



Photocontrol of leaf abscission.

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PHOTOCONTROL OF LEAF ABSCISSION

A Thesis Presented

By

DENNIS ROGER DECOTEAU

Submitted to the Graduate School of the
University of Massachusetts in partial fulfillment
of the requirements for the degree of

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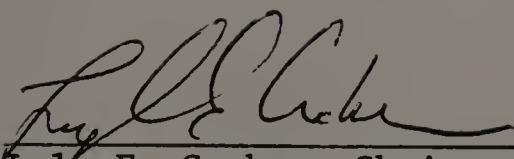
Department of Plant and Soil Sciences

PHOTOCONTROL OF LEAF ABSCISSION

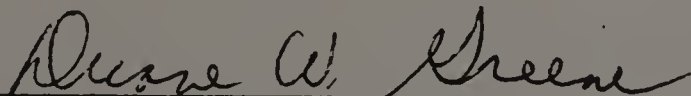
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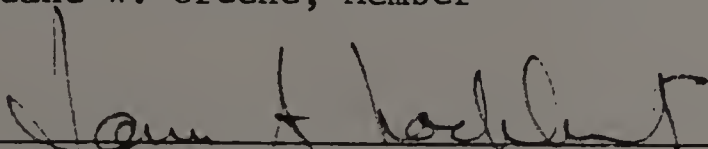
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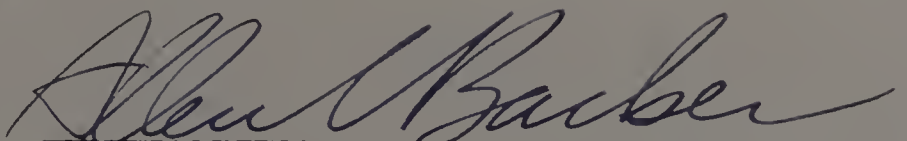
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C H A P T E R I

INTRODUCTION

The ability to regulate abscission processes is desirable for growers and handlers of many fruit, vegetable, flower and agronomic crops. For example, there are pressing agricultural needs to regulate flower retention and thinning plus fruit set and abscission in most fruit species, to defoliate and to prevent flower and pod drop in several vegetable and agronomic crops before harvest, and to preserve petals and leaves on cut flowers for extended vase life. Recorded losses due to premature flower and pod abscission in soybeans, an important food crop that has witnessed decreased yields over the past two decades (60) ranges from 43 to 81% of the reproductive structures (61) and researchers have speculated that if premature abscission could be prevented or reduced, then yields would increase (57, 64). Estimated economic losses in Massachusetts due to premature fruit drop of McIntosh apples ranges from 25 to 75% of the crop each year (56).

Currently, the application of growth regulator sprays and other chemicals to plants or plant parts serves as a major method of abscission control. Commercial fruit crop production can involve application of growth regulator sprays for thinning flower and fruit set, for preventing preharvest drop, and for loosening fruit prior to mechanical harvest (65). Defoliation of cotton is

accomplished by spraying plants with organic phosphorus compounds (43). Petal and bud drop in cut flowers are controlled by the use of NAA, 2,4-D, and inhibitors of ethylene biosynthesis (29). Yet, use of growth regulators and other compounds has disadvantages. Carbaryl, a regulator spray routinely used for apple fruit thinning in the spring, has become environmentally objectionable since it may eliminate mite predators (65). Naphthaleneacetic acid, succinic acid 2-2 dimethyl hydrazide, and 2,4-5TP used to prevent preharvest abscission in apple, can cause decreases in fruit size, influence retention of fruit quality during storage and injure twigs, shoots and buds on trees when used at high rates (65). 2,4-D prevents bud and petal drop in sweet pea but causes spike distortion (29).

Development of an alternative method for abscission control, one which does not require growth regulators or other chemical compounds or one which could reduce the amount of or enhance the effect of growth regulators, appears highly desirable. Recent work has indicated that the treatment of plants with low intensity light during the dark period can alter the abscission process in apples, cherries, plums and olives (14, 18). Still, the conditions and mechanisms that enable light to influence abscission have been virtually unstudied. Only a few (36, 37, 23) published reports on light inhibition of abscission are available.

Recent advances in lighting technology (15, 55) through development of new light sources and delivery systems make feasible

relatively inexpensive lighting of large areas of land in crop production. Before photocontrol of abscission can be effectively used as a successful economical management practice more basic research is needed on the most effective characteristics of light on inhibiting abscission and the physiological consequences of photocontrol of abscission must be elucidated.

C H A P T E R I I
LITERATURE REVIEW

Abscission is a natural plant process where the release of pollen, spores, seeds and fruit provide plants with a means for regeneration and for extending species distribution. The selective shedding of plant parts allow certain species to endure times of water and temperature stress. The natural thinning of fruit and flowers results in increased quality of the remaining fruit (42).

Abscission is known to be initiated and occur due to a variety of natural and artificial stimuli including temperature, daylength, water, mineral nutrition, soil conditions, atmosphere gases, pathological agents and physical injury (5, 7). Recent reviews (5, 8) have summarized the role of metabolic processes and various hormones in abscission. In most instances abscission involves the synthesis and/or action of plant hormones such as IAA (4, 6, 47), ethylene (2, 3), abscisic acid (21, 52), cytokinins (19, 33) and gibberellins (11, 19).

The abscission process generally occurs in an abscission zone where enzymes function in tissue digestion (62, 63). Although many enzymes may be involved, the more important ones are reported to be cellulase (1, 21, 50, 51), pectinase (46, 50) and polygalacturonase (48, 52). A rapid rise in tissue respiration is

often accompanied with the action of these enzymes (53).

Light has been shown to influence growth and development processes in plants not only through photosynthesis but also through modification of physiological and photomorphogenic processes. Research in the 1920's by Garner and Allard (26, 27) systematically deduced the role of daylength in differential growth. McClelland (44) several years later demonstrated that bulb production per onion plant could be altered by growth under different photoperiods. Research has also elucidated the importance of the discovery of phytochrome in mediating physiological processes in plants (13, 17, 32).

Use of supplemental light to improve quality and yield in plants has concentrated in the area of horticultural crops such as chrysanthemums, poinsettia and roses (10, 12). Recent investigators have begun studying the effects of supplemental low-intensity lights on growth and yield of vegetable and agronomic crops (55) through physiological control of developmental mechanisms in plant tissue. Results indicate increases in vegetable growth and number of flowers and bolls in cotton and an increase in the fresh weights of the primary ear in corn.

