

# Potassium Requirements for Garlic under Fertigation

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**The practice of fertigation is expanding yield potential by reducing plant growth limiting factors. This research provides a better estimate of the nutrient demands of garlic under fertigation, which is necessary to obtain optimal production levels.**

Crop yields under fertigation have shot up to potentials never before imagined (Papadopoulos, 1987; Hartz, 1994; Castellanos et al., 2001a). The principal reason for this increase is an optimized delivery system for water and nutrients which eliminates most plant growth limiting conditions. At high yield levels, nutrient demand also increases well above levels considered normal for furrow irrigation systems (Castellanos et al., 2001b). In light of the higher nutrient demand, it is important to review the rates of fertilization supplied to crops under modern fertigation systems.

Potassium (K) is a very important nutrient for increasing garlic yields. Proper application rates and timing are critical for generating a yield or quality response. As crop yields increase, the amount of K required also increases, along with all other nutrients. The amount applied ranges from 60 to 150 kg K<sub>2</sub>O/ha, depending on the soil K level, crop yield goal, and the site's soil characteristics.

Three basic steps are involved in maximizing garlic yield under fertigation: 1) soil analysis to prepare the most suitable fertigation program, 2) knowledge of the crop's nutrient demands throughout the season, and 3) reliable reference indices for nutrient concentrations in the most recently matured leaf (MRML), in order to correctly interpret tissue analyses and to fine-tune the fertigation program. A limited amount of literature has been published on these last two factors.

Garlic's demand for K ranges from 125 to 180 kg K<sub>2</sub>O/ha (Bertoni and Morard du L. Espagnacq, 1988; Zink, 1963). However, only one report has been published on tissue analysis for diagnosis of K status in this crop, and this reference only covers limited stages of crop development (Tyler et al., 1988). This source indicates that the correct content of K in the MRML varies from 4 percent in the pre-bulbing stage, to 3 percent in the bulbing stage and 2 percent in the post-bulbing stage. The MRML can be identified for sampling by the characteristic "ring" at its base, circling the stem. Garlic is a long-season crop that remains

in the field for up to seven months, reference information on leaf K status from the beginning of the season to the end is required. This would give farmers the opportunity to accurately identify and promptly correct any deficiencies.

The study was conducted in a Vertisol with a pH of 7.8 (soil:water of 1.2), 2.1 percent organic matter, 14 parts per million (ppm) Olsen-P, 18.1 cmol<sub>c</sub> calcium (Ca)/kg of soil, 5 cmol<sub>c</sub> magnesium (Mg)/kg of soil, 2.8 cmol<sub>c</sub> K/kg of soil, 5.7 ppm of DTPA-iron (Fe), 0.8 ppm of DTPA-copper (Cu), 1.2 ppm of DTPA-zinc (Zn), and 12 ppm of DTPA manganese (Mn). The research was conducted at the Celaya Agricultural Research Station of the National Institute of Agricultural Research (INIFAP), located in central Mexico at 20° 15' north latitude, 101° 39' west longitude, and at 1,650 meters above sea level, with a mean annual temperature of 19°C.

The study consisted of two experiments, one conducted in 1997-98 using furrow irrigation, and a second in 1998-99 in which fertigation was used. Plant K uptake data and the resulting uptake curves were obtained for both experiments, while the third fertigation experiment, (established in 1999-00) explored the effects of plant density on yields and the amount of K taken up by garlic plants.

In all three experiments, the crops received 80 kg of P<sub>2</sub>O<sub>5</sub>/ha at the time of planting and 240 and 285 kg of N/ha during the 1996-97 and 1997-98 growing seasons, respectively. In the plant density experiment, 405 kg N/ha was applied in 1999-00. In the 1997-98 experiments, N was divided into three applications throughout the season, while in the fertigation experiments N fertilizer was applied with irrigation water according to crop demand. In all three experiments, K was applied at 100 kg K<sub>2</sub>O/ha. In the 1997-98 furrow irrigation experiment, plant density was 300,000 plants/ha, while in the 1998-99 fertigation experiment it was 380,000 plants/ha. In the 1999-00 experiment, four different plant density treatments (300,000, 400,000, 500,000, and 600,000 plants/ha) were evaluated for yield and quality factors. In all cases, the cultivar was *cv.* Tacasuario.

**Figure 1.** Potassium extraction by garlic under different production levels in a Vertisol in central Mexico.

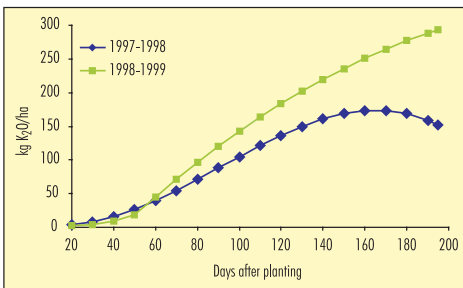


Figure 1 shows the amount of K taken up by the crop during the entire season in both experiments. Garlic demanded very little K in the first 50 days after planting, but increased substantially after that date. In the furrow irrigation experiment, K<sub>2</sub>O uptake by the crop was 175 kg K<sub>2</sub>O/ha, while in the fertigation experiment it was 295 kg K<sub>2</sub>O/ha. Crop yields were 19.1 t/ha in the 1997-98 furrow irrigated crop and 29 t/ha in the 1998-99 fertigation experiment. The higher yield potential of the fertigated crop increased plant demand

for K by almost 70 percent. Based on these results, it was concluded that for every tonne of garlic produced, as much as 9.1 to 10.1 kg of  $K_2O$  is taken up by the crop.

The effects of plant density on crop yield are shown in **Figure 2**. Garlic is highly responsive to plant density. Yields increased from 31 t/ha at 300,000 plants/ha to 39.7 t/ha at 600,000 plants/ha, with K uptake increasing from 238 to 302 kg  $K_2O$ /ha.

As garlic yields increased, bulb size decreased. This affects the value of the crop in the fresh market. For industrial purposes, high population density is not a problem; otherwise it may be more convenient to use a plant density of 300,000 plants/ha.

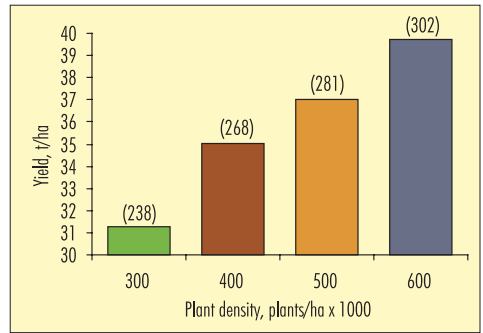
Two experiments indicate that through the greater part of the developmental stage the concentration of K in the MRML for optimum yield is between 2.5 to 3.5 percent, although this value decreased in furrow irrigation and was higher with fertigation.

As crop yield potential goes up, the amount of K needed by the crop also increases. No similar outstanding yields have been reported in the literature, and we believe that these results are due to the use of well-adapted cultivars and the effective use of fertigation. **BCI**

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**Figure 2.** Bulb yield and K extraction (kg  $K_2O$  extracted per ha) of garlic under fertigation for four different population densities, central Mexico.