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MAXIMILIAN SUNFLOWER
(*Helianthus maximiliani*)

Section 7.4.3, US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

by

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A plant materials report on Maximilian sunflower (*Helianthus maximiliani*) is provided as Section 7.4.3 of the US Army Corps of Engineers Wildlife Resources Management Manual. The report was prepared as a guide to assist the project biologist/natural resources manager with the selection, establishment, and management of appropriate plant materials for wildlife and habitat development programs. Major topics covered are description, distribution, habitat requirements, wildlife value, establishment, maintenance, and cautions and limitations.

Maximilian sunflower is a perennial forb native to the tall- and mixed-grass prairie region of the central United States and south-central Canada. The sunflower is known to provide food and cover for a variety of wildlife species, especially nongame birds. The species is also used for soil stabilization and site reclamation, and the showy yellow flowers make it popular for landscaping. Two cultivars are presently available for use in conservation plantings.

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The species grows best on medium sandy to clayey loams on sites that receive more than 14 in. (36 cm) of annual precipitation. Plants are tolerant of fire and moderately tolerant of drought and shade, but are unable to withstand saline soils and heavy grazing. Established plants are highly competitive unless management practices are employed to reduce their vigor. This report provides specifications for site selection and preparation, propagule selection, planting, and maintenance of Maximilian sunflower to improve wildlife habitat conditions within its region of greatest management use.

PREFACE

This work was sponsored by the US Army Corps of Engineers (USACE) Environmental Impact Research Program (EIRP) and the Department of Defense (DOD) military branches under the Defense Natural Resources Program. Technical Monitors for the study were Dr. John Bushman, Mr. David P. Buelow, and Mr. Dave Mathis of the Headquarters, USACE, and representatives of the Fish and Wildlife Committee of the Defense Natural Resources Group, DOD. The report serves as a section of the US Army Corps of Engineers Wildlife Resources Management Manual, as developed by the Headquarters, USACE, under EIRP Work Unit 32420.

This report was prepared by Dr. Donald R. Dietz, Mr. Clinton H. Wasser, and Dr. Phillip L. Dittberner of Natural Resource Professionals, Fort Collins, Colo., under Contract No. DACA39-88-P-0091 with the US Army Engineer Waterways Experiment Station (WES). Mr. Wasser is Professor Emeritus in the Range Science Department, Colorado State University, Fort Collins, Colo. Mr. Chester O. Martin, Team Leader, Wildlife Resources Team, Resource Analysis Group (RAG), Environmental Laboratory (EL), WES, was principal investigator for the work unit and contributed to the manuscript. Review and comments were provided by Dr. Wilma A. Mitchell, Dr. H. Glenn Hughes, and Mr. Kevin L. Grosz, EL.

The report was prepared under the general supervision of Mr. H. Roger Hamilton, Chief, RAG; Dr. Conrad J. Kirby, Chief, Environmental Resources Division; and Dr. John Harrison, Chief, EL. Dr. Roger T. Saucier, WES, was Program Manager, EIRP. The report was edited by Ms. Jessica S. Ruff of the WES Information Technology Laboratory (ITL). Drawings were prepared by Mr. Charles C. Calais, ITL.

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NOTE TO READER

This report is designated as Section 7.4.3 in Chapter 7 -- PLANT MATERIALS, Part 7.4 -- MISCELLANEOUS FORBS AND HERBACEOUS SPECIES, of the US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a separate Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 7.

MAXIMILIAN SUNFLOWER (*Helianthus maximiliani*)

Section 7.4.3, US ARMY CORPS OF ENGINEERS
WILDLIFE RESOURCES MANAGEMENT MANUAL

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Maximilian sunflower (*Helianthus maximiliani*) is a tall, showy perennial forb native to the tall- and mixed-grass prairies of the mid-continental United States and south-central Canada. Native plants of this species and two cultivars are valuable for soil conservation and wildlife food and cover; the large yellow flowers also make it popular for gardening and landscaping (Heiser et al. 1969, Rechenthin 1972, Wyman 1977, Salac et al. 1978, Thornburg 1982, Wasser 1982, Barkley 1986). Historically, plains Indians were known to eat the tuberous roots of Maximilian sunflower either raw or cooked (Owensby 1980). Wild sunflowers, including Maximilian, are being used extensively in hybrid crosses to improve the oil content, protein percent, and total production of commercial plantings (Whelan 1982).

First identified as *Helianthus subtuberosus*, this sunflower was later renamed after a Prussian Prince, Maximilian of Wied, who collected it on his travels through the United States from 1932 to 1934 (Heiser 1976). Other common names that have been used for Maximilian sunflower include Michaelmas

daisy (Gould 1975) and narrow-leaved sunflower (Stevens 1950). Sunflowers are placed taxonomically in the aster family (Asteraceae).

DESCRIPTION

Maximilian sunflower is a sod-forming species with the life form of a perennial forb (Redente et al. 1982) (Fig. 1). Plants have one to several stems that reach heights of 3 to 6 ft (1 to 2 m) (Stevens 1950). The roots are thick and fleshy, and plants spread laterally by short, stout rhizomes (Rechenthin 1972, Heiser 1976, Thornburg 1982).