Investigations on photocontrol mechanisms in the physiological processes of abscission have been done primarily with studies using leaf abscission in mung beans (22, 24) and fruit abscission with apples (18, 36). Although the mechanism of light control of abscission is not known, results of the above investigations indicated

that the red portion of the spectrum was the most effective and that phytochrome may be involved.

Red light has been shown to effect other physiological processes in plants such as levels of carbohydrates and nitrogenous substances (16, 41, 45), rates of respiration (30, 31, 49, 66), synthesis and activity of enzymes (9, 25, 35, 54), and levels and transport of hormones (28, 38, 40, 58, 59). Photocontrol of abscission could be expressed through one or more of these plant processes.

Recent work by Brooks (18) indicated that the photoreceptor for control of apple fruit abscission was probably located in the leaves with regulation through a translocatable substance. Application of NAA to light-treated trees had no effect on photocontrol of abscission and suggested that auxin was not involved.

C H A P T E R I I I

MATERIALS AND METHODS

Plant material. Seedlings of mung beans, Vigna radiata (L.)

Wilczek cv. Jumbo, were used in these experiments. Seeds were imbibed in tap water for 24 hr at room temperature and subsequently seeded 1 cm deep in vermiculite contained in plastic trays (5 × 25 × 50 cm) (100 seeds/tray). Trays containing seeds were placed into a controlled environmental chamber with a constant day/night temperature of 29°C and a 16 hr light period (irradiation level of 11 W/m², fluorescent to incandescent ratio of 12 to 1), for growth and development of the seedlings.

After 8 days experimental plant cuttings were made by slicing the hypocotyls of the developing seedlings 5 cm below the apical bud with a razor blade. The cuttings, consisting of primary opposite leaves and apical bud attached to 5 cm of hypocotyl, were inserted vertically into 50 ml beakers containing approximately 45 ml of distilled water, submerging the cut portion of the petiole until it reached the bottom of the flask. The beakers containing the cuttings were transferred into specially constructed exposure chambers designed for free air/gas exchange (Figure 1) for treatment with light.

Testing of the abscission zone. Abscission was quantitatively

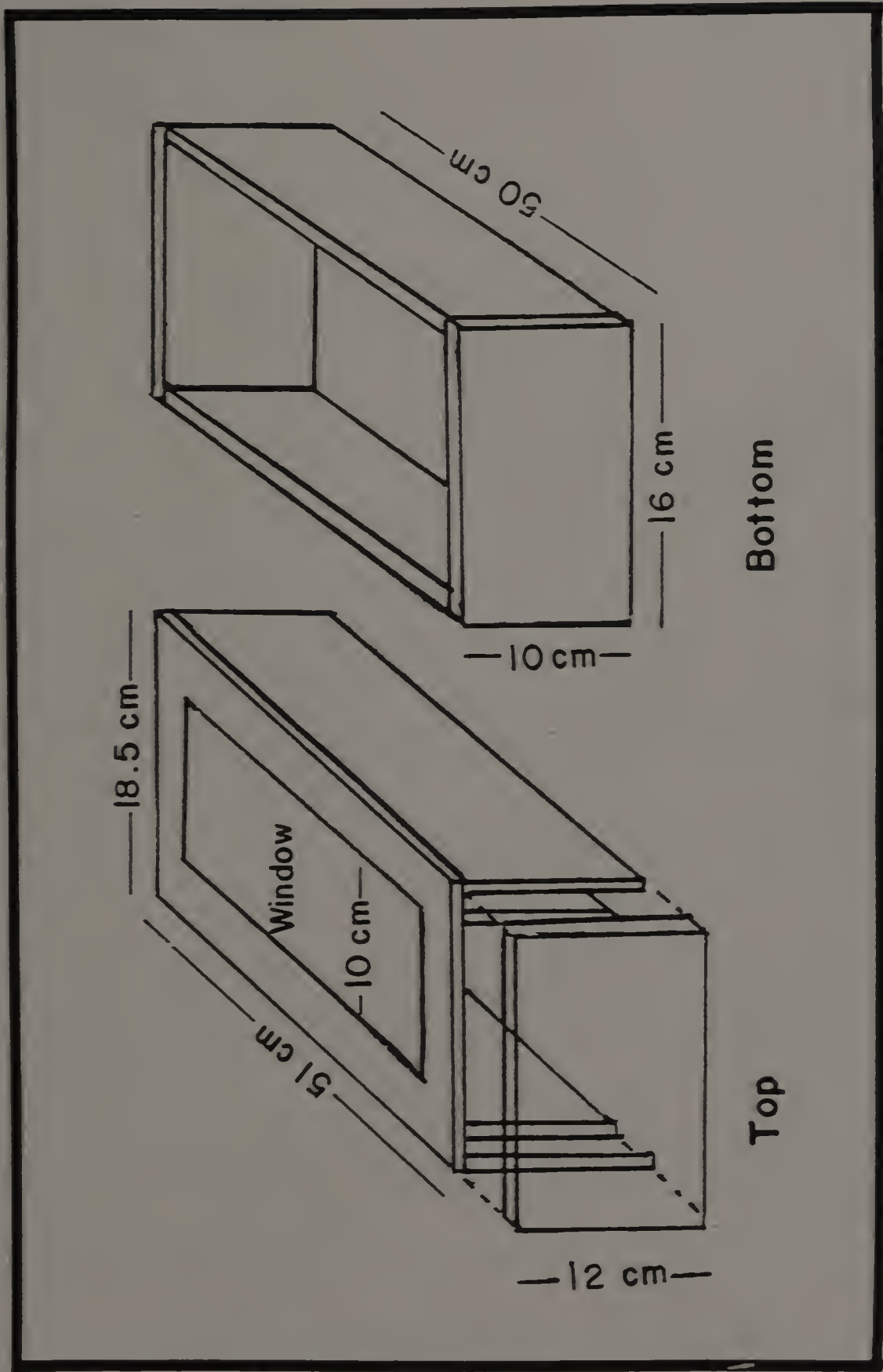


Fig. 1. Exposure Chamber.

measured, using a modified version of the recording abscissor, described by Craker and Abeles (20), where the pull strength required to separate a petiole from the stem was determined. This pull strength was recorded as the break strength of the leaf abscission zone and represents the force required to separate a petiole attached to the leaf from the stem at the abscission zone.

