

# Introducing a New Nutritional Program for Cucumber Production at the Arab-Qatari Agricultural Production Company under Greenhouse Conditions

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## Summary

Cucumber plants of Sohail hybrid cultivar were grown under cold greenhouse conditions during two subsequent summer seasons (2003 and 2004) and were fertilized using two different nutrition programs. The two programs Holland (control) and ABCD, were evaluated in terms of yield, length of harvesting period, nutrition program cost and total cash return. Cucumber yield significantly increased with marked elongation of fruit harvesting period when the ABCD nutrition program was used in comparison with the control. Furthermore, ABCD nutrition program was cheaper in cost and higher in total yield and cash return as compared to that of Holland.

**Keywords:** Cucumber; Yield and harvesting period; Nutrition programs; Nutrition cost and yield cash return.

## Introduction

The Arab-Qatari Agricultural Production Company (AQAPCo) is an affiliate of the Arab Authority for Agricultural Investment and Development (AAID), specialized in vegetable crop production and is located in Doha, Qatar. AQAPCo's farm has a cultivated area of about 48 hectares. This cultivated area includes six hectares of cold greenhouses (six glasshouses of 0.5ha each and 12 fiber houses of 0.25ha each), seven hectares of non-cold greenhouses and about 35 hectares of open fields. Cucumber is the major crop forming about 70-80% of the total amount of vegetable crops produced by the company (Atta-Aly, 2006a and b). It is totally produced inside cold greenhouses all year round and inside non-cold greenhouses during fall and winter seasons.

AQAPCo faced certain technical problems in its field of vegetable crop production. As a technical support offered by AAID to AQAPCo, several experts were sent by AAID to the company several times/year for a period of two years starting 2001. During that period, all technical problems were identified and several rehabilitation programs were designed and approved to be applied. The inappropriate nutrition program used for cucumber production was one of the major problems (Rasheed *et al.*, 2001; Atta-Aly, 2002 and Atta-Aly *et al.*, 2003). Symptoms of P, Mg, Ca, Fe and K deficiency were clearly identified on all cucumber plants grown (Rasheed *et al.*, 2001 and Atta-Aly *et al.*, 2003). Also, a very limited root volume, thin stem, abnormal stem elongation, a very short yielding period and high levels of fruit abortion were clearly identified (Atta-Aly *et al.*, 2003; Atta-Aly, 2006a and b). These identified symptoms resulted in substantial cucumber yield reduction (Rasheed *et al.*, 2001; Atta-Aly *et al.*, 2003 and Atta-Aly, 2006a & b).

The Holland company that was appointed for constructing and building AQAPCo's cold greenhouses introduced a cucumber nutrition program used for cucumber production since 1987. This nutrition program, therefore, was named Holland nutrition program. Based on plant physiological

age, cucumber plant mineral requirements varied as the plant developed from one physiological age to another (Epstein, 1972). The major problem facing Holland nutrition program in cucumber production is its inflexibility, as a fixed elemental ratio is used throughout the whole growth period of the plant regardless of the variability of plant physiological ages. It was reported that accurate and suitable nutrition programs that meet all plant mineral requirements throughout its growth resulted in healthy plants characterized by the ability to tolerate many diseases (Wicks, 1988; Stirling, 1991; Chelami & Olson, 1997; Barker & Kenning, 1998 and Akhtar & Malik, 2000). In addition, soil solarization during the hottest months of the summer season under Doha environmental conditions eliminated all visible symptoms of soilborne pests including nematodes, annual weeds and fungal diseases responsible for cucumber seedlings damping off with a marked yield increase (Atta-Aly, 2006a and b). When soil was solarized, an accurate and flexible nutrition program named ABCD nutrition program was introduced by Atta-Aly *et al.* (2003), as a part of AQAPCo's rehabilitation programs (Atta-Aly, 2006a and b). This new nutrition program suits all physiological ages of cucumber plants and strongly increased cucumber fruit yield (Atta-Aly, 2006a and b).

In this work, therefore, ABCD nutrition program was tested against Holland to clarify the differences between the two nutrition programs in terms of cucumber yield, length of harvesting period, nutrition program cost and total yield cash return.

