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CROPS FOR THE DOUGLAS DALY REGION

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CROPS FOR THE DOUGLAS DALY REGION

Prepared by Plant Industry and
Research Services

SUSTAINABLE AGRICULTURE

THE DEPARTMENT OF PRIMARY INDUSTRY AND FISHERIES IS COMMITTED TO THE PRINCIPLES AND PRACTICES OF SUSTAINABLE AGRICULTURE

Definition:

Sustainable agriculture is the use of practices and systems which maintain or enhance:

- the economic viability of agricultural production;
- the natural resource base; and
- other ecosystems which are influenced by agricultural activities.

Principles:

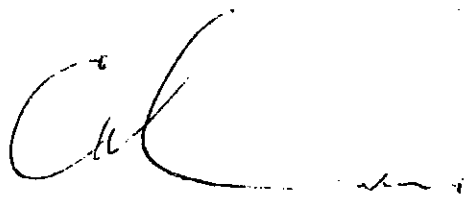
1. Agricultural productivity is sustained or enhanced over the long term.
2. Adverse impacts on the natural resource base of agricultural and associated ecosystems are ameliorated, minimised or avoided.
3. Harmful residues resulting from the use of chemicals for agriculture are minimised.
4. The nett social benefit (in both dollar and non-dollar terms) derived from agriculture is maximised.
5. Agricultural systems are sufficiently flexible to manage risks associated with the vagaries of climate and markets.

FORWARD

This publication provides a summary of the agronomic recommendations, diseases and insect pests relating to crops suitable for growing in the Douglas - Daly region. It has been specially produced on the request of A.D.M.A. for distribution to potential project farmers in the area.

It should be noted that some of the latest material is based on experimental plot work and not broadacre experiments, and it is likely that some of the recommendations may be modified in the future as a result of experiments currently being undertaken. Nevertheless, this publication contains the most up to date information available at the present time. Future updated recommendations will be published by the Department of Primary Production in the form of "Agnotes".

I am grateful to the many officers of the Department of Primary Production who are collectively responsible for this new and valuable publication.



C.H. GURD

A/Secretary of
Department of Primary Production

30 April 1981

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A SUMMARY OF RECOMMENDED PRACTICES FOR MAIZE GROWING IN THE NORTHERN TERRITORY

by G. Schultz, Agronomist (Crops), Darwin

MAIZE GROWING AREAS

The potential area for maize growing extends from the 859 mm isohyet through to the higher rainfall areas in the North. This means that the area north of Katherine is capable of supporting a maize crop in a normal wet season, although Katherine can be considered marginal in most seasons.

SITE SELECTION

Important factors to consider in site selection are:-

access, soil type, drainage and susceptibility to erosion.

If access is poor, early rain can interfere with transport of machinery to the site. Later the crop must be inspected for evidence of nutritional deficiencies, insect pests and disease. So good access is important.

Maize can be grown on a wide range of soil types, but they must have good drainage as maize will not tolerate waterlogging. Light textured soils are more desirable than heavy soils, so that the root system of the maize plant can fully develop. Soils should be moderately acid to neutral (pH 5.5 - 7.0).

The area selected should be as flat as possible, but if the site is sloping, soil conservation measures should be undertaken.

LAND PREPARATION

In clearing new land for maize, some trees may be left for shade so that the area can be used in rotation with pastures. These also act as a nesting place for birds which may cause considerable damage to emerging maize plants, so a plan for future rotations needs to be considered at clearing. Trees are best left as a group rather than as single trees.

Deep ploughing will aid in the removal of roots. A good chisel ploughing on the contour, followed by a heavy discing and harrowing, should prepare a seed bed suitable for maize.

The final seed bed should be free of weeds and cultivated enough for a fast emergence of the maize seedlings.

TIME OF PLANTING

The crop should be planted before the end of December so that flowering takes place in a favourable rainfall month, e.g. February. Time of planting will of course vary from season to season, but if late plantings are necessary it is advisable to use an early maturing variety.

RECOMMENDED VARIETIES

RAINFALL ZONE	VARIETY	HARVEST PLANT POPULATION PER HECTARE	MATURITY TIME (DAYS)
900 mm	XL81, PQ500	45 000	110
	(XL77, XL399)	40-45 000	115
1200 mm	QK217	45 000	120-140
	GH128	45 000	120-140
	GH390	45 000	120-140
	(XL99, F66)	45 000	120-140
1500 mm	QK217	45 000	120-140
	GH128	45 000	120-140
	XL99	40 000	120-140
	GH390	45 000	120-140

SOURCE OF SEED SUPPLY

PQ hybrids

Wright Stevenson and Co Ltd
45 Reginald Street
Rocklea, Queensland

XL hybrids

Dekalb Strand Seed Co Pty Ltd
121 Carthage Street
Tamworth, NSW

GH hybrids

NSW - Hybrid Maize Seed Co-op Ltd
PO Box 61
Grafton, NSW

OR

Arthur Yates and Co Pty Ltd
PO Box 147
Darra, Queensland

QK hybrids

Atherton Tableland Maize Board
Railway Lane
Atherton, Queensland

PLANTING

It is best to use a 2 row or 4 row planter suitable for maize seed. Careful calibration of the planter should be carried out. A normal combine seed drill can also be used for some types of seed by blocking off appropriate drill runs to give correct row spacing, but it should be checked frequently to ensure correct seed drop. Large seeded varieties will not go through a standard combine, so if using such a machine special grades of round seeds should be purchased, as flats may not feed evenly.

SEEDING DEPTH

Seed should be planted at a depth of 5 cm with the soil slightly compressed to put the seed in firm contact with the soil.

PLANT POPULATION AND ROW SPACING

Uniform seed distribution in the row is desirable. This spacing will depend on row spacing and the recommended plant population. Under our conditions, final harvest plant stands should not be less than 35 000 plants/ha.

A harvest population of 40 000 to 45 000 per hectare is recommended depending on variety. In wet years or under irrigation harvest populations can be higher. The planting population should be 15% higher than the desired harvest population, to allow for mortalities from planting to harvest.

Row spacing should be 75 - 90 cm so the seed spacing to be used within the rows can then be calculated, as shown in the following table. The row spacing is very important on some harvesters and a check of the row spacing for the harvester is necessary before planting.

TABLE 1

Seed spacing within rows at different row spacings and plant populations.

HARVEST POPULATION PER HECTARE	PLANTING POPULATION PER HECTARE	DISTANCE (CM) BETWEEN SEEDS WHEN PLANTING AT DIFFERENT ROW WIDTHS			
		50 cm	75 cm	90 cm	95 cm
35 000	40 250	50	33	28	26
40 000	46 000	43	29	24	21
45 000	51 750	39	26	21	20

There are 2640 - 4400 seeds per kg depending on type of seed, so weight of seed to order will vary with the type. It is best to buy good quality seed as a saving in buying poor seed will lead to losses in production far greater than the initial saving. A germination test should also be carried out before working out seeding rate as, if germination is poor, extra seed will be required. Seed should also be treated for Java Downy Mildew at planting. (For further information refer to Agnote 80/2, Agdex 111/637)

FERTILIZER

Amounts of fertilizer to apply will vary from soil to soil and the cropping history of the site, but the following general recommendations should be followed.

TABLE 2

Rates of fertilizer (kg/ha) to apply to maize on different soil types and in different areas.