The clamp of the abscissor was attached onto a distal end of a primary leaf while the opposite leaf was held against a stationary object. A steady horizontal force was placed on the abscission zone by pulling the abscissor away from the held leaf until one of the abscission zones separated, releasing a leaf from the stem. The separation force recorded represents the break strength of the abscission zone with one recorded abscission measurement per plant. Results are expressed as grams of force necessary to separate leaf from stem (break strength) at an abscission zone. Break strength from a sample of cuttings from the plant population were measured in the beginning of all experiments and represent initial break strength.

Light investigations.

Light quality, irradiance level and duration. To investigate and define the optimum light treatments for regulation of abscission, the effects of light quality, irradiance level and duration on the abscission process were measured. One or more sheets of acetate light filters (Table 1) either wrapped around the fluorescent light tubes or placed on the window of the exposure boxes

TABLE 1

LIGHT SOURCE AND ACETATE FILTERS USED FOR LIGHT TREATMENTS

<u>Light Quality</u>	<u>Light Source</u>	<u>Filters</u>	<u>Peak</u>	<u>½ Bandwidth</u>
Blue	40W cool White fluorescent tubes	Roscolux Brilliant Blue #69 & weatherable transparent	440	40
Green	40W cool white fluorescent tubes	Roscolux Moss Green #89 & weatherable transparent	540	40
Red	40W cool white fluorescent tubes	Cinemoid Orange #5, Cinemoid Red #6 & weatherable transparent	660	15
Far red	25W Incandescent bulbs	Rohm and Hass Plexiglas #2025	730	15

were used to establish defined wavelengths of light. Irradiance levels were controlled by varying the distance between the light source and the plant material and/or by shading the plant material with sections of cheesecloth placed on the window of the exposure boxes or wrapped around the fluorescent tube. The duration of the light treatments was regulated by the removal or addition of an opaque layer over the window of the exposure boxes. All experiments were completed in controlled environment chambers (constant temperature of 29°C).

Receptor site. The receptor site for the light stimulus was determined by selectively removing or shading portions of the

test plant. Leaf fractions were excised from the distal portion of the leaves. The remaining plant material, minus the excised portions, were placed in beakers as previously described and treated with red light (300 mW/m^2) for 5 days.

Hormonal investigations.

IAA, GA, ABA and kinetin. The role of selected plant hormones (IAA, GA_3 , ABA and kinetin) in the photocontrol of leaf abscission was investigated by treating plants with physiological concentrations (2, 19, 21) of these hormones. Hormones were dissolved into the basal water solution contained in beakers for uptake into the plant via the transpiration stream. The plants were placed with either red light or dark for 5 days. Plants with no hormone addition to the water in each light treatment served as controls. After the light treatment period, the abscission zone was tested for break strength.

Ethylene. The role of ethylene in photocontrol of abscission was investigated by determining the effect of red light on the production of ethylene from plants and the effect of ethylene in the light inhibition of abscission.

Plants in these experiments were grown and excised as previously discussed. One plant was placed with the cut end of the stem inserted into the water of a one dram (6 ml) vial containing approximately 4 ml of distilled water. The vial containing the plant was inserted into an inverted 125 ml Erlenmeyer flask and placed in light or dark following an 8 hour time period for bleeding off of wound ethylene, flasks containing the plants were

sealed with a rubber serum cap for collection of any light-induced ethylene. After the beakers containing the plants had been sealed and treated with the appropriate light treatment for 12 hours, gas samples were removed from each flask by inserting the needle of a syringe through the serum cap and withdrawing a 2 ml gas sample. Ethylene in the samples was identified and quantitatively measured by gas chromatography (2). Fresh weights of the plants were recorded at the end and ethylene values are expressed as nl/g of fresh weight.

The effect of red light on ethylene action was determined by injecting ethylene into the flasks containing cuttings, producing a gaseous environment containing 10 ppm ethylene. At 24 and 48 hours after ethylene treatment, break strength of the abscission zone was measured and compared with identically treated control plants that had no ethylene added to the flask.

Phytochrome. To determine the role of phytochrome in the photo-control of leaf abscission, break strength of the abscission zones of cuttings were measured to determine if red light inhibition of abscission was reversible by subsequent far red treatments. Cuttings were placed in exposure boxes equipped with either red, far red, or opaque exposure windows for the desired light treatment. The cuttings were treated daily with 12 hr of red and 12 hr far red. After 5 days break strength of the abscission zone was determined.

CHAPTER IV

RESULTS

Placing cuttings of mung beans in the dark initiates reduction in break strength in the abscission zones of the primary leaves (Figure 2). A significant decrease in break strength was observed following the third day of treatment in the dark. The greatest decrease in break strength was observed from day 3 to day 4. Almost all leaves had abscised by day 7.

Light appears to retard the abscission process (Table 2). Red

TABLE 2

RED LIGHT INHIBITION OF LEAF ABSCISSION IN MUNG BEANS

<u>Treatment</u> ¹	<u>Break Strength</u> ² (g)
Dark Control	0
Red Light	9.8 ± 0.5
Initials	10.3 ± 0.4

1. Red light irradiance level of 800 mW/m².
2. Data are means ± s.e. from 3 replicates each containing 20 plants measured after 5 days. Break strength of initials taken at time 0 and break strength of red light and dark controls taken after 5 days.

light was the most effective wavelength when compared on relative quantum effectiveness (Table 3). Blue and green light were less effective than red but more effective than far-red. Far-red had

