Response of Jojoba Seedlings to Different Photoperiods

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ABSTRACT

Lengthening the photoperiod under which jojoba seedlings are grown from 12 hours to continuous light increases the average number and length of stems, the number of leaves and the length of internodes and the dry weight of leaves, stems, and roots per plant. The simmondsin content of leaves increases but not that of roots.

INTRODUCTION

Natural jojoba populations occur in the Sonoran desert between 22° and 34° N. latitude. Interest in the culture of jojoba, however, is prevalent much farther to the south as well as to the north of this zone. While it is not difficult to find in these latitudes which are areas with environmental conditions that are similar to those prevailing in the natural habitat of jojoba, concern is highly justified regarding possible adverse effects of varying photoperiods on jojoba development and productivity when it is grown outside its zone of natural adaptation. Oil-producing crops such as soybeans and sesame have specific adaptation to particular zones of latitude, and they lose their yielding ability when grown away from those (1,2). The abundance of published information on the response of annual species to varying photoperiods is in sharp contrast to the complete lack of information on the response of perennial woody species such as jojoba.

Simmondsin occurring in jojoba seed makes its meal unsuitable as animal feed, although it contains ca. 30% protein (3). Reduction of simmondsin by genetic or cultural techniques would enhance the economic appeal of jojoba. Information on the possibility of modifying the simmondsin content of jojoba seed through genetic or environmental methods is unavailable. Since jojoba is now spreading to latitudes both to the south and to the north of its natural zone of adaptation, the effects of photoperiod on the biosynthesis of simmondsin need to be investigated. Data are presented in this report on the response of jojoba seedlings to three photoperiods in terms of botanic characteristics and simmondsin content of leaves, stems and roots.

MATERIALS AND METHODS

A group of 32 seedlings of jojoba grown for 6 weeks in liter pots under similar conditions in the greenhouse was placed in each of 3 growth chanbers set at constant temperatures of 30 C, light intensity at 2000 f.c. and photoperiods of 12, 18 and 24 hrs. The seed used to grow these seedlings was obtained from one maternal plant to minimize genetic variability among them. The seedlings were given normal care in the chambers, and the experiment was terminated when they had been in the chambers for 4 months. At that time, measurements were taken on each individual plant on branching and on dry weight of stems, leaves and roots. The plants from each chamber were then bulked so as to have 3 bulk samples for each chamber, i.e., stems, leaves, and roots. Analyses were conducted to measure simmondsin content in these 9 samples using the following procedures.

Test Materials

Samples of the respective plant tissues were ground in a laboratory mill until ca. 75% could be brushed through a 35 mesh screen. Assay samples were prepared by soxhlet extracting the ground plant material with acetone, evaporation of the acetone, and redissolving the residues in methanol. An aliquot of this methanolic solution was diluted with ethyl acetate and washed through a short column of silica gel, a procedure which removes highly polar and other plant materials which can interfere with assay (4). The eluant from the column was evaporated to dryness and brought to a known volume with methanol for chromatographic analysis.

Thin Layer Chromatography

The TLC methods used to assay the plant extracts for simmondsin (5) and simmondsin 2′-ferulate (6,7) followed reported procedures (4). This method is especially useful for simmondsin 2′-ferulate which fluoresces blue under UV light at 254 nm and where low concentrations can be detected.

Liquid Chromatography

High performance liquid chromatography was used to assay for simmondsin and simmondsin 2′-ferulate. The HPLC system used here is an improvement over our previously reported system (4). Conditions for this system are as follows:

Precolumn	Poracil A, 37-75μ, 3.2 x 40 mm
Column	Poracil A, 37-75μ, 3.2 x 500 mm
Solvent	Acetoniltrile:water (9:1)
Flow rate	1.0 ml/min.
Chart speed	0.5 cm/min.
Temperature	Ambient
Detector	UV at 220 nm
Retention	Simmondsin ~9.7 min
	Simmondsin 2′-ferulate ~6.7 min

Assays for the stems and roots utilized the (9:1) acetonitrile/water solvent. However, for leaves the solvent ratio

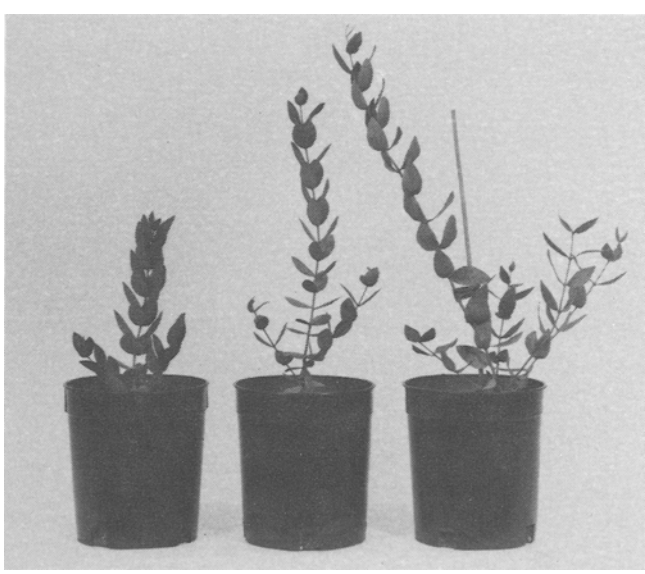

FIG. 1. Jojoba seedlings grown under 12 hr (left), 18 hr (center) and 24 hr (right) photoperiod at termination of experiment.

