# TECHNICAL NOTES

## U.S. DEPARTMENT OF AGRICULTURE
## SOIL CONSERVATION SERVICE
MICHIGAN

AGRONOMY #4a.
SUBJECT: Identification of Common Legumes
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The following information and pictures show prime characteristics in identification of common legumes from seedling to maturity:


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# LEGUMES CLASSIFIED ACCORDING TO PRACTICAL CONSIDERATIONS

SPECIALLY TOLERANT OF SOIL ACIDITY: cowpeas, alsike, vetches, crimson, clover.

MORE THAN AVERAGE TOLERANT OF DRY CONDITIONS: alfalfa, birdsfoot trefoil, sweet clover, mammoth red clover.

MORE THAN AVERAGE TOLERANT OF CONTINUOUSLY WET CONDITIONS: alsike clover.

MORE THAN AVERAGE TOLERANT OF MOIST OR MOIST ALTERNATING WITH WET CONDITIONS: ladino, common white clover, wild white clover, birdsfoot trefoil (after establishment).

MORE THAN AVERAGE TOLERANT OF EXTREMES - WET OR DRY: birdsfoot trefoil, mammoth red clover.

ESPECIALLY SLOW IN ESTABLISHMENT: birdsfoot trefoil, hop clovers.

ALMOST NEVER KILLED BY LOW TEMPERATURE: alsike clover.

ESPECIALLY SUSCEPTIBLE TO LOW TEMPERATURES: some common alfalfas, warm climate strains of red clover, some warm climate strains of common white clover, crimson clover.

ESPECIALLY SUSCEPTIBLE TO HEAVING INJURY: alfalfa, birdsfoot trefoil during first winter.

POSSESS MEANS OF MINIMIZING EFFECTS OF HEAVING INJURY: birdsfoot trefoil (once well rooted), alsike, common white clover, wild white clover, ladino, sweet clovers.

SPECIALLY RESPONSIVE TO HIGH FERTILITY: alfalfa, ladino, common white clover, wild white clover, medium red clover.

ESPECIALLY TOLERANT OF LOW FERTILITY LEVEL: cowpeas, hop clovers, mammoth red clover.

FOR SOIL BUILDING: practically no added advantage after the 1st hay year. However, except for big yield differences, up to that time generally perennials are better than biennials which are better than annuals. This order is, of course, changed if tops of one are plowed under in contrast to only stubble and roots of another.

LEAST LIKELY TO CAUSE BLOAT: birdsfoot trefoil.

MOST TOLERANT OF UNREGULATED CLOSE GRAZING: wild white clover.

SPREAD BY STOLONS: ladino, common white clover, wild white clover.

PERENNIALS: (live longer than 2 years) wild white clover, alfalfa, birdsfoot trefoil, ladino (alsike where wet continually) (some common white clovers where especially favorable).

PERENNIALS THAT PERFORM AS BIENNIALS: medium red clover, mammoth red clover, (alsike and common white clover on land that becomes dry).

TRUE BIENNIALS: (live 2 years) biennial white sweet clover, biennial yellow sweet clover.

WINTER ANNUALS: (fall-planted, die next summer) hop clovers, hairy vetch, (common vetch in mild climates) (crimson clover as managed in the South).

ANNUALS: (live 1 year) soybeans, cowpeas, velvet beans, field peas, common vetch, crimson clover grown in the North.

## SUGGESTIONS FOR THE USE OF THE ILLUSTRATIONS

To a person not familiar with cows all cattle of one breed may look alike. However the man who takes interest & pride in & milks them sees no two identical. Legumes are like that. Sometimes in a herd of Holsteins, with all breeding under absolute control, a red-and-white calf is born to black & white parents. One who knows the breed & some genetics does not pronounce the unusual colored specimen to be a hybrid. Off-type specimens occur in legumes too. In fact they are more common than in animals because insects contribute to cross-pollination involving unknown & unseen parentage. Thus originates variation, a boon to the plant breeder, but the bane of him who would classify or identify. Therefore in separating species & varieties which are not strikingly different it is important to examine large populations over several plant generations. This, the writer has done in his efforts to select the most common forms to sketch. He believes that the reader who works with populations of reasonable size will find that the drawings serve their intended purpose. Terms not made clear below & in the drawings are defined on the last page.

To identify seeds of legumes } Observe

- **Seed size** — Varies from 9/16" in longest dimension (velvet bean seed) to 3/64" in longest dimension (alsike, hop clovers & the 3 white clovers). See drawings in circles.
- **Seed weight** — Varies from as few as 227 in the case of to as many as 1,300,000 to the pound in low hop clover. (See printed pages opposite the drawings).
- **Seed shape** (See individual drawings)
  - NOTCH — Its depth & extent is determined by the position of the radicle within the seed-coat. Best shown in alfalfa.
  - BEAK — Caused by the protrusion of the tip end of the radicle. Most easily seen in yellow trefoil seeds.
  - GROOVE — A depression in the broad side of the seed extending laterally on the surface from the notch. Best illustrated in sweet clover.
  - HILUM — Represents the scar left when the seed breaks loose from the tiny stem-like funicle which, during development, connected ovule & ovary or legume. Varies between species (& varieties). Readily seen in cowpeas.
  - MICROPYLE — Is the healed over aperture in the "coats" of the ovule thru which the pollen tube grew. The scar which remains on the seed coat is most readily seen on peas.
  - KIDNEY-SHAPED - as in red & sweet clover & alfalfa.
  - HEART-SHAPED - as in ladino, other white clovers & alsike.
  - NEAR-ROUND - as in hairy vetch & some pea varieties.
  - FLAT-ROUND - as in some soybean varieties.
  - FLAT-OVAL - as in crimson clover & some soybean varieties.
  - ROUNDED-ANGULAR - as in some cowpeas & some velvet beans.
  - TWISTED - (in the narrow dimension) - as in alfalfa due to the spiral shaped legume in which the seed is borne.
- **Seed coat color**
  - SPECIES — May be separated thru the use of seed coat color. e.g. biennial white vs. biennial yellow sweet clover seeds.
  - VARIETIES — Are often separated on the basis of seed coat color as in soybeans, cowpeas & field peas. Some varieties include a range in color as in red clover & in alsike. Some seeds are mottled or parti-colored as common vetch & the "saddled" soybeans.
  - MATURITY — Sometimes causes confusion by introducing color variation. Example:- immature seeds in sweet clover & alfalfa may have a distinct greenish cast.
  - AGE — Alfalfa seed darkens & browns with age. Red clover seed, almost regardless of the original color of the individual seeds, ages to a dull reddish brown.

**To identify legumes when the plants are vegetative; i.e. beyond the seedling stage but not yet to the flowering stage.** — Observe:

**Arrangement or organization of leaflets in the leaves.**

- PINNATELY TRIFOLIOLATE (central-terminal leaflet borne on a conspicuous petiolule):- see alfalfa, soybeans, cowpeas, sw. clover.
- PALMATELY TRIFOLIOLATE (no distinct petiolule bearing the central-terminal leaflet):- see alsike, red, white clovers
- EVEN PINNATE - NO TENDRILS (leaflets more or less paired on opposite sides of petiole)-
- EVEN PINNATE - WITH TENDRILS (leaflets more or less paired on opposite sides of petiole which terminates in tendrils)- C. F. Pea.
- ODD PINNATE (2 pairs of lateral leaflets & a terminal one):- see birdsfoot trefoil.

**Shapes of leaflets**

- ELLIPTIC-LANCEOLATE:- see hairy vetch.
- OVAL TO OVATE:- sweet clover.
- OVATE:- to ovate-lanceolate:- soybeans.
  - to ovate-obtuse or to ovate-acute
  - lanceolate to oblique-ovate:- velvet bean.
- OBOVATE:-
  - to ovate:- half to full-grown red and alsike clover.
  - to obovate-oblong:- alfalfa.
  - to obovate-cuneate, truncate:- common vetch.
  - to obcordate, truncate:- yellow trefoil.
- OBCORDATE:- young red & alsike clovers.
  - to obovate:- crimson clover.
  - to obovate or to oval:- the white clovers.
- RHOMBOID-OVATE TO OBLIQUE-OVATE:- cowpeas.

**Pubescence or hairyness of leaflets & petioles.**

- DISTINCTLY PUBESCENT:- over all:- as in red & crimson clovers, hairy vetch, soybeans.
- MODERATELY PUBESCENT:- especially on stems & petioles - yellow trefoil;
- NOT PUBESCENT:- or very finely so:- ladino, common & wild white clovers, alsike, sweet clover, alfalfa, birdsfoot trefoil, common vetch, cowpeas, field peas.
- UNDER SIDE OF LEAFLET VERY GLOSSY:- the 3 white clovers.

**Leaflet margins**

- CONSPICUOUSLY SERRATED:- thruout entire length - sweet clover, only in outer 1/3 to 1/2 - alfalfa.
- WEAKLY SERRATED:- as in alsike, ladino & other white clovers.
- NOT SERRATED:- no peculiarities about leaf tips - most legumes. often mucronate:- see yellow trefoil & common vetch.

**Leaflet marking**

- An inverted v-shaped so-called water-mark occurs not invariably but often on the red & white clovers.

**Some stipule variations.**

- TOOTHED & LOBED:- as in alfalfa.
- JOINED TO FORM A SHEATH:- see red & crimson clovers.
- LARGE & LEAF-LIKE:- field pea.
- TWO-PRONGED:- common & hairy vetch.
- BEARING A PURPLE SPOT:- common vetch.

**Stipels**

- Found on both petiole & petiolule of some species only. See soybeans, cowpeas, & velvet beans.

**Stolons**

- Are found on ladino, common white & wild white clovers.

To identify leguminous plants from their flowering & fruiting parts; i.e. when headed & in bloom or past bloom.

The reader may find it helpful to turn to the sketch of any character he cannot readily visualize.

Observe

- **Arrangement or organization of flowers in units**
  - RACEMES:- Long, loose, open - see hairy vetch.
  - Long, erect, symmetrical - as in sweet clover.
  - Short, head-like - as in alfalfa.
  - Loose, pendant - see velvet beans.
  - Small, axilary - as in common vetch
  - UMBELS:- see birdsfoot trefoil.
  - HEADS:- Loose, open - ladino, other white clovers & alsike.
  - Rounded, compact - medium & mammoth red clovers.
  - Inverted-cone-shaped - crimson clover.
- **Number of florets per unit**
  - RACEMES:- Bear from a low range of 1-to-3 as in common vetch to a high range of 10-to-96 in sweet clover.
  - UMBELS:- Bear 2-to-9 florets as in birdsfoot trefoil.
  - HEADS:- Range from 3-to-20 florets in least hop clover to 65-to-125 in crimson clover.
- **Petal shape variation**
  - STANDARD PETAL:- Taller than broad - as in most legumes.
  - Broader than tall - see cowpea & field pea.
  - Much shorter than other petals - velvet bean.
  - Longer than other petals - most legumes.
  - Apex laps forward with maturity - hop clovers.
  - WING PETALS:- Relatively long & narrow - as in alsike clover.
  - Relatively short & broad - cowpea & field pea.
  - KEEL PETAL:- Terminus blunt-round - as in the soybean.
  - Terminating in a conspicuous beak - birdsfoot.
- **Apetalous florets**
  - All species pictured have petals which normally emerge from the calyx, except the which bear some apetalous florets as well as some of the more common petaliferous form.
- **Petal colors**
  - ONE COLOR:- Biennial white sweet clover, & biennial yellow sweet clover, sickle alfalfa.
  - TWO COLORS:- Common alfalfa, red clovers, field pea & soybean varieties, birdsfoot.
  - SEVERAL COLORS: (or shades) - Variegated alfalfa, cowpeas, crimson clover, ladino, other white clovers & alsike.
- **Sepal shapes**
  - LONG & POINTED:- Smooth - as in hop clover.
  - Hairy - crimson clover
  - SOME UNITED:- 2 of the 5 joined - soybeans & velvet beans
  - UNEQUAL LENGTH:- Forward 1 longer - red clovers & cowpeas.
  - 2 short ones - hop clovers & hairy vetch.
- **Bracteoles**
  - Are conspicuous at the base of the calyx in both in many soybean varieties.
- **Legume shape**
  - CYLINDRICAL:- to flat-cylindrical, ends tapered:- Most legumes.
  - but much constricted between the seeds:-
  - SPIRAL:- Both common & variegated alfalfas.
  - SICKLE-SHAPED:- Sickle alfalfa.
- **Number of seeds in a legume (Some examples)**
  - 1 or usually 1:- red, sweet & crimson clovers.
  - 1 to 3:- Alsike.
  - 1 to 4:- ladino, common white & wild white clovers.
  - 2 to 6:- Velvet bean & soybean.
  - 2 to 8 or 9:- common vetch & field peas.
  - 3 to 43:- Birdsfoot trefoil.
  - 4 to 10:- Hairy vetch.
  - 12 to 26:- Cowpeas.

SOME AIDS TO THE IDENTIFICATION OF LEGUME SEEDLINGS --- To be used in conjunction with the drawings

| | 2 cotyledons after germination | Unifoliolate first true leaves: No. | Unifoliolate first true leaves: Special characteristics | Subsequent early leaves: No. of leaflets | Subsequent early leaves: Leaf organization | Other characteristics |
|---|---|---|---|---|---|---|
| Soybeans | " | 2 | More or less cordate; usually hairy; 1"+ long. | 3(5-7) | pinnate | Stipels present. |
| Cowpeas | " | 2 | Upper surfaces distinctly glossy; 1"+ long. | 3 | pinnate | Stipels present. |
| Medium & mammoth red clover | " | 1 | American strains hairy. Stipulate sheath strongly veined; upper 1/2 acute; apex always bristled. Med. not separable from Mam. til near maturity. | 3 | palmate | Many leaflets have inverted V. Dead leaflets kept wet darken to brown or black in a few hours. |
| Crimson clover | " | 1 | All strains hairy. Stipulate sheath membraneous, broad, less acute; apex not always bristled. Lateral leaflets less symmetrical than those of red | 3 | palmate | Dead leaflets kept wet become gray or buff. No inverted V's. Obcordate leaflets numerous. |
| Field hop | " | 1 | Obcordate; smooth upper; dull under surface. | 3 | palmate | Stipules long, lanceolate. |
| Low hop clo. | " | 1 | Shaped like red clover; smooth; dull under surface | 3 | pinnate | Stipules ovate-lanceolate. |
| Least hop clo | " | 1 | Identical to low hop clover at this stage. | 3 | pinnate | Stipules tiny ovate-lanceolate. |
| Alsike clover | " | 1 | Most common shape obcordate; under surface dull. | 3 | palmate | Stipules long, taper-pointed. No inverted V's. |
| Wild white | " | 1 | Most common shape not obcordate; under surface | 3 | palmate | Inverted V's on some leaflets. |
| Ladino & Common white | " | 1 | glossy. The three white clovers cannot be separated from each other at very early stages. | | | Stipules short, terminating in acute spices. Thin, delicate. |
| Yel. trefoil | " | 1 | Petiole finely hairy. Blade width 1-1½ x length. | 3 | pinnate | Leaflets distinctly mucronate. |
| Alfalfa | " | 1 | Petiole nearly smooth. Blade width 1-1¼ x length Common, sickle & variegated not separable so early. | 3 | pinnate | Leaflets not distinctly mucronate, other than an occasional one. |
| Bien. white | " | 1 | Coumarin odor & taste. Blade width 1-1¼ x length | 3 | pinnate | Leaflets serrated thru entire length. Awl-shaped stipules. Node bearing unifol. leaf lifted. |
| Bien. yellow sweet clovers | | 1 | (cotyledon petioles ascending to appear lacking) These 2 species cannot be separated so early. | | | |
| Birdsfoot | " | 0 | First true leaves are trifoliolate. | 3-4-5 | pinnate | Veins relatively inconspicuous. |
| Field Pea | Remain where planted | 0 | Two or 3 scale-like leaves; 1 or more of which are not lifted above surface. Buds in axils may give rise to branches. (See last column.) | 2-4-6 | even-pinnate | Stipules large; resemble leaflets. First 2 or 3 leaves bear only 2 leaflets. |
| Hairy vetch | " | 0 | Usually 3 scale-like leaves; 2 or all lifted above surface. Buds in axils may become branches | 4-22 | (tendrils) | 1st leaves bear 4 leaflets. 2-pronged stipules no purple spot. |
| Common vetch | " | 0 | Very similar to hairy vetch at early stages but may be separated when first true leaf develops. | 2-18 | (tendrils) | 1st leaves bear 2 leaflets. 2-pronged stipules purple spotted. |
| Velvet bean | " | 2 | Smooth & more or less sagittate. | 3 | pinnate | Stipels present. |

# ALFALFA

Common:-195,000-210,000; Variegated:-216,000-235,000; Sickle:-208,000-238,000 seeds/lb.
Bushel weight range: 57 to 63 lbs. Standard weight 60 lbs.

| Stage of growth: | 4" tall | Before bloom | In bloom | Seeds plump |
|---|---|---|---|---|
| Total crude protein (dry) | 32.9% | 21.8% | 17.5% | 12.9% |

Alfalfa is native to areas in south-western Asia where the climate is warmer than that of most of northern U.S., about as dry as our great plains states, & where the soils provide abundant lime. It should be remembered that these are conditions unlike those in much of the U.S. where farmers undertake alfalfa culture. Low temperature tolerance in alfalfa under American conditions seems to be associated with the ability of varieties like those in the variegated group to harden & become progressively dormant as days shorten in late autumn. Our first outstanding variegated variety was that produced by Wendelin Grimm of Minnesota. It is believed that this low temperature tolerance is due to the yellow-flowered parent involved in producing the original variegated varieties of the Old World, & that the yellow flowered species may have grown wild in Siberia.

