Proximal Dominance and Sprout Formation in Sweet Potato (*Ipomoea batatas* (L.) Lam) Root Pieces

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Abstract

Sweet potato root pieces of the cultivar 'Centennial' excised from the parent root maintained proximal dominance over sprout formation, although the degree of proximal dominance was distincly less than that exhibited by uncut parent roots. Root pieces derived from the more proximal end of the parent root had greater proximal dominance over sprout formation than root pieces from the more distal portion of the parent root. Root piece site of origin on the parent root did not affect the size of sprouts formed. In addition, the size of the root piece did not affect the degree of proximal dominance over sprouting displayed by the root piece. Root piece size, however, substantially affected the size of the sprouts, with larger root pieces producing progressively larger sprouts.

Introduction

Commercial reproduction of sweet potatoes using root pieces has a number of distinct advantages over current methods (vine cuttings and transplants) in areas where dry weather or cool temperatures during parts of a year prevent a year round growing season. The production of vine cuttings and/or transplants in these areas is labor intensive, expensive and typically requires the construction of specialized "seed" beds. As a consequence, considerable interest has been directed toward the potential of producing sweet potatoes using root pieces, similar to the production of Irish potatoes (*Solanum tuberosum* L.) from tubers.

Early attempts to reproduce sweet potatoes more economically by direct planting of root pieces were discouraging (Lutz, et al; 1947). More recent studies in Japan and the United States (Boukamp and Scott, 1972), however, have been more promising, with yields and quality of sweet potatoes produced from root pieces being comparable to those of transplants.

Sweet potato storage roots exhibit a distinct proximal dominance in the production of sprouts, the degree of which varies with cultivar (Cooley and Krishnam, 1938). It has been demonstrated that "breaking" the proximal dominance within the parent root increases the number of sprouts produced (Beattie and Thompson, 1932; Demprey 1961; Thompson and Beattie, 1931; Welch and Little, 1966). This "breaking" the proximal dominance can be induced by both mechanical and chemical means (Drinkwater, 1969). For example, cutting the parent root transversely into 3 or 4 sections releases the inhibition of the more distal portion of the root by the proximal end, (Beattie and Thompson, 1932; Demprey, 1961; Thompson and Beattie, 1931). In addition, some chemical treatments have been successful in duplicating this effect, e.g. ethylene chlorohydrin, (Michael and Smith 1952), 2-chloroethyl phosphoric acid, (Thomkins and Bowers, 1970), dimethyl sulfoxide (Whatley et al. 1968) and others.

The precise cause of the dominance of the proximal end of the storage root over sprout development has not been established. Detailed anatomical studies have shown no structural differences in the roots that could account for the dominance (Artachuager, 1924). It has been suggested that an auxin-mediated repression of lateral buds, similar to that described in apical meristems (Škog and Thimana, 1954) is operative. While this would explain the loss of dominance due to decapitation or cutting the parent roots, its existence in the sweet potato roots remains conjecture.

Since proximal dominance has a significant effect on sprouting, it is of interest to determine if dominance is eliminated upon the sectioning of the storage root for the production of root pieces or merely maintained at the root piece level of organization. If proximal dominance is maintained in root pieces then chemical manipulation of dominance may be advantageous for enhanced sprout growth of root pieces.

Materials and Methods

Sweet potato roots 7 to 8 cm in diameter of the cultivar 'Centennial' were used in the following experiments. Root pieces derived from these parent roots were dipped in a sodium hypochloride solution (5 ml/l of H_2O) and then dipped in a dichloran solution (20.6 gm of Botran 71 WP/l of H_2O) to control soft rot (Boukamp et al., 1971). All root pieces were then incubated in growth chambers at 29°C, 98% RH for 7 days prior to planting to allow wound callus to form. Following incubation, the root pieces were planted in a hot bed under 3 to 4 cm of hardwood sawdust.

