



Genetic Engineering for a Naturally Caffeine-free Coffee

John I. Stiles

Approximately 30% of the US coffee market involves decaffeinated coffee, yet the best decaffeination processes are expensive and decrease coffee quality. Biotechnology is being developed and used to produce coffee plants that do not synthesize caffeine which would retain quality while reducing or eliminating decaffeination costs.

Two segments of the coffee industry are currently experiencing rapid growth - specialty coffee and decaffeinated coffee. Approximately 30% of the US coffee market is decaffeinated, yet the best decaffeination processes are expensive and reduce coffee quality. A naturally caffeine-free coffee would provide two advantages; (1) it would retain quality, a



Coffee tree with berries in Hawaii.

→ page 3

Establishment and Persistence of Grazing Grasses in Florida and Puerto Rico

Kenneth H. Quesenberry, Lynn E. Sollenberger, and Antonio Sotomayor-Rios

Legumes in the genus, Arachis, which are tolerant of grazing, competitive with native grasses and high in nutritive value have been found which can replace native grasses of low nutritional value in the tropics and subtropics where more than one-half of the world's cattle produce less than one-third of the world's meat and one-sixth of the dairy products.

The tropics and subtropics support more than one-half of the world's cattle but produce less than one-third of the world's meat and one-sixth of the dairy products. Planted and native grasslands provide nearly all of the nutrients consumed by cattle in these regions, but low nutritional value of these forages limits animal performance.

One of the obvious shortcomings of forage-livestock systems in Florida, Puerto Rico,

and many areas of the subtropics and tropics is the lack of adapted forage legumes.

Legumes are desirable because they convert atmospheric nitrogen into forms that plants can use. Legumes are high in nitrogen and very digestible when fed to livestock, but often they do not tolerate grazing nor do they compete well with vigorous tropical grasses.

→ page 8

Improved Field Production of Herbs and Spices Benefit Growers in the U.S. Virgin Islands

Manuel C. Palada

Improved production and management practices for major herb varieties grown locally, prominent in the local cuisine and satisfying to the palates of visitors, have reduced labor requirements, inefficient use of water, fertilizer and land and increased production of these commodities for local consumption and the possible export to major markets.

Herbs and spices are prominent in the local cuisine tempting the palates of visitors as well as residents of the Virgin Islands who use them every day. But in the Virgin Islands, because of inefficient production and management techniques and poor use of labor, land and water resources, locally grown herbs are available only at roadside stands and do not constitute a significant export product despite a perfect growing climate. In recent years consumption of culinary herbs and spices has steadily increased in the U.S. More Americans are consuming fresh, frozen, processed and dried culinary herbs and spices than ever before and this trend will continue. Increased consumption is resulting from interest in new foods and tastes, availability of more fresh herbs, advertising promotion by food services and supermarkets, and expanding ethnic populations demanding food and flavorings of their homeland.



Typical small "farm" of high-value herbs on St. Thomas.

Herbs are imported to a growing U.S. market from tropical regions such as Africa, Latin America, the Mediterranean and other Caribbean islands. American imports of spices and herbs more than doubled from 1969 to 1990. Estimates by the USDA Foreign Agricultural Service showed that more than \$349 million of dried condiments, seasonings and flavorings and \$20 million of spices were imported in the U.S. in 1988.

Culinary herbs are important horticultural crops in the Virgin Islands. An informal 1988 survey showed that sales of herbs and spices constitute a major source of income for many small-scale growers on St. Thomas and St. Croix. Although most herbs are easily adapted to

the tropical climate of the Virgin Islands, some problems hinder the development of herb farming as an agricultural industry. Chief among the problems is the shortage of water. There are no rivers on the islands and only a limited number of wells. Homes and farms collect rainwater in cisterns. Consequently farmers do not plant crops which require a lot of water. Since traditional watering methods are inefficient wasting water, farmers are being encouraged to use drip irrigation. Another problem is the use of manual methods making production labor intensive.