## Materials and Methods

### Identification of nutrition problems:

Holland nutrition program was the only nutrition program used for cucumber nutrition since 1987. In this program, each cucumber plant was grown in a black polyethylene (PE) bag of eight liters volume filled with washed sand as a sort of sand culture growing media with a capacity of 2.5 plant/m<sup>2</sup>. At each plantation, the old growing media has to be replaced by new ones. The high price of the new washed sand (40 QR/m<sup>3</sup>) and its large amount required (6000m<sup>3</sup>/year) for cultivating eight hectares of greenhouses as well as the high cost of the extensive labor used for replacing the old growing media (old sand) by a new one (new washed sand) at each plantation (four times/year) resulted in

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unprofitable cucumber cultivation. AQAPCo was, therefore, forced to wash and re-use the old growing media several times/year for many years. Washing the old growing media can eliminate soil salinity, acidity or alkalinity, but not soil-borne pests. At each fertigation, the excess amount of Holland solution was drained into the greenhouse sandy floor through small openings at the base of each PE bag. This resulted in intensive weed growth on greenhouses sandy floors, and consequently, severe nematode infection was obtained in both the greenhouse floor and cucumber growing media. The growing media was severely infected with nematodes through the bag's drainage openings, particularly when the same media was re-used several times/year for many years.

Therefore, AAAID experts suggested to use sand beds supplemented with sand 50m<sup>3</sup> organic manure/ha as cucumber growing media instead of PE bags (Rasheed *et al.*, 2001 and Atta-Aly, *et al.*, 2003). Routine application of organic matter proved to decrease nematode pest population and associated damages to the crops grown (Akhtar and Malik, 2000). Before the application of AQAPCo's rehabilitation programs, sandy soil collected from the farm borders was, therefore, used for constructing and building sand beds as a new growing media for cucumber production during 2002. Using sand beds for cucumber production eliminated the high costs of the new washed sand, PE bags and extensive labor at each plantation. Sand beds constructed by AQAPCo's team during 2002 were narrow (40cm width) and shallow (20cm depth). Such limited volume of the constructed sand beds arrested cucumber root growth and subsequently fruit yield. Therefore, doubling the volume of the sand beds by supplementing the existing sand beds with extra amounts of sandy soil was included in the rehabilitation programs that started on July 2003 to reach sand beds of 80cm width and 40cm depth. Chemical analysis of the constructed sand beds revealed soil salinity and alkalinity with an EC of 8.20 dS/m and pH of 8.35. After soil leaching and preparation, soil EC was reduced to 5.24 dS/m before the first plantation and to 3.25 dS/m before the second plantation. In contrast, the high levels of soil alkalinity remained always constant (pH between 8.06 and 8.35). Soil salinity and alkalinity reduced to levels close to normal (i.e. EC values of 2.5-3.0 dS/m and pH levels of 6.5-7.5) at the location of each emitter (root zones), but only during the fertigation times (total period of about 30-40 min/day). One or two hours after the termination of each fertigation time, soil salinity and alkalinity became dominant (Atta-Aly *et al.*, 2003). Under such dominant soil alkalinity, Holland nutrition program became inappropriate for cucumber production.

Holland nutrition program consists of A and B solutions (Table 1) and both are mixed together with the irrigation water directly before each fertigation. Solution A contains Ca and Mg as well as Fe in EDTA form, while P is one of solution B constituents. Under soil alkaline conditions, Ca and Mg react with P at the termination of each fertigation time forming the insoluble form of triple Ca-Mg phosphate (Busman *et al.*, 1998) resulting in the identified symptoms

of P, Mg and Ca deficiency (Rasheed *et al.*, 2001 and Atta-Aly *et al.*, 2003). In addition, Fe in forms other than EDTA became also insoluble under such alkaline conditions (Epstein, 1972). Symptoms of Mg and Fe deficiency meaning leaf poor chlorophyll content that resulted in a marked reduction in plant net photosynthesis (Epstein, 1972). Furthermore, Ca deficiency resulted in plant apical death and increased plant respiration that consumed a great deal of plant net photosynthesis (Epstein, 1972). Symptoms of K deficiency were also identified (Rasheed *et al.*, 2001 and Atta-Aly, *et al.*, 2003). The sum of the above listed symptoms resulted in a marked increase of cucumber fruit abortion to a level significantly higher than normal (Atta-Aly, 2002 and Atta-Aly *et al.*, 2003) causing a substantial cucumber yield reduction. Based on the above-identified problems related to the use of Holland nutrition program, a new program named ABCD nutrition program (Table 2) was introduced as one of the AQAPCo's rehabilitation programs to overcome all identified nutrition problems.

