Date Breeding and Improvement in North America

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Introduction

Early attempts to improve date (*Phoenix dactylifera* L.) varieties in North America had their origin in seedling-date plantings grown from seed distributed by the U.S. Department of Agriculture to private experimenters in Arizona, California, and Texas during the early years of the present century. Several new varieties originated from these seedling plantings, but none attained more than minor local importance in the Coachella Valley of California.

The first effort to study inheritance in dates began in 1910 (1, 2), when the University of Arizona initiated a project using seedlings of the 'Deglet Noor' variety. In this inbreeding experiment, female seedlings were pollinated with pollen from male seedlings of the same progeny; but after three generations, the study was discontinued. No varieties were named or introduced as a result of this work.

In 1948, J. R. Furr and R. W. Nixon of the U.S. Date and Citrus Station at Indio, California, began a comprehensive date-improvement program. They began by selecting potential parents for a backcrossing program from the best of the imported and domestic varieties available. Selection was based on a variety's possessing one or more outstanding characters that might be desirable in an improved variety. It is normally not possible to make crosses directly between fruit-bearing varieties because the date is dioecious. However, by a suitable breeding technique, a male or pollinating variety with a genetic composition similar to that of a given ancestral fruit-bearing variety may be synthesized. Their procedure used a fruit-bearing variety as a recurrent female parent by pollinating that variety for several subsequent generations with a different male selection obtained from successive backcross progenies. In this scheme, a male seedling selection from a first-generation cross was used to pollinate the mother fruit-bearing variety to produce a progeny of seedlings from which the next or second-generation male was selected. This second-generation male was used in turn to pollinate the same mother fruit-bearing variety to produce third-generation seedlings, etc. They planned to continue this backcrossing for at least five generations, in order to develop a male seedling with sufficient homozygosity to make it nearly an exact counterpart of its ancestral fruit-bearing variety, thus carrying the desirable characteristics of that variety.

In the second phase of the program, these male counterparts were to be used in making "intervarietal crosses," which would combine the desirable traits of two or more of the original fruit-bearing varieties. Thus, it took more than 20 years to create the pollen parents before any significant crossing could be done to actually initiate a date-breeding program. In a previous paper, Nixon and Furr (3) discussed the origin, some of the problems, and the progress made in the backcrossing phase of the date-breeding project through 1964. The present article is a report on the progress made since then and a discussion of some of the more recent aspects of this program.

Breeding Objectives

Only indirect or inferential selection methods are available to the date breeder, because the fruit characters carried by a male palm are unknown. Primarily for this reason, the criteria

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used for selection of male palms in the backcrossing phase were the vegetative resemblances of the males to their female parents. The program was started with 35 varieties representing 48 lines, but genetic weaknesses and changes in objectives have eliminated many lines. The greatest changes have occurred since it became apparent that improved varieties must not only meet the requirements for desirable fruit quality, but should be adapted to mechanized cultural and harvesting operations.

Dates require large labor inputs in de-spining, pruning, pollinating, fruit thinning, and installing rain-protective fruit covers, as well as in harvesting and processing. A date breeder should anticipate and search for those characters that will facilitate the development of varieties meeting the complex demands that mechanization will surely require.

Many characters that would be desirable in improved varieties, whether handled in traditional fashion or mechanized, are generally obvious; but others of possible value are less apparent. Some of great potential value are scarce or absent, but their utility might justify a prolonged search for them. Examples in this category would be spineless leaf blades and hermaphroditic flowers.

Leaf spines: The dangerous spines on the leaf blade of date palms are the source of painful injuries to workers and must be removed at the beginning of each season, before the cultural sequence that begins with pollination and ends with harvest. Thus far, we have found no completely spineless plants; but the considerable variation in spine development among clones is being used in the breeding program.