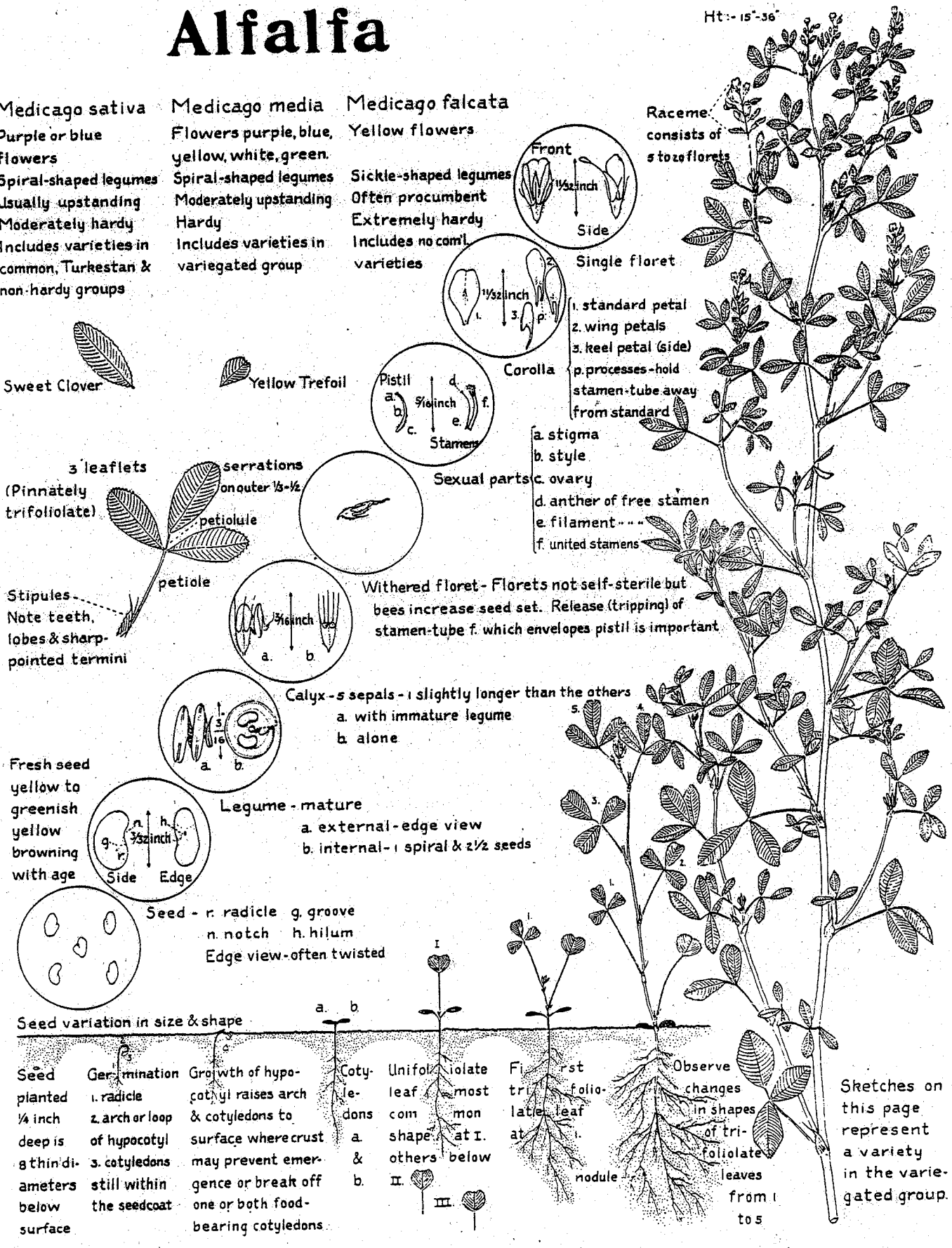
The ability of alfalfa to produce highly nutritious feed & more of it per acre & over long periods of time has caused this legume to appeal to livestockmen almost everywhere. Thousands of farmers who cannot & should not grow this drought tolerant perennial have wasted money on costly failures. Most common cause of failure, assuming hardy seed is sown, is frost-heaving. The latter is related to poor drainage which results in water-logged or very wet soils that thaw at mid-day & freeze at night most frequently during late winter & early spring. It is the same process which lifts fence posts & cracks thick slabs of steel-reinforced concrete pavement. Where fence posts are lifted greatly despite the protective cover of fence-row vegetation caution in sowing alfalfa is strongly urged. Because water-logging & frost-heaving are related to drainage & drainage is related to tight layers or hard-pans which provide certain tell-tale sub-soil coloration called mottling, the following suggestions should help avoid expensive failures:- When the mottled layer is closer than 15" avoid alfalfa. Where mottling occurs between 15 & 24" & spring grain planting is often delayed, sow alfalfa with a protective (from excessive freezing & thawing) grass species & be very careful of autumn management. Where mottling is below 24", pure alfalfa is safe.

The writer's experience on 5400 N.Y. farms convinces him that it is not possible to be dogmatic concerning success at any particular minimum pH level. However, a good generalization is that as soils deviate from pH 6.8 in the direction of greater acidity chances for success are somewhat reduced, unless manure has been liberally used. The best alfalfa field the writer ever saw was at pH 5.6 on land very heavily manured. Size of lime application should be based on several factors including soil texture, presence or absence of lime in the subsoil, surface soil pH, & manurial history. In alkali tolerance alfalfa ranks high but not equal to sweet clover.

Where low temperatures, acidity, & heaving are not important, there are still problems in alfalfa culture. One is seedling establishment. Early in its life alfalfa lacks competitiveness so that very dry weather, excessive weed competition, or too much companion crop may be injurious or fatal. Hard seed, not scarified, would not detract from the problem. Inoculation is a must. Effecting the length of life of stands is bacterial wilt which is best combated by the use of resistant varieties. There are other diseases, less wide-spread for which practical controls have not been worked out. Insect pests are numerous. Perhaps most widespread & conspicuous is alfalfa yellows caused by the leaf-hopper. We have learned how to prevent spittle-bug damage. Good nutrition is very important in both establishment & stand maintenance. Phosphorus & potash most often give profitable responses, but sometimes boron helps. In stand maintenance it is important to avoid top-growth removal within 6 weeks of the cessation of growth & to allow one growth each year to reach the full-bloom stage.

Spring seeding with spring grains or on winter grains is most commonly practiced. However, summer seeding is more likely to be successful than with the common clovers. Summer seeding should take place not less than 10 weeks before the cessation of growth. On land that is relatively clean the seed-bed may be worked until mid-May at which time seeding may occur without a companion crop & a hay crop cut in August. For pure seedings the maximum amount of seed per acre should be 18 lbs. of common or 15 lbs. of variegated. As conditions approach ideal, less will suffice. A little over half of those amounts should be the maximum in mixtures along with such grasses as timothy, or brome, or orchard grass. To prevent too great over-balance of grass a good rule to follow is more lbs. of alfalfa than grass.

# Alfalfa


Ht:- 15"-36"
Medicago sativa
Purple or blue flowers
Spiral-shaped legumes
Usually upstanding
Moderately hardy
Includes varieties in common, Turkestan & non-hardy groups
Medicago media
Flowers purple, blue, yellow, white, green.
Spiral-shaped legumes
Moderately upstanding
Hardy
Includes varieties in variegated group
Medicago falcata
Yellow flowers
Sickle-shaped legumes
Often procumbent
Extremely hardy
Includes no com'l. varieties
Raceme consists of 5 to 20 florets
Front
11/32 inch
Side
Single floret
1. standard petal
2. wing petals
3. keel petal (side)
p. processes - hold stamen-tube away from standard
Corolla
Sweet Clover
Yellow Trefoil
Pistil
a.
b.
c.
d.
e.
f.
5/16 inch
Stamens
Sexual parts
a. stigma
b. style
c. ovary
d. anther of free stamen
e. filament
f. united stamens
3 leaflets
(Pinnately trifoliolate)
serrations on outer 1/3-1/2
petiolule
petiole
Stipules
Note teeth, lobes & sharp-pointed termini
Withered floret - Florets not self-sterile but bees increase seed set. Release (tripping) of stamen-tube f. which envelopes pistil is important
3/16 inch
a.
b.
Calyx - 5 sepals - 1 slightly longer than the others
a. with immature legume
b. alone
3/16
Fresh seed yellow to greenish yellow browning with age
Legume - mature
a. external - edge view
b. internal - 1 spiral & 2 1/2 seeds
n.
h.
3/32 inch
g.
r.
Side
Edge
Seed - r. radicle g. groove
n. notch h. hilum
Edge view - often twisted
Seed variation in size & shape
Seed planted 1/4 inch deep is 8 thin diameters below surface
Germination
1. radicle
2. arch or loop of hypocotyl
3. cotyledons still within the seedcoat
Growth of hypocotyl raises arch & cotyledons to surface where crust may prevent emergence or break off one or both food-bearing cotyledons
Cotyledons a & b.
Unifoliolate leaf most common shape at I. others below
I.
II.
III.
First trifoliolate leaf at 1.
nodule
Observe changes in shapes of trifoliolate leaves from 1 to 5
1.
2.
3.
4.
5.
Sketches on this page represent a variety in the variegated group.

# ALSIKE CLOVER

676,000 to 710,000 seeds per pound

Bushel weight range 58 to 63 lbs. Standard weight 60 lbs.

| Stage of growth: | 4" tall | Before bloom | In bloom | Seeds plump |
|---|---|---|---|---|
| Total crude protein (dry): | 27.6% | 18.9% | 16.6% | 12.4% |

This clover is named for the Parish of Alsike which centers around an attractive old white church not far from Uppsala in Sweden. Earlier some believed it to have first appeared as a result of bees hybridizing red & white clovers. Hybrid origin is discredited. Alsike clover was probably first brought to the U.S. by early settlers from northern Europe. In America it gained prominence as a legume to replace red clover on acid soils that were pronounced "clover sick" in the latter part of the 19th & the early part of the 20th century.

No other legume will tolerate a soil so completely water-logged as will alsike & no other clover will thrive in the presence of so much acidity. The ladino clover boom has done more than all previous education to adjust alsike to its proper place on American farms. More ladino is being sown on the less acid moist soils while alsike has been relegated by well-informed farmers to acid soils that are either continually wet or alternately wet & moist. Ladino, because of its quick recovery, is superior in moist situations where aftermath grazing is important & where early cutting of first growth for hay or hay-crop silage is possible. Alsike makes a heavier first cutting but only makes a second cutting or aftermath grazing on overflow lands or in fields with high water-tables. If hay acreage is large so that some late cutting is necessary, alsike is advantageous because ladino will not persist or yield well under such management.

Alsike does not thrive under warm, dry conditions such as favor alfalfa. It cannot be recommended for acid upland conditions if they are dry, nor for hard-pan soils which altho they are wet in early spring often become very dry in summer. It is a cool weather legume lacking drought tolerance. Where the water-table is too high for ladino to persist alsike often behaves like the perennial it is. In most uplands dryness & the clover root borer combine to make it perform like a biennial. Alsike tolerates winter temperatures lower than any other clover. Its much branched root system has such regenerative powers that the usual frost heaving rarely kills it. Altho alsike plants sometimes exist in pastures & good stands are sometimes grazed rather than mowed, ladino is a superior legume for short-term big-bite pastures.

The white to pinkish flowers are borne on peduncles which originate in leaf axils. Thus an alsike plant may bear buds, flowers, immature seeds, & ripe seeds simultaneously. This type of development is called indeterminate. Seeds may have shattered before blooming ceases & thus reseeding is possible. Sometimes the seeds are hard & lie in the ground for long periods before producing volunteer plants. Hard seed occurs in many commercial lots of seed but not to such extent that seedsmen have often resorted to scarification, altho more lots might have benefited by such treatment.

Too much has been written without substantiation to the effect that smooth alsike stems & leaves make less dusty hay than hairy red clover plants. The examination of over 1000 samples from N.Y. farmers' mows provided convincing evidence that dustiness in hay is due to mold & that alsike & ladino are as subject to mold as other species.

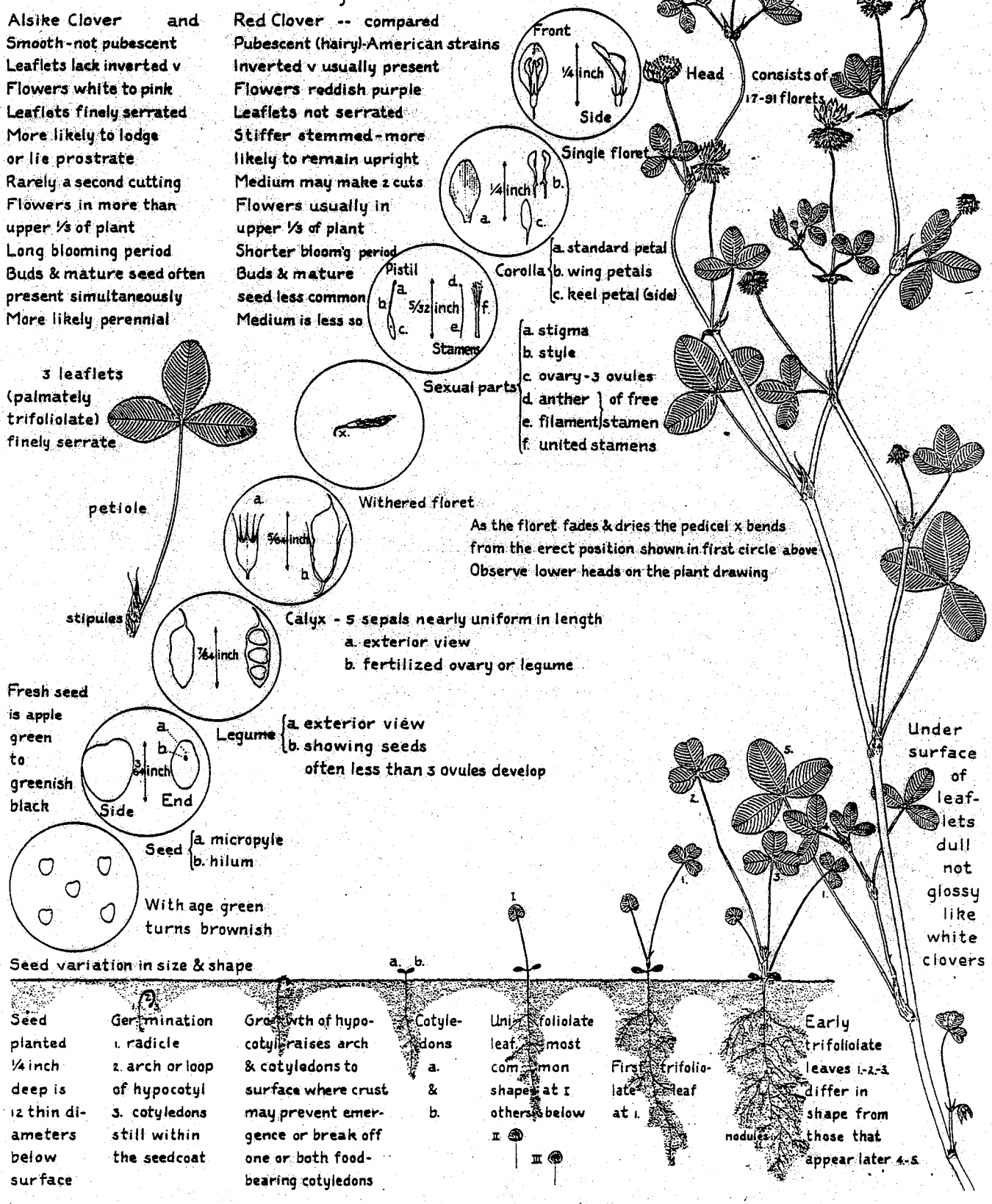
Alsike is weak-stemmed. In pure stand it may present a mowing problem approaching that of ladino. Therefore it should be sown with other species capable of giving it some support. For this purpose some have tried the water-tolerant Reed canary grass only to learn that alsike will not survive the shade produced by this taller species. When alsike lodges lower leaves are discolored & lost & the resulting hay is stemmy, but unless very late cut the stems remain soft. In curing it is easier to retain green color than with red clover.

Ease of establishment is such as to make alsike a more certain crop than the more consistently perennial species. However, alsike may be made more dependable & valuable if it be sown not over 1/4 to 1/2" deep & only on moist to wet soils that do not dry out in summer. Acid tolerant, it responds to lime but not always with profit, & it tolerates alkalinity well. Like other legumes it responds to fertilization when minerals are lacking. Inoculation is difficult to justify unless alsike or other legumes in its group have been absent from the land for close to a decade. A full seeding of alsike would be 6 to 8 lbs. per acre. With red-top the maximum total seed should be about 10 lbs. per acre; with red-top & timothy 12 lbs. To avoid excessive competition always sow more lbs. of legume than of grass. For fields with wet spots it is often wise to replace 2 lbs. of red clover with 1 1/2 lbs. of alsike, or broadcast alsike in wet spots.

