FIELD ANALYSIS OF EMITTERS USED IN IRRIGATED LOTS LOCATED IN THE JACARÉ-CURITUBA PUBLIC IRRIGATION PROJECT

Clayton Moura de Carvalho[1], Antenor de Oliveira Aguiar Netto[2], Raimundo Rodrigues Gomes Filho[3], Ariovaldo Antonio Tadeu Lucas[4], Manoel Valnir Júnior[5], Leonaria Luna Silva de Carvalho[6]

ABSTRACT: Parameters related to irrigation practices are essential for proper planning and operation of irrigated systems. In this sense, it is recommended to carry out annual maintenance of two irrigation systems, as well as to periodically verify the uniformity of water distribution, with the objective of evaluating their performance and correcting any operational errors. Likewise, an analysis of irrigation systems was carried out in different lots belonging to the Jacaré-Curituba Irrigation Public Project, located between the municipalities of Canindé de São Francisco and Poço Redondo, in the state of Sergipe. The data of vacuum and pressure were collected at strategic points, according to the methodology proposed by Keller & Karmeli (1975), with the average variations of vacuum (ΔQ) and pressure (ΔP) being determined along the side lines of each analyzed batch. Based on the results obtained, it is verified that all the evaluated lots present systems with high variations in pressure and pressure in the irrigation lines, values considered unacceptable according to technical literature.

KEYWORDS: Localized irrigation, Microsprinkling, Irrigated Perimeter, Irrigated Agriculture.

ANÁLISE EM CAMPO DOS EMISSORES UTILIZADOS EM LOTES IRRIGADOS LOCALIZADOS NO PROJETO PÚBLICO DE IRRIGAÇÃO JACARÉ-CURITUBA

RESUMO: Os parâmetros relacionados às boas práticas de irrigação são fundamentais para o adequado planejamento e operação dos sistemas irrigados. Nesse sentido, recomenda-se a

[1] Doctor in Agricultural Engineering, PosDoc Scholarship Holder at FAPITEC/SE, Collaborating Professor at UFS, carvalho_cmc@yahoo.com.br
[2] Doctor in Agronomy, Professor at UFS, anternor.ufs@gmail.com
[3] Doctor in Agricultural Engineering, Professor at UFS, rrgomesfilho@hotmail.com
[4] Doctor in Applied Ecology, Professor at UFS, aatlucas@academico.ufs.br
[5] Doctor in Agricultural Engineering, Professor at IFCE Sobral, valnir@ifce.edu.br
[6] Master in Agricultural Engineering, UFC, leonarialuna@hotmail.com

realização de manutenção anual dos sistemas de irrigação, bem como a verificação periódica da uniformidade de distribuição da água, com o objetivo de avaliar seu desempenho e corrigir eventuais falhas operacionais. Assim, foi realizada a análise de sistemas de irrigação em diferentes lotes pertencentes ao Projeto Público de Irrigação Jacaré-Curituba, localizado entre os municípios de Canindé de São Francisco e Poço Redondo, no estado de Sergipe. Foram coletados dados de vazão e pressão em pontos estratégicos, conforme a metodologia proposta por Keller & Karmeli (1975), sendo determinadas as variações médias de vazão (ΔQ) e pressão (ΔP) ao longo das linhas laterais de cada lote analisado. Com base nos resultados obtidos, verificou-se que todos os lotes avaliados apresentaram sistemas com elevadas variações de vazão e pressão nas linhas de irrigação, valores considerados inaceitáveis segundo a literatura técnica.
PALAVRAS-CHAVE: Irrigação localizada, Microaspersão, Perímetro Irrigado, Agricultura Irrigada.

INTRODUCTION

The semi-arid region of Brazil stands out as an important agricultural production area, with intensive use of irrigation, especially in the São Francisco River Valley. This reality is justified by the need to increase food production, as well as meet the growing demand for job and income generation for the populations living in this region (Santos et al., 2025).

Public irrigation projects play a fundamental role in the socioeconomic development of the Brazilian semi-arid region (Silva et al., 2020). One example is the Jacaré-Curituba Public Irrigation Project, located between the municipalities of Canindé de São Francisco and Poço Redondo in the state of Sergipe. It is supplied with water from the São Francisco River, stored in an artificial reservoir located within the project area itself (Santos & Lucas, 2015).