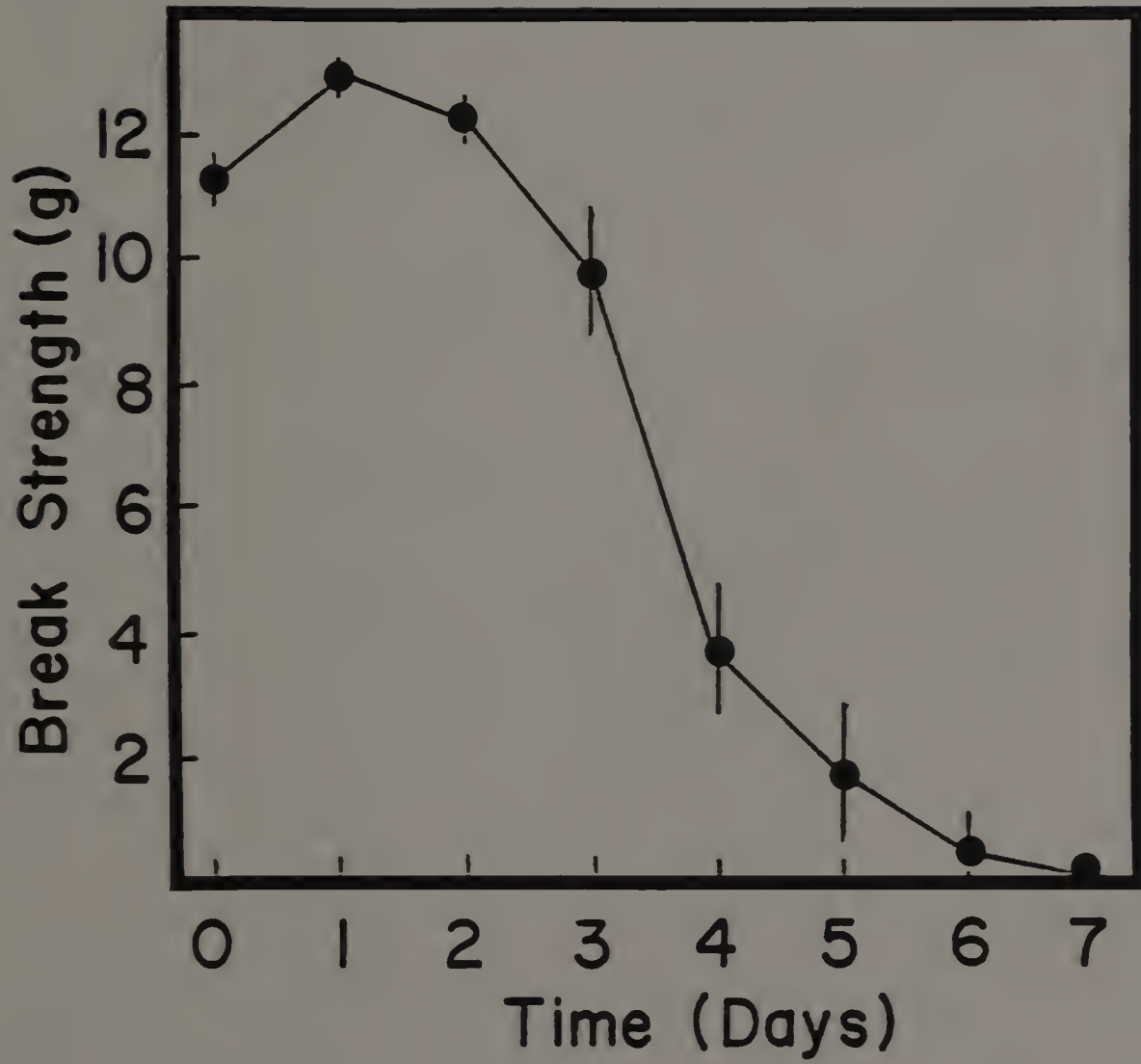


Fig. 2. Break strength of leaf abscission zone of mung bean cuttings placed in dark. Means \pm s.e. from 3 replicates each containing 8 plants at each sampling date.

TABLE 3
LIGHT QUALITY AND INHIBITION OF LEAF ABSCISSION

<u>Wavelength</u>	<u>Peak (nm)</u>	<u>Trials¹ (no.)</u>	<u>Relative Quantum Effectiveness²</u>
Red	660	5	1.00
Blue	440	2	0.41
Green	540	2	0.27
Far Red	730	1	-0.02

1. Each trial consists of 20 plants with 5 day treatment period.
2. Calculated by dividing the response (% of initial break strength at each light quality tested minus % of initial break strength of dark controls) by the irradiance. Data were corrected to equal quanta at 660 nm and all values normalized to an arbitrary value of 1 at 660 nm.

no effect on delaying loss of abscission zone break strength.

The receptor site for the light inhibition of abscission appears to be located in the leaves. Experiments that removed portions of leaves and the remaining plant treated in red light resulted in a decrease in break strength (Table 4). The decrease appears to be proportional to the amount of leaf removed. When $\frac{1}{2}$ of the leaf area was removed, the break strength decreased by 40% of initial break strength as compared to control plants (no leaf portions removed). When most of the leaf area was removed no inhibition of abscission is observed. Experiments which either removed the apical bud or covered the stem had no significant

TABLE 4
LOCATION OF LIGHT RECEPTOR SITE

<u>Treatment</u> ¹	<u>Break Strength</u> ² (% of initials)
Control	72.3 ± 2.1
No Apical Bud	73.4 ± 3.8
Minus ½ leaf	40.6 ± 8.3
No Apical Bud + Minus ½ leaf	31.5 ± 5.2
Stem Covered	71.1 ± 5.2
Minus ~ All leaf	0

1. Red light at 300 mW/m² for 5 days.
2. Data are means ± s.e. from 3 replicates each containing 8 plants.

effect on break strength of red light treated plants.

The effectiveness of red light in delaying abscission is enhanced by increased levels of irradiation. An irradiation level of 800 mW/m² was sufficient to completely inhibit the abscission process (Figure 3). As the level of irradiation is lowered, the amount of inhibition is decreased ($r = 0.97$).

Maximum red light inhibition of abscission is observed when plants are treated with light each day of the treatment period. Plants placed in the dark for 1 day or longer before red light treatment have a reduction in break strength that is not reversible by subsequent red light treatments ($r = 0.97$) (Figure 4).

