Giant castor bean, bioenergy and phytoremediating crop for the Subtropics

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Castor bean (*Ricinus communis*) has been grown as an ornamental and deterrent to ground moles in yards and gardens since the pioneer days. Both clusters of plants and large individual plants are found growing wild throughout peninsular Florida. In the tropics and warmer subtropics castor bean is a weak perennial and may form a tree 9 to 12 m tall and a stem 15 cm or more in diameter at the base. Where mild freezes occur the topgrowth is killed back, but the main stem survives for many seasons and regrows so that large basal stems occur. In colder subtropics, the entire plant may be killed by freezes and castor bean acts as an annual. Boyd Pridmore, who has observed and made valuable wood products from castor in the Lakeland, Florida, area under trademark "Fla Balsawood," encouraged its evaluation as a possible energy crop. This is a progress report on the evaluation.

Giant castor bean planted in April grew to 6.7 m in height and had dry matter stem yields of 40 Mg ha^{-1} at Gainesville, Florida, in 1997. Unharvested plants survived the winter frosts, but stems were killed to 3 m above soil. Plants grew only 5.3 m tall and had a two season stem yield of 65.4 Mg ha^{-1} in 1998. In February 2000, we harvested samples from a naturally reseeded stand of a tall castor bean ecotype at Lakeland, Floida, that had been growing since the previous winter. The highest yielding areas in the stand were sampled and gave an average yield of 66.6 Mg ha^{-1} oven dry stems. Many plants were over 7 meters tall. These high yields led to research on giant castor used as an energy crop when irrigated with city sewage effluent and as a possible phytoremediating crop.

Yield of castor bean grown with sewage effluent on sandhills near Winter Garden, Florida, also has been influenced by additional cultural amendments. With effluent (E) alone, height increased from 0.35m at 2.5 months to 1.7m at 8 months and 2.4m at 15 months. After 2.5 months, compost (C) and mulch (M) amendments to E further increased heights, and the ECM amendment resulted in 2.7m tall castor bean at 15 months. Destructive sampling at 20 months determined that castor bean stems had green and dry weight densities of 0.69 and 0.28 tons m^{-3}. Based on these stem densities and measurement of three replications, the ECM amendment yield of 12.2 green tons ha^{-1} at 15 months was three times that of E alone (Table 1). After 34 months, harvesting of one replication suggested that the differential between the E and ECM amendments was only twofold. At 34 months, volunteer castor beans constituted from 3 to 7% of plot biomass in the E, EM, and ECM amendments but were about one-third of the yield in the EC plot. In terms of annual productivity, 34 month yields, up to 6.3 dry tons ha^{-1}, were about twice the 15 month yields for the corresponding amendments.

Table 1. Castor bean biomass production in response to E = effluent (E) alone, EC = E + compost (C), EM = E + mulch (M), and ECM = E + C + M at 15 and 34 months after planting.

Treatment	15 month yield	34 month yield		
	Green tons ha^{-1}	Dry tons ha^{-1}	Green tons ha^{-1}	Volunteer percent
E	4.2	9.5	25.8	3.2
EM	5.8	7.9	21.6	7.4
EC	8.8	14.1	38.5	33.1
ECM	12.2	17.7	48.4	4.2

Castor bean's potential for phytoremediating soils contaminated with heavy metals was surveyed in a preliminary greenhouse study (Table 2). In comparison to eight tree species, castor bean may accumulate higher concentrations of arsenic, chromium, and copper. Both castor bean and baldcypress contained high copper concentrations.

Table 2. Arsenic, chromium, and copper concentrations (mg kg^{-1}) in stem tissue of nine species.

Species	Arsenic	Chromium	Copper
Eucalyptus camaldulensis	1.6	.2	4.5
Eucalyptus grandis	.7	.2	1.3
Leuceana leucocephala	1.8	.1	.7
sweetgum	.4	.3	.3
red maple	1.3	.3	1.1
tuliptree	1.2	.3	.9
sycamore	2.6	.5	4.3
castor bean	3.3	.9	15.5
baldcypress	1.5	.7	16.6

Conclusion

Under favorable conditions giant castor bean makes very high annual biomass yields, but it needs further study as an energy and phytoremediating crop. The presence of ricin and other toxic compounds in plant parts may limit its use as an energy crop.