Effect of location of the root piece on parent root in relation to sprout formation and proximal dominance. Individual sweet potato roots with their proximal and distal tips removed were cut transversely into 5 sections 2.54 cm. thick. Each section was labeled with 1 being the most proximal section and 5 being the most distal. Each section was then cut into root pieces with a surface area of 6.4 sq cm[1/] and a thickness of 7.5 to 10 mm. As each root piece was cut the proximal end was marked.

Effect of root piece surface area on sprout formation and root piece proximal dominance.

Root pieces 7.5 to 10 mm in thickness were cut from parent roots with surface areas of 6.4, 14.4 or 25.6 sq. cm. The proximal end of each root piece was marked and 6 replications of 10 root pieces for each treatment were incubated and planted as previously described.

Data for all experiments were collected 30 days after planting. The number and dry weight of sprouts on the proximal and distal halves of the root piece were determined. Individual parent roots were treated as replications with multiple root pieces within specific treatments as sub-samples.

Results

Cutting the parent root into root pieces for planting substantially decreased the degree of proximal dominance over sprout formation. However, a distinct dominance at the root piece level remained (Fig. 1). Sectioning decreased the percentage of sprouts at the proximal end from 100 percent in the uncut controls to approximately 60 percent in the root pieces. In addition, the degree of proximal dominance decreased in root pieces cut from the more distal end of the parent root. The most distal section from the parent root had an equal distribution of sprouts over the seed piece. There was no significant difference in the dry weight of the sprouts produced from different segments of the parent root (Fig. 1).

The amount of surface area of the root piece did not have a significant effect upon the degree of proximal dominance exhibited by the root piece (Fig. 2). The most pronounced effect of root piece surface area was on the mean dry weight of the sprouts produced (Fig. 2). Larger root pieces produced progressively larger sprouts. These sprouts were substantially smaller than sprouts produced by intact parent roots growing under similar conditions. The mean sprout dry weight for uncut roots was 1.99 gm. Root pieces, however, had mean sprout weights of 0.22, 0.50 and 0.76 gm for 6.4, 14.4 and 25.6 sq cm pieces, respectively. Smaller root pieces (6.4 sq cm) produced slightly more sprouts per sq cm of surface area (0.14) after thirty days compared to larger pieces (both 0.11).

Discussion

Root pieces exhibit the presence of proximal dominance over sprout formation, though to a much lesser extent than in uncut parent roots. The location of the root piece on the parent root affected the degree of dominance of the proximal end. However, it did not affect the dry weight of the sprouts produced. As a consequence, sprout production per unit surface area of parent root can be increased by dissection, as noted in other studies. In seed pieces this treatment appears to alter the degree of control the proximal end exhibits over the remainder of the tissue. It is probable, however, that the lack of lag time between dissection and exposure to conditions conducive to sprout formation, minimized the level of control that otherwise might be re-established. If this were the case, then delays between producing root pieces and placing them under conditions favorable to sprout induction and growth would increase the level of control of the proximal end to above that displayed in these experiments. In addition, it is anticipated that the degree of proximal dominance in root pieces will vary considerably with cultivar, similar to that of intact roots.

The amount of surface area of the parent root used for each root piece did not influence the degree of proximal dominance over sprout formation. Surface area had a significant effect upon the size (dry wt.) of the sprouts produced. For example, root pieces with a surface area of 25.6 sq cm had sprouts which were only 40 percent of the weight of those from uncut parent roots. As a consequence, one can anticipate progressively longer delays of emergence and stand establishment as the size of the root piece diminishes. In areas where the growing season is sufficiently long, this delay would pose less of a problem than in areas where the growing season is shorter. Competition from weeds may also be more critical with delay emergence and slower growth. The use of smaller root pieces remains attractive, since root pieces lend themselves more readily to mechanized planting and require fewer parent roots per ha. Whether these advantages are outweighed by the decreased emergence rate remains to be seen.

