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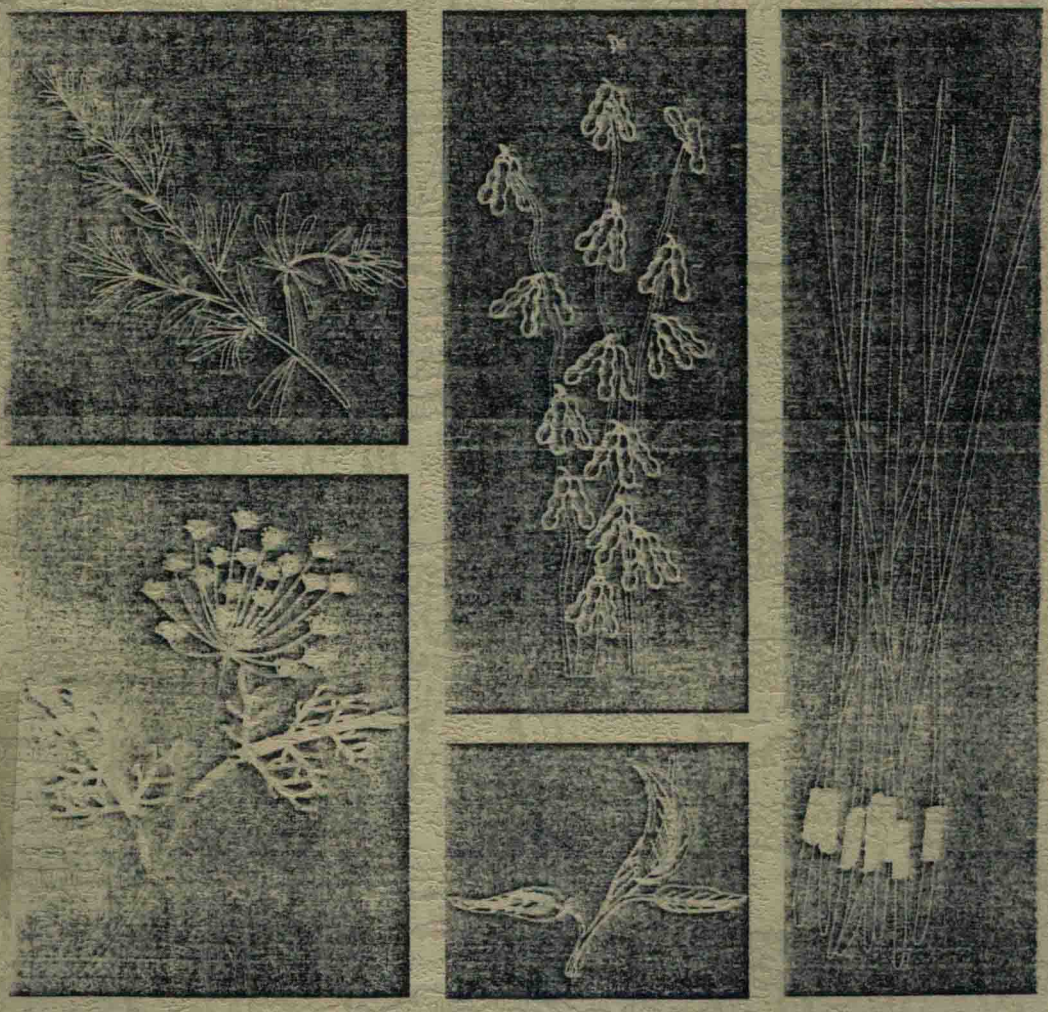
MEDICINAL PLANTS

(2)

Culture, Utilization and Phytopharmacology



CHAPTER 5

Cultivation and Harvesting

In the past, medicinal plants were collected from the wild in sufficient quantities to meet the market demand. Over the years, some popular species became scarce and endangered. To meet future increasing demand, medicinal plants must be cultivated. In addition to ensuring a sufficient supply, cultivation of medicinal plants permits production of uniform quality raw materials of known identity and properties.

Growing medicinal plants commercially requires consideration of soil and environmental requirements, reliability of seed sources, horticultural techniques, harvesting, and costs of production Most of the active ingredients in medicinal herbs are secondary metabolites such as alkaloids, and their biosynthesis is genetically controlled. However, environmental conditions play an important role in plant growth and in the formation and quantity of the secondary metabolites. Because most alkaloids are formed in young, actively growing tissues, factors that influence plant growth can also influence the production of the secondary metabolites. Environmental factors such as temperature, light intensity and photoperiod, soil fertility, and water supply determine the suitable growing area and life form of medicinal plants, and also have a substantial effect on production. Cultural practices, such as plant propagation, sowing dates, irrigation and fertilization, improving drainage, herbicides and pesticides, and postharvest treatments, also have a great impact on the final biomass and phytochemical yields of medicinal plants.

