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Growth and productivity of potato as influenced by cultivar and reproductive growth II. Growth analysis, tuber yield and quality

T. Tekalign *, P.S. Hammes

Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa

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Abstract

A field experiment was conducted under sub-humid tropical conditions in Ethiopia using determinate cultivars Al-624, Al-436, CIP-388453-3(A) and CIP-388453-3(B) to study the effect of flowering and berry set on the growth, tuber yield, and quality of potato. Three treatments, viz. debudded, flowering, and fruiting plants were compared and standard growth analysis techniques were applied to study the growth pattern. Fruiting plants exhibited reduced leaf area index, tuber growth rate, and partitioning coefficient, but had higher crop growth rates and net assimilation rates. Fruit development reduced total and marketable tuber mass and tuber number without affecting the unmarketable component. Cultivars varied with respect to tuber yield, tuber number, size distribution, specific gravity, dry matter content, and nutrient composition. Fruiting reduced tuber specific gravity and dry matter content while increasing P, K, Mg, Fe, and Mn content of the tubers. Reproductive growth did not affect tuber Ca, S, Cu, and Zn concentrations. The field experiment demonstrated that reproductive growth restricts vegetative growth and reduces tuber yield and dry matter content of potato.
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Keywords: Berry set; Dry matter content; Growth analysis; Tuber quality; Tuber yield

1. Introduction

In most herbaceous annual plants, vegetative growth is terminated by reproductive growth. Developing flowers and fruit are stronger sinks for mineral nutrients, sugar and

* Corresponding author. Present address: Alemaya University, P.O. Box 150, Ethiopia.
Tel.: +251 5 610708; fax: +251 5 610719.
E-mail address: tekalignt segaw@yahoo.com (T. Tekalign).

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amino acids, and there is a corresponding decrease in the amounts available for the growth of other plant parts (Salisbury and Ross, 1992). Studies in various crops showed that growing fruit are strong sinks and suppress the growth of vegetative organs (Cockshull et al., 1992; Eckstein et al., 1995; Letchamo and Gosselin, 1995; Heuvelink, 1997). There is evidence indicating that during the reproductive phase, leaves, stems, and other vegetative parts compete for assimilates with the developing fruit (Eckstein et al., 1995; Heuvelink, 1997; Famiani et al., 2000) and sometimes previously accumulated carbon and minerals are mobilized and redistributed (Gardner et al., 1985). The distribution of assimilates within the plant is primarily regulated by the sink strength of sink organs (Ho et al., 1989; Marcelis, 1996).

Dry weight accumulation is commonly used as parameter to characterize growth because it usually has a great economic significance. The total dry matter yield of crops depends on the size of leaf canopy, the rate at which the leaf functions (efficiency), and the length of time the canopy persists (duration). The production of assimilates by the leaves (source) and the extent to which they can be accumulated in the sink representing the organs that are harvested significantly influences crop yield (Hahn, 1977). Growth analysis has widely been used to study yield influencing factors and plant development as net photosynthate accumulation over time (Gardner et al., 1985). A study of the pattern of dry matter distribution among plant parts is important for the evaluation of the growth rate, productivity and the yield level of potato (Nganga, 1982).

Albeit their relationship is not well understood, shoot and tuber growth of potato are genetically considered as competing processes (Almekinders and Struik, 1996). The inflorescence as a sink in potato plants has not received adequate attention and growers view flowers and berries as a minor nuisance. Results with other root crops showed that reproductive growth restrict the development of underground storage organs such as sugar beet (Wood and Scott, 1975), onion (Khan and Asif, 1981) and Jerusalem artichoke (Rice et al., 1990). However, detail work has not been done regarding the effects of reproductive growth on potato tuber growth, and results are conflicting. So and so reported flower and berry set have depressing effect on tuber growth (ProundFoot, 1965; Jansky and Thompson, 1990). On the contrary, Haile-Micheal (1973) observed no consistent relationship between reproductive growth and tuber growth. A previous Ethiopian study on the effect of reproductive growth on vegetative growth and tuber yield of potato showed that reproductive growth restricted vegetative growth and reduced tuber yield and quality (Tsegaw and Zelleke, 2002). This finding called for a more detailed investigation of how reproductive growth affects growth, tuber yield, tuber quality and nutrient composition. Accordingly, this paper reports on the effect of reproductive growth on growth, yield, quality and nutrient composition of potato tubers.

2. Materials and methods

2.1. Area descriptions

The study was conducted during February–June 2003 on the research farm of Alemaya University, Ethiopia. The experimental site is located at 42°3′E longitude, 9°26′N latitude

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