# Alsike Clover

## Trifolium hybridum

| Alsike Clover and | Red Clover -- compared |
|---|---|
| Smooth-not pubescent | Pubescent (hairy)-American strains |
| Leaflets lack inverted v | Inverted v usually present |
| Flowers white to pink | Flowers reddish purple |
| Leaflets finely serrated | Leaflets not serrated |
| More likely to lodge or lie prostrate | Stiffer stemmed-more likely to remain upright |
| Rarely a second cutting | Medium may make 2 cuts |
| Flowers in more than upper 1/3 of plant | Flowers usually in upper 1/3 of plant |
| Long blooming period | Shorter bloom'g period |
| Buds & mature seed often present simultaneously | Buds & mature seed less common |
| More likely perennial | Medium is less so |



# BIRDSFOOT TREFOIL

Broad leaved 368,000 to 375,000; Narrow leaved 371,000 to 409,000 seeds per pound.
Bushel weight range: Broad 1: 58 - 64 lbs.; Narrow 1: 57 - 64 lbs.; Std. weight 60 lbs.

| Stage of growth: | 4" tall | Before bloom | In bloom | Seeds plump | |
|---|---|---|---|---|---|
| Total crude protein (dry): | 30.9% | 20.4% | 16.8% | 12.6% | Broad leaved |
| | 31.8% | 20.6% | 16.4% | 12.4% | Narrow leaved |

To some American farmers birdsfoot trefoil is a new legume, but to Europeans it is at least 300 years old. Overseas, Italy has the greatest acreage. In that country it ranked in 1951 as the 5th most important legume for dry situations. Its perennial habit, probably more than any other characteristic, has attracted attention to it. When well established, no other non-creeping legume will stand so much abuse under grazing. As a hay plant it approaches alfalfa in feeding value; is fine-stemmed & fairly palatable, but probably should be compared with alsike in tendency to lodge & difficulty of mowing when not supported by associated grass. Sometimes lodging is followed by killing if the lodged growth is not soon removed. It retains green color (but not lower leaves or feeding value) better with maturity than most legumes. It presents fewer preservation problems in the silo than other legumes. No authentic case of bloat to date. Once establishment problems are hurdled it will persist on soils too poorly drained for alfalfa. The broad leaved species is more productive than the narrow leaved.

Why has birdsfoot trefoil not attained greater prominence in countries where it has long been known? It could be for lack of American "know-how" or due to some of its real weaknesses. With the best of advice U.S. seeding failures are far too numerous. The writer knows of no legume which makes the feeble start so characteristic of birdsfoot. The root system is the smallest & weakest at all of the formative stages shown in this book. Is not this fact behind the widely recognized slow start made by birdsfoot? Even the staunchest supporters of this legume admit that it is as susceptible to heaving during the first winter as other perennials. Yet they recommend it for wet slopes where hay is to remain for a long time -- without warning the farmer that some associated crop (not too competitive) must hold soil & snow cover until birdsfoot becomes established -- if that follow with time. The mature birdsfoot root is excellent -- more regenerative than that of alfalfa. However, birdsfoot trefoil withstood the dry summer of 1949 considerably less well than the deeper rooted alfalfa.

Contributing to the low yield & high price of domestic birdsfoot trefoil seed is the indeterminate habit of the plant & the dehiscence or shattering of the seeds with uneven maturity. Influencing the establishment of stands is the fact that birdsfoot makes more hard seed than most legumes & seed that persists in the hard condition longer than that of many legumes. Sometimes failures are attributed to faulty inoculation cultures. Adding to establishment costs are the recommendations that, for competitive reasons, companion crops be omitted or that winter grains such as wheat, the most profitable of small grains, be avoided. Some of these problems will yield to research, but slow, weak start; lack of competitiveness; & dehiscence appear to be inherent. The writer never has recommended the growing of any legume unless he could offer suggestions with assurance that when followed they would reduce risks to a reasonable minimum. Not being able to do this for birdsfoot trefoil he declines to recommend its culture, preferring to allow someone else to enjoy that responsibility & to derive any credit therefrom. Below are verbatum recommendations from Cornell Extension Bulletin #797 which are the best to date. (Too many honest farmers claim to have followed earlier college recommendations with failure as the result.)

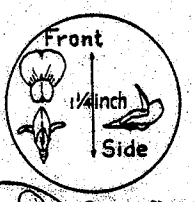
1. Prepare a good seedbed. 2. Lime & fertilize as for red clover.
3. Use a complete fertilizer when seeding, following an old grass sod.
4. Inoculate with the special culture required.
5. Seed following a grain or tilled crop, if possible.
6. Seed preferably in early spring.
7. Omit a companion crop or use a spring sown cereal seeded at a low rate.
8. Avoid seeding on winter wheat or rye; such seedings often fail.
9. Seed shallow in a firm seedbed & cover lightly.
10. Seed not less than 5 pounds to the acre for hay or pasture.
11. Avoid surface seedings on old pastures; they usually fail or are slow to establish.
12. Use birdsfoot trefoil in simple mixtures, usually with a grass & no other legume.
13. Avoid grazing young seedling plants except to remove competition.
14. Give birdsfoot time to establish -- it may establish slowly.
15. Manage birdsfoot trefoil as you would alfalfa for hay or ladino clover for pasture.

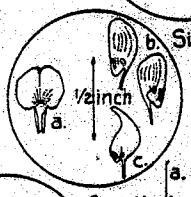
# Birdsfoot Trefoil

Lotus species

**Lotus corniculatus**
Broad leaved
Large buds & flowers
Deeper root system
Stems coarser - variable habit but more likely erect. Will average greater length.

**Lotus tenuis**
Narrow leaved
Smaller buds & flowers
Roots less extensive
Stems more often prostrate to semi-erect.

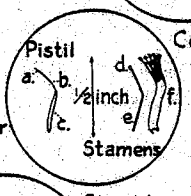


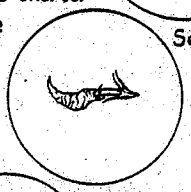

Corolla: a. standard petal, b. wing petals, c. keel petal-side

Leaf consists of 5 leaflets - not 3 as the name trefoil would imply. Observe lower pair differ in size & shape from the upper 3

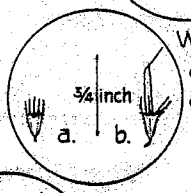
Smaller narrower leaflets - shorter petiole



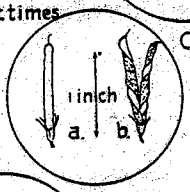

Sexual parts: a. stigma, b. style, c. ovary, d. anther, e. filament, f. united stamens



No stipule or sheath at base of petiole. However rudimentary stipules may be observed at times

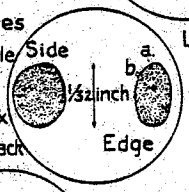



Withered floret - following fertilization, dependence for which is on bees, the legume develops & petals gradually slough off

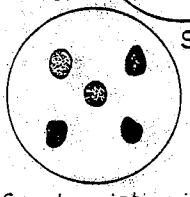



Calyx: - a. frontal view showing 5 sepals
b. side view showing developing legume

Seeds mostly olive-brown -- sometimes buff, purple mottled purplish & nearly black

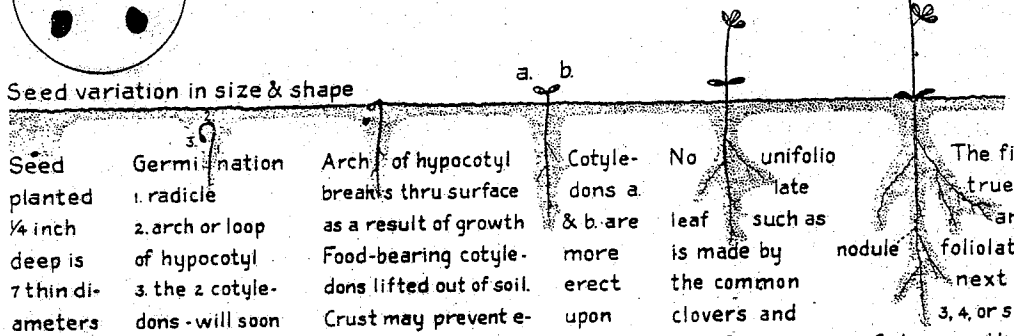



Legume: - a. mature - bears 3-43 seeds
b. dehisced - seeds scattered



Seed: - a. micropyle
b. hilum (round)

Seed variation in size & shape




Seed planted ¼ inch deep is 7 thin diameters below surface

Germination
1. radicle
2. arch or loop of hypocotyl
3. the 2 cotyledons - will soon break out of encasing seed coat

Arch of hypocotyl breaks thru surface as a result of growth. Food-bearing cotyledons lifted out of soil. Crust may prevent emergence or break off 1 or both cotyledons

Cotyledons a. & b. are more erect upon emergence

No unifoliate leaf such as is made by the common clovers and alfalfa

nodule

The first 2 true leaves are trifoliolate. The next 2 have 3, 4, or 5 leaflets

Subsequently most leaves have 5 leaflets

Stem length: - 15" - 44"

Inflorescence is an umbel bearing 2-9 florets which are lemon-yellow to orange

Altho birdsfoot non-hard seed germinates as rapidly as that of other species, its seedling makes the least robust top-growth & most restricted root-growth during first 8-10 weeks. May not be true later.

# YELLOW TREFOIL

251,000 to 282,000 seeds per pound
Bushel weight range 58 to 66 lbs. Standard weight 60 lbs.

| Stage of growth: | 4" tall | Before bloom | In bloom | Seeds plump |
|---|---|---|---|---|
| Total crude protein (dry): | 24.5% | 24.1% | 20.6% | 10.5% |

Yellow trefoil, or black medic, or nonesuch is another of the many legumes brought to America from the Old World. It has incorrectly been called hop clover. At no stage of development does its head even remotely resemble the fruit of the hop plant as does the head of field hop clover (Trifolium agrarium) & that of low hop clover (Trifolium procumbens). However there is a little similarity between the flower of least hop clover (Trifolium dubium) & yellow trefoil, but only in the early stages of bloom. Neither makes a flower resembling the fruit of the hop. (See sketches.)

In America yellow trefoil is widespread but far from abundant. The writer has seen it in every county of two northeastern states. It sometimes occurs in waste places but rarely on poor soils & never on very acid soils or in wet situations. It almost never makes up a high proportion of the vegetation in hay fields, but may be conspicuous in an occasional moderately to poorly grazed old pasture where it reseeds itself. In such situations, because it produces varying amounts of hard seed, it appears & disappears. Farmers who know the plant speak of "yellow trefoil years", implying that there are years when the plant is more in evidence than in others. Such a year was 1951 when the writer was called upon to identify yellow trefoil for persons representing nearly one quarter of New York's 55 counties.

It is looked upon as a weed in some lawns where it is most likely to occur on slopes or in spots too dry for white clover. It detracts from the appearance of the lawn because tip ends of stems, grown prostrate under mowing, turn upward to create an uneven or ragged appearance. On the Cornell Campus is an area of lawn in front of the new Mann Library where only scattering yellow trefoil plants occurred prior to 1950 under close mowing. In 1951 construction prevented mowing some of this turf which resulted in one of the densest, purest, tangled masses of yellow trefoil ever seen here. The only explanation could be the accumulation over the years of hard seed.

A member of the alfalfa genus, yellow trefoil is not an important legume. It is listed in only 2 of 14 catalogs of reliable seedsmen. Long since, it gained a bad name in some quarters because it appeared as an adulterant in alfalfa seed, &, being of similar size & weight, it could not be mechanically separated. Objection to it is justified because it is so much less productive and shorter lived than alfalfa.

Yellow trefoil is either annual, winter annual, or a weak biennial. When spring-sown at Ithaca, N. Y., only 3 of 18 marked plants survived the winter to bloom & set seed the 2nd year. Death was not due to heaving, altho heaving may prove fatal. Nor was it likely that low temperatures caused deaths of the 15 plants, for it is reported as more tolerant to cold than red clover. Because of its ability to grow during the cooler part of the year, its greatest usefulness is probably in mild climates where plants starting in late summer may provide some late fall & winter grazing, followed by a larger amount of spring pasturage & usually by reseeding itself.

During his 30 years of professional agricultural work in the Northeast, the writer has never recommended the culture of yellow trefoil -- & the reason was not that knowledge of factors for success were lacking. Other annual legumes always seemed superior. Other winter annuals always held out promise of bigger yields. Other biennials always appeared more productive. The writer has, however, urged farmers for whom yellow trefoil frequently volunteered in dry parts of permanent pastures, to encourage it thru the the use of the same lime & fertilizer applications which were known to favor the growth of white clover & grass in the moister areas of the pasture. Lime especially, & superphosphate almost as regularly stimulated growth of yellow trefoil.

Even in mild climates pure stands are rarely sown. They would require a maximum of 15 lbs. of seed -- less if readily germinable or scarified. More common practice is the inclusion in a permanent pasture mixture of about 2 to 5 lbs. per acre with the hope that self-seeding would perpetuate it. Fall seeding is preferable in mild climates; spring seeding where it is colder. As is true of other legumes such as red clover, locally grown seed is superior to that brought from remote areas & usually much superior to European seed in producing good stands & yields. Inoculation is very important at stand establishment time. The soil should be sweet enough to grow sweet clover and should have mineral treatment similar to that given other legumes of permanent pastures.

# Black Medic or Yellow Trefoil

Medicago lupulina

| Most likely to be confused are:- | Yellow trefoil | Least hop clover |
|---|---|---|
| Flowering heads:- | 1/8"-1/4" | 3/16"-1/4" (diameter) |
| -in color:- | butter yellow | butter yellow |
| -no. florets:- | 9-28 | 3-20 |
| After flowering:- | heads compact | open up before drooping |
| When vegetative:- | | |
| entire plant:- | finely pubescent | nearly glabrous |
| leaflet serrations:- | usually outer 1/3-1/2 | usually outer 1/2-3/4 |
| Legume (ripe):- | inky black | brownish buff |

Head - compound inflorescence..... consisting of 9 to 28 florets - butter yellow

Ht:- 3" where the weak stems lie prostrate in lawns or pastures up to 30" where competition causes growth to be upright

front

3/64 inch

side

Single floret

a. standard petal
b. tube
c. wing petals
d. keel petal-side view

Corolla

Pistil

3/64 inch

Stamens

Sexual parts-
- a. stigma
- b. style
- c. ovary
- d. anther
- e. filament
- f. united stamens

A pubescence too fine to show in the sketches is often present on leaflets, petioles, legumes and stems

Leaves pinnately trifoliolate

leaflets - rarely over 3/4 inch long

conspicuous mucronate tip usually present

petiolule

petiole

leaflet serrations in outer 1/3 to 1/2

Stipules irregularly toothed or erose

Withered floret - more likely to have been fertilized if visited by insects

3/32 inch

Calyx - showing 5 sepals in view a. Observe pubescence. b. frontal view of legume - calyx tilted forward

3/32 inch

Legumes

Legume - bears 1 seed and is inky black when ripe

Fresh seed greenish yellow to pale buff

1/16 inch

Seed -
- a. micropyle
- b. hilum
- c. beak
- d. radicle
- e. cotyledon

Seed variation in size & shape

a. b.

I.

I.

2.

3.

| Seed planted 1/4 inch deep is thin diameters below surface | Germination 1. radicle 2. arch or loop of hypocotyl 3. both cotyledons still within the seed-coat | Growth of hypocotyl raises arch & cotyledons to surface where crust may prevent emergence or break off one or both food-bearing cotyledons | Cotyledons a. & b. | Unifoliolate leaf compound shape others II. | Unifoliolate most common at I. below III. | First trifoliolate at I. | First foliage leaf | Observe change in shape of trifoliolate leaves 1.-2.-3. |
|---|---|---|---|---|---|---|---|---|

nodule

## COMMON & HAIRY VETCH

Common:- 6,900 to 8,000; Hairy:- 10,800 to 14,600 seeds per pound
Bushel weight range: Common: 57 to 66 lbs.; Hairy: 58 to 65 lbs. Standard weight 60 lbs.

| Stage of growth: | 4" tall | Before bloom | In bloom | Seeds plump | |
|---|---|---|---|---|---|
| Total crude protein (dry): | 25.6% | 22.6% | 18.3% | 15.5% | Common |
| | 29.3% | 24.9% | 17.4% | 16.8% | Hairy |

Vetches are considered to be among the oldest of cultivated legumes, being mentioned in the earliest agricultural writings. The tares of the Holy Scriptures were probably common vetch. Altho the vetch genus (Vicia) includes over ten dozen species, only about one dozen of these have been cultivated agriculturally in the U.S. & space will permit treatment of only two here.

Vetches find a place in American agriculture because they are among the best legumes for low fertility sands & sandy loams, & still are capable of good performance on poor but well-drained heavy soils. Like other legumes, their best growth is not made on poor soils. Another reason for interest in them is their ability to thrive on very acid soils--tolerating as much or more acidity than alsike clover. For soil improvement vetches rank just a little below red clovers where both tops & roots are plowed under; & above the annual legumes where only stubble & roots are returned.

At one & possibly two stages vetches contain less total crude protein than alfalfa, but since they are fine-stemmed, leafy, & more digestible they usually excel alfalfa as feed. At the hay or silage stage they are weak-stemmed, twining, & tendril-bearing; so that in pure stands vetches make extremely difficult mowing. When lodging occurs lower leaves are shed to a serious degree. Therefore, small grains & stiff-culmed grasses are grown for support. By separation tests, the writer found the percentage of vetch plant tops to be much lower than one would estimate in the usual mixture with small grains--& often so low as to raise the question of return on seed investment. He would sow more seed than the usual minimum--or none. Vetch is also valuable as a means of extending the grazing season in the late fall & early spring. Controlled grazing seems desirable to prevent over-grazing of spots & wastage by trampling, and also to insure a reasonable amount of winter cover to minimize winter injury on heavy soils.

