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Botanical Aspects of Olive Culture Relevant to Jacob 5

Author(s): Wilford M. Hess, Daniel J. Fairbanks, John W. Welch, and
Jonathan K. Driggs

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BACKGROUND INFORMATION

The olive tree allegory of Jacob 5 offers a detailed metaphorical description of the dispersion and gathering of the House of Israel. While authors have practical and literary reasons for using an allegorical style, among its most effective uses is to illustrate an idea by drawing an analogy to a familiar setting. Although olives are not mentioned in the Book of Mormon after Jacob 5, olive culture was clearly a familiar and important part of agriculture in Palestine in Lehi's day and in Old Testament times generally. The purpose of this paper is to analyze the botanical and horticultural aspects of olive culture inherent in Zenos's allegory and compare them with ancient and modern information about raising and cultivating olives.

Ancient horticulturalists had a very good understanding of horticultural principles as they applied to olive culture. Because plants were ever present in their environment, ancient peoples often associated societal events with seasonal changes in surrounding vegetation. In the Mediterranean region, one of the few areas in the world that is well suited for olive culture, there are indications that its

inhabitants were familiar with olives very early and used olives symbolically in their writings and ceremonies. Even in villages and cities people had plants adjacent to their dwellings and referred to important events, such as births, marriages, and deaths, in terms of tree blossoms, fruit harvests, or other seasonal events. For this reason it was natural for Israelite prophets to use plant imagery in their messages. In addition, much of the populace in ancient times was illiterate, and precise time keeping, a relatively modern phenomenon, was not yet available. Therefore, it was customary in ancient times to refer to botanical imagery because of the common person's understanding of regular botanical events and seasonal changes.

Etymology

The Indo-European root of the word *olive* is thought to be *elaia*. Greek uses *elaion* for olive oil and *elaia* for olive tree. The terms *olive*, *oleo*, *oleaginous*, *oleograph*, *oleophilic*, *oil*, and *oily* are all derived from the Greek root word for olive.¹ In Latin it was *oliuetum* for olive grove, *oleum* for olive oil, *olea* for olive tree (*Olea* is the genus of true olives in scientific Latin), and *oleaster* the subspecies or varietal name for wild olive. This last term was adopted into English.² *Oliua* in Latin became *Oliuarius* in English, meaning "of or like" olives.

De Candolle discusses early references to olives and indicates that the earliest Hebrew books mention the olive as *sait* or *seit*, both wild and cultivated.³ He suggests that the Semitic word *sait* must date from remote antiquity. It is found in modern Persian as *seitun*, in Arabic as *zeitun* or *sjetun*, and in Turkish or among the Tartars of the Crimea as *seitun*, which may signify that it is of Turanian origin or

from the remote epoch when the Turanian and Semitic peoples intermixed.

De Candolle also states that the ancient Egyptians cultivated the olive tree, which they called *tat*.⁴ Branches or leaves of olive have been found in sarcophagi. He suggests that the Egyptian name, quite different than the Semitic, shows an awareness of olives more ancient than the earliest Egyptian dynasties. The olive apparently did not play a major role in Egyptian or Lower Mesopotamian agriculture, based on archaeological evidence, but olive oil was important from Palestine to Egypt.⁵

The Berber name for the olive, both tree and fruit, has the root *taz* or *tas*, similar to the *tat* of the ancient Egyptians. The French-Berber dictionary calls the wild olive *tazebboujt*, *testtha*, and *ou' zebbouj*, and the grafted olive *tazemourt*, *tasettha*, and *ou' zemmour*. Another Berber nation, the Touaregs, call it *tamahinet*. These are strong indications of the antiquity of the olive in Africa.⁶

The Arabs of Algiers use the term *zenboudje* for the wild olive, *zitoun* for the cultivated olive, and *zit* for olive oil. The Andalusians call the wild olive *azebuche* and the cultivated olive *aceytuno*. In other provinces, the Latin *olivio* was used together with the Arabic words. The reference to oil in Spanish is *aceite* and in Portuguese *azeite*, which are similar to the Hebrew name. However, the holy oils are called *óleos santos* because they came from Rome. The Basques used the Latin name for the olive tree, *olea*.⁷

The early etymology is reflected in present terminology as follows: French, *olive*; Spanish, *oliva*; Italian, *oliva*; Portuguese, *azeitona*; Rumanian, *maslina*; German, *Olive* or *Ölbaum*; Dutch, *olijf*; Swedish, *oliv*; Danish, *oliven*; Norwegian, *oliven*; Polish *oliwka*; Czech, *oliva*; Serbo-Croatian, *maslina*; Hungarian, *olajbogyo*; Finnish, *oliivi*;

Turkish, *zeytin*; Indonesian, *zait*; Esperanto, *olivo*; Russian, *aliva*; Greek, *elia*; Arabic, *zaytoun*; Hebrew, *sayit*; Yiddish, *olif*; Japanese, *oriibu*; Swahili, *zeituni*.⁸

Archaeological and Historical Evidences of the Domestication of the Olive

Renfrew states that "nothing could be more misleading than to attribute the emergence of Aegean civilization" to only subsistence changes.⁹ Although evidence on the beginnings of fruit horticulture is fragmentary, "examinations of plant remains in Neolithic and Bronze Age sites in the Near East and Greece . . . indicate that olives, dates, . . . grapes, figs, and pomegranates were already under cultivation in protohistoric times."¹⁰ From the beginning of the Neolithic period (around 6000 B.C.), the plants and animals, which were to have a significant role in late Bronze Age times, were already there. Renfrew suggests that "the early neolithic was probably based upon cereals," centering on emmer wheat. During the later neolithic much more diversity developed and there was "a deliberate collection [and] exploitation of a whole range of wild species, including the fig and grape."¹¹ As a result of some specialized uses of these various species, the vine and olive were also domesticated.

By 7000 B.C. permanent agricultural villages were well established throughout the Near East. Grain-farming and stock raising, especially sheep and goats, were important. This pattern predominated for the next four thousand years. With the Bronze Age, horticulture was developed in the Levant to give agriculture its distinctively Mediterranean character. Some evidence indicates that by 3100 B.C., five fruits had been domesticated: olive, grape, date, fig,

and pomegranate.¹² An olive press was unearthed at Ugarit (present-day Syria) in a late third millennium context.¹³

In addition to the philological data in the foregoing section, it is evident that olives were present in Palestine by the fourth millennium B.C. based upon the presence of numerous well-preserved olive stones. Olive stones and olive wood charcoal have been found in Chalcolithic horizons (3200 B.C.) of Tell Mashosh near Beersheva and in early Bronze Age deposits (2900–2700 B.C.). Olive wood and stones are also present in Middle Bronze Age deposits, but few early finds of olive have been reported outside Palestine.¹⁴

Regarding the beginnings of olive cultivation, Kathleen Kenyon stated that it is reasonably certain that olives were cultivated in Palestine by at least the early third millennium B.C. and possibly as early as the fourth millennium.¹⁵ This conclusion was drawn from the discovery of olive and date stones stored in stone-lined silos at Teleilat Ghassul, just east of the Jordan near the Dead Sea. In his review, Boardman states, "The place and time of its first cultivation, if there was a single place and time, and its first use for the production of oil, is less clear. It has normally been assumed that this happened somewhere in the Syria-Palestine region, probably in the Early Bronze Age or Chalcolithic period."¹⁶

Neef agrees that olive cultivation probably started in the area of Northern Palestine-Southern Syria.¹⁷ He mentions that plant micro-remains from three Chalcolithic sites in the Jordan Valley indicate early olive tree cultivation and an economy largely based on the olive tree. Noy, Legge, and Higgs point out that materials were found in various levels excavated at Nahal Oren Kebaran, about 10 km south of Haifa in the Wadi Fellah.¹⁸ The materials were dated from approximately 14,000 to 16,000 B.C. The site was repeatedly

occupied over thousands of years by culture after culture. Seeds from several plants were found, including olive seeds. The authors did not indicate whether they thought they were wild or domesticated, although they most likely were wild.

Maria Hopf studied remains of cultivated plants from Arad from the Early Bronze Age.¹⁹ She stated that by this time the diet was enriched by olives. Throughout the two hundred years of settlement the olive stones were almost the same size. She suggested that the inhabitants of Arad probably did not need to plant olive trees but could utilize (and perhaps graft) trees growing locally. Judging from the slightly longer, younger stones, the assumption was made that the olive trees may subsequently have enjoyed special care and attention. The size of the stones from wild or cultivated trees originally differed very little, especially under varying conditions of growth. She stated that "only in Greece and Italy are we sure that any olive trees we meet have been nursed by man." An additional point of interest is that the evidence of Egyptian documents suggests that oil was a commodity brought from regions outside Egypt and that Egyptian jars were found in Arad. The assumption was made that Arad was one of the Canaanite centers of trade with Egypt.

In harmony with a Palestinian-Syrian origin for the beginnings of olive cultivation, Greek mythological legends suggest that the cultivated olive came into Greece from an outside source. Turrill points out that Greek myths and legends emphasize the importance of vegetative propagation as a source of beginnings for the cultivated olive in that part of the world.²⁰ Turrill adds that archaeological evidence confirms the importance of the olive in Greece only from Early Minoan times onward (circa 1300 B.C.), while evidence is

certain that the olive, *Olea europaea* L., has been cultivated in the Mediterranean basin from the days of the earliest civilizations.²¹

Not all writers have concluded, however, that the olive was first cultivated in Palestine. Renfrew assumes that the olive was domesticated in the Aegean rather than in the Levant. He states that the significance of the olive as a food must have been fully appreciated, as the Linear A and B Tablets document transfer of olive oil as well as olives, for both of which there are ideograms.²² It would be interesting to know whether the olives were used exclusively for oil, not yet pressed, or for pickling and for oil.

Suggesting that olive cultivation occurred in Greek lands in the Early Bronze Age (circa 1000 B.C.), Boardman believes that the olive was not of prime importance at that time.²³ He points out that some transitional types of olive stones from Crete, between wild and cultivated types of olives, raise the question of whether cultivation was achieved either first or perhaps independently in Crete.

The importance of the olive in the Aegean is discussed by Cotterell.²⁴ After 6000 B.C., hunting and gathering were followed by sedentary agriculture. In southern Thessaly, at its height after 4800 B.C., farmers in Sesklo planted wheat, barley, millet, peas, vetch, almonds, figs, pears, and acorns. They also took advantage of wild vines and olives growing in the region. After the third millennium B.C., there was a southward shift of population in Thessaly, and the grain and livestock farming was supplemented by the cultivation of olive and the vine. The approximately thirty years required for full productivity of the olive and its uneven yield from season to season imply ordered social conditions. The Greeks chose the olive branch as a symbol of peace, and olive oil soon became a staple commodity. Its

three chief uses were cooking, cleaning the body, and lighting. The domestication of the olive was a decisive step as it altered the pattern of land use.

In addition to archaeological evidence, as well as clues from myths and legends, historical sources suggest that olives have been cultivated from the earliest periods of Western history. Sturtevant cites evidence from several historical sources: Homer's mention of green olives in the garden of Alcinous and Laertes, brought by Cecrops, the founder of Athens; the cultivated tree distinguished from the wild by Dioscorides; the olive first being brought to Italy at the time of Pliny and carried over the Alps to Gaul and Spain; and, at the time of Cato, the Romans's acquaintance with nine kinds of olives, and later twelve kinds at the time of Pliny.²⁵

A recent popular article,²⁶ however, raises questions regarding the eastern Mediterranean Basin being the only source of the cultivated olive. The article reports on the finding of an olive pit in Southeastern Spain in a rock shelter known as *Cova de la Flaguera* in which a two-fifths inch long single olive seed, typical of domestic olives, was discovered. The seed was charred indicating that there was human intervention and it was carbon dated between 6430 and 6090 B.C. This predates the Bronze Age by more than two thousand years and puts it into the Old Stone Age with artifacts of hunter-gatherers. If it is a domesticated, rather than a wild olive, it has significant implications concerning the emergence of agriculture. The earliest other credible evidence for agriculture in Spain dates from about 5000 B.C. The presence of a single olive seed allows archaeologists to wonder whether agriculture arose indigenously in Spain, rather than being imported from the Middle East. Additional studies should help to answer this question.

Genetic Evidences of the Early History and Domestication of the Olive

Having examined the beginnings of olive cultivation from a geographical perspective, we now turn our attention to the evidence of the cultivated olive's genetic beginnings. "*Olea europaea* is the only Mediterranean representative of the genus *Olea* L., which includes 35–40 species . . . [in] tropical and southern Africa (the main center), south Asia, . . . eastern Australia, New Caledonia and New Zealand."²⁷ Several wild species in these areas are taxonomically close to *O. europaea* and are probably interfertile, or partly interfertile, but are separated geographically from those other species. The African and south Asian wild olives are adapted to strikingly different climatic regimes. Neither wild nor domesticated forms of *O. europaea* extend beyond the Mediterranean region and reproductively they are well separated from other wild members of the genus *Olea*.²⁸

There are many theories on the genetic origins of the cultivated olive. Turrill suggests three possibilities.²⁹ The first is domestication of the cultivated olive from the *oleaster* or "wild olive" (*Olea europaea* var. *oleaster*), which has substantial genetic variability and many characteristics that are similar to the cultivated olive (*Olea europaea* L.). As part of this first possibility, Turrill suggests that *oleaster* plants were derived from cultivated plants. Cultivated plants require human care to maintain their cultivated characteristics because most saplings raised from the seeds of a cultivated plant resemble wild forms in their characteristics and are useless in terms of fruit quality.³⁰ The second possibility is that the *Olea chrysophylla*, presently grown in Madagascar and tropical Africa, may be the ancestor of the cultivated olive.³¹ Turrill's third suggestion is that *Olea laperrini*, native to the Saharan mountains, is the immediate ancestral stock

that formerly had a much wider and more continuous range than at present.³² It may have been a link between *O. chrysophylla* and *O. europaea*.