Recognizing the need to improve field production methods and reduce labor costs so that farmers would be in a position to market herbs on a large scale, the University of the

CAFFEINE-FREE COFFEE

from page 1

critical factor in Hawaii's coffee industry, and (2) it would recover at least some of the decaffeination costs at the farm gate. Biotechnology through genetic engineering offers the potential of creating a caffeine-free coffee plant by inhibiting caffeine biosynthesis in the plant itself.

Currently biotechnology can be used to either add or remove traits from plants. New traits are added by inserting a novel gene into the plant. Needed is a gene that imparts (1) desired characteristics, (2) regulatory sequences so the gene is expressed in the right tissues at

the right time, and (3) a system for incorporating the gene into the plant (i.e. a transformation system). For example, a number of plants have been made herbicide resistant by using genetic engineering to insert a bacterial gene that inactivates the herbicide - an example of adding a new trait.

Existing traits can also be removed using a technique called antisense. In "silencing" a gene using antisense, a copy of the gene is inserted into the plant opposite its normal orientation. This causes an antisense mRNA to be produced that "cancels out" the normal mRNA and results in no gene product being produced. Generally genes produce mRNAs that carry the genetic information

from the nucleus to the cytoplasm where the mRNAs are translated into enzymes that carry out the genetic function, synthesis of a specific molecule for example. If the information cannot get to the cytoplasm because of the antisense gene, then the gene function can not take place and the specific molecule is not made.

T-STAR supported research is utilizing antisense to remove the ability to produce caffeine. Little was known about the genes involved in caffeine biosynthesis when this research was started. Ideally, the objective was to inhibit caffeine biosynthesis at the first step unique to the pathway. The starting product of

→ page 11

Management of Cabbage Pests of the Asia Pacific Low Land Tropics

R. Muniappan and T. S. Lali

The use of trap crops - Chinese cabbage cv. Tempest, radish cv. Minowase Summer 3 and Indian mustard - in cabbage fields reduced insect damage caused by four cabbage pests. Combining these trap crops with the release of natural enemies effectively suppressed cabbage pests on Guam, thus reducing the use of chemical insecticides.

Cabbage (*Brassica oleracea* var. *capitata* L.) on Guam is attacked by a complex of 12 arthropod pests, 6 of which cause most of the damage to the crop.

The majority of these pests also occur in the low land tropics of the Asia-Pacific region. Control of these pests with insecticides has resulted in the development of insecticide resistance in some cases, pest resurgence and the reduction of natural enemies introduced to control other pests within the complex. This situation led to research under a T-STAR project at the University of Guam involving trap cropping and the integration of trap cropping with the release of natural enemies. Based on many laboratory and field experiments, a method was developed for



Trap crops (Chinese cabbage, radish and mustard rows) in experimental cabbage plot in Guam.

using Chinese cabbage cv. Tempest, radish cv. Minowase Summer 3 and Indian mustard as trap crops in cabbage fields for control of the cabbage webworm, *Hellula undalis* (F), the flea hopper, *Halticus tivialis* (Reuter) and the mustard aphid, *Liphaphis erysimi* (Davis).

In fields with trap crops, cabbage webworms were found

→ page 4

CABBAGE PESTS

from page 3

mostly on radish and mustard trap crops. There were significantly more cabbage webworm larvae on cabbage plants in plots without trap crops than on the ones with trap crops. The reduction of the population of cabbage webworm reduced the incidence of soft rot disease in cabbage - the incidence of soft rot on cabbage in the nontrapped plot was 34.5 percent higher than in the trapped crop.

Cabbage cluster caterpillars were found mostly on Chinese cabbage and mustard trap plants. Adults and nymphs of the flea hopper were found mostly on radish and Chinese cabbage

plants. The trap crops, Chinese cabbage, radish and the Indian mustard did not have any attraction to the cutworm, *Spodoptera littura* (F.), or the diamondback moth, *Plutella xylostella* (L.).