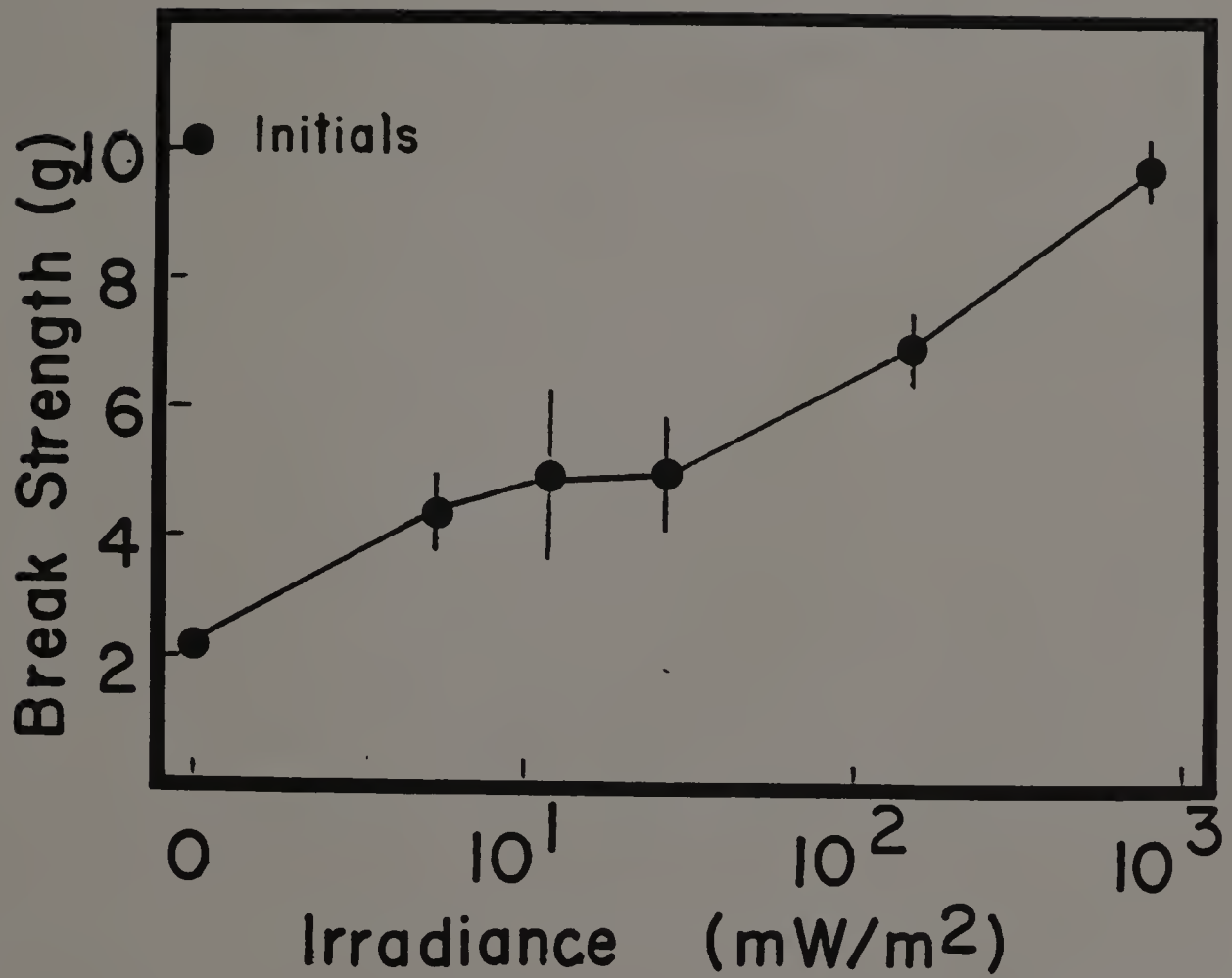


Fig. 3. Irradiance level and light control of abscission. Light was at indicated level of irradiance for 5 days. Means \pm s.e. from 3 replicates of 20 plants each.

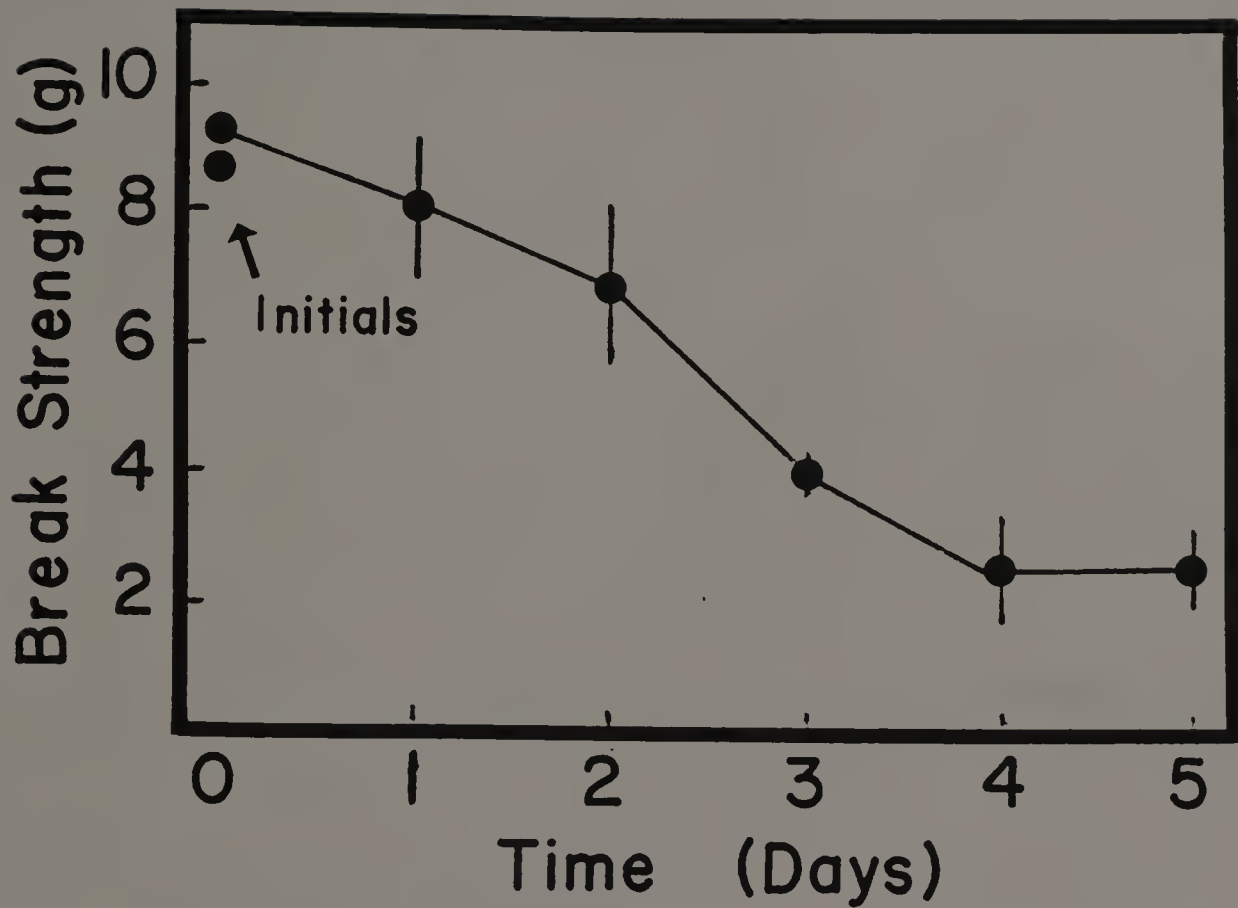


Fig. 4. Influence of dark pretreatment on light inhibition of abscission. Data are means \pm s.e. of 3 replicates of 20 plants each sampling period. Red light irradiance level of 650 mW/m^2 .

