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Polar Horticulture Report of Tenth Antarctic Expedition

R. P. JOSHI

Defence Agricultural Research Laboratory, Defence Research & Development Organization, HaIdwani-263 139

Introduction

Antarctica lacks higher forms of plants except few species of grasses. However, lower plant species like algae, mosses and lichens exist, maintain their survival during winter and grow very slowly in summer when snow melts in lakes and stream begin to flow, In such a place where there is a harsh combination of rapidly changing temperature, strong dry winds, irregular nutrient and water supply, frequent snow drifts and blizzards, the only way of growing plants is through protected cultivation.

DARL suggested a plan for establishing a green house for cultivation of vegetables at Maitri, in the Schirmacher Oasis (Queen Maud Land-East Antarctica). In a properly oriented green house, as at Maitri, auxiliary heating is not required during summer months except during high speed winds and blizzards. During Ninth Antarctic Expedition some vegetables like tomato, coriander and few flowers were grown in greenhouse. The environmental control systems were non functional. The temperature was being maintained manually to some extent.

Taking into consideration the space available for cultivation, it was decided to do experiments in hydroponics and peat moss. Instead of pots, wooden and cardboard boxes with inner polythene lining were used for proper utilization of the available space. Due to the limitation in green house size, all the aspects projected for wintering period could not be undertaken. However, the important ones viz., establishment of hydroponic system for growing vegetables in greenhouse and performance of different vegetables during polar night and day at Maitri were attended to. Vegetable crops grown during the polar night and days were mainly tomato, cucumber, chilli, capsicum, brinjal, beans and leafy vegetables like coriander, *methi,* spinach, lettuce, celery, radish etc. Some of these crops were in hydroponics and peat moss but the leafy vegetables were mainly tried in peat moss.

To have regular production of vegetables at Maitri, seeds of respective vegetables were sown as and when the space was available. During the summer season of 1990-91 the sowing of different vegetable seeds was done on priority basis. Data

regarding their germination and growth etc. was taken. The hydroponic system was designed and fabricated and made functional on 8th Feb. 1991. Tomato was the main crop in hydroponics; other crops were grown in peat moss. Successful production of tomato, cucumber, chilli, lettuce, coriander, *methi,* spinach, apart from flowers etc., was an achievement during the expedition.

Materials and Methods

Establishment of Hydroponic System

The artificial culture for growing plants in some medium other than soil has played a vital role in the advancement of knowledge about plants and their requirement (Bridwell, 1974; Douglas, 1976; Resh, 1981 etc). Higher yields of various crops have been reported. Hydroponics basically is the method of growing plants in water with certain essential macro nutrients i.e., calcium, phosphorus, potassium, magnesium, sulphur, nitrogen and micronutrients like zinc, copper, boron, molybdenum, manganese and iron. These are solely responsible for plant growth and development.

Structurally many systems exist for hydroponic cultivation but one developed at Maitri was a modified closed type of nutrient film technique. A 490 cm long, 60 cm wide and 8 cm high frame was made using 2.5 cm thick wooden planks. It was fixed on a raised long platform towards the east side of the green house. It was lined internally by thick double sheet of polythene. One opening at 5 cm and another at 2 cm were made and flexible conduit pipes were attached. The former was for incoming nutrient supply and latter for drainage. One plastic tank of 150 litre capacity was placed below the level of the trench. Small pump was installed with , its suction fixed at the bottom of the reservoir and its delivery to the inlet of cultivation trench. The drainage pipe of cultivation trench was kept above the reservoir, making it a closed system. The slope of the cultivation trough was adjusted in such a way that there was no stagnation of solution. It also helped in uniform flow of nutrient solution and aeration to the roots of growing plants.

The importance of aeration of the rooting media for growth of plant has long been recognized and has been the subject of a considerable amount of research (Grable, 1966). It is difficult to separate the effect of aeration, supply of water and nutrients and mechanical resistance in soil. In nutrient solution, the situation is simpler as the supply of water to roots is never limiting and the mechanical resistance of the media to root growth is negligible (Troughton, 1972). Degree of aeration i.e. under and over aeration also varies among species (Hewitt, 1966).

While most plants grow well in a continuously flowing solution, it becomes advantageous to intermittently turn the pump on and off as the plants get older (Harry *et al.,* 1982).

When the root system enlarges and forms a dense mat on the bottom of the trough the movement of oxygen to the roots, even in thin film of nutrient solution, may be limiting. Solution should drain from the trough exposing the roots to the air, at the same time the roots should remain moist and never allowed to become dry. For this a sequential timer was used to operate the pump and the on/off timing was regulated according to the state of crop growing.