In light of the above, it can be stated that irrigated agriculture plays an essential role in regional development. However, for it to be a profitable and sustainable activity, it is crucial that it is conducted appropriately, using techniques that maximize the efficiency of water and land resource use.

Irrigation assessment is a fundamental step in obtaining information related to water use efficiency, losses during application, and uniformity in water distribution. Furthermore, it allows for verifying the actual operation of the system (considering variables such as flow rate, pressure, applied depth, clogging, among others) and identifying the need for maintenance. This process helps prevent problems associated with low uniformity and efficiency, promoting more appropriate and acceptable application values (Carvalho et al., 2006; Mantovani et al., 2009; Valnir Júnior et al., 2011; Andrade et al., 2021; Silva et al., 2023).

In this context, the present study aimed to analyze the irrigation systems in different lots of the Jacaré-Curituba Public Irrigation Project, with the purpose of outlining the technical-operational profile of this activity in the region and identifying possible operational failures in the implemented systems.

MATERIALS AND METHODS

The study was conducted in November 2024, at the Jacaré-Curituba Public Irrigation Project, located in the northwestern region of the state of Sergipe, covering the municipalities of Canindé de São Francisco and Poço Redondo, in the semi-arid region of Alto Sertão Sergipano (Figure 1).

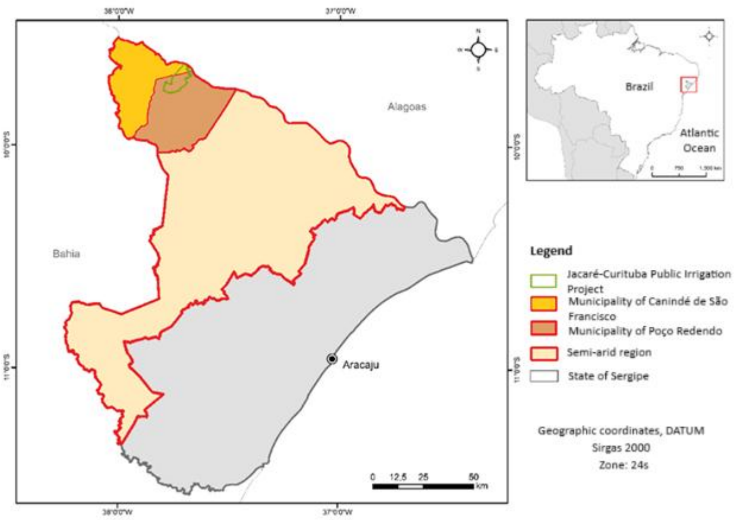

Figure 1. Location of the study area in the state of Sergipe, Brazil. Source: Lucas et al. (2021).

According to Menezes et al. (2015), the total irrigated area of the Jacaré-Curituba Public Irrigation Project is 1,860 hectares, divided into four sectors numbered from 0 to 3, designated for irrigation and livestock activities. The project comprises 630 lots, with sizes ranging between 2.5 and 3 hectares, making it the largest public irrigation project in Latin America focused on family farming, benefiting approximately 700 families. The predominant irrigation systems are localized irrigation, with an emphasis on microsprinkling and drip irrigation. The main crops cultivated include okra, beans, corn, cassava, fruits, and vegetables in general.

For the evaluation of the irrigation systems, 16 distinct lots were selected within the Jacaré-Curituba Public Irrigation Project. These lots belonged to different irrigators and showed no apparent signs of soil salinization. The selection focused on lots located in sectors 1, 2, and 3, since sector 0, although also irrigated, operates by gravity and does not rely on booster pumps for the irrigation systems to function (Figure 2).