TABLE I

Differences in Botanical Characteristics and Simmondson Content in Leaves, Stems, and Roots of Jojoba Seedlings Grown for 4 Months under 12, 18 and 24 Hours of Light

Botanical characteristics[a]	Hours of light			
	12	18	24	LSD(.95)[b]
No. of stems per plant	4.1	3.9	4.9	0.4
Length of stems in each plant (cm)	14.1	18.3	24.6	2.2
No. of leaves per plant	61.6	67.6	89.7	7.5
Length of internodes in each plant (mm)	31.2	33.3	36.3	1.1
Dry weight of leaves (g)	4.3	4.5	5.9	0.6
Dry weight of stems (g)	1.3	1.9	3.1	0.5
Dry weight of roots (g)	1.1	1.2	1.6	0.2
Simmondsin content (%)[c]				
Leaves	0.1	0.2	0.3	
Stems	0.1	0.2	0.3	
Roots	0.3	0.3	0.3	

[a]Means based on 32 individual plants in each photoperiod.
[b]Least significant difference at the 0.95 level of probability.
[c]On a moisture free basis.

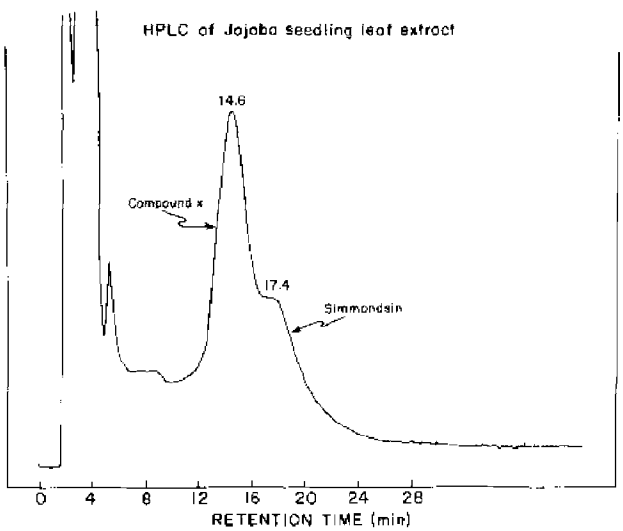

FIG. 2. HPLC of jojoba seedling leaf extract.

was changed to (92.5:7.5) in order to improve separation of simmondsin from a strong adjacent peak. Retention times in the latter solvent are simmondsin 17.4 min. and simmondsin 2′-ferulate 8.0 min.

RESULTS AND DISCUSSION

Longer photoperiods affected stems more than they did leaves and roots. Each 6 hr increment in the photoperiod resulted in a significant increase in both stem and internode length (Fig. 1, Table I). Because of lack of replication, statistical significance cannot be estimated for changes in simmondsin content. Nevertheless, the latter increased in stems and leaves as photoperiods became longer. Significant increases in number of leaves per plant and dry weight of leaves and roots did not occur except when photoperiod was extended from 18 to 24 hr.

Although simmondsin was present in all of the plant parts, simmondsin 2′-ferulate was not detected either by TLC or HPLC. Apparently the latter compound occurs only in seeds. No attempt was made to estimate whether either of the secondary 2-cyanomethylene-cyclohexyl glucosides were present in these plant parts (6). Levels of simmondsin in these plant tissues are relatively low compared to high levels found in seeds. Levels in stems and leaves from these seedlings, except in the case of leaves growing under continuous light, were lower than those found in stems and leaves of older plants which were 0.63-0.71% and 0.19-0.23% respectively (4).

HPLC analysis of leaf extract presented a problem using the acetonitrile/water (9:1) elution solvent. A substantial peak appeared with a retnetion time very close to simmondsin, which was observed as a shoulder on the stronger peak. The acetonitrile/water (92.5:7.5) solvent system was devised to separate these two peaks, for quantitation of simmondsin as seen in Figure 2. It is conceivable that peak X represents a compound structurally related to simmondsin, perhaps a metabolic precursor. This peak was less noticeable in HPLC scans of mature plant leaves. The unknown compound absorbs strongly at 220 nm and has a polarity similar to simmondsin. The retention of simmondsin on the Poracil A absorbant, a silica, is largely determined by the glucose moiety, which leads one to think that compound X may be a glucoside also.

Some commercial plantations of jojoba are planted with greenhouse grown seedlings. The higher rate of vegetative growth of seedlings under continuous light could have a practical application in accelerating the rate of growth of commercially produced seedlings.

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