Alberta Agriculture, Food and Rural Development

May-August, 2006

Volume 5, Issue 3-4

The Greenhouse Business

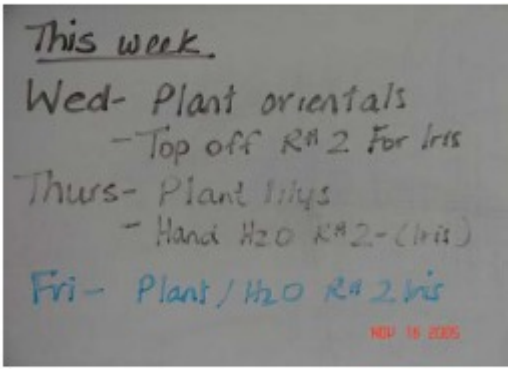
HAPPY EMPLOYEES ARE GOOD FOR YOUR BUSINESS?

M. Mirza

I originally wrote an article for the AGGA newsletter on How To Energize Your Employees. Many of the clients read it and gave different comments. One day I walked into a greenhouse, and it was coffee time. Look at the picture below:

What's In this Issue?

The workers were smiling, offered me coffee and asked me to join them. The grower was sitting with them and there was a positive feeling. They asked me why I was taking pictures. I told them "I like happy people" and they smiled more. Suddenly, a horn sounded and everybody was up, and back to work. On one writing board I found a daily work plan. Who is going to work where? And, what is expected to be accomplished that day. There was a note for the next day, as well. I went to another greenhouse and found a lonely, young male, playing his guitar on a lonely bench, a distance from the greenhouse. This was his way to relax and enjoy his break. He was definitely not singing a song about lycopene rich tomatoes. He was just absorbed in his guitar, though he did smile and wave at me.



I found the above note in one greenhouse. I thought it was a great idea that work had been identified for the next three days, so that workers could plan their schedules. When availability of labor is becoming an issue, it is a good idea for workers to know in advance and plan their family time accordingly.

(Continued on Page 2)

Volume 5, Issue 3-4

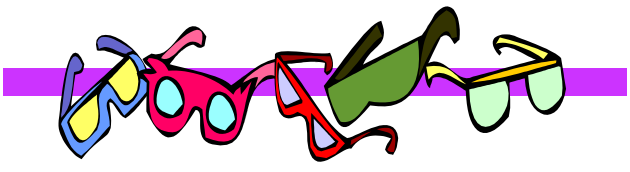
The Greenhouse Business

(Continued from Page 1)

So how to keep your employees happy and energized, so they look forward to coming to work?

- Give them a sense of belonging with the work they are doing. I mean don't just give them instruction to go and prune a tomato or cucumber. Instead, tell them what plants are and how important the job is they are doing. Give them more information about the produce when it reaches the consumer - what do they appreciate? If you are selling directly to the consumers, then take them with you once in a while.
- Take a personal interest in their well being. Last year my employer, Government of Alberta, established a Health and Wellness Fund, and each employee could spend up to $500 on a variety of health and wellness related activities, including purchasing a computer, buying a treadmill, gym costs, a subscription to health magazines and many others. I was truly impressed with this approach. I bought a treadmill and am working hard to lose some weight. Have something like this for your employees. Subscribe to some health magazines, and place them in lunchrooms, so that your employees can browse through them. You must have experienced a doctor's office. Many times while waiting to see my doctor, I tore some pages of old magazines, on health related topics, which I thought was great information. Of course tearing those pages was a challenge. They always make more noise in a quiet room.
- Occasionally, send your employees to workshops and courses, which can add to their knowledge. I am always happy to see workers show up at the Horticultural Congress or run into them at Trade Shows. Last year, one greenhouse owner paid $50.00 each for six of his employees to bring them to the AGGA banquet and he also paid for their room and board.
- Once a month, at least, plan a social activity. It does not need to be expensive. Potlucks work pretty well.
- Have a performance evaluation system in place, not just a hiring and firing strategy. Not a complicated system.
- Bring some expert to talk to them about common health issues and concerns. Health is a major topic of interest at any time, especially if you don't like your staff to be absent too long, for health related issues. Also, giving them more information about health and health related matters, can help them make good decisions about when not to come to work, if they have flu-like symptoms.

