OPTIMISING FRUIT LOAD AND STEM DENSITY OF ORGANIC TOMATO GROWN UNDER A SEMI-CLOSED GREENHOUSE

BÉATRICE PERRON[1], DAMIEN DE HALLEUX[2], MARISE VALLIÈRES[2], FRANÇOIS BÉLANGER[3] AND MARTINE DORAIS[14]

[1]CENTRE DE RECHERCHE ET D'INNOVATION SUR LES VÉGÉTAUX, DEPT. OF PLANT SCIENCE, LAVAL UNIVERSITY, QUEBEC, QC, CANADA, G1V 0A6 BEATRICE.PERRON.1@ULAVAL.CA

[2]CENTRE DE RECHERCHE ET D'INNOVATION SUR LES VÉGÉTAUX, DEPT. OF SOIL AND AGRI-FOOD ENGINEERING, LAVAL UNIVERSITY, QUEBEC, QC, CANADA, G1V 0A6 DAMIEN.DE.HALLEUX@FSAA.ULAVAL.CA

[3]LES SERRES JARDIN-NATURE, NEW RICHMOND, QC, CANADA, G0C 2B0 FBELANGER@JARDINSNATURE.CA

[4]AGRICULTURE AND AGRI-FOOD CANADA, PACIFIC AGRI-FOOD RESEARCH CENTRE, AGASSIZ, CANADA, V0M 1A0 MARTINE.DORAIS@AGR.GC.CA

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INTRODUCTION

- ↑ Greenhouse microclimate : ↑ Productivity
- Development of new systems: closed and semi-closed greenhouses
- ↑ Climate control (temperature, humidity, CO_2) using geothermal systems to ensure cooling and/or heating (Nederhoff et al., 2010); ↓ Rate of CO_2 supply (Opdam, 2005)
- Heuvelink et al. (2007) suggested that the density could be increased by at least **17%** in a closed greenhouse
- No study has previously focused on stem density and fruit load control in semi-closed greenhouse.

AIM

Compare **density** and **fruit load** treatments in a **semi-closed greenhouse** context by analysing yield, fruit size, crop growth, climate parameters and fruit quality.

MATERIAL AND METHODS

- Two semi-closed double polyethylene 225 m^2 compartments (R2 and R3) located at Les Serres Jardins-Nature, Qc, Canada (48.15°N, 65.84°W)
- Cooled using water from the water table (12°C) which was directed in a heat exchanger
- Polyethylene tubes located above the canopy to ensure the airflow
- 2015 growing season (January-October)

- Three stem density treatments (3.0, 3.3 and 3.6 plants/m^2) in R2
- Three fruit load treatments (70, 85 and 90 fruits per m^2) in R3
- Climate monitoring, crop growth, yield, fruit size and fruit quality

Cooling capacity R2 > R3

RESULTS

- 24h T°C, day T°C, relative humidity higher in R3 compartment (lower cooling capacity)
- CO_2 concentration was 46 µL L^{-1} higher in the R2 than in R3 compartment

Table 1. Climate parameters for the two semi-closed compartments for 2015 growing season.

Compartment	Day temperature (°C)	Night temperature (°C)	24h temperature (°C)	Day relative humidity (%)	24h temperature (°C)	24h relative humidity (%)
R2	20.7 ± 2.4	18.4 ± 2.3	19.6 ± 2.1	85.6 ± 5.3	85.8 ± 7.4	85.5 ± 6.2
R3	21.7 ± 2.5	18.5 ± 2.1	20.2 ± 2.1	86.2 ± 8.9	85.8 ±10.8	86.5 ± 9.4

Table 4. Air CO_2 concentration and injected CO_2 in the two semi-closed compartments for 2015 growing season.

