COMPONENTS OF TUBER YIELD IN SWEET POTATO

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SUMMARY

Studies on the relationships of components of yield with yield itself using correlation and regression analysis lead to a conclusion that the maintenance of the potential for growth in girth of the roots during the latter half of the vegetative growth cycle may be an important determinant of potential yield in the sweet potato.

RESUME

Des études sur les rapports entre éléments du rendement et le rendement lui-même au moyen d'analyse de corrélation et de régression ont permis de conclure que l'entretien du potentiel de croissance de la partie périphérique des racines pendant la dernière moitié du cycle végétatif doit avoir une importance déterminante dans le potentiel de rendement de la patate douce.

RESUMEN

Estudios sobre las interrelaciones entre los componentes del rendimiento, con el rendimiento en sí mismo usando análisis de correlación y regresión, condujeron a la conclusión de que el mantenimiento del potencial para el crecimiento perimetral de las raíces, durante la segunda mitad del ciclo vegetativo de crecimiento, puede ser un factor determinante del rendimiento potencial en camote.

INTRODUCTION

At the crop level, the numbers and sizes of organs per plant are the immediate components of yield, e.g. in cereals,[1,8] number of grains and mean grain weight, and in root crops,[4] number and size of roots. In root crops the economic yield is often not the total yield, but that of roots which have attained a minimum size and weight at harvest[9].

Tuber volume and tuber density may be considered as further sub-components of tuber weight, and tuber cell number and the mean size of tuber cells may, in turn, be considered as sub-components of tuber volume. To obtain a fully analysed understanding of tuber crop yield and to identify possible limitations to tuber yield development, yield components can be considered both at the crop level and at the plant and tuber levels.

In this paper, interrelationships between crop yield in six sweet potato cultivars of different foliage[10] and tuber[3] characteristics are examined. Effects of tuber shape on the volume component of tuber weight and of some anatomical attributes of tuber meristems which relate to cell numbers in tubers are outlined. Possible implications of tuber shape and tuber meristem characteristics on tuber crop yield are discussed.

MATERIALS AND METHODS

The six cultivars used in the study include a commercial cultivar 049 as well as A28/7, C9/9, 162, A16/15 and a low yielding cultivar 03/62. Agronomic, physiological and anatomical techniques used in the study are described elsewhere and reference is made to the sources of these techniques in the text. All tuber weights referred to are fresh weights.

RESULTS AND DISCUSSION

Components of sweet potato crop yield

The immediate components of sweet potato crop yield, mean tuber weight and tuber number were found to be in different relationships with tuber yield in the six sweet potato cultivars studied[4]. In a comparison of within-cultivar correlation and regression coefficient among tuber number, mean tuber weight and yield, there were significant positive correlations between tuber number and yield in cultivars A28/7

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and 03/62. Correlations between mean tuber weight and total yield were significant for all cultivars except cultivar 049. Cultivars could be grouped into three types as follows:

1. Types in which both components were positively correlated with tuber yield, A28/7, 03/62.
2. Types in which only tuber weight was positively correlated with yield, C9/9, 162, A16/15.
3. A type in which neither yield component was significantly correlated with yield, 049.

There were significant negative correlation coefficients between the two yield components in all cultivars except cultivar 03/62. This is an expression of the usual compensatory relationship between tuber number and mean tuber weight. This compensatory relationship was most prominent in cultivar 049, where an increase in tuber number by one resulted in a 50 g (approx.) reduction in mean tuber weight. In this cultivar also there was not a significant relationship between either yield component and yield which is another reflection of the same compensatory interaction.

For the combined data for five of the six cultivars studied (excluding 03/62), there was a negative regression coefficient for mean tuber weight on tuber number (Fig. 1), indicating that the relationship between the two components in these cultivars was similar to that observed for individual cultivars. Optimal tuber number for maximal yield in the cultivars studied was four, and it is suggested that there may be an optimal tuber number/mean tuber weight relationship for maximal tuber yield in the sweet potato.

Contribution of yield components to variability in total yield

Sweet potato yield in a crop population is characterized by considerable plant to plant variability[7,2]. However, the contribution of individual yield components to this variability depends on the relationship between yield and the component[5]. Thus, in cultivars A16/15 and A28/7, there were positive regressions of total yield on tuber number and in these cultivars, 16 and 26 percent respectively, of the variability in total yield was attributable to the regression of yield on tuber number (Table 1). Similarly, there were positive regressions of yield on mean tuber weight in all cultivars, except 049 and in these cultivars, 16—48 percent of the variability in total yield can be accounted for by the regression of yield on mean tuber weight. In cultivar A28/7, regressions of yield on tuber number and mean tuber weight together accounted for more than 50 percent of the total yield variability in this cultivar. Moreover, in cultivar 049, in which there was no significant relationship between either yield component and total yield, yield was most stable (lowest variability) between plants.

Variability in mean tuber weight appears therefore to be a more important contributing factor to between plant variability in total yield than tuber number in the cultivars studied. Since tuber initiation was completed in all cultivars except 162 by 8 weeks after planting, the variation in tuber weight observed was due to different rates of growth of individual tubers on a single plant.