**Table 1.** Stock solution constituents of Holland nutrition program. Solutions A and B are mixed with irrigation water at each fertigation throughout the whole growth period of cucumber plant with EC automatic adjustment according to plant physiological age with an EC gradual increase from 1.8 to 2.5 dS/m

Solution	Nutrient Commercial Name	Nutrient Element Content (%)	Amount (kg/m <sup>3</sup> )
A	Calcium nitrate	15.5% N + 26.5% CaO	150
	Magnesium nitrate	8.8% N + 9.7% MgO	10
	Iron chelate (EDTA)	6% Fe	2.7
	Iron chelate (EDTA)	13% Fe	1.2
B	Magnesium sulfate	16% MgO	50
	Mono-potassium phosphate	50% P <sub>2</sub> O <sub>5</sub> + 34% K <sub>2</sub> O	40
	Potassium sulfate	50% K <sub>2</sub> O + 46% SO <sub>4</sub>	28
	Potassium nitrate	13% N + 46% K <sub>2</sub> O	25
	Manganese sulfate	13% MnO	0.325
	Zinc sulfate	13.5% ZnO	0.140
	Borax	11.1% B	0.365
	Copper sulfate	25% CuO	0.02
Sodium molybdate	38.9% Mo	0.01	

### Soil preparation, solarization and other rehabilitation programs:

The application of AQAPCo's rehabilitation programs started in July 2003 and completed by the end of summer season 2004. In the first season, only the routine practice used by the company for soil preparation was applied. This include sand beds supplementation with 50m<sup>3</sup> old composted cattle manure and 500kg TSP/ha, respectively. Among all planned rehabilitation programs, only doubling sand beds volume (depth from 20 to 40 cm and width from 40 to 80 cm) were carried out by supplementing the existing sand beds with extra amounts of sandy soil collected from the

**Table 2.** Stock solution constituents of ABCD nutrition program. To avoid solutions mix, cucumber plants were alternatively fertigated with A and D solutions during vegetative stage and with B and D solutions during flowering (early fruiting) stage while, C and D solutions were used for yielding stage with a capacity of one solution/day. At each fertigation, EC was automatically adjusted according to plant physiological age with a gradual increase from 1.8 to 2.5 dS/m

Nutrient Commercial Name	Nutrient Element Content (%)	Amount (kg/m <sup>3</sup> )			
		Solut. A	Solut. B	Solut. C	Solut. D
Potassium nitrate	13% N + 46% K <sub>2</sub> O	45	77	132	-
Mono-potassium phosphate	50% P <sub>2</sub> O <sub>5</sub> +34% K <sub>2</sub> O	100	50	50	-
Urea	46% N	100	35	20	-
Manganese chelate	13% Mn	2	2	1	-
Zinc chelate	13.5% Zn	2	2	1	-
Borax	11.1% B	0.5	0.5	0.25	-
Sodium molybdate	38.9% Mo	0.01	0.01	-	-
Calcium nitrate	15.5% N+26.5% CaO	-	-	-	45
Magnesium nitrate	8.8% N+9.7% MgO	-	-	-	100
Iron chelate (EDTA)	6% Fe	-	-	-	100

farm uncultivated borders. In the second season however, sand beds were supplemented with old composed cattle manure and other chemical nutrients listed in Table (3). This was followed by the solarization of soil and drip irrigation surface net, as one of the applied rehabilitation programs, which was applied as previously described by Atta-Aly (2006a and b). Other rehabilitation programs were applied before the onset and during the second season as follows:

- Renewing and maintaining greenhouses (GH) cooling systems.
  - Replacing old or blocked cooling pads by new ones.
  - Cleaning and sanitizing water pools, cooling pads and recycled water used for GH cooling systems.
  - Enriching water pools with copper sulfate to prevent algae growth inside the cooling pads.
- Constructing mechanical systems for insect control.
  - Tightly closing the two main doors of each GH, except between plantations.
  - Constructing one double door for each GH.
  - Covering GH cooling pads with insect net sheets as insect mechanical barrier.
- Sanitizing GH walls, ceilings, wires, chains, shading curtains.etc.