The cultivation of medicinal plants is a recent and relatively new horticultural practice. The requirements for growing them vary widely. Some medicinal plants have specific environmental requirements, such as shade, winter temperature, and chilling requirements. The best method of understanding how to cultivate a plant is to grow the plant in soil and conditions resembling as closely as possible their natural habitat. It is not easy to determine the environmental factors responsible for changes in the level of active ingredients; however, it is important to determine which part or parts of the plant contain the active ingredient and how a certain environmental factor may influence these parts during production. Medicinal

plants are more heterogeneous genetically than vegetable plants and fruit trees in their botanical and physiological properties. Similar to ornamental plants, medicinal plants include annual, biennial, and perennial species with herbaceous or woody stalks, shrub or tree forms with or without fruit.

One of the most important procedures in the cultivation of medicinal plants is harvesting. The complexity of the operation depends on which part or parts (because the kind and level of active ingredients are different in various parts) of the plant are going to be harvested, such as flowers, leaves, bark, stems, rhizomes, roots, or seeds. Thus, the mechanization of harvesting is difficult. Furthermore, medicinal plants usually must be harvested over a very short optimal time period, because losses of active ingredients will result over a longer period, with consequent losses in value. Therefore, most medicinal plants can only be harvested with a high amount of labor.

The time of collection of medicinal plants is most important, because the composition of the plant and the level of active ingredient vary at different times of the year. Roots and rhizomes of biennial and perennial plants should be dug in the autumn of the first year, and in the autumn of the second year or after, respectively. Bark should be collected in spring when the sap begins to flow, but the process may be performed at any time during the winter. Healthy green leaves are collected in the early spring when the plant is in bloom. Where the whole green plant or herb is used, only the younger branches, flowers, and leaves should be harvested. Flowers are collected just after they open and before they begin to wither. Fruits and seeds are picked when mature with few exceptions.

Table 5. Origin of medicinal plants and their life cycle, plant form, propagation and growing site and planting space.

Scientific name	Common name	Origin[a]	Life cycle[b]	Plant form[c]	Culti-vated	Growing site[d]	Propagation	Planting space
Abies balsamea (L.) Mill.	Balsam fir	Te	P	W (T)	No	S or Sh	Seeds	15 m
Achillea millefolium L.	Yarrow	Te	P	H	Yes	FS	Division, seeds	30 cm
Aconitum napellus L.	Monkshood	Te	P	H	No	Sh	Division, seeds	40 cm
Acorus calamus L. var. Americanus Wolff. *A. tatarinowii* L.	Calamus, sweet flag Shi Chang Pu	Tr	P	H	Yes	S	Division	30 cm
Actaea alba L. *A. rubra* (Ait.) Willd.	Baneberry Red baneberry	Te	P	W (S)	No	S	Seeds, division	5-10 m
Aesculus hippocastanum L.	Horse chestnut	Te	P	W (T)	Yes	S or PSh	Seeds, grafting	5-8 m
Agastache foeniculum L.	Aniseed	Te	P	W (S)	Yes	S	Seeds, cutting, division	50 cm
Agrimonia eupatoria L.	Agrimony	Te	P	H	No	S	Division, seeds	30 cm
Agropyron repens (L.) Beauvois	Couch grass	Te	P	H	No	S or PSh	Seeds, rhizome cuttings	3-5 cm
Alchemilla vulgaris L. *A. xanthochlora* Rothm.	Lady's mantle	Te	A	H	No	S or SSh	Seeds, division	60 cm
Allium cepa L.	Onion	Te	A	H	Yes	FS	Seeds	20 cm

Scientific name	Common name	Origin[a]	Life cycle[b]	Plant form[c]	Culti-vated	Growing site[d]	Propagation	Planting space
A. sativum L.	Garlic	Te	A	H	Yes	FS	Cloves	15 cm
A. schoenoprasum L.	Chives	Te	A	H	Yes	FS	Seeds, bulb	15 cm
Alnus crispus (Ait.) Pursh. *A. incana* (L.) Moench. subsp. *tenufolia* *A. glutinosa* (L.) Gaertn.	Alder	Te	P	W (T)	No	S or PSh	Seeds	10 m
Aloe vera (L.) Burm. *A. barbadensis* L.	Aloe	Tr	P	H	Yes	S	Division	24 cm
Althaea officinalis L.	Marshmallow	Te	P	H	No	S	Seeds, division	30 cm