Control of growth is especially important in the early stage of plant development (Hunter, 1989). Excessive vegetative growth and the abortion of early trusses, all too rapidly, occur in nutrient film technique systems (Cooper *et al.,* 1968), particularly in low light intensities. Effective control may be exercised by restricting the water supply to the plants (Graves *et al.,* 1983). Flow time should be increased as light level improves and day temperature rises.

Stock solution of various nutrients was made and applied in correct concentration depending upon the stage of plant growth. The following was the main nutrient combination (Hoagland, 1950).

Salt	Stock solution gm/lit	Final solution ml/litre
$Ca(NO_3)_2.4H_2O$	236.2	5
KNO_3	101.1	5
KH_2PO_4	136.1	1
$MgSO_4.7H_2O$	246.5	2

Iron was given as ferric citrate at a rate of 5 ppm and the rest of micro nutrient were used in the following concentration:

Element	Concentration ppm	Salt
B	0.5	H_3BO_3
Mn	0.05	$MnSO_4H_2O$
Zn	0.05	$ZnSO_47H_2O$
Cu	0.02	$CuSO_4.5H_2O$
Mo	0.01	$(NH_4)6Mo_7O_{24}.4H_2O$

Water used for growing plants was the same that was used for drinking purpose in Maitri station. The pH is slightly acidic (6.4), which is best for tomato. It is also free from heavy metals (Nijampurkar, 1988).

Seedlings of tomato, chilli and capsicum were grown separately on peat moss in special cuptrays. Rock wool (a type of glass wool) were cut in size of 75 cm x 75 cm x 70 cm and placed along the trough. Seedlings were transferred to these blocks. Long black polythene strips were nailed along the length of trough on both sides, they were fixed in such a way that they covered the nutrient solution, the rock wool slabs and the roots from sunlight and had gaps for air exchange also.

Initially the concentration of the flowing nutrient solution was kept one fourth of the original i.e. for seedling establishment. After 15 days it was increased to 1/2 and finally when plants developed flowers and fruits, the normal concentration was used.

Addition of nutrient solution was done after 30 days during seedling establishment. Later it was done after 15 days. The solution level in the reservoir was maintained at a constant EC level using water (when plants were small) or dilute nutrient solutions (1/2 or 1/4 of the original concentration) when the plants matured. Some times it was essential to drain out solution of the reservoir to avoid plants from high salt concentration, problem which generally results in a closed nutrient film technique system where the level of unwanted elements for plants rises.

Visual diagnosis was the only tool for monitoring nutrient status of the plants at Maitri whenever such instances occur,'foliar spray of respective nutrient at correct concentration helped to get rid of the deficiency before the same was added to solution.

Almost all the tomato cultivars were transplanted on 8th Feb 91. As soon as their growth started, sunshine hours for the green house began to reduce. Owing to lesser solar radiations, these plants grew tall. Chilli and capsicum seedlings were comparatively small when they were transplanted on 18th Feb. 91.

Results and Discussion

Tomato varieties namely Marglobe, Hy.UHN-52, Hy.Beef Master Difuzzed, Hy UHN-63 grew tall due to lessening sunshine hours. These plants were pruned in such a fashion that they formed a horizontal canopy that could be provided with supplementary light with ease. Flowering started in April in almost every cultivar of tomato except Beef Master difuzzed, which exhibited only vegetative growth. Its flower trusses were rather rudimentary and did not develop flowers. It was ultimately roughed out. The plants were staked properly with the help of nylon strings. During the flowering period vibration, given to flowers by stroking the strings that held the tomato plants, played a significant role in fruit set. It was done regularly by hands.

Fruit set is the vital event for production. Artificial pollination must be provided in a green house for good fruit setting. Instead of an electric vibrator, supported wires were struck regularly for fruit set as suggested by Cebula (1988), although Tzombankis (1984) and Smardas and Petrakis (1984) did referred electric vibrators.

Besides vibration of flowers, temperature has undoubtedly the most significant effect on fruit set (Dhaliwal, 1989). Although tomato plants can grow under a wide range of temperature, fruit set is limited to a relatively narrow range (Kuo *et al.,* 1978). The optimum night temperature range being 15-20^{o}C (Went & Cosper,

Fig, 1. Tomato cultivars in Hydroponics.

1945). The minimum temperature of green house at Maitri was not detrimental to fruit set as low temperature at night causes flower drop resulting in limited fruit set. Flower drop is also associated with injuries caused by high night temperature (Went, 1944) or high day temperature (Iwahori, 1965). The latter situation was delayed by placing high pressure vapour lamps at a height above plant canopy that did not cause temperature to rise too much. Higher temperatures cause style elongation and thus stigma exerts out beyond the anther cone which affects self pollination, even after vibration specially in flowers that are upright.