**Table 3.** Organic and chemical substrates used for greenhouse soil preparation

Soil preparation substrate	Amount/ha
Composted cattle manure	60 m <sup>3</sup>
TSP (45% P <sub>2</sub> O <sub>5</sub> ) <sup>(1)</sup>	600 kg
Urea (46% N)	200 kg
Potassium sulfate (50% K <sub>2</sub> O)	100 kg
Magnesium sulfate (16% MgO)	50 kg
Agricultural sulfur	50 kg

(1) TSP = Triple super phosphate.

- Replacing fiber houses old ceilings (10 years old), which became dark in colour and poor in light transmission, by transparent PE of 220 $\mu$  thickness for more light transmission.
- Direct cucumber seed sowing during hot seasons (summer, fall and spring) instead of seedlings transplanting for expense saving and vigorous plant growth.

#### Experimental precaution:

Drip irrigation system of each greenhouse is connected to a fertigation tank, in which irrigation water and nutrient solutions are mixed, through a computerized system, to form a fertigation solution of an adjusted EC. Therefore, only the EC of the fertigation solution, but not the elemental ratio, can be changed or re-adjusted as required according to subsequent plant physiological ages. According to such fixed fertigation system, it was impossible to use both Holland and ABCD nutrition programs in one greenhouse, but each nutrition program has to be used in a separate greenhouse. Therefore, two identical fiber houses (the two available houses at the time of experiment onset) were used in the first season (2003), while two identical glasshouses were selected for the second season (2004) with a capacity of one greenhouse per nutrition program per season. To ensure the accurate application of both nutrition programs, 10 random samples of drained solution were collected from plant root zones for each greenhouse and analyzed at weekly intervals for EC monitoring and subsequently for re-adjusting both nutrition programs to similar EC levels throughout the whole plant life. This EC monitoring program was carried out, as one of the established rehabilitation programs, in the whole cultivated areas of the farm.

#### Plant materials:

Cucumber (*Cucumis sativus*) hybrid seeds of Sohail cultivar were directly sown on June 26<sup>th</sup>, 2003 and on June 20<sup>th</sup>, 2004 for the first and second seasons, respectively, with a plant density of 2.8 seeds/m<sup>2</sup>. At the same day, seeds were also sown in polystyrene trays filled with a mixture of peat moss and vermiculite (1:1 volume) with a capacity of 10 trays (840 seedlings) per greenhouse for replacing the un-germinated seeds or damaged seedlings with new ones two weeks later. After seed sowing, trays were kept at the walk-side of the same greenhouse and sand beds were irrigated for one hour at the same day of seed sowing followed by six min/four times/day until complete germination. With the exception of plant nutrition programs, all cultural practices were then carried out as usually recommended for cucumber production under cold greenhouse conditions (Atta-Aly, 2006a and b).

#### Nutrition programs (treatments):

In this experiment, Holland and ABCD nutrition programs were applied as two separate treatments with a capacity of one nutrition program/greenhouse/season. Holland nutrition program consists of two solutions, A and B as listed in Table (1). In this program, A and B are the only solutions used throughout the whole growth period of cucumber plant and both are mixed with the irrigation water

**Table 4.** Weekly fertigation program for cucumber production grown under cold greenhouse conditions during the summer seasons using ABCD nutrition program.