Recommendations for trap cropping include using Chinese cabbage, radish and Indian mustard every 15 rows of cabbage. The mustard row should be either the outermost or the middle one in the trap crops to avoid caterpillars being blown by wind onto the cabbage plants.

Since no trap crop effective against the diamondback moth has been found, natural enemies have proven to be effective. These include the egg parasitoid,

Trichogramma sp, and the larval parasitoid, *Cotesia plutellae*, for the diamondback moth, and the egg parasitoid, *Telenomus nawasi*, and the larval parasitoids, *Euplectrus xanthocephalus* and *Cotesia variventris* for the cutworm. Combining the natural enemies for the diamondback moth and the cutworm with the use of trap crops for other major pests proved effective in suppressing the cabbage pests on Guam. ■

Dr. Muniappan is Professor Emeritus and Mr. T. S. Lali is Research Assistant, both at the Agricultural Experiment Station, College of Agriculture and Life Sciences, University of Guam, Mangilao, Guam.

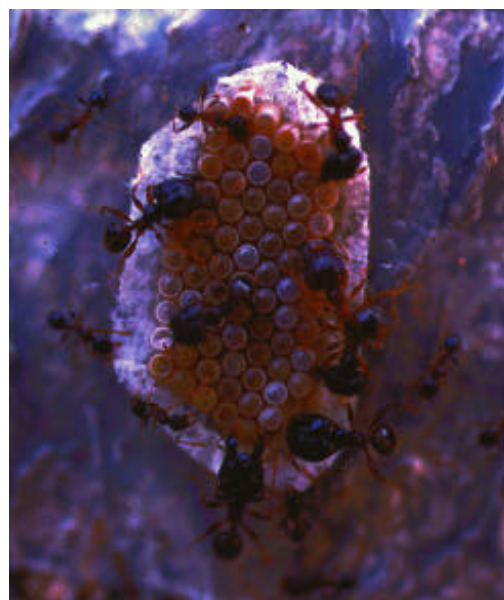
Improved Management Reduces Southern Green Stinkbug Damage in Hawaiian Macadamia Nuts

Vincent P. Jones, Roy K. Nishimoto and Peter W. Shearer

The Southern Green Stinkbug is a serious pest of macadamia nuts in Hawaii. T-STAR research has shown that by understanding diet requirements of this insect and the role of its natural enemies in regulating populations, management of weed and possibly ant populations can reduce stinkbug numbers and the damage it causes to the nuts.

T-STAR funded research has helped improve management of the southern green stinkbug, *Nezara viridula*, by increasing our understanding of its diet

requirements and the role of its natural enemies in population regulation. Our studies have documented that stinkbugs fed on laboratory diets of green beans and peanuts survive and reproduce normally while those fed on macadamia nuts alone experienced 100% mortality in the immature stages. When fed standard lab diets as immatures and then switched to a macadamia nuts only diet as adults, they died sooner and suffered a 90% reduction in reproductive capacity



Ants attacking stinkbug eggs.

when compared to those reared on the standard laboratory diet. Stinkbugs fed on a common orchard weed, beggarweed (*Desmodium tortuosum*), reproduced and survived as well as those on the standard laboratory diet. These studies suggest that stinkbugs are feeding and reproducing primarily on weeds in and adjacent to the orchard and are attacking macadamia when other host plants are unavailable.

Additional T-STAR field studies showed that in orchards with no weeds within the orchard, damage from stinkbugs was concentrated at the trees immediately adjacent to the weedy border early in the season while weeds were flowering and setting seed pods. Once weeds became unattractive or were destroyed, stinkbug moved into the orchard and damage became evenly distributed throughout the area. These studies and others funded by T-STAR also provide information on weed phenology and suitability throughout the year at orchards growing across the different climatic zones where macadamia is grown. This information will be provided to growers as a chart to indicate the times of greatest risk of stinkbug damage and dispersal. In orchards with high weed populations within the orchard, we found that weed control (mowing) used to help harvesting operations actually 'herds' stinkbugs from areas mowed to adjacent unmowed areas and results in increased damage in the unmowed areas. These effects were noticeable up to 190 meters away from the mowed areas. We are currently testing whether herbicides, which cause a relatively slow decline of the

weeds compared to mowing, cause the same problems.

