INFLUENCE OF LIGHT ON INFLORESCENCE DEVELOPMENT AND SEED YIELD IN WHITE CLOVER (*TRIFOLIUM REPENS L.*)

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DEDICATION

To my parents, Sri Krishna Pasumarty and Seshi Rekha Pasumarty, without their encouragement and help this thesis could not have been written.

ABSTRACT

White clover (*Trifolium repens* L.) florets have the capacity to produce up to 6 seeds, yet normally the average number of seeds per floret is somewhere between 2 and 3.5. The cause of this low seed set is not known, but such an understanding is necessary as a basis for the development of improved management practices for seed production. Low light intensity has been implicated in the reduction of seed number per flower head and even in the abortion of developing flower heads. Therefore the present study examined the influence of light intensity on inflorescence development and seed yield of "Grasslands Huia" and "Grasslands Pitau" white clover (*Trifolium repens* L.). Investigations were also carried out to examine the effects of light intensity on sink strength of young flower heads with a view to understanding the mode of action of light.

Under controlled environmental conditions when plants were grown at a range of light intensities from 2000 to 10000 lux, the ovary length, number of florets per inflorescence, the size of the ovules within the carpel, percentage of fertile ovules and percentage of ovules setting seed in the plants grown at the lowest intensity were decreased by 18, 53, 13, 75% respectively compared with controls grown at the highest intensity. A stain-clearing technique was used to examine the cytoplasmic state of embryo sacs in intact, unfertilized, mature ovules. Ovules with fully formed embryo sacs containing a full complement of nuclei were classed as fertile ovule. Ovules with shrunken embryo sacs which lacked a full complement of nuclei were classed as sterile. Light intensity had no significant effect on ovule number. However, in the field, the young flower heads experience very low light levels due to shading by foliage canopy only when they are young. Within the canopy light intensities may be as low as 1% of full light even at midday when incoming radiation is most intense. To simulate field conditions in the glasshouse the inflorescences were shaded on otherwise fully lit plants by using either neutral shade or simulated shade light at wavelengths similar to those of light filtered through a leaf canopy. Low light had a slight effect on pollen fertility, the effect being significant only at some stages of inflorescence development. These stages of inflorescence development were synchronized with the development of pollen mother cells into pollen grain. Irrespective of the stage of inflorescence development, shading the inflorescence alone decreased the length of the ovary. The most striking observation was that even in good growing conditions only 70% of ovules formed in a flower head had fertile embryo sacs capable of setting seeds. The reduction in seed number per head was brought about by an increase in the number of florets aborting, and by a decrease in the percentage of ovules setting seeds. The close correlation between the percentage of apparently fertile ovules and the percentage of ovules setting seeds strongly suggests

that this reduction was largely brought about by an increase in ovule sterility. The degree of ovule sterility was greatest when shade was applied to the inflorescence at the eighth node below the apex on a stolon. Shade treatments might have interfered with meiosis (formation of megaspores).

To examine the significance of these observations for seed production practices, field experiments were set up to determine to what extent and under what growing conditions flower head development and seed yield per head were influenced by canopy density and simulated overcast weather conditions in plants of "Grasslands Huia" and also "Grasslands Pitau". Field studies showed that flower heads developed in a dense canopy produced 37-39% fewer seeds per head than those formed in an open canopy. Some of this reduction was brought about by an increase in the number of florets aborting, but much of it was caused by a higher proportion of sterile ovules in dense canopies than in open canopies. Simulation of overcast weather by artificial shading also strongly affected the seed yield per flower head. When plants were shaded before pollination only, there was a 24-31% reduction in seed number per head; when shade was applied only after pollination there was a reduction of 25-28%. Therefore overcast weather conditions during early stages of inflorescence development or during the seed maturation period could lead to reduction in seed number per head. In the past, low seed number per flower head has been attributed to poor pollination. The results obtained in the present investigation showed that a high percentage of pollinated carpels contained sufficient pollen tubes for the fertilization of all ovules. The observation of a random seed set pattern and a positive correlation between the ovule fertility and the ovules setting seed also strongly suggest that pollination was probably not the limiting factor. Rather, the limiting factor appeared to be the degree of sterility of unfertilized ovules.

These results showed that there was a direct effect of light intensity on flower head development. Therefore investigations were carried out to study the influence of shade on the growth and sink activity of young flower heads and peduncles. Measurement of the peduncle elongation rate by using a linear voltage displacement transducer showed that when the inflorescence alone was shaded, peduncle elongation was higher than in the light. Translocation studies using a ^{11}C-labelling technique showed that shading the inflorescence alone had little effect on translocation of assimilates into the inflorescence, but induced a major change in partitioning of assimilates within it. Peduncle elongation induced by shade was accompanied by an increase in partitioning of photoassimilates to the peduncle, at the expense of the flower head.

The results of this study suggest that one of the major advantages of the practice of defoliation at the time of closing the paddock for seed production is probably the enhancement of ovule fertility; and that decreased seed yield in duller, wetter summers is probably, at least in part, attributable to increased ovule sterility in the dense canopies formed under those conditions. Form this point of view, for best seed production an optimal management strategy would be to grow the crop as spaced plants with an open canopy rather than a denser sward with a closed canopy.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES