Original Article

TECHNICAL FEASIBILITY OF FERTIGATION IN POTATO FARMING

VIABILIDADE TÉCNICA DA FERTIRRIGAÇÃO NO CULTIVO DE BATATA

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ABSTRACT: Excessive water use in irrigation of potato has caused concern because of the constant predictions of scarcity. The objective of this work was to study the technical feasibility of fertigation of potato. The experimental design was randomized blocks in a 2 x 3 x 3 factorial scheme with a total of 18 treatments with three replicates. The factors studied were: fertigation (two types: surface and subsurface), nitrogen (three doses: 75, 150 and 225 kg ha^{-1}), potassium (three doses: 210, 310 and 410 kg ha^{-1}). Significant interactions between the factors nitrogen and potassium were observed only for tuber weight. There were no significant differences in the types of fertigation (surface and subsurface). Significant effects were observed only for the treatment of nitrogen and potassium. It was concluded that it is possible to produce potato fertirrigated with the use of a trickle irrigation system whether it be surface or subsurface.

KEYWORDS: *Solanum tuberosum* L.. Irrigation. Fertilization.

INTRODUCTION

In Brazil, the potato, *Solanum tuberosum* L., is the most important vegetable crop produced with around two million tonnes annually. The technology requires high investments due to the importation of potato seed and also the excessive use of fertilizers and agrochemicals. Irrigation made by the various sprinkler systems is responsible for an excessive waste of water which causes constant risks of groundwater contamination and degradation of soils through erosion, especially on plantations in hilly areas. The activity is organized in itinerant production systems, i.e., in new areas which had never been recently occupied with cultivation of Solanaceae. This is, essentially, a 'technical' potato, since a large amount of pathogens and insects-pests are common to these species (FILGUEIRAS, 2003). Moreover, the practice of irrigation creates a favorable environment for the development and proliferation of these organisms, compounded by the washing of pesticides from leaves by irrigation water which forces the use of increasingly strong pesticides.

According to the commission of soil fertility in Minas Gerais (1999), for a yield of 30 t ha^{-1}, the nitrogen fertilization recommendation is fixed at 190 kg ha^{-1}. For phosphorus and potassium the recommended doses range from 50 to 420 kg ha^{-1} and 0 to 350 kg ha^{-1}, respectively, according to the levels of these elements in the soil, increasing the saturation to 60%. At planting 20% N, 80% P and 20% K is placed, 35 days after planting (during the hilling) covering application is made using the rest of N, P and K. If there are two hilling operations, the amount of fertilizer to be applied should be divided in installments in both hillings.

When properly delivered nitrogen contributes to vegetative growth, expansion of photosynthetic area, and increases the yield potential of crops in general (CARDOSO; HIRAKI, 2001; FILGUEIRAS, 2003). Because it is a nutrient that has great dynamics in the soil-plant system, the appropriate management of N is considered one of the most difficult (Santos et al., 2006), as it essential for obtaining high yields. Therefore, it should be made available to the plant in time and at suitable sites which requires split application, topdressing (CARVALHO et al., 2001).

Potassium is essential for the translocation of sugars and starch synthesis (REIS JR.; FONTES, 1996), being the nutrient most absorbed by the potato (REIS JR.; MONNERAT, 2001). Potassium, according to Moinuddin and Bansal (2006), is also responsible for increasing the yield of tubers.

Drip irrigation can be used both on the soil surface, and buried, in this case denominated subsurface drip irrigation. According Phene e Ruskin (1995), the subsurface drip irrigation improves the efficiency of application, because the stored volume can be greater than in other irrigation systems. Moreover, Manfrinato (1985), Lopes e Buso (1999), argue that the efficiency of this

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irrigation method varies between 80% and 100%, which can be used in potato.

The cultivation of potato adopts a production system where certain practices are essential in order to have a productivity considered adequate. One of these practices is the hilling that consists of piling up soil around the plant at the neck. This operation is extremely important because it protects the stolons creating the essential condition for development of tubers. On the other hand, this practice also hinders localized irrigation technology and therefore fertigation, a technology already widely used in many economically important crops such as tomatoes, peppers, cucumbers, and fruit in general and others. This study aimed to evaluated the technical feasibility of the use of fertigation in potato.