Studies of the natural enemies of stinkbug have confirmed our previous work that parasitism by the egg parasite, *Trissolcus basalis*, is not as effective as previously reported and is of minor importance in population regulation of stinkbug populations in and adjacent to macadamia orchards. It was first thought that this may have been related to either the stinkbug or *T. basalis* entering reproductive diapause (a state of suspended reproductive activity in insects) during the summer or winter, but laboratory studies showed that the extremes of temperature and photoperiod experienced in Hawaii were not enough to cause more than 50% of the stinkbug population to enter diapause and that *T. basalis* females were able to survive for more than 60 days without mortality as long as a nectar source was available.

Our studies confirmed that ants are the major cause of stinkbug egg mortality. Studies in 4 orchards occurring throughout the geographical and climatological range of macadamia nut production on the island of Hawaii showed the dominant ant species varies between orchards, but in general, at least 2 species are codominant at each orchard. We are currently examining the interaction of these two different ant species and the resulting effects on damage observed. In one of our test orchards, we find there are large areas dominated totally by the long-legged ant, *Anoplolepis longipes*, immediately adjacent (across a single tree row) to another large area where only the big-headed ant,

Pheidole megacephala, is present. The interface between these two species shifts over the course of time and the stinkbug damage in the three areas shows that the damage progresses from being the highest where *P. megacephala* occurs, intermediate at the interface, and lowest where *A. longipes* occurs. This suggests that selective ant baiting at certain times of the year may reduce damage by replacing one ant species with the other.

Our T-STAR funded research has a much greater audience than just the macadamia growers in Hawaii. Previously, the only areas where southern green stinkbug was considered under good control by *T. basalis* were Australia and Hawaii. Studies performed under this grant and studies by Dr. Tony Clarke in Australia have shown that *T. basalis* is not as effective as previously thought and that other factors may have been responsible for stinkbug population regulation. Our studies suggest that ants are a major mortality factor and parasitoids other than *T. basalis* should be considered for biological control in areas where stinkbug damage is unacceptable. ■

Dr. Vincent P. Jones is a Professor and Entomologist in the Department of Entomology and Dr. Roy K. Nishimoto is Professor and Weed Scientist in the Department of Horticulture, both in the College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa. Dr. Peter W. Shearer, was formerly a graduate research associate, Department of Entomology, University of Hawaii at Manoa and is currently Assistant Specialist in Entomology at Rutgers University, New Brunswick, NJ.

Allelopathy Aids Weed Control in Vegetables in Puerto Rico

Nelson Semidey

Allelopathy, one plant affecting another, shows promise in controlling weeds in vegetables in Puerto Rico, thereby reducing the use of chemical herbicides.

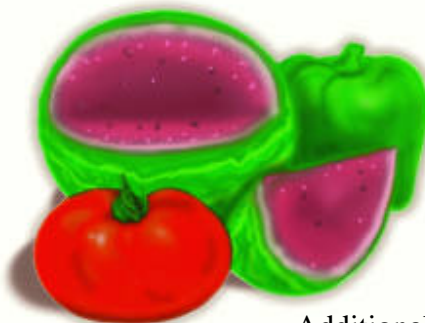
Allelopathy is the effect of one plant on another through the release of chemical substances that escape in the plant environment. Pigeon pea (*Cajanus cajan*), a cultivated legume, has demonstrated allelopathic activity against some of the major weed species affecting selected vegetable crops in Puerto Rico. These findings were made under a T-STAR project at the University of Puerto Rico.

Field studies were conducted to evaluate weed suppression by cultivars and pigeon pea breeding lines that were grown for six months in Juana Diaz, Puerto Rico in 1993 and 1994. Whole plant material was incorporated into the soil by disking plant residues into test plots. Then tomato and pepper seedlings were transplanted into the plots six weeks later.

