

Introduction

The soils cultivated with andean blackberry in Colombia are fertilized without considering the species nutritional requirements. Fertilization is carried out without certainty of when applications are required depending of the phenological stage of the established crops. The aim of this study was to estimate the reference values of foliar concentration of N, P, K and Ca for andean blackberry crops in Colombia.

Methodology

Vegetal material

Plants of andean blackberry (*Rubus glaucus* Benth.) with stinger (sexual seed) (Figure 1).

Experimental Design

An orthogonal central composite design of 25 treatments was proposed, considering five levels per nutrient (N, P, K y Ca) in a randomized complete block design. The fertilization treatments and destructive samplings/stage were carry out as follows:

- Vegetative:** six fertilizations (one each month) and samplings at 72, 112, 138, 166, 195 y 225 dat (days after transplanting).
- Reproductive:** one fertilization and samplings at 293, 355 y 435 dat.
- Productive:** nine fertilizations every two months. Samplings at 481, 548, 625, 681 and 758 dat (during the first year); and at 793, 863, 919 and 972 dat (during the second year).



Figure 1. Plant of andean blackberry.

In each sampling were separated leaves, stems, roots and fruits of the plant of each experimental unit. Macro and micronutrients analyses were conducted for each plant's sampled organ. With the concentration values the vegetative index was calculated for each organ and stage (Valenzuela et al., 1993). To define adequate ranges of vegetative index a normal value between 1 and 2 was proposed. Taking as reference the foliar concentration ranges of N, P, K and Ca for *Rubus* sp. (SBCS, 2004); mean values were plotted, values above and below the normal value and values in deficit and excess at each sampling point and for each fertilization treatment.

Results

Foliar concentration during vegetative and reproductive stages

The most of fertilization treatments allowed for the plants to have high concentration of N during vegetative growth. At the end of reproductive growth (435 dat) the plants had a deficit concentration of N.

P concentration during vegetative growth was below of the normal range in some of the six samplings (Figure 2). Particularly, low P concentration in plants that received high dosages of N and CaO and low dosages of P₂O₅ and K₂O (treatment 6).

The P concentration was below of normal range in all samplings of reproductive stage (Figure 2), except for plants that received the treatments 11 and 15, which had low dosages of N and high dosages of P₂O₅ and CaO. N and P concentrations was higher during reproductive bud stage (293 dat) than during fruit setting (435 dat). Considering the values of SBCS (2004) it is necessary to adjust the phosphorus ranges for andean blackberry crops in Colombia: **underestimation of P.**