The stems of Maximilian sunflower are pubescent, especially toward the tips where the short white hairs are appressed or subappressed. Leaves are alternate, lanceolate, acuminate, 6 to 10 in. (15 to 25 cm) long, and 0.8 to 2.0 in. (2 to 5 cm) wide. The leaves have pinnate venation, slightly serrate margins, and heavily pubescent and scabrous surfaces. Leaves of the elongated stems arch distinctly from the middle, with the two halves of the blade folding trough-like toward each other (Harrington 1964, Salac et al. 1978, Wasser 1982).

The typical composite head has bright yellow outer ray and central disk flowers. The long, lanceolate acuminate bracts are covered with short white hairs and exceed the length of the disk. The heads are arranged in a simple terminal racemose pattern and are approximately 2.0 to 3.0 in. (5.0 to 7.5 cm) wide. The seed unit, or fruit, is a flat, brown, four-angled achene that is 0.16 to 0.20 in. (4 to 5 mm) long and about one-fourth as wide (Harrington 1964, Rechenthin 1972, Wasser 1982).

Maximilian sunflower initiates growth in late spring or early summer, flowers from midsummer into fall, and matures in late fall (Heiser 1976, Wasser 1982). Plants established from seed may bloom during their first year. The northern strains of this species are small in stature and flower from June through July, whereas southern strains grow larger and bloom from September through October (SCS 1973, 1978). Environmental factors such as moisture, temperature, and altitude will affect growth, maturity, and reproduction (Johnson and Nichols 1970, Rechenthin 1972).

DISTRIBUTION

Maximilian sunflower is native to the central prairie region, ranging from southern Alberta and Saskatchewan, Canada, southward through most of Texas except for the very arid Trans-Pecos region (Fig. 1). The species is

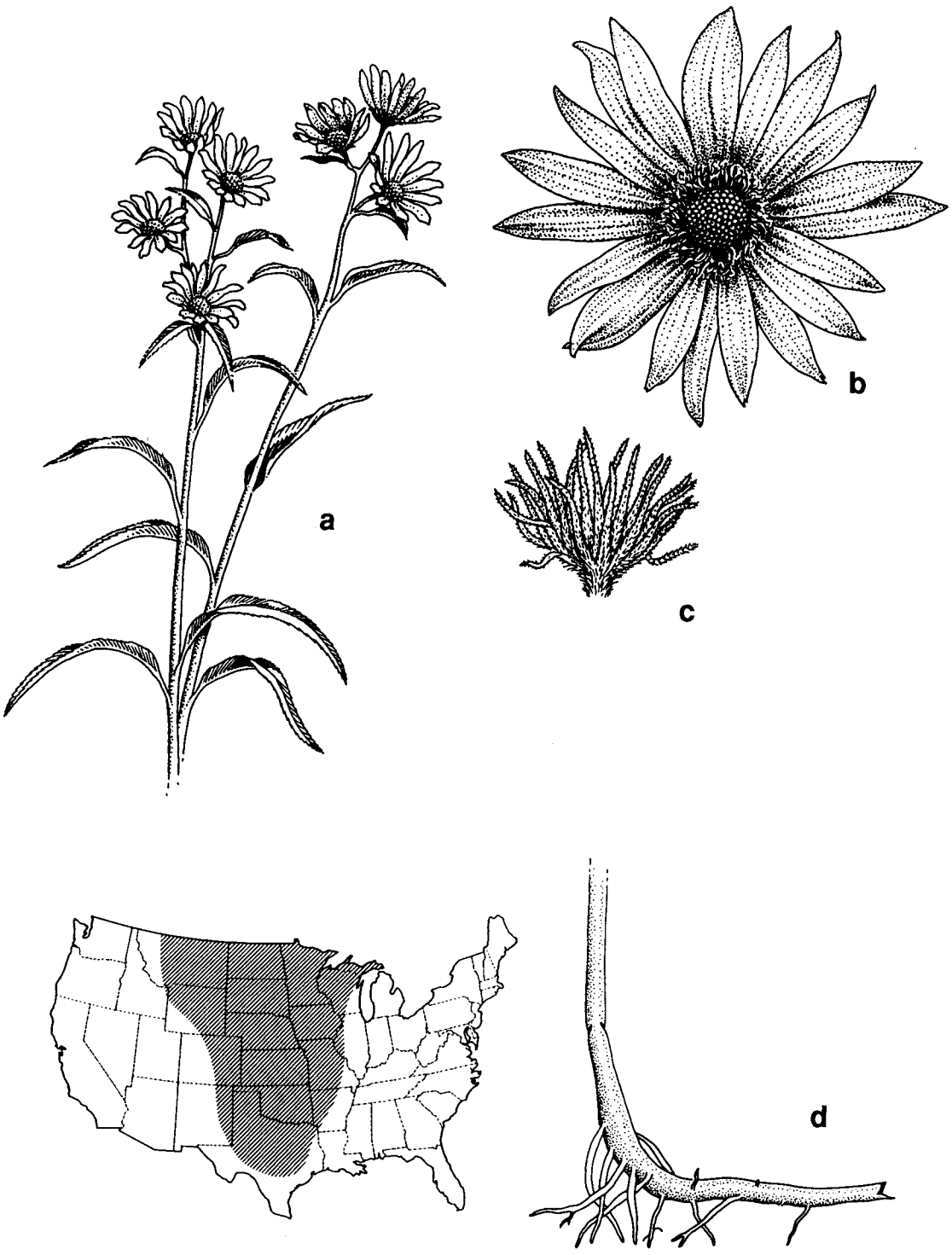

Figure 1. Distribution and distinguishing characteristics of Maximilian sunflower (*Helianthus maximiliani*): (a) typical growth form, showing stem and leaves, (b) composite head, (c) involucre bract, and (d) root