Each year of the experiments, total weed emergence was lower in tomato and pepper plots that followed pigeon pea compared to check plots. Pigeon pea rotation suppressed purple nutsedge (*Cyperus rotundus*) in tomato. Tomato plots that followed cultivars Kaki, 2B-Bushy, and

Line 84 reduced the initial nutsedge population over 90 percent. These results suggest that pigeon pea rotation may be integrated into a management strategy for purple nutsedge in vegetable crops.

A pigeon pea-tomato cropping sequence was further evaluated as a weed management strategy. This time different preemergence herbicides were applied to pigeon pea and the residual activity was evaluated in combination with pigeon pea plant residues added after the tomato crop was harvested. Herbicide residual activity showed no differences for five herbicide sequences that followed, either with pigeon pea or without pigeon pea plant residue. However, tomato plots treated with pigeon pea residue showed weed density was reduced by 57 percent irrespective of the herbicide treatment. This reduction in weed density was attributed to pigeon pea allelopathy. The reduced weed density did not improve tomato yield, but total gross income for a single year may be increased when the value of the pigeon pea production is added to the value of the tomato or pepper harvest. Integration of pigeon pea in both cropping systems may contribute, either to weed suppression or to an increased gross income, when compared to a single cropping system without rotation.



Additional field studies were conducted at Lajas, Puerto Rico, in 1995, in an attempt to determine the sources of allelopathic chemicals in pigeon pea. After six months of growth, pigeon pea was harvested and then plant residues divided into roots, green foliage, leaf litter or whole plant components. Bedding plots were prepared with these materials and tomato seedlings planted six weeks later.

In these studies, weed dry weight as well as tomato yield were lower in plots where whole plant residue was removed or leaf litter plus the root system were added to the plot. Therefore, it is theorized that allelopathic chemicals may be produced and liberated from pigeon pea foliage during plant growth, or may be derived from leaf litter decomposition after reaching the soil.

It appears that allelopathic chemicals, after being released from pigeon pea plants, remain in the soil for a long time. Therefore, to avoid potential yield losses in following crops, pigeon pea residue must be manipulated for a longer period of time before transplanting a following crop. ■

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Heat Tolerance in Various Breeds and Crosses of Cattle

T. A. Olson and Danilo Cianzio

Experiments with various breeds and reciprocal crosses of tropically-adapted and non-tropically- adapted cattle suggest the existence of a major gene responsible for the short hair and heat tolerance in the Senepol breed from St Croix, U.S. Virgin Islands. Confirmation of the existence of this gene and its mode of inheritance would permit the incorporation of heat tolerance into preferred and more productive non-tropically-adapted dairy and beef cattle.

The heat tolerance, in terms of rectal temperatures and respiration rates, of tropically adapted non-zebu breeds, the Senepol from St. Croix, U.S. Virgin Islands and the Romosinuano from Colombia was compared to Brahman (*Bos indicus*) and temperate *Bos taurus* breeds, Hereford and Angus in Florida and Holstein in Puerto Rico. In Florida reciprocal cross progeny of Senepol and Hereford matings were evaluated to determine the inheritance pattern of heat tolerance. In addition, in Florida, the heat tolerance of Brahman X Angus, Senepol X Angus, and Tuli (a *Bos taurus* breed from south-central Africa) X Angus yearling heifers was compared to that of Brahman, Senepol and Angus

heifers. Finally a study was conducted to investigate the existence of a major gene responsible for the short hair and heat tolerance found in the Senepol breed.

At the Subtropical Agricultural Research Station in Brooksville, FL rectal temperatures and respiration rates were measured on three consecutive weeks in late July and early August and again on three consecutive weeks in late November and early December. On the hottest day (August 19) the Angus and Hereford heifers had the highest rectal temperatures (40.4 and 40.2); the Brahman and Romosinuano were 39.6 and 39.5; and the Senepol heifers were the lowest (39.2). Rectal temperatures of Senepol X Hereford and Hereford X Senepol crossbred heifers were nearly as low as those of the Senepol indicating a substantial degree of dominance for heat tolerance of the Senepol.

