

EFFECTS OF MALEIC HYDRAZIDE ON PHOTOSYNTHESIS
AND RESPIRATION OF RED KIDNEY BEAN

by

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PREVIEW

TABLE OF CONTENTS

	Page
INTRODUCTION AND LITERATURE REVIEW	1
METHODS	6
Preliminary Studies	6
Adopted Procedures	9
Growth and treatment of plants	9
Apparatus	9
Method of testing photosynthesis	15
Method of testing respiration	16
Dry matter determination	17
RESULTS	18
DISCUSSION	30
SUMMARY	34
LITERATURE CITED	35

INTRODUCTION AND LITERATURE REVIEW

The discovery that maleic hydrazide* (1, 2 dihydro-pyridazine-3, 6-dione) acts as a plant growth regulant or retardant was first reported by Schoene and Hoffman (29) in 1949. They demonstrated in preliminary experiments with MH that the chemical applied as a spray at a concentration of 2,000 parts per million had "a pronounced but temporary inhibitory effect on plant growth." Growth regulation ranged all the way from temporary inhibition to gradual death of the plant depending upon such factors as dosage, kind of plant, method of application, and the stage of plant growth at which the chemical was applied.

There has been considerable research on the visible effects and possible practical use of MH based on its inhibitory action (33). Naylor (24) reported markedly inhibited growth in maize treated with MH. A concentration of 0.2% completely prevented flower expression. Even at a concentration of 0.025%, the tassels were sterile. Wittwer and Hillyer (32) working with squash reported male sterility as a result of treatment with MH. This chemical has been reported as a sprout inhibitor for onion by Paterson and Wittwer (27). Crafts, Currier, and Day (6) discussed the response of crop

*The abbreviation "MH" is used throughout this paper to mean "maleic hydrazide."

plants and weeds to MH and suggested its possible use as a selective herbicide. Moore (22) has grouped the visible effects of MH on plants in the following nine categories: (1) a temporary suspension of stem elongation from terminal buds or death of terminal buds and adjacent tissues, (2) expansion of lateral buds some time after the terminal bud had been affected, (3) a transient intensification of green in the leaves of stunted plants, (4) a localized accumulation of anthocyanins or other non-green pigments, (5) a narrowing of leaves on both monocots and dicots, (6) several patterns of leaf chlorosis, (7) an interference with water absorption, apparently caused by death of root tips, (8) suppression of nodule formation on bush beans, and (9) varying degrees of sterility.

Several interesting studies on the effect of MH on respiration have appeared. Naylor and Davis (25,26) attempted to elucidate the mechanism of action of MH by measuring the respiration of root tips of sunflower, Rutgers tomato, corn, peanut, tobacco, cocklebur, pea, oat, barley, and wheat. Respiration was not inhibited when the pH of the solution in which the root tips were suspended was 6.0. However, respiration was inhibited in proportion to the concentration of MH at pH 4.0. Pea and corn root tips were least affected and root tips of oats, wheat, and barley were inhibited the most. Isenberg et al (15), working with young rapidly growing onion plants, indicated that MH sprayed on the foliage of plants

affected respiration through the partial inactivation or inhibition of one or more of the dehydrogenases. Later results of Isenberg et al (16) indicated that low concentrations of MH stimulated the respiration of onion bulbs but that high concentrations were inhibitory.

Gruelach (10), studying starch metabolism of beans and tomatoes, found that MH did not block either starch synthesis or starch breakdown.

Leopold and Klein (18) reported that MH behaved as an antiauxin in plants. They found that this chemical inhibited growth where auxin was limiting, and the inhibition disappeared when auxin was not limiting. MH (at 3 and 10 mg/l) inhibited growth in the presence of low concentrations of auxin (.01 and .1 mg indoleacetic acid (IAA)/l) but did not inhibit growth in the presence of high concentrations of auxin (10 and 100 mg IAA/l).

A limited amount of anatomical and cytological work has been published. Gruelach and Atchison (11), working with root tips of Yellow Globe onions, reported that lower concentrations of MH probably inhibit cell division but not cell enlargement. Higher concentrations appeared to inhibit both cell division and cell enlargement. Deleterious effects on tissue structure were observed only in roots treated continuously with solutions of 1,000 and 2,000 ppm. In these two latter groups there was also some failure to recover following treatment. Compton (5) studied the effects of MH on

growth and cell division in seedlings of garden pea and demonstrated that it can act as an antimitotic agent. Her results are essentially the same as those of Gruelach and Atchison.

Gruelach (9) reported that treated beans grown in the greenhouse transpired about one third as rapidly as control plants. The osmotic pressure of the leaves of treated plants of both bean and sunflower was higher than that of controls, as might be expected from accumulation of sucrose in the leaves of the plants treated with MH. Gruelach believed the differences observed in the osmotic pressure were sufficient to explain the differences in transpiration rates. Moore (23) used corn grown in water culture to study the effects of MH upon the loss of water vapor from the plants. Transpiration of treated plants, expressed as a percentage of that for controls, decreased steadily after the third day. He also found that the percentage dry matter of shoots was increased by treatment with MH.

Carbon assimilation by plants may be quantitatively determined by measuring the absorption of CO_2 , the evolution of oxygen, or an increase in dry weight. Heincke (12) and Heincke and Hoffman (13) described in detail a rather simple apparatus for CO_2 determination from a continuous gas stream. They employed a fritted glass disk at the base of each absorption tower to break the entering air stream into small bubbles. Thomas (31) suggested further decreasing the bubble size by

addition of n-butanol to the absorbing solution. Butanol decreases surface tension, thus increasing foaming and the efficiency of CO_2 absorption. Many modifications of the CO_2 absorption tower have appeared in the literature (3, 8, 19).

No reports have been found either on the effect of MH on photosynthesis or on the respiration of green leaves. To obtain information in this area, the research reported herein was undertaken.

PREVIEW