Table 2. Suggested fertilizer guide for tropical fruits in South Florida.

Year	Times per year	Amount/tree/ application (lbs)[1]	Total amt/tree/ yr (lbs)	Minor element sprays (times/yr)[2]	Iron chelate drenches (oz/tree/yr)[3]
1	6	.25-0.5	1.5-3.0	6	0.5-0.75
2	6	0.5-1.0	3.0-6.0	6	0.75-1.0
3	6	1.0-1.5	6.0-9.0	6	1.0-1.5
4	4	1.5-2.5	9.0-10.0	6	1.5-2
5	4	2.5-3.5	10.0-14.0	4-6	2-4
6	4	3.5-4.0	14.0-16.0	4-6	2-4
7	4	4.0-4.5	16.0-18.0	4-6	2-4
8	4	4.5-5	18.0-20.0	4-6	2-4

[1]Use 6-6-6, 8-3-9, young tree, or slow release fertilizer.
[2]Spray should contain zinc, manganese, boron, molybdenum and may also contain iron. Apply from april to September.
[3]Iron chelate drenches will avoid iron deficiency, not the sprays. Apply from June to September.

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SHARING OUR AGRICULTURAL ROOTS (SOAR) SCHOOL GARDENS: BEHAVIORAL EFFECTS

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Abstract. **The positive psychological benefits of gardens and gardening have been known for some time. In particular, school gardens are thought to enhance academic performance of children. During spring 1997, a school garden program called "Students SOAR" was initiated in southern Florida. To evaluate the effectiveness of this program, a multi-year, multi-methodological behavioral study of 25 schools in Palm Beach County participating in SOAR was initiated. Results of the first two phases of the study indicate that SOAR's effect is "outstanding." Students participating in this program are enthusiastic and inquisitive, take possession of the gardens, and also take great pride in garden accomplishments. Gardens are a natural learning environment, and while most children call their garden activities "fun," time spent in the gardens is time spent learning. Two key indicators for success are described: the necessity for discipline in the gardens, and the need for enthusiasm and engagement on the part of the teachers.**

There is a long-standing debate concerning therapeutic effects of gardening (Burchett, 1995; Flagler, 1994; Lewis, 1995; Relf, 1995; Zhou,1995). A surge in interest in school gardens suggests that many researchers feel that gardens, indeed, enhance health and the quality of life. There are additional claims that they enhance children's academic performance (Alexander et al., 1995; Finch, 1995; Konoshima, 1995; Ocone and Pranis, 1990). Students S.O.A.R (***S***haring ***O***ur ***A***gricultural ***R***oots), a school gardening program in Palm Beach County (PBC), Florida, was initiated at two elementary schools during spring,1997. Initial success of the program has led to expansion at twenty-five elementary and middle schools. The number of students participating per school ranges from 30 to over 1,200. In total, there are approximately 3,500 students currently involved, with more than 25,000 square feet of formal school gardens established. The program is adaptable to students from kindergarten through middle school (8th grade).

The primary goal of Students SOAR is to enhance agricultural and environmental awareness. Simply put, it is meant to teach our children where much of their food, clothing, and shelter comes from, and how plants are grown (Nagata and Raid, 1997). A garden is a practical, hands-on learning tool that can be used as an outdoor classroom.

In the garden, children learn to experience and experience to learn. With only a little imagination, gardens may lend relevance to the entire curriculum, i.e., mathematics, science, geography, history, English and literature, social studies, even music and art (Weeks, 1990). Moreover, school gardens lend themselves to practical lessons on many current topics such as conservation, recycling, organic farming, pesticides, fertilizers, and pest management. Native vegetation can be used for instruction in natural science courses (Fitzpatrick et al., 1984) while multicultural themes can easily be built into every subject of the curriculum (Eames-Sheavley, 1994; Thomas, 1997). In addition, several schools have used the gardens to conduct fundraisers, providing an excellent opportunity to teach business and marketing principles. School gardens in PBC vary tremendously. There are vegetable, butterfly and ornamental gardens, simulated ecosystems, tree nurseries, water gardens, and miniature corn and wheat fields. Typically, SOAR gardens are long and narrow, so that students may work with plants with a minimum of intrusion into the garden itself. The majority are constructed as 20' × 5' raised bed units. This size plot will easily accommodate a class of 25 to 35 students at the same time. However, SOAR gardens vary widely in size and shape, adapting to the desires of the teacher, land availability, or school layout. It is important to note that because school gardens are located on school property, they are visible to the public and accessible to interested parties. School gardens frequently become a major school focal point, earning outside recognition.