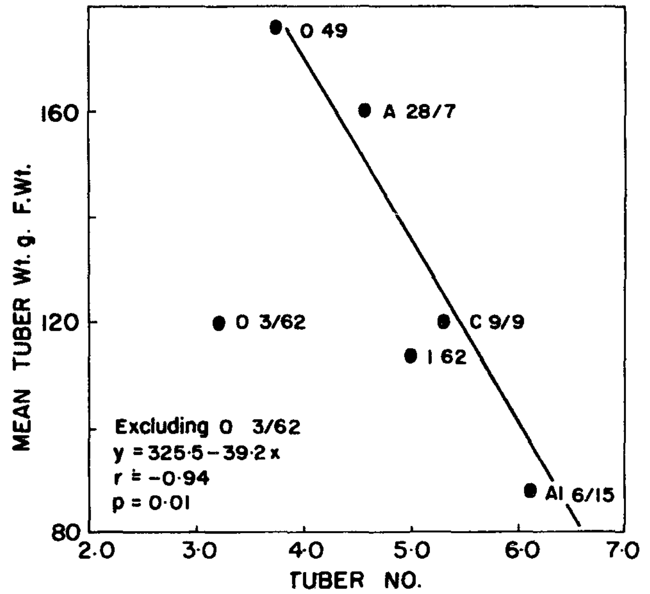
Interrelationships between tuber shape and yield

In tubers of two sweet potato cultivars with contrasting tuber shapes (globular vs. narrowly fusiform), it was shown by Lowe and Wilson[6] that the development of tuber weight was related to tuber shape. Also, that longitudinal and lateral growth associated with changes in shape occurred at different times in the tuber growth cycle. Increase in tuber length occurred in the period up to 16 weeks after planting and major increases in tuber diameter took place in the period 16—24 weeks after planting. These increases in tuber diameter were related to increase in mean tuber weight and changes in tuber shape (Fig. 2). Thus, the more globular tubers of cultivar 049 showed major increases in mean tuber weight in the latter half of the tuber growth cycle whereas in the narrowly fusiform tubers of cultivar A16/15 changes in mean tuber weight related to change in tuber shape were minimal.

Tuber meristems and tuber growth

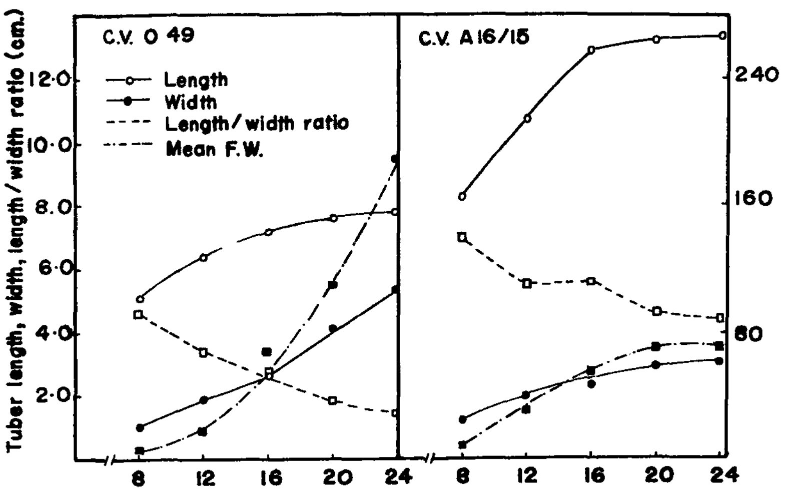
Tuber growth in sweet potato is effected by the meristem activity of the primary cambium as well as of secondary and tertiary meristematic strips[11]. It has been shown that in the globular tubers of cultivar 049 rapid increase in tuber diameter is associated with the presence of numerous active secondary and tertiary meristems. These provide for the rapid proliferation of storage parenchyma cells. In contrast, such secondary and tertiary meristems are relatively little developed in the narrowly fusiform tubers of cultivar A16/15[11] and the tuber growth even in the latter half of the cycle continues to be largely mediated by the activity of the primary cambium.

Thus it seems that relatively poor development of secondary and tertiary peristems in tubers of cultivars A16/15 is responsible for the low mean tuber weight and narrowly fusiform tuber shape in this cultivar.



FIG·I RELATIONSHIP BETWEEN TUBER NO. & TUBER WEIGHT IN SIX SWEET POTATO CULTIVARS

(From Lowe & Wilson (1974)



FIG· 2 Changes in tuber dimensions and length/width ratios in two sweet potato cultivars with development.

Tuber number and tuber meristems

In cultivar 049, in which secondary and tertiary tuber meristems are active, the mean tuber number per plant is low (3.8). Conversely, in cultivar A16/15, tuber number per plant is high (6.1).[11] These characteristics are associated with high tuber yield per plant in cultivar 049 (526 g/plant). It is suggested, therefore, that an important component of tuber crop yield in sweet potato may be the prolongation of the activity of tuber growth potential by secondary and tertiary meristems developing during the latter half of the growing season (extending the sink potential). A limiting factor in sweet potato tuber yield may be a quantitatively generated cell division factor promoting the development and continued activity of secondary and tertiary meristems.

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TABLE 1

Percentage of total yield variability due to regression of yield on mean tuber weight and tuber number

Yield component	Percentage of total yield variability					
	049	A2817	C9/9	I62	A16/15	03/62
Mean tuber wt.	N.S.	28	35	39	16	27
Tuber no.	N.S.	26	N.S.	N.S.	N.S.	16
Total	-	54	35	39	16	43