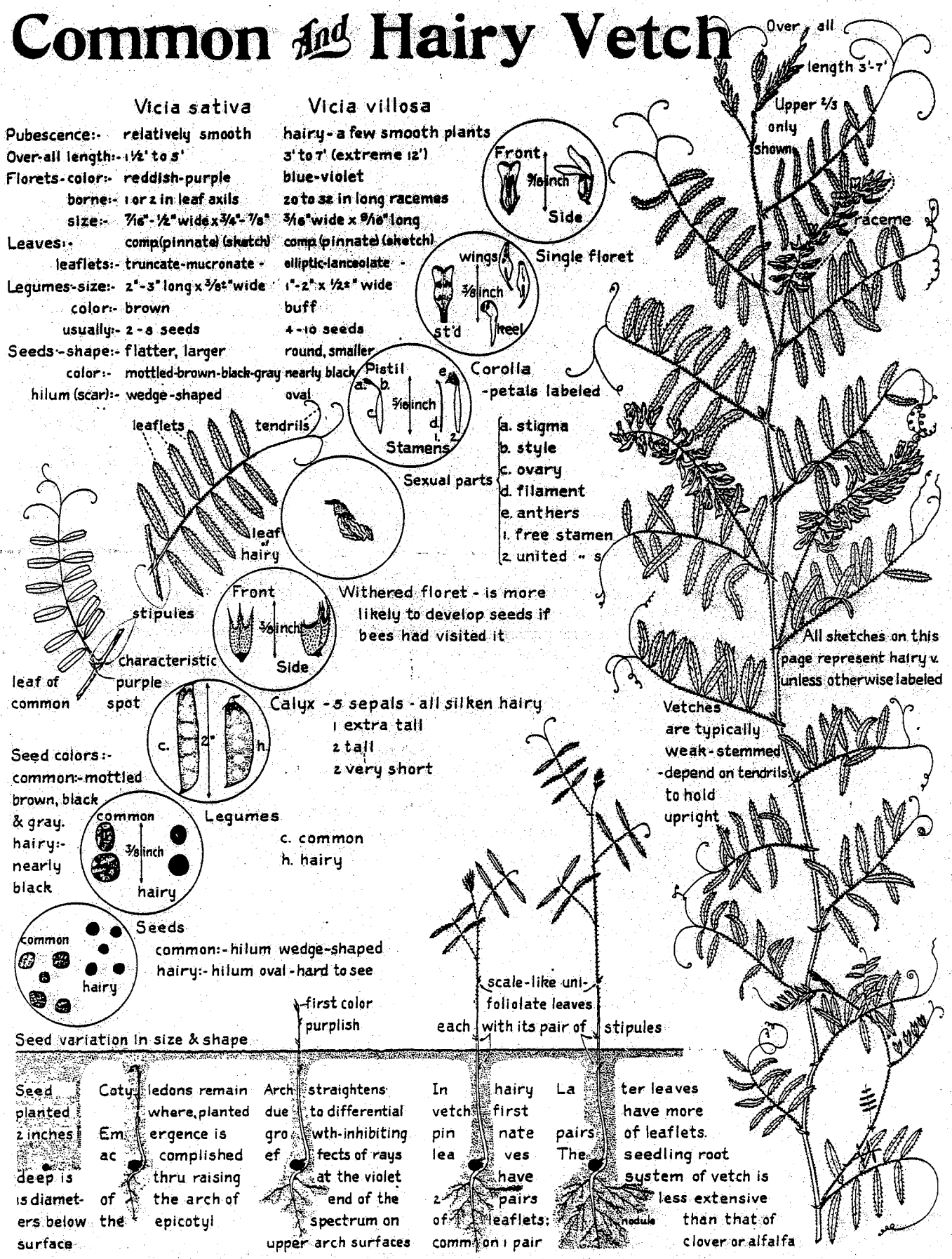
Hairy vetch (sand vetch) is of wider adaptation than common vetch because it is much more winter hardy. Low temperatures rarely kill true hairy vetch in any northern state. Heaving, on wet soils, may prove damaging but rarely fatal as it is with alfalfa. Hairy vetch (fall sown) is most widely used as a winter annual. As such it provides cover for soils subject to erosion. It fits quite well into the agriculture of the southeastern states where there is a special need for a winter cover crop. Spring sown, it may serve as an annual, & as such it usually outyields common vetch--or it may behave as a biennial, making a seed crop the second year. Complicating the varietal picture is the fact that there is a smooth subspecies of hairy vetch (Vicia villosa glabrescens) as well as the normal hairy one (Vicia villosa). This smooth mutant is probably a little less winter hardy than the true hairy species, but is reported to be hardy enough for most of the northerly situations in the U.S. A large part of the seed sold is of this smooth subspecies & it is sold under the name of smooth vetch. It is produced in the Pacific Northwest, in the Great Lakes area & South-central states, but planted extensively in the South & Southeast. Persons desiring true hairy vetch may purchase certified seed in Madison County, Nebraska.

Common vetch over-winters only in the mildest climates, so that it must be treated as an annual where winters are severe. A variety of common vetch called Willamette is superior in yield & winter hardiness to the commercial or ordinary stock. One may be sure he gets genuine Willamette only by insisting upon certified seed since the two are indistinguishable. Willamette does not approach the hardiness of hairy vetch.

Vetches respond especially to superphosphate--perhaps because of its gypsum as well as its phosphorus content. This is especially true in the Pacific Northwest where application of gypsum for its sulfur is often justified. Inoculation is of very great importance on vetches in all areas except the Pacific Northwest. Omission means almost certain failure. Commercial inoculants are superior now to those which, in earlier days, failed on vetches but were effective on field peas which crop had to precede vetch in some areas to make vetch growing safe.

In the North, fall seeding should take place not later than the Hessian fly-free date & preferably 2 weeks before that time; in the South, after nematode danger. Spring seeding is best at oat planting time. With small grains, sow 15 to 20 lbs. of hairy or smooth; twice that amount of common. Alone, 20 to 40 lbs. of hairy or smooth, & 40 to 80 lbs. of common. Minimum rates apply to the South.

# Common and Hairy Vetch



# COWPEAS

1400 to 4450 seeds per pound

Bushel weight range:- 55 to 63 lbs. Usual standard 60 lbs.

| Stage of growth:- | 4" tall | Before bloom | In bloom | Seeds plump |
|---|---|---|---|---|
| Total crude protein (dry):- | 27.6% | 23.2% | 18.9% | 16.1% |

The cowpea is not a pea but a bean. It is believed to have originated in central Africa where a wild form, with which the domestic form readily crosses, still occurs. From Africa it was taken to southern Asia & Mediterranean Europe. Its introduction to the new world was very early & by way of the West Indies. It is an important annual legume in the southeastern & southcentral states, California, & in a few others where the frost-free period is long & where temperatures are relatively high. The cowpea is extremely sensitive to frost which fact makes it unfortunate for the farmer who normally grows the frost-resistant Canada Field pea as forage for cows to make the mistake of ordering cowpea seed. The cowpea requires much more heat than the minimum for corn. Another annual, the soybean, slightly less sensitive to frost & less exacting as to heat is usually a more dependable crop north of the latitude of northern Virginia & central Illinois.

However, within its climatic range the cowpea possesses some advantages over the soybean. Cowpeas will thrive on soils a little more acid than those on which soybeans succeed. Cowpeas usually adapt themselves to low fertility better than soybeans. Cowpeas tolerate partial shade better than soybeans, which fact makes them better suited for growing in association with corn than soybeans & also better cover for land in orchard. When once established the cowpea is less sensitive to poor drainage than the soybean, but neither will germinate well nor thrive on cold, wet soils. Over 20 years of observations of cowpeas growing beside soybeans led to the conclusion that there is not much difference in drought tolerance between the two species, but when a difference occurs it usually is in favor of the cowpea. These facts help to justify the oft-made comment that cowpeas are a crop which succeeds in the face of adversity. Despite this, & in common with other legumes, invariably best forage yields & usually best seed yields are made on the most productive soils.

In addition to the ecological responses of the cowpea as outlined above, the purpose for which grown (or utilization) is an important consideration in deciding whether the cowpea or some other annual is best for any farmer's specific conditions. The soybean which matures all of its seed at approximately the same time (determinate habit) is a more economical seed producer than the cowpea. The latter may bear ripe seeds, green seeds & new flowers simultaneously (indeterminate habit). This also means that it is easier to justify the growing of soybean seed to be processed for livestock feeding.

In the Southeast almost any variety of cowpea which has a white or near-white seed-coat (testa) & a black hilum may be called a black-eyed pea. When prepared with the skill of a good southern cook the black-eyed pea becomes a most palatable & nutritious food for humans - the equivalent of the famed Boston baked beans. The latter involves the use of very different, northern-grown, popularly called "navy" or pea bean of the genus Phaseolus. "Shelled" green the seeds of one or two varieties of cowpea are put up in tin cans and sold commercially.

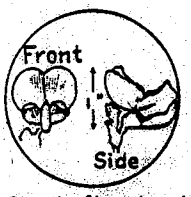
For forage the higher seed-cost of the cowpea places it at some disadvantage when compared to the soybean. If the forage is to be harvested, the trailing nature of the plants of many varieties of cowpea provides a mechanical harvesting problem. However, varieties of trailing habit are advantageous from the standpoint of density of ground cover & for grazing during the late summer. It should not be inferred from the previous statements that all varieties of cowpea are viney & prostrate. Some are bunchy and more or less erect.

Because of its performance in situations needing improvement the cowpea ranks high among annual legumes as a soil improving crop when the tops are plowed under or grazed or are fed & the manure returned to the land. Like all other annual legumes when only the relatively small root plus stubble is turned down, cowpeas rank below those legumes which live longer & leave larger residues. As a hay crop they are difficult to cure because of fleshy stems, broad leaves, & the long thick legumes. Growing with a grass may help cure.

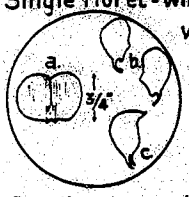
Best yields commonly result from planting about 2 weeks after corn planting time. The shorter season varieties may be planted after winter grain harvest in the South. Cowpeas should be fertilized like soybeans. Inoculation becomes more important where they are grown less well & less frequently. For seed plant 2 to 3 pecks per acre in rows 21" to 42" apart. For forage or green manure in pure stands, drill solid & double the amount of seed. In mixture 8 to 12 lbs. of Sudan grass or millet may replace a peck of cowpea seed.

# Cowpeas

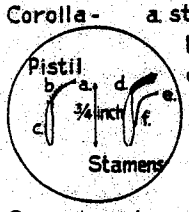
Vigna sinensis




Single floret - white or tinged with violet or all purple.

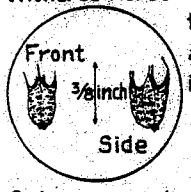



Corolla - a. standard petal
b. wing petals
c. keel petal

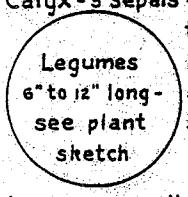



Sexual parts - a. stigma b. style
c. ovary
d. united stamens
e. anther } of free
f. filament } stamen

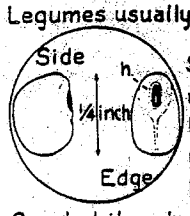
Withered floret - insect visitation unimportant. Self fertilization the rule




Calyx - 5 sepals - the one close to keel is extra long - the 2 behind standard petal short, paired.

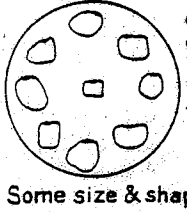



Legumes usually bear 12-26 seeds




Seed colors:- red, white, buff, brown, clay, near-black & bluish purple.

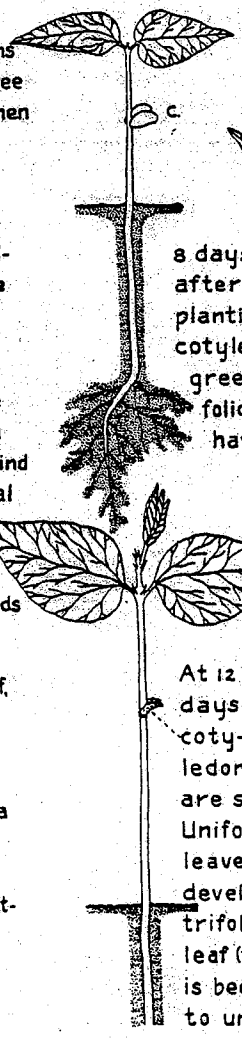
Seed - hilum h. is white with a dark frame. Vari-colored seeds are spotted, marbled, or mottled.



Some size & shape variations

Seed planted 2 inches deep is 14 thin diameters below the surface.

Arch of hypocotyl a. lifts cotyledons c. thru surface of soil. Plumule pl. projects beyond cotyledons Radicle r. grows downward.




8 days after planting c. cotyledons are green & the unifoliolate leaves have unfolded.

At 12 days coty-ledons are shriveling Unifoliolate leaves have developed & trifoliolate leaf (first one) is beginning to unfold.

Heights:-
Erect varieties:- 20"-36"
Prostrate:- 12"-18"
Over-all length:-
Prostrate or Trailing 30"-192"

Leaves pinnately trifoliolate

stipels

petiolule

stipels

racemes 2-4 florets

Stems & especially petioles more or less fluted & slightly rough when rubbed upward (retrorsely) scabrous

legumes

stipule

Shown here only one main branch

All sketches on this page represent the Brabham variety which is tall, erect & half-bushy. Some varieties are weaker-stemmed & tend to be prostrate.

# CRIMSON CLOVER

123,000 to 184,000 seeds per pound
Bushel weight range 59 to 66 lbs. Standard weight 60 lbs.

| Stage of growth: | 4" tall | Before bloom | In bloom | Seeds plump |
|---|---|---|---|---|
| Total crude protein (dry) | 27.5% | 18.9% | 15.9% | 12.4% |

Crimson clover, or incarnate clover, or scarlet clover is native to southern Europe. It probably originated just north of the Mediterranean & Black Seas. Currently it is of greatest importance in southern France & in Hungary. At one time production in Italy caused it to be called Italian Clover. Another name is Napoleons. In America it is most useful in the southeast quarter of the U.S. where it is commonly treated as a winter annual. Because of its inability to survive low temperatures, very little is grown north of central New Jersey. On Long Island (southern-most N.Y.) it winter-killed 2 years in 4. Crimson Clover attracts tourist attention in the potato-growing area of Maine where it is late-spring seeded & managed as a summer annual. There it makes luxuriant growth because of mineral residues from previous very heavy potato fertilization & it serves as a green manure crop. It is also occasionally seeded in some other northern states. Because it tolerates shade better than many other legumes, in earlier days it was sometimes tried as an orchard cover crop in counties on both sides of the Niagara River. Alsike clover is the only clover more acid tolerant.

Chief use is for pasture & simultaneously winter cover. It provides fall grazing; some winter grazing depending on temperature; & much spring grazing. Bloat does occur but is probably less likely than with other clovers. By removing livestock 6 to 8 weeks before flowering time a seed crop can result. Crimson clover produces seed abundantly so that its use has never been limited by excessive seed costs. As a hay or silage crop early harvest is especially important. The barbed hairs found on the calyx of each of the many florets that make up the head toughen with maturity. When the crop is grazed continuously or taken for hay close to maturity large masses of these hairs may ball up & plug the intestinal tract of a horse or a mule -- sometimes fatally. When used for green manure, the drier the soil & the more mature the crimson clover, the longer the time interval needs to be between it & the succeeding crop.

Seed of the common variety of this legume germinates quickly & soon makes a strong extensive seedling root system (see drawings). Despite this, crimson clover is not heat or drought tolerant like alfalfa. It establishes best during the cool, humid, autumn months; makes some winter growth where conditions permit; develops numerous stems in the spring; & flowers & fruits before the intense heat of summer. Its inflorescence is terminal. Following reproduction it invariably dies. Greenhouse attempts to keep it alive following fruiting have failed.

Probably more valuable than the common variety of crimson clover in some farming systems are the (self) reseeding varieties such as Dixie, Auburn, & Autauga which give this winter annual somewhat the equivalent of the perennial in performance. When the plants mature, seeds are readily shattered from the heads. In the common variety much of this shattered seed germinates as soon as conditions become favorable. Then intense heat & dry weather may take their toll. In the case of the reseeding varieties, the % of temporarily hard seed is higher so that germination takes place gradually over a long period extending thru the cool, humid autumn months, thus practically insuring a stand from one or more lots of successively germinating seeds. To get genuine reseeding varieties, certified seed is urged.

When intended for use as a winter annual, crimson clover seed is sown from mid-summer to late autumn, depending on location & use to be made of the crop. During establishment moisture is so important that it is often more difficult for a farmer to make a successful seeding on sandy than on heavy soils. As one approaches its northern limits for practical over-wintering, seeding should be earlier. On heavy soils frost heaving can be serious where temperatures fluctuate periodically & especially if they fluctuate from day to night. In such situations a fair amount of top-growth helps reduce alternate freezing & thawing of the soil (the cause of heaving) so that seeding early enough to assure good cover is advisable. On the other hand, too much cover encourages crown & root rots.

Shallow planting (1/4" in heavy to 1/2" in light soil) helps reduce seeding failures. Ten to 20 lbs. of seed (3 or 4 times as much if in the hull) are sown. The minimum would apply to quick germinating seed of the common variety under ideal conditions. Lesser amounts would, of course, be used in mixture with grass. Inoculation is usually important, except where crimson clover is grown successfully at short intervals. Usually phosphorus & potash are the fertilizer elements of greatest value.