SOIL TYPE	SUPER-PHOSPHATE	UREA	POTASH	TRACE ELEMENTS
Adelaide River North				
Lateritic Gravelling Soils	500	200	100	-
Red Brown Soils	400	200	-	Zn & Mg?
Levee	300	200	50	Zn & Mg?
Daly Basin				
Red Clay Loams	300	180	-	-
Sandy Clay Loams	300	200	-	Zn?
Others	350	200	50	?
Katherine Area				
Levee	300	150	100	Zn?
Red Earths	250	150	-	-
Others	300	150	50	-

If the maize planter is fitted with fertilizer units, it is best to use these at sowing. If not, then the fertilizer should be broadcast. For more information on fertilizers for your area contact your district office.

TIMING OF FERTILIZER APPLICATION

Phosphorus is essential for early seedling growth and should be applied at or before planting. Large demands for nitrogen occur from about 30 days onwards. In the high rainfall areas and on light textured soils, nitrogen (urea) applications should be split if possible as nitrogen is easily lost from the soil.

One third to one half of the amount should be applied at planting and the remainder 25 days later. Potassium (muriate of potash) can be applied at any time from planting to mid-vegetative growth. As the maize planter has only one fertilizer box, this should be used for the urea. Super and potash can be applied early during the weed cultivations.

WEED CONTROL

Chemical weed control is necessary after land preparation has given a clean seed bed. ATRAZINE applied as a pre-emergence or early post-emergence spray has given good control of broad leaved weeds and satisfactory control of most grass weeds.

Atrazine is available commercially in both powder and liquid forms. If it is applied post-weed emergence it should be applied in combination with a wetting agent.

The rates of active constituent of atrazine that should be applied are:-

Clay Loam Soils	2.5 - 3.5 kg/ha 4.0 - 5.0 L/ha
Sandy Loam and Levee Soils	2.5 kg/ha 4.0 L/ha

USE HEAVIER RATES WHEN GRASS WEEDS ARE BAD

N.B. These are active constituent levels of chemical. The actual rate of compound applied is higher, e.g.:-

Gesaprim 500 FW®	500 g/L atrazine
Gesaprim 80®	800 g/kg atrazine
Atradex 50 Flocal®	500 g/L atrazine
Atradex 80®	800 g/kg atrazine

The chemical needs to be applied with a minimum of 100 L of water per sprayed ha - higher volumes give more uniform spray. Large clods prevent the spray reaching germinating seeds and cause uneven results. Post-emergent sprays need a wetting agent at the rate of 250 mL/100 L of spray. For grass weeds Dual® can be added at 2 L/ha Dual® and 3 L/ha atrazine for better weed control.

WARNING : ALL CHEMICALS ARE DANGEROUS. READ AND FOLLOW DIRECTIONS ON LABEL.

PESTS

If wallabies and pigs are in the maize growing area, attention should be paid to fencing. Magpie geese and corellas can cause damage by digging up the seed after sowing. If there is water close to the crop geese normally graze that particular area - they can harvest the grain of low areas.

Note: R appearing after a chemical name indicates that it is a registered trade name.

HARVESTING

It is advisable to delay harvesting until the grain has dried on the plant to safe storage moisture levels (12 - 13%). Maize picker and picker shellers are marketed but these are losing favour to attachments for fitting to standard "all crops" harvesters.

STORAGE

Safe storage requires that the moisture content of the grain be below 14%. For short term storage, cobs may be left in the husks and shelled as required. For long term storage, the grain should be shelled and stored in silos.

For more detailed information on maize growing, contact the crops agronomists of the Department of Primary Production at either Darwin or Katherine (phone 89.7398 or 72.1722).

DISEASES OF MAIZE

by B.D. Conde
Plant Pathologist, Darwin

The Northern Territory is remarkably free of maize diseases compared with the rest of Australia. A race of Southern leaf blight, however, caused considerable damage to maize crops in the early 1970's. Recently, Java downy mildew of maize, an important disease in parts of Indonesia, was found in the Northern Territory.

JAVA DOWNY MILDEW

Downy mildews cause significant losses to maize crops through out the world. Java downy mildew, caused by the fungus *Sclerospora maydis*, was first observed in Australia in 1980 in a triangular area enclosed by Daly Waters and Adelaide River in the Northern Territory and by Kununurra, in the north-west of Western Australia. Previously, Java downy mildew was known only in parts in Indonesia where it caused considerable loss to maize crops.

Symptoms

The most common symptom of Java downy mildew is a broad, light green striping of the leaves of the maize plant. The fungus invades the growing plant by aerial infection and produces stripes in successive leaves. Infected plants are often distorted in many other ways such as dwarfing or gigantism, or the production of abnormal tassels or cobs.

Control

Treat seed with Apron^{R} fungicide at planting. Plant crops as early as possible in the season. Use varieties with resistance such as Sergeant, Major or CM3. (For further information refer to Agnote 80/2, Agdex 111/637).

SOUTHERN LEAF BLIGHT

Southern leaf blight is caused by the fungus *Drechslera maydis*. Race T of this fungus caused a severe disease in hybrids where the Texas male sterile cytoplasm was used.

Symptoms

Small oval (up to 10 mm long and 5 mm wide) pale brown spots with a dark border, sometimes surrounded by a pale-yellow halo, occur on leaves, leaf sheaths and cob husks. The spots may reach 40 mm in length in favourable weather on highly susceptible varieties. Affected leaves will die prematurely.

Control

Southern leaf blight is no longer a problem because susceptible cultivars containing the Texas male sterile cytoplasm are not available.

NORTHERN LEAF BLIGHT

Northern leaf blight is caused by the fungus *Drechslera turcica*.

Symptoms

Long spindle-shaped (up to and exceeding 10 cm long but seldom more than 2 cm wide) greyish green watersoaked spots, becoming light brown or grey in colour occur on the leaves.

Control

Infections of northern leaf blight in the Northern Territory have never been severe enough to warrant control.

TROPICAL RUST

Tropical rust caused by *Puccinia polysora* occurs only sporadically in the Northern Territory.

Symptoms

Small (0.5 to 1 mm diameter) round reddish brown pustules or rust spots are usually distributed relatively uniformly over the maize leaf. Rust spots on mid ribs, leaf sheaths and ear husks are larger and elongate to irregular in shape.

Control

Not necessary in the Northern Territory. In Queensland control is achieved by the use of resistant varieties.

WALLABY EAR

Wallaby ear is a disease with virus-like symptoms and is thought to be caused by a virus. This disease is associated with the feeding of the leaf hopper *Cicadulina bipunctella*. Wallaby ear is more prevalent in later crops than early crops and in coastal areas than inland.

Symptoms

Leaves on affected plants are dark green, rolled inwards, harsher and stand upwards at an acute angle to the stalk. Secondary veins are thickened at intervals on the lower surface of leaves, forming galls. Plants affected early in their life are severely stunted, while plants affected later in their life are slightly affected and may grow out of the disease. Plants older than three weeks old appear to be resistant.

Control

Do not plant maize late in the season in coastal areas. Spraying with recommended insecticides is beneficial where *Cicadulina* leaf hoppers are prevalent.

MAIZE STRIPE

Maize stripe which is caused by maize mosaic virus, has been found in the Darwin area. The virus is not related to maize dwarf mosaic virus which occurs in Qld. and N.S.W. Maize mosaic virus is transmitted by a small brown leaf hopper, *Peregrinus maidis*.

Symptoms

The initial infection appears as light specks on young leaves. Later symptoms are yellow or almost white stripes or broad bands radiating out from the leaf bases parallel to the veins. Plants affected early are stunted, kinked and bleached. Ants are often attracted by the leaf hoppers which frequently establish colonies in the plants.

Control

Not generally warranted and no effective controls known.

INSECT PESTS OF MAIZE

by A.J. Allwood, Senior Entomologist, Darwin

Compared with many crops grown in the Northern Territory, maize does not seem to have the same problems with insects. The range of insects which attack maize is quite large but their economic importance is not necessarily related to the frequency with which they occur.

