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INFLUENCE OF GROWTH REGULATORS, TEMPERATURE, AND RED LIGHT ON SPROUT PRODUCTION OF THREE SWEET POTATO (IPOMOEA BATATAS (L) LAM.) CULTIVARS

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Abstract. **Roots of 3 sweet potato (Ipomoea batatas (L.) Lam.) cultivars 'Julian,' 'Tuskegee 100' and 'Jewel' were treated with different growth regulators, 2 temperature regimes and red light in an attempt to reduce proximal dominance and increase sprout production. Ethephon, gibberellic acid (GA_3), and thiourea separately or in combination were superior to kinetin (KN), benzyladenine (BA) and succinic acid (SA) in advancing sprouting date, increasing shoot number and length. Temperature effect ranked second in increasing sprout production followed by light treatment. 'Jewel' responded more favorably to the different treatments than 'Tuskegee 100'. 'Julian' was a sparse plant producer and was the least responsive to the above treatments.**

Proximal dominance of sweet potato roots is considered a problem of economic importance. It is the inhibition of shoots except at the proximal end of the root, which imposes undesirable limitation on the vegetative reproduction of this crop, and an increase in production cost. The reproduction potential of roots is presumably related to proximal dominance, which in turn is affected by the genetic make-up of the cultivar. Proximal dominance in sweet potato may be viewed as similar to apical dominance in potato tubers of *Solanum tuberosum* L. (2). Different cultivars show wide variation in the degree of proximal dominance and, subsequently, the degree of earliness or lateness of sprouting as well as total sprout production (6, 7, 16). There have been many attempts to increase sprout production of sweet potato through the reduction or elimination of proximal dominance. Root sectioning, (1, 12, 13, 17, 18, 19), planting in heated beds (2, 10, 17, 18), chemicals or growth regulators treatment (4, 5, 11, 20), and variation in light quality (3) have been investigated in an effort to enhance sprouting or reduce proximal dominance in sweet potato as well as other crops. This study was undertaken to examine the influence of several plant growth regulators, bed temperature, and red light on sprout production of roots of 3 sweet potato cultivars.

Materials and Methods

The roots of 3 sweet potato (*Ipomoea batatas* (L.) Lam.) cultivars 'Julian,' 'Tuskegee 100' and 'Jewel' were cured at 26-32°C for 10 days after harvest, then were stored at 13°C until used. Three locations within the greenhouse were identified as blocks. Within each location 96 uniform roots of each of the 3 cultivars were randomly assigned to 8 groups. Seven groups were soaked for 24 hr each in a different solution of the following growth regulators or combination: 1000 ppm GA_3, 1000 ppm ethephon, 20,000 ppm thiourea, GA_3 + ethephon + thiourea (1:1:1 v/v), 5 ppm KN, 5 ppm BA, and 0.008 ppm SA. The eighth group was used as a control.

After the soaking period, one half of the roots received overhead illumination from three incandescent and 4 Grolux® flourescent lamps directed through a custom made red filter to give a light spectrum extending from 580 to 700 mm with a maximum at 625 mm and a photon flux density of 300 $\mu E/m^2/sec$. Following the illumination period of 24 hr, the roots were treated with two fungicides and placed in heated or unheated sprouting media. The average maximum temperature at about 10 cm depth in the heated sawdust sprouting media was maintained at 35 $\pm$ 1°C by electric heating cables. In the unheated beds, the average maximum temperature was 21 $\pm$ 1°C. Sprouting recording began 1 wk after bedding and continued for 8 wk when the experiment was terminated.

Results and Discussion

Effects on 'Julian' sweet potato. Growth regulators increased significantly the number of sprouts of 'Julian' sweet potato (Table 1). Ethephon, GA_3, and thiourea separately or in combination were more enhancing to sprout production than KN, BA, or SA. In most cases heated beds also increased significantly the rate of sprouting compared to unheated beds. In general the increases in number of sprouts were 33 and 25% for roots treated with or without red light, respectively. The shoots developed in heated beds were 23% taller than similar ones developed from roots in unheated beds. This is in agreement with previous reports in which heated beds at 38-42°C increased sprouting of different sweet potato cultivars (10, 15, 17). Regardless of the growth regulators treatments the increase in sprouting of roots exposed for 24 hr to red light irradiation prior to planting in heated beds was 159% compared to control plants. However, the increase was more obvious under heated than unheated beds.