These views are not shared by the geneticist Simmonds, who refers to the olive as one of the relics of the tropical mid-Tertiary flora (fifteen to eleven million years ago) of the Mediterranean, the only member of the genus *Olea* to have survived from that age in the area.³³ He mentions that the parent species of the cultivated olive are not known but are generally inferred to have been two species, one a form with narrow leaves with a golden underside and the other which contributed to the oily pulp character, a "proto-*Olea*" of Ciferri, which became extinct. The crop probably originated as a hybrid swarm in the mountains of the eastern Mediterranean: the Taurus, Amanus, and Lebanese mountains, as far as High Galilee. The great diversity of stone types, dated to the fourth millennium B.C., also suggests a hybrid origin.³⁴ Thus, wild *oleaster*, in light of evolutionary views, must be regarded as an escaped variety rather than being truly wild, or in any sense ancestral to the cultivated forms.

On the other hand, Zohary and Spiegel-Roy suggest that the wild olive did not escape from cultivation because the *oleaster* olives occupy niches in many areas along the shores of the Mediterranean not disturbed by cultivation.³⁵ They thrive as an important constituent of garigue (low open scrubland characterized by shrubs, low trees, and bunchgrass) and the thick scrubby underbrush of maquis evergreen plant associations. They "are particularly common in the lower-latitude belt (0–300 m) along the Aegean shores, the coast of southern Turkey, and the maritime belt of Lebanon and Israel, as far south as Mount Carmel."³⁶ They are also present in northeastern Anatolia, in Cyrenaic,



The symbolism of the olive is most deeply rooted in the land of Israel. Most evidence confirms that the domestication of the olive began in the region of Syria and Palestine, then moved (as shown by the darker arrows) westward into the Aegean area, and then later (as shown by the lighter arrows) into Italy, Sicily, North Africa, and western Europe.

Tunisia, Algeria, Morocco, southern Spain, southern Italy, and many other western Mediterranean countries. In these areas they grow in association with oaks, pistachios, and other trees and shrubs and are considered genuinely wild. However, they also frequently grow at the edges of fields and in abandoned terrace cultivation. Since they are used extensively as rootstock material, they frequently occur in modern times as escapees.

From the eastern Mediterranean, the olive moved westward and generated a secondary center of diversity in the Aegean area and perhaps a tertiary center farther west in southern Italy and Tunisia. In the Aegean center the plants produced large-fruited types, which occurred only as "impurities" in the Near Eastern populations. The Tunisian populations in the tertiary center were likely influenced by the local wild forms.³⁷

Although there are many species of olive,³⁸ there is only

one wild olive which is closely related to *Olea europaea*, the domesticated fruit tree grown for olive production. The wild olive, *O. oleaster*, and the domesticated forms are present in the same general geographic and climatic belt. Wild olives are distributed over the entire Mediterranean basin and have a small fruit size and low oil content. In some areas they are extensively used as rootstock material onto which cultivated varieties are grafted. Since the cultivated varieties grow in the same geographic and climatic zones, there is parallel variation in wild forms and trees under cultivation. The two forms are loosely interconnected genetically and, in many respects, comprise a single wild and cultivated species complex, which agrees with the archaeological data. Thus, based upon combined evidence, Zohary and Spiegel-Roy conclude that the East Mediterranean wild *oleaster* olives are "stock from which the cultivated olive was derived, and the Levant is the place where the olive was probably first brought into cultivation."³⁹

Since there is a tendency for domesticates to revert to a "wild" state unless they are given constant attention, and since the wild *oleaster* olives "are self-incompatible and reproduce entirely from seed,"⁴⁰ we favor the assumption that cultivated or domesticated olives are selections from wild forms. As is characteristic of cross-pollinated plants, both cultivated and wild forms of olive are extremely heterozygous. When their seeds are planted, the progeny segregate genetically, yielding very diverse progeny. Thus, as would be expected, seedlings raised from a cultivated plant resemble wild forms in their morphology and are useless in terms of fruit quality. As a result, propagation from seed is impractical in olive culture.⁴¹ In order to select and stabilize useful varieties, the grower must use clonal propagation. Saplings must be grown from desirable cuttings by vegeta-

tive rather than sexual propagation. In this way the saplings have the same genetic makeup as the tree from which they are taken.

Botanical Characteristics and Cultural Practices

Olives are evergreen trees with gray-green foliage. The flowers are produced on a cluster ("inflorescence") of about fifteen flowers, each of which arise in leaf axils of shoots produced the previous season. Most olive flowers have anthers, the male portion of the flower that produces pollen, and pistils, the female portion that produces fruit. However, the pistils may abort leaving non-fruiting trees. The olive is wind-pollinated, and trees of most cultivars set some fruit with their own pollen. Fruit set is normally heavier with cross-pollination.

The fruit is a drupe (a stone fruit such as peaches and apricots). The pericarp, stone, and seed proper all contain oil in different proportions.⁴² In some years the environmental conditions result in heavy fruit set so fruit thinning is necessary to increase the size of the fruit. Without thinning, fruit may be small, maturity is delayed, and normally the trees will not bloom the next year, resulting in alternate year bearing.⁴³ Among the oil crops, the olive is unique in that the oil is present primarily in the flesh of the fruit rather than the seed. About ninety percent of the world's olive production is for oil.⁴⁴

The *oleaster* (wild) olives have smaller fruits, and they usually have spinescent lower branches. "The fruits have a less fleshy mesocarp [middle layer of the pericarp] and contain less oil."⁴⁵ The stones are not considerably smaller than in domesticated olives,⁴⁶ which makes it difficult, if not impossible, to tell whether stones found in archaeological sites are from wild or cultivated olives. However, the pres-

ence or absence of wild olives currently growing in areas of archaeological interest is a relevant factor.⁴⁷

Cultivated olives, including the large fruited cultivars that have been examined, are almost all diploid with $2n = 46$ chromosomes. Occasional tetraploids and triploids have been reported, and one case of polysomaty ($2n = 55$) was reported. The chromosomes of related wild species apparently have not been counted.⁴⁸

Olive trees live for hundreds of years and grow in very few areas of the world. They generally require a Mediterranean climate of moderately cold winters and long, hot summers with low humidity. Olives grown for commercial production grow best between latitudes from thirty to forty-five degrees, both north and south, in areas free from severe winters. Most cultivars require at least two months of mild winter chilling, between 1.5 C (34.5 F) and 15.5 C (60 F), for flower initiation to occur. "Trees are killed to the ground by temperatures below -11 C (12 F)."⁴⁹ Olive trees grow well in a range of soil conditions from rocky hillsides with rocky soil to deep fertile valley soils ranging from acid to alkaline conditions. They tolerate considerable salinity and boron, but do not withstand poorly drained soils. They die if water stands around the roots for a few weeks.⁵⁰

Although olive trees may live hundreds of years, the life span of permanent plantations is not as important as before. Economic and social situations, as well as consumer preferences, are changing rapidly. There is now little incentive to limit short-term productive capacity in favor of longevity even though olive groves do not attain full production until after the seventh or eighth year. This non-productive period discourages the planting of olive trees in fertile areas that can be used for other more profitable crops, including other

tree crops. Formerly, groves were planted by parents for the profit of their children.

Both in past and modern times, grove density has been as low as ten meters or more between trees, or a density of one hundred trees or less per hectare (2.47 acres). With traditional spacing, a large proportion of the ground remains uncovered and unused for many years and this increases the costs of deep-ploughing. In modern times it is not unusual for farmers to increase significantly the density of plantations. New groves with more than one thousand plants per hectare are common.⁵¹

Concerning the raising of new olive plants, most olives can be propagated very easily by one of several methods. One of the most common ways is by placing hardwood cuttings in nursery rows or by rooting young softwood cuttings in mist propagating beds. While mycorrhizae (a mutually beneficial association in which the mycelium of a fungus invades the roots of a seed plant) may be important in production of some fruits, very little emphasis has been placed upon mycorrhizae associations with olive roots.⁵²

Grafting or budding is also used to propagate olives. Although this can be done in many ways, it is common to top-work older trees to change cultivars. This is done by bark grafting, which brings cambial layers (regions of active cell division) into contact so the tissues of the stock and scion can grow together.⁵³

Another method is the use of *uovoli* (which means "little eggs" in Italian). These are called "ovules" in English and are protuberances formed in the parts of the plant where build-up of sap or slowing down of sap circulation occurs, normally at the base of the trunk. There is often hypernutrition which causes cambial cells, from which roots and stems arise, to form aerial sprouts and adventitious roots. If they

are rooted in nurseries, they can be transplanted directly or divided after roots and sprouts appear. The ovules may be left attached to the tree for propagation. This may be necessary when old trees are cut down or damaged by frost, or some other factor. The base of the tree is covered with a light layer of soil to stimulate root production.

"Strangulation" may also be used, which stimulates sucker formation. This consists of strongly binding the base of the tree with one or two turns of wire. Alternatively, a strip of bark can be cut out around the tree. The suckers which form may be taken to a nursery for further development or they can be planted directly.⁵⁴

Olive wood is extremely plastic and has great powers of regeneration. Growers in Andalusia, for example, practice another method for establishing new olive groves by using pieces of olive wood six to twelve centimeters by three meters. The pieces of wood are planted at the end of winter after pruning. Where the climate is hot and dry they are planted early to induce rooting before it becomes too hot. The buried cuttings are banked with a conical hill of soil leaving only twenty to thirty centimeters of the cutting exposed. The cuttings from thick branches almost always form new trees, which are known for being vigorous and productive.⁵⁵

Productive olive trees are also developed by combining desired rootstocks with desired branches. Most fruit and nut trees consist of the above-ground fruiting portion and the below-ground rooting portion. The two parts are often joined together by budding or grafting, normally when the plants are young in the nursery. Rootstocks are generally selected because the growers are concerned about tree size (some root stocks cause "dwarfing"), resistance to soil-borne organisms (some rootstocks make it possible to grow

plants in pest- or disease-infested soil), resistance to unfavorable soil conditions (rootstocks may be more tolerant to poorly drained, heavy, or saline soils), and resistance to low winter temperatures (cold winters may be tolerated better on some rootstocks than others).⁵⁶ These procedures were used anciently and continue to be used in modern times.⁵⁷

Once the trees are propagated by using one of the previously mentioned methods, the young trees should be pruned carefully and sparingly. Care should be taken to establish a central trunk with four or five well-spaced scaffold branches. Since mature trees bear fruit laterally on shoots produced the previous summer, moderate annual pruning is required to stimulate productive shoots. Nonproductive branches that are diseased, broken, or old, should be removed. When old trees lose vigor and production drops, heavy pruning may stimulate new growth that will recover the fruit yield.⁵⁸

Fruit and Oil

Cultivated olives are often divided into two main types: oil varieties, which contain from twenty to thirty percent oil in ripe fruits; and less oily varieties used for fruit. Table olives are harvested in the autumn when the fruits are green to straw in color. The raw olives contain a glucoside, which makes them very bitter until they are treated with a dilute alkaline solution to remove the glucoside. If olives are exposed to air during the treatment, the oxidation of phenolic compounds causes the olives to turn black. If they are kept submerged during the treatment they remain green.

A different treatment is used for Spanish-green fermented olives, primarily in the Mediterranean countries. The fruits are picked green, then subjected to a lye treat-

ment to remove the bitterness. They are then thoroughly washed and are transferred to barrels containing a salimeter brine solution where a six- to eight-month lactic acid fermentation process transforms them to a product that can be sealed in salimeter brine for storage and consumption.⁵⁹

If oil is the desired product, the fruit is left on the tree until midwinter and is normally black when harvested. The olives are then washed and ground in crushers, creating an olive paste, which is then pressed in hydraulic presses. The oil is then allowed to rise to the top, is drawn off, and is washed with warm water to remove the bitterness. Centrifugation is used to remove the water, leaving the final product a clear, golden oil.⁶⁰

Classification of the different types of cultivars used for olive production is generally based upon the characteristics of the fruit. A cultivar is a "cultivated variety," which has been given an international designation based on its clearly distinguishable characteristics. Whether reproduced sexually or asexually, a tree of a cultivated variety retains its distinguishing characteristics throughout its life.⁶¹ The cultivated olive, *O. europaea*, has a large number of cultivars, which normally have vernacular names. Several classifications have been proposed, but the classification is, as mentioned, usually based on the general shape and taste of the fruit. The fact that there is great plasticity in olive foliage makes it difficult to use foliage factors as constant characters for purposes of classification;⁶² since the fruit is the primary economic reason for olive production, fruit characteristics are usually used for classification. As is the case with most domesticated plants, the domesticated olive has great diversity of forms, which have been developed for diverse climatic and geographic niches.

"All olive-producing countries have their own local cul-

tivars, many of which have been grown for centuries."⁶³ Examples of important oil cultivars are Picual, Frantojo, Cornicabra, Chemlali, and Souri. Important table olive cultivars are Manzanillo, Sevillano, Ascolano, Conservolia, Calamata, and Galega.⁶⁴

Pathogens, Pests, and Nutrition

Olives are susceptible to an array of insect and other disease pests. In the Mediterranean countries the "olive fly" (*Dacus oleae*) and the "olive moth" (*Prays eleaellus*) are the most common insects, but they are not present in California. Another insect, "black scale" (*Saissetia oleae*) can be severe in most olive-producing countries. A bacterium (*Pseudomonas savastanoi*) causes galls that cut off the supply of sap to the ends of the branches ("apical zones"). One common fungus, "verticillium wilt" (*Verticillium spp.*), affects the roots, and another, "peacock spot" or "peacock eye" (*Cycloconium oleaginum*), can defoliate trees.⁶⁵

Other examples of olive diseases caused by fungi, which are discussed by Azpeitia, include "olive shield" caused by *Macrophoma dalmatica*.⁶⁶ This fungus primarily attacks a section of the individual fruit, but less commonly it may cause a diffuse infection over the whole olive, causing it to dry and wrinkle with a loss of fruit weight and increased acidity in the oil. More commonly it causes an isolated infected zone, which looks like an oil stain or "shield." The infected zone is depressed from one to two millimeters, making the fruit unfit for use as a table olive. Another fungal disease called "soapy olives" is caused by *Gloeosporium olivarum* and may attack the wood, leaves, and fruit, the latter being the most common target. It dehydrates the fruit, increases acidity of the oils, and causes premature fruit to fall. A fungal disease of less concern is sooty mold, caused

by *Capnodium elaeophilum*. This disease causes damage by covering the leaf and keeping out light, thus impeding the development of chlorophyll, which in turn reduces production.