Plants treated in red light and subsequently placed in the dark for periods of 1 day or longer before testing for break strength of abscission zone also indicate a decrease in break strength that appears proportional to the amount of time in the dark ($r = 0.99$) (Figure 5). While red light treatments must occur every day for maximum effect of inhibition of abscission, 12 hours of red light per day is equally effective as 24 hours (Figure 6). Lesser treatment periods than 12 hours per day result in decreased break strength.

IAA, GA₃, ABA and kinetin addition to the water for uptake into the plant had no significant effect on break strength of red light or dark treated plants (Tables 5, 6, 7, 8). Red light had no effect on ethylene synthesis (Table 9), but appeared to have a delaying effect on ethylene action (Table 10). Red light was partially able to overcome ethylene's ability to induce abscission in plants for up to 24 hours. Break strength of ethylene treated plants in the dark compared to dark controls (no ethylene added) after 24 hours decreased by 86%, while the ethylene treatment to red light treated plants decreased only 25% of the break strength of red light treated plants that received no additional ethylene. By 48 hours ethylene treated plants were essentially all abscised regardless of the light quality treatment.

Phytochrome appears to be involved in the light delay of leaf abscission in mung beans (Table 11). Red light inhibition of abscission was reversible by subsequent far-red treatments. Red

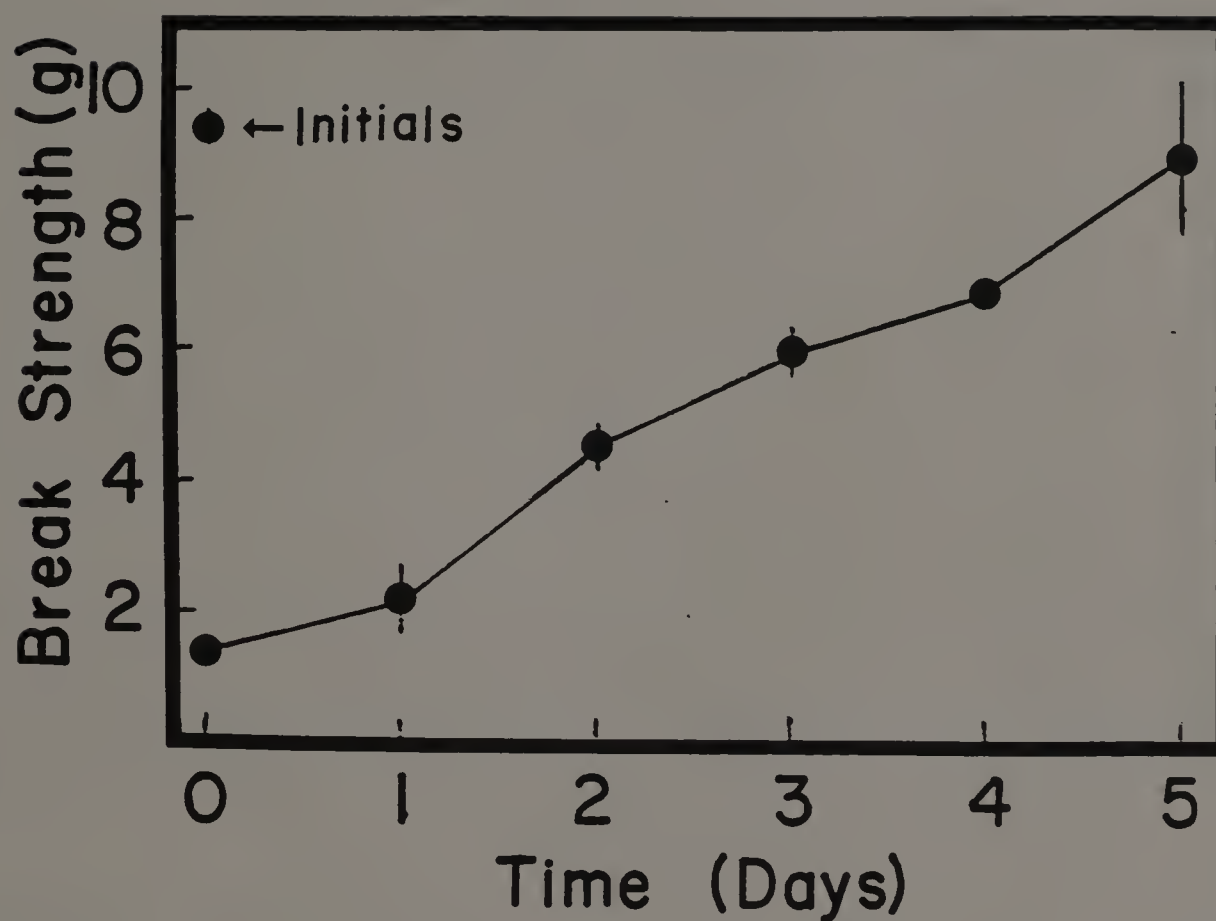


Fig. 5. Influence of red light pretreatment on dark induced abscission. Data are means \pm s.e. of 3 replicates of 20 plants at each sampling period. Red light irradiance level of 650 mW/m^2 .