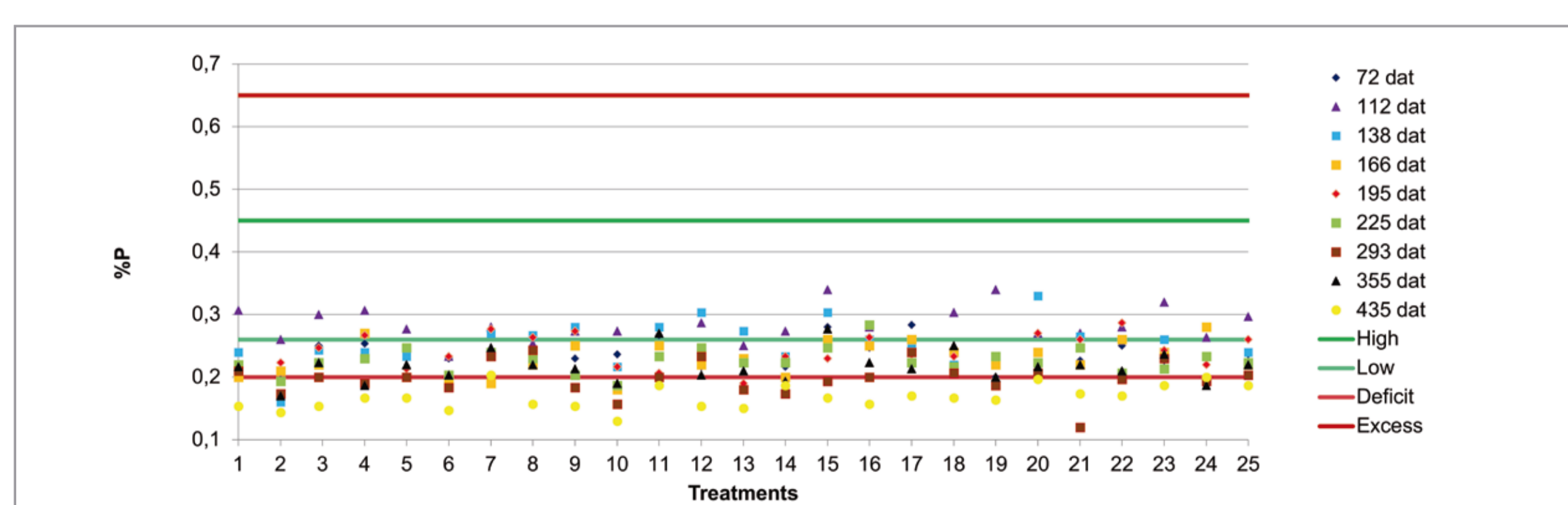


Figure 2. P foliar concentration in andean blackberry plants during vegetative and reproductive growth.

The plants showed a deficit in the K concentration at 72 and 138 dat, contrasting against the other samplings (adequate concentration). Concentration of Ca foliar was in deficit at 138 dat.

Concentration of K and Ca during reproductive stage showed adequate reference values. K values were highest during reproductive bud stage. In contrast with the other nutrients evaluated, it was observed that calcium values were high during fruit setting.

VI during vegetative and reproductive stages

During the vegetative stage, VI of leaves were lower than 1 at 72 dat: concentration of Ca and Mg were higher than that of N, P and K. In contrast, at 112 dat it was found a high concentration of N, P and K in the leaf; which tended to decrease at 225 dat. During of reproductive stage VI of leaves was higher than 1.

The VI of stem had values lower than 1, indicating importance of Ca and Mg at 72 and 138 dat; also signaling high concentration of divalent bases regarding N, P and K. The VI of root was superior to 1 during the reproductive stage. In leaf and stem, the concentration of Ca and Mg was higher than N, P and K, in the reproductive bud stage contrasting them against the fruit setting stage. However, the higher values of VI of stem indicate lower concentration of divalent cations in these vegetative structures in contrast with the leaves.

The VI of roots with values higher than 1 indicates high concentration of N, P and K, throughout the vegetative stage. However, a decrease in the VI of roots can be observed at 225 dat, contrasting against the samplings taken at 112 and 195 dat. The values of VI in reproductive bud stage are considerably lower than those at fruit setting stage, indicating the importance of Ca and Mg when plants are emitting their flower buds.

Foliar concentration during productive stage

- During reproductive stage, no excessive concentrations of N were found. At 548 dat the N concentration was low, but at 758, 863 y 972 dat it was normal.
- In all samplings, P concentration were low or deficitary with the different fertilization treatments (Figure 3).
- No high values for concentration of K and Ca, were found at foliar level.