Olive trees also suffer from disorders that are nonparasitic.⁶⁷ Some of the most important disorders in the Mediterranean basin are caused by (1) climatic factors, including late frosts—particularly in areas that are ecologically marginal for olive tree production, (2) excess water in the root zone, (3) lack of soil water, particularly with non-irrigated olives, and (4) sharp changes in humidity and temperature, which cause a physiological disorder resulting in dehydration of the tip of the fruit (“apical zone”) between one and three months after pollination.

In addition to controlling pests, fungi, and nonparasitic disorders, it is important to provide proper nutrition for the olive if production is to be successful. Chemical analysis of soil, analysis of leaf tissue (called “foliar diagnosis”), and systematic experimentation permitting the comparison of yields from fertilized crops with those where one or more elements have been withheld or reduced, make it possible to determine what nutrient supplements should be used to increase olive production. Proper nutrition can also help to reduce the problem of alternate year bearing.

The principal fertilizing elements for olive production are discussed by Llamas.⁶⁸ He stresses the importance of nitrogenous fertilizers, which can be applied in various forms, and points out that all organic fertilizers contain some nitrogen. In modern olive production, mineral fertilizers are more commonly found as nitrate, as ammonia, or as a mixture of the two. Nitrogen may also be supplied as urea or calcium cyanamid. Llamas also discusses the use and importance of soluble phosphates, partially soluble

phosphates, and "natural" or "rock" phosphates to supply phosphorus to plants, as well as the need for potassium fertilizers. The most common nutrients used as supplements for cultivated plants worldwide are nitrogen, phosphorus, and potassium.

Organic materials play a number of important roles in olive fertilization. They provide cohesion in loose sandy soils and improve the texture of heavy soils; they help to stabilize the pH, increase the capacity of ion exchange in the soil, aid in retention of humidity, and reduce excessive runoff in hilly areas. Organic materials in the soil also activate microorganisms that aid in the assimilation of nutritive elements by the roots. For all of these reasons, organic materials are a fundamental factor in fertilizer programs.

Application of organic materials, either in the form of natural or artificial manure, should be done in the autumn and be buried as deeply as possible. In dry climates, five to ten tons per hectare should be applied every one or two years. In more humid climates the application should be every three or four years. The scarcity of manure has obliged olive growers to seek other types of organic material. Where there is sufficient rainfall for decomposition of organic material, green manuring is used. This involves burying winter legume crops in the spring as compost. This procedure can supply a great quantity of easily decomposable organic material.⁶⁹

Trace elements are also important in olive production. They consist of minerals and chemicals used in minute quantities by the plant and are important for proper plant growth and fruit production. There are ever-increasing deficiencies of trace elements because of the lack of manure, the use of increasingly purified chemical fertilizers, and the increased extraction of soil resources in intensive olive-

growing areas. For olives one of the most important trace elements that needs to be supplied is boron. Boron deficiency can be easily corrected by the application of borax to the soil or leaves. Sulphur deficiencies can be partially corrected by sulphur dusting two or three weeks before flowering.⁷⁰

Botanical Anomalies or Unusual Circumstances in Jacob 5

Nearly all of the allegory in Jacob 5 corresponds exceptionally well with both ancient and modern botanical principles and horticultural practices. It is hard to imagine that its author was not personally familiar with the minute details and practices involved in raising good olives in a Mediterranean climate. However, there appear to be three points in the allegory that may strike a modern botanist as unusual. While these anomalies or unusual circumstances are relatively minor from a scientific standpoint, they represent important metaphorical points of the allegory that were apparently necessary to portray Zenos's intended meaning. Such anomalies are often introduced in allegories, partly to remind the audience that the allegory represents a reality beyond its constituted parts and also to cause the audience to remember the extraordinary powers that impel the depicted events. As another example of a similar phenomenon, the parable of the Prodigal Son dramatically begins with the shocking circumstance of a son requesting the distribution of his inheritance while his father is still alive; the Jewish law of Jesus' day, in all likelihood, would not have permitted a son to accelerate his future interest in his father's estate.

1. Botanical aspects of the Jacob 5 allegory are briefly discussed by Hess, indicating one possible anomaly.⁷¹

“Wild” branches do not naturally yield “tame” fruit—in other words a grafted olive branch keeps its genetic constitution regardless of what type of olive tree it is grafted onto. When branches of a wild olive tree are grafted onto a tame olive tree (Jacob 5:10), we assume that this is analogous to grafting a wild species (*O. oleaster*) onto a domesticated species (*O. europaea*). If this assumption is correct we would not expect to obtain the desirable large-fruited tame olives from the small-fruited wild olive branches. The tame olives are selected for their desirable characteristics and each cell of any branch will be genetically the same as the tree from which it was cut. Thus, the grafted wild olive branch has an inferior genetic constitution for fruit size, and other characteristics, causing all of the fruit on the wild branch to be small and undesirable. Cultural practices involving proper nutrition, elimination of diseased parts, proper pruning, irrigation, and so forth, will not cause wild fruit to attain the same size and desirable characteristics as tame fruit, particularly if compared with trees or branches that are genetically tame and are properly tended. If wild trees are carefully tended, the fruit becomes larger than normal, but it would still have the same genetic characteristics of the wild species. The manner in which the servant and Lord of the vineyard speak of the olive tree in verses 16–18 implies that they were pleasantly surprised that the wild branches bore fruit “like unto the natural fruit”: “Behold, look here; behold the tree.” This result would not normally have been expected without divine assistance or extraordinary conditions.

Likewise, when the tame tree produced much fruit (Jacob 5:23) and then became corrupt (Jacob 5:39), this seems to represent a fundamental botanical change. The text states that the natural tree “had become wild” (Jacob

5:55). If this refers to a change in the actual nature of the fruit, this could only be accomplished by grafting, for one cannot obtain wild fruit from a tame tree in the natural course of events. While a domesticated tree does not become wild in the sense of changing species, the fruit set may become too light or too heavy, or pests or disease may damage the crop left unattended. With lack of care the fruit would be small and unusable like wild fruit, but it would still have the other desirable genetic characteristics for which it was originally selected and cloned. By asserting that the natural fruit became wild, the allegory emphasizes the serious and extensive nature of changes that result from corruption within the House of Israel.

2. Although it would also have been unusual for an olive grower to graft wild branches onto a tame tree, circumstances exist when it makes good sense to do so. Due to the vigor and disease resistance of certain wild species, grafting wild stock onto a tame tree can strengthen and revitalize a distressed plant (see question thirty-nine, later in this chapter.). Zenos's allegory portrays the Lord of the vineyard as somewhat exasperated, trying all available options to revive his old, beloved tree, including the extraordinary step of experimenting to see if any good might come by grafting wild stock onto the branches of the natural tree. Although doing this would have been an unconventional, perhaps even desperate measure, the Lord will spare no effort to obtain again the desired fruit from his choice plant.

3. It might also seem odd that one of the trees planted in poor soil should produce good fruit. One of the branches was planted in "a poor spot of ground . . . poorer than the first" (Jacob 5:22–23). Nevertheless, this plant thrived. Although olives sometimes do well in poor soils because of

their long maturing period and ability to tolerate considerable salinity, boron, etc., it is only with much attention to cultural practices that productive trees will grow on poor soil. When all of the important cultural factors are carefully optimized, olive trees will grow and produce a crop on poor soil. Accordingly, the unusual poorness of the soil in this part of the allegory draws attention to the extraordinary care and power of the Lord of the vineyard. The production of good fruit by the plant under these circumstances is attributable exclusively to the fact that the Lord had "nourished it this long time" (Jacob 5:23).

QUESTIONS AND ANSWERS

The foregoing general principles apply to specific elements in Zenos's allegory of the olive tree as follows:

Olives in General

1. What is a "tame olive tree" (Jacob 5:3)?

The term "tame" is synonymous with cultivated, "natural," domesticated, and "good." As indicated by Pansiot and Rebour, "The first agricultural peoples selected the best of [the] wild varieties and from these initial selections and many subsequent ones, . . . present varieties [(cultivars) were] derived."² Only one species, *Olea europaea* L., commonly called the European Olive, is used for fruit and oil production today. Jacob 5:3 sketches the typical lifespan of such a tree: it was taken and planted and nourished, it grew, waxed old, and began to decay.

2. What is a "wild olive tree" (Jacob 5:7, 9, 10, 17, 18, 34, 46)?

The term "wild" is synonymous with bad, nondomesticated, and weed. Although there are many species of wild olive, the "wild" or nondomesticated subspecies *Olea*

europaea oleaster is the one normally referred to as wild in the olive-growing areas around the Mediterranean. It is derived from seed and differs greatly from plant to plant, displaying markedly varying characteristics. However, it generally has thorns and small leaves and produces small drupes (fruits). Some *oleasters* are large trees and some are only of moderate size. The small tree types can be used as rootstocks to dwarf cultivated olive trees, which is important today since increased planting density is now common.⁷³

Several types of both cultivated and wild olives are classified under the designation *O. europaea sativa*. The wild forms are found in natural olive groves and have characteristics much like cultivated varieties. It has been suggested that these wild trees come from seeds "of cultivated varieties disseminated by birds."⁷⁴ Seedlings raised from any mother tree segregate genetically, manifesting variation for numerous traits including size, shape, and palatability of the fruits.

3. How do "tame" olive trees revert to having "wild" characteristics (Jacob 5:46)?

In Zenos's allegory, the tame tree is twice portrayed as changing to produce bad fruit or as becoming wild: "It hath brought forth much fruit, and there is none of it which is good. And behold there are all kinds of bad fruit" (Jacob 5:32); "the fruit of the natural branches had become corrupt" (Jacob 5:39); "they took from the natural tree which had become wild" (Jacob 5:55); "they also took of the natural trees which had become wild" (Jacob 5:56). In saying that the natural tree became wild, it appears that the allegory may have reference only to a change in the quality of the tree's fruit and not its genetic composition, since it is not likely that anyone in Zenos's day understood the necessary principles of genetics that remained undiscovered until the

latter part of the nineteenth century. As discussed earlier, a specific “tame” tree will not genetically change to a “wild” tree. However, a tame tree can produce inferior (bad or wild-like) fruit and will revert to manifesting wild characteristics if it is not properly cultivated.

In order to maintain production, maximize fruit size, and maintain the health of cultivated or domesticated trees, it is necessary to attend to proper pruning, adequate nutrition, thinning, and when necessary, controlling pathogens and pests. When this is done, the fruit quality and size is maximized. However, if domesticated trees are neglected, there is a tendency for the fruit quality and production to be inferior and, as is stated by Hillhouse: “Fruit trees and flowers lose in reproduction, the properties which they had acquired by culture, and tend anew to the state of nature.”⁷⁵ One of the characteristics of domesticated plants is that if they are properly cared for the size and quality of the fruit will be significantly better than on either wild or unattended domesticated trees.

Accordingly, the main factor mentioned in the allegory as the cause of fruit loss was cultural rather than genetic, leading to the withering of good branches. Good branches were grafted onto trees in the nethermost part of the vineyard (Jacob 5:8), but the wild parts of those trees eventually overran them, “even that the [grafted natural] branch had withered away and died” (Jacob 5:40; see also Jacob 5:43), “because I plucked not the [wild] branches thereof and cast them into the fire” (Jacob 5:45).

Domesticated trees have been genetically selected to produce well under a grower’s carefully applied cultural practices. If both “tame” and “wild” trees receive the same cultural attention by growers, the “tame” or domesticated tree will, almost without exception, yield fruit of superior

quality and size. On the other hand, if the same trees, both "tame" and "wild," are left without attention, the "wild" is more likely to survive, even though the fruit will be genetically inferior.

Cultivated trees, with the desired genetic characteristics, must be propagated vegetatively, as opposed to propagation by seed, to maintain the superior genetic constitution. In this way all of the offspring from a clone will genetically be the same. Thus, all of the plants in a grove can be genetically identical, which can cause pollination problems because of potential genetic self-incompatibility. However, if seeds from these plants are used to propagate seedlings, the new plants may be of the wild type, as is pointed out by Bioletti and Colby,⁷⁶ Renfrew,⁷⁷ and Hillhouse.⁷⁸ With seed production, the chromosomes of two plants combine, causing segregation of the genetic characteristics resulting in genetic diversity. Because of this genetic diversity, if the seeds produced on one tree during one season were all grown, rarely would one of the new plants have all the desirable characteristics of the "mother" plant.

4. How do "wild" trees bring forth fruit "like unto the natural fruit" (Jacob 5:17)?

Similarly, a wild olive graft does not genetically become tame. Each cell of any branch will remain genetically the same as the parent tree from which it was cut. Cultural practices involving increased nutrition, proper pruning, irrigation, and so forth, will not cause wild fruit to attain the same size and desirable characteristics as tame fruit, but some improvement might be shown.

On one occasion Zenos states that the wild branches began to produce good fruit. But the Lord of the vineyard attributes this solely to the strength of the roots, not to any constitutional change: "Behold, the branches of the wild

tree have taken hold of the moisture of the root thereof, that the root thereof hath brought forth much strength; and because of the much strength of the root thereof, the wild branches have brought forth tame fruit" (Jacob 5:18). Later the Lord will remember that because of the strength of the roots, "they have hitherto brought forth, from the wild branches, good fruit" (Jacob 5:36). Not only do the servant and Lord of the vineyard seem somewhat surprised that the wild branches have borne fruit that is "like unto the natural fruit" (Jacob 5:17), but this singular event did not last long. In time the wild branches completely overran the roots and the tree became worthless (Jacob 5:37).