# Crimson Clover

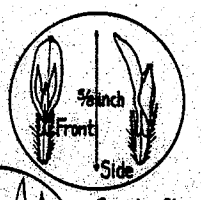
Trifolium incarnatum

Most likely to be confused are:-

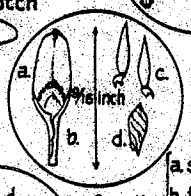
| Crimson Clover | Red Clover |
|---|---|
| No inverted V | Inverted V usually evident on leaflets |
| More hairy | Hairy or pubescent |
| Annual or winter annual | Biennial or perennial |
| Seeds larger - one color | Seeds vari-colored, deeper notch |
| Mature leaflet | Leaflet on mature plant |
| Commonest unifoliolate | Most common unifoliolate leaf |
| After water-soaking dried leaflets do not darken | After water-soaking dried leaflets darken perceptibly |
| Heads long | Heads rounded |
| Stipules short rounded | Stipules long pointed |

Ht:- 12 to 36 inches

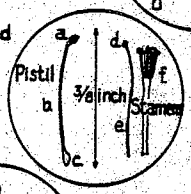
Head compound inflorescence consisting of 65 to 125 florets usually crimson red - odd specimens may be yellow, rose white or variegated crimson & white.



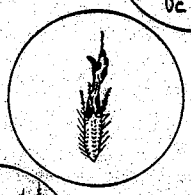

Single floret



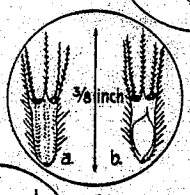

Corolla
- a. standard petal
- b. tube
- c. wing petals
- d. keel petal-side view




Sexual parts
- a. stigma
- b. style
- c. ovary - 2 ovules - usually 1 develops
- d. anther } of free stamen
- e. filament }
- f. united stamens



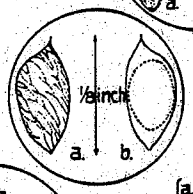
Withered floret
altho self-fertile
florets are not self-pollinating - require bee visitation




3 leaflets (Palmately trifoliolate)

petiole

stipulate sheath one lobe on each side very hairy sometimes fringed with reddish-purple

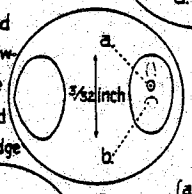



Calyx - 5 sepals - 1 slightly longer than the others
- a. exterior view
- b. dotted lines show position of legume

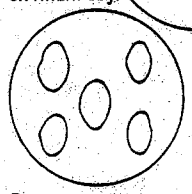
Each sepal terminates in a long barbed hair

Legume
- a. exterior view
- b. showing seed

Fresh seed glossy yellowish orange pinkish-red on hilum edge

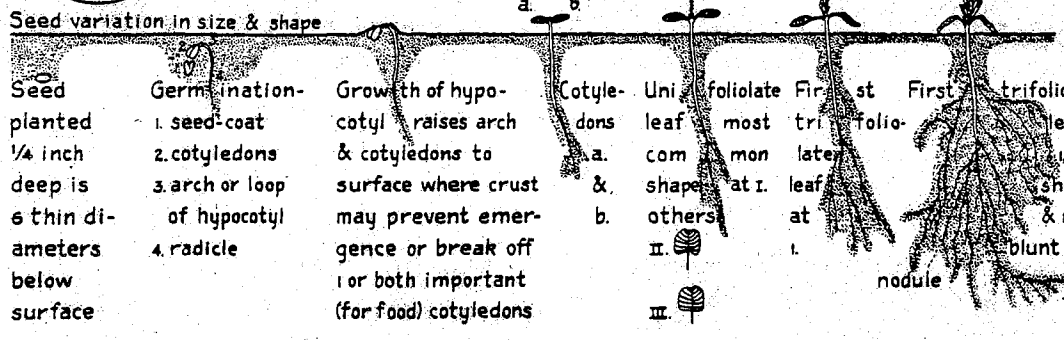



Seed -
- a. hilum
- b. micropyle



Old seed - dull brownish

Seed variation in size & shape




Seed planted ¼ inch deep is 6 thin diameters below surface

Germination -
1. seed-coat
2. cotyledons
3. arch or loop of hypocotyl
4. radicle

Growth of hypocotyl raises arch & cotyledons to surface where crust may prevent emergence or break off 1 or both important (for food) cotyledons

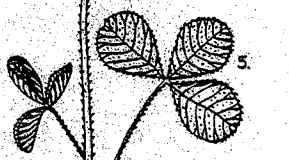
Cotyledons a. & b.

Unifoliolate leaf compound shape others

Trifoliolate most common at 1.

First true leaf at 1.

First trifoliolate leaflets 1, 2, & 3 shorter & more blunt than those appearing later 4. & 5.




A wild botanical variety, molinerii is native to much of the southern half of Europe. It is shorter, more hairy, & has yellow or yellowish white flowers.

Crimson clover produces more branches originating at the crown with a little less rebranching above that level than other upright clovers.

2,000 to 4,300 seeds per pound

Bushel weight range:- 52 to 65 lbs. Usual standard:- 60 lbs.

| Stage of growth:- | 4" tall | Before bloom | In bloom | Seeds plump |
|---|---|---|---|---|
| Total crude protein (dry):- | 33.6% | 21.9% | 16.6% | 15.8% |

Field peas, like numerous other legumes, are indigenous to western Asia & the Mediterranean area from whence they spread to northern Europe. There is no good record of when they were first introduced to American agriculture. Wherever found they thrive best during cool moist weather & are sensitive to hot dry conditions which have a pronounced adverse effect on both vegetative growth & fruit development. They tolerate heavy frosts without apparent injury. Confusion with the cowpea leads to disappointment.

Nearly all American seed is produced in the Northwest (mostly in Colorado, Idaho, Montana, Oregon, & Washington), but a little is still produced in the lake states. Records of utilization for forage purposes are either non-existent or very incomplete. Observers report that field peas are probably most extensively used as forage in the states where the seed is produced & others of similar climate - except for the Austrian Winter Pea which serves as winter cover & green manure in some parts of the cotton belt.

In the Northeast observations indicate declining acreage. Insects & diseases have added to growing costs. The expense of controlling these is easier to justify for the so-called vegetable peas which have higher acre value. Farmers located within trucking distance of a cannery find it more profitable to grow varieties of more delicate flavor, higher in sugar for "direct" human consumption. Others located near cities where school children & their parents like to supplement family income in June & early July prefer to grow peas to be hand-picked & marketed "in the shell". Sometimes when grown for canning the vinery refuse is available to the farmer to haul home for feed or to put in his silo. More often the vines are stacked & usually vile-smelling silage results. This may be had during the barn-feeding season at which time the hauling problem is one of the items which determine who makes use of the contents of the stack.

In the early 1920's tests by Cornell agronomists showed that by planting 1 bushel of oats, 1 bushel of barley, & ½ bushel of what are commonly called Canada Field Peas (Golden Vine variety) that the best harvested grain crops contained from a little less to a little more than 25% of pea seed. This mixture appealed to animal husbandmen & others who at that time were much aware of the high cost of protein. The result was no little emphasis on home-growing this higher protein mixture. However, the oat-barley-pea boom was short-lived due largely to what the farmer called root-rot, but what was really caused by a fusarium which lived as long as 4 years in the soil & was also seed-borne. Seed analysts developed techniques for determining the presence of the fusarium organism on the seed, but no practical way was found to avoid its carry-over in the field - except lengthening the rotation which is not always as simple as it seems. Today an occasional northeastern farmer who has lost his seeding & needs an emergency hay crop, plants a bushel or a bushel & a half of what is loosely called Canada Field Peas along with a like quantity of oats & the mixture is usually cured for hay. However, pure oats are more often used as an emergency hay crop. Very few continue to grow the grain mixture. Still fewer grow the crop to be sold for splitting for soup (mostly grown where the seed is produced). Whole peas & split pea screenings make good pigeon feed. The status of the field pea is better in the northeastern Canadian provinces, where climate is more favorable; pests less serious; farmers maintain pure varieties; & seedsmen merchandize dependable named varieties & not just field peas. Varieties were once numerous on the U.S. side of the line. In 1924 the writer had 26 - all different & varying in growing season from 70 to 120 days.

In the cotton belt & on the Pacific coast Austrian Winter Peas are usually planted between Sept. 15 & Oct. 15 at 2 or 3 pecks per acre. The plants make good cover & hold the soil thruout the winter. For green manure they are commonly plowed under in late February or early March.

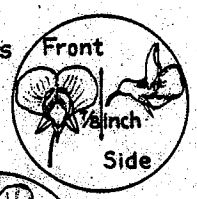
Field peas as grown in most of the North thrive best on soils containing enough lime to support red or ladino clover well. They are not a poor soil crop - often respond to liberal mineral fertilization. Inoculation is especially important & should be looked upon as cheap insurance. Early planting is a "must" for it helps the plants to avoid the unfavorable effects of hot dry weather. To make this possible fall plowing is advised for soils which do not erode or "run together" too badly. The grain drill is most commonly used for planting. Field peas are one of the few crops not too seriously affected by relatively deep planting. For pure stands, 4 to 6 pks. of the small-seeded varieties are adequate. This amount should be increased (as seed size increases) up to about 12 pks. per acre.

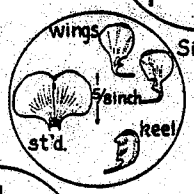
# Field Peas

Pisum species

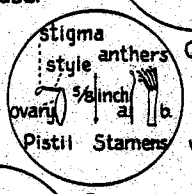
**Pisum arvense**
Field Peas or feed crop peas
More often smooth-seeded.
Rarely high in sugar.
Varieties with yellow or green cotyledons split & used for soup.
Green manure an important use.

**Pisum sativum**
Garden or vegetable peas may be used as field peas
More often wrinkled-seeded.
Usually high in sugar.
Varieties with yellow or green cotyledons split & used for soup.
Green manure not an important use.




Single floret

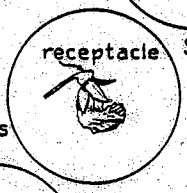



Corolla - petals labeled

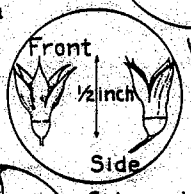
Most varieties white or reddish-purple

The Austrian winter pea differs from the various spring field pea varieties in that:-

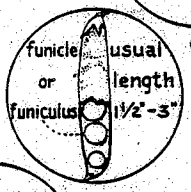
1. It is winter-hardy in mild climates.
2. It has smaller leaves.
3. The leaflets are more rounded. (stipules are similar)
4. Racemes usually limited to 2 florets
5. The standard petal is a lighter shade of purple than the wing petals.




Sexual parts
a. filament of free stamen
b. united stamens

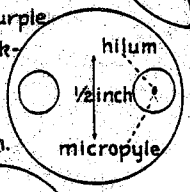



Withered floret - after fertilization -usually self-fertilized

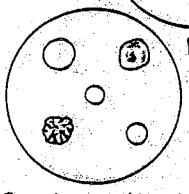



Calyx - showing 5 sepals forward one slightly longer than others

Seed colors:- yellow, "white", green, bluish, brown, purple, gray flecked with purple or brown.

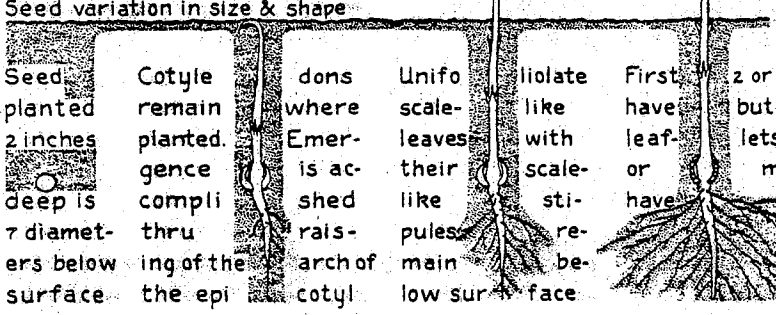


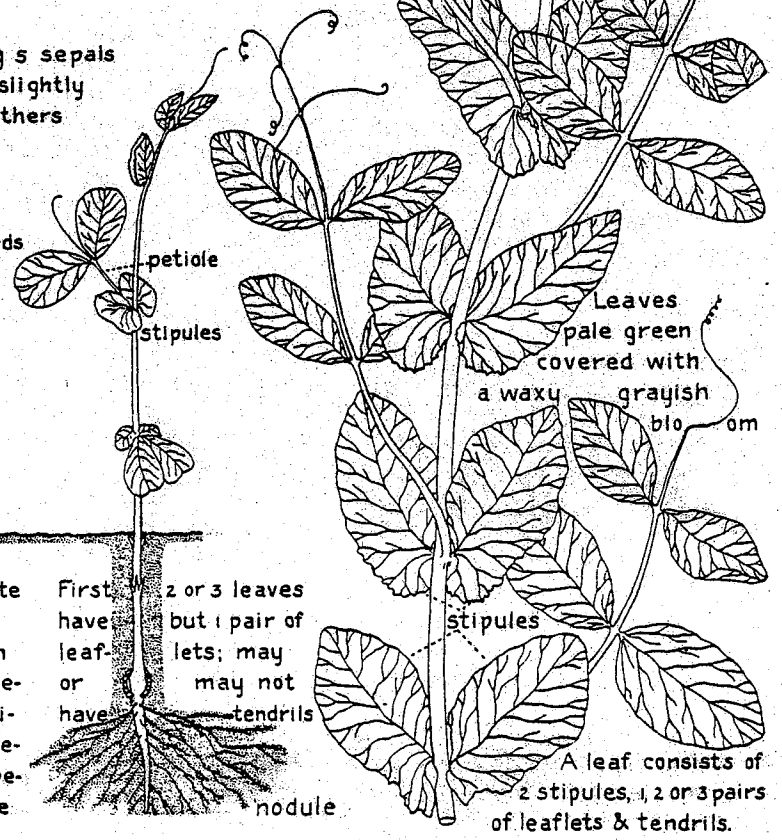

Legume - usual range: 2-9 seeds



Round seed - above - other shapes:- angular & wrinkled

Seed variation in size & shape



## THE HOP CLOVERS

Seeds per lb.:- Field 976,000-1,004,000; Low 911,000-1,300,000; Least 771,000-1,020,000
Bushel weight range:- 53 to 64 lbs. Standard weight 60 lbs.

| Stage of growth:- | 4" tall | Before bloom | In bloom | Seeds plump | |
|---|---|---|---|---|---|
| Total crude protein (dry):- | 26.1% | 23.3% | 16.4% | 9.3% | Field |
| | 26.2% | 22.6% | 15.3% | 10.5% | Low |
| | 24.1% | 21.8% | 16.6% | 9.3% | Least |

The 3 hop clovers were probably introduced from their native Europe as impurities in other seeds. They are winter annuals; regarded as tolerant of low fertility; and are seldom grown in pure stands. Field hop clover (T. agrarium) perpetuates itself in decidedly spasmodic fashion in the northeastern quarter of the U.S. Least hop clover (T. dubium) is called suckling clover in England & has been called yellow suckling or wild trefoil in the Northeast. It has also been given the doubtful designation "the true shamrock". Altho it has been found in New England, New Jersey, New York, Ontario, Michigan, some northwestern states & British Columbia, it is most widespread in the deep South. The third species (T. procumbens) is better called low hop clover rather than large hop clover because field hop clover is most often the largest of the 3. Low hop clover volunteers less commonly in the Northeast than field hop clover & less frequently than least hop clover in the Northwest, but is most abundant in the northern half of the southern states.

The hop clovers are most useful as pasture species. Under grazing conditions they resemble somewhat the habit of alsike clover in pastures in that they become more or less prostrate & are less easily defoliated to serious extent than if they grew upright in association with species cut for hay. However, they do not creep & root at the nodes like the white clovers (no stolons).

In the North field hop clover is most conspicuous in thin old hayfields on land below average in fertility. Its spontaneous appearance after absence of several years has led to the term "hop clover year" & often results in persons not acquainted with it enquiring as to its identity & value. In New York State at least once each year for the past 2 decades someone has asked if it could poison livestock - which, of course, is never the case. Because it most readily adapts its growth habit to hay or pasture, & because of its size, the writer believes the greatest potentialities of the 3 species is possessed by the field hop clover. However, he has never recommended its culture as a farm crop because he cannot tell you how to succeed even reasonably well with it. An associate, the late Prof. John H. Barron, made extended but futile efforts to cause the seed of field hop clover to germinate according to the needs of the farmer & under conditions of cultivation. His hand scarification (no impaction) suggested that some form of dormancy rather than hardness may be a factor.

Experience of southern farmers; observations of agricultural workers & the cooperative investigations of Hollowell & experiment station agronomists have helped to point the way for the culture of low & least hop clovers primarily as pasture species in the Southeast & extending westward to include parts of Oklahoma. Unless soil moisture is especially constant, seeding these hop clovers in plowed & worked fields proved less dependable than seeding in established sods. Also September or October seeding proved more satisfactory than earlier or later. Tall northern grass species which are stimulated into active vegetative growth with the advent of the cooler autumn weather often provide too much competition for hop clover establishment.