Okay, that is enough. I am running out of ideas. I am sure you can think of your own strategies and how to implement them.



Volume 5, Issue 3-4

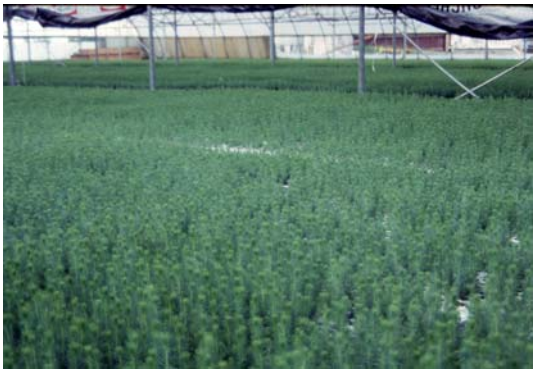
The Greenhouse Business

WHAT IS CSTP?

M. Mirza

In any business, one must know and understand what it is that you are doing. If you are manufacturing a product, then you must understand the whole process, from raw material to finished product, the quality, quantity, efficiencies and deficiencies, and whatever. In the greenhouse business, one must know that plants are very complex and extremely integrated factories, which manufacture a whole series of ingredients from very basic raw materials, with the help of a large number of chemical reactions. It would not be wrong that your livelihood depends on the fact that plants are taking carbon dioxide from the air through the openings called stomata, and fix it inside the leaves with the help of light and water. And the fascinating fact is that it takes about 500 kg of water to move from roots to the leaves, and out of the stomata to make one kg of dry matter. That is a remarkable processing factory and your job is to understand this process and make sure the plant has the tools to get the job done properly and profitably. Just look at the pictures below and think what the plant is trying to accomplish for you, so that you can feed yourself and your family and still put the kids through school, college and university.

The Greenhouse Business



So, you see these pictures, that is the business you are in. You are 'manufacturing' vegetables for their nutritional value, flowers for their emotional value, tree seedlings for their environmental value, and I have missed mentioning nursery crops, fruit crops and some others as well. All these plants have CSTP in common.

C is for **Carbon Dioxide, S** is for **Stomata, T** is for **Transpiration** and **P** is for **Photosynthesis.** In 1992, the Alberta Greenhouse Growers Association got some funding from an FSAM II program, through Agriculture Canada and got translated some Dutch research information, of course from Dutch to English, and made it available to our growers. I don't know how many of you still have this 2-3 page material with you. I found this information very useful and am presenting it to our growers. The material was originally published in Groenten & Fruit, March 6, 1992, and the authors are E. Nederhodd and R. de Graaf. I have added a few comments here and there.

Carbon dioxide: The research on tomatoes, peppers, cucumber and eggplant showed that at CO_2 concentrations of 350 and 700 ppm, the openings of stomata get smaller as the CO_2 concentration increases. As the opening gets smaller, transpiration is reduced. This results in less water vapor in the air and a drop in humidity. Leaf temperature increases, because there is less cooling. The increase in leaf temperature as a result of CO_2 supplementation, however, is only approximately 1 degree centigrade.

The low humidity and higher leaf temperature both contribute to a further closing of stomata. Measurements showed that they can close for as much as

(Continued on Pg. 5)

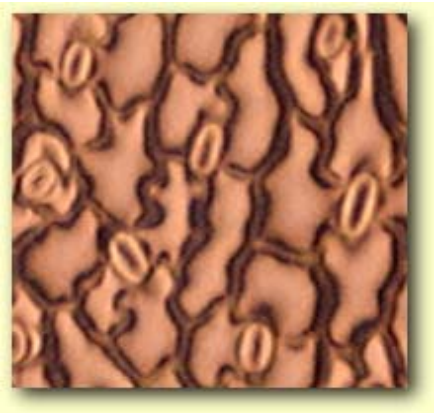
The Greenhouse Business

(*Continued from Pg. 4)*

40%, and even more for eggplant. The partial closing of stomata can be called "apparent" effect of CO_2 supplementation.