As in all insect control situations, the earlier that an infestation can be recognised and identified the earlier insect control can be implemented. Insects can be more easily controlled in the earlier stages of their life cycle e.g. Heliothis caterpillars are easier to control if they are 10 mm long rather than if they are 30 mm long. In addition, if left to later stages, more damage is done.

It is important, therefore, that growers be able to recognise the major insect pests and the damage they do. To do this successfully, regular checks of crops are absolutely essential.

The major pests of maize are Heliothis caterpillar (or corn earworm), armyworms, locusts, corn aphid, various leaf hoppers and mites.

HELIOTHIS CATERPILLAR OR CORN EARWORM (*Heliothis armiger*)

Heliothis is the most common insect pest of maize and sweet corn. The adult is a stout-bodied moth with a wing span of 35-40 mm. The forewing is pale brown to reddish-brown while the hind wing is greyish with a large smoky margin. The damaging stage, the caterpillar or larva, varies in colour from yellow through green to brown or almost black. It always has longitudinal lighter stripes along its body. In the early stages, the larva is cream with a distinct black head. It is well to remember that Heliothis larvae have obvious hairs while army worms do not.

Eggs are laid singly on the tassels and silks. The eggs are cream and spherical, about the size of a pin-head.

Larvae cause damage to foliage in early stage of growth of the crop. It is unlikely that this damage is significant in broad hectacreages. The most susceptible stage of the crop is at tasseling when pollen and anthers are eaten and at silking. Damage to silks can result in poor fertilization and so uneven seed set on the cob. At this time, entry of the cob can occur at the point where the silks enter the cob sheath. Feeding on the upper 20-25 mm of the cob often results. Entry to the cob can also occur through the sheath at any point along the cob's length. This is not common, however.

Though it seems that significant damage could result from Heliothis infestations, the experience in the N.T. is that it is not economical to chemically control populations. Naturally occurring control agents e.g. parasitic flies and wasps and predators such as ants, wasps and spiders take their toll of larvae. Bacterial and virus diseases are also present. The fact that Heliothis larvae are cannibalistic is demonstrated by rarely being able to find more than one larvae per cob.

Where populations are high, chemical control can be obtained by using:-

(i) endosulfan at the rate of 740 g active constituent per hectare, or
(ii) trichlorfon at the rate of 840 g active constituent per hectare.

To be effective, these have to be applied at tasseling and/or at silking and certainly when the larvae are small.

ARMYWORMS (*Spodoptera exempta* (Walker) and *Mythimna separata* (Walker))

Two species of armyworms are found on maize, these being day-feeding armyworms, *S. exempta*, and northern armyworm, *M. separata*.

Day-feeding armyworm can be a major pest of many cereals and grasses but, fortunately, in the N.T., it is a sporadic pest. It occurs in pest numbers in March - April. It feeds on leaves of maize and, when present in high numbers, can completely strip maize plants. As the larvae are gregarious, they tend to move in a front (hence the name armyworm).

Eggs are laid on leaves in rafts consisting of one or more layers. Egg masses consist of 10 - 300 eggs and are covered with light brown scales from the body of the female. Caterpillars are greyish-green when small, becoming black with light longitudinal stripes as they age. The adult is a grey-brown moth with pale hindwings and a distinct kidney-shaped whitish mark on the forewings.

Total life cycle lasts 23 - 58 days depending on weather conditions.

Northern armyworm regularly occurs in grain crops in the N.T. When in high numbers in the early stage of maize crops, damage can be devastating and losses can be very high. The norm, however, is that numbers are not high and damage is only minor.

Eggs are laid inside the rolled leaves or between the leaf sheaths and the stem. They are subspherical, greenish-white, becoming yellow with age. The larvae are pinkish and have four distinct longitudinal stripes down the body. They have only two pairs of prolegs. Larvae fall to the ground where they pupate in an oval silken cocoons about 4 cm deep in the soil. Adults are reddish to grey moths with two pale spots on each forewing.

The whole life cycle takes about 30 days (range 25 - 64 days) and there can be several generations per year.

Damage by northern armyworms is in the form of general leaf feeding and, more particularly, feeding in the throat of the maize plant. Neither armyworm feeds on the cob.

Under normal conditions, controls for these pests are not required. Biological control organisms (e.g. tachinid flies, wasps and various diseases) have some effect on numbers. However, when in plague numbers, chemical control is required. The following chemicals are recommended:-

(i) chlorpyriphos at the rate of 350 - 450 g active constituent per hectare. High rate is used for large larvae, particularly in dense crops.

(ii) diazinon at the rate of 800 g active constituent per hectare.

(iii) trichlorfon at the rate of 550 g active constituent per hectare.

(iv) malathion ULV at the rate of 700 ml per hectare (aerial application of undiluted concentrate).

LOCUSTS

Three species of locusts are regularly recorded on maize crops. These are spur-throated locust (*Austracris guttulosa*), yellow-winged locust (*Gastrimargus musicus*) and migratory locust (*Locusta migratoria*).

None of these really constitutes an economic problem to maize production as they occur very late in the growing season. They occur after grain filling as the foliage starts to dry off.

In newly cleared areas, migratory locust may pose a greater problem as it tends to become more prevalent in newly cleared areas. This has been observed in Queensland and at Willeroo Station in the N.T.

Control can be obtained by using one of the following chemicals:-

(i) malathion ULV at the rate of 450 - 700 ml per hectare, applied aerially as undiluted concentrate.

(ii) malathion at the rate of 500 - 700 g active constituent per hectare, applied to swarms in early morning or late afternoon when insects are nesting.

(iii) diazinon ULV at the rate of 580 - 720 ml per hectare applied aerially as undiluted concentrate.

(iv) diazinon at the rate of 550 - 700 g active constituent per hectare, applied to swarms at rest in the early morning or late afternoon. Use the higher rate for dense crops and/or against adults.

(v) chlorpyriphos ULV at the rate of 1250 - 1500 ml per hectare, applied aerially as undiluted concentrate. Use low rate for nymphs and high rate for adults and/or dense crops.

CORN APHID (*Rhopalosiphum maidis*)

The corn aphid has an almost cosmospolitian distribution throughout the tropics, subtropics and warmer temperate regions. Its main host is maize but it occurs on sorghum, millets, wheat, barley, rice and other Gramineae.

Though an important pest elsewhere, it is not considered of great significance in the N.T. Leaves, leaf sheaths and inflorescences are often covered with colonies of dark green aphids. New growth may be distorted. However, healthy vigorously growing plants can withstand very high populations. Aphids produce a sticky secretion (honeydew) which promotes the growth of moulds.

Corn aphids are soft-bodied, mostly dark green and can be winged or apterous. They reproduce mostly or entirely by parthenogenesis (i.e. give birth to live young without going through an egg stage). The life cycle in the tropics is completed in about 8 days so numbers can build up very quickly.

Chemical control is not recommended as chemical treatment can result in a resurgence of aphid populations because of the removal of parasites and predators. Predators such as syrphid fly larvae and larvae of ladybirds and lacewings adequately control aphid populations in the absence of insecticides.

LEAF HOPPERS

Like aphids, leafhoppers have the ability to transmit virus diseases of maize e.g. a condition called Wallaby-ear of maize is caused by a virus transmitted by leafhoppers. This condition appears to be more prevalent nearer the coast in the N.T. than in the areas where maize is likely to be grown commercially.

Control of leafhopper vectors in this case is not considered worthwhile.

MITES

Mites have recently caused severe leaf damage to maize in the Katherine area. Mites are very small globular organisms which have eight legs, are cream in colour and form webbing on the underside of maize leaves. The webbing and consequently the feeding is adjacent to the midrib. Damage appears as yellowing and stippling adjacent to the midrib.