Respiration rates of the Brahman were much lower than any of the *Bos taurus* breeds, temperate or heat tolerant. But the respiration rates of the Senepol and Rososinuano were less than the Angus.

Similar results were observed when the study was replicated the next year. Other studies in Florida indicated that each of the F1 crosses (Tuli, Senepol and Brahman) with Angus resulted in good heat tolerance relative to



that of the purebred Brahman. Considerable dominance of heat tolerance was shown in both the Senepol and Brahman F1 crosses.

In studies conducted in Puerto Rico at the Isabela Substation of the University of Puerto Rico with Brahman, Senepol and Holstein (Angus are not found on Puerto Rico) cattle, mean rectal temperatures of the Holstein were higher than the Brahman or Senepol, and mean average daily gains on forage were much lower for the Holstein. It appeared that the Holstein heifers were not able to gain at the same rate on forage during these trials, at least in part, as a result of a lack of heat tolerance.

In general Senepol heifers consistently showed lower rectal temperatures during periods of elevated temperatures than those of the *Bos taurus* breeds, Angus, Hereford and Holstein. The F1 progeny of Senepol X Hereford and reciprocal crossbred matings indicated a dominant mode of inheritance for the heat tolerance of the Senepol breed. A final study suggested the existence of a major gene influencing hair

CATTLE

from page 7

coat length and heat tolerance in the Senepol breed supporting a hypotheses that such a gene responsible for extremely short, “slick” hair exists and is

responsible for all or part of the heat tolerance of the Senepol breed. As a result of these studies it is suggested that crossbreeding programs could be developed for the southern U.S. and Caribbean to produce heat

tolerant cattle without utilizing *Bos indicus* germplasm. ■

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GRAZING GRASSES

from page 1

Legumes in the genus, *Arachis*, have been found that are tolerant of grazing, competitive with native grasses, and high in nutritive value. The *Arachis* forage adapted to Florida (*Arachis glabrata*; called rhizoma perennial peanut) has these desirable traits and has survived more than 20 years of grazing. However, it does not produce much seed so it must be propagated using below-ground stems called rhizomes. To reduce risk to farmers using rhizoma peanut, a better understanding is needed of the factors that determine success or failure of propagation. Additionally, there are many *Arachis* plant types that have been collected but need to be evaluated in Florida and Puerto Rico to determine if they are superior to those currently in use.

Rhizoma peanut is most often planted in Florida in late winter and early spring. Mid- to late-spring drought is a problem for new plantings. Other planting dates should be considered, and it should be determined if the ability of new plants to survive drought is related to the characteristics of the planting material from which they grew.



Rhizoma peanut pasture in Florida.

A series of experiments showed that frequent grazing, and particularly frequent, heavy grazing, during the summer before the rhizomes were harvested for use in planting decreased their size and the amount of nitrogen and carbohydrate that they contained. These small rhizomes that had less nitrogen and carbohydrate produced new plants that were slower to emerge, were less robust when they did emerge, and many did not survive the spring drought. Rhizomes from plants that were grazed less

intensively produced shoots that grew rapidly and were able to survive drought. Date of planting studies showed that alternatives to winter planting do exist.

Eighty plant introductions of *Arachis* were evaluated in Puerto Rico. Ground cover was measured 24 and 36 weeks after planting to identify types with superior establishment potential. Two types were found that were superior in that environment to the cultivars currently in use in Florida. Several lines had lateral spread of 2.2 meters in one year. Sixteen months after planting,

twelve introductions were chosen for further study. Seven of the twelve were among those that had performed best in Florida. Followup work with these lines showed that one, P.I. 262839, had highest yield in addition to achieving most rapid cover. Grazing evaluation showed that year-round production of high quality forage is attainable in Puerto Rico. Ongoing efforts are targeting establishment and grazing management questions.