A secondary goal of Students SOAR is to improve the interpersonal skills of students. Teamwork, organizational and communication skills, and civility are mandated in the gardens, and research has shown that these behaviors are improved through the use of gardens (National Gardening Association, 2000). Moreover, gardens serve as sites and sources of community beautification, charitable fund-raisers, and school pride. Even self-esteem and critical thinking are said to be outcomes of school gardens (National Gardening Association, 2000). The objective of the present study was to determine the effects of gardening on academic achievement and behavior of school children.

Coordinated by the University of Florida's Cooperative Extension and 4-H, Students SOAR is supported by the Palm Beach County (PBC) School District, PBC agriculture (including the Western Palm Beach Farm Bureau and the Florida Nurserymen and Growers Association), the PBC Solid Waste Authority, USDA's South Florida Community Urban Resource Partnerships, local municipal governments, private individuals and foundations. The entire program was made possible with seed monies from the Sugar Cane Growers Cooperative of Florida which continues as a major contributor along with the United States Sugar Corporation.

Materials and Methods

A sociological impact study on the influence of gardening on school children was initiated during the 1999/2000 school year. Academic and social achievements as defined by teachers were examined. The evaluation was divided into four phases, following a "triangulation model" (Babbie, 1995) where ethnographic qualitative data are combined with quantitative data. The first two phases were aimed at understanding SOAR accomplishments. These two phases were partitioned into 1) teacher interviews, and 2) participant observation, in order to establish quantifiable variables for the third and fourth phases of the research. Those two quantitative phases, i.e., construction of a questionnaire and subsequent comparison of scores and grade point average in an experimental/control group design, are still in progress.

Permission to conduct teacher interviews was formally requested in writing from all 25 principals of schools involved in Students SOAR. Twenty schools granted permission, and interviews were subsequently conducted at 14 of these. Twenty-eight teachers participated. Interviews at the remaining 6 schools could not be conducted due to time constraints imposed by preparation for the state standardized test (FCAT) and the onset of summer vacation.

General questions about academic and behavioral outcomes of the gardens were asked during the open-ended interviews with teachers. Responses were used to identify indicators that can be quantified for questionnaires intended for both teachers and parents.

The participant observation phase of the project was conducted at an inner-city, low performance school (as measured by FCAT scores). Observations were made over the course of four consecutive days during which gardens were being constructed. Participant observations were made by a sociologist throughout the construction of the garden. Construction involved removal of existing vegetation, soil preparation and tillage, building of the standard 20' × 5' raised beds, and import of compost into beds to serve as growing medium. Over the span of four days, over 300 children from 22 different classrooms were observed. Additional sets of observations were made on two more occasions when students displayed products grown and harvested in their gardens.

Results and Discussion

Gardening enhanced the general educational program for Palm Beach County students. **All** teachers reported that students' interpersonal skills and academic achievement improved. It is believed that these improvements are directly related to the experiential nature of the learning program. **All** teachers felt that basic skills improved, i.e., math, reading and writing. **All** teachers reported that benefits from the gardens extended beyond science and math, and **all** interviewees reported that there have been noticeable changes in discipline, civility, and attitudes of students. **All** teachers believed that students apply garden-based experiences to real world problems and that their abstract thinking skills have been sharpened.