Hermaphroditic flowers: An intensive search has been made for a plant with hermaphroditic flowers. None has been found, but a selection bearing male and female flowers interspersed on each strand has been isolated from a backcross progeny of 'Deglet Noor'. Indications are that environmental factors may influence expression of this trait, because in some years this plant produces only unisexual male flowers. Crosses have been made in attempts to intensify the bisexual flower expression in related lines. Incorporation of either the bisexual or hermaphroditic flower trait in the breeding lines could result in a breakdown of the natural breeding system and release heretofore untapped variability for selection. This trait would also enable the development of greater homozygosity in the breeding lines in less time than at present. The practical value to a grower would be considerable, since the labor required for traditional pollination practices could be eliminated.

Figure 1. Fruit of some "intervarietal" date crosses and the mother parent varieties. Top row (left to right), 1, 2, 3—three seedling selections of Halawy X BC_3 male selection of Medjool. 4—a selection of Medjool X BC_3 male selection of Deglet Noor. Bottom row (left to right), Halawy, Medjool, Deglet Noor.

Precocity: Precocious flowering and fruiting is highly desirable for both

breeder and grower. It decreases the length of the reproductive cycle, and thus makes the breeding program more efficient. For the grower, precocity enables earlier production with earlier and longer-sustained profits. The 'Khadrawy' variety has been a prime source for the precocious-flowering trait.

Fruit clusters: Mechanization of harvesting demands a large fruit cluster with long, uniform-length strands borne on a long, flexible fruit stalk. Uniform maturity on the cluster is very important also, since this would allow the harvesting of a whole cluster at one time. Uniform maturity should increase market opportunities and consumer satisfaction, since there would be no excuse to put an inferior product like hydrated dates on the market.

Fruit firmness: It is especially important that a variety suitable for mechanized harvest should have sufficient firmness to withstand handling during and after harvest, without becoming sticky or embedded with foreign matter. Dry-type varieties such as 'Deglet Beida' and 'Thoory' have excellent potential for mechanized harvest, but are so little known by consumers that the market potential is low. Soft-type varieties are familiar to consumers, but these have almost zero potential for mechanized harvest. Semidry varieties such as 'Deglet Noor' are considered to have sufficient firmness for mechanized harvest, and excellent market potential as well.

Palm stature: The vertical growth rate of 'Deglet Noor' and many varieties of similar vigor is from 24 to 30 inches per year in the Coachella Valley. Palms reaching full commercial production in 12 to 15 years are thus about 30 feet in height. Cultural operations become more difficult and inefficient in tall palms, thus increasing production costs. Varieties with a low vertical-growth rate would increase the productive life span of a palm planting. The 'Khadrawy' variety, which has a vertical-growth rate about one-half that of 'Deglet' Noor', is being used as a source of size-controlling genes in the breeding program.

Other characters: Table 1 lists sources of some desirable characters

Table 1. Source of some desirable characters used in the date-breeding program

Variety	Desirable Characters
Abbada	Attractiveness, glossy black fruit with frost-like bloom, midseason maturity.
Amir Hajj	High quality, little spoilage of fruit in wet weather.
Barhee	High quality, heavy yield, late maturity, low tannin in khalal stage.
Bedraya	Large fruit, firm texture, midseason maturity.
Dayri	High quality, distinctive rich flavor, moisture tolerance, good size, semidry texture.
Deglet Beida	Light-colored fruit, smooth skin, very firm texture, early maturity.
Deglet Noor	Superior quality, distinctive rich flavor, semidry texture, long fruitstalks.
Empress	High quality, attractiveness, good size, distinctive rich flavor.
Halawy	High quality, distinctive rich flavor, moisture tolerance, early maturity.
Horra	Good size, very firm texture, long fruitstalks, midseason maturity.
Khadrawy	High quality, dwarf stature, moisture tolerance, precocious flowering, sparse spines, early maturity.
Kush Zebda	Superior fruit quality, distinctive rich flavor, long fruitstalks.
Medjool	Large fruit, moisture tolerance, early maturity, good quality.
Tadala	Large fruit, moderate moisture tolerance, attractiveness, early maturity.
Thoory	Light-colored fruit, moderately large fruit, very firm, moisture tolerance, late maturity.

found in varieties used in the breeding program. Many other characters are being sought or are considered in the evaluation of seedlings. Examples are resistance to date mites, nematodes, and diseases; tolerance of cold; and tolerance of unfavorable soil and water conditions.