MATERIAL AND METHODS

The experiment was carried out from 02/03/2009 to 11/06/2009, at the José do Rosário Vellano University in areas of the Department of Horticulture and Experimentation, located in Alfenas, MG.

The material used consisted of the potato cultivar Asterix, certified of good origin and widely cultivated in the region. The irrigation system donated by Metasul (Irrigation Systems Ltd.) consisted of the following: the dripline with Metasim emitters spaced at 25 cm and flow rate of 4 L h^{-1}, a 1000 L water tank was also used to apply the nutrient solution; a Web timer, with time adjustments for irrigation and the rest every 15 minutes and its multiples; Thebe motor pump, 5 m^3h^{-1}, 40 mwc and tensiometers.

The experimental design was randomized blocks in a 2x3x3 factorial constituting 18 treatments with three replicates. The factors consisted of two methods of irrigation, surface and subsurface, three nitrogen (75, 150 and 225 kg ha^{-1}) and three potassium doses (210, 310 and 410 kg ha^{-1}) with all possible combinations of these factors. Surface irrigation was made with the drip tube next to each plant line. At the time of hilling, 30 days after planting, the drip tubes were removed and replaced over the surface of the piles formed where they remained until the end of the trial. The subsurface irrigation was performed with the grounding of the final drip tube during the hilling procedure. White potassium chloride was used as a source of potassium with 60% K_2O and as nitrogen source, urea with 45% N.

Each plot had dimensions of 1.6 m x 2.5 m consisting of two 2.50 m long rows spaced 0.80 m, comprising 20 plants that were evaluated by the 16 central plants with other plants considered as borderline . Irrigation was done according to the indications of the tensiometers strategically placed near the experimental area. Irrigation was conducted when the tensiometer readings registered -30 and -50 kPa.

Fertigation was done weekly according to the treatments and the tensiometer readings. The experimental area initially showed the following nutrient content: pH (H_2O) = 5,5; OM = 1,18 dag/kg; P (Mehlich)= 25 mg/dm^{-3}, K (Mehlich)= 111 mg/dm^{-3}; Ca^{2+} = 0,9 cmolc/dm^{-3}; Mg^{2+} cmolc/dm^{-3} = 0.6; cmolc/dm^{-3} Al^{3+} = 0,1; H+Al = 3,2 cmolc/dm^{-3}. The phosphorus in the form of superphosphate was placed entirely in the plot five days before planting in a single dose for all treatments. Nitrogen and potassium were applied in coverage weekly in accordance with the scheduled doses. There were eight coverages during the crop cycle and according to its phenological stages. For these applications, was used fertigation. For each treatment (different doses of nitrogen fertilizer and potassium) the volume of nutrient solution, the time of fertigation and irrigation time to wash the equipment was determined. For the fertigation the venturi applicator was not used; 1,000 gallons used for irrigation being directly deposited.

Before fertigation, according to each treatment, the tank was supplied with enough water to fill the entire pipeline and start the drip in all related emitters only to the portions corresponding to the treatment in question. After this procedure, the tank was supplied with the nutrient solution and then this solution was applied fully in the corresponding plots. At 101 days after planting the following characteristics were evaluated: average weight of the tuber, in grams and commercial production in tonnes per hectare. Data were subjected to analysis of variance and then the averages were submitted to regression analysis. For these procedures we used the Sanest.

RESULTS AND DISCUSSION

Average Weight of Tubers

There were significant interactions between factors nitrogen and potassium. No significant effects of irrigation types (Surface and Sub-surface) indicating no need to remove the tube emitters at hilling time (Table 1). According to Camp (1998) sub-surface drip irrigation has been compared with other irrigation systems for different types of culture, in all cases the output is equal to or greater than other systems. The tubers reached adequate size for the cultivar within commercial standard in this region, regardless of type of irrigation used. For both types of irrigation observed a quadratic response to doses of 210 and 310 kg ha^{-1} of potassium. Specifically for surface irrigation, the dose of 310 kg ha^{-1} of potassium was found to be the best result when combined with an estimated dose of 112,5 kg ha^{-1} of nitrogen. From this dose on there was a gradual decreased in average weight of the tubers, indicating a harmful effect of the fertilizer (Figure 1). For a dose of 410 kg ha^{-1} of potassium it was observed a linearly effect, with a gradual decrease of the average tuber weight with the increase of nitrogen. Similar behavior was observed with the sub-surface irrigation indicating no influence of irrigation on fertilizer application as well as the irrigation itself (Figure 2).

