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Water and nitrate movement in drip-irrigated onion under fertigation and irrigation treatments

T.B.S. Rajput *, Neelam Patel

Water Technology Centre (WTC), Indian Agricultural Research Institute (IARI), Pusa, New Delhi, Delhi 110012, India

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Abstract

Frequent fertigation of crops is often advocated in the technical and popular literature, but there is limited evidence of the benefits of high-frequency fertigation. Field experiments were conducted on an Indo-American Hybrid var., Creole Red, of onion crop during three winter seasons of 1999–2000 through 2001–2002 in coarse-textured soil of Delhi under the semi-arid region of India. Three irrigation levels of 60, 80 and 100% of the crop evapotranspiration (ET) and four fertigation frequencies of daily, alternate day, weekly and monthly comprised the fertigation treatment. Analysis of soil samples indicated considerable influence of fertigation frequency on NO_3-N distribution in soil profile. NO_3-N in lower soil profiles (30.0–60.0 cm soil depth) was marginally affected in daily, alternate day and weekly fertigation. However, fluctuations of NO_3-N content in 0.0–15.0, 15.0–30.0, 30.0–45.0 and 45.0–60.0 cm soil depth was more in monthly fertigation frequency. The level of soil NO_3-N after the crop season shows that more NO_3-N leached through the soil profile in monthly fertigation frequency. Amounts of irrigation water applied in three irrigation treatments proved to be too small to cause significant differences in the content of NO_3-N leached beyond rooting depth of onion. Yield of onion was not significantly affected in daily, alternate day and weekly fertigation, though there was a trend of lower yields with monthly fertigation. The highest yield was recorded in daily fertigation (28.74 t ha^{-1}) followed by alternate day fertigation (28.4 t ha^{-1}). Lowest yield was recorded in monthly fertigation frequency (21.4 t ha^{-1}). Application of 56.4 cm irrigation water and 3.4 kg ha^{-1} urea per fertigation (daily) resulted in highest yield of onion with less leaching of NO_3-N.

Keywords: Onion; Drip irrigation; Water and N management; NO_3-N leaching; Fertigation

* Corresponding author. Tel.: +91 11 25846790; fax: +91 11 25843112.
E-mail address: tbsraj@iari.res.in (T.B.S. Rajput).

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1. Introduction

Drip irrigation is often preferred over other irrigation methods because of the former's high water-application efficiency on account of reduced losses, surface evaporation and deep percolation. Because of high frequency water application, concentrations of salts remain manageable in the rooting zone (Mantell et al., 1985). Onions have a shallow, sparsely branched root system with most roots in the top 30.0 cm of soil. Rooting density decreases with soil depth. The sparse, shallow rooting of onions is an important consideration for efficient management of mobile nutrients such as nitrate-nitrogen (NO_3-N) (Sullivan et al., 2001; Patel and Rajput, 2002). Boswell et al., (1985) reported that NO_3-N is relatively unreactive, and therefore, susceptible to movement through diffusion and mass transport in the soil water.

Fertigation enables the application of soluble fertilizers and other chemicals along with irrigation water, uniformly and more efficiently (Patel and Rajput, 2000; Narda and Chawla, 2002). Nevertheless, the increasing use of nitrogenous fertilizers have caused environmental problems, generally manifest in groundwater contamination. There is a direct relation between large NO_3-N losses and inefficient fertigation and irrigation management. Therefore, water and N fertilizer inputs should be carefully managed in order to avoid losses. Improved water efficiency under drip irrigation, by reducing percolation and evaporation losses, provides for environmentally safer fertilizer application through the irrigation water (Mmolawa and Or, 2000; Rolston et al., 1979). The overall problem is to identify economically viable practices that offer a significant reduction of NO_3-N losses, which also fit in the farming systems practised under a particular soil type and set of climate conditions (Watts and Martin, 1981). For that purpose, a better understanding of the impact of current practices on the crop and on losses of water and nitrogen from the root zone is necessary, which should be obtained from a sound base of field experimentation and environmental mechanics.

Onion (botanical name: *Allium cepa*) is a member of Amaryllidaceae family. Onion belongs to bulb vegetables group and ranks at the top in its production and consumption in India as well as in the world. Area-wise, India ranks second while production wise it ranks third among the total onion production in the world. Onion can be grown under a wide range of climatic conditions. However, it cannot stand too hot or too cold weather. Onion possesses very good nutritive and medicinal values. One hundred grams of onion contains 1.2 g proteins, 11.0 g fat, 11.0 g carbohydrates enriched in Vitamins B and C. The pungent taste of onion is due to volatile oil allyl propyl disulphide present in it. There are hundreds of varieties of onions grown in the world. According to colour, there are red, white and yellow types. Red and white varieties are mostly grown in India. Onion requires well-drained, fertile soil having pH between 6.5 and 8.0. Onion seeds are sown in nursery from October to November. About 8–10 kg onion seeds are required for transplanting of onion in 1.0 ha field. Seedlings transplanted early (in mid-December) yield more (Singh et al., 1995; Kumar et al., 1998; Mishra and Mishra, 1991).

Fertilizers should be applied in a form that becomes available in synchrony with crop demand for maximum utilization of nitrogen from fertilizers (Boyhan et al., 2001). The amount of nitrogen fertilizer recommended for onion varies widely. Onion responds well to additional fertilizer applied 40–60 days after transplanting (Mohanty and Das, 2001;