On the other hand, southern species like Bermuda grass (Cynoden dactylon) do not make so dense a sward & tend to become less active with the advent of cooler weather so that they provide a little protective cover without excessive competition for moisture. Whether clipt or not, establishment in Bermuda grass was satisfactory. In contrast, carpet grass (Axonopus compressa) makes a more dense sward & establishment was favored by clipping the top growth of this grass. Fertility, which favored grass growth, reduced the "catch" of seedlings.

These hop clovers, being winter annuals, provide late winter & early spring pasturage; whereas the annual lespedezas start slowly in spring & provide late spring & summer grazing. Except where fertility is very low & moisture very spotty attempts at growing the 2 legumes together in the same field have usually been at the expense of the lespedeza. However, the latter volunteers more dependably.

Once established, low & least hop clovers are a little less spasmodic in their volunteer appearance than field hop clover. For new stands a minimum of 3 pounds of seed is suggested. Inoculation is cheap insurance & especially important where members of the clover group have not recently been successfully grown.

# The Hop Clovers

Trifolium species

**T. agrarium** — FIELD HOP CLOVER
Central leaflet "sessile"
Stipules ½-¾"
Heads compact
30-60 flowered
After flowering standard petal remains spread
Slightly hairy
6" to 26" tall

**T. procumbens** — LOW HOP CLOVER
Central leaflet on petiolule
Stipules ⅓-½"
Heads compact
20-40 flowered
After flowering standard petal remains spread
More hairy
4" to 20" tall

**T. dubium** — LEAST HOP CLOVER
Central leaflet on petiolule
Stipules
Heads often open & lax
3-20 flowered ¼"
After flowering standard petal envelopes legume
Not hairy
4" to 20" tall

Inflorescence is butter yellow aging to a rich light brown

Head or "Hop"

Each scale-like structure is the back of the bent-forward tip end of the more or less horizontal standard petal.

Front
5/32 inch
Side

Single floret

a. standard petal
b. wing petals
c. keel petal
(side view)

Corolla - 5/32 inch

Pistil
a. b. c.
5/32 inch
d. e.
Stamens

petiole short - ⅛ to ¾ inch long

3 leaflets - palmately trifoliolate
margins serrated ½ to ⅔
distance from outer end
alfalfa ⅓-½
sweet clover ⅔

Stipules observe long sharp-pointed structure

Sexual parts
Pistil - a. stigma b. style c. ovary
Stamens - d. free e. united

Withered floret - showing how tip of standard petal bends forward. In its normal withered horizontal position the opposite face of the floret would be up with only x showing in head

5/32 inch
a. b.

Calyx - 5 sepals the 2 behind standard petal are shorter
a. exterior view
b. dotted lines show position of legume

1/16 inch
a. b.
Legume

Plant habit & all other sketches represent field hop clover unless otherwise stated.

Plants vary greatly in stem diameter, stiffness & branching

Fresh seed greenish yellow to deep orange

3/64 inch
b.
Seed

a. hilum
b. micropyle

Seed variation in size & shape a. b.

1. 2. 3. 4.

Seed planted ¼ inch deep is in thin diameters below surface

Germination radicle 1., cotyledons partially covered by broken seed-coat 2., arch or loop of hypocotyl 3.

Growth of hypocotyl 4. raises arch & cotyledons to the surface. A crust may prevent emergence or break off one or both important (for food) cotyledons

Cotyledons a. & b.

Unifoliolate leaf most common shape 1. Only one other shape in populations studied

First trifoliolate leaf at 1.

Trifoliolate leaves numbered in order of appearance to show typical First serrations is number 3. In weakness of early seedling growth hop clover approaches birdsfoot trefoil.

630,000 to 842,000 seeds per pound
Bushel weight range 58 to 66 lbs. Standard weight 60 lbs.

| Stage of growth: | 4" Tall | Before bloom | In bloom | Seeds plump |
|---|---|---|---|---|
| Total crude protein (dry): | 32.6% | 21.6% | 17.4% | 16.9% |

Ladino or giant white clover was brought to the U.S. from the Po Valley of Italy. In the latter country it is the leading legume for moist to wet soils. However, Italians, following the example of well-informed American farmers, are now becoming interested in alsike clover for their very wet soils. Ladino clover acreage in the U.S. has expanded very rapidly during the past few years. Where well adapted it is the best yielding white clover.

Despite its Italian origin the comparatively shallow root system contributes to the restriction of its most efficient utilization to areas where summers are relatively cool with a good supply of rainfall well distributed. Hot dry periods definitely reduce its growth, but do not kill it unless they are of long duration. It persists and grows longer during the heat of summer than wild white clover but is more susceptible than the latter to winter injury. However, when well managed in grass associations & under favorable soil & nutritional conditions ladino has withstood some very low temperatures. In most situations it behaves as a short-lived perennial sometimes perpetuated by volunteer re-seeding. Heavy textured soils are better than those of light texture, altho on silts & clays water retention often contributes to heaving injury. Ideal would be a productive, moderately drained loam with irrigation during dry periods. It is less seriously injured by heaving on hard-pan soils than red clover or alfalfa, but on such soils it commonly suffers from summer drought.

Altho ladino responds to lime up to a pH approaching 7, probably it is most practically limed as for red clover. This high fertility level legume needs much phosphorus & potash. These fertilizers are best applied annually. Nitrogen applications frequently complicate its management in grass associations. Inoculation of seed is practical only where none of the common clovers has thrived on the land for 8 to 10 years.

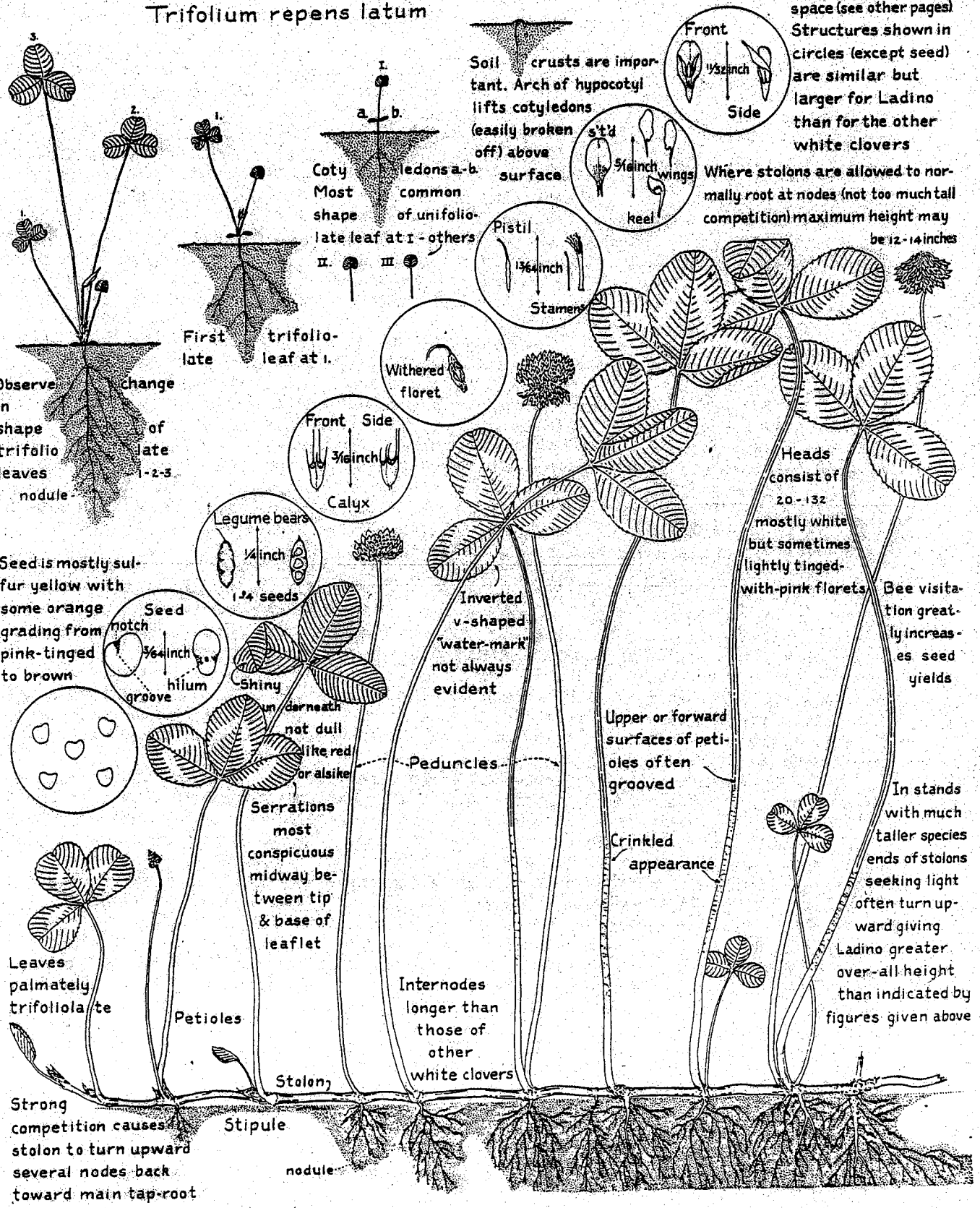
The creeping (stoloniferous) habit of ladino makes it more convenient to use it for pasturage than for hay or silage. However, the silage-pasturage combination is indeed commendable. It is seldom sown in pure stands because the presence of grass tends to reduce winter injury; to reduce the danger of bloat; & to reduce the very difficult problem of mowing. Grasses, by over-shadowing, complicate management problems. It is sometimes sown with the shorter lived red clover, timothy being the usual grass. When this mixture is cut as late as is common on some farms little ladino survives the long period of shading by the taller species. On the other hand, cut early for hay-crop silage in such a mixture, ladino may contribute much to after-growth. Grown with the very early orchard grass it must be grazed or cut for silage before that species becomes woody & provides shade for too long. In brome grass associations ladino has often thinned when removal time was gauged according to the later maturity of the brome grass. Bluegrass is a poor associate because that grass is a lighter yielder & because too close grazing usually defoliates the bluegrass much less seriously than the ladino. Thus, when used primarily for pasturage the management of ladino clover must not be like that ordinarily given Kentucky bluegrass and wild white clover in permanent pastures. Growth should reach approximately 8" before cutting or grazing. Closeness of grazing should depend on species of associated grass. With timothy or brome 2" or 3" is close enough. When the associate is orchard grass it is important that grazing be to 1" or 2".

Managing ladino to reduce winter injury is complicated by the fact that species like orchard grass continue to grow later than ladino as autumn days become cooler. To curb the grass some light grazing is required at this time. This top-growth removal reduces storage of food reserves important for the winter survival of the ladino clover. Carbohydrate & other food reserves are probably built up faster under high fertility conditions. This may be another reason for the better performance of ladino when liberally fertilized. Too late grazing also removes top-growth which helps hold snow to reduce freezing & thawing & the heaving that is associated with those processes.

Since ladino and the smaller white clovers cross when worked by bees, it is important that certified seed be sown. Amounts used in various mixtures range from 1/2 to 4 lbs. per acre but 1 to 2 lbs. are most common. Good combinations are 1 to 2 lbs. of ladino & not over 5 or 6 lbs. of orchard grass or 10 lbs. of brome grass. In mixtures with grass & upstanding legumes like red clover 1 lb. of ladino, because it creeps, may replace 2 lbs. of the taller growing legume species.

# Ladino (White) Clover

Trifolium repens latum



## OTHER WHITE CLOVERS

Common: 689,000 to 744,000; Wild: 659,000 to 733,000 seeds per pound
Bushel weight range: 57 to 64 lbs. Standard weight 60 lbs.

| Stage of growth: | 4" tall | Before bloom | In bloom | Seeds plump | |
|---|---|---|---|---|---|
| Total crude protein (dry) | 33.3% | 22.1% | 19.3% | 17.5% | Common |
| | 33.5% | 23.8% | 21.4% | 20.4% | Wild |

Common white clover & wild white clover are closely related & readily intercross, in fact all 3 white clovers may be crossed by bees. Because of their more or less prostrate habit they cannot persist very long unless some means of subduing associated taller vegetation is employed. For this reason they have followed with the intensification of agriculture. They probably originated not far from southeastern Europe, later spread to northern Europe & were brought to America by early settlers. Their low-growing habit has caused them to serve almost exclusively as pasture species. Both are highly palatable & nutritious since livestock normally consume only the tender leaflets, petioles, & flower shoots; leaving the creeping stems (stolons) for further spread & production. Contributing to their natural dissemination is the hardness of some of the seeds. The retention of this hardness makes it possible for some to pass uninjured thru the digestive tracts of animals or to lie dormant in the soil, & it helps explain the sudden appearance of white clover where none was evident earlier. Hard seed does not detract from problems of seedling establishment.

No species of legume will tolerate the uncontrolled & continuous close grazing that wild white clover will. The writer photographed wild white clover in County Kent, England where sheep grazing had been characteristically close on stands maintained for as long as 80 years. Wild white clover is a good associate for grass species like bluegrasses & bentgrasses which will likewise persist under more or less continuous close grazing. Experiments on the rotational grazing of bluegrass-wild white clover mixtures have not consistently shown either advantage or disadvantage. The shorter-lived common white usually makes larger yields, but for the farmer with land too difficult to plow periodically or for the one who will not bother with the details of careful management & rotational grazing, wild white clover (native or imported, volunteer or seeded) will continue to fill an important place in pastures.

Common is a much more variable species than wild white. Sometimes it approaches the dwarfness of wild white & sometimes it approaches the tallness of ladino. The common white sold in the north either as such or under the name, White Dutch, usually persists but 2 or 3 years in lawns or pastures. Farmers say "it comes & goes", but often when the common white plants disappear there remain a few more dwarf plants which have led to the suspicion that either wild white seed occurred in the common or persisted in the soil as hard seed--or both. The common white clover of the South is usually selected for taller stature than that of the cool, humid areas. In the deep South where heat is intense & moisture deficient it may often behave as a winter annual. Planting Louisiana-grown seed in northern states has sometimes led to serious winter-killing.

White clovers are shallow-rooted & therefore perform well on soils that are moisture retentive - or respond to irrigation. When the growing season provides above average rainfall, well distributed, the farmers call it a "white clover year." White clovers have a lime requirement close to that of red clover. They usually respond to phosphorus & potash. Very rare are white clover roots without some nodulation. Therefore inoculation is recommended only for white clovers being seeded on soils which for 8 or 10 years previous to treatment had failed to grow white or any of the common clovers.

In the South common white clover is seeded either with or on appropriate grasses among which are Dallis & Bermuda, using 2 - 4 lbs. of white clover seed per acre. In the North & Far-west it is usually wiser to seed ladino for pasture where plowing is not too difficult & to use common white in lawns. For the latter purpose wild white is preferable if a high percentage of clover is to be maintained for a long period, but much clover makes lawns slippery at times. Of course, where it volunteers, common white should be encouraged by liming & fertilizing. In the Northeast stands of wild white clover equal to any that are produced by seeding may be caused to volunteer by liming and mineral fertilization, but one must usually wait 2 or 3 years for this result.

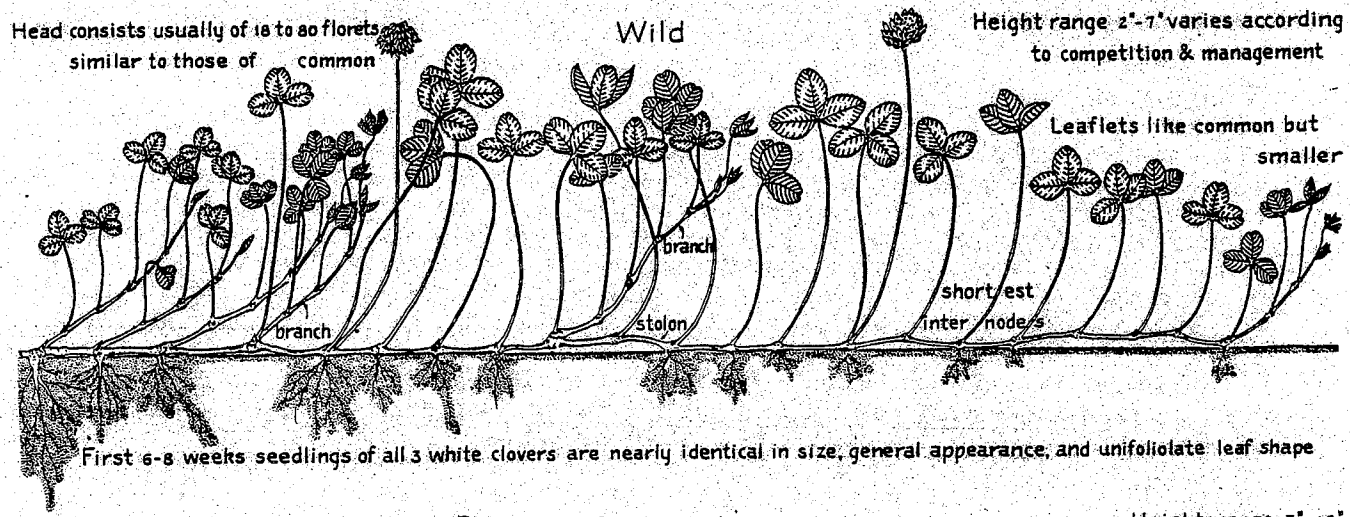
For seeding permanent pastures wild white may be justified over common on the basis of persistence & 1 or 2 lbs. should be sown with such species as bluegrasses. Such a seeding should include enough of some quick-starting grass like timothy or redtop to hold the soil during the establishment period. Total seed should not exceed 20 lbs./acre.