common along roadsides, in fields, and on prairies in North Dakota (Stevens 1950) and is found throughout South Dakota, especially on drier prairies and disturbed sites (Van Bruggen 1976). Plants have been found as far west as eastern Idaho and in Colorado to an elevation of 7000 ft (2134 m) (Harrington 1964). Irrigation permits Maximilian sunflower to grow on drier sites toward its western and southern limits (Weaver 1954, Johnson and Nichols 1970, Barkley 1986). The species has recently been used for site restoration in the East (Vogel 1981) and in planting mixtures for wildlife in the southern states (Mitchell and Tomlinson 1989). Plants frequently escape cultivation and are reported from areas outside of their normal range.

The map provided in Figure 1 shows the general distribution of Maximilian sunflower within its native range. Major sources used to construct the range map were Hitchcock and Cronquist (1973), Barkley (1968, 1977), and Owensby (1980).

HABITAT REQUIREMENTS

Maximilian sunflower will grow on a variety of soil types but is intolerant of saline conditions. Plants are tolerant of fire and moderately tolerant of drought and shade, but they are unable to withstand heavy grazing. Established plants are highly competitive unless management practices are employed to reduce their vigor (Wasser 1982).

Soils

Maximilian sunflower thrives in medium sandy to clayey loams but is inhibited by coarse sands and dense clays. Saline soils and typically dry sites also inhibit germination and growth (SCS 1978). While intolerant to even slightly saline conditions, this species adapts to moderately acidic to moderately alkaline soils (Rechenthin 1972, Salac et al. 1978, Vogel 1981). Most soils were satisfactory for the growth of this species in seeding and performance tests conducted in Texas, Oklahoma, Kansas, and Nebraska (SCS 1973, 1978). Its performance was fair to excellent on more than 30 soils in Texas, and excellent stands were produced on fine sandy loams and several types of clay soils in Oklahoma (SCS 1978). Plants have also done well when established on unstructured soil mixtures found on abandoned mine spoils in the central United States; these sites were reported to have a soil pH of 5.0 (Vogel 1981).

Moisture

Maximilian sunflower will grow on sites with suitable soils if they receive 14 in. (36 cm) or more of annual precipitation on northern ranges and at least 18 in. (46 cm) in the southern parts of the range. Plants are moderately tolerant of poorly drained soils. In the western portion of its range, wild plants are most commonly found on semi-riparian sites that either accumulate water or are located close to springs or streams (Johnson and Nichols 1970, SCS 1978, Texas Agricultural Experiment Station 1979). Excessive moisture, however, is detrimental to establishment of this species. Owens and Call (1985) reported that germination is inhibited by water stress and cold temperatures.

Plant Associates

Frequent associates of Maximilian sunflower on the tall- and mixed-grass prairies include big bluestem (*Andropogon gerardii*), little bluestem (*A. [Schizachyrium] scoparius*), yellow Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), and sideoats grama (*Bouteloua curtipendula*) (Salac et al. 1978, Wasser 1982). This sunflower is very competitive and will dominate less vigorous associates, spreading rapidly by rhizomes and natural seeding on disturbed and open sites. Its spread is curtailed by very dry sites, saline areas, excessive shade, and continually wet habitats (Rechenthin 1972; SCS 1973, 1978; Thornburg 1982).

WILDLIFE VALUE

Sunflowers in general are regarded to be of outstanding value to a variety of wildlife, and the large, nutritious seeds of most species are readily eaten by songbirds, game birds, and rodents (Martin et al. 1951, Davison 1967). Several big game species are also known to forage on sunflowers. Appendix A provides a listing of over 80 wildlife species reported to use sunflowers, primarily as a food source. This list is presented as an appendix, rather than a table within the text, because it combines wildlife use of all species of sunflowers collectively. Besides Maximilian sunflower, other species often cited as important wildlife foods are common sunflower (*Helianthus annuus*), prairie sunflower (*H. petiolaris*), and Jerusalem artichoke (*H. tuberosus*) (Martin et al. 1951, Davison 1967).

Well over 50 species of songbirds are known to eat sunflower seeds when available (Appendix A). Burger (1973) noted that although sunflowers are

often added to food patch mixtures to benefit small game, they are probably more useful for attracting songbirds. Also, sunflowers planted along a lot edge or fence line make an attractive and functional background for gardens, and when left on the stalk or harvested for use in feeders, their seeds serve as an excellent supplemental food source for wintering birds (Burger 1973).

