants had been chilled for five weeks and the minimum temperature for budbreak had decreased. Respiration then increased as internal dormancy was further released.

Changes in the composition of carbohydrate reserves are associated with the chilling process, and may affect the release of internal dormancy. Dormant plants required exposure to temperatures below 12.5C to increase the monosaccharide concentration above 4.5% dry weight and to depolymerise long chain fructans. Both these factors would decrease the substrate for some energy requiring process which must occur before budbreak can occur.

'Rutger's Beacon' required approximately 500 chilling units (calculated using the Utah model) to release 50% of the basal buds from internal dormancy and permit growth at 12.5C. The chilling response curve for asparagus appears to be flatter than the Utah model.

This thesis confirmed earlier work which indicated that improved agronomic performance may be related to increased partitioning into carbohydrate storage tissue i.e, the crown. Genotypic differences in depth of internal dormancy and spear growth rate will also affect yield.

Differences in carbohydrate metabolism are not the reason for agronomic differences between male and female plants. The strong sink effect of berries on female plants reduces crown dry weight and thus the crown carbohydrate pool.

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