The absolute effect of CO_2 could be measured if humidity and leaf temperature could be kept stable, but that is impossible. But we can calculate the absolute CO_2 effect. The stomata opening is reduced by approximately 10% if CO_2 increased from 350 to 700 ppm. That is about 3% for every 100 ppm increase. This applies to tomatoes, cucumbers and peppers, while the effect is three times stronger for eggplant.

Stomata



In case you have not seen stomata, here is what it looks like. There are several thousands of them per each square inch of the leaf area. What you see, are two bright guard cells, which open and close based on water status. Fully turgid guard cells open the stomata opening. These are located in the epidermis of the leaf and regulate the exit of water vapors and entry of CO_2. They can be almost totally closed, for instance, at nighttime and they can also be fully open and anything in between. Closing of stomata is not suddenly snapping shut, but more like squeezing down to reduce the opening. Reaching a new open position may take a few minutes to as much as half an hour.

By far the most important factor for opening stomata is light. More light leads to a larger opening. Secondly, availability of water and humidity of the air, are important. When there is shortage of water or air is too dry, stomata close a certain amount to protect the plant against drying out. The opening of stomata can also be reduced as a result of a high CO_2 concentration, high leaf temperature, aging of the leaf or plant, air pollution, etc.. Stomata have the largest opening in healthy young leaves, under high light intensity, good water supply, high relative humidity, and a moderate CO_2 level.

That reminds me, during a visit to a tomato greenhouse, it came to my attention that CO_2 generators were turned **ON** at 9:00 p.m. and remained **ON** all night, with the expectation that by daylight, the level of CO_2 will be optimum. It is not a recommended practice because there is minimum ventilation at night time and levels could build up far over 1000 ppm. Secondly, the level of CO may also become fairly high, and oxygen depletion may occur. Plants appear to be in a highly generative mode and fruit cracking was more than normal. CO_2 should only be used when sunlight is available. It is recommended to turn CO_2 generator **ON** an hour before sunrise.

Transpiration:

Simply stated, transpiration is loss of water from leaves through stomata and this process creates a pull from leaves to roots. I think the roots and leaves actively communicate with each other in a very efficient manner without any hold back of information.

(*Continued on Pg. 6)*

The Greenhouse Business

(*Continued from Pg. 5)*

If there is not enough water in the root zone, they will tell the stomata there is no water, so start closing down.

In the research article I am talking about, it is stated that the effect of partially closed stomata on transpiration depends on other conditions, but generally it is fairly small. This can be explained, as follows:

As a result of a higher concentration of CO_2 and partial closing of stomata, humidity drops and leaf temperature increases. These two factors (RH and leaf temperature) stimulate transpiration. The total effect of a CO_2 increase from 350 to 700 ppm, therefore, only 10% less transpiration while the reduction in the opening of stomata was 40%. The effect was larger with egg plant: 685 ppm CO_2 resulted in 20% less transpiration compared to 415 ppm CO_2.

On one hand, the change in humidity is the effect of less transpiration as a result of smaller stomata opening and, on the other hand, the environment. A lower humidity tends to contribute to closure of stomata, but it will stimulate transpiration.

These complicated effects are called "back coupling". The force of this depends on the vent opening, wind speed, plant size, etc.. This makes it impossible to estimate the change in transpiration at a given change in the opening of stomata, or at a certain change in CO_2 concentration. The percentages mentioned above only reflect the magnitude.

Photsynthesis:

Don't get scared with this scientific term. This is the most important component of your business. This is the process which is hidden from your eyes, but is one of the most complex processes whereby plant's green parts, mostly the leaves, take carbon dioxide from the air, water from the roots and light from the sun and convert that sunlight energy into a useable energy. That energy is fixed in the form of chemical bonds of glucose - $C_6H_{12}O_6$

So, let us see what these researchers found out about this process in relation to carbon dioxide and transpiration. They addressed the question that higher levels of CO_2 slows down transpiration to a small degree, so how do you explain the increase in growth and crop yields?

The background of this question is that many believe that transpiration is the same as growth, or that growth is a result of transpiration. That is not correct. Transpiration is water loss to the surrounding air. Growth and yield, however, are the result of photosynthesis which is uptake of CO_2 and the use of subsequent transformation into sugars.

Photosynthesis and transpiration are totally different processes, although both have something to do with stomata. In addition, photosynthesis and transpiration both are dependent on solar radiation: more radiation means more CO_2 uptake and also more transpiration.