Stage of Growth	Weeks <sup>(1)</sup> after seed sowing	Fertigating <sup>(2)</sup> solution EC (dS/m)	Weekly Application of Nutrient Solutions (A, B, C or D)						
			Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri. <sup>(3)</sup>
Vegetative Stage	1	1.2	W	W	W	W	W	W	W
	2	1.8	A	D	A	D	A	D	W
	3	2.0	A	D	A	D	A	D	W
	4	2.3	A	D	A	D	A	D	W
Transition Phase I	5	2.5	A	D	B	D	A	D	W
	6	2.5	B	D	A	D	B	D	W
Flowering <sup>(4)</sup> Stage	7-9	2.5	B	D	B	D	B	D	W
			B	D	B	D	B	D	W
Transition Phase II	10	2.5	B	D	C	D	B	D	W
	11	2.5	C	D	B	D	C	D	W
Yielding Stage	12-14	2.5	C	D	C	D	C	D	W
	14-End	2.0	C	D	C	D	C	D	W

(1) Plane water was used for one week after seed sowing without nutrient supplementation.  
 (2) Fertigating solution EC listed in the Table is used for both Holland and ABCD nutrition programs.  
 (3) W=Plane water was used for soil leaching every Friday.  
 (4) Flowering Stage=Early fruiting stage.

directly before each fertigation. ABCD nutrition program, on the other hand, consists of four nutrient solutions, A, B, C and D (Table 2).

During the stage of cucumber vegetative growth, A and D solutions were alternatively used for six days/week (each was used three days/week and applied every other day). During plant flowering (early fruiting) stage, A solution was replaced by B. At yielding stage, however, B solution was replaced by C (Table 4). To ensure nutrient gradual transition from plant physiological age to another, two transition phases were applied in this nutrition program and each transition phase was applied for a period of two weeks. The first transition phase was between vegetative and flowering (early fruiting) stages when B solution was gradually introduced instead of A solution. This was also applied during the second transition phase between flowering (early fruiting) and yielding stages, when B solution was gradually replaced by C solution. Based on the procedure of ABCD nutrition program, it can be noticed that three couples of nutrient solutions were used and each couple was used for three weeks. In addition, there were two transition phases of two weeks each to form a total fertigation program of 13 weeks or more since C and D solutions may be used for a longer period until the termination of plant yielding stage (Table 4).

In both treatments, plant fertigation program starts one week after seed sowing with a gradual EC increase for both-nutrition programs. Both nutrition programs were applied for six days/week, while only plane water was used for soil leaching during the seventh day of each week (Table 4).

#### Yield, harvesting period, nutrition cost and total yield cash return:

Fruits were harvested at marketing stage (12-15cm length) and weighed on a daily bases. At the termination of the experiment, total yield was calculated and recorded as

tons/ha and the length of fruit harvesting period was recorded in days. In the second season (2004), as all rehabilitation programs were completed, the cost of each nutrition program/day and total yield cash return/treatment/ha were recorded in Qatari Ryals (QR), equal to 0.274 USD.

#### Experimental Design and Statistical Analysis:

Based on the experimental precautions that were previously explained, the design used was a complete randomized block design with four replicates. Each replicate comprised 16 sand beds with a total area of 408m<sup>2</sup>. Data were analyzed for statistically significant differences using Duncan's multiple range test. The standardized least significant range (LSR) at the 5% level was used to compare the effect of treatments according to Little and Hills (1978).

#### Results and Discussion

During the first season (2003), experiments were carried out without the application of all rehabilitation programs listed in the materials and methods section. In the second season (2004) however, all rehabilitation programs were applied. In both seasons, significant yield increase and harvesting period prolongation in cucumber were obtained with the application of ABCD nutrition program (Figs. 1 and 2) as compared to the control (Holland). It is clearly noticed that ABCD nutrition program significantly increased cucumber yield and prolonged its harvesting period either with or without the application of rehabilitation programs as compared to control during the first or second season, respectively. This strongly indicated the positive impacts of ABCD nutrition program on cucumber yield and harvesting period over the control treatment regardless of the application of other rehabilitation programs.