Inheritance of Characters in Date Breeding

Virtually nothing is known about date genetics. The date palm is a poor genetic model because of its long reproductive cycle, its natural breeding system, propagation problems, and other technical difficulties common to many arborescent fruit species. There has been little opportunity to study progeny derived from parents with contrasting character backgrounds, since the major part of the program has been, until recently, concerned with increasing character homozygosity in backcross male palms. The data that have been recorded give an incomplete picture and are a meager basis for other than tentative ideas about inheritance in dates. The following should be taken largely as an extension of the observations of Nixon and Furr on backcross lines, plus a few additional comments on the "intervarietal" progenies that have been observed since 1964.

Fruit size: Later backcross progenies of 'Medjool' have borne out the earlier assessment that large fruit size, one of the outstanding characters of this variety, appears in many of its female seedlings. Crosses[1] of 'Medjool' with 'Abbada', 'Deglet Noor', and 'Halawy' have produced many large-fruited individuals in those progenies. Figure 1 illustrates some seedling selections from 'Medjool' crosses.

Appearance: Skin color, amount of bloom, adherence and wrinkling of skin in cured fruit, shape, and even fruit size contribute to appearance and are considered in evaluating this trait. 'Abbada', an attractive, glossy-skinned, nearly black variety with a heavy, frost-like bloom, was crossed with 'Medjool'. Many of its progeny were similar in appearance and attractiveness to the 'Abbada' parent.

Quality: Our interpretation of quality in the program is based primarily on flavor and flesh consistency, with less emphasis on retention of these characters in storage. Many of the female seedlings in backcross progenies bear a close resemblance to the mother variety, but none has been quite its equal in quality. A few of the backcross females of 'Medjool' approach the mother fairly closely in quality; but none of the backcross females of 'Deglet Noor' progenies have been close to equaling the mother, perhaps because the superior quality of 'Deglet Noor' is a difficult standard to achieve. None of the small numbers of progeny in the "intervarietal crosses" fruiting to date have been of outstanding quality. The 'Abbada' x 'Medjool' progeny was disappointing, because fruit of most seedlings were soft, tended to have "mealy" texture, and lacked distinctive flavor.

Moisture tolerance: In the backcross progenies, tolerance of fruit to damage from moisture tended to be similar to that of the mother variety. It was difficult to find individuals with increased tolerance but without undesirable traits. In the "intervarietal crosses," all of the fruiting seedlings in small progenies of 'Barhee' x 'Deglet Noor' and 'Dayri' x 'Deglet Noor' cracked badly and soured. Progenies of 'Medjool' x 'Deglet Noor' and 'Halawy' x 'Medjool' had little cracking damage.

Fruitstalk characters: Fruitstalk characters have an important relationship to mechanized date technology, and considerable emphasis has been placed on this in the breeding pro-

[1]When "crosses" or "intervarietal crosses" are mentioned, it is understood that the parent varieties may be either the female variety itself, or a backcross male derivative, depending on the direction of the cross.

gram. A short, thick, and relatively stiff fruitstalk is one of the most serious defects of 'Medjool'. Unfortunately, this trait is found in most of its backcross progeny. The 'Deglet Noor' and 'Kush Zebda' varieties have been extensively used in recent "intervarietal" crossings in an effort to transmit the characters for very long, flexible fruitstalks with long, well-developed strands to their progenies. In "crosses" with 'Barhee', 'Dayri', and to a somewhat lesser extent with 'Medjool', 'Deglet Noor' has transmitted desirable fruitstalk characters to a worthwhile number of its offspring.

Spine development: As mentioned earlier, spines on leaf blades of dates are a dangerous menace to workers; and their removal constitutes a labor charge to growers. Despite our inability to find a plant without spines, there is considerable variability in spine development, which is being exploited in the date-improvement efforts. The 'Khadrawy' is notable for sparse development of short, weak spines. Fortunately, this character is readily transmitted to many of its backcross progeny. Figure 2 illustrates differences between individual date palms in spine development.