Table 1. Weight of tubers in function of treatments.

Irrigation	Average Weight of Tubers (g)
Sub-surface	92.47a
Surface	90.93a

- Means followed by different letters differ at 5% probability by Tukey test.

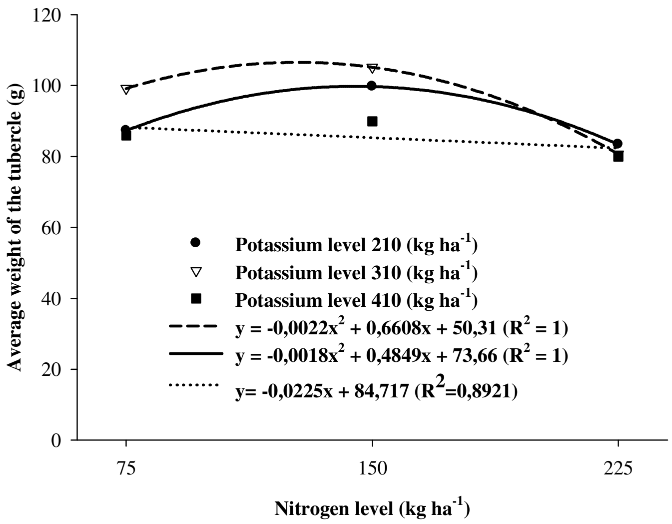

Figure 1. Effect of potassium and nitrogen level in the average weight of potato tubers with surface fertigation.

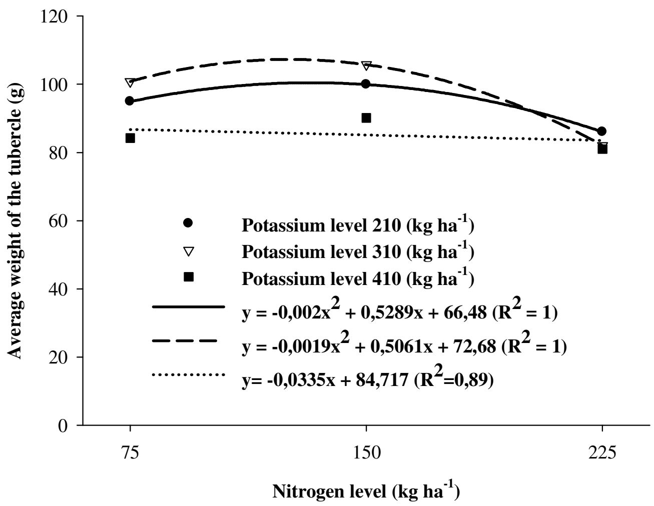

Figure 2. Effect of potassium and nitrogen level in the average weight of potato tubers with sub-surface fertigation.

By comparison, the dose of nitrogen is less than that indicated for potato, which is 190 kg ha^{-1} N and more than the recommended dose of potassium, considering the soil content of the nutrient being found to be good (FONTES, 1999). Probably this response is due to a lower initial dose of nitrogen and increased fragmentation of applications resulting in better use by the plants.

Commercial Production

There were no significant interactions between factors irrigation, nitrogen and potassium. The only significant effects were observed for the nitrogen and potassium treatments. Considering only the nitrogen, there was a quadratic effect with the doses of nitrogen applied to both types of irrigation. The highest yield, 28.56 and 28.03 t ha^{-1}, considering sub-surface and surface irrigation, respectively, was reached with an estimated dose of 138, 75 kg N ha^{-1}, from which there was a decrease in production with increasing doses (Figure 3 and Table 2). For potassium, similar behavior was observed with good commercial production levels compatible with those observed by potato growers in the region (Figure 4) with a significant drop in production from the dose of 310 kg ha^{-1} of potassium (Figure 4 and Table 2).