Although few studies have been conducted on the specific use of Maximilian sunflower by songbirds, seed preference trials performed by the Kansas Agricultural Experiment Station and the Kansas Fish and Game Commission indicated high value of sunflower seeds for several species (Taylor 1976, 1977; Browning et al. 1981). These trials showed that Maximilian sunflower and sawtooth sunflower (*H. grosseserratus*) were superior to roundhead lespedeza (*Lespediza capitata*) and thickspike gay flower (*Liatrus pycnostachya*) as a food source for nongame birds. Maximilian sunflower had the highest consumption by cardinals (*Cardinalis cardinalis*) and field sparrows (*Spizella pusilla*), and the trials indicated that these species showed a marked preference for sunflower seeds. Maximilian sunflower had the highest seed quality of the species tested based on energy content, crude protein, fat, and fiber percentages (Browning et al. 1981).

Several species of game birds readily use sunflowers for food and cover. Data from numerous range sites in Texas showed that Maximilian sunflower rated high as a seasonal food source for the northern bobwhite (*Colinus virginianus*), mourning dove (*Zenaida macroura*), wild turkey (*Meleagris gallopavo*), and greater prairie chicken (*Tympanuchus cupido*) (SCS 1978). Robel and Arruda (1986) conducted feeding trials for bobwhites in Kansas and compared the food value of Maximilian sunflower with poultry mash, sorghum (*Sorghum vulgare*), soybean (*Glycine max*), smooth sumac (*Rhus glabra*), and ox-eye (*Heliopsis* spp.). Bobwhites consumed and assimilated more energy from sunflower seeds than from soybean, ox-eye, or sumac; however, Maximilian sunflower was rated only as a mediocre bobwhite food in this study.

Sunflowers are considered a choice food for doves, but plants established in dove fields are generally large-seeded commercial varieties rather than native stock. However, Maximilian sunflower is occasionally planted with mixtures of browntop millet (*Panicum ramosum*), sorghum, and corn (*Zea mays*) to provide a supplemental food source for mourning doves and other upland game birds in the South (Mitchell and Tomlinson 1989). In northern regions, sunflowers interplanted or seeded in combination with taller species of millets make excellent food patches during the winter; these plants will often

protrude above the snow, thus making seeds available to wildlife (Burger 1973). Throughout the Midwest and plains states, pheasant habitat is enhanced by tall forb species growing in clumps, which provide important nesting and escape cover and protection from winter storms (Trautman 1952, Joselyn and Tate 1972, Forman and Baudry 1984, Snyder 1984). Maximilian sunflower flourishes on roadsides and in disturbed areas within its range, thus creating excellent habitat for pheasants and other game birds.

The SCS (1978) rated Maximilian sunflower as an important forage plant for livestock (including cattle, sheep, and goats), deer (*Odocoileus* spp.), and pronghorn (*Antilocapra americana*). Field plantings of the cultivar 'Aztec' in Texas and Oklahoma have been widely used by both deer and livestock. However, Maximilian sunflower has a low tolerance to grazing pressure, and heavy use can eliminate plantings (SCS 1978). Small mammals known to use sunflowers are listed in Appendix A; many additional species, primarily rodents, likely eat the seeds of Maximilian sunflower.

ESTABLISHMENT

Site Selection

Many areas can be improved for landscape beauty and stability, wildlife habitat, and reclamation by planting Maximilian sunflower either in pure stands or, preferably, as a tall forb component in seed mixtures (Salac et al. 1978, Texas Agricultural Experiment Station 1979, Vogel 1981). Sites that respond well to seeding include disturbed or overgrazed ranges, roadsides, mine reclamation sites, and locations where soil conservation or landscaping is an objective (Fig. 2) (Thornburg 1982). Sites to avoid seeding are those that have intense vegetative competition, dense overstory, saline soils, and either very wet or very dry soils (SCS 1978, Wasser 1982).

Site Preparation

Plot design. The management objective determines the size, shape, and number of sites to be seeded. For most species of wildlife, small, irregularly shaped, strategically placed plots are preferable to large oblong blocks because such an arrangement maximizes edge (Hammerstrom et al. 1957, Joselyn and Tate 1972, Salac et al. 1978).

If large areas are to be planted on depleted rangelands or abandoned fields, edge effect can be maximized by seeding sunflowers in patches dispersed throughout the field or by planting in intermittent strips. Roadside

Figure 2. Vigorous stand of Maximilian sunflowers growing along a field edge in south-central Kansas (photo courtesy of Michael A. Watkins, US Army Engineer District, Kansas City)

plantings should be established where mowing can be limited or delayed to permit seed maturity and completion of the nesting and brooding cycles of ground-nesting birds such as pheasants (Joselyn and Tate 1972).

When reclaiming mine spoil or revegetating other drastically disturbed lands, the design should provide for site stability and ease of maintenance. Maximilian sunflower has been densely planted with partial success on small terraces to reduce wind erosion in cotton fields (Bilbro and Fryrear 1983).