Compartment	CO_2 (µL L^{-1})	CO_2 injected (g/m^2)
R2	681 ± 138 (↑ 7%)	97 ± 41 (↓13%)
R3	635 ± 136	111 ± 43

RESULTS

- For the density treatments in R2, both week yield and cumulative yield were higher at density 3.0 plants/m² than at 3.3 or 3.6 plants/m²
- In the R3 compartment, it was the lowest fruit load that presented the highest yield and fruit size. This is consistent with the dry matter results, where the percentage of dry matter was decreasing with the increase of the fruit load as showed in Fig. 1.

Table 2. Production results in terms of fruit yield and fruit size for 2015 growing season in two semi-closed compartments

Treatment	Fruit size (g)	Yield (kg/m²/week)	Cumulative yield (kg/m²)
R2 D. 3.0	238 ± 32	1.92 ± 0.87	58.76 ± 7.23
R2 D. 3.3	237 ± 32	1.77 ± 0.68	54.14 ± 1.98
R2 D. 3.6	223 ± 36	1.77 ± 0.72	54.38 ± 4.85
R3 C. 70	228 ± 21	1.87 ± 0.82	57.83 ± 2.70
R3 C. 80	224 ± 26	1.81 ± 0.84	56.08 ± 4.72
R3 C. 90	223 ± 28	1.73 ± 0.70	53.53 ± 3.16

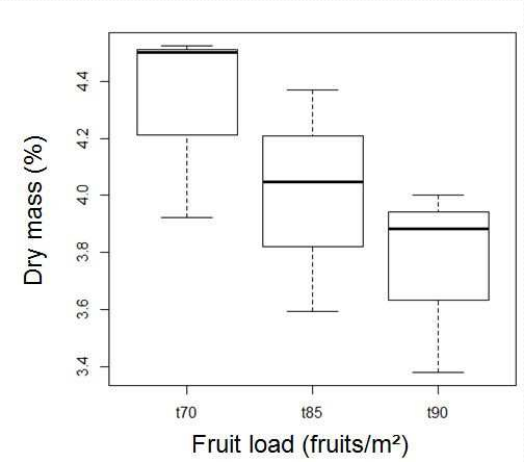

Fig. 1. Percentage of dry matter for the three fruit load treatments for August 2015 harvest

RESULTS

- Growth parameters as plant stem elongation, stem diameter, and apex-flower cluster distance were higher in R3 than in R2 compartment (3.6 plant/m² and fruit load between 70-90 fruit/plant depending on the treatment)

Table 3. Growth parameters for the six treatments means for 2015 growing season in two semi-closed compartments(D= stem density; C= fruit load)

Treatment	Elongation (cm)	Stem diameter (mm)	Mature leaf length (cm)	Apex-flower cluster distance (cm)	Flower set (cluster/week)	Fruit set (cluster/week)
R2 D. 3.0	19.5 ± 4.4	10.7 ± 1.5	53 ± 6	11 ± 3	0.75 ± 0.47	0.75 ± 0.39
R2 D. 3.3	19.2 ± 4.7	10.7 ± 2.2	53 ± 7	10 ± 4	0.76 ± 0.38	0.74 ± 0.39
R2 D. 3.6	19.3 ± 4.7	10.7 ± 1.5	53 ± 6	10 ± 3	0.73 ± 0.40	0.71 ± 0.40
R3 C. 70	21.1 ± 4.6	11.2 ± 1.6	53 ± 5	11 ± 4	0.80 ± 0.41	0.78 ± 0.44
R3 C. 80	21.3 ± 4.8	11.0 ± 1.5	52 ± 6	11 ± 4	0.79 ± 0.41	0.78± 0.44
R3 C. 90	21.1 ± 4.8	11.3 ± 4.4	53 ± 5	11 ± 4	0.75 ± 0.41	0.73 ± 0.41

CONCLUSION

- Climate and CO_2 differences: different system efficiencies
- Lowest fruit density treatment in R2 and lowest fruit load treatment in R3 both showed the best agronomic performance
- Semi-closed systems improved with a heat pump (night temperature/humidity control)
- Higher yield was achieved under semi-closed greenhouse growing conditions as compared to the commercial yield performance
- Soil → Soilless organic growing system (*Verticillium*)

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