PERFORMANCE OF A HYDRAULIC DOSER USED IN FERTIRRIGATION

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ABSTRACT: A system that makes the injection of fertilizers in the irrigation water is the one that uses injection pump. This requires adjustment, which can be done depending on the manufacturer's information or a calibration made by the user under real operating conditions, the latter being the most recommended, due to the uneven manufacturing of the equipment. This work aimed to evaluate the hydraulic performance of the Tefen chemical injection pump at different pressures of the system (300, 240, 160 and 60 kPa) and different solutions to be injected (only water, water with fertilizer conventional and water with highly soluble fertilizer). It was concluded that the equipment presents uniformity of work in the situations tested, which maintains an injection pattern independent of the injected solution and that there is linear correlation with high values of coefficient of determination (R^2) between the variables of system pressure and injection flow in all the solutions and all the adjustment points evaluated in the injector. Thus it is possible to calculate the injection flow rate of the equipment through the defined equations, for different situations tested.

KEY WORDS: calibration; fertigation; injection Tefen.

DESEMPENHO DE UM DOSIFICADOR HIDRÁULICO PARA FERTIRRIGAÇÃO

RESUMO: Um sistema que faz a injeção de fertilizantes na água de irrigação é o que utiliza bomba injetora. Esta necessita de regulagem, que pode ser feita em função da informação do fabricante ou de uma calibração feita pelo usuário em condições reais de funcionamento, sendo essa última a mais recomendada, devido à desuniformidade de fabricação dos equipamentos. Esse trabalho teve como objetivo avaliar o desempenho hidráulico da bomba injetora de produtos químicos da marca Tefen, em diferentes pressões do sistema (300, 240, 160 and 60

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kPa) e diferentes soluções a serem injetadas (somente água, água com fertilizante convencional e água com fertilizante altamente solúvel). Concluiu-se que o equipamento apresenta uniformidade de trabalho nas situações testadas, que mantém um padrão de injeção independente da solução injetada e que existe correlação linear com valores altos de coeficiente de determinação (R^2) entre as variáveis de pressão do sistema e vazão de injeção em todas as soluções e todos os pontos de regulagem avaliados no injetor. Assim é possível calcular a vazão de injeção do equipamento através das equações definidas, para diferentes situações ensaiadas.

PALAVRAS-CHAVE: calibração; fertirrigação; injetora Tefen.

INTRODUCTION

Agricultural development, crop intensity, economic aspect, lack of water in some regions, and labor shortages require greater efficiency and control in water and fertilizer applications. It has been shown that combined fertilization with irrigation responds to agricultural needs and is adaptable to different irrigation systems schemes, being whether fixed, semi-fixed or mobile. As a result, many irrigators have used the irrigation system to apply chemicals via irrigation water. Quimation is the generic name given to the practice that makes use of the irrigation system for the chemical products application (Ferreira et al., 1996).

According to Drumond & Fernandes (2001), there are several types of fertilizers that can be used in fertigation. In general, fertilizers can be found in the following ways: a) liquid fertilizers: products that contain nutrients, in suspension or solution, being able to provide a single nutrient or a combination of them; b) solid fertilizers: products that contain nutrients in isolated elements, and can be found in the form of powder (more easily mixed with water), mixture of granules and granules. For their use, they must be previously dissolved and applied in the water flow. They can be dissolved and mixed into separate water, in open tanks and fed into the irrigation network by fertilizer application systems.

These systems of fertilizer application via irrigation water can be classified into: a) tube connected to the suction of the pump or application by negative pressure: through a tube connected to the water suction pipe, the solution is suctioned through the pump irrigation; b) differential pressure systems: the principle of these systems is to cause or take advantage of a pressure difference between two points in the irrigation network, causing part of the water flow to flow between them, passing through the fertilizer tank and diluting The solution, which is being injected into the system; c) injection pumps: it is to inject the existing solution in an open tank in the irrigation network, by means of an appropriate pump. The pumps can be of the diaphragm type, piston or centrifugal pumps driven by the water pressure itself by electric motors or by combustion (Fernandes et al., 2003).