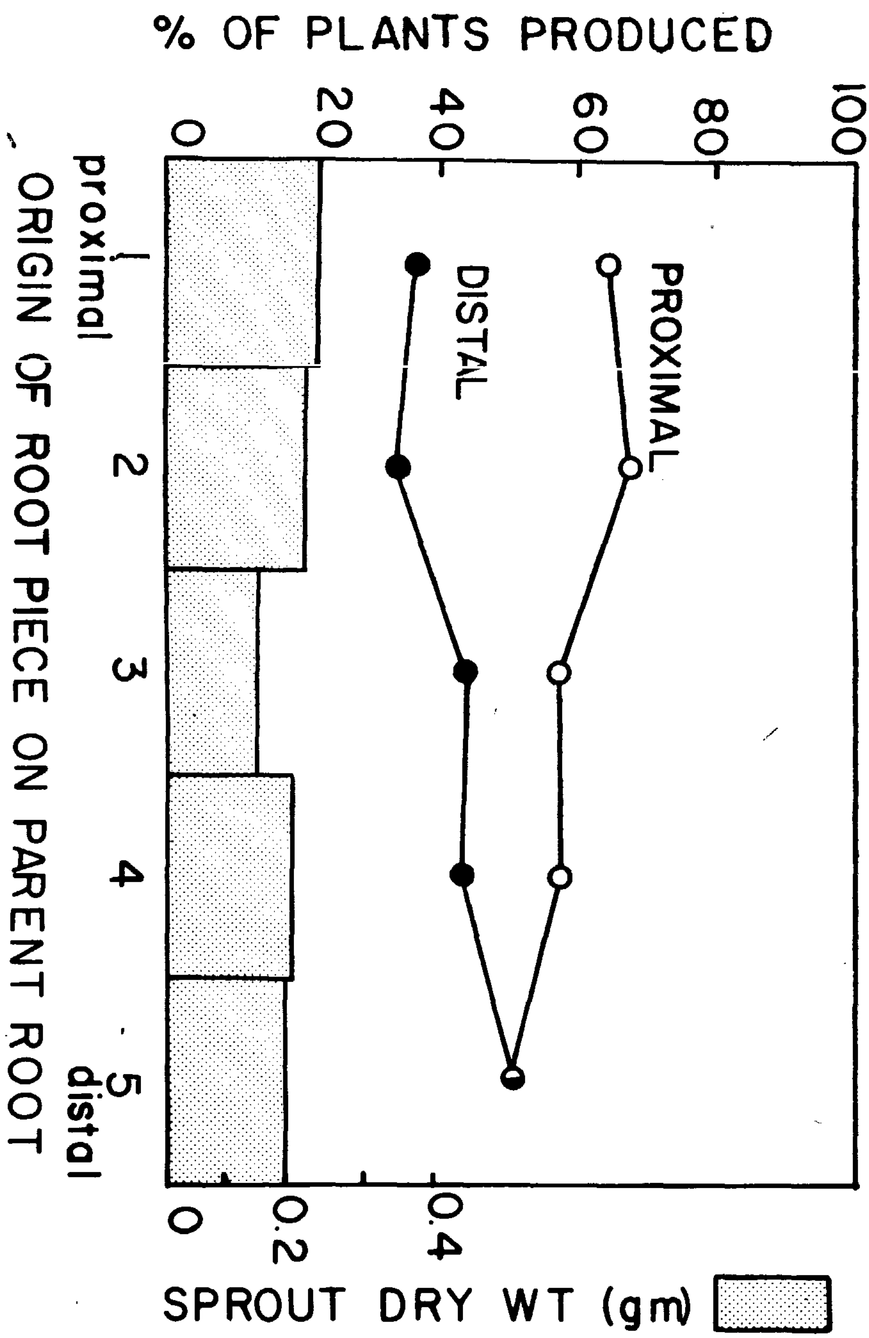

Figure 1. Effect of location of the root piece on the parent sweet potato root in relation to proximal dominance and sprout dry weight.

