Summary of Development, Introduction, and Marketing Strategy to Share Lotus in the Southeast United States©

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Lotus (*Nelumbo nucifera* Gaertn.) is a well-known plant based on its edible, ornamental, and medicinal uses. Lotus is an impressive flowering rhizomatous, perennial, aquatic herb, which has a long history in the diverse cultures of the Orient (Follett and Douglas, 2003). The plant is sacred in the Hindu and Buddhist religions. Sacred lotus has been cultivated in Asia for thousands of years and has been a prestigious crop in China for nearly 5,000 years (Shen et al., 2002). Lotus is known in the United States, and there is a native yellow-flowered species (*N. lutea* Willd.). However it is used sparsely in the landscape and rarely eaten. A developing and open world economy has led to increasing exchanges and meshing of cultures, ideas, and horticultural treasures. In 2000, two professors and two graduate students from Auburn University visited Wuhan Institute of Botany in Wuhan, China, in the Hubei province. Their hosts at the Institute shared the beauty, diversity, and development advances of lotus. Professors from Auburn University returned to Auburn with the enthusiasm and the cooperative relationship with China to develop and share the plant that is used and enjoyed by billions of people throughout the world with the gardeners and nursery producers of Alabama and the Southeast United States. This paper offers a summary of the on-going development and promotion of lotus and the exploration of opportunities for farmers in an economically depressed region of Alabama called the "Black Belt." The Black Belt is a crescent-shaped region extending from Texas through Alabama to Virginia and is characterized by the dark color of the soil that is also synonymous with large areas of economic poverty. It is also a region that has developed a viable catfish and tilapia industry. This industry has the potential to meet the cultural requirements of lotus as a companion crop.

The plan to develop this new economic venture was to establish a parallel program of research and marketing similar to other products in our economy. Research and marketing work hand-in-hand, so that when growers have the knowledge and infrastructure to produce and ship lotus, buyers will be knowledgeable and eager to buy the plants. Research involves cultivar evaluation and adapting production programs to meet the requirements of a U.S.A. workforce and economy. Economic analysis of the production program was planned to provide realistic information for farmers and bankers that may be financing the venture. Research also looks at incorporating lotus production into an already strong aquatic fisheries production industry to enhance utilization efficiency of production space and increase profits.

Marketing involves expanding the scope of the program, which currently includes Mississippi and Georgia as well as Alabama. The land-grant universities in these states have the respective Cooperative Extension systems, including the Master Gardener programs, to disseminate educational information as it becomes avail-

able. Cultivar evaluations are in Cullman and Auburn, Alabama, and Savannah, Georgia. Plantings are planned for Mississippi in 2007. Field days at research stations and displays at Botanical Gardens in Alabama are part of the promotional activities. A web site has been established to provide regular updates on our research activities to the interested gardeners and producers. Surveys at garden centers and botanical gardens will be conducted this year to learn consumer preferences for size, color, and acceptance of lotus for the garden. Target audiences will be random home gardeners and Master Gardeners within the various cooperating state programs. There is also an edible program being developed by vegetable specialists in the other cooperating states including cultivar evaluation and culinary evaluation for the American palette.

Some initial results from early research programs include fertility requirements, soil depth, storage requirements, and effects of disbudding on propagule development. One year's data has been collected on cultivar evaluation including desirable characteristics of color, size, flower number, height of flower above leaves, number of leaves, and overall ornamental ratings.

A preliminary study was conducted to investigate the effects of fertilization and soil level on performance of container lotus. Three ornamental cultivars were selected for the two studies. 'Embolene' (medium sized, with numerous leaves and flowers) and "98 Seed" (large unnamed seedling with numerous leaves and few but large flowers) were used in examining the effect of container soil level on the growth of lotus. "No1," another unnamed seedling (medium sized, with few emerging leaves and flowers) was used in testing the effect of two fertilization rates. Lotus rhizomes were divided and planted in 28.4-L (7.5-gal) black plastic containers [38 × 36 cm (15 × 14.2 inches)]with no holes on 17 May 2004, when new young leaves (coin leaves) had emerged in the original stock pot. For "No1," each pot was filled with 1/2 level ([1/2 L, 18 cm (7.1 inches)] of sandy loam soil. For the other two cultivars, containers were separated into two groups, one group was filled to 1/2 container soil level while the second group was filled to 3/4 container soil level [3/4 L, 27 cm (10.6 inches)] with a sandy loam soil.