Mechanical treatment. The use of herbicides on sites being rehabilitated can facilitate the direct seeding of Maximilian sunflower without plowing or other mechanical treatment. The loss of topsoil by erosion is reduced when mechanical site preparation is avoided. According to Joselyn and Tate (1972) and Prady (1985), application of appropriate herbicides is often less damaging to wildlife and their habitats than harsh mechanical treatments.

When tillage is necessary on disturbed sites and mine spoils, a site can be plowed on the contour to depths of 0.5 ft (0.15 m) or more. Satisfactory results may be obtained by working the site with a moldboard plow or disk in

the summer and harrowing or shallow disking just before seeding the following spring. Seed germination is greatly improved by seedbed firming and removal of competing vegetation (Rock 1981, Wasser 1982).

It may be necessary to plant sudan grass (*Sorghum sudanense*), sorghum, or other soil-binding plants on erosive sites prior to planting sunflowers. These plants should be grazed or mowed to a 6- to 12-in. (15.2- to 30.5-cm) stubble height; sunflower seeds can then be drilled directly into the stubble (Rock 1981). Heavy equipment, such as offset disc harrows and/or chisel plows, may be needed to prepare an adequate seedbed on very harsh sites or in areas with rocky soils (SCS 1978, Vogel 1981).

Soil amendments. Range sites to be seeded with Maximilian sunflower should be tested for soil fertility and physical characteristics. If required, lime and phosphates should be disked or plowed into surface soils as part of the seedbed preparation. Nitrogen should not be applied until sunflower is growing vigorously and outcompeting associated vegetation. Legumes can take the place of chemical fertilizers if planted in conjunction with sunflower seed. A green manure crop or other mulch may be required for stabilization on steep slopes and erosive or southerly sites. Hydromulching has been especially effective on roadsides and mine spoils (Merkel and Herbel 1973, SCS 1973, Vogel 1981).

Propagule Selection

Cultivars. Two cultivars of Maximilian sunflower ('Prairie Gold' and 'Aztec') are adaptable to much of the mid-continental prairies. 'Aztec' adapts well to the southern three-fourths of Oklahoma and to all but the western one-third of Texas. 'Prairie Gold' was developed for more northern sites, especially those receiving 14 in. (36 cm) or more of precipitation in northern Oklahoma, eastern Colorado, Kansas, Nebraska, and southern South Dakota (SCS 1973, 1978; SCS and Texas Agricultural Experiment Station 1978; Thornburg 1982).

Seed selection. Maximilian sunflower is readily established from seed and develops to maturity in one growing season under normal growing conditions. Seed production has averaged 72 lb/acre (80.1 kg/ha) at Knox City, Texas. From 1970 through 1976, test results ranged from 41 to 180 lb/acre (46 to 201.2 kg/ha) (SCS 1978). Germination and purity tests have shown that 'Aztec' seed quality may range from 85% to 98% purity, 60% to 78% germination, and 51% to 76% pure live seed (PLS) (SCS 1978). To be certified, however,

Maximilian sunflower seed must test at least 90% purity, 60% germination, and 54% PLS (Kansas Crop Improvement Association 1976).

Certified seed is available for two cultivars: 'Prairie Gold' from the Manhattan, Kansas, Plant Materials Center, and 'Aztec' from the Knox City, Texas, Plant Materials Center. The 'Aztec' seed originated from bulked seed with similar characteristics from 5 counties in Texas. Test data indicated that 'Aztec' was as good as or better than other native sunflower collections compared for stand production, vigor, and seed production at the Knox City and Manhattan Plant Materials Centers. It bloomed later but grew taller than most sunflowers observed at the Manhattan Center (SCS 1973, 1978). There are 150,000 to 300,000 seeds per pound (Swingle 1939). One thousand seeds weigh 2.23 g, and there are about 2,600 seeds per 4 stems (Stevens 1932). At a seeding rate of 1 lb/acre there would be 3.5 seeds/sq ft. Seed production can be increased by stem or stalk reduction (SCS 1978).

Maximilian sunflower seeds tested by Browning et al. (1981) had low moisture content, high crude fat, and low crude fiber. Seed characteristics of plants obtained from the SCS Plant Materials Center in Manhattan, Kansas, were: seeds/g = 580; energy/seed = 11.9 cal; energy/g = 6925 cal; moisture = 4.6%; crude protein = 42.1%; crude fat = 40.7%; and crude fiber = 2.3% (SCS 1973, Kansas Crop Improvement Association 1976).

Germination and vigor. Seeds usually germinate in 1 to 2 weeks, but about 50% may remain dormant (Wasser 1982). Seedling vigor was rated good to excellent based on many field plantings throughout Texas, Oklahoma, Kansas, and Nebraska (SCS 1978). Because of its aggressiveness, Maximilian sunflower seed should be greatly reduced in most seed mixtures to avoid outcompeting other desirable warm-season forbs and grasses. In tests conducted in Nebraska and Kansas, this sunflower outcompeted 12 perennial warm- and cool-season grass species (Salac et al. 1978).