Arctic tomato cultivars namely Sub Arctic Planty, Sub Arctic Cherry, Early Sub Arctic, Arctic midi and Arctic maxi were early yielding (Harris, 1972 & 1975) and started ripening after 106 days after transplanting i.e. at the end of May and lasted upto July. Here at Maitri Arctic midi produced more number of fruits and average fruit weight was also higher than all other cultivars. Average fruit yield per plant was maximum in Arctic midi (0.550 kg). Minimum yield per plant was in Sub Arctic cherry (0.170 kg). Although more in number; over all production in terms of fruit yield per plant was very small.

Among large fruited varieties Marglobe showed highest yield of 1.490 kg per plant, average fruit weight being 62 gms, followed by Hy Big boy 1.440 kg per plant. Average fruit weight was 96 gm although number of fruits per plant was less.

Hy. UHN-63 and UHN-52 gave 0.980 kg and 0.750 kg per plant with an average fruit weight of 61 and 44 gras, respectively.

One of the chilli varieties Pant-C 1 did not grow well in this nutrient combination, however variety Pusa Jwala grew well, flowering started after the 1st week of May i.e. 72 days after transplanting. Green chilli production in this variety started after 14th June 1991 and continued till Dec. 1991 (116-323 days after transplanting). Chillies were very pungent, average, fruit weight being 1.9 gm, No. of fruits per plant 166 and an average green chilli yield of 0.315 kg per plant was recorded. Capsicum Bharat was found not too productive, fruit size was small and weight was less (only 40 gm). Number of fruits per plant were only two. Most of the flowers did not produce fruits.

In the 2nd season, 16 tomato cultivars were transplanted on rockwool slabs on 12th Sept 91. Meanwhile the width of the trough was reduced by half and the place away from the glass was used as NFT trough. It was done firstly to prevent plants from damage due to snow accumulation along the glass panes during blizzards even after complete sealing; secondly to create space for curtain operations and thirdly, to prevent the gypsum falling down during strong winds from mixing with the nutrient solution. Gypsum was used by the previous wintering team as a sealing material for the greenhouse. In hydroponics it created problems associated with nutrient balance.

For this experiment, the earlier formulation of nutrients was changed, solution flow rate and size of rockwool block was kept the same. The basic components of macro-nutrients in the solution for the latter half was as follows:-

Element	Concentration (m eq/ltr)	Salt used
Ca	3	$Ca(N0_3)2.4H_20$
$N0_3$	5.7	-do-
K	4	KNO_3
PO4	2	KH_2PO_4
Mo	2	$MgS0_4$
S	2	-do-

Micronutrient composition was kept the same as in the winter experiment. No supplementary light was given to plants. All plants were pruned in such a way that only three or four stems per plant were left. Pruning permits closure planting, increases early yield of fruits and facilitate spraying and harvesting of fruits. (Edmund *et al,* 1979). Pruning may be defined as the process of removing side shoots when small and older lower leaves (Walls, 1983). The effect of pruning on tomato yield has been studied by a number of workers (Weibe, 1969; Wvrster *et al.,* 1971; Burgis and Lewis, 1975; Anserwadekar *et al,* 1980). Flowering started during October and November 1991. Ripening started in December 1991. The crop

Table 1: Performance of Tomato and Chilli in Hydroponic in Maitri Green House during Polar Nights

	Tomato	Chilli
Sowing date	16.1.91	2.1.91
Transplanting date	8.2.91	18.2.91

Characters	1	2	3	4	5	6	7	8
Tomato								
Marglobe	6	66	71	124	133-200	24	62	1.490
Hy UHN-52	9	70	79	131	-do-	17	44	0.750
Hy UHN-63	9	69	74	110	-do-	16	61	0.980
Sub Arctic Plenty	6	59	64	98	111-147	19	19	0.360
Hy Big boy	5	78	84	131	133-200	15	96	1.440
Sub Arctic Cherry	9	64	70	108	111-147	20	8.5	0.170
Arctic Midi	9	67	73	109	111-147	29	19	0.550
Early Sub Arctic	9	61	66	106	111-147	23	15.6	0.360
Arctic Maxi	7	67	72	108	111-147	21	10.5	0.220
Chilli								
Pusa Jwala	27	72	80	130	116-323	166	1.9	0.315
Capsicum Bharat	19	75	81	138	—	2	40	0.080

Characters : * 1. Days taken for germination; 2. Days taken for 1st flowering; 3. Days to first fruit set; 4. Days to first fruit ripening; 5. Harvesting period; 6. No. of fruits per plant; 7. Weight of average mature fruit (g); 8. Fruit yield per plant (kg)

was harvested completely on 7.1.92 to create space for summer experiments. The basic information is tabulated in Table 2.