Effects on 'Tuckegee 100' sweet potato. 'Tuskegee 100' sweet potato responded favorably to growth regulators, temperature and red light treatments (Table 2). Growth regulators induced 86.0 and 62.5% increases over control in sprout production of the roots treated with red light and planted in heated or unheated beds, respectively. Under the same conditions, GA_3, ethephon and thiourea, separately or in combination were markedly superior in increasing the number and the length of sprouts over KN, BA, or SA. Roots exposed to red light for 24 hr prior to bedding showed 7.7

Table 1. Effects of growth regulators, temperature and red light on sprout production of 'Julian' sweet potatoes.[z]

Treatment	Heated bed				Unheated bed			
	(+) Red light		(−) Red light		(+) Red light		(−) Red light	
	Sprouts/ root (no.)	Sprout length (cm)	Sprouts/ root (no.)	Sprout length (cm)	Sprouts/ root (no.)	Sprout length (cm)	Sprouts/ root (no.)	Sprout length (cm)
Gibberellic Acid	6.9 a	35 a	3.6 a	28 a	6.0 a	30 a	4.2 a	25 a
Ethephon	6.7 a	33 a	5.7 b	33 b	6.2 a	28 a	4.6 a	20 b
Thiourea	6.2 a	33 a	5.1 b	33 b	5.7 a	28 a	6.0 a	18 b
GA_3 + Eth + Thiourea	7.0 a	35 a	6.3 b	33 b	6.5 a	28 a	5.6 a	18 b
Kinetin	4.1 b	25 b	4.7 b	20 c	2.8 b	23 b	1.7 b	20 b
Benzyl Adenine	5.0 b	28 b	5.3 b	15 d	2.4 b	25 a	2.0 b	18 b
Succinic Acid	4.2 b	23 b	3.0 a	20 c	2.6 b	20 b	1.3 b	20 b
Control[y]	2.2 c	20 b	1.9 c	18 cd	2.0 b	20 b	1.8 b	20 b

[z]Each value is an average of 3 replications. Mean separation in columns by Duncan's multiple range test, 5% level.
[y]Roots received no growth regulators, red light or temperature treatments.

Table 2. Effects of growth regulators, temperature and red light on sprout production of 'Tuskegee 100' sweet potato.[z]

Treatment	Heated bed				Unheated bed			
	(+) Red light		(−) Red light		(+) Red light		(−) Red light	
	Sprouts/ root (no.)	Sprout length (cm)	Sprouts/ root (no.)	Sprout length (cm)	Sprouts/ root (no.)	Sprout length (cm)	Sprouts/ root (no.)	Sprout length (cm)
Gibberellic Acid	12.9 a	70 a	12.3 a	73 a	11.6 a	68 a	11.1 a	65 a
Ethephon	13.6 a	65 a	11.8 a	65 a	12.2 a	68 a	13.4 a	58 a
Thiourea	13.8 a	73 a	12.7 a	68 a	12.4 a	65 a	12.1 a	60 a
GA_3 + Eth + Thiourea	14.3 a	70 a	13.4 a	68 a	12.0 a	60 a	10.7 a	45 b
Kinetin	9.3 b	40 b	7.6 b	28 b	8.1 b	25 b	8.0 c	35 c
Benzyl Adenine	8.1 b	33 c	8.3 b	33 c	9.0 b	20 c	7.0 c	30 d
Succinic Acid	10.1 b	35 c	9.4 b	40 d	7.3 b	28 b	7.0 c	38 c
Control[y]	6.3 c	30 d	6.0 c	30 e	6.4 b	33 b	6.0 c	28 d

[z]Each value is an average of 3 replications. Mean separation in columns by Duncan's multiple range test, 5% level.
[y]Roots received no growth regulators, red light or temperature treatments.

and 2.6% increases in sprout production in heated and unheated beds, over similar roots receiving no light treatment, respectively. Red light, however, had no effect on length of shoots produced in unheated beds, while it produced a 7.8% increase.

Effects on 'Jewel' sweet potato. Data on sprout production from 'Jewel' sweet potato roots are shown in Table 3. Growth regulators tested varied significantly in their effectiveness in increasing sprout production. Under heated conditions, red light-treated roots resulted in 112.6, 125.8 and 74.8% increases in sprout production as a result of GA_3, ethephon and thiourea treatments, respectively. Red light generally enhanced significantly sprout production and shoot length. The enhancements were more obvious in roots planted in heated rather than unheated beds.