In most years, mites, though they occur in most crops, do not cause significant damage. However, during the 1980-81 growing season, rains ceased early in the Katherine area and the resultant dry weather promoted the build-up in mite populations. Control can be obtained by applying omethoate at the rate of 30 g active constituent per hectare or dimethoate at the rate of 36 g active constituent per hectare.

REMEMBER - READ THE LABEL ON PESTICIDE CONTAINERS BEFORE OPENING AND ADHERE TO THE INSTRUCTIONS.

HOW TO GROW GRAIN SORGHUM

by Irene Kernot, Agronomist (Crops), Katherine
and Graham Schultz, Agronomist (Crops), Darwin

WHERE CAN IT BE GROWN?

1. Rainfall

Grain sorghum grows best in the N.T. in areas where the average annual rainfall is between 760 mm (30") and 1140 mm (45"). Below this, the probability of having poor yields or crop failure due to droughts is high unless a soil with good water holding capacity is used, or a crop is not grown every wet season.

If it is grown in areas that receive more than 1140 mm (45") grain must be harvested moist and artificially dried to prevent field moulds from spoiling the grain. These moulds are brought on by late wet season showers.

2. Temperature

Grain sorghum grows best around 27°C but tolerates higher temperatures quite well. It does not establish and grow well at less than 16°C.

3. Soil

The red earths (which vary from clays and clay loams to sandy clay loams) are particularly suited to grain sorghum growing, although it will grow on all soils suitable for cropping in the N.T.

The sandier red earths are not recommended as they are very susceptible to erosion, unless adequate safety measures are taken.

Sorghum will not tolerate static waterlogging, so the crop should be grown on flat, well drained soils. Sorghum will tolerate a high water table but only for a short period of time.

If sloping land must be used then erosion can be prevented by the use of grass strips or contour banks.

LAND PREPARATION

If the surface vegetation is thick then heavy grazing prior to the first ploughing could aid in grass control, if time is available. A heavy disc ploughing done after the opening rains when the soil is reasonably moist and weed seed germination has occurred may be all that is required. Plough to a depth of 10 - 15 cm in the red earths. If the soil is sandier, a depth of 8 cm should be adequate.

Then once the soil is reasonably wet, scarify and harrow the seed bed so that it becomes a medium tilth. This may need to be done twice if weed infestation is heavy. Weeds must be killed at this stage as chemicals only stop weeds germinating - they do not kill existing weeds, especially grasses.

FERTILIZER

The response of sorghum to N and P fertilizers is closely linked and both are necessary for consistently good yields. K fertilizers may be necessary on some soils as could trace elements. Ask your district crop agronomist for more details for your area.

1. Phosphorus

Phosphorus is best applied as superphosphate.

On virgin ground, apply up to 250 kg/ha of superphosphate. On previously cropped soils, apply about 125 kg/ha of superphosphate.

Superphosphate is best applied prior to planting by broadcasting or drilling.

2. Nitrogen

Nitrogen should be applied at about 56 kg/ha. To provide this, 125 kg/ha of Urea, 180 kg/ha of Nitram, or 270 kg/ha of sulphate of ammonia should be used.

Nitrogen should be drilled in at the same time as the seed is.

If urea is used as the N source, it should not be broadcast as most of the N will disappear due to volatilization.

DAP can also be used as a fertilizer to supply both N and P but it is better not to use on new ground. For more detailed fertilizer requirements for your area, ask at your district office.

VARIETIES

Varieties recommended for the Katherine region are MONSOON, SOLO H, X5065 and NK006.

Varieties recommended for the Douglas Daly region are SM8, DORADO A and DE KALB E57.

PLANTING

The optimum time for planting is from Christmas to New Year. Plantings after mid-January should be avoided as the crop will run out of rainfall in an average year.

Good rainfall prior to and after planting (within 10 days) is essential for good sorghum establishment.

In the Katherine region, sow seed at the rate of 7.8 kg/ha. In the Douglas Daly region, sow seed at the rate of 10 kg/ha.

A row spacing of 36 cm is the most suitable for grain sorghum in drier areas. The row spacing should decrease in higher rainfall areas.

Sorghum is usually planted in the N.T. using ordinary combine seed drills. It is recommended that narrow planting boots with a narrow point in the front be used in the Katherine region.

Standard wheats seeding boots can be used in the Douglas Daly region, or a single disc or triple disc planter is most suitable. A light covering harrow is also desirable; press wheels are of little benefit in the Douglas Daly area.

WEED CONTROL

ATRAZINE is recommended for weed control. It should be applied at a rate of 2 - 3 kg/ha active constituent as either a pre or post emergent spray. It is best applied from a boom spray, using a minimum of 170 L/ha.

It is essential that rain falls within 7 - 10 days after spraying so that the chemical is activated.

It is important to note that atrazine won't kill growing grasses, but is has some control on growing broadleaf weeds. Atrazine gives up to 50 days control - by this stage the crop must maintain its own control by competition.

PESTS

Galahs and corellas can be extreme nuisances in sorghum crops. However in large crops they tend to damage only the edges of the crop, or areas around trees.

Feral pigs can also be a problem, especially in areas where sorghum is grown continuously. Correct fencing is the best means of controlling them - see Agnote "Fencing for Crops" - Agdex 100/723 Ref. No. 81/08 for recommendations.

HARVESTING

Grain sorghum can be harvested using a standard header harvester with sorghum fingers.

Sorghum grain is physiologically mature (i.e. grain filling is complete) at a moisture content of about 30% and will thresh at moisture contents up to 25%.

In the drier areas of the N.T., where the risk of late rains is low, sorghum can be left in the field until its moisture content is less than 12%. At this moisture level sorghum can be placed in storage without aeration.

In the higher rainfall areas where late showers are common, the grain can be harvested while it has a moisture content around 15 -18%. In this situation it should be immediately dried in order to prevent grain spoilage.

STORAGE

To maintain grain quality in storage the following criteria should be observed:-

1. Moisture Content - Should never be allowed to exceed 12%; therefore the shed should have provision for aeration of the crop.

2. No Live Insects - Insects can do extensive damage to stored grain in a very short time. In addition, all overseas purchasers of grain have imposed a nil tolerance of insects in grain being imported. Therefore the storage should be insect-proof, and adequate chemicals used.

   Thorough cleaning and insecticide treatment of the storage areas is recommended.

For further information refer to Agnote - "Insect, Pests and Stored Grains" - Agdex 100/615 Ref. No. 81/09.

DISEASES OF SORGHUM

by R.N. Pitkethley
Plant Pathologist, Darwin

The following diseases have been observed in experimental and commercial sorghum crops in the Northern Territory.

ANTHRACNOSE

There are two forms of this disease which is caused by the fungus *Colletotrichum graminicola*. The more conspicuous form is a leaf spot, but a stalk rot form is likely to cause more damage. Development and spread of the disease is favoured by warm, wet weather. The fungus can survive between seasons on volunteer sorghum plants and on native grasses. Anthracnose was prevalent in the early 1970s but has been seen only rarely in recent year, possibly because of increased resistance in current varieties.

Symptoms

Leaf spots are elliptical to elongated, usually 1 cm or less in length. Colour of the spot varies from tan, through red, to blackish purple, depending on variety. The centres of older spots may become greyish or straw coloured. It is within these areas that spore production occurs under favourable conditions.

Stalk rot is usually accompanied by a red discolouration in the internal tissue (pith). This discolouration may extend to the external tissue and appears as spots on the stalk surface, somewhat similar to those on the leaf. Internal discolouration may appear in short isolated lengths or may extend from one node to the next. The tissue of the node itself is not discoloured.

