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## **Optimum growing conditions for propagation of leafy spurge (*Euphorbia esula* L.) for leafy spurge biocontrol agents**

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Leafy spurge biocontrol agents presently require live plant material to complete their life cycle. To mass rear insects, the optimum leafy spurge growing conditions in the greenhouse have been investigated. Previously we determined that the optimum growing conditions are 27° C with 250 lb/A nitrogen using a complete 15-30-15 fertilizer, at pH 7 with a 16-hour day-length. The purpose of this research was to determine the effect of increased photoperiod, chilling the roots prior to planting, the ratio of N:P:K, and plant growth regulators on leafy spurge growth.

The plants were propagated by cutting 65 to 75 mm of stem apex from the plant. All but the upper 4 to 5 leaves were stripped from the stem. Then cuttings were dipped into 0.2% powdered NAA, were planted into conical tubes (1.5 inch diameter by 8 inches long) containing a mixture of peat and perlite, and were misted for 10 days to maximize root development. The plants were selected for uniformity prior to each experiment.

The plants were harvested and stem height, diameter, and dry weight were determined 36 days after treatment. An electronic caliper was used to measure the stem diameter about 2 cm from the stem cut. Roots were carefully washed to remove soil, and root diameter and dry weight were determined. The diameter of the largest true root and not the callus of the stem was measured. Each experiment was repeated.

Leafy spurge growth during a 10, 12, 14, 16, 18, and 20 hour photoperiod was determined. Plants from 10- or 20-day-old cuttings or regrown from roots were grown inside black plastic tents with natural light supplemented with metal halide lamps to achieve the correct photoperiod. The plants were fertilized at 100 lb N/A using a mixture of 23-19-17 water-soluble fertilizer. Optimum day-length for both shoot and root height and diameter was 16 to 20 hours and for shoot and root dry weight was 18 to 20 hours (Table, see page 3).

Plants were fertilized with various ratios of N:P:K (Table). In general there were no differences in plant growth regardless of the N:P:K ratio. In a second study, four water-soluble commercial fertilizers with a mixture of 15-30-15, 19-24-18, 20-20-20, and 23-19-17 N:P:K: were applied to 20-day-old leafy spurge plants at 200, 250, 300, and 350 lb N/A. Plant growth was similar regardless of fertilizer. Based on these and previous stud-

ies, the optimum growth of leafy spurge is achieved when at least 250 lb N/A is applied monthly regardless of the N:P:K ratio.

The effect of age of plants when first fertilized was evaluated. Cuttings 20, 30, 40, and 50 days old were fertilized using a fertilizer mixture of 15-30-15 at 250 lb N/A and harvested when 80 days old. Fertilization when the plants were 20 days old resulted in the best growth with almost double the stem and root dry weight compared to application when the plants were older (Table).

The effect of chilling roots to 2° C prior to planting was evaluated. Roots were chilled 48 hours and 1, 2, 4, and 8 weeks prior to planting. The roots were replanted and fertilized weekly with 20 lb N/A using a mixture of 15-30-15. Roots that had been chilled tended to grow more rapidly than the control (data not shown).

Plant growth regulators were applied as a soil drench at 1, 10, 100, 1000 ppm (Table). The plants were fertilized using a mixture of 15-30-15 at 100 lb N/A five days before treatment. GA increased shoot height and decreased root diameter and dry weight (Table). Ethephon (Ethrel), IAA and flurprimidol (Cutless) decreased growth. NAA at 1000 ppm was toxic to plants. Maleic hydrazide and chlormequat chloride (Cycocel) decreased shoot length slightly.

In summary, leafy spurge plants grew best in the greenhouse at 27° C, fertilized when 20 days old at a rate of 250 lb N/A, at pH 7 with a 16-hour photoperiod.

**Table. Effect of day-length, N:P:K ratios, water-soluble fertilizers, age of plant at first fertilizer application, and plant growth regulators on leafy spurge growth.**

Growth parameter	Shoot			Root	
	Height	Diameter	Dry wt.	Diameter	Dry wt.
	———— (mm) ————		(mg)	(mm)	(mg)
Day-length (H)					
10	139	1.52	192	0.95	176
12	133	1.53	215	0.97	220
14	148	1.65	320	0.96	244
16	172	1.77	392	1.03	278
18	170	1.81	441	0.99	297
20	182	1.84	477	1.05	315
LSD (0.05)	12	0.07	39	0.08	36
N:P:K ratio <sup>a</sup>					
2:2:1	165	2.02	567	1.16	368
2:1:2	154	1.90	486	1.13	367
4:2:1	171	2.00	571	1.21	362
4:1:2	164	1.97	543	1.12	345
6:2:1	165	1.89	543	1.20	365
6:1:2	165	1.94	569	1.22	396
4:4:2	179	2.00	595	1.20	385
4:2:4	164	1.95	522	1.19	343
6:6:3	193	2.08	624	1.23	360
6:3:6	165	1.89	558	1.23	341
LSD(0.05)	22	NS	NS	NS	NS
Fertilizer <sup>b</sup>					
15-30-15	168	2.01	510	1.15	277
19-24-18	201	2.12	696	1.19	348
20-20-20	182	2.10	641	1.20	401
23-19-17	182	2.25	681	1.20	374
LSD (0.05)	NS	NS	NS	NS	NS
Age at fertilization (days)					
20	163	2.03	715	1.47	808
30	129	1.89	356	1.27	435
40	120	1.98	444	1.04	383
50	119	1.68	378	0.76	257
LSD (0.05)	27	0.20	159	0.27	135
Plant growth regulators <sup>c</sup>					
GA	442	2.09	459	0.74	103
Ethephon	113	1.64	250	1.18	173
IAA	144	1.73	414	1.10	248
Flurprimidol	54	1.64	123	0.57	297
NAA	0	0	0	0	0
Maleic hydrazide	50	1.46	185	0.48	86
Chlormequat chloride	111	1.75	427	1.27	382

<sup>a</sup>1 equals 50 lb/A

<sup>b</sup>Applied at 250 lb N/A.

<sup>c</sup>1000 ppm.