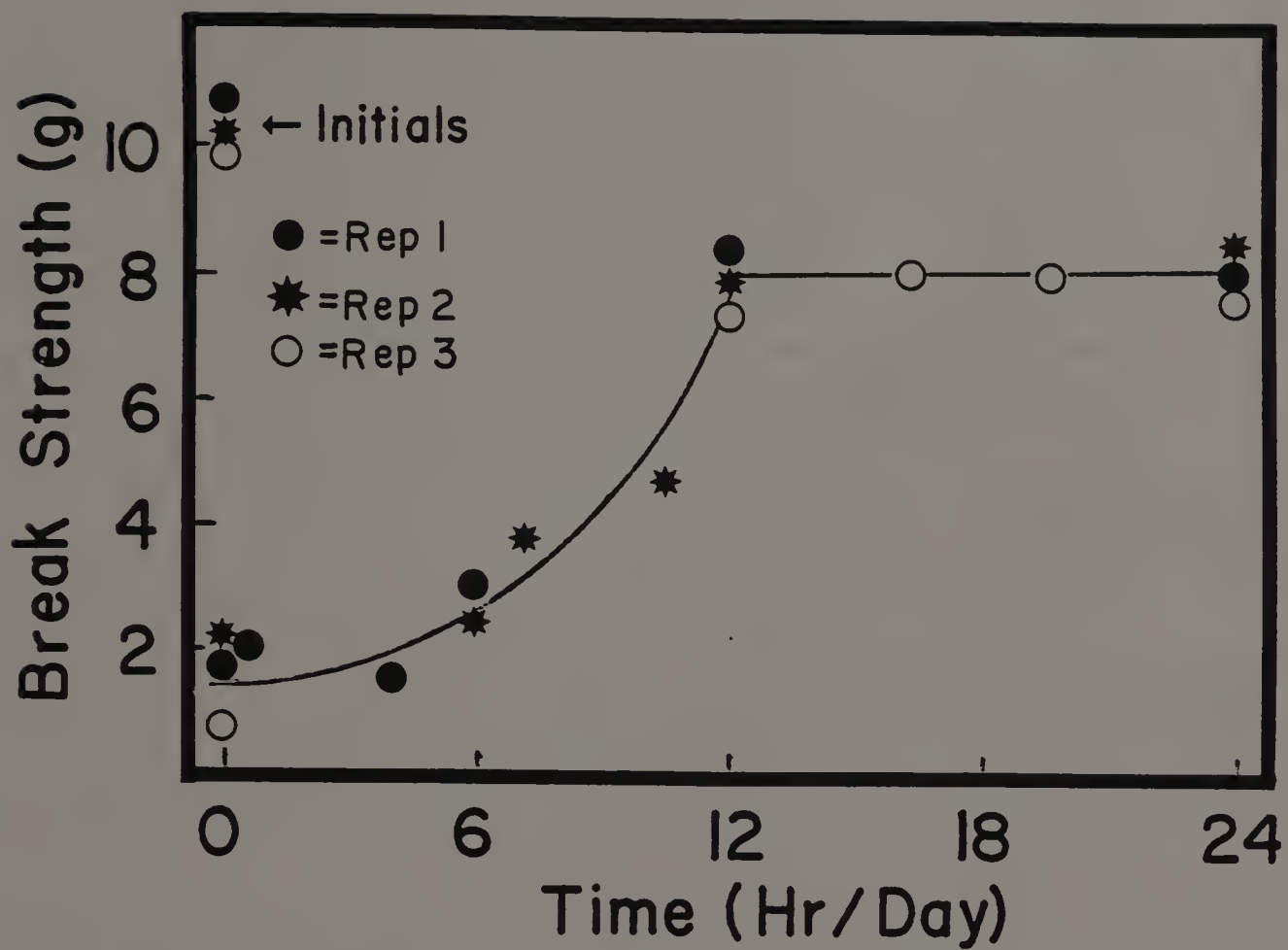


Fig. 6. Daily light requirement for inhibition of abscission. Light treatment for indicated number of hours per day at 650 mW/m^2 .

TABLE 5
IAA AND LIGHT CONTROL OF LEAF ABSCISSION

<u>Treatment</u> ¹	<u>Break Strength</u> ² (% of initials)
Dark Control	19.5 ± 4.7
Dark + IAA	21.4 ± 7.9
RL Control	78.6 ± 6.8
RL + IAA	72.4 ± 9.9

1. IAA concentration of 5×10^{-5} M. Red light (RL) at 300 mW/m² for 5 days.
2. Data are means ± s.e. from 3 replicates each containing 20 plants.

TABLE 6
GA₃ AND LIGHT CONTROL OF LEAF ABSCISSION

<u>Treatment</u> ¹	<u>Break Strength</u> ² (% of initials)
Dark Control	17.7 ± 6.7
Dark + GA	10.3 ± 2.6
RL Control	70.8 ± 5.5
RL + GA	68.0 ± 11.8

1. GA₃ concentration of 5×10^{-5} M. Red light (RL) at 300 mW/m² for 5 days.
2. Data are means ± s.e. from 3 replicates each containing 20 plants.

TABLE 7

ABA AND LIGHT CONTROL OF LEAF ABSCISSION

<u>Treatment</u> ¹	<u>Break Strength</u> ² (% of initials)
Dark Control	14.6 ± 4.9
Dark + ABA	10.7 ± 3.9
RL Control	70.6 ± 2.6
RL + ABA	65.7 ± 7.0

1. ABA concentration of 5×10^{-4} M. Red light (RL) at 300 mW/m² for 5 days.
2. Data are means ± s.e. from 3 replicates each containing 20 plants.

TABLE 8

KINETIN AND LIGHT CONTROL OF LEAF ABSCISSION

<u>Treatment</u> ¹	<u>Break Strength</u> ² (% of initials)
Dark Control	18.0 ± 6.5
Dark + Kinetin	20.6 ± 2.8
RL Control	84.1 ± 11.2
RL + Kinetin	85.8 ± 5.8

1. Kinetin concentration of 5×10^{-5} M. Red light (RL) at 300 mW/m² for 5 days.
2. Data are means ± s.e. from 3 replicates of 20 plants each.

TABLE 9
RED LIGHT AND ETHYLENE PRODUCTION

<u>Treatment</u> ¹	<u>Ethylene</u> ² (nl/g · Fwt)
Dark	57.3 ± 19.7
RL	43.9 ± 10.8

1. Red light (RL) irradiance level of 207 mW/m².
2. Data are means ± s.e. from 3 replicates of 4 plants each.

TABLE 10
ETHYLENE AND LEAF ABSCISSION

<u>Treatment</u> ¹	<u>Break Strength</u> ² (% of initials)	
	<u>24 hr</u>	<u>48 hr</u>
Dark Control	93.4 ± 5.7	56.5 ± 21.0
Dark + Ethylene	13.0 ± 12.8	0
RL Control	115.5 ± 6.1	101.7 ± 6.3
RL + Ethylene	75.2 ± 11.5	2.9 ± 2.9

1. Red light (RL) irradiance level of 5500 mW/m².
2. Data are the means ± s.e. from 3 replicates of 20 plants each.

TABLE 11

ROLE OF PHYTOCHROME AND LIGHT CONTROL OF ABSCISSION

<u>Treatment</u>	<u>Break Strength³</u> (% of initials)
Red/Dark ¹	87.2 ± 3.2
Red/Far-Red ²	14.6 ± 3.7
Dark	13.9 ± 5.7

1. 12 hr red light (1000 mW/m²), 12 hr dark per day for 5 days.
2. 12 hr red light (1000 mW/m²), 12 hr far-red (1000 mW/m²).
3. Data are means ± s.e. of 2 replicates of 20 plants each.

light delayed abscission to 87% of initial break strengths. Red reversed by far-red was the same as dark treated controls. Far-red light by itself had no effect on abscission (Table 2).