Amelanchier alnifolia Nutt.	Saskatoon	Te	P	W (S)	Yes	S	Seeds, suckers	3-5 m
Ananas comosus (L.) Merr.	Pineapple	Tr	P	H	Yes	FS	Seeds, offsets	1 m
Anaphalis margaritacea (L.) Bench & Hook	Everlastings	Te	P	H	No	S	Seeds	2-4 m
Anethum graveolens L.	Dill	Te	A	H	Yes	S	Seeds	20 cm
Angelica archangelica L. *A. sinensis* (Oliv.) Diels	Angelica Dong quai	Te	P	H	Yes	S or PSh	Seeds, division	1 m
Antennaria magellanica Schultz	Everlastings	See *Anaphalis margaritaceas*						
Anthemis nobilis L.	Chamomile	See *Chamaemelum nobile*						

Scientific name	Common name	Origin[a]	Life cycle[b]	Plant form[c]	Cultivated	Growing site[d]	Propagation	Planting space
Apium graveolens L.	Celery	Te	A	H	Yes	S or Psh	Seeds	30 cm
Aralia racemosa L. *A. nudicaulis* L.	Spikenard	Te	P	W (S)	No	PSh	Seeds	30 cm
Arctium lappa L.	Burdock	Te	B	W (S)	No	S or LSh	Seeds, division	1 m
Arctostaphylos uva-ursi (L.) Spreng	Bearberry, Uva-ursi	Te	P	W (S)	Yes	S or PSh	Seeds, layering, cutting, grafting	60 cm
Armoracia rusticana Gaerin, Mey & Scherb.	Horseradish	Te	P	H	Yes	S or PSh	Seeds, division	30 cm
Arnica latifolia Bong. *A. montana* L. *A. chamissonis* L. subsp. *foliosa* *A. condifolia* Hook *A. fulgens* Pursh *A. sororia* Greene	Arnica	Te	P	W (S)	Yes	S	Seeds, division	15 cm
Artemisia absinthium L.	Wormwood	Te	P	H	No	S	Division, seeds	60 cm
A. annua L.	Qing Hao	Te	A	H	No	S	Division, seeds	60 cm
A. dracunculus L.	Tarragon	Te	P	H	Yes	S	Seeds	45 cm
A. tridentata Nutt.	Sagebrush	Te	P	W (S)	No	FS	Division, seeds	1-3 m
A. vulgaris L.	Mugwort	Te	P	H	No	S	Division	1 m

Scientific name	Common name	Origin[a]	Life cycle[b]	Plant form[c]	Culti-vated	Growing site[d]	Propagation	Planting space
Asarum canadensis L.	Wild ginger	Tr	P	H	No	Psh	Division	1 m
Astragalus americana Bunge. *A. membranaceus* Bunge. *A. sinensis* L.	Astragalus Huang Qi	Te	A P	H	No	S	Seeds, division	40 cm
Avena sativa L.	Oat	Te	A	H	Yes	S	Seeds	2-3 cm
Baptisia tinctora (L.) R.Br. Ex Ait.f.	Wild indigo	Te	P	H	No	S	Seeds, division	50 cm
Bellis perennis L.	Daisy	Te	A	H	No	S or PSh	Seeds	10 cm
Berberis aquifolium L.	Oregon grape	See *Mahonia aquifolium*						
Berberis vulgaris L.	Barberry	Te	P	W (S)	No	S	Seeds	1-2 m
Beta vulgaris L.	Beet root	Te	P	H	Yes	S	Seeds	15 cm
Betula lenta L.	Birch	Te	P	W (T)	No	S or Sh	Seeds	5-10 m
Borago officinalis L.	Borage	Te	A	H	No	FS	Seeds, cutting, division	60 cm
Boswellia sacra Roxb. ex. Colebr. *B. carteri* Birdwood	Frankincense	Te	P	H	No	FS	Seeds	1-3 m
Brassica nigra (L.) Kock.	Black mustard	Te	A	H	Yes	FS	Seed	30cm

