Length-to-diameter ratio was measured in Indiana, and there was a positive correlation between tree vigor and the ratio. This relationship also was noted by Barritt et al. (4), who found that there was significant correlation between tree vigor and 'Delicious' fruit shape for a wide range of rootstocks. Assessment of tree vigor accounted for between 40 and 83% of the variation in length-to-diameter ratio. Barritt et al. (4) propose that rootstock may affect the elongation of fruit by influencing the hormonal levels in the fruit.

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Rootstock Effects Terminal Bud Set in 'Starkspur Supreme Delicious' Apples

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Cold hardiness is a major consideration in selecting suitable apple rootstocks as well as scion cultivars for Minnesota and other northern regions. Rootstocks effect many processes in apple tree growth including dwarfing, fruit ripening, and cold hardiness (1). One of the most important ways rootstocks influence hardiness of the scion cultivar is by inducing earlier maturity in the fall and delaying budbreak in the spring. Apple rootstocks, such as M.9 and M.7, have been shown to induce early maturity of the scion cultivar and thus tended to protect trees from fall freezes (7). However, induction of early maturity of the scion does not always translate to an increase in midwinter hardiness. Holubowicz et al. (3) demonstrated apple rootstocks differ in their midwinter hardiness and ability to deacclimate in winter as well as to affect the timing of growth processes in scions.

Howell and Weiser (5) found that leaves of apple scions produced a translocatable promoter of hardiness in response to short days, indicating that apple may be capable of a photoperiod-induced acclimation in late

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summer. Upon further examination of the acclimation process, Ketchie (6) described the physiological stages in apples; terminal bud set, vegetative maturity, winter rest, and spring bud break. The photoperiod response was found to occur beginning with terminal bud set and ending at vegetative maturity.

Timely onset of acclimation, measured by terminal bud set, is one of several important factors in preventing low-temperature injury during fall and winter. This study was conducted to determine whether the rootstock can alter the timing of terminal budset of 'Starkspur Supreme Delicious' in a non-bearing orchard.

Materials and Methods

'Starkspur Supreme Delicious' scions were grafted on to 15 different rootstocks and planted in 1984 at Lake City, MN for the NC-140 apple rootstock evaluation trial (4). The planting contained 10 trees per rootstock planted in a randomized complete block design. Blossoms were removed in spring as necessary. Terminal bud set was determined by observing the development of the bud. When no growth was observed in the terminal, it was recorded as set. Bud set was recorded separately for the central-leader terminal and the terminal buds of the 4 or 5 major scaffold branches on each tree. Data was collected on all branches for each tree on 5 dates from 8 August through 3 October 1985.

Results were analyzed by compiling the data over all replications to obtain a proportion of buds set for each tree of each rootstock on each date. Scatter plots of central leader vs. scaffold bud set failed to show any evidence of positional effect on the timing of bud set, so these data were combined to comprise a proportion of buds set for each rootstock at each date. Analysis of the data was accomplished using a generalized linear model for categorical data (SAS). Data was transformed to the arcsine prior to analysis. The ANOVA tested rootstock, block, and date, plus the interaction terms.

Results and Discussion

Most of the rootstocks had set greater than 70% of the terminal buds by 3 Oct. (Figure 1). Two rootstocks, MAC.39 and M.4, had set fewer than 70% of terminal buds by the last sampling date (3 Oct.) and were significantly different than the rest of the group. At the termination of the experiment in 1993, both of these root-

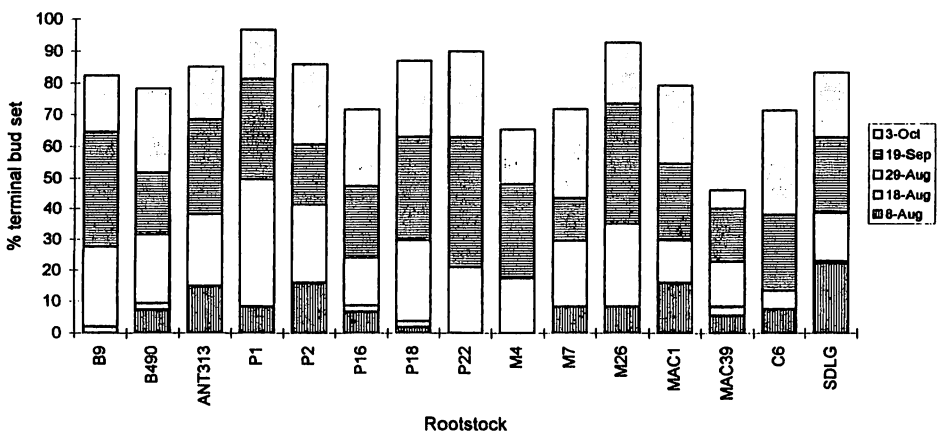

Figure 1. Percent terminal bud set of 'Starkspur Supreme Delicious' grafted onto 15 rootstocks during the third leaf (% terminal bud set = % of buds on 5 scaffold branchs/tree, 10 trees per rootstock).

stocks had poor survival rates (only 30%). Variation due to date accounted for almost half of the variation in the model indicating that sampling date has a large effect on bud set.

To test whether origin of rootstock effects terminal bud set, a contrast was done. Two rootstock groups were formed: East Malling, Kent, England; or Poland and Russia combined. When categorized this way, there were no difference among the rootstocks. Therefore place of origin, at least with this set of rootstocks, is not a factor in terminal bud set.

M.26 EMLA set 90% of the terminal buds by the end of the sampling period. Forsline (2) found M.26 EMLA was tardy in acclimating but tolerated low mid-winter temperatures. Our results indicate that M.26 EMLA formed terminal buds at a fairly steady rate throughout the fall. Although we did not express our data on a rate basis, if total number of buds set is an indication of the beginning of acclimation, M.26 EMLA was not behind on any given date during the study compared to this group of rootstocks.

The results of this study suggest that rootstocks are able to affect the timing of terminal bud set of 'Starkspur Supreme Delicious' scions in a non-bearing orchard. Whether this in turn affects the time to vegetative maturity and the onset of acclimation remains to be determined.

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Blackheart Injury in 'Starkspur Supreme Delicious' on 15 Rootstocks in the 1984 NC-140 Cooperative Planting

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Abstract

Blackheart injury was evaluated at 25 cm above the soil surface on trees in the NC-140 'Starkspur Supreme Delicious' plantings located in Iowa (IA), Kansas (KS), Massachusetts (MA), Maine (ME), Missouri (MO), North Carolina (NC), Nova Scotia (NOS), New York (NY), Quebec (QUE), and Virginia (VA) after 10 years growth. Trees grown in IA, KS, MO and QUE exhibited the greatest amount of blackheart, whereas those grown in MA, NC, NOS, NY, and VA had the least amount of damaged xylem tissue. Overall, trees on B.9. P.2, P.16, and P.22 were more susceptible to blackheart injury than those on B.490, MAC.1, C.6, and MAC.39. Tracing the area of the discolored xylem and the total xylem area and then calculating the percent blackheart injury on a weight basis resulted in a better separation of injury among rootstocks than estimating blackheart by other methods.

Introduction

Blackheart injury is commonly observed in the xylem tissue of trees following exposure to low temperatures (13, 14, 19). Brown, discolored tissue in the xylem of branches or the trunk is the primary symptom of black-