Accurate and suitable nutrition programs that meet all plant mineral requirements throughout its growth period resulted in healthy plants characterized by their ability to tolerate many diseases (Wicks, 1988; Stirling, 1991; Chellami & Olson, 1997; Barker & Kenning, 1998 and Akhtar & Malik, 2000). This may explain the positive impacts of ABCD nutrition program on cucumber yield and the length of harvesting period during the first season (Fig. 1) regardless of the spread of nematode infection as visibly noticed on the roots of all cucumber plants. After the application of all rehabilitation programs in the second season, ABCD nutrition program proved to be also superior in terms of cucumber yield and harvesting period over that of the control (Fig. 2). Holland nutrition program has a fixed mineral ratio throughout the whole growth period of the plant regardless of plant physiological age (Table 1). ABCD nutrition program however, is a flexible program since its mineral ratio can easily be changed as the plant developed from one physiological age to another (Tables 2 and 4) to meet cucumber plant mineral requirements at each physiological age throughout the whole growth period of the plant.

The significant increase in cucumber fruit yield with ABCD nutrition program reached 3.25 fold in the first season and 1.43 fold in the second season as compared to the control. This may be due to the absence of the new program of soil solarization (Table 1) introduced after the first sea-

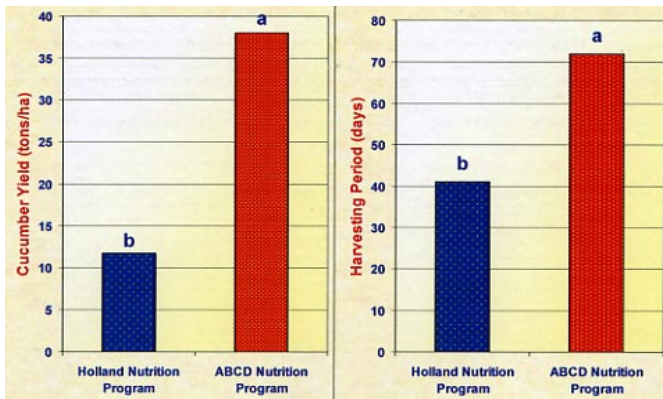


Fig. 1. Comparison between Holland and ABCD nutrition programs in terms of cucumber yield and harvesting period. Statistical significant differences were presented at 5% level.

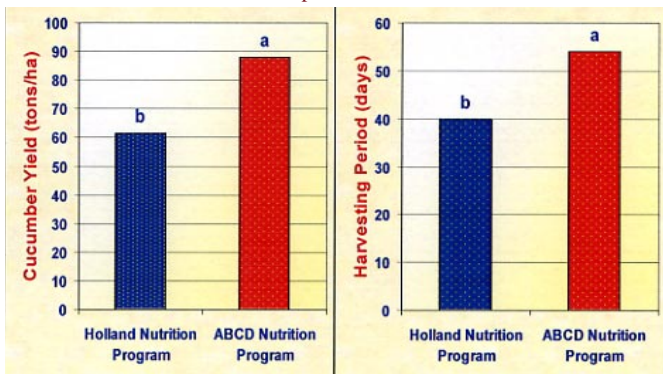


Fig. 2. Comparison between Holland and ABCD nutrition programs in terms of cucumber yield and harvesting period. Statistical significant differences were presented at 5% level.

son. This new program of soil preparation eliminated K and Mg deficiency problems associated with Holland nutrition program since both elements were supplemented at soil preparation. Regardless of this deference, the obtained data emphasize ABCD superiority over the control either with or without the application of other rehabilitation programs. Photo (1) showed also the superiority of ABCD nutrition program in terms of plant vigorous vegetative growth and the deeper green colour of the leaves over the control. The pale green colour of the leaves noticed with Holland nutrition program was a result of Mg and Fe deficiency (Epstein, 1972) and due mainly to soil alkalinity (pH values between 8.1 and 8.3). Under such alkaline conditions P react with Mg and Ca and all become unavailable as well as Fe in EDTA form (Busman *et al.*, 1998). Clear symptoms of K deficiency were also identified with Holland nutrition program (Rasheed *et al.*, 2001; Atta-Aly, 2002 and Atta-Aly *et al.*, 2003) and this will adversely affect the translocation of plant assimilates (Epstein, 1972). Such symptoms may indicate the differences between both nutrition programs in terms of plant net photosynthesis and the translocation of its assimilates to the fruits that resulted in a marked level of fruit abortion noticed only with Holland nutrition program as shown in Photo (1).