Severe leaf spot and/or stalk rot can retard the development of the head so that grain fails to fill.

Control

The use of resistant varieties is the most practicable control.

UPPER STALK ROT

This disease is caused by the fungus *Fusarium moniliforme* and has only become evident in recent years. It may have been confused with the stalk rot form of anthracnose. The significance of upper stalk rot in the N.T. has not been fully assessed.

Infection is favoured by warm, wet weather but it appears that moisture stress at the time of maturity can increase the severity of the disease. Infection can take place through the stalk or head, although the fungus survives in crop residues in the soil.

Symptoms

Externally the only sign of the disease may be a poorly filled head. If the upper stalk is cut open lengthwise red discolouration will be seen, particularly at the nodes. The adjacent stem tissue may have a dry, rotted appearance, possibly with some white fungal growth.

Control

Not available at present.

HEAD MOULDS

Head mould are caused by several species of fungi and are common under humid growing conditions. Generally, the mould growth is superficial, with the fungi utilizing plant or insect exudates or decaying plant parts as their food source. Occasionally some fungi grow as weak parasites, with some invasion of the tissues of the grain occurring, particularly in damaged grain. The fungi commonly seen in the N.T. includes species of *Curvularia*, *Cladosporium*, *Phoma*, *Penicillium* and *Aspergillus*. Another fungus, *Choanephora* is found particularly on the anthers and is thought to be a weak parasite on these parts.

The significance of head moulds lies in the reduction in grain quality which they cause.

Symptoms

Discolouration and mould growth on grains and other parts of the head.

Control

Head mould is most severe in compact headed varieties. The current trend towards more open headed varieties has reduced the incidence of head mould, although the problem can still occur in times of prolonged humid weather. Control of insects in the crop will reduce head mould damage by reducing insect exudates and damage to the grains.

CHARCOAL ROT

Charcoal rot is caused by the fungus *Macrophomina phaseolina* which is widely distributed in warm wet areas. It attacks a diverse range of plant species. Only isolated examples of this disease have been seen in the N.T., although it is difficult to gauge the full extent of the disease because external symptoms are not always apparent. The disease is mainly one of the maturing crop, particularly under conditions of moisture stress. The fungus is well adapted for survival in the soil.

Symptoms

Premature drying-off of the plant, poorly developed heads and small grain. If the lower stem is cut open, tissues will have a grey appearance due to the numerous small black resting bodies (sclerotia) of the fungus. Affected stem tissue has a fibrous dry appearance. Lodging may occur in plants weakened by the disease.

Control

No direct control is available. If possible, reduce moisture stress in the maturing crop by avoiding excessively late planting and excessive plant populations.

GREY LEAF SPOT

The incidences of this disease, which is caused by the fungus *Cercospora sorghi*, vary from season to season. The disease was first seen in 1974 when it was severe in some varieties. The low incidence of the disease in subsequent years has prevented assessment of varieties for resistance. The disease is favoured by warm, wet weather and the fungus survives in crop residues, in volunteer sorghum plants and in certain grasses.

Symptoms

Elongated red spots on leaves. The spots tend to have straight sides, limited by the veins of the leaf. The size of the spots varies from 5 - 15 mm long by 2 - 3 mm wide. Under humid conditions favourable for spore production, a diffuse grey mould growth appears on the spots on both upper and lower leaf surfaces. If spots are numerous, leaf function will be significantly impaired.

Control

Will depend on the use of resistant varieties when these are assessed.

SOOTY STRIPE

Is caused by the fungus *Ramulispora sorghi*. It is seen only infrequently in the N.T. and has not been severe. Spread of the disease is favoured by wet windy weather. The fungus survives on crop residues and volunteer plants.

Symptoms

Oval to elliptical spots on the leaves, up to 1 cm long. Spots have pale brown centres and thick red-purple margins. The pale centre has a sooty appearance as a result of numerous small black fungal structures (sclerotia).

Control

Not warranted.

ZONATE LEAF SPOT

This disease has only recently appeared in the N.T. It is caused by *Gloeocercospora sorghi*, a fungus. Spread of the disease is favoured by wet, windy weather. The fungus survives on crop residues, on volunteer sorghum plants and on certain grasses. It can also be carried on seed.

Symptoms

Initially small red spots on leaves. Spots may enlarge and merge to form large irregular patches, often with alternate stripes of red and pale brown.

Control

Probably not warranted, but the use of resistant varieties, seed treatment (thiram) and crop rotation can give control.

OTHER DISEASES

Some diseases have appeared rarely, some only in one isolated instance. At present they are not considered important in the N.T. These are:-

Rust	*Puccinia purpurea*
Mosaic	*Sugarcane mosaic virus*
Bacterial streak	*Xanthomonas holcicola*
Bacterial spot	*Pseudomonas syringae*
Bacterial stripe	*Pseudomonas andropogoni*

INSECT PESTS OF SORGHUM

by A.J. Allwood, Senior Entomologist, Darwin

Sorghum is attacked by a wide variety of insects in the Northern Territory. The importance of recognising and understanding the ecology of these pests is a prerequisite to controlling them. The most important insect pests of sorghum include sorghum midge, armyworms, locusts, corn earworm or Heliothis caterpillar, sorghum head caterpillar, pink corn worm, spider mite, and thrips.

SORGHUM MIDGE (*Contarinia sorghicola* [Coquillett])

Sorghum midge occurs in all areas of the Northern Territory where sorghum has been grown, with exception of the area west of Willeroo Station. It is a major pest of sorghum in all sorghum growing areas of Australia (with the exception of the Ord River Area) and the World.

Hosts

Sorghum midge attacks all varieties of grain sorghum (*Sorghum vulgare* Pers.) sweet sorghums (e.g. saccaline, sumac, sugardrip, white African, early orange, tracy) (*Sorghum vulgare* Pers.), all forage sorghums (*Sorghum alum Parodi*), Sudan grass (*Sorghum sudanese Stapf.*), Johnson grass (*Sorghum halepense* Pers.), broom millet (*Sorghum vulgare* Pers.) and hybrids between the above sorghums (e.g. the sweet Sudan grasses (SS6, Lahoma, Piper), the Sudan hybrids (Sudax, Zulu, FS22A, Bantu) and the Johnson hybrid (Krish). Native sorghums and other grasses do not act as a host for midge.

Midge is really only a problem in grain sorghum production as opposed to forage sorghum production. Grain loss means little to forage sorghum producers. It is a sporadic pest under present growing conditions (wet season rain grown). Should dry season irrigated grain sorghum crops be grown, the pest status of the midge could be increased dramatically.

Appearance and Biology

The adult sorghum midge is a tiny fly about 2 mm long and resembles a small mosquito. It has a bright orange body with black markings and a pair of delicate gauzy wings. The adult females fly in a jerky manner around heads during flowering. When they alight, they walk over the head searching for a suitable spikelet in which to lay eggs. They stand at the tip of the spikelet and insert their ovipositor between the glumes. The female midge cannot oviposit into a spikelet unless it is partly opened, i.e. opened to allow extrusion of the anthers. Once the seed has set, the female midge will not oviposit into the spikelet. Therefore, when scouting for midge, only flowering heads need be examined. The female midge lives for about 2 days while the male lives for a much shorter period.

In a few days the eggs laid within the spikelet hatch into small white larvae which feed on the developing ovary, resulting in a shrivelled ovary which soon desiccates. The outside glumes remain intact and, as no grain developes to push them apart, remain closed. Inside the floret, the larvae continues to develop and turn into pupae which are bright orange. Usually one, but sometimes three or four larvae develop in the one spikelet. About 16 days after egg laying the adult emerges, leaving the tiny white translucent remains of the pupal case between the tips of the glumes. These are quite distinctive and are diagnostic of midget attack. The adults mate and the females lay eggs within hours of emergence.