Scientific name	Common name	Origin[a]	Life cycle[b]	Plant form[c]	Culti-vated	Growing site[d]	Propagation	Planting space
Buxus sempervirens L.	Boxwood	Te	P	W (S)	No	S or Sh	Cutting, suckers, seeds division, layering,	1-3 m
Calamintha nepeta (L.) Savi *C. ascendens* L. *C. officinalis* L.	Basil thyme Calamint Mountain mint	Te	P	H	Yes	S	Seeds	40 cm
Calendula officinalis L.	Calendula, Marigold	Te	A	H	Yes	FS	Seeds	50 cm
Camellia sinensis (L.) Kunize	Green tea	Tr	P	W (S)	Yes	S or PSh	Cutting, grafting	1-2 m
Cananga odorata (Lam.) J. D. Hook & T. Thompson	Ylang-Ylang	Tr	P	W (S)	No	S	Seeds	5-10 m
Cannabis sativa L.	Hemp	Te	A	H	Yes	S	Seeds	40 cm
Capsella bursa-pastoris (L.) Medik.	Shepherd's purse	Tr	A	H	No	S or PSh	Seeds	10 cm
Capsicum annuum L. var. Annuum. *C. annum* L. var. Grossum. *C. annum* L. var. Acuminatum.	Cayenne pepper Sweet pepper Chilli pepper	Tr	A	H	Yes	S	Seeds	30 cm

Scientific name	Common name	Origin[a]	Life cycle[b]	Plant form[c]	Cultivated	Growing site[d]	Propagation	Planting space
Carbenia benedicta L.	Blessed thistle	See *Cnicus benedictus*						
Carduus benedita L.	Blessed thistle	See *Cnicus benedictus*						
Carica papaya L.	Papaya	Tr	P	W (T)	Yes	S	Seeds, cutting, grafting	3-5 m
Carthamus tinctorius L.	Safflower	Tr	A	H	No	FS	Seeds	50 cm
Carum caroi L.	Caraway	Te	B	H	Yes	FS	Seeds	40 cm
Cassia senns L. *C. angustifolia* Vahl.	Alexandria senna Tinnevelly senna	Tr	P	H	Yes	S	Seeds, division	30 cm
Castanea sativa Mill	Chestnut	Te	P	W (T)	Yes	S	Budding, grafting	10-15 m
Catharanthus roseus (L.) G. Don	Periwinkle	See *Vinca minor*						
Caulophyllum thalietroides (L.) Michx. *C. giganteum* (F.) Loconte & W. H. Blackwell	Blue cohosh	Te	P	W (S)	No	Sh	Seeds	1-2 m
Cedrus libani A. Rich subsp. *atlantica*	Cedarwood	Te	P	W (T)	No	S	Seeds	10 cm
Centaurea calcitrapa L.	Star thistle	Te	P	H	Yes	S	Seeds	25 cm

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Centella asiatica (L.) Urb.	Gotu Kola	Tr	P	H	No	S, Sh	Seeds	1-2 m
Chamaelirium luteum (L.) A. Gray	False unicorn root	Te	P	H	No	PSh	Seeds, division	50 cm
Chamaemelum nobile (L.) All.	Roman chamomile	Te	P	W (S)	Yes	FS	Seeds, division	30 cm
Chamaenerion angustifolium (L.) Scop.	Firewood	See *Epilobium angustifolium*						
Chenopodium album L.	Lamb's quarter	Tr.	A	H	Yes	S or Sh	Seeds	30 cm
C. ambrosioides L.	Wormseed	Tr	A	H	No	S or Sh	Seeds	30 cm
Chrysanthemum cinerarifolium (Trevir) Vis.	Pyrethrum	Te	P	H	No	S	Seeds, division	40 cm
C. parthenium (L.) Berhn.	Feverfew	Te	P	H	Yes	S	Seeds, division	30 cm
C. vulgare L.	Tansy	See *Tanacetum vulgare*						
Cichorium intybus L.	Chicory	Te	P	H	Yes	S	Seeds	45 cm
Cimicifuga racemosa (L.) Nutt.	Black cohosh	Te	P	H	Yes	PSh	Seeds	60 cm
Cinnamomum verum J. Pres. *C. cassia* (Nees) Nees & Eber	Cinnamon Camphor	Tr	P	W (S)	Yes	S or Psh	Seeds, cutting, root cutting, suckers	2-3 m