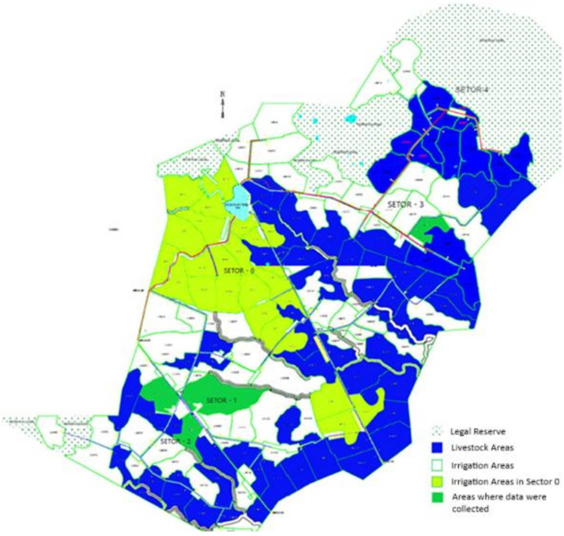

Figure 2. General Layout of the Jacaré-Curituba Public Irrigation Project.

For the evaluation of the irrigation systems, a digital stopwatch and graduated cylinders of 500 and 1,000 mL were used in the field to measure the flow rates of the emitters. The operating pressures of the emitters were determined using a glycerin-filled pressure gauge with a scale in kgf cm^{-2}, connected via appropriate fittings.

The evaluations of the selected emitters, following the methodology proposed by Keller & Karmeli (1975), were carried out through three repetitions of water volume collection, each lasting 30 seconds, in order to calculate an average. Subsequently, using a spreadsheet developed by the author, the average flow rate was calculated in liters per hour (L h^{-1}). Finally, the operating pressures of each selected microsprinkler were recorded.

With the obtained flow rate and pressure values, it was possible to determine the average variations in flow rate (ΔQ) and pressure (ΔP) along the lateral lines of each evaluated lot, as specified in Equations 1 and 2:

$$\Delta Q = \frac{Qmáx - Qmin}{Qmáx} \; x \; 100 \quad (1)$$

Where:

ΔQ - flow rate variation in %;

Qmáx - maximum flow rate value in L h^{-1};

Qmin - minimum flow rate value in L h^{-1}.

$$\Delta P = \frac{Pmáx - Pmin}{Pmáx} \; x \; 100 \quad (2)$$

Where:

ΔP - pressure variation in %;

Pmáx - maximum pressure value in kgf cm^{-2};

Pmin - minimum pressure value in kgf cm^{-2}.

RESULTS AND DISCUSSION

The results related to the flow rate and operating pressure of the emitters in the evaluated lots, as well as their respective variations, are presented in Table 1.

Table 1. Flow rate and pressure of the evaluated lots.

Lot	$Q_{méd}$	$P_{méd}$	L_P		$L_{1/3}$		$L_{2/3}$		L_U	
			ΔQ	ΔP	ΔQ	ΔP	ΔQ	ΔP	ΔQ	ΔP
L_1	42.56	81.40	73.79	50.00	29.11	0.00	18.03	28.57	19.35	10.00
L_2	49.20	152.00	55.00	37.50	66.85	41.18	84.69	22.22	73.60	5.00
L_3	29.33	49.03	72.30	66.67	35.59	75.00	100.00	62.50	43.84	77.78
L_4	55.73	120.62	100.00	66.67	17.95	0.00	100.00	60.00	25.61	64.71
L_5	27.45	40.21	100.00	88.89	100.00	88.89	100.00	80.00	58.82	83.33
L_6	54.00	202.02	56.77	8.70	22.35	15.00	7.95	0.00	51.88	9.09
L_7	42.90	118.66	11.84	20.00	61.49	25.00	10.14	15.38	30.67	21.43
L_8^*	157.16	-	15.51	-	17.50	-	34.90	-	43.71	-
L_9	50.29	102.97	65.19	7.69	75.00	63.64	60.74	41.67	55.88	21.43
L_{10}	49.50	195.15	26.88	9.52	3.45	13.04	16.47	15.79	13.19	13.64
L_{11}	35.21	105.91	44.26	10.00	22.58	10.00	40.00	10.00	27.03	47.37
L_{12}	29.93	86.30	100.00	46.15	100.00	45.45	100.00	54.55	100.00	45.45
L_{13}	38.48	34.32	63.89	0.00	67.54	0.00	61.29	60.00	44.76	37.50
L_{14}	25.91	35.30	17.78	33.33	14.63	60.00	34.62	60.00	62.77	50.00
L_{15}	46.20	101.01	53.17	45.45	61.78	16.67	76.82	9.09	100.00	20.00
L_{16}	58.69	154.95	39.39	5.88	48.67	16.67	17.43	14.29	47.06	35.29
Média	**49.53**	**105.32**	**55.99**	**33.10**	**46.53**	**31.37**	**53.94**	**35.60**	**49.29**	**36.13**