Data from these experiments provide information needed to reduce risk associated with planting rhizoma peanut. It is clear that defoliation management of areas used for producing planting stock is critical. The best planting stock will result if the area is not defoliated during the growing season before planting. If grazing or cutting for hay do occur, the last defoliation should be no later than mid-August. This allows accumulation of large amounts of rhizome planting stock that is high in nutrients. The shoots that grow after the rhizomes are planted will be very vigorous and have a good chance of surviving stress conditions, particularly spring drought. Another tool for managing risk is planting date. Producers lacking irrigation can plant rhizoma peanut during the summer rainy season. Competition from weeds will be more severe and must be managed, but loss of peanut shoots to drought is much less likely than for nonirrigated winter plantings.

Puerto Rican forage-livestock programs have emphasized nitrogen fertilized grasses. Work has identified superior lines of

WORKSHOP PROCEEDINGS AVAILABLE

The CBAG office has a limited number of copies of the Proceedings from five Workshops available for distribution.

Requests may be sent to the address shown for CBAG on Page 12.

The Proceedings that are available include:

1. "Enhancing the role of value-added agriculture in tropical island economies"
2. "Agroecosystems sustainability in the Caribbean and Pacific islands"
3. "Plant stress in the tropical environment"
4. "Important arthropod pests of the Caribbean Basin amenable to biological control: Homoptera, Coleoptera and Lepidoptera"
5. "Forage-livestock research needs for the Caribbean Basin"

HERBS*from page 2*

Virgin Islands Agricultural Experiment Station implemented a project to improve production and management practices for the major herb varieties. This project was supported by a grant from the USDA Tropical/Subtropical Agriculture Research Program (T-STAR).

Using commonly grown herbs such as basil and thyme, the project showed that using drip irrigation and mulching (compost and grass straw) increased yields of basil 40% when they were grown with compost mulch. Organic mulches reduce soil temperature and conserve soil moisture saving water. Growers who use drip irrigation and compost can receive high economic benefits from the production of basil. At \$4.00 per lb. wholesale they can gross \$28,500 from a quarter of an acre - a profitable practice giving the highest returns on irrigation water. Drip irrigation reduced the water requirement for thyme production by 40 to 60%. Even low levels of irrigation gave

thyme yields similar to those obtained with high irrigation rates. As a result of this project, about 90% of the herb growers in the Virgin Islands are now using drip irrigation with some type of mulching - a dramatic change from the traditional practice of watering with sprinkler cans and garden hoses.

The project also established optimum rates of nitrogen fertilizer for basil, oregano, sweet marjoram and thyme improving growth and yield in the high calcium soils of the Virgin Islands. This information helps farmers determine fertilizer needs for optimum growth and yield rather than estimating needs from recommendations for other crops with similar growing characteristics.

Continuing objectives for the project include: (1) to evaluate cultivars, genotypes and species of herbs and spices for yield, quality and disease- and pest-resistance; (2) to determine the response of selected species to fertilizer rates and elevated salinity; (3) to determine optimum plant spacing and

population density; (4) to determine minimum water requirements; and (5) to evaluate weed control methods. The germplasm collection and evaluation component will include anise, basil, chives, coriander, dill, marjoram, oregano, parsley, peppermint, perilla, rosemary, sage, spearmint, sorrel, summer savory and thyme. Weed management studies will emphasize methods of weed control other than herbicides because very few herbicides are registered for use on herbs and small-scale herb growers in the Caribbean do not have access to them.

Are herbs a viable export product in the Virgin Islands? They could be. With the assistance of information gathered from research studies, culinary herbs have the potential to be a major cash crop for export to the growing U.S. market. ■

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COFFEE*from page 3*

the caffeine biosynthetic pathway is xanthosine an organic molecule common to all living cells. The first step unique to caffeine biosynthesis is the methylation of xanthosine to form 7-methylxanthosine. The first task was to isolate and purify the enzyme, which had never been isolated before, responsible for this reaction. .