Theoretically, growth can be very good and transpiration very small, and vice versa. Activating the

(*Continued on Pg. 7)*

The Greenhouse Business

(*Continued from Pg. 6*)

crop by means of a minimum pipe temperature only helps to stimulate transpiration and not improve growth because the rate of photosynthesis does not change.

At a high CO_2 concentration, less air passes through the partially closed stomata, but the air contains more CO_2. The net effect is more CO_2 inside the leaf. CO_2 supplementation leads to a high rate of photosynthesis in spite of smaller stomata openings.

The rate of photosynthesis is important because it determines the growth rate. Transpiration is also important because it cools the plants and causes uptake of water and minerals. These minerals are needed for building plant tissue and consequently for development of good quality plants and fruit.

Recommendations:

- It is not well known how much transpiration is necessary. A few days with little transpiration is probably not a problem, but a whole week won't do the crop any good.
- The most important factor for transpiration is radiation. A reasonable radiation level will result in a fair rate of transpiration. But during lengthy radiation, levels will result in a fair rate of transpiration because of high, dark periods, an additional reduction in transpiration because of a high CO_2 concentration, can be detrimental. Besides, a high CO_2 level will not increase photosynthesis because the low light intensity is the limiting factor.
- A general recommendation is not to go above 700 ppm CO_2 during somewhat prolonged periods of dark weather (especially in the winter). During sunny periods, and if the crop is fairly healthy, the optimum CO_2 concentration is 1000 ppm, provided there is no risk of high Nitrogen oxide concentration.
- During spring and summer, it is favorable for the crop to have a high CO_2 level, but don't go above 1000 ppm. There is no extra risk of leaf scorch because the temperature increase of the top leaves on account of CO_2 will not be more than 1C.
- The current recommendations for CO_2 dosing do not have to be changed as a result of this research.

Summary:

- Stomata close 3% for every 100 ppm CO_2 increase
- CO_2 supplementation reduces transpiration by approximately 10%.
- CO_2 supplementation increases photosynthesis and thus growth.
- The recommended CO_2 concentration is 700 to 1000 ppm.
- Be more careful with eggplant.

The Greenhouse Business

TAKING ADVANTAGE OF MODERN TRENDS IN BREEDING FRUITS AND VEGETABLES

Mohyuddin Mirza

Modern Trends in Fruit Breeding - Breeding is no longer a simple case of increasing productivity. Disease resistance, quality, and increasingly, demands from processors and retailers who want to promote health and nutritional qualities are changing breeding criteria and priorities.

This was the title of an article in Fruit & Veg. Tech., Volume 6, No 2, 2006, which I was 'forced" to read, because it was so thought provoking and was connecting all the dots from markets to farm. The development of DNA-based markers has had a revolutionary impact on gene mapping and thus scientists can make selections according to the specific and different interests of various "client groups" from fruit growers to the processing industry to supermarket retailers, and, of course, to the final consumers.

What it means is that the breeding criteria will be highly focused on consumers. Here is what the article mentioned:

- **Pest and diseases resistance** so that organic markets can be expanded. Breeding in this direction is attempting to achieve zero chemical residues in the product. It reminds me that in the Alberta Green house Vegetable Industry, vegetables like cucumbers, tomatoes, peppers, lettuce and more recently, strawberries, are being grown with no chemical input. This is achieved by using disease resistant varie ties, and managing health of the plants, rather than pesticide use. One has to visit some farmers mar kets to see what happens when consumers and producers are brought face to face. I regularly go to Strathcona Market in Edmonton, and visit many producers who market both through commercial wholesale channels and direct marketing channels. The trust factor was very evident and most of the people I met were repeat customers. Fresh strawberries from a greenhouse, are a recent introduction to Alberta. Customers were paying double the price compared to field grown from California, and were happy to do that. You have to come and pick up a pack of local, greenhouse grown strawberries, picked the same morning, tasty, sweet and really a pleasure to eat.