Lot - evaluated lots; Qméd - average flow rate observed in the system (L h^{-1}); Pméd - average operating pressure of the system (kPa); LP - lateral line positioned at the beginning of the main/secondary line; L1/3 - lateral line positioned at 1/3 of the length of the main/secondary line; L2/3 - lateral line positioned at 2/3 of the length of the main/secondary line; LU - lateral line positioned at the end of the main/secondary line; ΔQ - flow rate variation along the lateral line (%); ΔP - pressure variation along the lateral line (%). * Lot where it was not possible to measure the operating pressure due to the diameter of the microtube installed in the microsprinkler and the lack of connection at the site.

The Public Irrigation Project, based on the evaluated lots, presented an average flow rate of 49.53 L h^{-1} and an average operating pressure of 105.32 kPa (Table 1). The projected flow rate for the evaluated systems was 35 L h^{-1} (Meneses et al., 2015), using the emitter identified as the Supernet Lr microsprinkler by Netafim, which has a recommended operating pressure range of 150 to 400 kPa. Only two of the evaluated lots (L8 and L12) have microsprinkler irrigation systems with less than nine years of use, while the other 14 lots still operate with the original irrigation system from the project.

During the field tests, actual flow rates ranged from 25.91 L h^{-1} to 58.69 L h^{-1}, with the average flow rates for each of the 16 lots presented in Table 1. These values show a narrower range of flow variation compared to those reported by Meneses et al. (2015), who recorded flow rates ranging from 13.2 to 90.6 L h^{-1} when evaluating eight irrigated lots within the same Public Irrigation Project on which this study is based.

In addition to presenting a narrower flow variation range compared to the results obtained by Meneses et al. (2015), no significant improvements were observed in irrigation practices within the referred Public Irrigation Project. Water leaks were identified in the lateral lines, as well as the presence of different microsprinklers with varying flow rates within the same irrigated lot. The absence of pressure-compensating diaphragms in some microsprinklers was also noted, along with partial or total clogging in others.

The variety of emitters present within the same irrigated lot is a result of the producers' lack of adequate technical knowledge. When emitters malfunction, they are often replaced with different models, preferably those with higher flow rates, leading to a wide variation in flow across the cultivated area. Similarly, the improper practice of removing the pressure-compensating diaphragm from microsprinklers to increase flow further contributes to inconsistencies in the irrigation system. The continued presence of partially or fully clogged emitters in the irrigated lots reflects both the producers’ neglect and the lack of proper care in the operation of the irrigation systems.

The issues mentioned above are clearly illustrated in Figure 3, where, in most of the evaluated lots, there is a significant variability in the average flow rates collected, both across different positions of the lateral lines and among the emitters within the same line.