# Other White Clovers

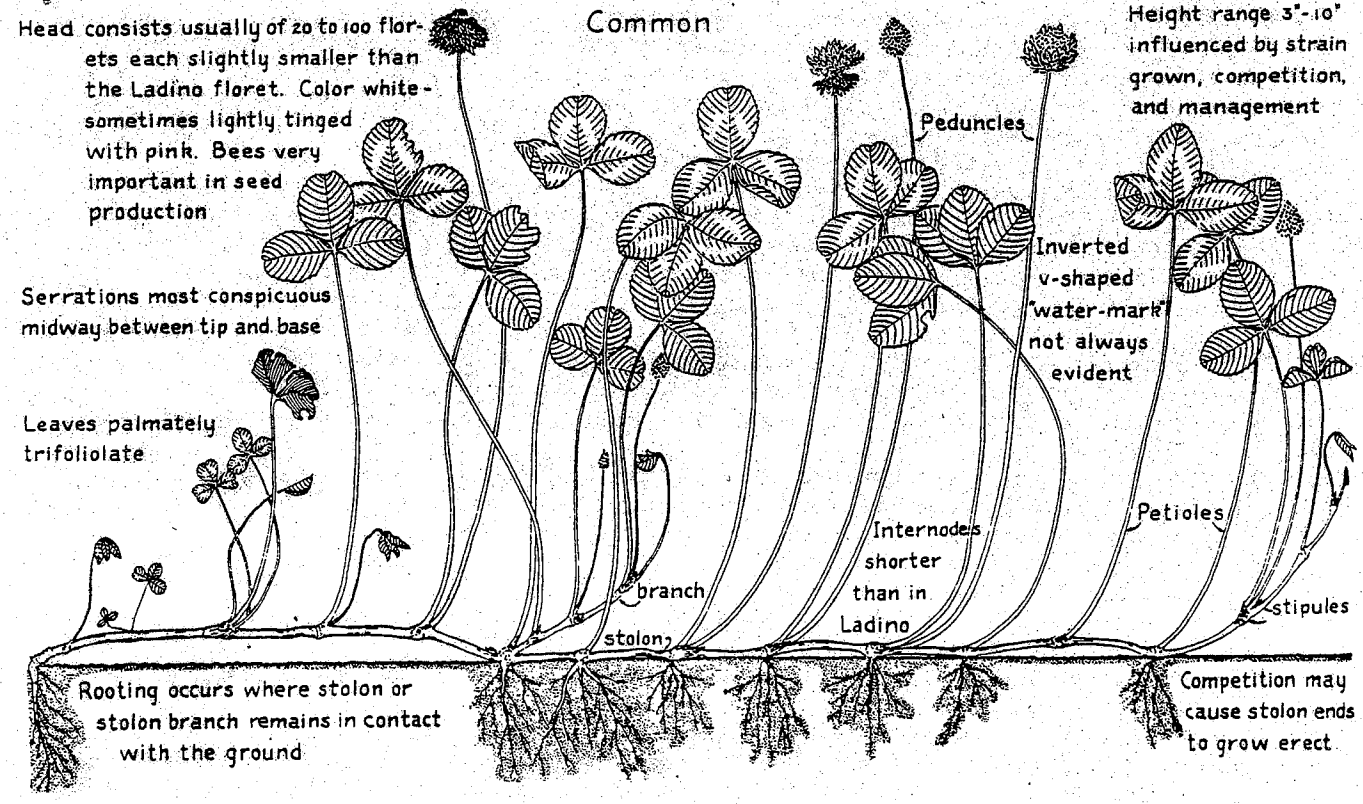
Common White Clover (Trifolium repens vulgare) Wild White Clover (Trifolium repens sylvestre)

A Quick Comparison of The Three White Clovers

| | Relative height | Leaflet size | Flowers per unit area | Florets per flower | Seeds-shape, color | Stolon inter-nodes | Stolon branch-ing | Length of life |
|---|---|---|---|---|---|---|---|---|
| Ladino | tall | large | intermed. | most | all | long | little | perennial |
| Common | medium | medium | most | intermediate | | medium | moderate | winter-annual, biennial, perennial |
| Wild | short | small | fewest | fewest | alike | short | much | long lived perennial |




First 6-8 weeks seedlings of all 3 white clovers are nearly identical in size, general appearance, and unifoliolate leaf shape



Medium: 258,000 to 291,000; Mammoth: 231,000 to 289,000 seeds per lb.
Bushel weight range 58 to 65 lbs. Standard weight 60 lbs.

| Stage of growth: | 4" tall | Before bloom | In bloom | Seeds plump | |
|---|---|---|---|---|---|
| Total crude protein (dry): | 27.8% | 18.8% | 15.3% | 12.1% | Medium |
| | 27.9% | 17.3% | 13.5% | 11.3% | Mammoth |

The red clovers are believed to have originated in south-western Asia. They attained importance first in Europe from whence they were introduced to America. They are most popular in the northeastern quarter of the U.S. where they are usually more dependable & more easily established than longer lived legumes. When farmers exercise somewhere near the care they take in seeding newer legumes, clover failures are uncommon. Because they more frequently function as biennials red clovers are best suited for use in rotations where land is in sod but one year. However, they are most commonly used where has is cut 2 to 3 years. In 1946 & 1947 a N. Y. survey revealed over 10% of red clover in 23%, 17% & 6% of 2nd, 3rd, & 4th haying year stands respectively. This could be explained by either or both--delayed germination of hard seeds or true perennial habit of some plants. Undoubtedly many of the perennial plants in a medium red clover field would survive longer if not for the ravages of diseases & the clover root borer. The latter probably has the greater effect because few plants escape. Mammoth red clover is inherently more perennial than medium.

Red clover is not as exacting in its lime, phosphorus, potash, & drainage requirements as is alfalfa but it is more so than alsike & various annual legumes such as soybeans & vetches. On the better soils & those with pH approaching 7 the medium is more satisfactory than the mammoth (or sapling) which grows tall, coarse & stemmy under such conditions. Where the soils are less productive, and especially on those that are droughty or have a pH not more than slightly below 6, mammoth would be preferable, as would be the case if the soil was wet in early spring & very dry in mid-summer. Winter-killing due to heaving increases rapidly as sub-soil mottling (reflecting poor drainage) occurs closer to the surface, beginning at about 15".

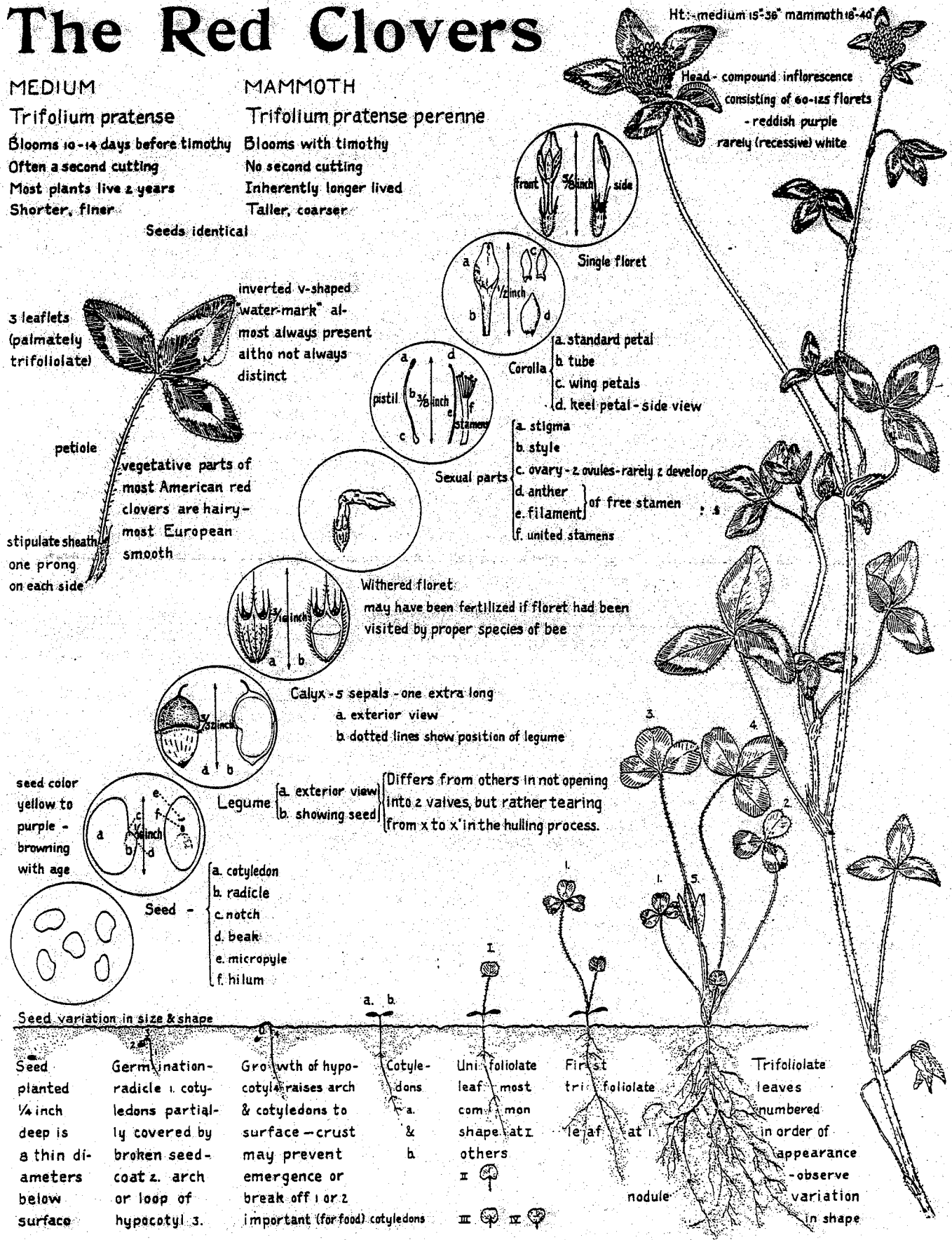
First cuttings are used mostly for hay, but ensiling is becoming increasingly popular as a means of reducing early June curing weather hazards. In hay-making preservation of green color is more difficult than with other legumes. Pasturing first growths may sometimes be advisable on land where a high % of land is plowable. After-growth of the medium becomes larger as the time of the first cutting is advanced from full-bloom toward early June, & the converse is also true. Such 2nd growths make excellent supplementary pasturage at a time when permanent pastures are unproductive, & if the first cutting was not taken too early, may make a seed crop. First growths are rarely harvested for seed. In contrast, mammoth red clover ("single cut") never makes a second hay crop in one season & usually provides little summer grazing. This is one reason why mammoth red clover seed is the more expensive.

Timothy is the most satisfactory grass to sow with red clover, but other grasses may be used. Medium red matures about 2 weeks before timothy; mammoth & timothy mature at about the same time. Timothy seed & red clover seed remain mixed in drill-boxes and present no mechanical seeding problems. Spring is the best time of year to sow red clover. It is less well suited to summer seeding than alfalfa probably because of temperature and moisture relations. Late summer & fall seedings are usually too susceptible to winter-killing. Close fall grazing or late cutting to denude spring-sown stands has reduced the snow-holding cover & increased heaving. Inoculation appears profitable only where soils become very acid or where none of the common clovers has been well-grown for 8 or 10 years.

The nearer to the farm where it is to be planted that clover seed is grown the better it will be adapted. Home-grown seed often does not have the advantage of processing thru expensive seed-cleaning machinery such as the better commercial seedsmen have & therefore may be less clean & pure. Clover seed is most economically produced in some of the valleys of the Rocky Mountain region, but much good seed is produced in Central & North-central states. Seed grown in areas where winters are less severe or seed which does not inherit winter hardiness should be avoided. Plant breeders have produced superior strains resistant to diseases but not to the very serious root-borer.

The upper limit of total red clover & timothy seed should be 16-18 lbs. per acre always with more than half clover. This amount may be reduced as the situation becomes more nearly ideal. Where early cutting is to be the rule, replace 2 lbs. of red clover with 1 lb. of ladino seed. For situations including wet spots 2 lbs. of red clover may be replaced by 1 1/2 lbs. of alsike--or the alsike may be broadcast in the wet spots.

# The Red Clovers



2,250 to 7,000 seeds per pound
Bushel weight range:- 54 to 66 lbs., standard weight 60 lbs.

| Stage of growth: | 4" tall | Before bloom | In bloom | Seeds plump |
|---|---|---|---|---|
| Total crude protein (dry): | 29.0% | 19.7% | 18.8% | 16.5% |

The soybean is one of the most ancient of cultivated crops; having been grown by Orientals largely for food, rather than feed, according to records for nearly 5000 years. As an American crop its greatest acreage expansion has occurred since 1930. About 5 times as many acres are producing soybean seed (grain) as hay. Altho some soybeans are grown in every state, the area of greatest concentration is in the corn-belt where they have replaced oats in those rotations in which occurs another crop usable as a companion for seedings. Another region in which acreage exceeds the average is in the Southeast. The soybean is a warm climate, warm soil annual.

Despite the fact that this crop is adapted over a fairly wide range of soils, yields are poor on dry sandy & wet heavy soils. Altho they grow fairly well on soils of low fertility, soybeans are not likely to become the salvation of the poorland farmer. The cowpea is much more widely adapted as to soils & fertility, but not nearly so widely adapted as to climate. Soybeans approach alsike in acidity tolerance. At Cornell in the last two decades the frosts which were heavy enough to kill corn also killed soybeans, but both survived light frosts which killed cowpeas. The soybean is a typical short day crop. In summer when day length has declined sufficiently, flowers appear almost regardless of the amount of vegetative growth previously made.

Over 100 so-called varieties are grown to greater or lesser extent in the U. S. These vary in many respects including:- color & shape of seed; color of legume; leaf size, shape & number; branching & strength of stem (growth habit); & length of growing season which ranges from less than 80 to over 200 days - usually the shorter the season the smaller the plant. Farmers & seedsmen complain that college varietal recommendations are ever-changing, but improvements & the ironing out of confusion in names justify changes. When grown for commercial processing, the yellow-seeded varieties should be chosen. For forage, color of seed is not as important as height, leafiness, freedom from lodging, & number of seeds per pound. For direct human consumption a special "vegetable" variety should be planted.

The oil content of the seed ranges from 15% to over 20%, method of processing being responsible for some of the variation. This oil is used for food & in many different ways in industry. The meal resulting from the removal of the oil contains approximately 45% of total crude protein & is used like cotton-seed meal in mixed feeds.

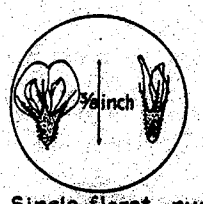
Soybeans as a hay crop are difficult to cure partly because of the thickness of the stems & partly because the leaves seem to impede the movement of air within the curing mass. More important, in much of the U.S. they are not ready to cut until the days have shortened appreciably; the temperature dropt; & dews have become heavy. Thus hours of curing weather are too few per day. Although soybeans are sometimes grazed, they cannot be favorably compared as a pasture crop with legumes which make recovery from crown buds. However, if grazing takes place when the plants are young enough (up to blossoming time) axilary buds may give rise to some re-growth. As forage one satisfactory use is as a substitute for a hay seeding that failed or winter-killed.

It is easy but not wise to view all legumes as soil improvers without drawing distinctions between annual, biennial, & perennial species. Like other legumes, this one may grow well without nodules on nitrogen-rich soils. Legumes may even bear nodules which fix little or no nitrogen. Also it is known that harvested legumes contribute to soil improvement according to the amount of residue made up of stubble & roots. In this respect all annual legumes rank below those which live longer. Soybean stubble leaves the ground in readily erodable condition. This legume draws heavily on soil minerals & that fact should be borne in mind in fertilizing. There is recent evidence that soybeans are best fertilized like a non-legume.

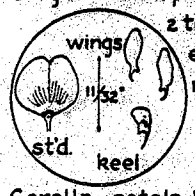
Soybeans are best planted immediately after corn planting time. They are poor competitors & weeds need to be controlled by seed-bed preparation; by delaying planting until they can grow somewhere near as rapidly as the weeds; & of course by cultivation between rows or with the rotary hoe & weeder, if drilled solid. Most soybeans grown for seed are planted in rows. Unless weeds prohibit, finer stemmed hay results from solid plantings which are also preferable for soiling & green manure. For row planting 1 to 5 pecks per acre provide for variation in seed size & row spacing; while drilling calls for 6 to 9 pecks. Two inch deep planting is safe in sandy loams but stand reduction occurs if seed is sown so deep in heavy soils. Inoculation is more important with soybeans than with most legumes.

# Soybeans

Glycine max or Glycine soja

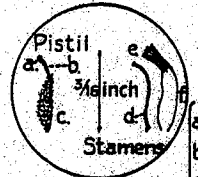



Single floret - purple or white

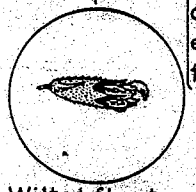



2 to 16 florets in each axilary raceme

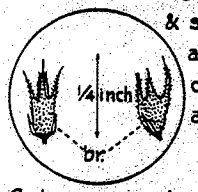
Corolla - petals labeled



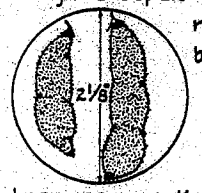

Sexual parts -
a. stigma
b. style
c. ovary
d. filament
e. anthers
f. united stamens



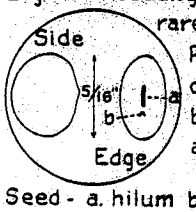
Wilted floret - self-pollinated & self-fertile but a small % of crossing is brot about by bees



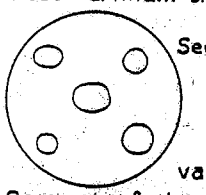

Calyx - 5 sepals - forward 1 longest rear 2 united as br. - bracteole




Legumes - usually contain 2 or 3, rarely more, seeds. Ripe legume colors: - yellow, brown, gray and black.