In the injection pumps, the injection process of the fertilizer solution in the irrigation line occurs as a function of obtaining and adjusting the injection ratio of the initial solution (Sousa et al., 2005).

According to Dourado Neto et al. (2001) the regulation of an injection pump is done according to the manufacturer's specification, or a calibration made by the user under real field operating conditions. The latter is the most recommended due to the unmanifest manufacturing of the equipment.

This way, the objective of this work was to evaluate the hydraulic performance of the chemical products injected by Tefen pump, in different system pressures and different injected solutions.

MATERIAL AND METHODS

The test of the Tefen injection pump by hydraulic drive was carried out at Hydraulic Laboratory of Associated Colleges of Uberaba - MG (FAZU) dependencies. The equipment used in the test were: Tefen injector (Figure 1A), solution storage tank with fertilizers, volumetric bucket, stopwatch, manometer, hydraulic fittings, precision balance, conventional fertilizer 20-05-20 and highly soluble fertilizer 20-05-20. Table 1 show the injector technical specification. The disposition of the materials in the place was made in a way that would allow the good progress of the tests, according to Figure 1B.

The hydraulic performance evaluation was performed with four different system pressures, as follow: 300, 240, 160 and 60 kPa, which correspond, respectively, to the flows in the same system, 2340, 1770, 1150 and 520 L h^{-1}. The different pressures were regulated by blocking register in the pressurizing line.

Three different solutions were tested: only water, water with conventional and water with highly soluble fertilizer. The tests were performed on four injector settings (4%, 3%, 2% and 1%). Three replicates were made in each assay for further averaging.

The collected data were submitted to regression analysis and from this were made correlations to verify the injection variation as a function of the solution to be injected and system pressure. For each type of solution, with all pressure variations, an equation relating to system pressure and injector flow rate was calibrated.

RESULTS AND DISCUSSION

The graphs of the correlations made between the different pressures of the system and the injection flows, in the different adjustments of the injector Tefen and in different solutions can be seen in Figure 2.

It is observed that, independently of the solution tested, the system pressure and the injector regulation, the collected values of the injection flow show an exponential tendency, which shows the uniformity of the equipment working in the different conditions tested.

This is in agreement with Oliveira (2003), which evaluated the uniformity of potassium distribution in a drip irrigation system when applied by different injectors, including the Dosmatic (equipment similar to that tested), and at different times of injection. The author observed that there was no significant variation in the potassium distribution uniformity due to the injectors used, and also observed that higher injection times allowed better uniformity of fertilizer distribution.

It is also observed that, as expected, as the pressure of the system and the regulation of the injector increased, so did the injection rate.

In addition, it was observed that the injection flow rates at the different adjustments and pressure of the system did not present trend difference when only the injected solution was altered. This means that the equipment maintains an injection pattern independent of the injected solution.

These findings are in agreement with studies carried out by Fernandes et al. (2007), which evaluated the use of organic mineral and chemical fertilizers in drip irrigation system for coffee fertigation and observed that the fertilizer sources used, both in fertigation and conventional application. The authors observed that did not show significant differences in productivity and they concluded that due to the fact that conventional sources of fertilizers present productivities equivalent to the sources of high solubility, it is feasible to use them in fertigation, due to its lower cost, provided that due care is taken to maintain the drip irrigation system.

Table 2 presents the determination coefficients (R^2) and the fitted equations defined based on the correlations between system pressure and injection inflows of the Tefen injector in its different configurations and in the different tested solutions.

It can be observed that there are exponential correlations between the variables of system pressure and injection flow in all situations tested and that the reliability percentage of the correlation model, indicated by the explanatory power, is high also in all situations.