Locations

5. How adaptable are olive trees to different locations and environments?

Zenos depicts olive branches being moved to various parts of the vineyard; yet conditions must not vary too widely for the olive to thrive. The olive is best adapted to the Mediterranean climate with warm, wet winters and hot, dry summers. Although winter chilling is required,⁷⁹ olives will not tolerate an average temperature below 1.3°C (34°F) for the coldest winter month. They will grow up to 550 meters above sea level, with some cultivars capable of existing up to 600 meters. Olives thrive best on "calcareous schistose sandy or even rocky soils, in well-drained situations."⁸⁰ Warren states that "the cultivated olive is the only tree to maintain a high growth rate on arid south aspects," where as a young tree it grows several millimeters in thickness annually and produces a crop at the same time.⁸¹

Most olive cultivars grow best in localized areas and there is risk in planting a specific cultivar outside its cultivation zone. There are many instances of good local culti-

vars “which have never been successful outside their own microclimate.”⁸² Accordingly, the Nephites may have realized more accurately by Zenos’s allegory the risks inherent in their travel to a distant land. However, there are some cultivars, called international varieties or cultivars, with a known adaptability to many environments. These cultivars are the best choice when it comes to adjusting to new environmental conditions.⁸³

6. How many trees make up a vineyard (grove)?

Plant densities vary from about seventeen to one thousand trees per hectare (2.47 acres).⁸⁴ Anciently it was common to plant well-spaced trees so there would be sufficient room for trees to grow large. Planting was intended for the next generation because nearly forty years were required for trees to mature. Now trees are brought into production more quickly and growers do not maintain plantations in production for as long. Better cultivars are developed in fewer years, consumer preference changes frequently, and there are modern methods to bring plantations into production much more quickly than in ancient times.

7. Do olives need to be in a vineyard for pollination or other ecological reasons?

Some varieties of olive are self-incompatible (self-sterile) to a greater or lesser degree, so compatible pollinators are normally used. Since the pollen is wind-borne, about ten percent of the trees need to be pollinators. If growers do not have knowledge about the potential for self-incompatibility in a cultivar, it is wise to plant two or three cultivars together.⁸⁵ There are also mutations in some cultivars of olive, which cause the breakdown of self-incompatibility resulting in cultivars which are self-pollinating.⁸⁶ Although Zenos focuses his attention on the main tree in the vineyard,

the Lord is clearly interested in the productivity of all his "trees" (Jacob 5:60, 74).

8. Regarding the "nethermost" part of the vineyard (Jacob 5:13, 14, 19, 38, 39, 52), do olives grow better or worse at lower locations?

"Nethermost" today refers to lower, furthest down, or inferior. Verse 14 says the Lord of the vineyard "hid the natural branches of the tame olive-tree in the nethermost parts of the vineyard, some in one and some in another," knowing that in some cases this was "a poor spot of ground" (Jacob 5:22). Olive trees do not prefer either very low or very elevated situations, but rather they are best adapted to gentle declivities.⁸⁷ In some orchards, lower elevations receive more moisture, but if the choicest place was originally selected for the main tree in Jacob 5 higher up in the orchard, then places lower in elevation would be less desirable.

Soils

9. Do olives produce well on poor spots of ground (Jacob 5:21–23)?

Because of its underground root system, olives can obtain water and nutrients in poor soils that receive little rainfall, provided the physical properties of the soil meet certain minimum standards and that the volume of soil is sufficient for each tree.⁸⁸ The olive needs sufficient, but not too much, water and is otherwise not particularly affected by soil variations. It is a "rich plant for poor soils," provided adequate nutrients are supplied. Even exceptionally poor soils can be used for the olive, but the lower the nutrient supply in the soil, the greater the volume of soil necessary. On poor soil, wide spacing is essential. The poorness of the site must be compensated by intensive cultural technique,

as is reflected in Jacob 5:22–23. Negligence of the least detail may jeopardize the trees. Olives need a light, well-drained soil and will not grow well on heavy or poorly drained soils.⁸⁹ They prefer loose, calcareous, fertile land mingled with stones.⁹⁰

10. What does it take to make olive trees thrive when planted in poor quality soil (Jacob 5:20–23)?

Several factors are necessary for an olive tree to produce well, including sufficient water, proper drainage, availability of nutrients for the roots, sufficient tilth to add nutrients, careful attention to pruning, and favorable concentration of salts in the soil. Bioletti and Colby state that it is a mistake to suppose that olives will yield profitable crops in poor soils.⁹¹ Poor soils must be well fertilized to insure good growth of young trees and good crops with old trees. Pansiot and Rebour state that “at times prosperous groves can be established under difficult conditions because the olive has no equal as a tree in its ability to thrive on poor sites.”⁹² In such cases, the poorness of the site must be compensated by intensive cultural management.

11. How does one select a site to start a new olive tree (Jacob 5:13)?

Zenos mentions briefly the fact that the Lord prepared a good spot of ground for the last branch that was planted in the nethermost part of the vineyard: “And thou beheldest that I also cut down that which cumbered this spot of ground, that I might plant this tree in the stead thereof” (Jacob 5:44). Pansiot and Rebour discuss factors that are important today when setting new plantations.⁹³ They include (1) research into and propagation of cultivars, marking of parent trees and grafting on seedling olives, (2) careful choice of planting sites determined by a study of conditions, (3) erosion control, particularly with contour

planting, (4) planting density, as determined by availability of water and nutrients, (5) careful preparation of the site by plowing or subsoiling, except in sandy soils, and (6) tree shaping to give trees a low form.

Before planting an olive grove, the local technical, economic, financial, and social conditions must be carefully studied. It will take six years to obtain a crop after the trees are planted, and they will not be in full production for about forty years. A map of the plantation must be made, especially if irrigation is used. It should show the contours before and after leveling, tree sites, roads, irrigation channels, sluices, and so forth. For at least six years there will be no income, so a planting contract should be made between the landlord and the tenant.⁹⁴

Roots

12. What characteristics indicate “that the roots are good” (Jacob 5:36)?

At first, the Lord of the vineyard appears unsure of the cause of decay in his beloved olive tree. He grafts wild branches into the tame rootstock hoping to revitalize it, and he grafts tame shoots onto other trees in case the tame root dies (Jacob 5:7–8). After seeing how the wild grafts flourish, he knows that the roots of his beloved tree are good (Jacob 5:36) and thus resolves to keep trying, eventually deciding to clear out the wild branches that had been grafted in and to graft back in the original stock from the trees in the nethermost parts of the vineyard (Jacob 5:52).

Good root structure is vital to the productivity of the olive and a valuable resource to be preserved and cared for (Jacob 5:11, 59). Up to the third or fourth year, olive roots grow vertically downward, after which these original roots are replaced by another underground root system devel-

oped from nodules, which form on the base of the trunk just below the soil surface. The nature of the roots can be judged in part by the soil, which helps to determine the manner of root growth. Heavy, poorly aerated soil causes a network of fine roots to form near the surface. Sandy soils are easy for roots to penetrate, so the root system becomes much more extensive.⁹⁵ One can also know whether the roots are good by the age of the tree and by examining the other vital signs such as leaf size, fruit set, and fruit size.

Care and Fertilizing

13. Can olives be productive without day-to-day attention? Can they be left on their own with only infrequent care?

Zenos depicts the Lord of the vineyard typically going away for a season and returning after a relatively long time (Jacob 5:15, 29). While it is important to give olive trees consistent care, they do not require constant attention. Pansiot and Rebour call olive the Cinderella of agriculture because it only needs care in the off-season when other crop work is finished.⁹⁶ Warren states that "in comparison [to] cereal production, only a modest and seasonal amount of time and manpower" is needed for cultivation.⁹⁷ The olive tree is called "the queen of trees" by White because it requires the least expense for cultivation.⁹⁸ The olive requires only a little seasonal attention, and it can be cultivated in areas where cereals and pulses will not grow.⁹⁹ If properly managed, olive groves only need to be worked twice or three times in the winter and usually "one (occasionally two)" cultivations in the summer, in addition to the usual pruning and fertilizing.¹⁰⁰ However, seasonal pruning is time consuming and is a very important component in maintaining a productive olive grove.

14. Do olive groves represent a long-term commitment of time and money?

The Lord of the vineyard often remarks: "It grieveth me that I should lose this tree" (Jacob 5:7, 11, 13, 32, 46, 47, 51, 66), and he weeps at the thought of losing his tree (Jacob 5:41). Zenos represents the tree as a precious commodity and a substantial asset. It takes about two years to grow and graft scions to rootstocks, and the plants remain in the nursery for another three to four years. After the trees are planted it will take at least six years to start production and about forty years for it to come into full production.¹⁰¹ White states that "a tree of such slow growth represents a heavy investment of time and labor."¹⁰²

To rejuvenate a tree may also take several years. Since fruit is only borne on second-year shoots, it is important to insure that there is ample second-year growth for fruit each year. When trees grow old and are neglected, the amount and kind of effort is very important to bring the trees back into production. This may necessitate grafting wild, more vigorous, branches on to the old tree, then later grafting on branches from productive cultivars to obtain good fruit (see question 39, later in this chapter). The roots and top must be balanced (see questions 21, 22, and 35). If trees are neglected too long, it may be more practical to burn them and start a new plantation from suckers from the roots of the burned trees (see questions 30 and 56). If this last resort is used the trees may not be lost, unless they had been grafted onto wild rootstocks, which would bring forth wild growth when they regenerate.

15. What kinds of steps must be taken in the general care of an olive grove?

As is true for domesticated crop plants in general, olive trees require consistent seasonal attention in order to ensure

good fruit production. The quality of the yield stands in direct relation to proper intelligent care, and thus the Lord speaks of "all the care we have taken of my vineyard" (Jacob 5:46). Most domesticated plants have been selected to produce more and better products when they are properly tended. If they are not tended, the products they produce may even be inferior to wild types or they may not produce at all, with the domesticated plants not even surviving. Domesticated plants such as maize, wheat, and potato will not survive in nature without human assistance. Even some domesticated weeds, selected unintentionally, which grow best in association with the domesticated plants, fail to grow outside cultivated fields. Olive trees are not excepted from this rule. They require specific kinds of attention, although olive culture is not as intensive as for many other domesticated crops. Without proper care they will cease to produce, whereas with proper care they will produce for a very long period of time.

Scaramuzzi discusses important points relative to care for olive groves: (1) the choice of a good natural site is important, (2) grafts should be carefully chosen and scion wood should be only from healthy trees, (3) plants from nurseries should be carefully inspected to ensure that they are pest-free, (4) trees should be well spaced in plantations, (5) balanced fertilizer should be applied at regular intervals, (6) trees should be correctly pruned to eliminate weak branches and to let in light and air, (7) soil should be cultivated frequently to destroy weeds, which are often alternate hosts of pests, and to help with penetration of nutrients into root zones, (8) when rainfall is insufficient, groves should be irrigated at the proper time and in proper amounts, (9) a watch should be kept for the first signs of pest infestation, which allows early local treatment, (10) the cultivated grove

should be well-aerated to reduce pest problems and to aid in weed control, and (11) simple and inexpensive preventive treatments such as liming trunks or coating wounds are also important.¹⁰³

16. How is an olive tree “nourished” (Jacob 5:3, 4, 11, 12)?

As is mentioned often in Jacob 5, fertilizing an olive tree is essential to good productivity. The amount of fertilizer used should be determined for each case based upon soil, climate, situation of the tree, tree age, cultivar, growth, and other factors. Fertilizer additions also need to be modified with the changes in the vegetative and nutritional state of the tree.¹⁰⁴ Pansiot and Rebour point out that although there are many factors, typical annual soil fertility amendments for olive trees per hectare (2.47 acres) is from seventeen to thirty-three kilograms of nitrogen, from eight to twenty kilograms of phosphoric acid, and from twenty to fifty kilograms of potash and lime.¹⁰⁵ They suggested that the fertilizer should be spread over the entire surface and then uniformly incorporated into the soil. When planting in holes, 2.5 to 3 kilograms of superphosphate and 0.5 to 0.8 kilograms of potassium sulfate per tree is normally sufficient. The upper soil layers trap phosphates and potash, which makes it difficult to make these nutrients available to the feeder roots once the plantation is established.¹⁰⁶ Ground breaking (“digging about”) makes it possible to place these fertilizers in the zone of root activity.

17. Why and how should olive trees be “dug about” (Jacob 5:4, 5, 11, 27, 47, 63, 64)?

In simple terms, it is necessary to loosen the soil to make nutrients and moisture available to the roots. Because the upper layers of soil tend to tie up phosphates and potash, they often do not reach the feeder roots unless the soil is

disturbed. Deep plowing of the whole area may be advisable in most cases. Light or sandy soils will not benefit from plowing because they are naturally well aerated and nutrients easily penetrate them. As clay content increases the need for deep plowing does as well. Shallow working of the soil by plowing and harrowing also has advantages. It forms an insulating layer, which prevents evaporation of water, increases permeability of the soil, kills weeds, and aerates the soil, increasing nitrification and root development.¹⁰⁷ Sometimes two plowings or more a year are advised: one in the summer to "prevent the ground from cracking and exposing the roots to the sun, and the other in mid-autumn, forming ditches from the higher to the lower slopes."¹⁰⁸

18. What is meant by "dunging" the trees (Jacob 5:47, 64, 76)?

Anciently, commercial fertilizers were not available, and it is likely that most farm units had farm animals. Not only did the dung build up, necessitating removal, but the benefits of application to crop plants were significant. It is still common throughout the world to apply dung to improve crop production, in spite of the extensive use of commercial fertilizers.