The whole cycle from adult to adult takes about 16 days and breeding will take place throughout the year if suitable flowering sorghum plants are available. However, in most areas of the Northern Territory, sorghum does not survive as a volunteer during the dry season. Sorghum midge avoids this problem of lack of available flowering sorghum plants by entering a physiological state of rest called diapause. At the approach of the dry season a certain percentage of larvae enter this state. The stimulus needed for this is not well understood but the percentage of diapause larvae increases as the dry season progesses. The diapause larva spins itself a silken cocoon and remains within the closed glumes of the aborted spikelet. At this stage, the diapause larva is highly resistant to desiccation and may remain viable within the aborted spikelet for 6 years or more. The diapause larva within the aborted spikelet can survive burning and can pass through the stomach of cattle and remain viable in droppings.

Adult midges emerge from diapause after thorough wetting of aborted spikelets followed by about 4 weeks of high humidity. Thus, emergence of adults begins about early February. Damaging populations of sorghum midge can be expected from about mid-March onwards in most seasons. Hence early plantings are less subject to midge attack than later plantings but they are more susceptible to fungal saprophytes in a prolonged wet.

Dispersal

The adult midges being so delicate cannot fly for more than about 8 km and so the main means of dispersal of midge is in the diapause larval stage. Sorghum trash from midge areas usually has viable diapause within aborted florets mixed with the trash. If this trash is mixed with seed consignments, or left in uncleaned headers, trucks, etc., then the diapause larvae can travel large distances and emerge as viable adults in an uninfested sorghum area. This is probably the mode of introduction of this pest into and within the Northern Territory. New sorghum growers in midge free areas should be particularly aware of these sources of infestation.

Symptoms of Damage

The symptoms of sorghum midge damage are adults flying around and resting on flowering heads, translucent pupal cases at the tips of aborted florets and heads with some grains perfectly normal and scattered randomly over an otherwise blasted head. The percentage damage can vary from 1 - 95%. Under good growing and management conditions in midge areas, midge would normally account for 10 - 25% loss of grain yield.

Midge damage can be confused with a number of other conditions in sorghum. Moisture stress at head emergence can cause sterility which can result in completely barren heads. This can be distinguished from midge damage by the complete lack of any normal grains at all on the head. Heat blast caused by high temperature winds can result in one side of the sorghum heads producing no grains. Again, it can be distinguished from midge damage as on the side of the head affected no grains are produced. Anthers are not extruded.

A fungal disease, anthracnose or red stalk rot (*Colletotrichum graminicola* (Ces.) Wils.) can infect the stalk so reducing, or completely stopping, grain filling, depending on the position and time of infection by the fungus. This can be distinguished from midge damage by cutting the stalk just below the head and examining for any dark areas within the stalk.

Control

Control of midge is looked at from three points of view - cultural, biological and chemical. When cultural and biological control fail, a farmer will have to resort to chemical control.

1. Cultural Control: In midge infested areas, the following cultural control recommendations should be followed as a routine procedure:

    a. After heading an infested crop, all ratoon sorghum, stubble and unharvested sorghum plants should be heavily grazed. No sorghum plants should be allowed to continue flowering after harvest.

    b. Before the next season, all early volunteer sorghum should be destroyed. This includes forage and grain sorghum, both of which are hosts for sorghum midge.

    c. Sowing should be over as short a period as possible so that flowering is not prolonged.

    d. Downwind areas should be planted first so that midge from early crops will not be blown onto later sown crops.

e. The seed planted should be clean and true to varietal type. This also assists in maintaining a short flowering period.

f. Planting should be on an evenly prepared seed bed, preferably at the most favourable moisture level to promote even flowering.

In midge free areas or in new sorghum areas reasonably isolated (more than 30 km) from existing midge areas, the possibility of sorghum midge gaining entry can be reduced by:

a. Strict quarantine of all seed machinery moving onto a property. All seed should be fumigated with Phostoxin® at the rate of 1 Phostoxin® tablet per 3 bushel bag for 5 days. All headers, trucks, and other machinery coming from midge infested areas should be thoroughly cleaned of trash (e.g. with a vacuum cleaner, then steam cleaned before being moved onto the property).

   Headers should be treated with 1.8 kg of 1% premium grade maldison dust per machine in the same manner as for stored grain pests.

b. Hay or silage made from forage sorghum grown in midge areas should not be brought into an uninfested area as it may contain diapause larvae. Fumigation with methyl bromide will ensure freedom from midge diapause larvae if movement is unavoidable.

c. Cattle feeding on sorghum stubble or forage sorghum in midge areas should not be brought immediately onto the farm as diapause larvae may pass through the stomach of the cattle during transport and be excreted, still in a viable condition, on the new, uninfested area. Digestion is much slower in the ruminant than in the non-ruminant and food residues from a particular meal may continue to appear in the faeces for 10 to 14 days after feeding. In the non-ruminant, food residues are usually voided within 2 to 3 days of feeding. Therefore, a period of at least 2 weeks for cattle and 4 days for pigs, should be left after cessation of feeding on sorghum grain, hay or silage before the animals are transported onto the midge free area.

d. Any midge free areas near midge infested areas should be aware of volunteer roadside sorghum which could allow adult midges to gradually disperse along the chain of isolated flowering sorghum plants. These should be slashed before flowering. Midge free areas which export sorghum by road from their properties through midge infested areas should be particularly aware of this problem.

2. Biological Control: Biological control agents include a tiny parasitic wasp (*Eupelmus australiensis* Gir.) and a number of predators including spiders and vespid paper wasps. However, these do not have a controlling influence on midge numbers as their numbers do not increase until very late in the season at which time most damage by midge has already been done. Hence, complete reliance should not be made on these biological agents for control of midge.

3. Chemical Control: Only when economic threshold levels are reached should chemical control be implemented. Crops of forage and grain sorghum should be inspected as often as possible during the flowering period. The best time to scout for midge is early morning before the wind rises. If an average of 6 or more adult females per head is present, control should be applied. If midge continue to be found in large numbers (greater than 4 per head), a second application should be made 4 to 5 days later.

The following chemicals are recommended for the control of sorghum midge:

(i) malathion ULV (ultra-low volume) at the rate of 450 mL per hectare.

(ii) diazinon ULV at the rate of 290 mL per hectare.

(iii) diazinon at the rate of 300 g per hectare.

(iv) chlorpyriphos ULV at the rate of 500 mL per hectare.

(v) chlorpyriphos at the rate of 250 g per hectare.

(vi) carbaryl at the rate of 1 - 1.25 kg per hectare.

NOTES:

- ULV or ultra-low volume refers to aerial application of undiluted concentrate.
- Chlorpyriphos must not be applied to Alpha and Pioneer 846 varieties because of phytotoxicities. Non-economic phytotoxicity may also occur in other varieties.
- A stock of one of these chemicals should be obtained before the growing season.
- Adhere to the withholding period of the chemical used.

ARMYWORMS

Two types of armyworm are commonly found on sorghum in the Northern Territory - the northern army worm (*Mythimna separata* (Walker)) and the day-feeding armyworm (*Spodoptera exempta* (Walker)).

The larvae of both armyworm grow to about 35 mm in length. Those of the northern armyworm are greyish green in colour with 2 longitudinal white stripes along each side. The best diagnostic character is the presence of a tiny grey dot on either side of the midline of each segment, on the upper surface of the larva. The larvae of the day-feeding armyworm are dark greenish black with longitudinal yellow stripes on the midline and on each side.