The fitted equations allow estimating the tested equipment injection rate at different set points, using different solutions and considering different pressures of the irrigation system.

CONCLUSIONS

Under the conditions in that the word was carried out, we concluded that:

• The equipment shows working uniformity in the situations tested;

• The equipment maintains an injection pattern independent of the injected solution;

• There is an exponential correlation of high percentage of reliability (R^2) between the system pressure variables and the injection flow in the whole as solutions and all control points tested.

• It is possible to calculate the injection vacuum of the equipment through the defined equations.

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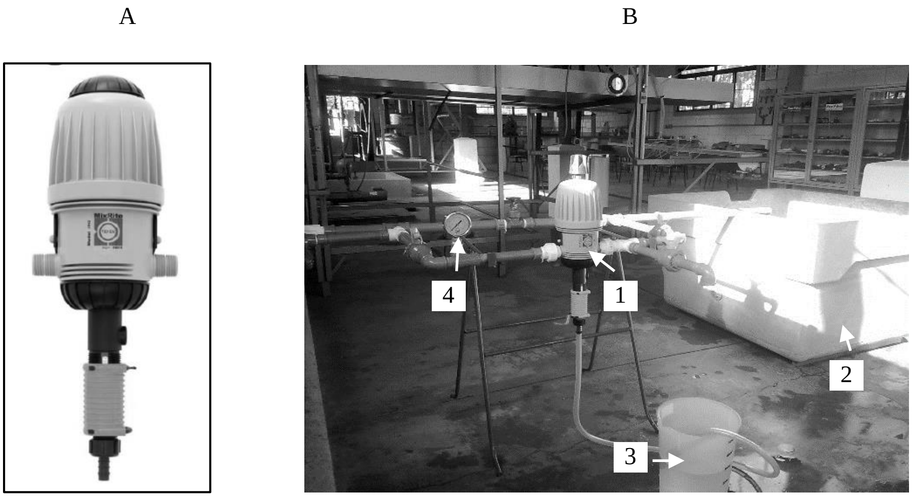

Figure 1. Injector used in the tests (A); Installation of the fertilizer injection system Tefen (B); Tefen injector (1); solution storage tank with fertilizers (2); volumetric bucket (3); manometer (4).