There was marked difference in fruit yield per plant amongst 16 tomato cultivars. Hybrid Big boy yielded 2.430 kg per plant followed by Hybrid Mangala 2.390 kg, Hybrid Better boy 2.210 kg, Marglobe 1.900 kg, Hybrid Rajani 1.770 kg, Master No. 3 1.710 kg per plant. Minimum yield 0.630 kg per plant was in variety UHN-63. These varieties also vary in number of fruits per plant. Maximum 37 fruits in Pusa Sheetal and minimum 8 fruits were in Money maker. Average fruit weight also varied amongst varieties. Maximum fruit weight 135 g (Hybrid Big boy) followed by Beef Master defused (85 g), Better boy (79 g), Hybrid Mangala (79.6 g). A minimum fruit weight was found in Hybrid Rupali (27.5 g).

Chilli plants from the previous winter experiments are still flowering and fruiting in this nutrient combination. Arctic tomatoes were not tried in the summer experiments under Hydroponics.

Table 2: Performance of Tomato Cultivars in Hydroponics during Polar Days in Maitri Green House

Sowing date: 22.8.1991
Transplanting date: 12.9.1991
Date of final harvest: 7.1.1992

Characters*	1	2	3	4	5	6	7	8
Money Maker	11	61	68	106	8	54.0	0.430	239.0
Hy Mangala	7	46	52	93	30	79.6	2.390	233.0
Hy Rashmi	6	74	83	—	17	36.6	0.620	202.5
Hy Rajani	9	53	60	99	32	55.2	1.770	177.5
Hy Rupali	6	46	52	100	26	27.5	0.715	220.0
Hy Naveen	6	56	64	99	30	38.7	1.160	222.5
Pusa Sheetal	7	48	56	102	37	39.2	1.450	187.0
Hy UHN-63	8	74	80	—	14	45.0	0.630	278.0
Hy Big Boy	9	46	54	94	18	135.0	2.430	205.0
Hy Beef Master De-fuzzed	6	82	86	106	9	85.0	0.765	311.5
Hy Better Boy	9	43	51	98	28	79.0	2.210	217.0
Marglobe	7	47	53	99	33	57.5	1.900	251.0
Master No. 3	8	27	32	92	24	71.4	1.710	246.0
Hy UAN-52	9	45	51	91	25	48.3	1.210	198.5
IAHS-88-1	8	60	—	—	No fruit set till 7.1.92			
Pant Bahar	8	48	58	98	27	48.9	1.320	173.5

Characters : 1, Days taken for germination; 2. Days from transplanting to 1st flowering; 3. Days from transplanting to 1st fruit set; 4. Days from transplanting to 1st fruit ripening; 5. Number of fruit per plant; 6. Average fruit weight (g); 7. Fruit yield per plant (kg); 8. Plant height at final harvest (cm).

Comparative Performance of Different Varieties of Vegetable Crops in Greenhouse at Maitri and Continuous Production Procedure of Vegetables all the Year Round

For studying the comparative performance of different varieties of vegetable crops, certain crops were taken in peat moss. Tomato and cucumber were grown round the year. The first crop of tomato was transplanted into pots using peat moss on 22.1.91. Flowering started after the second week of March and fruit ripening began mainly in April. Harvesting continued till 28.7.91 (Table 3A).

Early fruit ripening was in Hybrid SG-12 (93 days after transplanting) whereas in variety Marglobe first fruit ripening took 112 days. Number of fruits were more in SG-12 although average fruit weight was less (35 g). The yield per plant was

Table 3A: Comparative Performance of Tomato Cultivars during Polar Night in Peatmoss

Sowing date: 2.1.91
Transplanting date: 22.1.91
Date of final harvest: 28.7.91

Characters*	1	2	3	4	5	6	7	8	9	10
Marglobe	5	64	71	112	117-187	36	59.7	2.150	145.0	5
Hy SG-12	7	56	61	93	97-187	52	35.0	2.170	89.5	6
HT-8	5	59	65	94	99-187	43	37.0	1.590	78.5	4
HT-6	5	62	66	99	107-187	45	42.4	1.900	97.5	5

Characters: 1. Days taken for germination; 2. Days taken from transplanting to 1st flowering; 3. Days taken from transplanting to 1st fruit set; 4. Days taken from transplanting 1st fruit ripening; 5. Harvesting period (days from transplanting); 6. No. of fruits per plant; 7. Average fruit weight (gms); 8. Fruit yield per plant (kgs); 9. Plant height at final harvest (cm); 10. No. of primary branches.