Flower characters: The backcrossing program was designed to increase homozygosity of desirable characters in male palms, but there has been an unwanted but not unexpected dividend of deleterious characters, as well. The most obvious of these have been associated with the reproductive process and are manifestations of some form of sterility. The most common form observed is the failure of the male inflorescence to produce pollen, despite a normal appearance of flower morphology before anthesis. Another type of sterility noted is the development of pale green flowers in part or all of the strands, instead of the pale cream or nearly white color of normal flowers. These pale green flowers also fail to produce pollen. Some lines appear to have relatively more individuals affected with sterility problems than others. However, no backcross lines of any variety have been entirely free of them. Another flower anomaly noted has been the tendency of individual flowers to "shatter" or become separated from the strand at the point of attachment. Movement of the inflorescence by wind or a slight jarring soon after the spathe opens causes the flowers to fall, leaving barren strands on the

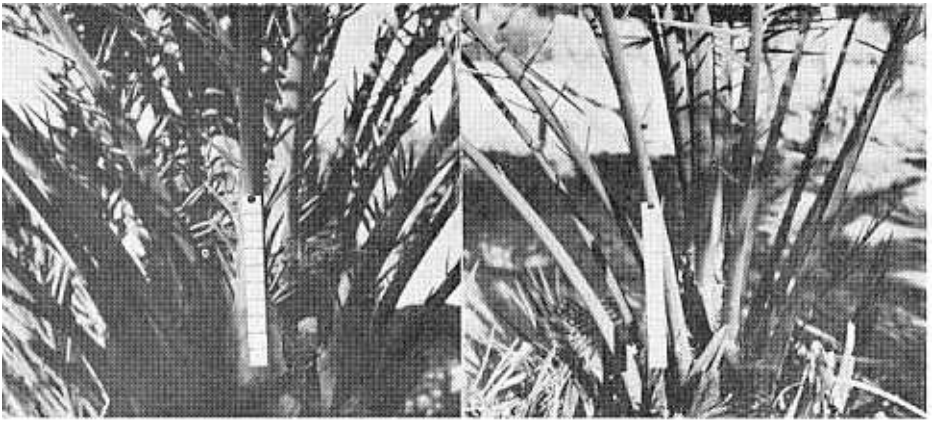

Figure 2. Differences in spine development in two backcross lines. Left—young palm of a line from Medjool with numerous, large spines. Right—same from Khadrawy with sparse, short, weak spines. Scale on leaf petiole is 10 inches.

Figure 3. Vigor depression in two different backcross lines of Deglet Noor. Left—average height in this line approximately 8 feet. Right—average height in this line approximately 15 feet. Both palms photographed at same distance.

fruitstalks. This trait has been especially serious in a line of 'Deglet Beida'.

Vegetative characters: Depression of vigor is common to the backcross lines of all varieties observed. Differences exist between varieties and between lines within a single variety. Figure 3 illustrates differences in vigor depression in two backcross lines of 'Deglet Noor'. It should be noted that the examples in the figure were selected to represent the average plant vigor of their respective lines and not contrasts between the smallest and largest individuals of their respective progenies. Another presumably recessive vegetative character that has appeared in some advanced backcross lines is "albino leaf." Figure 4 illustrates this character, as found in a number of individual palms in a fourth-generation 'Deglet Noor' backcross line.

Sufficient offshoot production is desirable in a variety, since at the present time this is the only way that date clones can be vegetatively propagated. Vigorous palms generally produce abundant offshoots; but there is some evidence to indicate that offshoot production is a heritable trait not necessarily having a close correlation with vigor. The 'Thoory' variety is vigorous, and its backcross progeny have been of average or greater vigor. However, 'Thoory' has a strong tendency to produce few offshoots, and its backcross progeny has shown the same tendency. An "intervarietal cross" of 'Deglet Beida' x 'Thoory' resulted in vigorous progeny, but the same tendency to produce few offshoots was noted.

Figure 4. "Albino leaf" character in a fourth generation backcross line of Deglet Noor. Affected leaves are pale cream color and lack normal chlorophyll development.

References

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