After planting, all pots were filled with water. Fertilizer was applied once every 20 days from 9 June 2004 when the lotus had at least several coin leaves and possibly one or two emerging leaves. Fertilizer treatments ended on 21 July 2004. Water solution samples were taken twice (1 h before fertilization and 24 h after fertilization) in the afternoon in the same pots to better monitor the nutrient status. When taking samples, pots were irrigated to the full level of water by hand carefully to ensure the same water level. On 23 Aug. 2004, young, fully expanded leaves were sampled from each cultivar for nutrient analysis. Fertilizer applied was water soluble 20-10-20 (Pro•Sol Inc, 1792 Jodie Parker Rd., Ozark Alabama 36360, U.S.A.). One and two teaspoons (4 g and 8 g, respectively) of fertilizer were added to each of 10 pots of lotus "No1." Cultivars in the soil level study received one teaspoon (4 g) of fertilizer at the same dates.

Data collected included number of emerging leaves, flowers, propagules (normally containing 2–3 internodes), and number of expanded internodes. Fresh root (combining rhizomes and roots) weight was also collected.

A summary of practical results of this initial evaluation was that the average initial pH value of 7.3 of all water samples taken from the three cultivars on 9 June vacillated depending on the cultivar, soil level, and concentration of fertilizer applied. Unlike pH, electrical conductivity (EC) in water solution exhibited regular expected changes for all cultivars during fertilization: (1) EC increased after fertilization and then went down with the absorption of fertilizer; (2) EC increased with the concentration of fertilizer within cultivars.

Two teaspoons of fertilizer on "No1" lotus increased root fresh weight, number of propagules, and expanded internodes, which are important parameters in commercial production compared to the number of emerging leaves and other parameters of lotus receiving 1 tsp of fertilizer. Lotus plants respond favorably to increased fertilizer rates. However, the response level to fertilizer depends on the cultivar, container size, and possibly the soil level. Generally, 2 tsp of fertilizer was excessive relative to fertilizer efficiency, because the utilization rates of N, P, and K were obviously lower than those of 1 tsp treatment.

In the soil level study, treatments of 1/2 L and 3/4 L for 'Embolene' and "98 Seed" had no significant effect on growth except for the flower number of the latter. In 3/4 L for 'Embolene', the fresh weight of roots, the number of propagules, and expanded internodes only slightly increased, but the number of emerging leaves and flowers slightly decreased in contrast to that of 1/2 L. For "98 Seed," in the group of 3/4 L, the number of flowers decreased in comparison with the group 1/2 L. All plants in 1/2 L containers had 1–3 flowers but only two of 6 pots in 3/4 L had 1–2 flowers. Data suggested increasing soil level in containers decreased flower formation and ornamental value of "98 Seed." Fresh weight of roots in 3/4 L also decreased. A slight increase was found in the number of propagules, expanded internodes and emerging leaves.

Edible lotus tubers have vitality for about 20 days under room temperature conditions. In a study evaluating treatments to extend the potential storage/shelf-life of lotus rhizomes, ornamental lotus, *N. nucifera* 'Embolene', was used to evaluate effects of gum acacia (natural bio-polymer), peat moss, and hydrogel (super-absorbent synthetic polymer) on cooler-stored lotus propagules. Results indicated there was no significant difference in retaining water and prolonging shelf-life among all treatments during 45 days of storage. After harvest, there were large differences in total sugar among treatment samples, but reducing sugar maintained a relatively stable level. No significant effect of treatments was found on carbohydrate change. Low temperature is possibly the most critical factor to influence the viability of lotus tubers or rhizomes during storage.

For the lotus cultivars tested, discarding or disbudding flowers increased biomass and the production of propagules. In production, where flowers are not necessarily needed, this cultural practice could increase profits, depending on the cost analysis for labor to execute the disbudding practice.

Some of this data represents only 1 year's results ,and the studies are currently being replicated. This project is an on-going effort to develop a production and marketing strategy to promote the value of lotus as an ornamental and food crop. People

throughout the world appreciate this plant. We would like to share that excitement with people in the southeast and at the same time offer economic opportunities to farmers in depressed areas of Alabama's Black Belt Region. You can follow our efforts on our web page at <www.ag.auburn.edu/landscape>. Look for "Lotus" under the heading of "Research."

LITERATURE CITED

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