Table 3B: Performance of Chilli Varieties in Peat Moss in Maitri Green House

Sowing Date: 2.1.91
Transplanting date : 15.2.91

Characters*	1	2	3	4	5	6	7	8	9	10	11
Bharat	16	129	146	21	208	9.3	3.3	2.5	209	0.523	122.0
PantC-1	27	178	183	18	248	7.3	2.0	1.4	297	0.415	68.0
Pusa Jwala	27	116	119	20	162	10.0	2.8	2.1	285	0.596	57.5

Characters : 1. Days taken in germination; 2. Days from transplanting to first flowering; 3. Days from transplanting to first fruit set; 4. Days from 1st fruit set to pungency; 5. Days from transplanting to 1st fruit ripening; 6. Average fruit length; 7. Average fruit girth; 8. Average fruit weight; 9. Number of fruits per plant; 10. Fruit yield (green) per plant (kg); 11. Plant height at final harvest (cm).

2.150 kg in Marglobe, 2.170 kg in Hybrid SG-12, 1.590 kg in HT-8 and 1.900 kg in HT-6.

After May, artificial light was provided using high pressure sodium vapour lamps that were placed 1/2 m above the plant canopy. Vibration to flowers was given regularly to have good fruit set. Dwarf varieties except Marglobe were tried. Weekly irrigation was given with the same solution as that of Hydroponic Occasional spray of 0.1% urea solution with micronutrient was done. In order to check calcium deficiency that frequently developed in peat moss, 0.015% foliar spray of calcium nitrate was done every fortnightly.

The second crop was transplanted on 9.8.91. Few varieties with hybrids were tried. Fruit set started in October 1991 and harvesting continued till 7.1.92 when the

Table 4: Comparative Performance of Tomato Cultivars during Polar Days in Maitri Green House Using Peat Moss

Sowing date: 22.7.91
Transplanting date: 9.8.91
Date of final harvest 7.1.92

Characters	1	2	3	4	5	6	7	8	9	10
Pusa Sheetal	7	49	54	94	106-151	43	32.2	1.390	152.5	5
Hybrid Karnataka	5	67	73	114	117-151	28	82.0	2.300	178.0	4
Hy SG-12	7	52	57	91	106-151	40	51.8	2.070	97.5	6
Hybrid Mangala	7	59	63	104	109-151	31	73.4	2.275	129.0	4
Hybrid Naveen	6	52	59	108	128-151	33	37.3	1.230	143.5	3
Marglobe	7	55	60	98	118-151	49	52.1	2.550	168.0	4

1. Days taken for germination; 2. Days from transplanting to first flowering; 3, Days from transplanting to 1st fruit set; 4. Days from transplanting to 1st fruit ripening; 5. Harvesting period (days from trans planting); 6.Number of fruits per plant; 7. Average fruit weight (g); 8. Fruit yield per plant (kg); 9. Plant height at final harvest (cm); 10. Number of primary branches.

crop was finally harvested to make space for summer scientific experiments (Table 4).

60 to 73 days were taken from transplanting to first fruit set by different tomato cultivars. Number of fruits per plant were highest in variety Marglobe (49) and minimum in Hybrid Karnataka (28). In hybrid Karnataka and Hybrid Mangala average fruit weight was higher i.e. 82.0 and 73.4 g respectively. In both varieties number of fruits per plant were less (28 and 31, respectively). Over all yield per plant was highest in Marglobe (2.550 kg), Hybrid Karnataka (2.300 kg), Hybrid Mangala (2.275 kg), Hybrid SG-12 (2.070 kg), Pusa sheetal (1.390 kg) and Hybrid Naveen (1.230 kg).

Three chilli varieties were transplanted on 15.2.91. These were Bharat, Pant C-l and Pusa Jwala. First flowering was 129, 178 and 116 days after transplanting, respectively. Number of fruits were 209, 297 and 285 and green chilli yield was 0.523 kg per plant for Bharat, 0.415 kg for Pant C-l and 0.596 kg for Pusa Jwala was recorded. The hottest was Pant C-l followed by Pusa Jwala. The Bharat was not too pungent (Table 3B).

Four Arctic cultivars of tomato were transplanted on 7.9.91. Fruit began to develop in the end of October. Harvesting started after 7.12.91. The yield per plant was not too much due to the small size of fruits (Table 5).

