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USE OF TWO DRIPPERS SPACING IN THE SAME LATERAL LINE AND THEIR EFFECTS ON THE WETTED BULB FORMATION, YIELD AND QUALITY OF RADISH (*RAPHANUS SATIVUS* L.).

LEONARDO PRETTO DE AZEVEDO¹, JOÃO CARLOS CURY SAAD²

¹ Instituto Federal de São Paulo, Campus São Roque, São Roque, SP, Brazil, leo_pretto@hotmail.com

² Faculdade de Ciências Agrônômicas, FCA – UNESP, Botucatu –SP, Brazil, joaosaad@fca.unesp.br

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ABSTRACT The objective of the present study was to compare drip lateral lines with the same between emitter spacing and lateral lines consisting of two sections, each one with a different emitter spacing, which results in better emission uniformity but has not been evaluated under field conditions. This research evaluated the generated wetted bulb for both conditions and the physical, chemical and physicochemical parameters of the radish. Conventional drip lateral lines with 20 cm emitter spacing were compared to proposed drip lines, with 24 cm emitter spacing in the first section and 20 cm emitter spacing in the final section; conventional drip lateral lines with 30 cm emitter spacing were compared to proposed drip lines, with 36 emitter spacing in the first section and 30 cm emitter spacing in the final section. In the first section 100 kPa head pressure was used and 70 kPa in the final section of all the drip lateral lines, keeping the same unit discharge per meter of the lateral line in all the treatments. The experiment was carried out in a greenhouse located in Sao Manuel, SP, Brazil. A randomized complete block design with six treatments and four replications was used to simulate the first and final sections of all the drip lateral lines evaluated. Results showed no difference among treatments for most of the evaluated variables. Thus it was concluded that differences between emitter spacing can be used in the same lateral line to increase the line length without decreasing the crop yield and quality.

Keywords: Radish, dripper, bulb, greenhouse

INTRODUCTION

Brazil has one of the largest agricultural areas on the planet but ranks only 12th of countries with the largest irrigated areas and 11th in the ratio of irrigated area/cultivated area per country. It is estimated that the growth potential for sustainable irrigation in Brazil is 4.6 million ha in upland areas and 14.9 million ha on lowland areas, totaling

29.5 million ha. Thus Brazil is using only 10.7% of its potential of suitable soils for sustainable agriculture (CHRISTOFIDIS, 2002).

One of the ways of increasing the irrigated area in a sustainable manner is to opt, when ever technically and economically viable, to implant localized irrigation systems with low water and energy consumption.

An alternative to diminish the effects of discharge loss in the lateral line is using self-compensating drippers, emitters that work with constant discharge in a very wide pressure range. The use of this type of dripper allows dimensioning systems with longer lateral lines with lower implantation costs. However, the cost of acquiring irrigation systems with self compensating drippers is significantly higher than the costs of systems with conventional drippers, so that many farmers choose the second.

In level planting, the use of drippers is an interesting alternative for the producer because it ensure proper uniformity levels with a well dimensioned lateral line length. Therefore it is important to develop new techniques or products that increase low cost water distribution uniformity and facilitate producers' access to this technology.

ANDRADE (2009) reported that dripper tube laterals using two spacings resulted in longer lines with better emitter uniformity compared to laterals with single between emitter spacing. However, whether the increase in the between dripper spacing in the first section of the lateral line damaged the crop development was not investigated.

According to Keller & Bliesner (1990), between dripper spacing should be equal or less than 80% of the maximum wetted diameter, so that a continuous, uniform wet band is formed, and concluded that equations and tables should only be used as estimates to start field tests.

Benami & Ofen (1984) reported that selecting the ideal between dripper spacing was not an easy task, in spite of the several equations developed to estimate the maximum between emitter distance. The authors considered the nonlinear ratios among the variables involved and concluded that the best results were always obtained with field tests.

Enciso et al. (2005) carried out field tests to assess the effects of between emitter spacing (15, 20 and 30 cm) and emitter depth (0, 15 and 30 cm) on the production and quality of dripper irrigated onions. No statistical difference was detected for the number of bulbs and onion yield in the different between emitter spacings and the depths used.

Kang & Wan (2005) stated that both radish yield and quality were a highly influenced by periods of drought or by improperly managed irrigation.

The research hypothesis of the present study is that the lateral line length can be increased by using carefully selected different between dripper spacings, as long as the discharge per linear meter is the same at the start and the end of the piping, without reducing yield and quality of the irrigated crop.

The objective of the present study was to compare lateral lines of two different segments with conventional lateral lines with a single segment, by analyzing the physical, chemical and physicochemical parameters of the radish crop and studying the formation of the wetted bulbs in the soil.

MATERIAL AND METHODS

The experiment was carried out in a protected environment, in São Manuel-SP, Brazil, at 22°46'35"S and 48°34'44"W, altitude 750 m. The climate of the region

according to the Köppen classification is the Cfa type, that is, humid subtropical, and the average temperature of the warmest month is over 22°C. The annual means in the municipality are 1433 mm rainfall, 71% relative air humidity and 23°C.