"When trees can be supplied with about 50 kilograms of well-rotted farmyard manure growth can be considerably advanced."¹⁰⁹ Organic manures are applied in the autumn so they can "decompose during the winter and make nutrients available . . . to sustain the spring flush."¹¹⁰ The manure must be incorporated into the soil as deeply as possible without damaging the roots.¹¹¹

The olive yard should be manured at least once every three or four years, but it is more beneficial to manure moderately every year. Excessive manure can impair the quality

of the fruit. Vegetable substances are preferable to animal manures for fruit trees in general, especially for the olive and the vine. When animal manure is used it should be tempered with other nonmanure organic material such as seaweed or leaves and applied when the whole is reduced to mold.¹¹²

Pruning

19. Do branches shoot forth naturally after pruning (Jacob 5:4), and how and why are olive trees pruned (Jacob 5:4, 27, 58, 62, 64, 69)?

All of the fruit of the olive is borne on second-year wood and the same wood does not bear again. For this reason a new crop of shoots each year is necessary for fruit set.¹¹³ With proper management, trees can be stimulated to produce young shoots. Zenos refers repeatedly to the process of pruning to stimulate fruit bearing.

In order to obtain fruit production each year, an olive grower must prune annually. There are a number of pruning procedures, which include lowering, reduction, crowning, pollarding, cutting back, and undercutting.¹¹⁴ Growers must carefully calculate the amount of wood to remove, requiring the pruner to be expert at his work. In extensive olive-growing areas, where labor-intensive methods cannot be applied, another type of pruning is often used. The olive tree is set up on a permanent trunk, which is maintained as low as possible. The principal branches of different ages are preserved only for a short period of production and then are suppressed in favor of younger branches. This allows production to be regulated and limits the volume of the crown. This method of pruning is much less expensive, although pathogens are more likely to enter cuts where large branches are removed.¹¹⁵ All of these pruning methods

concentrate on making young and tender branches shoot forth so there is second-year wood for fruit production.

On older trees, the grower must pay attention to the leaf-wood relationship. Aged trees have few useful leaves and few shoots large enough to bear fruit but have lots of wood. The leaf-wood relationship, therefore, is an important index relative to the productivity of the olive tree. Rejuvenating operations usually involve improved cultivation, nitrogenous fertilization, and achieving proper leaf-wood ratios, but these procedures have to be accompanied by good pruning for high production of fruit.¹¹⁶

"Bad pruning is the most important factor in tree aging, whereas proper pruning is the best corrective [measure]."¹¹⁷ If olive trees develop naturally, they pass through an early shrub-like period. Later they develop into tree form, according to the conditions of the soil and climate. With time, biennial bearing begins and the trunk becomes thicker and irregular. Some sections of the bark become necrotic (old and diseased), and strips of live bark maintain the connection between the active roots and the active parts of the crown. These are common symptoms of aging. The interior of the trunk eventually rots, which causes further decrease in production. This usually takes place within seventy to eighty years.

If most or all of the aerial part of the tree is eliminated by pruning, leaving only the trunk, a circle of sprouts will form a short distance from the trunk. After a year these sprouts are thinned out leaving only those that will remain permanently. Obtaining a new tree from a sprout takes from three to eight years. The reconstruction of an olive grove by such pruning is an ancient practice, according to Elant.¹¹⁸ Cutting back is an expensive operation, and it involves intensive hand labor.

20. What happens when the top has “overrun the roots” (Jacob 5:37, 48)?

One of the problems confronted by the Lord of the vineyard was the fact that the branches overcame the roots by growing “faster than the strength of the roots, taking strength unto themselves” (Jacob 5:48). There is a distinction between mineral uptake by roots, particularly the influence of nitrogen compounds, which are necessary for wood growth, and carbon assimilation by photosynthesis, which takes place in the leaves and supplies carbon for the forming of the plant body, including the fruit. In order to get a full crop of olives an equilibrium must be maintained between these two processes. However, the relation between photosynthesis and underground nutrient absorption depends largely upon the age of the tree. As trees age it becomes more difficult for the roots to continue to grow and obtain nourishment for the tree, while the foliage is still very active. The equilibrium is broken when mineral substances from the roots become less available. When this happens rejuvenation pruning is necessary to reduce the aerial portions of the tree.¹¹⁹ Accordingly, when the older rootstock of the main tree in Jacob 5 is rejuvenated by extensive grafting, it cannot keep up with the vigorous new growth of the wild stock (Jacob 5:37), and pruning and grafting are necessary as a corrective measure.

21. How does a change in the branches affect the roots; “because of the change of the branches, that the good may overcome the evil” (Jacob 5:59)?

Rootstocks have a direct bearing on the quality of the fruit. Temperate fruit tree growers “often select a certain rootstock for a particular fruiting cultivar because it will dwarf the tree” to facilitate fruit harvesting and, in most instances, will bring the tree into production sooner. The tree

is dwarfed, but not the roots nor the fruit. Hartmann *et al.* point out that for "some species, particularly citrus, the type of rootstock can . . . influence the quality of fruit produced by the scion cultivar. . . . When sweet orange seedlings are used as the rootstock for orange trees, the fruits will be of much higher quality than when 'Rough' lemon is used."¹²⁰

The reasons for these rootstock influences are not known. Possibly certain dwarfing rootstocks produce relatively large amounts of growth inhibitors, such as abscisic acid which is translocated through the graft union to the fruiting scion.¹²¹ There is little information on similar grafting effects for olives. It is known that some olive varieties benefit from grafting onto a compatible rootstock. An example of a beneficial graft is "Gordal" grafted on "Zorzaleigne" in the Seville region. In dry cultivation the Gordal is not sufficiently vigorous on its own roots to produce large table olives, while with the Zorzaleigne rootstock it is.¹²² Control of tree size and sometimes changes in tree shape may be significant rootstock effects, as well as influencing the vigor of certain scion cultivars.¹²³

Hartmann, Kofranek, Rubatzky, and Flocker also point out that if a strongly growing scion cultivar is grafted on a weak rootstock, the growth of the rootstock will be stimulated and will become larger than if left ungrafted.¹²⁴ If a weakly growing scion cultivar is grafted on a vigorous rootstock, the growth of the rootstock will be lessened compared to what it might have been without grafting. With the olive, the productivity of each scion-rootstock combination must be tested individually. The vigor of one cultivar or variety on a particular rootstock may not be duplicated by another scion variety.¹²⁵

22. Why it is necessary "that the root and top . . . be equal in strength" (Jacob 5:66, 73)?

It is necessary to achieve and maintain a proper balance between the roots and branches of the olive tree. Due to various climate and soil conditions, the one may grow more vigorously than the other. Pruning does not necessarily stop excessive growth when trees are young and may even aggravate the imbalance between the above- and below-ground portions of the tree. When trees are young with inadequate foliage, pruning should be minimized. As trees get older more severe pruning becomes necessary because of the now diminished root activity.¹²⁶

23. As the grafts grow, why would one prune away the branches with bitter fruit “according to the strength of the good and the size thereof” (Jacob 5:65)?

As suggested in Jacob 5:11, the wild branches were grafted in to save the roots, probably because the wild branches had more vigor than tame branches. If this assumption is correct, wild branches could have been grafted from many wild plants (see “all kinds of bad fruit,” Jacob 5:32). Some branches would produce fruit more bitter than others, depending upon the genetic constitution of the individual wild plants, particularly since wild plants reproduce from seeds that will result in significant genetic diversity. The most bitter fruit would be the least desirable to retain; thus, it would be eliminated first to replace the wild branches with tame branches. However, all of the wild branches would be replaced only as there was sufficient vigor in the tame branches to support the roots, precisely as is depicted in Jacob 5:65–66.

24. If you clear out the bad too quickly, what happens when the root becomes “too strong for the graft” (Jacob 5:65)?

In Jacob 5:65 it is stated, “And ye shall not clear away the bad thereof all at once, lest the roots thereof should be too strong for the graft, and the graft thereof shall perish, and I

lose the trees of my vineyard." If all of the branches were replaced at the same time, the tree and roots could be overstressed. Perhaps the "roots being too strong for the graft" refers to excess water and minerals being made available at the deficit of photosynthetic products, because the newly grafted branches would not have enough foliage to photosynthesize and translocate carbon compounds to the roots.

25. What procedure is implied by the term "pluck-off" (Jacob 5:7, 26, 52, 57, 58)?

To pluck means to pick out, cull or strip,¹²⁷ cut or remove. Zenos reflects a difference in the severity of pruning: ranging from "plucking off" whole branches or sections (Jacob 5:7) to "trimming up" selected growth (Jacob 5:58). White states that after several years trees should be pruned and all unwanted branches should be lopped: "Remember the old proverb 'He who ploughs the olive-grove, asks it for fruit; he who manures it, begs for fruit; he who lops it, forces it to give fruit.'"¹²⁸

26. What is wrong with "loftiness" (Jacob 5:48)?

In Jacob 5:48 the servant diagnosed the problem with the master's tree: "Is it not the loftiness of thy vineyard?" It appears that loftiness refers to the branches overcoming the roots. The tree is too tall and there is too much foliage for the roots to feed (see question 20, discussed earlier.) This is a common problem with olive trees. Pansiot and Rebour state, "In the course of time, the tree can grow to a considerable size. If left to itself, it can attain a height of 15 to 20 meters, but then, of course, picking the crop becomes very difficult."¹²⁹ These authors also state that a tree should not grow so tall that the trunk is exposed to the sun.¹³⁰

27. How are pruning teams organized (Jacob 5:61, 70–72), and is it typical that the "laborers are few" (Jacob 5:70)?

In order to accomplish the necessary pruning, the Lord

instructed the servant to “go to, and call servants” (Jacob 5:61). The servant organized a small pruning team (Jacob 5:70), and the Lord encouraged them to work hard (Jacob 5:71). They then went to work, taking instructions from the Lord and working together with him (Jacob 5:72).

Pansiot and Rebour discuss pruning teams in modern groves.¹³¹ They are normally composed of from eight to twelve apprentices with a very competent foreman (as compared to the servant). The most competent specialist cuts back the large branches and works with the conservation of the replacement branches. The less skilled worker might thin the small fruiting branches, as this is easier. Adolescents trim and cover the wounds with grafting wax. Children bring supplies and equipment. Even when experienced pruners are used proper organization of the work teams is important, and each worker must be given appropriate instructions.

The foreman gives the directions for the overall tasks to be performed. At the foot of each tree he tells the workmen the pruning plan. He discusses places where thinning should be thorough and where it should be lighter, the main branches that need to be eliminated, and if necessary, he uses chalk to mark spots where main cuts will be made. He supervises the work and checks it when completed. The branches are left on the ground where they fall so their former positions on the trees are clear in the event that discussions about them are necessary.¹³² It is significant that the Lord of the vineyard himself works the vineyard at first (Jacob 5:5, 15, 29) and works alongside his servant-foreman and his hired hands as the season draws near (Jacob 5:72).

The point that only a few laborers were engaged by the Lord of the vineyard (Jacob 5:70) appears to be necessary for the message of the allegory, but it is also relevant to olive culture. A fairly small crew of pruners and workers can

maintain a vineyard or plantation (see question 13, earlier in this chapter.)

28. How were hired workers usually paid?

In the ancient world, where cash currency was not always available, wages for workers hired for the season would have been paid by giving them part of the harvest, but in more developed economies, wages and exchange equivalences were fixed by law. For example, in Babylonia wages could be paid to harvesters, winnowers, and hired hands in set amounts of either barley or silver.¹³³ The importance of the olive is suggested by palace accounts of Mycenaean princes who made meticulous entries indicating rations of oil awarded to staff. In ancient Israel “there was little demand or market for hired labour. The hiring in most cases was a poor foreigner lacking a plot of land of his own.”¹³⁴ In Zenos’s allegory, labor seems to be organized at first by the day (Jacob 5:47) and then for the final season (Jacob 5:70–77). Labor contracts could be made by the day (Deuteronomy 24:15), possibly by the harvest season (Ruth 2:3), or by the year (Leviticus 25:50, 53; Isaiah 16:14; 21:16). It was a mark of great generosity for a master to furnish his workers, in the end, not just with money but “liberally out of thy flock, and out of thy [threshing] floor, and out of thy winepress” (Deuteronomy 15:14). Therefore, in Zenos’s allegory, when the Lord of the vineyard promised his workers a share of the crop, he should probably be understood as being very generous (Jacob 5:72).

Transplanting and Asexual Propagation

29. How can olive branches be “planted” (Jacob 5:23, 24, 25, 54)?

One of the key elements of the allegory of Zenos is the image of taking cuttings from the tame tree and not just

grafting them into other trees (Jacob 5:8–9) but clearing the ground (Jacob 5:44) and “planting” them elsewhere (Jacob 5:23, 24, 25, 54). These branches will take root (Jacob 5:54).

The ancients relied principally upon propagation by slips, which is accomplished by taking stem pieces or cuttings of roots and burying them in an inclined position in trenches four inches deep. They normally sprout within a year.¹³⁵ The olive is one of the few fruit trees that can be propagated by taking a branch of a tree and burying it in the ground. This is apparently what Zenos had in mind when he indicates that the Lord of the vineyard took branches and “planted” them, saying that the natural branches were “hid” in the ground (Jacob 5:14). Hillhouse states that the olive is extremely tenacious.¹³⁶ When the trunk has perished by frost or by fire it forms new sprouts. If a bit of the bark, with a thin layer of wood, is buried in the earth, it becomes a perfect plant. All of the branches and even the trunk can be removed and the tree may still live (see question 19). Olive shoots can be cut off, placed in soil, and indeed they will root.

30. What is meant by “young and tender branches” (Jacob 5:8)? Does this refer to suckers? Do they bear fruit? Can they be grafted elsewhere or transplanted?