Cumulative germination of Maximilian sunflower seed is affected by a combination of water availability and night/day temperatures. Germination was inhibited by moderate to severe water stress when night/day temperature varied from 50/68° F to 68/86° F (10/20° to 20/30° C), respectively. At these temperatures, germination averaged at or above 60% when little or light water stress was applied to the test seeds. These laboratory results apply to field plantings where seed germination is inhibited by a combination of dry soils and extremes in day/night temperatures (Owens and Call 1985).

Planting Methods

Time of planting. Maximilian sunflower should be planted when soil temperature and moisture conditions are favorable for germination and early growth. January through March are preferred months in Texas, while May is recommended for the central Great Plains (SCS 1973, 1978; Wasser 1982). Prairie restoration is usually done in late spring, or after late moisture is received (Rock 1981); in the central Great Plains, seeds may be planted in the fall when soil moisture extends several feet deep (SCS 1973).

Seeding. Seeds of this sunflower are usually drilled rather than broadcast, especially on large tracts of land. Drills and seeders effective on prepared range sites include rangeland drills, Nisbet grass drills, sod or no-till drills, and cultipacker seeders. Drills that can handle chaffy grass seed can easily handle sunflower seed. Seeds are normally planted 1/4 in. to 1 in. deep, depending upon soil moisture conditions. To create strips or patches for wildlife, seeds can be added or withheld at appropriate times or added to only 1/2 of the planting mix in a divided seedbox (Wasser 1982).

Broadcasting sunflower seeds requires that some form of soil covering be provided after seeding. Harrowing with spikes set flat, light disking, or dragging with chain or brush may provide the proper soil covering. Because of the aggressiveness of Maximilian sunflower, it should be planted conservatively at 0.25 to 0.50 lb/acre (0.3 to 0.6 kg/ha) when mixed with other plant species. For pure stands a seeding rate of 1 to 3 lb/acre (1.1 to 3.4 kg/ha) is suggested for disturbed sites; however, this rate may be as high as 6 lb/acre (6.7 kg/ha) on critical or harsh sites. Less competitive warm-season grasses require less competition from the aggressive sunflower; therefore, crisscross seeding patterns or alternate row plantings provide relief (SCS 1973, Texas Agricultural Experiment Station 1979, Vogel 1981, Wasser 1982).

Transplanting. Vegetative propagules of Maximilian sunflower can be transplanted successfully. Pieces of rhizomes and fleshy roots are generally used for transplanting. However, crown transplants were found to be more effective than direct seeding in a study conducted on abandoned cropland in the Post Oak Savannah of Texas; the crown transplants performed well because of their high levels of carbohydrate reserves (Owens and Call 1985). Although transplanting may be useful on special sites such as gardens, most plantings of this perennial sunflower are done with seed drills (Thornburg 1982, Wasser 1982) because the ease of drilling offsets any differences in survival rates.

Planting mixtures. Site restoration in prairie regions is often designed to replicate the original tall-grass species composition. Excellent stands can be produced from seed mixtures of big and little bluestem, yellow Indiangrass, switchgrass, and occasionally sideoats grama, with sunflowers added as a forb component. However, when mixed with shorter growing warm-season grasses, competition from Maximilian sunflower may be too severe. In this case, the sunflower seed should be planted at low rates in alternate rows or in patches (Salac et al. 1978, Wasser 1982).

MAINTENANCE

Weed control is best accomplished by mowing or burning in sunflower stands because chemical herbicides are destructive to this forb. Carefully planned grazing schedules can also play an important part in weed control and, when coupled with other management practices, can eliminate the need for herbicides (Joselyn and Tate 1972, Launchbaugh and Owensby 1978).

Mowing

Mowing for weed control in early summer is commonly recommended for maintaining stands of Maximilian sunflower. Mowing height should be adjusted to cut just above the tips of growing seedlings. Mowing during this early bud stage may increase the abundance of flowers and length of the flowering period (Salac et al. 1978). Gernes et al. (1987) reported that a reduction of stalk density will also increase second-year yield and growth in this species. Mowing will prevent the excessive buildup of litter that suppresses stand vigor and growth and presents a fire hazard. In landscape plantings it may be necessary to mow once or twice around buildings where burning would be unsafe; physiological injury is lessened if this is done after sunflowers reach maturity. This can also promote regrowth and late flowering, especially during wet years (Salac et al. 1978). Wildlife must be considered when mowing to prevent destruction of nests or young birds (Joselyn and Tate 1972).

Grazing

No safe levels of grazing intensity have been documented, as this species is quite sensitive and easily eliminated under heavy grazing pressure. Presence of Maximilian sunflower on range sites is an indication of good to excellent range condition (Johnson and Nichols 1970). Grazing should be delayed until sunflowers are in the early bud stage, unless a management objective is to exert pressure on this aggressive species to benefit less

competitive plants. Adjusting the kinds and numbers of livestock can influence the composition of grasses and forbs even to the point of curbing sunflower dominance. Grazing by horses tends to favor sunflowers and other forbs since grasses comprise the bulk of the equine diet. The opposite is true when sheep or goats are grazed because they favor a diet of forbs and shrubs over grass species (Johnson and Nichols 1970, Salac et al. 1978).