The northern armyworm tends to be a persistent pest occurring every season but the day-feeding armyworm occurs sporadically depending upon seasonal conditions. The 1972-73 season saw huge numbers of day-feeding armyworm right across northern Australia and P.N.G. It feeds exclusively on grasses, but seems to prefer the graminaceous crops. It was not found in either the season before or after the 1972-73 outbreak. The most destructive populations of this pest occur from mid-February to late March.

The northern armyworm is found on sorghum, maize, millet and rice. It has not been seen so far on other grasses. It occurs every season in most regions (Katherine, Douglas-Daly, Berrimah) but the numbers fluctuate greatly according to seasonal conditions. Damaging populations occur throughout the year with economic damage occurring on both wet season rain grown crops and dry season irrigated crops.

Both armyworms are foliage feeders. The day-feeding armyworms, as the name suggests, feeds exposed on foliage during the day. The northern armyworm larvae remain within the whorls or young plants and emerge to feed on leaf blades during the night. This gives the leaves a rather ragged appearance. Sometimes up to 10 larvae can be found in each whorl but the usual number is 1 to 2. Under high population pressure, the larvae of the northern armyworm may enter the head, feeding on the vegetative sterile pedicelled spikelets or on the vegetative ratoon heads. It does no damage to the developing grain. The major problem with the armyworm feeding in the head is the dung which fouls the grain and allows the growth of moulds. Up to 10 larvae have been found feeding in the head but the usual number is 2 or 3.

When large numbers of armyworms are present, leaves may be stripped back to the midrib. The main stalk is generally not eaten. This loss of vegetative material is extremely important to forage sorghum growers whose main aim is production of dry matter. It is of variable importance to grain sorghum growers depending on what stage of crop growth the defoliation occurs.

If the defoliation takes place before the crop is physiologically mature, then a loss of yield will result. Defoliation after physiological maturity is of no real economic importance.

Grain sorghum should only be sprayed if peak armyworm activity occurs before physiological crop maturity. If chemical control is necessary the following chemicals may be used:

(i) trichlorfon using conventional sprays at a rate of 500 g active constituent per hectare.

(NOTE: Trichlorphon is not recommended on varieties Pioneer 846 or Alpha due to phytotoxicity problems).

(ii) endosulfan at a rate of 750 g active constituent per hectare.

(iii) chlorpyriphos at a rate of 350 - 450 g active constituent per hectare.

Note that the comment made on trichlorfon applies also to chlorpyriphos.

LOCUSTS

The three main species of locusts found on sorghum are:

Austracris guttulosa (Walker) - spur-throated locust
Gastrimargus musicus (Fabricius) - yellow winged locust
Locusta migratoria (Linnaeus) - migratory locust

All three species may occur in the same crop, but usually one species occurs in much larger numbers than the others. Small numbers of all three locusts occur all year round but outbreaks usually occur in the late dry season (August to October) or the late wet season (March to April).

Usually rain grown wet season grain crops escape locust damage because they are mature before plagues occur but even so losses of seedlings and vegetative material are incurred in most seasons. Feeding on stalks just below the head can also cause serious losses to maturing sorghum. Dry season irrigated forage and grain sorghum crops suffer badly.

CHEMICALS RECOMMENDED FOR CONTROL OF LOCUSTS ARE:

(i) malathion ULV at the rate of 450-700 mL of chemical per hectare, applied aerially as undiluted concentrate.

(ii) malathion at the rate of 500-700 g active constituent per hectare.

(iii) diazinon ULV at the rate of 580-720 mL of chemical per hectare, applied aerially as undiluted concentrate.

(iv) diazinon at the rate of 550-700 g active constituent per hectare.

If an attack on a crop is likely, it is preferable to control the grasshopper swarms before the invasion into the crops area actually occurs. Results will be more satisfactory when treatment is applied against the hopper stage. However, if insects have developed to the winged adult, swarm control can be obtained by using the higher rates of insecticide.

Where spray machinery is unavailable, baiting for grasshopper control is a reasonable alternative but baiting is more costly in time, labour and materials than spraying. The most satisfactory baiting procedure is to mix 11 kg of bran thoroughly with 420 mL of 50% emulsifiable concentrate malathion and distribute in the late afternoon. This quantity is sufficient to cover 1 hectare. Do not mix or disperse the bait by unprotected hand. Scatter the bait in front of invading locust bands.

CORN EARWORM OR HELIOTHIS CATERPILLAR *(Heliothis armiger* (Hubner))

The larvae of this pest are found eating foliage either exposed or in the whorls of immature plants, but the main problems with this pest is the loss of yield associated with its feeding on immature grain. As the grain matures, damage decreases.

The larvae is quite variable in colour, ranging from various mixtures of orange, black and yellow, to an almost light green form. However, it always has dark coloured tubercles from which small hairs arise and it is distinctly hairier than the armyworm. The larva grows to about 35 mm in length.

Small numbers of the pest occur all year round and in all sorghum-growing areas. Outbreaks depend on seasonal conditions, availability of alternate hosts on which numbers can build up and on other crops grown near or in association with sorghum e.g. if pigeon pea or maize is grown adjacent to sorghum, the population of Heliothis caterpillars is likely to be higher than if sorghum was grown separately.

The corn earworm should present no problems to forage sorghum growers but is of varying importance to grain sorghum growers. The economics of Heliothis attack on rain grown wet season crops has not been adequately studied. Up to 10 larvae have been seen in a single head but the usual number is 2 or 3 per head.

Preliminary work on dry season irrigated grain sorghum (open headed variety) in the Ord River area in 1970 showed that it was economical to spray when 4 Heliothis larvae were found per head. Recent results from elsewhere in Australia indicate that this level of infestation per head should be substantially less than 4 before spraying is economical. It is doubtful that the economics of rain grown sorghum allows chemical control to be implemented. On the other hand irrigated crops whose yields are high probably warrant the extra cost of chemical control.

Predators, parasites and cannibalism among larvae play integral parts in reducing numbers of Heliothis larvae. The long-term view is that biological control will become more important in the control of this pest. If control is considered necessary, the following chemicals can be used:

(i) endosulfan at the rate of 750 g active constituent per hectare.

(ii) trichlorfon at the rate of 840 g active constituent per hectare.

(NOTE: Not to be used on Alpha of Pioneer 846 varieties).

(iii) methomyl at the rate of 350-450 g active constituent per hectare.

When using chemical control it is easier to control Heliothis larvae when they are less than 10 - 12 mm long.

SORGHUM HEAD CATERPILLAR *(Cryptoblabes adoceta* (Turner))

The larva of this pest feeds on maturing grain and feeding can continue until the crop is harvested. The larvae secrete silken web shelters and live and feed within the head. Consequently, the head is fouled with excrement and mould and secondary insect scavengers such as cockroaches and fungus beetles are encouraged. The larvae will not attack harvested grain.

The colour of the larva varies from light brown to grey green with dark longitudinal stripes along either side of the midline. It grows to about 15 mm in length and is a lot smaller than the Heliothis caterpillar and armyworm. It is very active when disturbed.

This pest occurs in all sorghum growing areas and can be expected in both dry season and wet season crops. It is of no importance to forage sorghum growers but can be important to grain sorghum growers under some circumstances. Damage by this pest is most severe on closed headed varieties because of greater protection afforded from predators and parasites. The longer a crop is left before harvest, the greater will be the damage by this pest. Therefore, the best method of control for this pest is to plant where possible, open headed varieties and to harvest the grain as soon as it is mature.

If this fails or is not possible, chemical control can be obtained by using:

(i) endosulfan at the rate of 750 g active constituent per hectare.

(ii) trichlorfon at the rate of 550 g active constituent per hectare.