Regarding the young and tender branches, they appear to be new growth that resulted from the heavy pruning mentioned in Jacob 5:4, 7. Suckers are “shoots arising from the underground parts of the plant, usually coming from adventitious buds on roots. In grafted trees they generally arise from the rootstock below the graft union.”¹³⁷ If suckers arise from the rootstock, they should be removed as soon as they are noticed, since the rootstock’s genetic constitution is rarely suitable for fruit production. Rootstocks normally originate from seeds of cultivated varieties or from wild

varieties, which creates the genetic diversity and the resulting unsuitability for fruit bearing. Unlike scions used for fruit production, rootstocks are not typically propagated vegetatively. However, in California, a cloned rootstock is frequently used because of its resistance to the fungus *Verticillium Albo-atrum*.¹³⁸

Vigorously growing above-ground branches are also called suckers. This normally happens when trees have been overpruned. If above-ground suckers alone are used as the shoots to produce new trees it may take ten years or longer for them to bear fruit.¹³⁹ Elant states that when suckers are removed from a main trunk, "obtaining a new tree may take up to eight years, but three or four years are often sufficient."¹⁴⁰ He does not indicate whether obtaining a new tree also implies fruit production. Accordingly, if the Lord of the vineyard used suckers, it is appropriate that the allegory mentions that he allowed "a long time" for them to grow (Jacob 5:15).

Such shoots can be transplanted. Ovules, protuberances at the base of trees, may form aerial sprouts that can be rooted or grafted. The ovules can be induced to produce rooted suckers *in situ*, which is their natural function, by covering the base of the tree with a light layer of soil.¹⁴¹

Aging

31. What happens when an olive tree "waxes old" (Jacob 5:3)?

As olive trees age, the roundness of the trunk is lost and ridges form on the surface, separated by hollows. Even though the old wood is very hard, it may deteriorate, especially in rainy areas. It then becomes difficult for the roots to continue proper growth and to supply nutrients to the tree. At the same time, the foliage may be very active and

the equilibrium is broken as a result of the falloff in the supply of mineral substances by the roots. Growth slows down and cannot keep pace with fruit production. Pruning is then necessary to rejuvenate the tree by reducing the aerial portions of the tree, thereby maintaining a proper balance between the top and the root.¹⁴²

There is a tendency for olive trees to form more fruit than they can maintain with the available nutrients. As trees age this tendency becomes accentuated. If the excessive fruit is not thinned, fruiting the following year will be considerably reduced, or even non-existent.¹⁴³

32. What is the "main top" (Jacob 5:6)?

The term "main top" is not commonly used in modern terminology. In the context of Jacob 5:6, it appears to refer to the "main branches" (Jacob 5:7) of the original tree, which were replaced because of the age of the tree or neglect. Pansiot and Rebour state that "the sap flows most readily to the best-lit portions of the tree, which are generally the branches at the top."¹⁴⁴ The lower boughs are more shaded and tend to become weakened. The main branches, with the greatest access to the light and sap, are the most important to the tree and should have the best chance for becoming productive, but when they become old and unproductive they need to be removed.

33. How can old trees be rejuvenated?

There are many ways to rejuvenate old trees, and thus the Lord of the vineyard would have many options in trying to preserve his beloved tree. Olive trees have extraordinary vitality and powers for recuperation. Old trees that are apparently dying, if properly tended, can become vigorous, high-yielding, renewed trees with only elementary care (cf. Jacob 5:8). When the lower portion of a tree has some vitality left, only the diseased, decayed, or dead portions are

removed (see Jacob 5:7). New growth starts again at varying speeds. In favorable circumstances, new shoots form a new framework within a few years and trees will resume normal fruiting after four to five years.¹⁴⁵ After a certain point, however, rejuvenation is impractical or impossible and the tree dies. Hence, the Lord of the vineyard recognizes that the end is at hand when he goes into the orchard to prune and harvest for the last time (Jacob 5:75).

34. What occurs when a tree first “begins to decay” (Jacob 5:3)?

Biological systems go through a natural aging process. When multicellular living organisms are young, the genetic mechanism dictates development and growth. With maturity there is a shift to a maintenance of cells. Human cells in culture appear to divide about fifty times, then the entire population dies. If frozen for a period of years and then allowed to divide again, the clock is reset, and they divide fifty more times before they die.¹⁴⁶ Although the specific causes are not known, aging is a common occurrence in biological organisms. Most species of trees grow to a certain size, then age and die. However, many trees may be propagated vegetatively. New shoots and suckers can reinitiate the cycle of growth. This principle is used to rejuvenate old olive trees.

From a biological point of view, “decay” (Jacob 5:3) can refer to natural deterioration, which may or may not involve microorganisms. It can also refer to decomposition caused by parasitic or saprophytic microorganisms and macroorganisms. When tree trunks are young they are normally covered completely by living tissue, which produces resins and other products that help to deter microorganisms and insects. As trees get older the bark splits, exposing underlying non-living wood that is no longer protected by

the living cells. Microorganisms, insects, and natural weathering cause decay, which in some instances may spread to the living tissues.

35. Is it natural, as a tree ages, for the branches to grow faster than the roots and “overcome the roots” (Jacob 5:48)?

“As a tree grows old, it becomes [more] difficult for the roots to continue their growth and provide minerals for the tree.” The foliage normally remains active, causing root stress. This eventually results in slowed root growth and less abundant fruit production. Rejuvenation by pruning, which reduces the aerial portions of the tree, is used to correct this situation.¹⁴⁷ Dealing with this very problem, the Lord of the vineyard determines, “We will nourish again the trees of the vineyard, and we will trim up the branches thereof; and we will pluck from the trees those branches which are ripened” (Jacob 5:58).

36. What does it mean when “branches are ripened” (Jacob 5:37, 58)?

As the Lord of the vineyard inspects his tree, he observes that “it beginneth to perish; and it will soon become ripened” (Jacob 5:37). When branches become excessively long or bent over, they lose their vitality. Stress causes the sap to seek the nearest outlet, usually causing the branches to fade and vigorous suckers to grow at the base of the branches. When the suckers occur at the base of the scaffold branches, it indicates that the branches are dying and rejuvenation pruning is necessary.¹⁴⁸ Also, wood that has born fruit once will not bear again and may be considered as “ripened.”

37. Can olive groves be reclaimed through grafting?

Zenos presents the image of an entire orchard that has become useless. The Lord of the vineyard tries to rejuvenate his whole orchard by grafting genetic material from his best

tree onto the rootstock of other trees (Jacob 5:8) and by planting shoots from that tree in various new parts of his vineyard (Jacob 5:14). Indeed, vast wild olive groves have sometimes been improved by such grafting and are found throughout the Mediterranean Basin. It is a complicated and costly process and normally calls for soil improvement.¹⁴⁹ Grafting more desirable branches onto native stands of wild olive rootstocks has given some good results, but it is currently less practical than setting out new plantations. Cultivating wild olive trees may save a few years in bringing trees into bearing, but the trees will not bear as well later.¹⁵⁰ Accordingly, the Lord of the vineyard obtains positive results at first (Jacob 5:20–24), but in time all the trees in his orchard became poor producers (Jacob 5:39, 46).

38. What is a “mother tree” (Jacob 5:54, 60)?

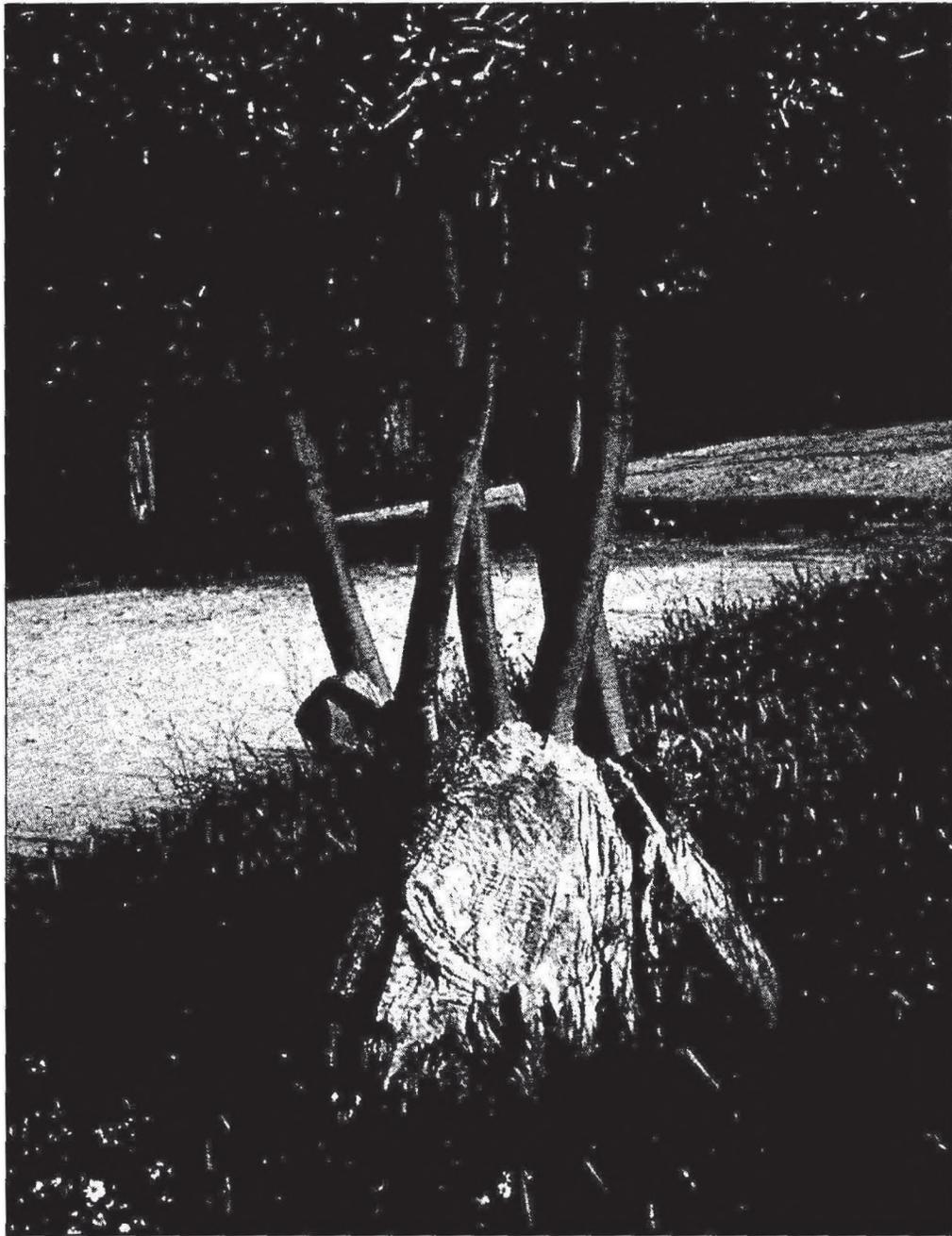
“Mother tree” is not a common term today, but it is sometimes used. It appears four times, late, in Zenos’s allegory. The term usually refers to a tree with desirable genetic characteristics from which cuttings are derived to produce asexually propagated offspring.

Grafting

39. How does grafting preserve the roots (Jacob 5:10, 11, 17, 34)?

The main strategy used by the Lord of the vineyard to preserve the rootstock of the main tree was to graft in branches from a wild olive (Jacob 5:9, 17). “And the servant said unto his master: Behold, because thou didst graft in the branches of the wild olive-tree they have nourished the roots, that they are alive and they have not perished” (Jacob 5:34).

Although it would be unusual to graft branches of wild olive onto tame trees to save the roots, there may be



Grafts growing on old stump. Grafting is one of the main techniques used in cultivating olives. Grafting slips from a wild olive may help resuscitate a tree that has borne badly, stimulating the rootstock and providing vigorous foliage growth. Clearly, the author of *Jacob 5* was intimately familiar with the botanical characteristics of olive trees and the requirements to make them productive.

instances where the wild branches are more vigorous than tame or domesticated branches and would therefore be beneficial. White suggests that slips from the wild olive may help to resuscitate a tree that bore badly.¹⁵¹ Possibly they could supply carbon products from photosynthesis more rapidly to support the roots, because of their vigor. Without carbon compounds produced in the aboveground portion, roots will perish. If a strongly growing scion cultivar is grafted on a weak rootstock, the growth of the rootstock will be stimulated and become larger than if it were left ungrafted.¹⁵²

One other possibility is that the foliage from the mother tree had become infected with insect, virus, fungal, bacterial, or other parasites, and the "wild" shoots were used because they were resistant to the disease-causing organisms. This possibility is enhanced by the fact that Jacob 5:9 says the old branches were to be "cast into the fire," a procedure that makes sense especially if the branches were infested.