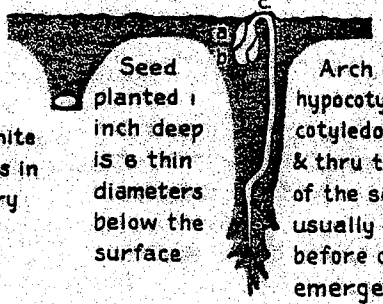



Seed - a. hilum b. micropyle



Seeds - yellow
green
brown
black
vari-colored

Some size & shape variations



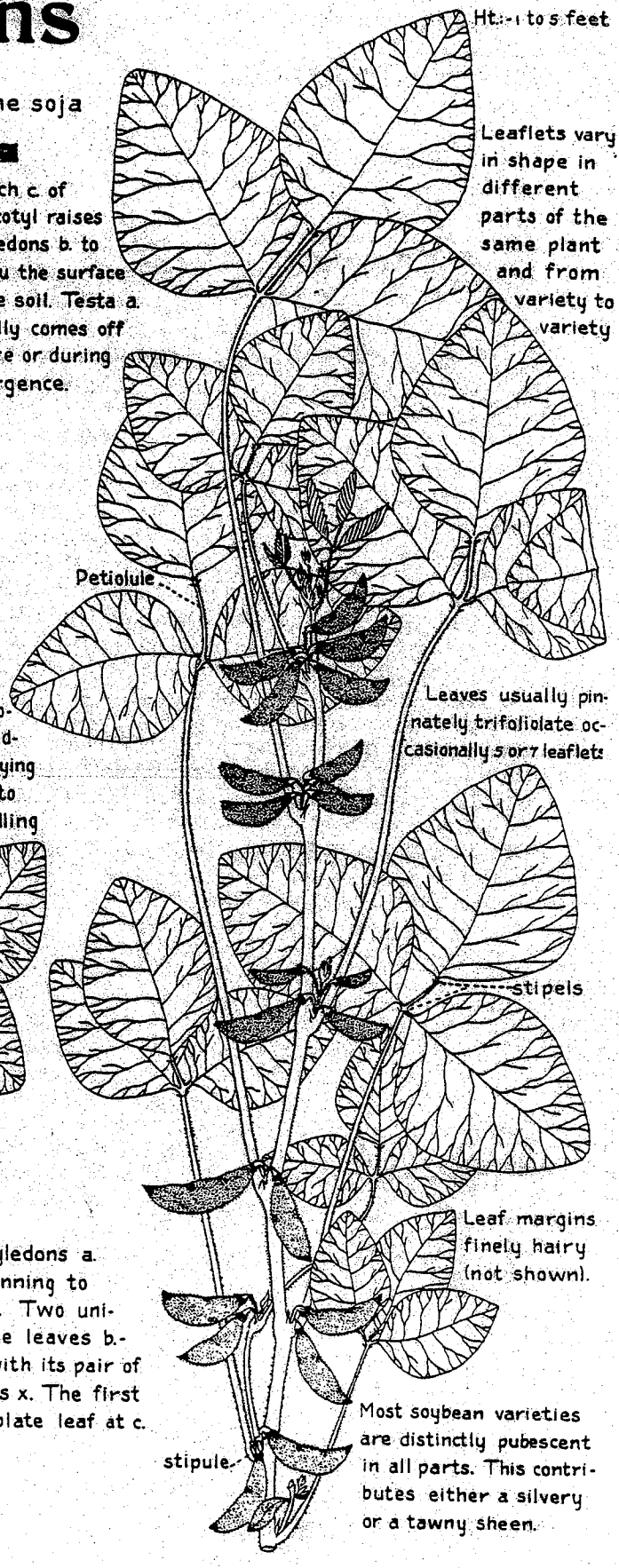

Seed planted 1 inch deep is 6 thin diameters below the surface

Arch c. of hypocotyl raises cotyledons b. to & thru the surface of the soil. Testa a. usually comes off before or during emergence.

Cotyledons a. have grown very large - serve in photosynthesis in addition to supplying reserve food to start the seedling

Cotyledons a. beginning to wither. Two unifoliolate leaves b. - each with its pair of stipules x. The first trifoliolate leaf at c.

Ht: - 1 to 5 feet




Leaflets vary in shape in different parts of the same plant and from variety to variety

Leaves usually pinnately trifoliolate occasionally 5 or 7 leaflets

Leaf margins finely hairy (not shown).

Most soybean varieties are distinctly pubescent in all parts. This contributes either a silvery or a tawny sheen.

# BIENNIAL SWEET CLOVERS

White: 210,000 to 258,000; Yellow: 248,000 to 260,000 seeds per pound.
Bushel weight range: hulless seed 57 to 64 lbs. Standard weight 60 lbs.

| Stage of growth: | 4" tall | Before bloom | In bloom | Seeds plump | |
|---|---|---|---|---|---|
| Total crude protein (dry) | 25.9% | 18.6% | 15.4% | 10.3% | White |
| | 26.1% | 18.9% | 16.4% | 10.4% | Yellow |

Sweet clover is native to the old world where it gained the generic name Melilotus, which translated from the Greek, means honey lotus. European bee-keepers were first to appreciate the potential yields of light honey which may come from its nectar. American apiarists called it bokhara clover & often undertook to scatter its seed for bee pasture. Sweet clover is somewhat of a misnomer for, while its fragrance is sweet, the plant tastes distinctly bitter due to the presence of coumarin. The latter compound sometimes breaks down in spoiled hay & silage to adversely affect the clotting powers of the blood of livestock, but causes no trouble if the forage is either unspoiled or fresh.

Biennial sweet clover includes both yellow & white flowered species; the latter being much the more common, the former a little easier to establish under adverse conditions. Natural mutations within each species have led to varieties too numerous to mention here. There are also 2 annual species which are of lesser agricultural value & not considered in this discourse. Perhaps too much has been written about sweet clover as a hay plant & not enough about its value for pasture. When it is ready to cut for hay (late bud) in humid states the ground is high in moisture & the sap content of the plant is very high. Leaves dry too rapidly & stems too slowly usually resulting in coarse stemmy hay. Leaves may be saved by ensiling rather than curing, but because of its high lime, protein & water content, preservatives help make better silage with lower storage losses. If a 2nd year 2nd growth is desired, early cutting is necessary & at heights approaching 12" because live buds in the leaf or stem axils are the only source of new growth since there are no crown buds then. Hay of quality approaching alfalfa may be cut in the late summer of the year of seeding when seeded alone or if the nurse crop is removed early.

For grazing it has great carrying capacity once stock learn to like it. Late flowering white blossom varieties are preferable. The nearer knee height it can be maintained the better will be the quality of the herbage & sacrifice in yield will not be important. This is a difficult standard because growth rate is not uniform to the end of the 2nd year. A system whereby some late summer grazing is provided by first year stands & early spring to mid-summer grazing by second year stands approaches maximum utilization but rarely carries thru the warm period with adequate feed. The danger of bloat is ever-present but probably less serious than with alfalfa, the common clovers & ladino. In understocked pastures the less desirable early varieties may re-seed.

Sweet clover thrives on most soils which contain enough lime for alfalfa, but its range of adaptation is wider than that of alfalfa. Where both can be grown, the latter is finer stemmed, perennial & usually preferable. Sweet clover is more tolerant of alkali than alfalfa & about as drought tolerant. In northern states on poorly drained soils it may heave out to the extent of 5" & still make a fair crop. The warm, humid environment of our southeastern states has a lesser adverse effect on sweet clover than on alfalfa. Very few alfalfa varieties are more cold tolerant than sweet clover.

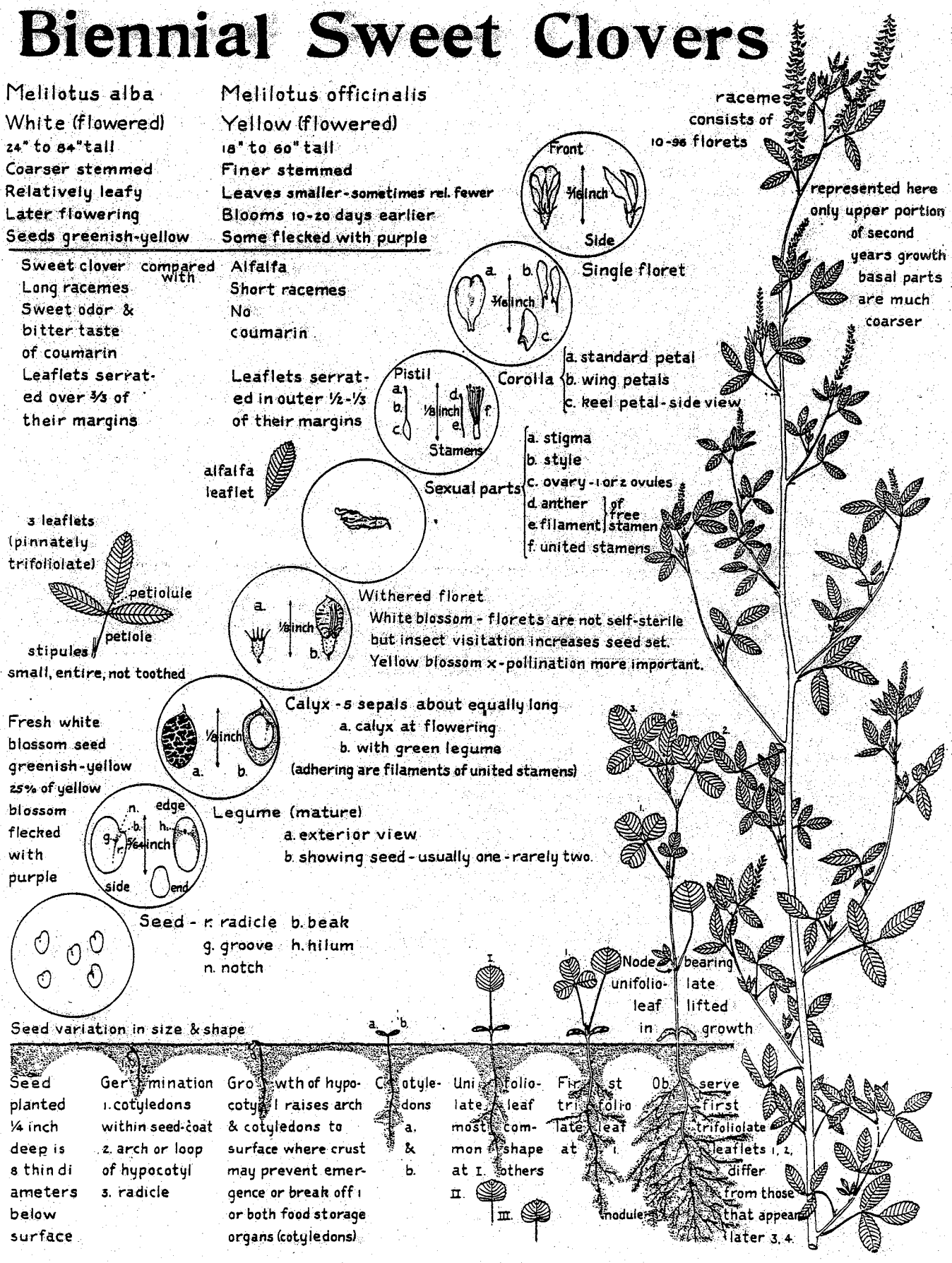
For soil maintenance & improvement sweet clover ranks especially high if the tops are plowed under at the best stage. It also excells other legumes when tops are removed & only stubble & roots are returned to the land. The ideal time to plow is in the spring when it has made 6" to 12" of top-growth. Fall plowing commonly fails to kill it.

One of the problems of sweet clover culture is its strong tendency to produce hard seed. When the percentage runs above 50, as is often the case, careful light scarification is desirable to improve germination without injuring the non-hard seed. When not scarified, hard seed has been known to lie in the soil for many years without germinating. Early spring seeding is most common. When the companion crop is winter grain, it is desirable to enlist the aid of nature in covering the seed by sowing when the ground is honey-combed with frost. If this is not possible, what at the time appears to be very drastic treatment--spike tooth harrowing with teeth set backward--of the winter grain seems to be necessary to cover the clover seed. About 15 lbs. per acre of seed capable of quick germination should be the maximum--less will suffice if the environment approaches ideal. Inoculation is important. Sometimes, despite the danger of early spring freezes killing seedlings, winter seeding is practiced. For this it is seldom wise to sow over 20 lbs. of unscarified (high % hard) seed or 25 to 30 lbs. of seed in the hull per acre.

# Biennial Sweet Clovers

| Melilotus alba | Melilotus officinalis |
|---|---|
| White (flowered) | Yellow (flowered) |
| 24" to 84" tall | 18" to 60" tall |
| Coarser stemmed | Finer stemmed |
| Relatively leafy | Leaves smaller - sometimes rel. fewer |
| Later flowering | Blooms 10-20 days earlier |
| Seeds greenish-yellow | Some flecked with purple |

| Sweet clover compared with | Alfalfa |
|---|---|
| Long racemes | Short racemes |
| Sweet odor & bitter taste of coumarin | No coumarin |
| Leaflets serrated over 3/3 of their margins | Leaflets serrated in outer 1/2-1/3 of their margins |



# DEFINITIONS OF COMMONLY USED LEGUME TERMS

ACUTE:- Ending in a sharp angle.
AFTERMATH:- (same as rowen) The second, shorter growth of a stand previously cut for hay, hay crop silage, or (much less likely) for seed.
APETALOUS:- Having no petals.
APPRESSED:- Lying close against a surface.
AXILARY:- Originating in the angle formed by a stem with a leaf petiole or branch.
CILIATE:- Fringed with marginal hairs.
CORDATE:- Heart-shaped with the point upward.
DEHISCE:- To naturally & automatically separate the two valves setting free the seeds.
DIADELPHOUS (stamens):- Grouped by their filaments into 2 sets; in most legumes 9 & 1.
DOMINANT:- A character possessed by one parent of a hybrid which is manifested in the hybrid to the apparent exclusion of the contrasting or recessive character.
DORSAL:- The back or outer surface of a part or structure. (opposite of ventral)
EMBRYO:- The miniature or rudimentary resting-stage plantlet found within the seed.
FLORET:- Usually one flower of a group which makes up what is called the inflorescence.
FOLIATE:- Having leaves.
FOLIOLATE:- Having leaflets.
FRUIT:- The ripened ovary which contains the seed. (legume itself technically speaking)
FUNICLE (same as funiculus):- The tiny stalk arising from the placenta of the ovary (or legume) which bears the ovule that ripens into the seed.
GLAUCOUS:- Appearing as if covered with a fine powdery wax which may be rubbed off with the fingers as is possible with that found on the fruit of the grape.
INFLORESCENCE:- A cluster or group of flowers which are organized either into a raceme, an umbel or a head.
IRREGULAR (flower):- Showing inequality in the size, shape, or union of similar parts.
KEEL (petal):- The 2 united anterior (front) petals in which are found the sexual parts.
LATERAL:- On or at the side.
LEGUME:- Technically, the fruit that results from the ripening of the ovary of a leguminous plant. It is inaccurately called a pod. It is one-celled; two-valved; consists of a simple pistil; & the seeds are borne along the inner or ventral suture. Wide usage has resulted in leguminous plants being called legumes.
MIDRIB:- The main or central vein (or rib) of a leaf.
MONODELPHOUS:- All stamens united into one group by their filaments.
OBCORDATE:- Heart-shaped with the point downward.
OBOVATE:- Egg-shaped with the larger end upward.
OVATE:- Egg-shaped with the larger end downward.
OVULE:- The body found within the ovary which after fertilization becomes the seed.
OVARY:- The basal part of the pistil which contains the ovules. It becomes the legume.
PISTIL:- The important female structure which consists of ovary, style & stigma.
PEDICEL:- The stem of an individual flower in a group such as a raceme.
PEDUNCLE:- The stem of a group of flowers such as a head or raceme or an umbel.
PETIOLE:- The stem or stalk of a leaf.
PETIOLULE:- The stem or stalk of a single leaflet.
POD:- A loose, non-specific word, used to refer to any dry, dehiscent fruit.
RACEME:- A simple inflorescence of pediceled flowers upon a common, more or less elongated stem-like structure or axis.
RADICLE:- The part of the embryo below the cotyledons; the lower portion of which develops into primary root.
RECESSIVE:- A term applied to describe a characteristic which fails to manifest itself in a hybrid because it is masked by the dominant form; the gene is nevertheless present, & may become evident in a succeeding generation.
RHOMBOID-OVATE:- An ovate shape modified to the extent of suggesting a parallelogram with no two adjacent sides equal.
SAGITTATE:- Like an arrow-head with basal lobes directed down-ward.
SEED:- The ripened ovule.
SESSILE:- Without a stalk of any kind; no pedicel or peduncle; no petiole or petiolule.
TESTA:- The outer, usually hard, sometimes brittle seed-coat.
UMBEL:- An inflorescence in which the pedicels all appear to originate from one point.
VALVE:- One of the two halves into which the legume may split or be split.
VENTRAL:- The front, inner, or anterior part of an organ. (opposite of dorsal)