In case you are itching to eat them, here is how they look:

(Continued on Page 9)

The Greenhouse Business

(Continued from Page 8)

- **Yield and Consistency** is very important from a supply and marketing viewpoint. In Alberta, we can benefit from varieties of fruits and vegetables which are frost tolerant, and we can supply the market for longer periods of time. Mushrooms are a good example where yield and consistency are maintained year round.
- **Processing Industry:** The processing industry (Fruit juice, soft drinks, yogurt, freeze dried prod ucts, etc.) has a different requirement when compared to fresh industry. It is primarily interested in the content and nutrient value of vegetables and fruits. They are interested to find varieties which have higher juice squeezable rate, higher sugar concentration and vitamin and mineral content. For example, breeders are looking for how to have consistently higher quantities of Vitamin C in black currents because it varies significantly with season, varieties and location. It also declines in the ber- ries as they ripen. Increasing vitamin C content consistently in Alberta grown berries will make pro duction more competitive.
- **Retail Industry:** Supermarkets want fruit and vegetables with consumer appeal, attractive appear ance, with a sweet, juicy texture and a size matching with use. I was in London in April and found very interesting packaging of greenhouse vegetables. Here is a sample of cucumbers:

  "5 cm portion is part of a five day fruit and veggie. Each portion provides so much Vitamin C and Calcium, grown by, packaging date and best before date".

  Supermarkets are increasingly interested in health, giving properties of fruits and vegetables, because consumers are demanding it. It is mentioned in this article "Media Promotion in the UK by ASDA focusing on health, diet, and aphrodisiac properties of strawberries, resulted in a 14% increase in sales in 2003/2004. Government health recommendations, new packaging and presentation in their straw berries (about 10 fruits) as containing 77 mg of vitamin C (more than an orange per unit weight), 20 mg of folic acid, 0.06 mg of Vitamin B6, a little fibre and 27 calories. The major health promoting qualities come from ellagic acid and the flavonoids (anthocyanin, catechin, quercetin and kaemprerol). The compounds are potent antioxidants."

The Greenhouse Business

British Supermarket Giant Tesco Has Launched a British-Grown Tomato That Offers Double the Lycopene Content Of Normal Tomatoes, as the Company Continues to Expand its Functional Food Range

(11/04/2006)

Tomatoes are a valuable source of nutrients, including beta-carotene, Vitamins C and E, and the carotenoid lycopene, a potent antioxidant that gives the fruit its characteristic red colour.

Recent studies have linked tomatoes and their extracts to reducing the risk of several diseases, such as prostate cancer, and lowering inflammation that may cause hypertension and heart disease.

"This is the first step for Tesco into the developing world of functional foods and we plan to extend our range as public interest grows," said Ian Reed, produce technical manager for Tesco.

Public interest is already on the rise, says Tesco, with demand for tomatoes reported to have soared by 10 percent in the last year.

The new Tesco Healthy Living Tomato on the Vine variety, grown by West Sussex specialist grower Humber VHB, are said to contain 36 percent more lycopene than the standard tomato variety, Elegance.

The tomato was bred in Holland from different types of tomatoes with high lycopene levels.

"Functional foods such as tomatoes, naturally have high levels of lycopene, however, this naturally-bred variety has even higher levels than standard ones," said Reed.

"The health benefits of antioxidants such as lycopene in our diets have recently attracted a lot of positive attention from both the medical and culinary worlds," he said.

The tomatoes will only be available in packs of four to five tomatoes (retail price £1.89) in the company's south coast stores, but if sales are good, as Reed expects them to be, then the variety will be made available throughout the UK.

Growing public understanding of several fruits and vegetables has also seen demand increase across the UK in recent times. Sales of blueberries are reported to have rocketed by 130 percent, while raspberry sales grew by 62 percent in the last two years, and strawberries by 34 percent. Even old classics like rhubarb, that had fallen from favor, are reported to be back in fashion with supermarket chain, Morrisons, for example, reporting to have seen sales double in one month, making it their number one vegetable, in terms of sales.

Volume 5, Issue 3-4

The Greenhouse Business

GUIDELINES FOR MANAGING NUTRIENTS IN GREENHOUSE VEGETABLES GROWN ON COIR IN ALBERTA

Mohyuddin Mirza and Nick Savidov

Prepared for presentation at "New Innovations in Substrate Use and Disease Management in Greenhouse Vegetables". A seminar held on May 25, 2006, at Olds College.