40. What is meant by "natural branches" as distinguished from grafted branches?

The natural branches are assumed to be the branches that were originally propagated by cuttings from the mother tree. Our assumption is that "natural branches" refers to branches of *O. europaea* as opposed to branches of *O. oleaster* or wild olives. Natural branches may be grafted branches as it is a common practice to graft *O. europaea* branches onto *O. oleaster*. White states that fruit farmers have learned by experience that a grafted branch will give fruit true to type.¹⁵³

41. What is the success rate of grafting?

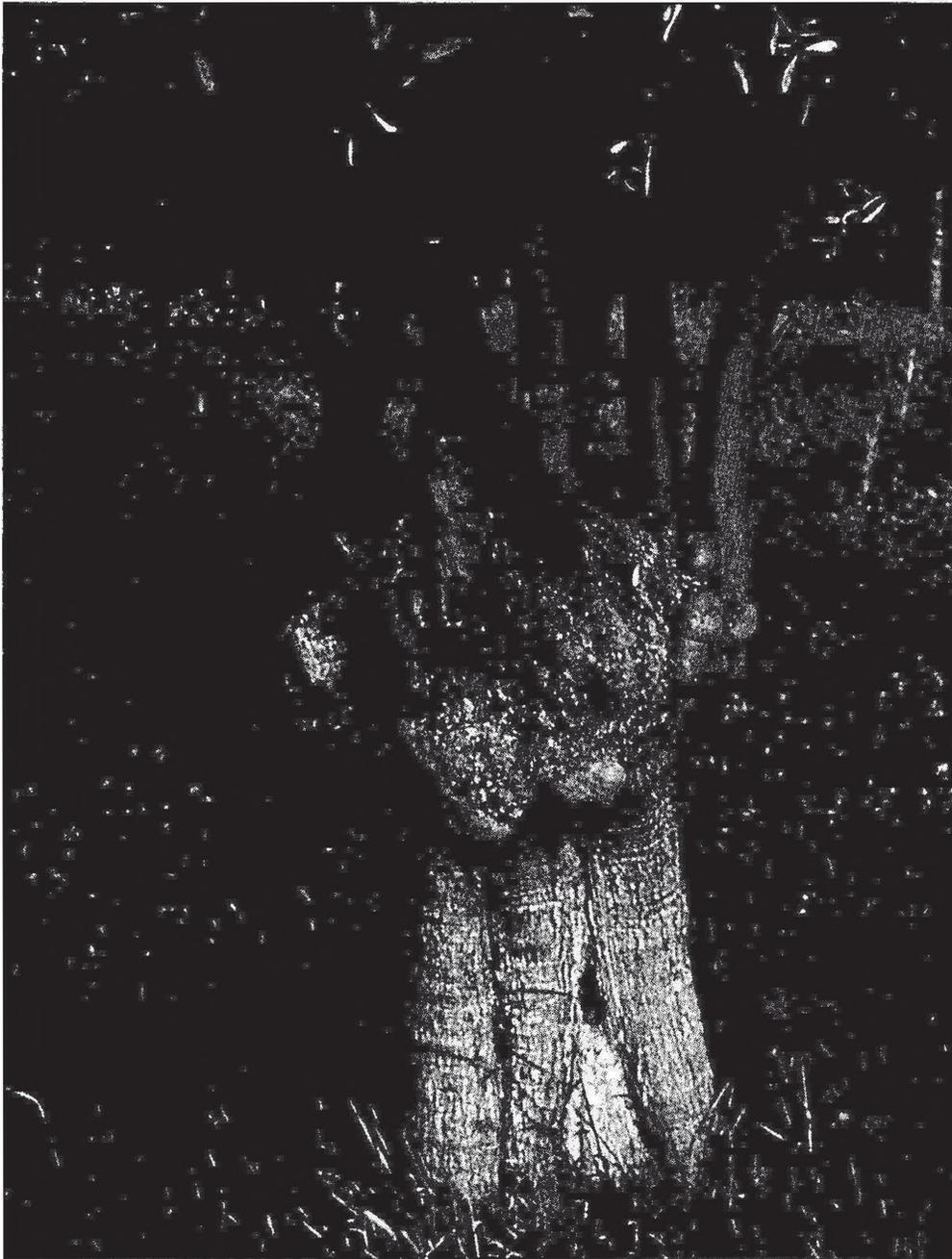
The Lord of the vineyard expresses some doubt whether certain grafts will grow: "If it be so that these last grafts

shall grow" (Jacob 5:64). With temperate fruits, grafts are highly compatible if the two partners are different cultivars or clones within a species. There are few cases where graft combinations are successful with different genera in the same family. "If the two graft partners are in the same genus but different species, then the chances of success are greatly improved," although many of these types of graft combinations will not unite successfully.¹⁵⁴ Wild and domesticated olives are in the same genus, and they graft readily. There are many factors that determine whether grafts are successful. Examples include grafting during the proper season, the care taken to make the graft, the compatibility of the cultivar used for the scion with the particular root stock, the age of the tissue, and whether disease organisms hamper the graft. Bioletti and Colby state that a certain portion of the olive grafted scions will not grow even with the best of care, and many will remain dormant from one to two years.¹⁵⁵

Accordingly, the Lord's strategy optimized the success rate of the grafts, for he determined to graft the natural material from the nethermost parts of the vineyard back into its natural mother trunk (Jacob 5:52, 60, 67). At the same time he took additional material from that tame tree and grafted it onto "the roots of the natural branches" that had previously come from the same tree and had grown in the nethermost parts of the vineyard. The later step was taken "that I may preserve them also [the roots in the nethermost parts of the vineyard] for mine own purpose" (Jacob 5:54; see also 5:68).

42. Why is it worth working to preserve the natural branches by grafting them onto other trees (Jacob 5:13–14)?

While rootstock is important, it does not determine the quality of fruit. The natural branches from the "tame tree"



Grafts growing on old trunk. Wild and domesticated olives graft readily. In Jacob 5, the Lord's strategy optimized the chances for success when he grafted the natural material from the nethermost part of the vineyard back into its mother trunk, thereby guaranteeing the compatibility of the grafted cultivar and the host trunk.

represent a desirable clone or cultivar. Therefore, it had the genetic constitution for the desirable or domesticated fruit rather than the “wild” tree with undesirable fruit. If we have a clone or cultivar that produces good fruit, has disease resistance, is adapted to the local environment, and that grows well, we strive to preserve that clone or cultivar so we do not lose the precious genetic material. This would be true for olive or other temperate fruit trees.

43. What condition is described by the phrase “all sorts of fruit did cumber the tree” (Jacob 5:30)? Does this suggest poor fruit quality (Jacob 5:32)? Are olives especially vulnerable to this problem?

In Jacob 5:30 the natural branches are described as having been broken off and wild branches grafted in. Because of this “all sorts of fruit did cumber the tree” and “there is none of it which is good” (Jacob 5:32). This could happen if the rootstock of an old tree was rejuvenated with grafts from wild trees. If the wild branches were taken from many wild trees there would be much genetic diversity resulting in a tree that would bring forth all sorts of undesirable fruit. As mentioned earlier, when the fruit set is heavy, thinning is necessary to increase the size of the fruit so maturity will not be delayed, resulting in alternate year bearing.¹⁵⁶

In addition, olive trees tend to produce more fruit than they can supply with available nutrients. This becomes accentuated with age.¹⁵⁷ Wild olives often produce five or six fruits on each peduncle; however, cultivated trees have flowers that abort, casting green fruit during each growth stage and resulting in only one or two fruits in a cluster at maturity.¹⁵⁸ This causes wild fruit or fruit on untended trees to be thicker, smaller, and more bitter than cultivated fruit. This is another way a tree could be cumbered. Proper pruning can help to reduce this problem.¹⁵⁹

44. Why should the Lord take the liberty to graft or plant young shoots "whithersoever [he] will" (Jacob 5:8)?

As has been discussed (see questions 19, 29, 30), the olive is very easy to propagate as long as basic cultural practices are adhered to. Pansiot and Rebour report that "rooting is usually easy, except for some varieties which are not easily propagated by cuttings."¹⁶⁰ By planting or grafting the natural branches into various parts of the vineyard, the Lord may be experimenting to see how these branches grow at different elevations, in various fresh soils, or with different amounts of moisture.

45. In what sense is "grafting a wild branch" onto a good tree "contrary to nature" (Romans 11:24)?

There are many references to the olive in the Old and New Testaments. In Romans 11:24 it is stated that it is contrary to nature to graft a wild olive tree onto a good olive tree. As discussed previously, the wild olive is related to the domesticated olive and they are both present in more or less the same geographic and climatic belt.¹⁶¹ Cultivated and wild olives are interfertile and are closely related morphologically.¹⁶² Therefore, it is relatively easy to graft wild onto domesticated and domesticated onto wild. In Romans 11:24 perhaps it is contrary to nature because we normally graft domesticated onto wild so we can use the desirable genetic characteristics of the wild root, such as vigor, disease resistance, and drought resistance in the rootstock, to enhance the genetically determined fruit of the good cultivars. We would not normally want to graft wild onto domesticated. In normal situations there would be no advantage. On the other hand, White states that strenuous efforts are sometimes made to resuscitate a tree that bore badly, including inserting slips from the wild olive along with fertilizing with urine, liming, and grafting.¹⁶³

46. What is involved when the Lord plucks out the most bitter and grafts the natural branches back into the mother tree (Jacob 5:56–57)?

Jacob 5:56 says, “And they also took of the natural trees [branches that had been planted] which had become wild, and grafted [them back] into their mother tree.” Natural trees do not change genetically to “become wild” (see questions 3 and 4). In the instance of Jacob 5:57, the wild branches are not plucked from the tree except those that are the most bitter. The only reason for grafting wild branches on tame trees is that they may provide more vigor for rejuvenation than tame branches. However, there are good reasons to remove the branches with the most bitter fruit (see questions 23 and 50).

47. Do grafted branches have a long-term future (as implied by Romans 11:25) or must they eventually all be pruned out (as in Jacob 5:73)?

In Jacob 5:73 “the natural branches began to grow and thrive exceedingly; and the wild branches began to be plucked off and to be cast away.” This presumes that all the wild branches are eventually removed from the tame tree. The viability of a graft, however, does not depend on its fruit-bearing characteristics.

If the tame tree originated from a graft of a scion onto a rootstock, all of the aboveground portion of the tree would be from a grafted branch. That tree can produce fruit from the original scion as long as it is properly pruned. If the tree is neglected and becomes old with a lot of old wood it may be necessary to graft again, particularly if it is burned or killed by frost. The new suckers that would form would be from the wild rootstock and would produce undesirable fruit. However, new grafts could be made onto them from

tame trees. Thus, for any graft, the eventuality of being pruned out would depend upon the care of the tree.

In Romans 11:24–25, Israel is the natural branch to be grafted into their own olive tree when “the fullness of the Gentiles be come in.” Thus, botanically speaking, there either could be a long-term future or branches could eventually be all pruned out.

48. How long does it take for a graft to produce fruit (Jacob 5:15)?

The length of time required for a graft to produce fruit depends upon which of the many grafting procedures available is used and numerous other factors. Grafts may be made with branches from cultivated plants onto young plants grown from wild or cultivated stones (seeds), or grafts may be made onto small or large branches of mature trees or onto ovules. There are many other types of grafts as well. Other important factors involve significant genetic diversity with rootstocks and scions, weather conditions, and the proper season for the type of graft.

In Italy, particularly in the Pescia and Foggia area where the nursery industry is very important, the “feather” graft is most often used. Feather grafting involves introduction of the graft beneath the bark of a rootstock from which the crown has been removed. The graft is made high or low on rootstocks, which may be large or small depending upon the geographic area. For example, in North Africa this graft is used most commonly on large rootstocks. It takes the plants a full season to reach a height of thirty to seventy centimeters and the diameter of a pencil before they are grafted. The five-to-six centimeter scions are taken from the central portion of one-year-old shoots. After about two weeks the leaves of the scion fall at the least touch. This is an indication that the graft has taken. When the two shoots

from the graft grow to about twenty centimeters the weaker shoot is eliminated and the other is attached to a support after several additional weeks. In March or April of the following year, when the grafted plants have reached a height of fifty to one hundred centimeters, they are moved to nursery beds and are planted in rows.¹⁶⁴

During the two or three years that the plants remain in the nursery, they are pruned to give them the proper form. Opinions vary concerning how long they should remain in the nursery before being planted in groves. Some horticulturalists believe that the higher value of plants, from three to four years old, more than offsets a shorter non-productive period. Some maintain that younger plants recover more quickly from the trauma of transplanting. Dryness, humidity, plantation size, and other factors may also be significant. Planting with a ball of soil surrounding the roots normally gives better results than planting with bare roots, particularly in dry climates.

The length of time it takes for the trees to begin fruit production after being planted in a grove also varies, depending upon a number of genetic and environmental factors. Therefore, many factors influence how long it takes for a graft to produce fruit. Pansiot and Rebour state that after the trees are planted it will take at least six years to start production with a new plantation¹⁶⁵ and about forty years for it to come into full production.

49. How does fruit behave on a graft (Jacob 5:17–18)?

The difference between fruit on a two-year-old graft and fruit on a normal two-year branch is related to the genetic constitution of the graft. If the graft is from a selected domesticated cultivar it will have essentially the same characteristic flavor, size, disease resistance, drought resistance, and so forth, or lack thereof, that the “mother tree” had. On

the other hand, if the graft is from a wild plant with small and bitter fruit, the graft will also have small bitter fruit. All fruits are borne on two-year-old wood. Also, the graft must be of sufficient size and age to produce fruit.

Grafted branches will yield fruit true to type.¹⁶⁶ Therefore, in our estimation, wild branches would normally not bring forth tame fruit. It may be possible to obtain fruit that resembles the wild type on a tame tree if the tree is not properly thinned, watered, fertilized, and pruned. However, the tame branch still has the genetics potential to produce good fruit. It does not revert to the wild type genetically.

50. Can one tree bring forth both good and bad fruit (Jacob 5:25) or all sorts of fruit (Jacob 5:30) at the same time?

Grafting can be used to change the variety of fruit a plant produces. As an example, several kinds of apple stocks can be grafted onto the same rootstock so the same tree bears several kinds of apples. An important point is that grafting cannot be used to create new kinds of fruit or flowers, even when the scion and stock belong to different species. If a Bartlett pear scion is grafted onto a quince stock the tree will produce Bartlett pears. Bringing forth good, bad, and all sorts of fruit on one tree would require grafting; it would not happen naturally. Thus, it is not surprising that the tame tree with its wild grafts would produce all kinds of fruits (Jacob 5:30), but the branch planted in the nethermost part of the vineyard would not naturally bring forth good fruit on some branches and bad fruit on others, unless someone had come in and grafted wild material onto that scion. Perhaps this is why the Lord of the vineyard asks, "Who is it that has corrupted my vineyard?" (Jacob 5:47).

Fruit

51. What was olive fruit used for?

There appears to be good evidence that the olive was important very early all around the ancient Mediterranean. The fruit of olive can be used either for pickling (eating) or for oil. It was very valuable in the life and economy of the ancient world, and thus was "most precious above all other fruit" (Jacob 5:61, 74).