Sub Arctic plenty yielded 1.065 kg per plant followed by Arctic Midi 0.680 kg per plant, Arctic Maxi 0.580 kg and Arctic Cherry 0.425 kg per plant. Number of

Table 5: Comparative Performance of Arctic Tomato Cultivars during Polar Days at Maitri Green House Using Peat Moss

Sowing date: 22.8.91
Transplanting date: 7.9.91
Date of final harvest: 7.1.92

Characters*	1	2	3	4	5	6	7	8	9	10
Sub Arctic Plenty	6	51	55	83	91-122	36	29.6	1.065	68.5	3
Arctic Midi	7	41	53	79	-do-	32	21.2	0.680	62.0	4
Arctic Maxi	9	45	48	77	-do-	29	20.0	0.580	52.5	4
Sub Arctic Cherry	6	49	53	83	-do-	42	10.1	0.425	48.0	4

Characters : 1. Days taken for germination; 2. Days from transplanting to lst flowering; 3. Days from transplanting to 1st fruit set; 4. Days from transplanting to 1st fruit ripening; 5. Harvesting period (days from transplanting); 6. Number of fruits per plant; 7. Average fruit weight (g); 8. Fruit yield per plant (kg); 9. Fruit height at final harvest (cm); 10. Number of primary branches,

fruits per plant were highest in cherry variety (42) but the average fruit weight was less (10.1 g).

Cucumber varieties were tried throughout the year. The first transplanting was on 22.2.91. The performance was different depending upon the variety and transplanting date. Pollination was done artificially. The crop harvesting started after 15.6.91 and continued till the end of the year.

In cultivar DARL Sel that was transplanted on 22.2.91 first female flower appeared after 42 days of transplanting. It took 71 days and only 220 g fruit was harvested. Then female flower production was almost ceased. Tip pinching was done. After 130 days two female flowers were formed that were harvested 31 days after pollination and the fruit weight was only 70 and 85 g. After 206 days of transplanting i.e. in the month of September, many more female flowers were developed, pollinated and harvested. These took less time to grow and an average of 340 g fruits with an average length and dia. of 21 cm and 16 cm were harvested. It clearly indicates that the sunshine hours and intensity both play vital role in the production of large size and early maturing fruits. During wintering, small size was due to non-availability of sun light and less artificial illumination. Because the vines were quite higher than the light source and only diffused radiation upto 300 to 500 lux was available to their leaves. This crop yielded 1.730 kg per plant in 246 days. The second crop of the same variety that was transplanted on 28.8.91 an average yield of 1.175 kg per plant was harvested within 121 days. Average fruit weight was higher (390 g) in contrast to previous crop (247 g).

In cultivar Hybrid Priya 130 g fruit was harvested from the plant transplanted in March 91 and 175 g fruit from plant transplanted in May 91. Three more plantings

Fig, 2. Cucumber cultivars in peat moss.

were done in June, July and August. Average fruit weight was 423 g, 261 g and 322 g, respectively.

Four cultivars of cucumber viz., Hybrid Priya, Sweet slice, Money maker and Bush crop were transplanted on 12.8.91. Variety Hybrid Priya produced an average of 4 fruits per plant. Average time taken from pollination till harvest of the fruit was 18 days. Fruit length and diameter were 21 and 17.4 cm, respectively. Total yield per plant was 1.215 kg. The crop took 109 days from transplanting till complete harvest. In variety Sweet slice first female flower developed after 46 days of transplanting which was harvested after 26 days. Length and diameter were 24.2 and 17.6 cm, respectively. Fruit weight was 340 g. The plant gave total 4 fruits weighing 1.070 kg. In variety Money maker, days taken from pollination till harvest of an average fruit were 16 and average fruit weight was 357 g. In variety Bush crop number of fruits per plant were 5. An average fruit weight was 202 g (Table 9).

Five spinach varieties viz., All green, Banarasi, Olympia, Barker, Jopner green were sown on 3.4.91 in peat moss. Their growth was quite good. Harvesting was done on 5.7.91. Variety Barker gave highest yield 2.830 kg per sq.m., followed by Olympia 2.700 kg per sq.m., All green 2.360 kg per sq.m., Jopner green 1.780 kg per sq.m and Banarasi 1.230 kg per sq.m All varieties varied 45 to 53.3 cm in height and 17 to 35 in number of leaf per plant (Table 6).

Table 6: Comparative Performance of Spinach Varieties during Polar Nights in Maitri Green House Using Peat Moss

Sowing date: 3.4.91

Date of final harvest: 5.7.91

Characters*	1	2	3	4	5	6
All Green	7	51.5	17	17.675	141.400	2.360
Banarasi	11	45.0	35	9.235	73.880	1.230
Olympia	6	53.5	32	20.276	162.210	2.700
Barker	7	45.5	29	21.217	169.736	2.830
Jopner Green	7	50.0	31	13.335	106.664	1.780

Characters : *1. Days taken for germination; 2. Plant height at harvest; 3. No. of leaves per plant; 4. Fresh weight per plant (gms); 5. Yield per plot (gms); 6. Yield per m^2 (kgs).