In the first season, cucumber yield was about 24.85 tons/ha and increased up to three folds (74.4 tons/ha) in the second season regardless of the nutrition program used. Comparing ABCD nutrition program vrs control in both seasons in terms of cucumber yield/day resulted in 528 vrs 285 kg/day in the first season and 1630 vrs 1535kg/day in the second season, respectively. Nevertheless, ABCD nutrition pro-

gram significantly prolonged cucumber harvesting period over control in both seasons (Figs. 1 and 2). The total cucumber yield throughout the whole season was higher in the second season than that of the first one. This marked yield increase obtained during the second season is mainly due to the application of the other rehabilitation programs that have been applied only in the second season. Atta-Aly (2006a and b) reported that soil solarization, as one of the applied rehabilitation programs, significantly increased cucumber yield. This may explain the substantial yield increase of the second season as compared to the first one. It was noticed that cucumber harvesting period in the first season (2003) was longer than that of the second one (Figs 1 and 2). During the first season, most of the cold greenhouses were under the application of rehabilitation programs, which adversely affected cucumber summer yield of 2003. Therefore, the AQAPCo requested to keep up cucumber production as long as possible during this season. In the second season (2004) however, all rehabilitation programs were completed and plants were removed when they reached the level of unprofitable production for earlier new plantation.



Photo 1. Comparison between Holland (left) and ABCD (right) nutrition programs in terms of cucumber plant vegetative growth, green colour deepness of the leaves and level of fruit abortion during the summer season of 2004 (second season).

The final goals to be achieved from this work are reducing fertilization cost and maximizing product total cash return. This will help the AQAPCo not only to cease its annual cash loss but also to achieve profitable cash return from cucumber production. The cost of both nutrition programs and total yield cash return were, therefore, recorded. This was carried out only after the completion of all rehabilitation programs that have been applied only during the second season to avoid obtaining false data if the data of first season were included. Data presented in Figure (3) revealed that ABCD nutrition program was not only cheaper in cost (230 vrs 353 QR/day/ha or 9550 vrs 10400 QR/ha/season for ABCD vrs control, respectively) but also higher in total yield cash return (220750 vrs 153250 QR/ha/season for ABCD vrs control, respectively) as compared to that of control. The net difference in the yield net income reached about 68000 QR (18600 US\$)/ha/summer season in the favor of ABCD over Holland nutrition program. In contrast to Holland nutrition program, the presented data strongly indicated that ABCD nutrition program achieved all required goals and addressed all identified problems of cucumber nutrition.

### Practical Implications

Based on the obtained data, AQAPCo decided to replace

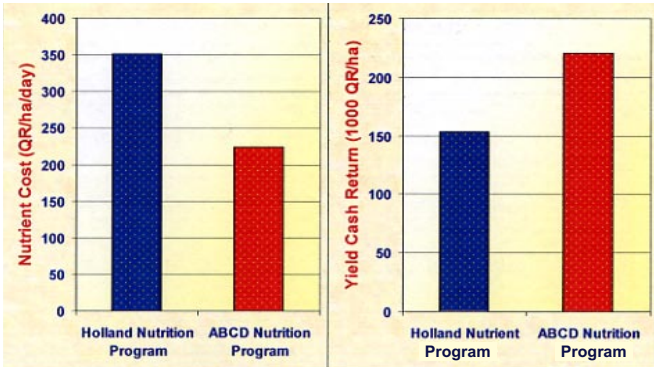


Fig. 3. Comparison between Holland and ABCD nutrition programs in terms of nutrition cost and total yield cash return in Qatari Ryals (QR) for cucumber crop grown under cold glasshouse conditions during the summer season of 2004.

the Holland nutrition program by the ABCD one for all vegetable crops grown, either in cold or non-cold greenhouses as well as for those grown in open fields since 2004. Data obtained during the subsequent seasons (after the summer season of 2004) indicated a marked yield increase of all crops grown with ABCD nutrition program than those produced using Holland nutrition program. Furthermore, ABCD nutrition program is recommended for the farms or soils suffering from alkaline conditions with pH values ranging between 8.1 and 8.3.

**Acknowledgement:** The author expresses his deep gratitude to AQAPCo for its unlimited support and facilities offered and to AAAID for its continuous support.

