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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.



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 ^{14}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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CHAPTER 3: GENERAL MATERIALS AND METHODS

3.1 Materials	29
3.1.1 Plant material	29
3.1.2 Propagation and plant maintenance	29
3.2 Methods	30
3.2.1 Cytological technique to observe ovule fertility	30
3.2.1.1 Hydration	31
3.2.1.2 Staining and destaining	31
3.2.1.3 Dehydration	31
3.2.1.4 Clearing	31
3.2.2 Pollen fertility	32

CHAPTER 4: EFFECT OF LIGHT INTENSITY ON INFLORESCENCE DEVELOPMENT

4.1 Introduction	34
4.2 Materials and methods	36
4.2.1 Plant material	36
4.2.2 Experimental procedure	36
4.2.3 Measurements	38
4.2.3.1 Number of ovules per floret	38
4.2.3.2 Ovule fertility	38
4.2.3.3 Seed number	45
4.3 Results	45
4.3.1 Floral development	45
4.3.2 Ovule number	51a
4.3.3 Ovule fertility	51a
4.3.4 Seed yield components	53
4.4 Discussion	53

CHAPTER 5: INFLUENCE OF SHADE ON INFLORESCENCE DEVELOPMENT AND SEED YIELD

5.1 Introduction	57
5.2 Materials and methods	58
5.2.1 Plant material	58
5.2.2 Experimental procedure	61
5.2.2.1 Experiment 1	61
5.2.2.2 Experiment 2	61
5.2.2.3 Experiment 3	61
5.2.3 Measurements	61
5.2.3.1 Floral development	61
5.2.3.2 Ovule fertility	62
5.2.3.3 Pollen fertility	62
5.2.3.4 Seed number per floret	66
5.3 Results	66
5.3.1 Experiment 1: Shading young flower heads with paper tubes	66

5.3.1.1 Floral development	66
5.3.1.2 Seed yield components	66
5.3.2 Experiment 2: The effect on floral development and seed yield caused by shading inflorescences at different stages of development	73
5.3.2.1 Floral development	73
5.3.2.2 Seed yield components	77
5.3.3 Experiment 3: The effect on floral development and seed yield, caused by exposing inflorescence at different stages of development, to low R/FR light	81
5.3.3.1 Floral development	81
5.3.3.2 Seed yield components	81
5.3.4 Fitting the binomial distribution and testing the goodness-of-fit	84
5.3.5 Correlation test	84
5.4 Discussion	85

CHAPTER 6: FIELD EXPERIMENT 1988/89 - CLONAL MATERIAL OF "GRASSLANDS HUIA"

6.1 Introduction	90
6.2 Materials and Methods	93
6.2.1 Experimental site and field procedure	93
6.2.2 Measurements	95
6.2.2.1 Ovule fertility	95
6.2.2.2 Pollen fertility	95
6.2.2.3 Pollen load	99
6.3 Results	102
6.3.1 Pollen fertility	102
6.3.2 Ovule fertility	102
6.3.3 Number of florets per head	102
6.3.4 Number of seeds	102
6.3.5 Seed weight	105
6.3.6 Fitting the binomial distribution and testing the goodness-of-fit	105
6.3.7 Pollen load	107
6.4 Discussion	107

CHAPTER 7: FIELD EXPERIMENT 1989/90 - CULTIVAR "GRASSLANDS PITAU"

7.1 Introduction	110
7.2 Materials and methods	110
7.2.1 Experimental site and field procedure	110
7.2.2 Measurements	112

	PAGE
7.3 Results	115
7.3.1 Number of florets per head	115
7.3.2 Number of ovules per floret	115
7.3.3 Number of seeds	115
7.3.4 Seed weight	116
7.4 Discussion	116
SECTION B: INFLUENCE OF LOW LIGHT ON THE GROWTH AND SINK ACTIVITY OF YOUNG FLOWER HEADS AND PEDUNCLES	
 Introduction	 119
CHAPTER 8: GENERAL MATERIALS AND METHODS	
8.1 Growth studies	121
8.1.1 Plant material	121
8.1.2 Method	121
8.2 Translocation studies	123
8.2.1 Plant material	123
8.2.2 Method	123
8.2.2.1 ¹¹ C ₂ production	123
8.2.2.2 Data handling	125
CHAPTER 9: INFLUENCE OF SHADE ON PEDUNCLE ELONGATION	
9.1 Introduction	126
9.2 Method	126
9.3 Results	129
9.4 Discussion	135
CHAPTER 10: INFLUENCE OF SHADE ON THE SINK ACTIVITY OF YOUNG FLOWER HEADS AND PEDUNCLES	
10.1 Introduction	136
10.2 Method	136
10.3 Results	142
10.4 Discussion	144
CHAPTER 11: GENERAL DISCUSSION AND CONCLUSIONS	148
Bibliography	158
Appendices	175