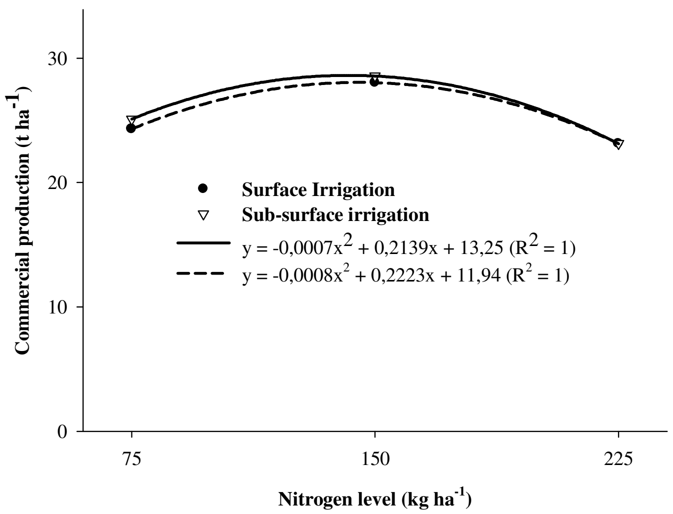

Figure 3. Effect of nitrogen level in commercial potato depending on the type of fertigation.

TABLE 2. Commercial production of potato (t ha^{-1}) in function of nitrogen and potassium rates and the type of irrigation.

Irrigation	Nitrogen level (kg ha^{-1})			Potassium level (kg ha^{-1})		
	75	150	225	210	310	410
Surface	24.30	28.03	23.13	25.45	25.6	18.33
Sub-surface	25.1	28.56	23.63	25.6	26.51	18.78

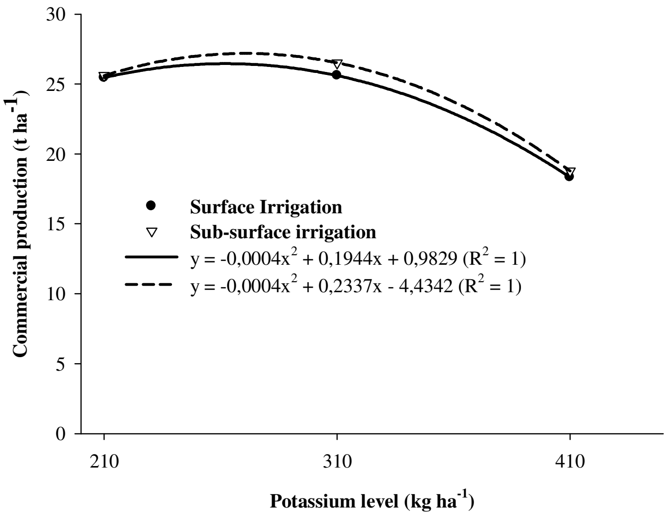

Figure 4. Effect of potassium level commercial potato depending on the type of fertigation.

CONCLUSION

It is possible to produce potatoes fertigated with the use of a localized trickle irrigation system, independent of it being surface or subsurface.

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RESUMO: Viabilidade técnica da fertirrigação no cultivo de batata. O uso excessivo de água na irrigação da batata tem causado preocupação em razão das constantes previsões de escassez. O objetivo do presente trabalho foi estudar a viabilidade técnica de fertirrigação na cultura da batata. O delineamento experimental foi em blocos ao acaso em esquema fatorial 2 x 3 x 3 totalizando 18 tratamentos com três repetições. Os fatores estudados foram: fertirrigação (dois tipos: superficial e sub-superficial); nitrogênio (três doses: 75, 150 e 225 kg ha^{-1}); potássio (três doses: 210, 310 e 410 kg ha^{-1}). Para peso médio dos tubérculos, foram observadas interações significativas apenas entre os fatores nitrogênio e potássio.. Não houve diferenças significativas para os tipos de fertirrigação (superficial e sub-superficial). Os efeitos significativos foram observados apenas para os tratamentos doses de nitrogênio e doses de potássio. Concluiu-se que é possível produzir batata fertirrigada com uso de sistema de irrigação localizada independente de ser superficial ou sub-superficial.

PALAVRAS-CHAVE: *Solanum tuberosum* L.. Irrigação. Fertilização.

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