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Citrus limon (L.) Burm. *C. bergamia* Risso & Poit *C. reticulata* Blanco *C. aurantifolia* Swingle *C. aurantium* L. *C. paradisi* Macfad	Lemon Bergamot orange Mandarin Lime Bitter orange Grapefuit	Tr	P	W (T)	Yes	S	Grafting	2-5 m
Cnicus benedictus L.	Blessed thistle	Te	A	H	No	S	Seeds, division	50 cm
Cochlearia amorucia L.	Horseradish	See *Armoracia rusticana*						
Codonopsis pilosula (Franch) Nannfeldt. *C. tangshen* Oliver	Codonopsis, dang shen Bellflower	Te	P	H (V)	No	SSh	Seeds	1-2 m
Coffea arabica L.	Coffee	Tr	P	W (S)	Yes	SSh	Cutting, seeds	1-2 m
Colchicum autumnale L.	Crocus, Meadow saffron	Tr	P	H	No	S or SSh	Division, seeds	30 cm
Collinsonia canadensis L.	Pilewort	Te	P	H	No	PSh	Seeds, division	50 cm
Commiphoe molmol Engl. ex Tschirch *C. myrrha* (Nees) Engl.	Myrrh	Te	P	W (T)	No	S	Cuttings, seeds	1 m
Convallaria majalis L.	Lily of the valley	Te	P	H	No	S	Division, seeds	15 cm
Convolvulus arvensis L. *C. sepium* L.	Bindweed	Te	A	H	No	S	Seeds, cutting	1 m

Scientific name	Common name	Origin[a]	Life cycle[b]	Plant form[c]	Cultivated	Growing site[d]	Propagation	Planting space
Coriandrum sativum L.	Coriander, Cilantro	Te	A	H	Yes	S	Seeds	30 cm
Cornus canadensis L.	Bunchberry	Te	P	W (S)	No	S or SSh	Cutting, layering, budding, grafting	8-10 m
C. florida L.	Dogwood	Te	P	W (T)	No	S	Seeds, cutting	8-10 m
Corylus cornuta Marsh. *C. rostrata* Marsh. *C. avellana* L.	Hazelnut	Te	P	W (T)	Yes	S	Seeds	15 cm
Crataegus monogyna Jacq. *C. pinnatifida* Bge.	English hawthorn Chinese hawthorn	Te	P	W (T)	No	S or PSh	Seeds, budding, grafting on *C. oxyacanthoides* or other species	5 m
Crocus sativus L.	Saffron	Tr	P	H	No	FS	Seeds	10 cm
Cryptotaenia japonica Hassk.	Japanese parsley, Mitsuba	See *Petroselinum crispum*						
Cucurbita pepo L.	Pumpkin	Te	A	H	Yes	S	Seeds	3-4 m
Cuminum cyminum L.	Cumin	Tr	A	H	No	FS	Seeds	15 cm
Curcuma domestica L. *C. xanthorrhiza* L. *C. longa* L.	Curcuma, Jiang Huang	Tr	P	H	Yes	S	Division	2-6 m

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Cuscuta epithymum Murr.	Dodder	Te	P	H	No	S	Seeds, cutting	2-4 m
Cymbopogon citratus (DC. ex Nees) Stapf. *C. nardus* L. *C. winterlanus* Jowitt *C. martinii* (Roxb) Wats	Lemon grass Citronella Palmarosa, gingergrass	Tr	P	W (S)	Yes	S	Seeds, division	1 m
Cynara scolymus L. *C. cardunculus* L.	Artichoke Wild artichoke	Te	A	H	Yes	S	Seeds	1 m
Cypripedium calceolus L.	Lady's slipper	Te	A	H	No	Sh	Seeds	40 cm
Cytisus scoparius (L.) Link.	Broom	Te	P	W (S)	No	S	Seeds, division	75 cm
Daucus carota L.	Carrot	Te	A	H	Yes	S or PSh	Seeds	15 cm
Digitalis purpurea L.	Foxglove	Te	B	H	No	PSh	Seeds	50 cm
Dioscorea oppositae Thunb. *D. villosa* L.	Chinese yam, ShenYao Wild or Mexican yam	Tr	P	H	Yes	S or PSh	Seeds, cuttings	2 m
Echinacea angustifolia DC. *E. pallida* (Nutt.) Nutt. *E. pururea* (L.) Moench.	Narrowleaf echinacea Pale-flower echinacea Purple coneflower	Te	P	H	Yes	S	Seeds, division	30 cm

