THE EFFECT OF WATER STRESS ON POTATO GROWTH, DEVELOPMENT, AND YIELD

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Abstract

The effect of water stress on plant morphology, production rate and marketable yield is discussed based on the literature. Compared to other species the potato is a drought sensitive plant. The reduction of yield as a result of water stress can be caused by reduced leaf area and/or reduced photosynthesis per unit of leaf area. Water shortage during the tuber bulking period decreases yield to a larger extent than drought during other growth stages.

The relationship between the stress parameters relative water content (RWC), leaf water potential (LWP) and stomatal diffusion resistance on the one hand and photosynthesis on the other is discussed. Further it is shown how the amount of water needed by the potato crop depends on climate, soil and plant characters. Finally the effect of water stress on marketable yield and varietal differences to shortage of moisture are discussed.

Resumen

Basándose en la literatura, se discute el efecto del stress hídrico sobre la morfología de la papa, la rata de producción y el rendimiento comercial.

Comparada con otras especies, la papa es sensible a la sequía. La reducción del rendimiento como resultado de este stress puede ser debida, a la reducción del área foliar y/o a la reducción de la fotosíntesis por unidad de área foliar. La reducción del rendimiento causada por escasez de agua durante el período de tuberización, es mayor que aquella causada durante otros estados de desarrollo.

También se discute la relación entre la fotosíntesis y los parámetros de stress hídricos, tales como: contenido hídrico relativo (RWC), potencial hídrico de la hoja (LWP) y la resistencia a la difusión por los estomas. Se muestra además que la cantidad de agua requerida por el cultivo, depende del clima, del suelo y de las características específicas de la planta.

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Introduction

In this paper the effect of water stress on plant morphology, production rate, and marketable yield of the potato will be discussed based on the literature. An attempt will be made to define more closely which levels of water deficit are critical in different stages of the vegetative cycle.

Water is essential for plant growth. Many physiological processes depend on it. Further it is a major constituent of living plant tissues, which consist of about 90% water. However, only a very small part — about 1% — of the water needed by a plant is used in metabolic processes. The rest is used for transpiration. Water stress may inhibit or even completely stop one or more physiological processes such as transpiration, photosynthesis, cell enlargement, and enzymatic activities.

Water stress or plant water deficit can be satisfactorily described by two parameters: the relative water content (RWC) \((\text{fresh weight minus dry weight}/\text{full turgid weight minus dry weight}) \times 100\); or the energy status of the contained water, plant, or leaf water potential (LWP) (26).

Other plant characteristics which are associated with RWC and LWP also can be used as indirect estimates of water deficits, e.g., stomatal aperture or stomatal resistance (3). In the following, these parameters will be used to indicate stress levels in the plant.

Potato Compared to Other Plant Species

Compared to other species the potato is very sensitive to water stress (25, 49). To prevent yield losses, irrigation frequency of potatoes therefore should be higher than for crops such as tomatoes, corn, and sugar-beet (21). According to Rijtema and Aboukhaled (45) stomata of potato leaves close at relatively small water deficits, resulting in reduced transpiration. They found transpiration to be reduced at a LWP of \(-3\frac{1}{2}\) bars. In a growth chamber experiment, Campbell et al. (12) found about the same value. This is much "wetter" than for crops such as soybean and cotton, with respectively \(-11\) and \(-13\) bars (7, 45).

Shepherd (49) compared potatoes, ryegrass, and clover under well watered and droughted conditions. At high evapotranspiration rates the RWC was lowest for potatoes and clover. In the afternoon LWP was wettest for potatoes (-6 bars) against -8.5 bars for clover. Leaf diffusion resistance increased more in potatoes than in clover and ryegrass (Table 1).

Burrows (10) showed that at decreasing soil water deficit the relative transpiration rate (actual transpiration rate/potential transpiration rate) of potatoes decreased faster than that of sugarbeet. Ackerson (1) observed a much slower recovery of LWP during the night for potato than for cotton.