Burning

Maximilian sunflower can be burned in the dormant state if there is no visible leaf development. Burning after growth starts will reduce vigor and production. However, burning under proper site conditions will remove litter and not damage sunflower rhizomes. Burning offers a form of suppression when this species outcompetes associate grass species. As with mowing, burning must be delayed until nesting birds are fledged and sufficiently mobile to escape the fire. Following a cool burn, succulent young plants will sprout, thus enhancing wildlife food supplies.

Fertilization

Weed control programs may also be combined with fertilizer applications to enhance sunflower stand vigor and productivity. In the subhumid to humid prairie regions, fertilization of mowed areas with 40 lb nitrogen/acre (44.8 kg/ha) will help maintain sunflower stands (Launchbaugh and Owensby 1978). Caution should be used in applying nitrogen to newly seeded sites to prevent excessive vegetative competition to the newly emerged sunflower seedlings.

CAUTIONS AND LIMITATIONS

Competition

Natural resource managers, horticulturalists, and landscapers who plan to establish Maximilian sunflower stands are cautioned that this is a very aggressive species and that care should be taken to prevent undesired spread or takeover of less competitive species. Planting this sunflower at a rate of 0.25 to 0.50 lb/acre (0.3 to 0.6 kg/ha) and mixing with competitive tall grass species is recommended to avoid or lessen plant competition (Wasser 1982). Managers should be prepared to use available control techniques (including grazing, mowing, burning, or the application of herbicides) to limit the spread of Maximilian sunflower or to maintain it at about 5% to 10% of the total vegetative composition. Caution should be taken so that wildlife

species are not harmed by control programs, especially during the nesting period of ground-nesting birds (Joselyn and Tate 1972).

Sunflowers have been reported to produce toxic concentrations of nitrates that could be harmful to grazing animals, especially sheep and cattle (Kingsbury 1964). There have been reports of sunflower species producing allelopathic chemicals that inhibit germination and growth of associated plant species and can even inhibit the following years' sunflower crop when turned into the ground after harvest. Managers who plant or manipulate Maximilian sunflower should apply skill and flexibility to the management of this species when designing programs that fit the conditions of the range site and meet the operational objectives for livestock, wildlife, and landscaping (Shiflet and Heady 1971, Launchbaugh and Owensby 1978).

Animal Damage

Deer have been known to severely damage and even eliminate complete plantings of Maximilian sunflower on Texas ranges (SCS 1978). Some birds, especially blackbirds, are very damaging to sunflowers in general, but the major problem is with predation on commercial crops of oil-seed varieties. Male blackbirds are more destructive than females because they have larger bills and feed directly on seed heads, whereas females feed more frequently on the ground (Linz et al. 1984). Various control methods can be used if blackbird predation on sunflower seed becomes a serious problem. One method is to plant more bird-resistant varieties such as those producing purple hulls, which retain the seed tightly and contain the toxin anthocyanin. Other methods include chemical frightening devices, decoy crops, repellents such as methiocarb, and toxic avicides such as Avitrol (Fox and Linz 1983, Besser et al. 1984, Guarino 1984, Linz et al. 1984, Cummings et al. 1986).

Insects and Diseases

Sunflowers in general are highly attractive to a variety of insects (Beckham and Tippins 1972). According to Dr. Gary Brewer (Department of Entomology, North Dakota State University), the most serious insect pest to Maximilian sunflower throughout its range is the sunflower moth (*Homeosoma electellum*); other pests common to sunflowers in the Great Plains are the red sunflower seed weevil (*Smicronyx fulvus*), banded sunflower moth (*Cochylis hospes*), sunflower beetle (*Zygrommana exclamationis*), sunflower midge (*Contarinia schulzi*), and stem weevil (*Cylindrocopturus adspersus*). The stem weevil is also a serious pest to commercial sunflower plantings (Charlet

1983). Sunflower bud moths (*Suleima helianthana*) have been found on Maximilian sunflower in several Texas plantings (Rogers 1977, 1979). The carrot beetle (*Bothynus gibbosus*) is a very serious pest on sunflower varieties grown in the Texas High Plains. This insect destroyed several Maximilian sunflower plants at the Texas Plant Materials Center at Knox City; however, many of the plants sprouted adventitious roots above the injury level and survived (Rogers and Howell 1973).

Insecticide tests with 11 chemical formulations applied to sunflower varieties grown in the Texas High Plains failed to protect the plants from severe damage from the carrot beetle (Bottrell et al. 1973). However, Burkhardt (1957) reported that both dieldrin and heptachlor provided economic control of this beetle in Kansas. Extensive use of insecticides is not recommended for sunflower plantings developed for wildlife management because of potential toxicity to animals and/or their food supplies.

Recent studies in the United States and Canada confirm Soviet reports of disease resistance in wild sunflowers. Thus, wild sunflower species offer a vast reservoir of disease-resistant genotypes for improving cultivated varieties. Wild species, including Maximilian sunflower, have provided the key to efficient production of vigorous hybrids (Fick 1978). Maximilian sunflower is one of a number of wild species resistant to the major insect pests of cultivated annual sunflowers. Major terpenoids produced by wild species of sunflowers are sesquiterpene lactones, which are being tested on the sunflower moth. Maximilian sunflowers from south-central Texas were found to have a completely different sesquiterpene lactone chemistry than those from collections farther north in Texas and Kansas (Gershenzon and Mabry 1984). Young larvae of the sunflower moth were especially damaged by sesquiterpene lactone production by Maximilian sunflower (Rossiter et al. 1986).