Table 7: Performance of Lettuce Curing Polar Day and Night in Maitri Green House Using Peat Moss

1	2	3	4	5	6	7*
05.04.91	15.04.91	25.04,91	24.08.91	51.7	13	17.2
25.04.91	29.04.91	13.05.91	19.06.91	31.5	17	7.2
06.06.91	11.06.91	26.06.91	15.08.91	21.5	9	10.3
12.06.91	22.06.91	13.07.91	16.10.91	48.5	48	240.0
24.08.91	12.09.91	26.09.91	04.12.91	35.4	41	235.0
24.08.91	12.09.91	26.09.91	12.12.91	40.5	45	255.0

Characters : *1, Sowing Date; 2. Date of Germination; 3. Transplanting Date; 4. Date of Harvest; 5. Plant height at harvest (in cm); 6. Number of leaf per plant; 7. Fresh weight of leaves per plant (in g).

Table 8: Performance of Coriander (Bulgarian) during Polar Night and Day in Maitri Green House Using Peat Moss

1	2	3	4	5	6	7	8*
24.04.91	02.05.91	09.08.91	32.3	17	4.150	99.60	0.772
27.04.91	05.05.91	09.06.91	28.5	7	1.685	40.40	0.313
20.06.91	27.06.91	15.08.91	12.5	8	2.750	66.00	0.512
03.07.91	11.07.91	18.09.91	26.0	13	2.065	49.60	0.384
21.09.91	28.09.91	23.12.91	32.5	16	5.375	129.0	1.000

Characters : *1. Sowing date; 2, Date of germination; 3. Date of harvest; 4. Plain Height nt harvest (in cm); 5. Number of leaf per plant; 6. Fresh weight of leaves per plant (in g); 7. Yield per plot (in g); 8. Yield per sq.m.(in kg).

Table 9 : Comparative Performance of Cucumber Varieties during Polar Night and Days in Maitri Green House Using Peat Moss

Variety	Transplant date	Pollination date	Harvest date	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)
DARL-Sel	22.02.91	05.04.91	15.06.91	16.0	17.5	220
		02.07.91	02.08.91	07.5	08.0	070
		03.07.91	02.08.91.	07.0	10.5	0.85
		26.07.91	15.08.91	14.5	14.0	325
		16.09.91	04.10.91	26.0	17.0	415
		25.09.91	24.10.91	22.0	15.0	280
		25.09.91	26.10.91	23.0	18.0	335
Hy-Priya	23.03.91	05.06.91	13.07.91	14.5	18.0	130
	04.05.91	11.07.91	09.08.91	23.0	16.5	275
		18.07.91	15.08.91	11.7	12.5	180
		16.09.91	22.10.91	20.0	16.5	245
		17.10.91	04.11.91	28.0	16.5	330
		16.11.91	23.12.91	27.0	21.7	560
	21.05.91	28.07.91	15.08.91	11.5	13.2	175
	09.06.91	25.08.91	12.09.91	22.0	13.5	375
		17.09.91	05.10.91	18.0	14.0	275
		12.10.91	30.10.91	23.5	17.5	375
		05.11.91	23.11.91	31.0	21.2	730
		12.11.91	24.12.91	23.0	19.7	400
	03.07.91	20.08.91	03.09.91	25.0	15.5	315
		14.09.91	29.09.91	19.5	16.5	245
		18.09.91	05.10.91	19.7	16.4	225
	12.08.91	14.10.91	30.10.91	20.2	16.2	225
		17.10.91	07.11.91	23.5	17.5	380
		29.10.91	29.11.91	22.0	17.5	360
		31.11.91	20.12.91	19.7	17.0	325
DARL-Sel	28.08.91	07.11.91	27.12.91	24.0	20.5	675
		08.11.91	27.11.91	16.5	14.5	230
		09.12.91	27.12.91	16.5	16.0	270

Contd..