The greenhouse for protected cultivation was installed in the east to west direction and was 30 m long, 7 m wide and 3 m high. It was covered with 150 micras thick transparent low density polyethylene film; the sides were protected by the same film to a height of one meter and completely closed by a 1.0 mm black nylon mesh.

The proposed methodology of using lateral lines with two different between emitter spacings equalized the discharge per meter of the first and final sections and longer lateral lines could be used compared to the lateral lines of single between dripper spacing. In the present study, according to the characteristics of the material used and following the methodology proposed by Andrade (2009), the lateral lines assessed had the following characteristics: a) Situation 1 (*two spacings*): lateral line with 24 cm first spacing and 20 cm final spacing; maximum length 95.4 m; b) Situation 2 (*two spacings*) lateral line with 36 cm first spacing and 30 cm final spacing; maximum length 128.5 m; c) Situation 3 (*single spacing*) lateral line with 20 cm first and final spacing; maximum length 91.8 m; and d) Situation 4 (*single spacing*) lateral line with 30 cm first and final spacing; maximum length 124.2 m.

The main idea of the study was to compare the first and final segments of a lateral line with single between dripper spacing with the same segments of a lateral line with two spacings. Each lateral line proposed was called *Situation* and consisted of two different segments, a first and a final, characterized by the operation pressure and between emitter spacing.

Situation 1 represented a lateral line with 24 cm between emitter spacing in the first segment (calculated according to methodology reported by ANDRADE, 2009) and 20 cm in the final segment (commercial spacing). This situation was compared to *Situation 3* (control situation) where the lateral line presented only one emitter spacing of 20 cm for all the sections, including the first and final sections. Thus the differences could be assessed between the first and final sections of lateral lines with single spacing (20 cm) with the same lateral line section with varied spacing (24 and 20 cm). The same reasoning was considered for *Situation 2* and *Situation 4*. *Situation 2* represented a lateral line with 36 cm between dripper spacing in the first segment (calculated spacing) and 30 cm in the final segment (commercial spacing). This situation was compared to *Situation 4* (control situation), where the lateral line presented only one spacing (30 cm). In all the *Situations*, 100 kPa pressure was adopted in the first segment and 70 kPa in the final segment.

The statistical analysis was carried out with a complete randomized experimental design and 1.0 m wide and 5.0 m long plots. The four treatments (situations) were compared, where:

Table 1. Treatments assessed

Treatments	First Segment		Final Segment	
	Between dripper spacing (cm)	Pressure (kPa)	Between dripper spacing (cm)	Pressure (kPa)
1	24	100	20	70
2	36	100	30	70
3	20	100	20	70
4	30	100	30	70

The values were defined in the lateral lines with two between dripper spacings so that the single first unit stretch of the lateral line had the same discharge as the final unit stretch, although the pressure difference between the start and end of the lateral line was greater than the 20% recommended by Karmeli & Keller (1975). Thus it would be possible to use conventional drippers on longer lateral lines, that is economically advantageous.

The irrigation bulbs were assessed at three different times, MO (immediately after finishing irrigation), M1 (one hour after finishing irrigation) and M 2 (two hours after finishing the irrigation). Samples were taken of these bulbs to determine the soil moisture using the gravimetric method, in the direction of the lateral line (X axle) and in the direction perpendicular to the irrigation lateral line (Y axle) starting from a dripper taken as reference, in the third week of the crop development.

In the Y direction, these samples removed from the central planting the line, at six points, for all the treatments, namely: a) point 1: on the planting line; b) point 2: 10 cm from the planting line; c) point 3: 20 cm from the planting line, coinciding with the reference emitter; point 4: 30 cm from the planting line; point 5: 40 cm from the planting line; point 6: 50 cm from the planting line.

In the X direction , the number of points sampled and the distance between them varied according to the spacing between the treatment drippers, so that they always started at point 3 of axle Y and the last sample point forcibly coincided with the following emitter on the lateral line. Thus the sampled points were: a) 20cm spacing (3 sampled points): first point, at 10 cm and 20 cm from the first point; b) 24cm spacing (4 sampled points): first point, at 8 cm, 16 cm and 24 cm from the first point; c) 30cm

spacing (4 sampled points): first point, at 10 cm, 20 cm and 30 cm from the first point; and d) 36 cm spacing (5 sampled points): first point, at 9 cm, 18 cm and 27 cm and 36 cm from the first point.

Soil samples were removed at each sample point from four layers: 0-5 cm, 5-10 cm, 10-20 cm and 20-30 cm. Because they were destructible samplings, at times M0, M1 and M2 the samples were removed from three reference emitters as close as possible in the same plot and under equal working conditions.

RESULTS AND DISCUSSION

Generally, when the irrigation bulbs were assessed in the X and Y directions, almost all the treatments presented similar water distribution tendencies in the soil; and only treatment 3 (Figure 1) presented water shortage areas at the effective root depth, and in exactly at the greatest between dripper spacing assessed.