Introduction: Substrates to grow plants have a major impact on growth and fruiting of greenhouse crops and can also determine profitability. Greenhouse crops were grown in soil and starting in 1984, different types of hydroponic production methods have been adopted. When the switch was made from soil production to hydroponics methods, peat based media and rockwool were adopted as growing media. Economics data indicated that production increased significantly from 1984 to 1994. Peat based media for vegetable production phased out in favor of rockwool while they are being widely used in bedding, potted and nursery plants. When rockwool became expensive, Alberta growers switched over to spruce and pine sawdust with occasional use of yellow cedar sawdust from B.C.

Sawdust decomposes rapidly and its water holding characteristics changed significantly, and over all, productivity of vegetables decreased. Based on the extensive research and good marketing strategies by coir producing companies from Siri-Lanka, coir is now widely used in Ontario and Alberta for greenhouse vegetable production. Growers have been asking for more specific information on managing greenhouse vegetables grown on coir under Alberta conditions. The information below is based on research and commercial growers experience in Alberta.

What is Coir? Simply stated, Coir is a coarse fibre extracted from the fibrous outer shell of coconut. It has some unique chemical, physical and biological characteristics. For example, it has a high water holding capacity, 8 - 9 times of dry weight. A one liter compacted brick, will swell to about 8 - 9 liters of fluffed up material. The pH and E.C. are acceptable. It has excellent wetability and very high Cation Exchange Capacity, meaning that it can hold and exchange nutrients with the root of absorption.

Pre-washed, coarse, Coir bags.

(*Continued on Pg. 12*)

The Greenhouse Business

(Continued from page 11)

Pre-crop handling of coir bags: Pillow bags can be purchased pre-washed or unwashed. Pre-washed means that coir was washed with water or a nutrient solution to get rid of any sodium chloride in them, and you are ready to wet them and plant seedlings. Washing, means that you soak them with a calcium nitrate solution, at generally one gram/liter strength, and then soak the bags for 24-48 hours, then drain that water out. Starting E.C. of leach for most of the crops is suggested to be around 2.0 mmhos/cm.

Planting of Seedlings: Make holes according to your calculation of space requirements, that is, distance between rows and between plants. Generally, growers place these pillow bags end to end and place 4 plants of tomatoes, three of cucumbers and 3 of peppers. Row spacing is such to give a plant density of 1.4 plants of cucumbers/m2, 2.5 plants of tomatoes/m2 and 2.5 plants of peppers/m2. Drips are adjusted to feed each plant.

Basic Fertilizer Program: A complete nutrient feed is required. Here are general guidelines for a basic feeding program:

Nitrogen	175 - 250 ppm
Phosphorus	30 - 50 ppm
Potassium	250 - 400 ppm
Calcium	150 - 250 ppm
Magnesium	50 - 70 ppm
Sulfur	40 - 100 ppm
Chloride	20 - 70 ppm (tomatoes on higher side)
Iron	2 - 4 ppm
Manganese	0.5 - 1.0 ppm
Copper	0.15-0.25 ppm
Zinc	0.12-0.20 ppm
Boron	0.25 (cucs) 0.35 (tomatoes), 0.90 (peppers)
Molybdenum	0.12 - 0.15 ppm

(Continued on Pg. 13)

The Greenhouse Business

(Continued from page 12)

Some pointers on managing nutrients:

- Because of higher water holding capacity, higher E.C. when compared to sawdust can be maintained. For leach E.C. in case of cucumbers maintain around 3.0 in winter and fall and 2.5 in summer and spring. For tomatoes, maintain an E.C. of around 4.0 in winter and fall and around 3.0 in summer. For peppers, and E.C. of 3.0 in winter and 2.5 in summer.
- Make regular adjustment for pH which should be maintained in leach around 5.5 to 6.2.
- Copper and molybdenum have been found to be below detection in leach many times. Make sure that higher levels are used in the feed. Those growers who manipulate E.C. without changing the stock solution, should make sure that the levels of trace elements are not reduced when E.C. is reduced. Idea is to feed trace elements separately from calcium nitrate and other major nutrients. This practice will certainly help to achieve higher yields.
- Boron levels with peppers are far higher than cucumbers and tomatoes, so if you are growing both crops, just make sure that peppers get adequate boron levels.
- Regular testing is important to maintain a good quality fertility program.