The sweet potato producers are confronted by a unique problem of economic importance. To produce enough sprouts from sweet potato roots to set one acre, at one pulling, approximately 420-630 bu of seed-roots are needed. With the exception of few cultivars, many breeding lines are characterized by low sprout production, most of which occur at the proximal end of the root. Attempts to eliminate

Table 3. Effects of growth regulators, temperature and red light on sprout production of 'Jewels' sweet potato.[z]

Treatment	Heated bed				Unheated bed			
	(+) Red light		(−) Red light		(+) Red light		(−) Red light	
	Sprouts/ root (no.)	Sprout length (cm)	Sprouts/ root (no.)	Sprout length (cm)	Sprouts/ root (no.)	Sprout length (cm)	Sprouts/ root (no.)	Sprout length (cm)
Gibberellic Acid	32.1 a	83 a	29.0 a	65 a	24.0 a	75 a	20.5 a	78 a
Ethephon	34.1 a	73 b	29.0 a	75 b	23.1 a	83 a	21.7 a	53 c
Thiourea	26.4 b	83 a	27.0 a	70 a	20.5 b	68 a	18.3 b	70 b
GA_3 + Eth + Thiourea	33.9 a	81 a	30.3 a	88 b	24.7 a	78 a	25.8 a	45 c
Kinetin	16.2 c	68 b	16.4 b	48 c	14.6 c	55 c	12.3 c	33 d
Benzyl Adenine	18.0 c	63 c	15.2 b	63 c	12.0 c	50 c	13.4 c	55 c
Succinic Acid	21.3 c	55 c	17.6 b	58 c	15.1 c	53 c	9.7 d	25 d
Control[y]	15.2 d	40 d	15.0 c	40 d	15.3 d	40 d	15.0 e	40 e

[z]Each value is an average of 3 replications. Mean separation in columns by Duncan's multiple range test, 5% level.
[y]Roots received no growth regulators, red light or temperature treatments.

proximal dominance and increase sprout production would be of valuable assistance to the sweet potato plant producer. The studies reported herein show that significant increases in sprout production were obtained from root treatment with a variety of growth regulators, high temperature or red light treatments. These treatments enhance sprout emergence which took place 18, 7, and 13 days after bedding for 'Julian', 'Tuskegee 100' and 'Jewel', respectively, as compared with 29, 24, and 39 days for control plants of the same cultivars in the same order. Soaking the roots for 24 hr in GA_3, ethephon, thiourea or mixture of these chemicals markedly overcame the proximal dominance in all three cultivars. 'Jewel' cultivar responded more favorably to growth regulators than 'Tuskegee 100'. 'Julian' on the other hand, was the least responsive to any of the above treatments. This cultivar is considered a sparse plant producer and was characterized by delayed sprout emergence associated with slow sprout growth.

There have been few studies of the post-harvest physiology in connection with proximal dominance and plant production in sweet potato. Some physiological and biochemical differences, particularly the delicate balance between the growth promotion and inhibiting substances, are assumed to exist among cultivars which exhibit strong proximal dominance and those where this phenomenon is slight. In the former cultivars, a growth inhibitor (s) may be dominant, while in the latter, growth promotors may exist in substantial amounts to overcome the effects of the growth retarding substances (4, 14). The inhibition of the biosynthesis of almost all the growth promoting substances in higher plants by the growth retardants has been demonstrated (8, 16). There seems to be an antimetablite of many of the growth promotor biosynthesis which, in the case of sweet potato may lead to sprout inhibition. The differences in the degree of sprout production among the 3 cultivars can only be interpreted as variations in the amount and the activity of the enzymes involved in the biosynthesis of the growth promoting substances, which make them more or less sensitive to the growth inhibitors.

Heated beds are finding a widespread use among sweet potato plant producers. The high temperature to which the plants were subjected had a marked effect on the time of sprout production depending on the cultivar. High temperature bedding rated second, after growth regulators treatment, in increasing sprout production in the three cultivars. The effect of temperature in influencing many metabolic reactions has long been documented. It is conceivable that high temperature enhanced the biochemical reactions in the sweet potato roots which lead to the production of sprouts. Such reactions as the increase of enzymatic activity, the breakdown and metabolism of the storage products to supply the energy required for the developing sprouts.

The stimulatory action of light, particularly the red region, and its interactions with other factors was recognized by several workers (3, 9). Different spectural zones affect germination quite differently. In the visible, 400 to 700 nm, it is shown that the range 560 to 700 nm and especially red light, usually promoted germination. This response is mediated by the red far-red absorbing pigment systems (phytochromes). The detailed interpretations of the effect of red light on seed germination, or sprout induction as in sweet potato is immensely complicated. Despite of the numerous suggestions which have been made, the way in which the active form of phytochrome brings about its effect on enhancing sprouting is still unclear. It is probable that phytochromes act in some way on cell membrane, in the alteration of the forms of metabolism or interaction of phytochromes with other factors.

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