Author observations support the conclusion that gardening has an exceptionally positive effect on students. Everything done in the gardens, whether building, maintaining or harvesting them, was a learning experience. Most children enjoyed the physical work and built construction teams on their own initiative. Building, seeding and planting were also actively pursued. Managing pests became an important learning opportunity during the course of raising crops.

A very important observation from this study is that the relationship between gardens and students is not mono-causal. The impact of the gardens on students is mediated in large degree by the enthusiasm of individual teachers. It is evident that except for a few who are avid gardeners, teachers require substantial assistance in day-to-day gardening activities. Among the 28 teachers interviewed, and another 20 observed, less than a handful of individuals were able to develop top-notch gardens. The remaining teachers require frequent and explicit advice on everything from watering to seeding schedules.

Another important observation was that a disciplined, *highly directed* learning environment was necessary to make SOAR gardens effective parts of the curriculum. The more disciplined the students, the more engaged they become in gardening activities, and hence the more focused their attention on the material being presented.

Thirdly, SOAR gardens seemed particularly suited to children with a history of minimal academic achievement and/or specific learning disabilities. Children who are developmentally or emotionally challenged, especially, loved gardening. Teachers of such classes sing the program's loudest praises, and this relationship warrants further investigation.

Conclusion

School gardens seem to be an ideal tool for teaching children a multitude of things: where their food comes from, respect for the environment, even multicultural sensitivity; furthermore, they can be used to teach a wide variety of subjects in both elementary and middle schools.

For example, one fifth grade class grew "space wheat," a variety of wheat developed specifically for growing in outer space on the space lab currently under construction. Obtained through Utah State University over the Internet, this added special appeal to the project. The children prepared the soil and planted the seeds, utilizing math and measurement in estimating desired plant density. They studied the distribution of wheat throughout the U.S. and globally, learning geography. They learned the importance of growing wheat, a storable commodity, to the success of the Egyptian and Roman empires, for it allowed these ancient civilizations to endure periods of drought and famine. This was relevant to history. All students were required to maintain a garden journal, thus utilizing writing skills and English. They read the story of "The Little Red Hen," literature directly related to their activity, and drew detailed sketches of the wheat plant and grain (art), studying plant anatomy (science). Finally, the children harvested, threshed and milled their wheat into flour right in their classroom, baking it into bread using bread makers borrowed from parents. All students ate their product, gaining insight into nutritional benefits of whole wheat bread. For many students, this was the first time they had even tried whole grain bread! Projects like these foster agricultural awareness among students as it gives them an opportunity to experience problems faced by growers, for example insect and disease pressures.

Creative ideas for school gardens are endless, maintaining interest by both teachers and students. A few exciting events held at schools in Palm Beach County have been inter-scholastic cucumber-growing competitions; a "sticky situation" event where sugarcane is hand-milled, the juice made into syrup, which is then served over pancakes made by the kids for teachers and parents; "blossoming friendship" events where flowers are raised for elderly friends and relatives, and the children write about their conversations; and lunches hosted by students with salads grown in their garden.

Children do not need to be educated about having fun in the garden. Teachers, however, need help. SOAR personnel have set up a series of workshops for teachers beginning in September 2000. During these workshops, teachers will be given easy tips on garden establishment and maintenance. In addition, they will be provided with lesson plans across the curriculum.

There are two more benefits of this program: children who garden in school often involve their parents so that gardening can become an activity jointly pursued by parents and their kids. In this way, SOAR reaches past the children involved and can educate parents about agricultural and environmental issues. In addition, SOAR is a wonderful venue to introduce urban areas to the University of Florida, Institute of Food and Agricultural Sciences, and its mission.

The National Environmental Education and Training Foundation (Anonymous, 2000) has asserted that "(t)he average American has nothing more than a comic book knowledge of environmental issues." This equally holds true for knowledge about raising our food. SOAR gardens give us a chance to educate the next generation of Floridians about their food and their environment.

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