Coir is considered a more vegetative medium, what does it mean?

Because of higher water holding capacity, coir is called a more vegetative growth medium. It means that plants will have a tendency to produce more leaves and shoots, especially early in crop life. If you are not careful, the plant will get too strong and vegetative, and it will take time to bring it back to a generative stage. Use higher E.C. to make the plant more generative, as suggested above.

Understanding Nutrient Analyses:

Different labs use many different media extraction solutions. For example, sodium acetate, ammonium acetate, hot water for boron, and so on. The following guidelines and standards are provided for water extractable nutrients. Make sure you know the extraction procedure from the lab. If you are getting a water sample analyzed, then extraction procedures are of no consequence.

(Continued on Pg. 14)

The Greenhouse Business

(Continued from Page 13)

Typical Leach Examples from Alberta:

Tomato Leach - Mature Crop - First 2 Clusters Harvested - Total 12 Clusters set

NUTRIENT TESTED	UNITS MG/L (mmol/L)	STANDARD mg/L (mmol/L
pH	6.25	5.5 - 6.0
E.C. mS/cm	3.84	3.5 - 4.5
Nitrate & Nitrite - N	246 (17.6)	200 - 300 (14 - 21)
Orthophosphate - P	51.2 (1.65)	32 - 150 (1.0 - 5.0)
Potassium	378 (9.66)	195 - 312 (5.0 - 8.0)
Calcium	318 (7.92)	200-320 (5.0 - 8.0)
Magnesium	133 (5.48)	85 - 109 (3.5 - 4.5)
Sulfur	266 (8.28)	56 - 104 (1.75 - 32.5)
Sodium	128 (5.55)	23 - 115 (1.0 - 5.0)
Iron	2.5 (0.045)	2 - 4 (0.035 - 0.070)
Manganese	0.086 (0.0016)	0.5 - 1.0 (0.009 - 0.018)
Copper	0.22 (0.0035)	0.10 - 0.25 (0.0015 -0.0039)
Zinc	1.08 (0.0165)	0.12 - 0.25 (0.0018-0.0038)
Boron	3.60 (0.33)	0.20 - 0.30 (0.018-0.027)
Molybdenum	0.01 (0.0001)	0.01 - 0.08 (0.0001-0.0008)
Chloride	112 (3.28)	35 - 175 (1.0 - 5.0)

(Continued on Page 15)

The Greenhouse Business

(Continued from Page 14)

Standards for Tomatoes, Cucumbers and Peppers

NUTRIENTS	TOMATOES	CUCUMBERS	PEPPERS
pH	5.5 - 6.0	5.5 - 6.0	5.5 - 6.0
E.C. mS/cm	3.5 - 4.5	2.5 - 3.5	2.5 - 3.5
	Mg/L (mmols/L)	Mg/L (mmols/L)	Mg/L (mmols/L)
Nitrate & Nitrite - N	200-300 (14-21)	210 - 336 (15 - 24)	210-336 (14-25)
Orthophosphate - P	32 - 150 (1.0-5.0)	25 - 50 (1.0 - 1.5)	18 - 37 (0.6 - 1.2)
Potassium	195 - 312 (5.0 - 8.0)	234 - 400 (6 - 10)	234 - 352 (6.0 - 9.0)
Calcium	200 - 320 (5.0 - 8.0)	220 - 320 (5.0 - 8.0)	220 - 340 (5.5 - 8.5)
Magnesium	85 - 109 (3.5 - 4.5)	36 - 109 (1.5 - 4.5)	55 - 103 (2.25-4.25)
Sulfur	56 - 104 (1.75 - 3.25)	48 - 150 (1.5 - 4.6)	48 - 150 (1.5 - 4.6)
Sodium	23 - 115 (1.0 - 5.0)	23 - 115 (1.0 - 5.0)	23 - 115 (1.0 - 5.0)
Iron	2 - 4 (0.035 - 0.070)	2 - 4 (0.035 - 0.070)	2 - 4 (0.035 - 0.070)
Manganese	0.5-1.0 (0.009-0.018)	0.5-1.0 (0.009-0.0039)	0.5-1.0 (0.009-0.018)
Copper	0.10-0.25(0.0015-0.0039)	0.1-0.25 (0.0015.0.0039)	0.10-0.25(0.0015-0.0039)
Zinc	0.12-0.25 (0.0018-0.0038)	0.12-0.25 (0.0018-0.0038)	0.12-0.25(0.0018-0.0038)
Boron	0.20-0.30 (0.018 - 0.027)	0.20-0.30 (0.018 - 0.027)	0.45-0.75 (0.041-0.069)
Molybdenum	0.01-0.08 (0.0001-0.0008)	0.01-0.08 (0.0001-0.0008)	0.01-0.08(0.0001-0.0008)
Chloride	35-175 (1.0-5.0	35 -175 (1.0-5.0)	35 -175 (1.0 1.5)

