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**CROWN DEVELOPMENT AND RELATED CHANGES IN  
MORPHOLOGY AND PHYSIOLOGY OF ASPARAGUS  
PLANTS ASSOCIATED WITH THEIR PRODUCTIVITY**

A thesis presented in partial fulfilment  
of the requirements for the degree of

*Doctor of Philosophy*

in  
Plant Science



Institute of Natural Resources  
**Massey University**  
Palmerston North, New Zealand

**ENTIN DANINGSIH**

2004



**CERTIFICATE OF REGULATORY COMPLIANCE**

This is to certify that the research carried out in the Doctoral thesis entitled “Crown Development and Related Changes in Morphology and Physiology of Asparagus Plants Associated with their Productivity” in the Institute of Natural Resources at Massey University, New Zealand:

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Dr D J Woolley

Chief Supervisor

Entin Daningsih

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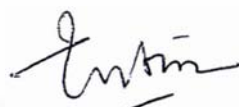
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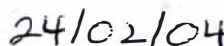


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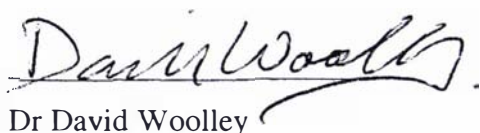
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Dr David Woolley

Chief Supervisor

24-02-04

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## ABSTRACT

The results are presented of eight experiments designed to investigate the influence of interrelationships between bud population dynamics and carbohydrate supply from root stores on spear production in asparagus (*Asparagus officinalis* L). These investigations involved studies in the field and the greenhouse, and using aeroponics and hydroponics techniques to facilitate non-destructive studies of plant development. The evidence indicated that spear yield was limited by the number of buds of adequate size for developing into marketable spears, rather than total bud number. It was shown that bud development continues throughout the harvest period. About 14% of these buds contributed to fern production after harvest, but the majority were involved, following a period of dormancy, in development of the next season's spears. Approximately 16% of the new buds contributed to spear yield in the current harvest, 68% were dormant until the following summer and contributed to 18% of total buds at that time. Spear production was most efficient in plants with large crowns, since the effects of correlative inhibition on spear development were greater in small than large crowns. Nevertheless, increase in crown size in terms of root mass is not necessarily accompanied by an equivalent increase in bud number or cluster number, and bud availability is potentially an important yield limiting factor. However, large crowns reduced the period of correlative inhibition within a bud cluster. Crown size and bud population were sensitive to nutrient supply, and it is suggested that control of nutrient supply over the harvest period may be best achieved by use of slow-release fertilizer or split application of nitrogen. Carbohydrate partitioning and possibly photosynthetic rate were also sensitive to daylength, and there was some evidence of genotypic variation in the response to daylength changes and contrasts. Principal component analysis indicated that numbers of buds and bud clusters, plant size and chlorophyll content were the main determinants of spear yield, and cluster analysis demonstrated potentially important

genetic variation for these variables in potentially high yielding cultivars. Spear yield is the product of harvest intensity and harvest duration, and harvest duration itself was shown to be sensitive to genotype and management effects on bud initiation and development. A conceptual model is used to illustrate the influence of bud population and bud cluster characteristics on harvest intensity and duration, and on spear yield, and the relative importance of management manipulation of bud dynamics and carbohydrate supply to spear yield.

Keywords: carbohydrate partitioning, yield, hydroponics, aeroponics, bud dynamics, bud clusters, crown size, chlorophyll, yield limiting factor, daylength, plant growth, correlative inhibition, multivariate cluster analysis, principal components.

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Setetes embun membasahi keringnya permukaan tanah  
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