CHAPTER V

DISCUSSION

Results of these investigations indicate that light can be used to effectively inhibit abscission in plants. Although mung bean cuttings placed in the dark normally initiate leaf abscission within 3 days and almost completely abscise by 7 days, addition of red light stopped abscission processes and break strength of the abscission zone remains similar to that of vigorously growing plants. The data agrees with previous suggestions (14, 36) on light inhibition of abscission in apples, soybeans and plums. Examination of various wavelengths demonstrated a relative quantum effectiveness in the red light band of over 2 times other wavelengths. Previous reports (18, 24), have suggested that light regulation of abscission was under phytochrome control and data in this report support this hypothesis. Treatment with far-red light would quantitatively reverse red light inhibition of abscission.

Removal of leaf sections and/or tissue fractions indicate that the leaves are the primary reception site for red light inhibition of leaf abscission in mung beans. Covering the stem and removing the apical bud had no effect on light inhibition of abscission. However, removing the leaf (leaving just an abscission zone) prevented light from inhibiting abscission processes. Removing $\frac{1}{2}$

of the leaf area reduced the inhibition of the red light by approximately 50%. Brooks (18) working with red light control of apple fruit drop, also observed that the leaves appeared to be the reception site and that the light stimulus inhibiting fruit abscission could be blocked by using girdling techniques to prevent translocation of the message to the fruit.

Red light inhibition was directly related to the level of irradiance ($r = 0.97$). After 5 days at the highest level of irradiance tested (800 mW/m^2), break strength of the abscission zone had only decreased by 5% from initials. Lower irradiance levels of red light were only partially effective as those at the higher levels. Previous investigations by Curtis (54) comparing two levels of irradiance (800 mW/m^2 and 4200 mW/m^2) indicated no significant difference in their effectiveness in preventing abscission, but these results may be explained by the fact that both these levels are above the light saturation level. Although previous work with apples (18) showed no significant difference in inhibition of fruit abscission at irradiance levels of 100 mW/m^2 and 2000 mW/m^2 , this may be due to apples reaching light saturation at a lower irradiation level than for mung beans.

Maximum effectiveness in red light inhibition of abscission processes only occurred when the mung bean cuttings received a minimum of 12 hours of light per day. An intermediate level of abscission inhibition occurred with light treatments of 6 to 12 hours per day, while light treatments of less than 6 hours per

day had no effect in preventing abscission in mung beans. The reason for the minimum light requirement is not known.

Application of light at time periods after dark abscission has been initiated, or removal of plants from an abscission inhibiting red light treatment indicated that red light was necessary each day to prevent abscission and that the abscission processes were stopped and/or started with application of the red light or dark respectively. Cuttings placed in the dark decreased in break strength upon removal from red light. These results suggest that red light inhibition is relatively quick acting and not permanently changing physiological processes. Indeed, red light appears to delay or inhibit abscission processes through control mechanisms in the later stages of abscission processes as the required 1 to 2 day normal aging period required for abscission to start once fresh cuttings are placed in the dark are not observed with transfer of the red light treated cuttings to the dark. Apparently, the early aging requirements proceed even in the light so that the loosening of the abscission zone can occur quickly upon transfer of the lighted cutting to the dark.

Of the growth regulators tested only ethylene had any significant effect. Treatment of cuttings in the dark with IAA, GA, ABA and kinetin could not substitute for the red light response and suggest that these hormones play no role in light inhibition of abscission. Brooks (18) found no effect of NAA on apples.

Although ethylene production was neither stimulated nor in-

hibited by red light, red light could delay the abscission inducing effect of exogenous ethylene. The addition of ethylene to dark treated cuttings significantly decreased the break strength as compared with controls (no ethylene), while ethylene in red light cuttings could inhibit ethylene's inducing action for up to 24 hours. After 24 hours red light could no longer inhibit ethylene's response and abscission occurred. Red light may work by controlling low level physiologically active internal concentrations of ethylene.

Results of these studies suggest that carefully programmed light treatments could control leaf abscission. The process appears to be a phytochrome response with the leaf as the reception site. The response is rapid and does not appear to be hormonal.

C H A P T E R V I

CONCLUSIONS

Low level irradiance retards the dark-induced leaf abscission process in mung beans. Red light was found to be the most effective wavelength of light for controlling abscission. These results are similar to those reported by Curtis (22, 24).

The site of red light reception appears to be in the primary leaves. The level of inhibition of abscission was proportional to the amount of leaf present. These results should be viewed cautiously since leaf portions were excised to determine the amount of leaf necessary for maximal effect and the physiology of a cut leaf may be different than that of an intact leaf. Removal or shading of the stem had no effect on inhibition of abscission and may indicate that the receptor site is not located in these plant parts.

The level of red light irradiation and the length of red light treatment period are influential factors in determining the amount of inhibition of abscission. Maximum effect of inhibition is observed when plants are treated with red light every day of the treatment period for at least 12 hours per day with the highest level of irradiation tested (800 mW/m^2).

Phytochrome appears to function in the photocontrol of abscission and is supported by previous work by Curtis (23) and

Brooks (18). While phytochrome appears to be involved, the mechanism of phytochrome action in the photocontrol of abscission is not known.

A role for the plant hormones IAA, GA₃, ABA and kinetin in the photocontrol of abscission has not been determined from these studies. Addition of these hormones to the plant for uptake into the plant had no effect on the abscission process.

Red light may be functioning by delaying ethylene action for up to 24 hours after ethylene treatment. This inhibition of abscission was lost after 48 hours. Red light had no effect on ethylene synthesis.

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