Continued on page 16

The Greenhouse Business

(Continued from page 16)

Examples of Nutrient Deficiencies Which Can Occur In Coir

Potassium deficiency in tomatoes. Leach analysis showed potassium below 50 ppm. There were more than 25 fruits on 12 clusters when this deficiency occurred. At this stage, tomato plants should get potassium double of nitrogen.

In coir cucumber, use potassium very fast, at the time when fruit is filling in. Temporary shortage of potassium can occur if enough nutrient solution is not applied during fruiting stage. In summer, when light is more than 1600 joules/cm, plants should get a minimum of 5-7L of nutrient solution/m2.

(Continued on page 17)

The Greenhouse Business

(Continued from page 16)

Shortage of copper can occur in mini and salad cucumbers. It appears that they require more copper than regular seedless cucumbers. The level of copper can be increased up to 0.5 ppm if deficiency is seen. This is what the symptoms look like in mature leaves.

Both regular and mini cucumbers can show boron deficiency in the fruit. Levels should be adjusted in the feed and reflected in the leach.

Peppers are very sensitive to high E.C. in the coir slab. This damage occurred when the E.C. went over 4.5 mS/cm on a very hot day. Management of E.C. in coir is as important as nutrient management. On bright days, sunlight over 2000 joules/cm E.C. should be reduced from 11:00 to 3:00 p.m. by at least one unit.

The Greenhouse Business

Summary: Coir is an organic medium and has a very high cation exchange capacity. It has a tendency to hold on to copper and molybdenum, but exchange with roots depending on the pH of the growing medium. Regular nutrient tests should be taken both of the feed solution and leach solution, and adjustments made accordingly.

Bedding Plants Round Up: Bedding plant season appears to be coming to a close, although many greenhouse businesses in urban area are still busy with hanging baskets and perennials. Talking to many growers, the past season was described as pretty good though that one week of cloudy weather and rain around the Victoria Day weekend, slowed down the sales. Most of the bedding plant growers make their most income in May and early June.

Smaller growers reported that they were sold out by early June. Herbicide damage was reported by one grower and causes significant loss to the business. In this case, the herbicide picloram came into the dugout from roadside spray in the 2005 season. The level of picloram was tested at 1.00 ppb, that is part per billion. In all such cases, good records should be kept of all relevant dates, loss of income, loss of sales in future and also don't forget that the contaminated water may not be useable for several years. So, you have to install a charcoal filter system or truck in water. Those costs should also be kept in mind.

FOR SALE: Greenhouse structure, 12 bays, 39,000 square feet, and other equipment like boiler, environmental control computer, etc. Contact Dr. Mirza at 780-415-2303.

The Greenhouse Business is published bi-monthly by the Business Development Branch of Business and Innovations Division of Alberta Agriculture, Food and Rural Development.

Editor: Dr. Mohyuddin Mirza, Crop Diversification Centre, North, 17507 Fort Rd., Edmonton, AB. Canada, T5Y 6H3. Phone: (780) 415-2303, Fax: (780) 422-6096, Email: mohyudin.mirza@gov.ab.ca

Contributing Editors:

Nick Savidov, Greenhouse Crop Scientist, Crop Diversification, Centre South, Brooks

Dr. Ron Howard, Plant Pathologist, Crop Diversification, Centre South, Brooks

Thom Rypien, Westgro Horticultural Supplies Inc.,, Calgary

Newsletter Layout: Linda Gnam & Linda Thomas, Fairview