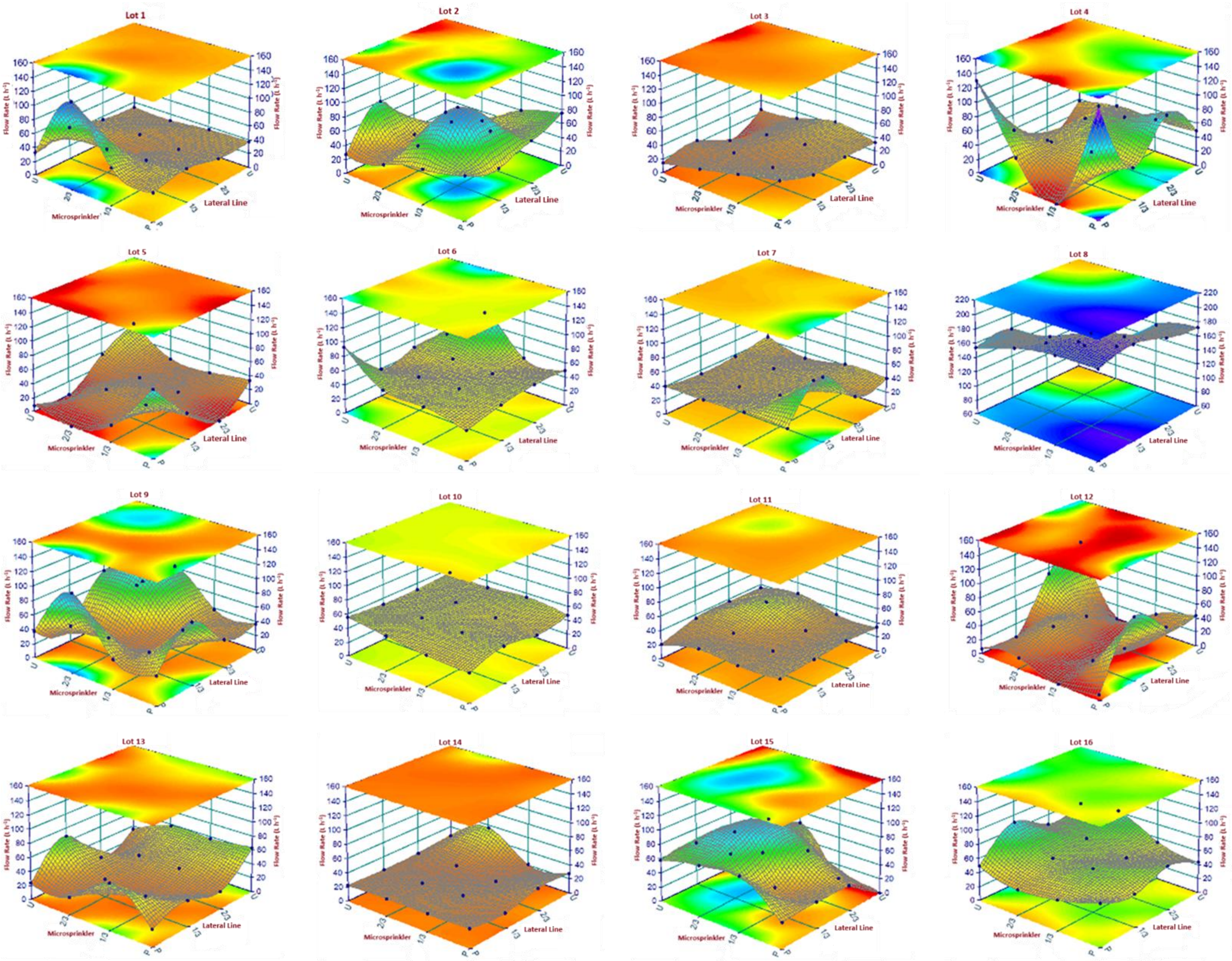

Figure 3. Behavior of pressure and flow rate variation observed in the evaluated lots.

The variation in average flow rate observed among the evaluated lots was 51.44%, a value considerably higher than the 10% limit recommended by Keller and Karmeli (1974). It was found that only the lateral line positioned at one-third of the length of the secondary/distribution line in lot 10, and the lateral line positioned at two-thirds of the same line in lot 6, exhibited flow rate variations within the acceptable limits established by the literature.

This result is consistent with the findings of Alves et al. (2008), who, in a study conducted in a soursop cultivation area within the São Gonçalo Irrigation Project in Paraíba, observed a flow rate variation of 36.36% among both new and used emitters. Similarly, Meneses et al. (2015) reported that, out of a total of eight lots evaluated in the Jacaré-Curituba Public Irrigation Project, only one lot exhibited a flow rate variation within the 10% limit recommended by the literature.

Regarding operating pressure, it was observed that only 28.57% of the evaluated lots, with irrigation systems aged nine years or more, showed service pressures equal to or greater than 150 kPa. Additionally, 40% of all 16 lots evaluated in this study presented average operating pressure values below 100 kPa, a threshold considered limiting for the proper functioning of microsprinklers, as indicated by Dwivwdi & Pandya (2016).

