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番茄综合营养品质指标构建及其对水肥供应的响应

Construction of comprehensive nutritional quality index for tomato and its response to water and fertilizer supply

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中文关键词: 肥料 灌溉 层次分析法 番茄 综合营养品质评价 灌水量 四元二次正交旋转组合设计

英文关键词:fertilizers irrigation analytic hierarchy process tomato comprehensive evaluation of nutritional quality irrigation amount a composite quadratic orthogonal regressive rotation design with four factors

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中文摘要:

为构建番茄综合营养品质指标，分析其对水肥供应的响应，该文以灌水量和氮、磷、钾肥用量为试验因素，按照四元二次正交旋转组合设计，进行番茄盆栽试验，监测番茄可溶性固形物、可溶性糖、可滴定酸、糖酸比、番茄红素和维生素C 6项单一品质指标，根据主观层次分析法与客观熵权法和基于博弈论的组合赋权法，确定番茄单一营养品质评价指标权重，次序为：番茄红素＞糖酸比＞维生素C＞可溶性糖＞可溶性固形物＞可滴定酸；通过近似理想解法，构建番茄果实综合营养品质评价指标。在此基础上，通过回归分析建立番茄综合营养品质与水肥因子的数学模型，分析其对水肥因子的响应关系。结果表明，各水肥因子对番茄综合营养品质的主效应表现为：施磷量＞施氮量＞灌水量＞施钾量。当其他因素为中间水平时，番茄营养品质随灌水量或施氮量的增加呈开口向下的抛物线型变化，随磷肥用量的增加线性增加，随施钾量的增加呈开口向上的抛物线型变化。交互作用表现为，灌水量与施氮量、磷与钾肥用量之间存在显著交互作用。表明灌水量、氮肥用量过高不利于番茄综合营养品质的提高，合理增施磷肥和钾肥可有效提高番茄营养品质。

英文摘要:

Abstract: In recent years, the nutritional quality of vegetables has been increasingly concerned by people and investigated by researchers. However, the decline in vegetable internal quality is common due to excessive irrigation and irrational fertilization. Although tomatoes have been grown successfully for many years, there is no accurate formula or recipe on amount of irrigation or fertilizer levels to get tomato fruit with high quality. For tomato fruits, the nutritional quality largely depends on the content of soluble solids, soluble sugar, titratible acid, Vitamine C and lycopene, some of which are correlated with each other. Therefore, tomato nutritional quality could not be assessed according to any one of these attributes. But the comprehensive evaluation of vegetable nutritional quality has not been well studied yet. To construct a comprehensive nutritional quality index of tomato fruits and investigate its response to irrigation amount and fertilizer rates of nitrogen, phosphorus and potassium, a composite quadratic orthogonal regressive rotation design of four factors and five levels was used in a pot experiment. The contents of soluble solids, soluble sugar, titratable acid, lycopene, Vitamin C and sugar-acid ratio were determined for tomato fruits. By using entropy weighting method, the objective weights of six single quality attributes were calculated based on measurements of these attributes. The subjective weights of these six attributes were calculated based on the analytic hierarchy process (AHP) from survey data from both consumers and horticulture experts. Based on these, the comprehensive weighting method of game theory was used to determine the balanced weight of single tomato quality attributes. Results indicated that the attributes were ranked based on their importance by lycopene>sugar-acid ratio>Vitamin C>soluble sugar>soluble solid>titratable acid. The comprehensive nutritional quality index was constructed according to the technique for order preference by similarity to ideal solution (TOPSIS). Moreover, a regression model on the amount of irrigation water and fertilizers and tomato comprehensive nutritional quality index was established. Based on the regression equation, the single, interactive and coupling effects of these four experimental factors on the comprehensive nutritional quality index were analyzed. The results showed that the main effects of four experimental factors on the comprehensive nutritional quality were ordered by P rate>N rate>irrigation amount>K rate. If codes of other three factors were zero, the comprehensive nutritional quality showed a downward quadratic parabola in response to the increase of irrigation amount, as it did in the case of N rate. It is interesting that an upward quadratic parabola occurred with the increase of K rate. The comprehensive nutritional quality increased linearly with P rate. Interaction between amount of irrigation and N, P and K fertilizers significantly affected comprehensive quality of tomato fruits. It indicated that comprehensive tomato nutritional quality decreased with excess input of irrigation amount and N fertilizer, and could be improved by appropriate supply of P and K fertilizers. The findings from this study also allowed us to optimize comprehensive evaluation of vegetable quality that could be used to study the management of water and fertilizers in the future.

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