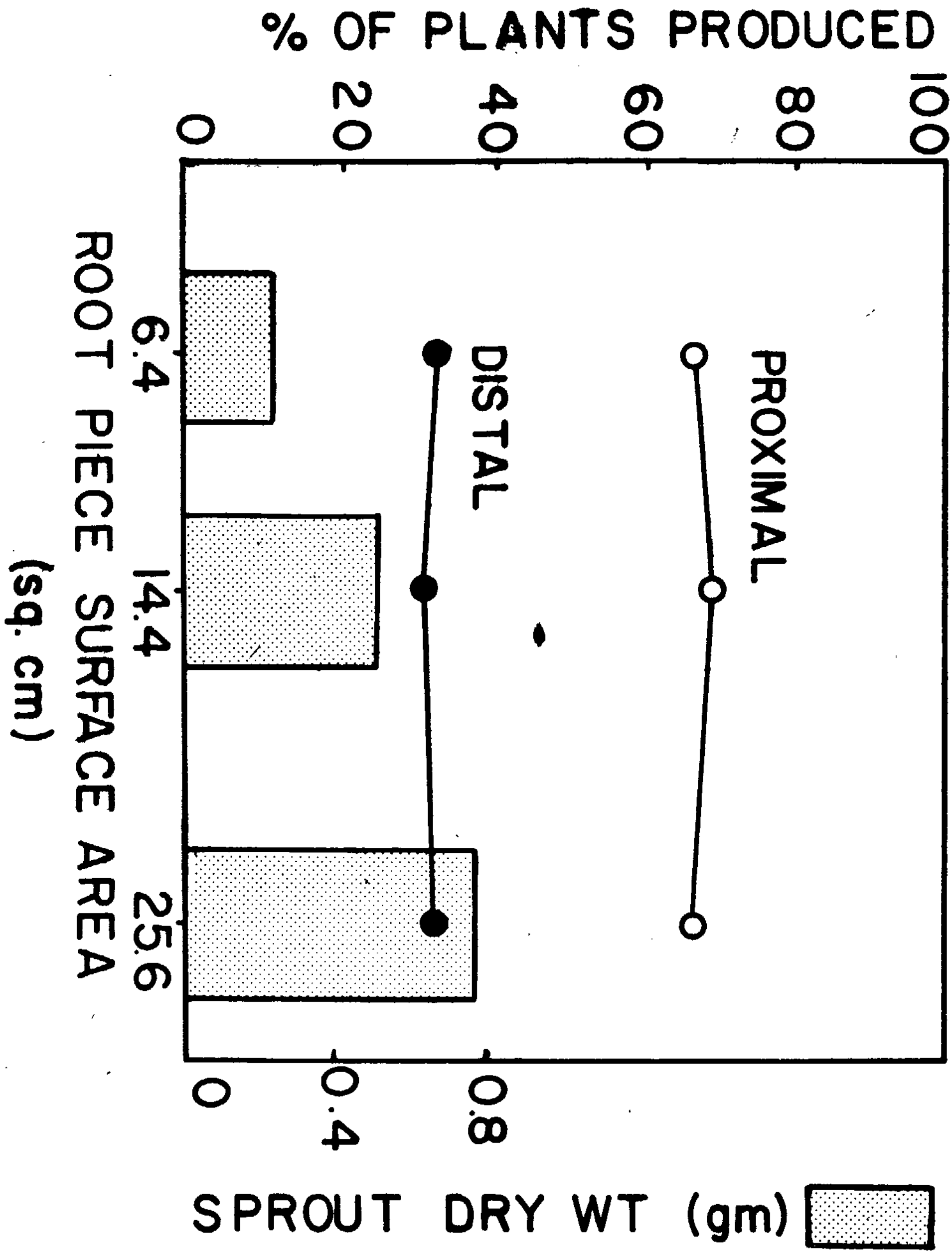

Table 2. Effect of sweet potato root piece surface area on proximal dominance and sprout dry weight.

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