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Echinopanax horridus (Sm.) Decne. & Planch. ex. H. A. T. Harms	Devil's club	See *Oplopanax horridus*						
Elaeagnus angustifolia L.	Russian olive	Te	P	W (S)	No	S	Seeds	2-4 m
Eleutherococcus senticosus (Rupr. ex Maxim) Maxim.	Siberian ginseng	Te	P	W (S)	Yes	S or PSh	Seeds, cuttings	25 cm
Elymus repens L.	Couch grass	See *Agropyron repens*						
Ephedra distachya L. *E. nevadensis* Wats. *E. sinica* Stapf.	Ephedra Mormon tea Ma Huang	Te	P	H	No	S	Seeds, division, suckers, layering	75 cm
Epilobium angustifolium L.	Fireweed	Te	P	H	Yes	S	Seeds, division	50 cm
Epilobium parviflorum Schreb.	Small-flowered willow herb	Te	P	H	Yes	S	Seeds, division	50 cm
Equisetum arvense L. *E. telmateia* Ehrh.	Horsetail	Te	P	H	No	S or PSh	Division, seeds	1 m
Erythroxylum coca Lam.	Coca	Tr.	P	W (S)	Yes	S	Seeds	2 m
Eschscholtzia californica Cham.	California poppy	Te	A	H	Yes	FS	Seeds	30 cm
Eucalyptus citriodora Hool. *E. globulus* Labill.	Gum tree Eucalyptus	Tr	P	W (T)	No	S	Seeds	1.5 m

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Eugenia caryophyllata L.	Clove	See *Syzygium aromaticum*						
Eupatorium perfoliatum L.	Boneset	Te	P	W (S)	No	S or PSh	Seeds, sucker	90 cm
Euphrasia officinalis L.	Eyebright	Te	P	H	No	S	Seeds	20 cm
Fagopyrum tataricum L.	Buckwheat	Te	A	H	Yes	S	Seeds	4-8 cm
Fagus grandfolia Ehrh. *F. sylvatica* L.	Beech European beech	Te	P	W (T)	No	S or PSh	Seeds	5-10 m
Filipendula ulmaria (L.) Maxim.	Meadow sweet	Te	P	H	No	S or PSh	Seeds, division	30 cm
Foeniculum vulgare Mill.	Fennel	Te	B	H	Yes	FS	Seeds	50 cm
Forsythia suspensa (Thunb.) Vahl.	Forsythia, Lian qiao	Te	P	W (S)	No	S or PSh	Cuttings	2-4 m
Fragaria vesca L.	Strawberry	Te	A	H	Yes	S or PSh	Seeds, division	30 cm
Fraxinus americana L. *F. excelsior* L.	White ash	Te	P	W(T)	No	S	Seeds	3-5 m
Fucus vesiculosus L.	Kelp	Te	P	H	Yes	S	Seeds, cuttings	30 cm
Galium aparine L.	Cleavers	Te	P	H	Yes	Sh	Seeds, division	20 cm
Gaultheria procumbens L.	Wintergreen, teaberry	Te	P	W(S)	No	PSh	Seeds, layering, sucker, division, cutting	10 cm

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Geranium macrorhizum L.	Geranium, Am. cranesbill	Te	A	H	Yes	S or Psh	Seeds, cuttings	40 cm
Ginkgo biloba L.	Ginkgo	Te	P	W(T)	Yes	S	Seeds, cutting	2-4 m
Glechoma hederacea L.	Ground ivy	Te	P	H	No	S or Sh	Seeds, division	50 cm
Glycine max (L.) Merrill	Soybean	Tr	A	H	Yes	FS	Seeds	15 cm
Glycyrrhiza glabra L. *G. uralensis* Fisch ex DC	Licorice Chinese licorice	Te	P	W(S)	No	S	Seeds, division	40 cm
Gossypium hirsutum L.	Cotton	Tr	A	H	Yes	S	Seeds	1 m
Grindelia robusta Nutt. *G. squarrosa* (Pursh) Donal.	Gumweed	Te	P	H	No	S	Seeds, division	50 cm
Hamamelis virginiana L.	Witch hazel	Te	P	W(S)	Yes	S or PSh	Seeds	2-4 m
Harpagophytum procumbens DC.	Devil's claw	Tr	P	W(T)	Yes	S	Seeds	2-4 m
Hedeoma pulegiodes (L) Pers	Pennyroyal	Te	A	H	Yes	S or PSh	Seeds	10 cm
Hedera helix L.	English ivy	Te	P	W(V)	No	S or PSh	Cuttings	3-4 m
Helianthus annuus L.	Sunflower	Te	A	H	Yes	S	Seeds	40 cm
Helichrysum angustifolium (Lam.) DC.	Curry plant	Tr	A	H	Yes	S	Seeds	30 cm