LIST OF TABLES

TABLE	PAGE
4.1 Effect of light intensity on average ovule number, size, and percentage of "fertile" ovules	46
4.2 Effect of light intensity on seed yield components.	52
5.1 Effect of low light on flower head development in glasshouse grown plants.	69
5.2 Effect of low light on pollen fertility.	70
5.3 Effect of low light on ovule number, % of fertile ovules and % of ovules setting seed	71
5.4 Effect of low light on number of fertile ovules per carpel	74
5.5 Effect of low light on seed number per carpel	75
5.6 Effect of low light on seed yield components	76
5.7 Effect of filtered light on pollen fertility, % of fertile ovules, and % of ovules setting seed	79
5.8 Effect of filtered light on seed yield components	80
5.9 Observed and expected frequency from the binomial distribution of pods with 0 to 5 seeds	82
6.1 Basic weather data for Palmerston North	91
6.2 Effect of treatments on ovule number per carpel, % of ovules setting seed, and % of fertile ovules per carpel	100
6.3 Effect of treatments on seed yield components	101
6.4 Percentage reduction in various seed yield components	103
6.5 Observed and expected frequency from the binomial distribution of pods with 0 to 5 seeds	104
6.6 Effect of treatment on pollen load	106
7.1 Effect of treatments on seed yield components	113
7.2 Percentage reduction in various seed yield components	114
9.1 Effect of light level on peduncle elongation rate	131

LIST OF FIGURES

FIGURE	PAGE	
4.1	Diagrammatic representation (not to scale) of stages of inflorescence and leaf development in white clover relative to distance from the stolon apex	35
4.2	The size of floral organs in the oldest florets of inflorescences present at successive nodes of stolons of plants growing in the controlled environment growth room	39
4.3A	The effect of light intensity on sepal growth	40
4.3B	The effect of light intensity on petal growth	41
4.3C	The effect of light intensity on ovary growth	42
4.3D	The effect of light intensity on filament growth	43
4.3E	The effect of light intensity on style growth	44
4.4	The relationship between ovule size and position within the carpel	46
5.1	Percentage transmission of different wavelengths of light by the cellophane filters used in Experiment 3	59
5.2	The effect of low light on flower head development	68
5.3	The effect of low light on flower head development (Experiment 2)	72
5.4	The effect of simulated foliage canopy shade on flower head development	78
5.5	The frequency distribution of fertile ovules per carpel and the number of seeds per pod	83
6.1	Trial layout. Field experiment 1988/89	92
6.2	Carpel structure	96
7.1	Trial layout. Field experiment 1989/90	111
8.1	^{14}C production line and gas recovery system	122

8.2	Schematic diagram showing how a linear configuration of scintillation detectors is used to observe phloem translocation of ^{11}C -photosynthate along a maize leaf	1 2 4
9.1	Observations of peduncle growth over a 10-hour period	1 2 8
9.2	Schematic diagram showing the system used for measuring peduncle growth rate of a clover plant	1 3 0
9.3	Peduncle elongation of inflorescences when the whole plants were in full light and total darkness	1 3 2
9.4	Peduncle elongation of inflorescences in light and shade	1 3 3
9.5	Peduncle elongation of inflorescences in shade and light	1 3 4
10.1	Schematic diagram showing the system used to study the partitioning of photoassimilates within a inflorescence	1 3 8
10.2	Tracer profiles, and derived partitioning coefficients, seen in a clover plant under constant light	1 4 1
10.3	Tracer profiles, and derived partitioning coefficients, seen in a clover plant when shade applied to the inflorescence alone	1 4 3
11.1	Relationship between growing conditions, ovule fertility and post fertilization abortion	1 4 8
11.2	Resource limitation model	1 5 3

LIST OF PLATES

PLATE	PAGE
4.1 Plants growing in different light intensities in the controlled environment growth room	37
4.2 A fertile ovule consisting of a healthy embryo sac	48
4.3 A sterile ovule consisting of an embryo sac which is rather shrunken with no visible nuclei	48
4.4A Enlarged version of plate 4.2 showing polar nuclei more clearly	49
4.4B Immature ovule from a mature carpel	49
4.4C Ovule containing an embryo sac with no visible nuclei	50
4.4D Shrivelled Ovule	50
4.4E Ovules in wrong orientation with micropyle facing upwards	51
5.1 The wooden box used in experiments 2 & 3 to shade the stolon tips and inflorescences being studied	60
5.2 Pollen grains stained with Snow's alcoholic carmine	63
5.3 Physical set up of the apparatus used for measurement of pollen grain germination	64
5.4 Pollen tube growth in vitro on liquid media	65
5.5 Plants transferred from the glasshouse into a prolifically flowering field plot of white clover	67
6.1 Plants being shaded artificially before pollination to simulate overcast weather conditions	94
6.2 Pollen tubes growing on the surface of the placental region of a carpel	97
6.3 X-ray photograph showing number of ovules forming seeds in carpels of upper florets collected from flower heads developed in open and dense canopies	98

- 9.1 Physical set up of the apparatus used to measure the peduncle growth of an inflorescence in shade 127
- 10.1 Physical set up of the apparatus used to study the partitioning of photoassimilates within an inflorescence 137

LIST OF APPENDICES

APPENDIX

- 1 A stain clearing technique for observations within whole ovules
- 2 Effect of light intensity on ovule length and width at each of six positions within carpels of lower florets in a flower head
- 3 Spectrophotometer specifications
- 4 Effect of light intensity on development of floral organs
- 5 Effect of clover canopy on photosynthetically active radiation photon flux beneath them
- 6 Influence of low light on ovule size at each of six positions within carpels of lower florets in a flower head
- 7 Influence of floret position in a flower head on ovule number per carpel
- 8 Changes in inflorescence size, average percentage of fertile pollen and ovule, ovule and seed number, and the size of floral organs with time of the year
- 9 Influence of canopy density and simulated overcast weather conditions on size of floral organs
- 10 Influence of canopy density and simulated overcast weather conditions on percentage of viable seed, hard seed and dead seed