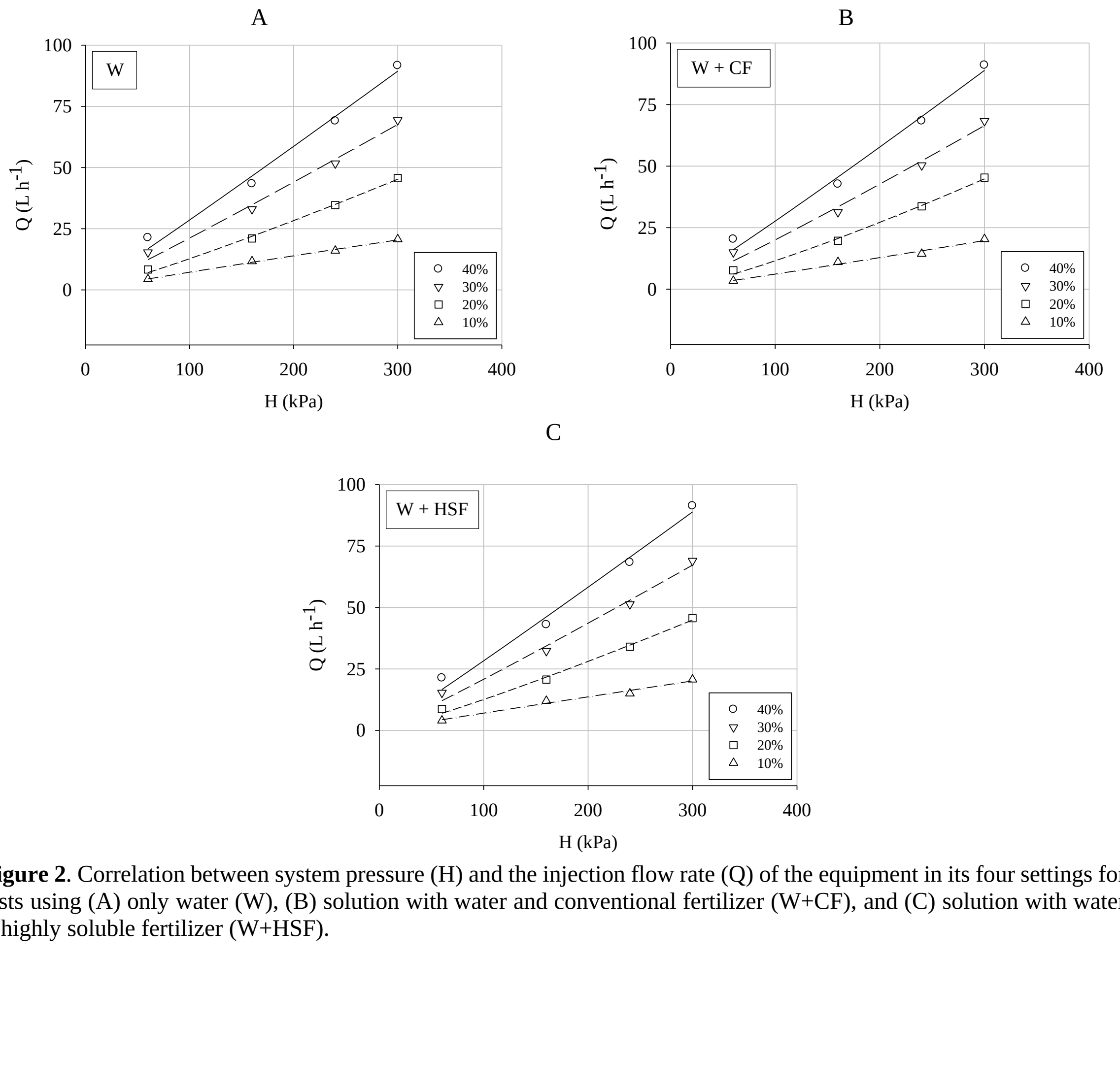

Figure 2. Correlation between system pressure (H) and the injection flow rate (Q) of the equipment in its four settings for tests using (A) only water (W), (B) solution with water and conventional fertilizer (W+CF), and (C) solution with water + highly soluble fertilizer (W+HSF).

Table 1. Technical specification of Tefen model 2504.

Injection flow	10 - 2500 L h^{-1}
Working pressure	20 – 800 kPa
Rate of addition	0,4 - 4%
Injection rate	0,12 - 100 L h^{-1}
PVDF Option	Yes
Option for chlorination	Yes
ON / OFF option	Yes
Option for Bypass	Yes

Font: Tefen (2015).

Table 2. Determination coefficients (R^2) and fitted equations based on the correlations between system pressure and injector flow rate of Tefen injector in its different settings and in the different tested solutions.

Regulation	Application type					
	W		W + CF		W + HSF	
	Equation	R^2	Equation	R^2	Equation	R^2
40%	$Q = 0.239\ H^{1.039}$	0.986	$Q = 0.206\ H^{1.063}$	0.988	$Q = 0.234\ H^{1.041}$	0.985
30%	$Q = 0.163\ H^{1.057}$	0.989	$Q = 0.131\ H^{1.092}$	0.985	$Q = 0.152\ H^{1.068}$	0.987
20%	$Q = 0.063\ H^{1.154}$	0.997	$Q = 0.039\ H^{1.235}$	0.996	$Q = 0.061\ H^{1.159}$	0.994
10%	$Q = 0.092\ H^{0.947}$	0.996	$Q = 0.045\ H^{1.065}$	0.982	$Q = 0.086\ H^{0.957}$	0.980