## References

- Akhtar, A. and Malik, A. 2000. Roles of organic soil amendments and soil organisms in the biological control of plant parasitic nematodes: A review. *Biore-source Technology*, 74, 1.
- Atta-Aly, M. A. 2002. Performance Evaluation Report of the Arab-Qatari Agricultural Production Company (AQAPCo). Arab Authority for Agricultural Investment and Development (AAAID), Unpublished.
- Atta-Aly, M. A. 2006a. Rehabilitation Programs of the Arab-Qatari Agricultural Production Company-Arab

- Authority for Agricultural Investment and Development. 1. Effect of soil solarization on cucumber production under cold glasshouse conditions. ISHS International Symposium on Advances in Soil and Soilless Cultivation under Protected Environment, Agadir, Morocco, 19-24 February 2006.
- Atta-Aly, M. A. 2006b. Rehabilitation Programs of the Arab-Qatari Agricultural Production Company-Arab Authority for Agricultural Investment and Development. 2. Long-term impact of soil solarization on cucumber production under cold greenhouse conditions. ISHS International Symposium on Advances in Soil and Soilless Cultivation under Protected Environment, Agadir, Morocco, 19-24 February 2006.
- Atta-Aly, M. A.; Aly, M. K. and Ebrahim, A. A. 2003. Performance Evaluation Report of the Arab-Qatari Agricultural Production Company (AQAPCo). Arab Authority for Agricultural Investment and Development (AAAID), Unpublished.
- Barker, K. R. and Koenning, S. R. 1998. Developing sustainable systems for nematode management. *Ann. Rev. Phytopathology*, 36,165.
- Busman, L.; Lamb, J.; Randal, G.; Rehm, G. and Schmitt, M. 1998. The nature of phosphorus in soils. *Univ. Minnesota Ext. Service*, FO-6795-GO.
- Chellami, D. O. and Olson, S. M. 1997. Adaptation of soil solarization to the integrated management of soilborn pests of tomato under humid conditions. *Phytopathology*, March, p. 250.
- Epstein, E. 1972. *Mineral Nutrition of Plants: Principles and Perspectives*. John Wiley & Sons, Inc., New York, USA.
- Little, T. M. and Hills, F. J. 1978. *Agricultural Experimentation*. John Wiley & Sons, Inc., New York, USDA, p. 31.
- Rasheed, N. H.; Alani, A. N.; Atta-Aly, M. A.; El-Habib, M. A. and Hassan, B. 2001. Performance evaluation report of the Arab-Qatari Agricultural Production Company (AQAPCo). Arab Authority for Agricultural Investment and Development (AAAID), Unpublished.
- Stirling, G. R. 1991. *Biological Control of Plant Parasitic Nematodes*. CAB International, Wallingford, UK, p. 1.
- Wicks, T. J. 1988. Effect of solarization on the control of *Phytophthora cambivora* in almond and cherry. *Aust. J. Exp. Agric.*, 28, 539.

## إدخال نظام تسميدي جديد لإنتاج الخيار بالشركة العربية القطرية للإنتاج الزراعي تحت ظروف البيوت المحمية المبردة

مُرَضِي عبد العظيم عطا علي<sup>1</sup>

### الخلاصة

تمت زراعة صنف الخيار الهجين سهيل (Sohail) داخل البيوت المحمية المُبرَّدة خلال الموسمين الصيفيين المتعاقبين لعامي 2003 و 2004 وتم تسميده بنظامي تسميد مختلفين هما نظام التسميد الهولندي Holland (مُعَامَلَة مُقَارَنَة) ونظام التسميد بمحاليل ABCD، وتمَّت المُقَارَنَة بين النظامين من حيث الإنتاج وتكاليف البرنامج التسميدي والعائد النقدي. أدى التسميد بنظام محاليل ABCD إلى زيادة عالية المعنوية في المحصول الثمري للخيار وإلى إطالة كبيرة في فترة الحصاد مُقَارَنَة بنظام التسميد الهولندي، بالإضافة إلى انخفاض تكلفة التسميد بنظام محاليل ABCD وزيادة العائد النقدي لمحصول الخيار الناتج عند استخدامه في التسميد مُقَارَنَة بنظام التسميد الهولندي.

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