Not only was the oil used for lamps, anointing, and food, but it was also used in rituals accompanying death, on the skin to prevent windburn, and as a cosmetic.¹⁶⁷ In Classical Greece, athletes and others rubbed oil on their bodies then scraped off the mixed oil, dirt, and sweat with a scraper. It is possible that the olive was used for oil before it was used for fruit, since the fruit is naturally bitter and it may have taken longer to discover how to rid the fruit of its bitterness. The ancients would have easily noticed the olive's potential as an oil source, for when ripe, the fruits make oily spots on the ground and anything else they contact. Also, oil and oil containers have been discovered in the archaeological record, leaving little doubt that olive oil was used very early. The oil probably could have been used for lamps without removing the bitter glucosides.

Although it is obvious that oil was important very early, it is also likely that the value of the fruit as food was discovered shortly thereafter. Renfrew states that in prehistoric times in Europe, olives certainly were eaten as well as used for oil.¹⁶⁸ He mentions that we can only speculate that oil was used for cooking, but it was almost certainly used as fuel for lamps. Zohary and Hopf indicate that since the Bronze Age, many Mediterranean peoples cultivated the olive for oil, eating, cooking, ointment, and lighting.¹⁶⁹ It was also a principal article of commerce primarily because

of its excellent storage qualities. Perhaps more archaeological investigations will help to further elucidate this question.

The oil is by far the most important income product. It is greatly prized throughout the Mediterranean Basin both for fine flavor and cooking properties. Pickled olives come in two types, green and black, with the green having the highest demand. Black olives are more nutritious but less commonly eaten. There are also by-products of importance. The press cake is used for manure or fuel, the wood is used by cabinet makers, and the leaves can be used as cattle feed and for pharmaceutical purposes. The stones are now also of interest and are used for molded products, plastics, and furfural makers.¹⁷⁰ Anciently, the olive was probably used much as it is used today: for cooking, oil for lamps, anointing, cosmetics, and for eating. Likely, washing that removed most of the bitter glucosides from the oil eventually led to ways for removal of the glucoside from the fruits.

52. What is meant by "laying up fruit against the season" (Jacob 5:13, 19, 20, 27, 29, 31, 46, 71, 76)? What are the characteristics of good fruit, and how is the fruit or oil stored?

Evidence for the storage of oil and wine in the ancient Mediterranean is abundant, according to Renfrew, although it is not always easy to determine whether it was wine or oil that was stored. "The magazines of Quartier XI at Mallia . . . showed a carefully planned device to avoid wasting liquid."¹⁷¹ Each of six bays in a storage vault had a bench on both sides for standing jars, with drainage furrows running transversely to the two central channels that emptied into a jar sunk into the floor.

Wace briefly discusses a similar storage space at Mycenae in the so-called "House of the Oil Merchant,"

thought to be a palace annex.¹⁷² One room contained eleven large pithoi with an oval collection pit in the center of the floor. Thirty large stirrup jars were found, and the clay of many of them was clearly impregnated with oil. Many of the jars had been stopped with clay and sealed. It is believed that this building was concerned largely with the storage and handling of olive oil, suggesting that it was a common item in their culture

The Philistines (1200–700 B.C.) had an extensive olive industry in Ekron, on the coastal plain of Canaan.¹⁷³ Although archaeologists have only excavated about three percent of the site, they have identified 105 olive installations. They expect the number of known olive installations to increase dramatically with additional excavations. With the 105 installations already discovered they estimated that the Ekron Philistines produced 1000 tons of oil annually. The 290,000 gallons would have required 48,000 storage jars each year. This output equals one-fifth of Israel's current export production.

53. What makes some olive fruit bitter (Jacob 5:52)?

Olives as picked from the tree are very bitter. Accordingly, the Lord tasted the fruit of his trees and found that they all were bitter (Jacob 5:31–32). They cannot be eaten because of a bitter glucoside in the raw fruits called oleuropein.¹⁷⁴ The glucoside can be partially washed out with running water. Repeated applications of alkaline solutions followed by water can be used to remove the remaining glucoside.¹⁷⁵ Because of genetic diversity there are distinct differences in bitterness. Cultivated olives are selected for their desirable characteristics, which include lack of bitterness, size, flavor, oil content, adaptation to the local area, and disease resistance. Bioletti and Colby point out that if "olives are gathered too green the oil will be bitter, if too

ripe it will be rancid."¹⁷⁶ Spanish green olives cured in lye may not be treated long enough to remove all of the glucoside, which may contribute to the characteristic flavor.

A recent Consumer Reports article indicates that different brands of olive oil varied widely in olive flavor intensity, from decidedly pronounced to barely perceptible.¹⁷⁷ Other flavors found in the oil were "green"—the flavor of slightly unripe fruit; "fruity"—a complex of ripened fruit flavors sometimes undifferentiated and sometimes reminiscent of melon, peach, or green-to-ripe banana; and "evergreen/herbal"—a flavor like fresh herbal with a pine-like character. Some extra virgin oils and pure oils exhibited a slight bitterness or astringency. Others produced a sensation called throatburn, which was a slight tingling or burning impression in the back of the throat. Therefore, not only do olives vary in the amount of bitter glucosides present in fruits but other flavor components are also important.

Achieving uniformity in the crop is obviously desirable, since a small percentage of very bitter fruit mixed in with the rest would reduce the quality of oil for the entire batch. Hence, the Lord of the vineyard strived to achieve a situation in which all the trees "became like unto one body; and the fruits were equal" (Jacob 5:74). Once this condition was achieved, the crop was stabilized "for a long time" of fruitful harvesting (Jacob 5:76).

Destroying Old Olive Trees

54. When the fruit becomes "corrupted," the whole tree is declared to be "good for nothing" (Jacob 5:42, 46). Are there no other uses for such a tree?

The word "corrupted" is not a botanical term. One can interpret the term to mean generally unsound. If this is correct it likely means that the branches were literally of no

more use. In verse 40, “the branch hath withered away and died” and verse 43 refers to a tree “whose branch had withered away.” This suggests that the branches were no longer functional. The life had gone out of them or perhaps they were decayed. If the wood is dead the best option may be for them to be “hewn down and cast into the fire” (Jacob 5:42). Dead wood is also likely to have parasites and pathogens, and one of the best ways to reduce the inoculum potential is to burn the infested plant materials. Olive wood contains resin and oil, so it burns quite readily.

If the wood was not decayed, it could be used for a variety of purposes. It is heavy, compact, fine-grained, and has many other desirable characteristics for wood products. Cabinetmakers use it to inlay. The ancients used it as a hard and durable wood, such as ebony and cedar. It was used for the hinges of doors because of its hardness, and the Greeks selected it for the images of their gods.¹⁷⁸

55. Why is it necessary to burn the bad wood (Jacob 5:7, 9, 37, 42, 47, 58)?

Burning is important in order to eliminate parasites and pathogens. Disease-causing organisms could be present in the branches that were removed, necessitating the need to burn them to prevent additional infection. Thus, the ground is not cumbered (Jacob 5:9). There is no direct evidence in Zenos’s allegory of plant pathogens being the cause for removal of the branches. However, it is still common today to burn infected material from trees and debris under those trees to reduce the reinfection potential of pathogens and parasites. In addition, if branches are heaped on the ground, weeds grow in the debris, and the ground cannot be ploughed, cultivated, or fertilized. Olive wood burns well before or after it is dried because of its resins and oleaginous nature.¹⁷⁹

56. Why is it advantageous to incinerate an entire old vineyard (Jacob 5:49, 77)?

It has been known since ancient times that olive groves destroyed by fire sprout vigorously. The Lord appears ready to burn his entire vineyard and start over in verse 49, but the servant persuades him to work with the existing trees a little longer (Jacob 5:50).

Groves are sometimes burned deliberately to reconstitute them.¹⁸⁰ When reconstituting an olive tree by burning, the tree is taken up, leaving only the large roots. The bases are either burned or ripped up with a tractor. The new shoots are vigorous, but they do not grow in the same spot as the original tree, which complicates cultivation. Three of the main shoots are selected about a meter from each other. They are trimmed leaving three small-rooted bases, which are covered with soil. In today's practice, the hole left by the base of the old tree is filled with fifty kilograms of manure and two units each of phosphate and potassium, mixed with soil. The trunks remain one meter apart, which makes it possible to get from two hundred to three hundred trees per hectare in what was a grove with one hundred trees per hectare before it was burned.

Thus, burning an olive grove is a symbol of rebirth. The Lord's efforts throughout the allegory represent the last effort, leading to the "last time" that he will graft and plant as he does to rejuvenate the old tree in his vineyard (Jacob 5:62–64, 71, 75–77), but the image of burning in the end is not one of destruction. It conveys botanically the idea of starting over. It reminds us that the Lord had preserved the roots of the young shoots planted in the nethermost parts for an unstated future purpose (Jacob 5:54). After the vineyard is burned, the old stump will be removed and the

young roots will shoot forth new growth carrying forth the favorable genetic material of the beloved tame tree.

CONCLUSION AND PERSPECTIVES

Based on the botanical and horticultural information present in the archaeological and historical record, and reflected in Jacob 5, we can conclude that the ancients were superb horticulturalists and had a profound understanding of vital biological and plant cultural principles. Most of the botanical and horticultural principles in Jacob 5 are sound and are very important for olive culture. In addition, the one or two points, according to our interpretation, that represent unusual or anomalous circumstances are necessary enhancements to the message of the allegory.

In this single chapter of the Book of Mormon there are many detailed horticultural practices and procedures that were not likely known by an untrained person, and may not have been fully appreciated by professional botanists or horticulturalists at the time the Book of Mormon was translated. Even today, outside of olive-growing areas, professional horticulturalists may not fully appreciate some of the unique aspects of olive culture. Given the extensive detail about olive culture present in Jacob 5, we must give Zenos much credit for a high degree of horticultural knowledge, which many take for granted.

Examples of what the ancients and Zenos evidently knew were how to prune, dig about, dung, and nourish; how to graft tame to wild and wild to tame, and how to graft tame back into tame; how to balance tops and roots by pruning, and the reasons for doing this; how to save the roots of trees whose branches had decayed, and how to transplant branches to preserve the desired traits of good plants; how to preserve and store fruit and how to distin-

guish between good and bad fruit; how well plants grow on good and bad soil; how to care for trees to cause young and tender branches to shoot forth; that they could graft wild to tame to rejuvenate tame; that specific cultivars produced well only in certain areas; how to remove the bitter glucosides from the fruit; that they could burn an orchard to reestablish a new one; that plants grown from seeds would not have desirable characteristics; the importance of elimination of old wood and debris by burning, and how to deal with pests and pathogens; how to prevent heavy bearing one year and no bearing the next by proper pruning; the necessity to plant more than one cultivar for pollination; and how to propagate scions with the desirable genetic material.

Interestingly, much of this sophisticated technology was probably lost in Nephite civilization, for the olive is not mentioned again in the Book of Mormon after Jacob 5, an indication that the lands of the Book of Mormon may not have been suitable for growing olives. It seems reasonable to conjecture that given the importance of olives, Lehi and his group might have carried olives with them as they did other plants (1 Nephi 8:1; 16:11; 18:6). However, these references mention seeds, but not cuttings, and fruit-bearing olives are not usually grown from seeds. Warren reported that the strongest, heaviest bearing, and longest living trees are those grown from seed.¹⁸¹ But trees from seedlings tend to resemble wild forms, and the resultant fruit is normally unsuited for either oil or pickling. To have the desired quality of fruit, the tree must be cloned from a selected and proven cultivar.¹⁸² Moreover, with the very restrictive climatic requirements for olive production it is not surprising that there is no New World mention of olives in the Book of Mormon. The only regions on the American continents with

Mediterranean climates where olive culture is economically feasible are the regions of California, Chile, and Argentina.

Joseph Smith probably knew how to prune, dig about, dung, and nourish local fruit trees; he probably knew a little about grafting, and he may have been familiar with some other horticultural principles, but not likely those peculiarly related to olive culture. In the Gerard *Herbal*, published in 1633,¹⁸³ there is a brief description of the olive tree, and some limited information about its characteristics and its "vertues" (virtues). In that description it is stated, "[t]he tame or manured olive tree groweth high and great with many branches, full of long narrow leaves not much unlike the leaves of willowes, but narrower and smaller: the floures be white and very small, growing upon clusters or bunches: the fruit is long and round, wherein is an hard stone: from which fruit is pressed that liquor which we call oyle olive. The wilde olive is like unto the tame or garden olive tree, saving that the leaves are something smaller: among which sometimes do grow many prickely thornes: the fruit hereof is lesser than the former, and moe in number, which do seldome come to maturitie or ripenes in somuch that the oile which is made of those berries continueth ever green, and is called Oile Omphacine, or oile of unripe olives." From *Jahn's Biblical Archaeology*, the following limited information (and certain misinformation) from and about the Bible could have been general knowledge in Joseph Smith's day: "Olive trees . . . were a very ancient and profitable object of agriculture. . . . Olives in Palestine are of the best growth and afford the best oil; hence this region is often extolled on account of this tree, and especially in opposition to Egypt, which is destitute of good olives. . . . Land that is barren, sandy, dry and mountainous, is favourable to the production of the olive. . . . It flourishes

about two hundred years, and even while it is living, young olives spring up around it which occupy its place when dead. . . . It was customary, notwithstanding, to raise the tree from suckers, which were transplanted. It requires no other cultivation than digging the ground and pruning the branches. . . . The *cotinus* and the *oleaster* are both called wild Olive-trees. They are nevertheless of different kinds, though they are sometimes confounded by the Greeks *themselves*. The fruit of the *cotinus* is used for no other purpose than colouring; the oleaster, *the agrippa elaeagnus of Linnaeus*, is that species of wild olive, whose branches (see Schulz, in Paulus' collection of Travels, VI.290) are grafted into barren olive-trees, that are in a state of cultivation, in order that fruitfulness may be produced, comp. Rom. 11:17, 24."¹⁸⁴ Not much more than this was known about olives in the eastern United States (an area not suitable for olive cultivation) in 1829 when the Book of Mormon was translated. Most of the information discussed in this chapter, however, was known and practiced in the lands around the Mediterranean from ancient times to the present.

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