Table 9: *contd.*

Hy-Priya	12.09.91	29.10.91	15.11.91	21.5	14.0	210
		10.11.91	23.11.91	18.5	16.4	200
		12.11.91	23.11.91	17.5	16.2	275
		28.11.91	30.12.91	27.5	23.0	460
Hy-Sweet slice	12.09.91	28.10.91	23.11.91	24.2	17.6	540
		11.11.91	03.12.91	22.5	17.5	320
		26.11.91	22.12.91	19.6	15.2	210
		04.12.91	22.12.91	18.0	13.7	200
HY-Money maker	12.09.91	12.11.91	28.11,91	18.5	15.2	270
		13.11.91	03.12.91	22.5	17.5	365
		09.12.91	22.12.91	18.0	12.0	315
HY-Bush crop	12.09.91	01.11.91	23.11.91	18.0	13.3	160
		09.11.91	23.11.91	13.0	13.0	100
		30.11.91	24.12.91	22.0	15.2	250
		30.11.91	30.12.91	22.5	18.5	310
		01.12.91	22.12.91	19.0	14.2	190

Table 10: Comparative Performance of *Methi* Varieties during Polar Night in Maitri Green House Using Peat Moss

Size of Cultivation Troughs - 43 x 30 cm

Variety	*1	2	3	4	5	6	. 7	8	9	10
Pusa	01.07	05.07	27.07	075	04.08	50	25.08	45	170	1.320
Kashmiri	31.08	05.09	15.10	085	14.11	75	01.12	40	200	1.550
Early	01.07	07,07	27.07	080	04.08	55	25.08	55	190	1.470
Bunches	31.08	03.09	15.10	102	14.11	95	01.12	56	253	1.960
Pusa	01.07	05.07	27.07	70	04.08	30	25.08	47	147	1.140
Kasuri	31.08	02.09	15.10	90	14.11	90	01.12	45	225	1.740

Character: * 1 - Sowing Date; 2 - Date of Germination; 3 - Date of First Cutting; 4 - Fresh Weight in Grams; 5 - Date of Second Cutting; 6 - Fresh Weight in Grams; 7 - Date of Third Cutting; 8 - Fresh Weight in Grams; 9 - Total Yield per Trough; 10 - Yield per sq.m. (in kg).

Table 11: Performance of Bean Varieties in Maitri Green House

Sowing Date: 22.8.91
Harvesting Date ; 19.11.91

Characters*	1	2	3	4	5	6	7
Pusa Contender	7	38	43	4	13.8	16	48.5
Pusa Parvati	26	36	42	3	11.8	9	55.0
VLBauni-1	4	28	34	5	11.9	15	45.5
VL-5	4	37	42	4	9.3	19	49.5
Sel-4	5	30	33	4	12.0	14	52.0
P2	4	45	50	3	6.6	24	77.5

Characters: *1. Days taken for germination; 2. Days taken for flowering; 3. Days to 1 st pod set; 4. No. of pods per cluster; 5. Av. pod length cm; 6. No, of pods per plant; 7. Plant height at final harvest (cm).

Fig, 3. Brinjal in peat moss.

Fig. 4. Flowers/ornamental plants grown throughout the year.

Lettuce that was grown during April and May showed lesser fresh weight per plant but that was shown during onset of summer grew healthy. An average plant weight of 235 g and 255 g per plant was harvested. The no. of leaves per plant were 41 and 45 (Table 7).

Five varieties of radish viz. JWL, National, Fire candle, Cherry bell and scarlet globe were sown from time to time. Their germination was good but subsequent growth was not satisfactory. Only variety Scarlet globe that was sown on 20.6.91 produced roots. Roots were harvested on 3.9.91. Average length and diameter of root was 13.5 and 16.5 cm, average weight 125 gm, no. of leaves 13 were recorded.

Brinjal variety Pusa Purple round was transplanted on 7.6.91 and 25.7.91. First fruit set was on 6.8.91 and 16.10.91. Harvesting was done on 17.11.91 and 7.1.92. Average plant height was 33 and 53 cm. Fruit length 8 and 9 cm, fruit girth 21.6 and 20.0 cm and average weight of 145 g and 110 g was recorded, respectively.

Six cultivars of bean viz Pusa contender, Pusa parvati VL-1, VL-5, Selection-4 and P-2 were sown on 22.8.91. They took 4 to 7 days for germination, 28 to 45 days for first flowering, 33 to 50 days to first pod set. The no. of pods per plant was highest in P-2 (24) followed by VL-5 (19). Minimum pods were in variety Pusa parvati (9) (Table 11).

Besides vegetables, flowers were also tried. Marigold, pansy, dog flower and coleus grew well which gave an aesthetic sense to the wintering members during their hard stay in Antarctica.

Conclusion

Antarctica has high production potentials. Greenhouse technology is fully successful in Antarctica especially for tomatoes, cucumber, chilli, methi, spinach, coriander, lettuce etc. Any crop can be grown by a minor manipulation of temperature, light, photoperiod. Crop selection plays a vital role in a situation where production is of prime importance. Crops in such a remote and vegetation free area provide great psychological boost to people living there.

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