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APPENDIX A

WILDLIFE SPECIES KNOWN TO USE SUNFLOWERS AS FOOD OR COVER*

Common Name	Scientific Name
Game Birds	
Wild turkey	*Meleagris gallopavo*
Sharp-tailed grouse	*Tympanuchus phasianellus*
Greater prairie chicken	*T. cupido*
Scaled quail	*Callipepla squamata*
Gambel's quail	*C. gambelii*
Montezuma quail	*Cyrtonyx montezumae*
Northern bobwhite	*Colinus virginianus*
Ring-necked pheasant	*Phasianus colchicus*
Gray partridge	*Perdix perdix*
Mourning dove	*Zenaida macroura*
White-winged dove	*Z. asiatica*
Common snipe	*Gallinago gallinago*
Songbirds	
Tufted titmouse	*Parus bicolor*
Black-capped chickadee	*P. atricapillus*
Carolina chickadee	*P. carolinensis*
Boreal chickadee	*P. hudsonicus*
White-breasted nuthatch	*Sitta carolinensis*
Red-breasted nuthatch	*S. canadensis*
Brown-headed nuthatch	*S. pusilla*
American crow	*Corvus brachyrhynchos*
Chihuahuan raven	*C. cryptoleucus*
Blue jay	*Cyanocitta cristata*
Scrub jay	*Aphelocoma coerulescens*
Red-bellied woodpecker	*Melanerpes carolinus*
Hairy woodpecker	*Picoides villosus*
Downy woodpecker	*P. pubescens*
Horned lark	*Eremophila alpestris*
European starling	*Sturnus vulgaris*
House sparrow	*Passer domesticus*
Bobolink	*Dolichonyx oryzivorus*
Eastern meadowlark	*Sturnella magna*
Western meadowlark	*S. neglecta*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
Red-winged blackbird	*Agelaius phoenicus*
Brewer's blackbird	*Euphagus cyanocephalus*
Common grackle	*Quiscalus quiscula*
Brown-headed cowbird	*Molothrus ater*
Northern cardinal	*Cardinalis cardinalis*
Pyrrhuloxia	*C. sinuatus*

(Continued)

* Reported for all species of sunflowers combined.
Major sources: Martin et al. 1951; Davison 1967; SCS 1978.

Common Name	Scientific Name
Songbirds (Continued)	
Rose-breasted grosbeak	*Pheucticus ludovicianus*
Black-headed grosbeak	*P. melanocephalus*
Evening grosbeak	*Coccothraustes vespertinus*
Blue grosbeak	*Guiraca caerulea*
Lazuli bunting	*Passerina amoena*
Purple finch	*Carpodacus cassinii*
House finch	*C. mexicanus*
Pine siskin	*Carduelis pinus*
American goldfinch	*C. tristis*
Lesser goldfinch	*C. psaltria*
Lawrence's goldfinch	*C. lawrencei*
White-winged crossbill	*Loxia leucoptera*
Rufous-sided towhee	*Pipilo crythropthalmus*
Dark-eyed junco	*Junco hyemalis*
Savannah sparrow	*Passerculus sandwichensis*
Grasshopper sparrow	*Ammodramus savannarum*
Lark bunting	*Calamospiza melanocorys*
Vesper sparrow	*Pooecetes gramineus*
Lark sparrow	*Chondestes grammacus*
American tree sparrow	*Spizella arborea*
Field sparrow	*S. pusilla*
Harris' sparrow	*Zonotrichia querula*
White-crowned sparrow	*Z. leucophrys*
White-throated sparrow	*Z. albicollis*
Lincoln's sparrow	*Melospiza lincolnii*
Song sparrow	*M. melodia*
McCown's longspur	*Calcarius mccownii*
Chestnut-collared tongspur	*C. ornatus*
Big Game Mammals	
Pronghorn	*Antilocapra americana*
Mule deer	*Odocoileus hemionus*
White-tailed deer	*O. virginianus*
Moose	*Alces alces*
Nongame Mammals	
Cottontails (primarily cover)	*Sylvilagus* spp.
Least chipmunk	*Eutamias minimus*
Richardson's ground squirrel	*Spermophilus richardsonii*
Thirteen-lined ground squirrel	*S. tridecemlineatus*
Black-tailed prairie dog	*Cynomys ludovicianus*
Plains pocket gopher	*Geomys bursarius*
Pocket mice	*Perognathus* spp.
Kangaroo rats	*Dipodomys* spp.
White-footed mouse	*Peromyscus leucopus*
Deer mouse	*P. maniculatus*

(Continued)

Common Name	Scientific Name
Nongame Mammals (Continued)	
Meadow vole	*Microtus pennsylvanicus*
Muskrat (stems and foliage)	*Ondatra zibethicus*
Southern bog lemming	*Synaptomys cooperi*
House mouse	*Mus musculus*