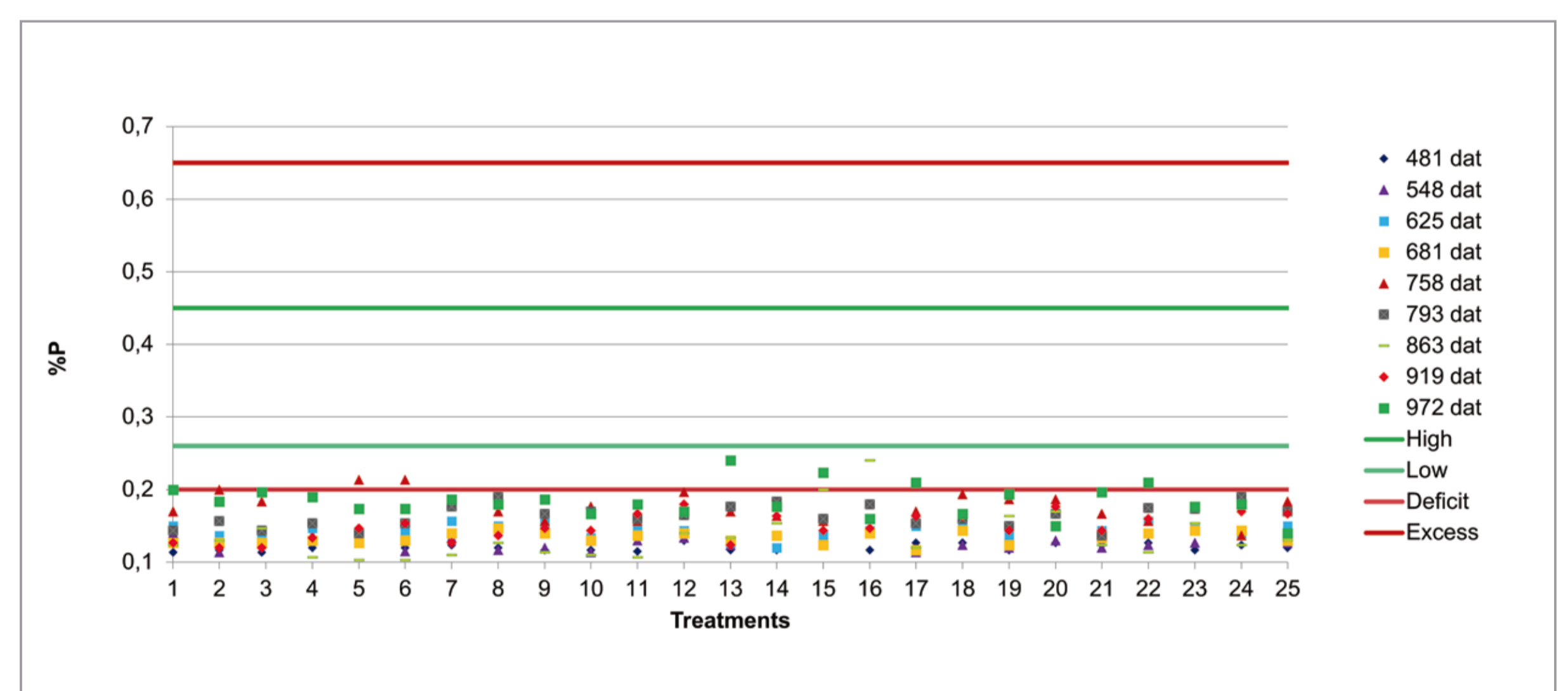


Figure 3. P foliar concentration in andean blackberry plants during productive stage.

Vegetative Index during productive stage

- The values of VI in leaves, stems and roots during productive stage were all superior to 1.
- The values of VI in leaves were less than 2 in samples taken at 481, 548, 758 y 793 dat. The values of VI in stems were lower than 2 in the samples taken at 758 and 793 dat.
- The values of VI in roots were lower than 2 in samples taken at 625, 758 y 793 dat. In contrast, the values of VI in fruits were higher than 2 for all the samplings.

Conclusion and recommendations

The results evidence that it is needed to adjust the P ranges for andean blackberry crops in Colombia, as they seem to show **underestimation of P values.** However, the reference values of SBCS (2004) could be safely used to analyze the N, K and Ca concentrations. It is also suggested that foliar samplings for nutritional diagnosis purposes could be made two years after the crop were established.

To define the phosphorus sufficiency ranges, the information generated by the graphs of P in each stage of the crop was crossed with the allometric variables, nutritional absorption and the potential yield obtained with the application of each treatment; allowing to suggest the following ranges:

Vegetative stage sufficiency range: 0.22 % - 0.27 %,

Reproductive stage sufficiency range: 0.12 % - 0.22 %,

Productive stage sufficiency range: 0.12 % - 0.19 %.

Bibliographic references

- SBCS – Sociedade Brasileira Da Ciência Do Solo. (2004). Manual de adubação e calagem para os estados do Rio Grande Sul e de Santa Catarina. 10. ed. Porto Alegre: Comissão de Química e Fertilidade do Solo - RS/SC. 400 p.
- Valenzuela, J.L., Guzmán, M., Sánchez, A., del Río, A. y Romero, L. (1993). Relationship between biochemical indicators and physiological parameters of nitrogen and physiological plant age. pp: 215-257. In: M.A.C. Fragoso y M.L. van Beusichem (eds.). Optimization of Plant Nutrition. Kluwer Academic Publishers. The Netherlands.