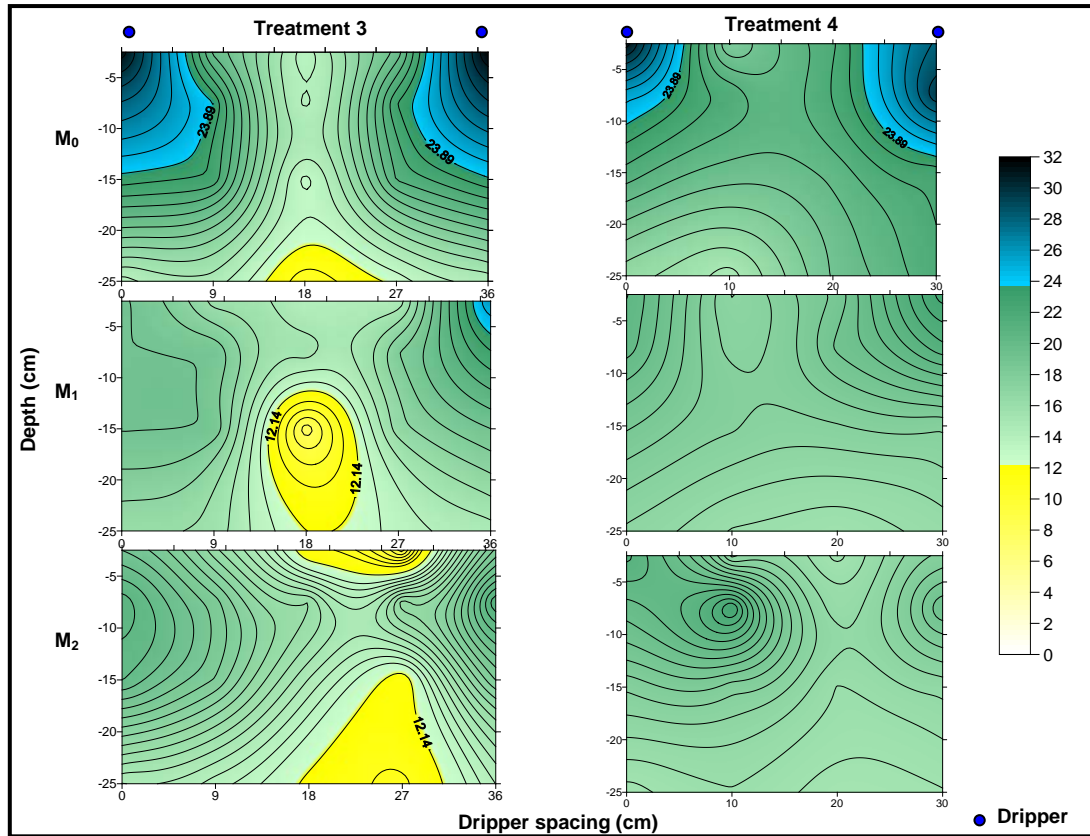


Figure 1: Graphic representation of the soil humidity (% volume) in the direction X of the treatments 3 and 4, immediately after irrigation (M0), one hour (M1) and two hours (M2) later

Table 2 shows the values obtained for physical parameters that indicate that there was no significant difference among the situations for the physical parameters assessed, showing that the lateral lines in varied spacings (Situations 1 and 3) performed equivalently to the lateral lines with single spacing (Situations 2 and 4).

Table 2. Values of the weight of total fresh matter, fresh matter per linear meter, total dry matter, dry matter per linear meter and radish diameter, among treatments in cycle 1.

Treatment	Total fresh matter (g)	Fresh matter per linear meter (g m^{-1})	Total dry matter l (g)	Dry matter per linear meter (g m^{-1})	Diameter (mm)
1	845.00 a	221.19 a	37.4675 a	9.8800 a	34.33 a

2	1106.00 a	245.96 a	44.3150 a	9.8500 a	35.95 a
3	944.00 a	206.18 a	44.1625 a	9.7325 a	34.60 a
4	946.00 a	231.53 a	38.7475 a	9.6050 a	35.48 a
5	936.75 a	235.61 a	38.9375 a	9.8925 a	35.45 a
6	1055.50 a	265.22 a	39.4750 a	9.8475 a	36.34 a
CV (%)	22.04	13.97	18.90	13.03	4.53

Means followed by the same letters on the vertical do not differ statistically by the Tukey test at 5%.

The diameters obtained in Situations 2, 3 and 4 were greater than those reported by Torres et al. (2003), that varied from 31.49 to 33.57 mm; Situation 1 was statistically equal to the others and presented 33.19 mean diameter, within the range of values quoted by the authors.

CONCLUSIONS

Under the conditions of the present study, it was concluded that

-There was no significant difference between the lateral lines with two spacings and the lateral lines with single spacing, for all the production parameters assessed.

-The use of different between dripper spacings on the same lateral line, that permitted increase line length and decreased its manufacture cost per tube meter, can be considered a viable technique for drip irrigation.

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