Among the factors explaining the low operating pressure observed in the lots, besides the leaks found in the irrigation lines, the hydraulic design of the Jacaré-Curituba Public Irrigation Project itself can be considered a significant contributing factor. The irrigation perimeter was originally designed to serve large commercial lots; however, these lots were later subdivided into smaller lots to support rural settlements focused on family farming, without implementing the necessary hydraulic adjustments to ensure the system's efficiency.

According to the results presented in Table 1, only 13.33% (L6 and L10) of the lots for which operating pressure data were obtained showed pressure variations across all lateral lines below the maximum variation limit of 20% recommended by Keller and Karmeli (1974). On the other hand, 26.67% (L3, L5, L12 and L14) of these lots exhibited pressure variations entirely above this limit. A similar result was observed by Meneses et al. (2015) in the same public irrigation project, where only 2 out of the 8 evaluated lots were within the maximum limit recommended by the literature.

It is worth noting that even in lateral lines where the pressure variation was well below the maximum recommended limit, reaching 0% in some cases, a significant variation in flow rate was observed along the line (Figure 4).

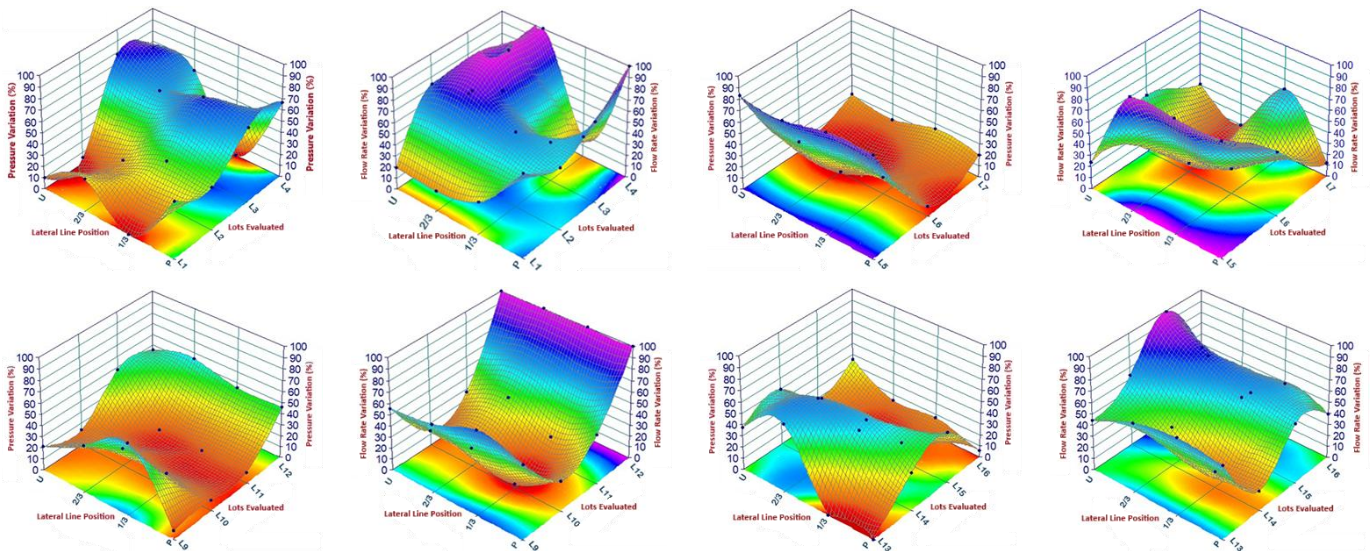

Figure 4. Behavior of pressure and flow rate variation observed in the evaluated lots.

This behavior can once again be explained by the problematic presence of different microsprinklers along the same lateral line, in addition to the significant number of partially or completely clogged emitters. These factors result in varying flow rates even when the operating pressure remains the same.

CONCLUSIONS

All evaluated lots showed irrigation systems with significant variations in flow rate and pressure along the irrigation lines, values considered unacceptable according to the literature, resulting in a pronounced non-uniformity in water distribution. The apparent causes of these issues include leaks, blockages, and, most notably, the presence of different types of emitters within the same irrigation line.

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