After a considerable amount of effort xanthosine-N⁷-methyl transferase was purified and a portion of its amino acid sequence obtained. From this information a probe for its gene was constructed. Using this probe the gene was isolated and, through the use of recombinant DNA technology, a cloning vector for expressing this gene in coffee in the antisense mode was constructed. A collaborator at

the Hawaii Agriculture Research Center is currently inserting this gene into several cultivars of coffee and the objective is to have caffeine-free trees within a few years. ■

Dr. John I. Stiles is an Associate Professor in the Department of Plant Molecular Physiology, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa.

GRAZING GRASSES

from page 9

the legume *Arachis* that have potential to contribute to animal agriculture in Puerto Rico.

Further research and on-farm testing is needed, but these legumes are productive and able to persist when defoliated, traits lacking in most legumes tested on the island. ■

Dr. Quesenberry is Professor of Forage Genetics and Dr. Sollenberger is Professor of Tropical Forage Management in the Agronomy Department, University of Florida, Gainesville, FL. Dr. Sotomayor is Research Agronomist, Tropical Agriculture Research Station, USDA-ARS, Mayaguez, Puerto Rico.

Dr. Darshan S. Padda Retires

September 30, 1996, marked Dr. Darshan S. Padda's last day at the University of the Virgin Islands. He has embarked on a sabbatical leave to chronicle more than two decades of progress at the Virgin Islands Agricultural Experiment Station and Cooperative Extension Service under his leadership as Director of both agencies and develop policy recommendations for the future. On March 4, 1997, he will relinquish these positions and the position of Vice President of Research and Land-Grant Affairs.

Dr. Padda's departure marks a new era for CBAG and the T-STAR program. The original members of CBAG elected Dr. Padda as the first Chairman, and he remained Chairman for over 10 years. At the CBAG Fall '96 Meeting in Zamorano, Honduras, CBAG awarded Dr. Padda a beautiful plaque honoring his long service. Dr. Padda greatly influenced the direction of the CBAG research program keeping it focused on the needs of Caribbean agriculture. In addition, he helped establish operational procedures for the CBAG committee. CBAG will

miss his outstanding knowledge of Caribbean agriculture and understanding of the ongoing research in the Caribbean institutions. Dr. Padda placed great importance in maintaining linkages between CBAG and the research stations throughout the Caribbean.

Dr. Padda served in various capacities in several professional organizations. Most notable was the 1995 appointment to the Executive Committee of the Extension Committee on Organization and Policy, the highest national policy making body on extension programs. His contributions to agriculture have been recognized through several prestigious awards, namely, a Rockefeller Foundation Scholarship, the Rafi Ahmed



Kidwai Memorial Prize, USDA's Distinguished Service Award, and the Office of International Cooperation and Development's International Honor Award.

Dr. Padda and his wife Kay plan to divide their time between St. Croix and Chicago with occasional trips to India. ■



ALOHA to Dr. Victor Phillips

Dr. Victor (Vic) Phillips, who was the PBAG Coordinator for five years, left his position as Assistant Director for Agricultural and Social Sciences in the College of Tropical Agriculture and Human Resources (CTAHR), University of Hawaii at Manoa for a position in Malaysia. Vic came to CTAHR in July 1991 from the Hawaii Natural Energy Institute at the University of Hawaii, where he was Manager of Bioresources and Environmental Research. In addition to his PBAG responsibilities, Vic was active in the area of forest resource management, and the

ADAP (Agricultural Development in the American Pacific) Program. All members of the T-STAR Program wish Vic well in his new venture in Malaysia.

Assuming responsibility for PBAG is Dr. Kenneth G. Rohrbach, Assistant Director of Agricultural Resource Development in CTAHR, and Dr. Lynn M. LeBeck, an Assistant Specialist in the same office. Ken manages many state and federal grant programs for agricultural research and development and is a plant pathologist with international expertise in pineapple diseases. Lynn assists with many of these same programs and has a background in entomology. ■

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