PINK CORN WORM (*Sathrobrota rileyi* (Walsingham))

The larvae of this pest feed also on maturing grain but do not attack the head as early as the sorghum head caterpillar. They continue to feed until the crop is harvested. They will not attack harvested grain. They secrete a tough silken shelter and live within this, energing to feed on the germ, eating it out and then eventually consuming all the endosperm of the seed. The larva found shelter within hollowed out seeds. It is quite distinctive, being bright pink on the upper surface and grows to about 8 mm in length.

This pest occurs in all sorghum growing areas and can be expected in both dry season and wet season crops. It is of no importance to forage sorghum growers and is usually of no real importance to grain sorghum growers. The longer the mature sorghum remains unharvested, the more susceptible it is to attack by pink corn worm. Closed headed varieties are more susceptible to attack than open head varieties.

Control is best obtained by planting where possible, open headed varieties and to harvest the grain as soon as it matures. Chemical control of this pest is usually not necessary but the combined damage of sorghum head caterpillar and pink corn worm may warrant control if management problems prevent early harvest. Endosulfan and trichlorfon should be used at the same rate as for sorghum head caterpillar.

APHIDS (*Rhopalosiphum sp.*)

These are soft-bodied greenish coloured insects about 1 - 2 mm in length. All immature stages are wingless and the adult may or may not have 2 pairs of long transparent wings. They live in colonies either in the whorls of immature plants or on individual leaves or in the head itself. They feed by sucking sap. They excrete copious quantities of a sticky sugary substance called honeydew.

The actual loss of sap is of no real consequence in a leafy, well grown crop. However, if large aphid populations occur in the whorls of young plants, then their feeding may cause some leaf malformation and may also prevent full extrusion of the head.

Perhaps the greatest problem with aphid infestations is the associated honeydew. This may form a sticky coating over the leaves and grain, which attracts fungi and scavenger insects such as ants, blowflies, dried fruit beetles, cockroaches, pumpkin beetles and mottled flower beetle. These insects feed only on the honeydew and are of no economic significance. The aphids occur in such large numbers on occasions that many growers become alarmed at their presence. Sometimes, the sticky honeydew occurs in such large quantities that harvesting is made difficult due to the fouling of the headers.

Aphids can be expected to occur in both wet season and dry season forage and grain crops in all sorghum growing areas. However, they are hardly ever a problem as numerous parasites and predators are capable of controlling aphid populations. There are about 7 species of ladybird predators and about 2 species of hoverfly predators.

Chemical control is not recommended and is in fact ill advised as the insecticide will kill both the aphids and predators and when the aphid populations begin to build up again in a few weeks the aphids breed much more quickly than the predators and the aphid problem will be much worse than before spraying.

SPIDER MITES (*Tetranychus sp.*)

This is a microscopic pest which is best recognised by the damage it does.

On young leaves, colonies of this pest build silken shelters on the undersurface. The mites live under this shelter and feed by rasping the leaf tissue. The feeding areas turn yellowish green, giving the leaf a blotchy light and dark green effect when viewed from above. On older leaves, the damage is manifested as red streaky patches along the midrib on the undersurface of the leaf. These mites have been found on immature grain in the head.

The damage potential of this pest has not been studied. So far, no economic damage has been reported from any sorghum growing area. This pest prefers hot dry weather and therefore is mainly a pest on late maturing wet season crops or irrigated dry season crops.

Chemical control is not considered necessary.

THRIPS (*Haplothrips sp.* and other species)

These are tiny black insects about 1.5 mm in length and are extremely abundant when sorghum crops are flowering. The younger stages are red. They feed on sap.

The thrips nymphs are usually found within the spikelets. They most probably feed on the glumes or other related parts inside the spikelets but it is also likely that they feed on the young ovary. In fact feeding punctures have been seen on some young ovaries. However, only 1 or 2 thrip nymphs have ever been found within the one spikelet and combined with this fact and their small size and limited feeding potential, it seems that they have little effect on seed setting and development.

No adults have been found within spikelets. They are found crawling on the outside of the spikelets and feed presumably, mainly on the glumes, and probably only to a limited extent, on the maturing grain. Queensland work suggests that the thrips feed on glumes and related parts causing a slight reduction in the weight of trash per head. They did not appear to have any effect on grain setting or weight of grain.

Chemical control is not considered necessary.

GROWING PEANUTS IN THE N.T.

by G. Schultz, Agronomist (Crops), Darwin

INTRODUCTION

Peanuts have been grown in the N.T. since 1887. Given adequate moisture by supplementary irrigation and frost free nights, they grow well throughout the Territory at any time of the year. Raw peanuts are a good source of protein, essential fatty acids, energy, vitamins B (thiamin, riboflavin, niacin) and E, and minerals potassium, magnesium, phosphorus and sulphur.

SOIL

For ease of digging and good drainage, a light sandy loam is ideal for peanuts. They will, however, grow on most soils despite low fertility. Heavy soils may cause peanuts to rot if water-logged and will often set hard when dry. On the other hand, sandy soils are subject to leaching and erosion. The site should therefore be level and avoid water courses. Grassed contour strips and contour planting helps to control erosion.

ROTATION

Peanuts are a crop which can deplete a soil of nutrients and structure very quickly and as such should not be grown on the same area of ground more than two years in a row. A rotation of three years peanuts in a ten year rotation would be most suitable, with large amounts of fertilizer being applied to the crop or pasture in the year previous to peanuts.

SEED BED PREPARATION

Cultivation should bury previous crop residues to a depth of 20 cm thus reducing disease carry-over. The soil should then be worked down level to a medium tilth. To control grass and some other weeds, Treflan® is sprayed onto the soil at 5 L/ha in about 300 L of water. The herbicide must be incorporated into the top 5 cm of soil as soon after application as possible.

FERTILIZER

Peanuts, being legumes, do not usually benefit from applied nitrogen. A dressing of 200 kg superphosphate/ha (200 g/10 m^2) banded 5 cm to one side of the seed is usually sufficient.

On some sandy soils a response may be obtained to an early application of 100 kg/ha of ammonium sulphate. Gypsum will benefit large seeded peanut varieties if broadcast at up to 500 kg/ha over the rows in the fourth week. For Spanish varieties, up to 300 kg/ha gypsum should be applied.

VARIETIES

Virginia Bunch (VB) is commonly grown for roasting and salting. These large nuts take about 135 days to mature. The large, dark green VB bushes are resistant to leaf spot. This variety is difficult to grow and should not be grown without supplementary irrigation.

Red Spanish (RS) bushes are smaller and paler than VB. They produce small, round, dark red kernels which have an oil content of up to 50%. These tasty kernels are used in confectionery and paste. Rejected and surplus nuts are crushed for oil. RS mature after 115 days and as such fit our wet season better than VB.

Starr is a popular, high yielding variety in the U.S.A. In Australia it is only grown in the N.T. and W.A. and has similar uses to RS. Starr is a White Spanish variety producing small, round, pink kernels. The nuts grow in a compact bunch and mature between 100 - 200 days. The bushes resemble RS and are likewise susceptible to leaf spot. White Spanish are more difficult to dig as they don't hang on the peg as well as Red Spanish.

Peanut seed for sowing may be ordered through the N.T. Producers' Co-operative at Adelaide River. Queensland seed from Kingaroy is infected with peanut mottle virus and should not be sown.

TABLE 1

PEANUT PLANNING GUIDE FOR TOP END N.T.

LOCATION	BERRIMAH	TIPPERARY		KATHERINE		MATARANKA
SOIL	LOAMY RED EARTH	BLAIN SANDY LOAM	TIPPERA CLAY LOAM	LEVEE SANDY LOAM	TIPPERA CLAY LOAM	SANDY RED EARTH
Variety	VB	VB	VB	VB	Starr	Starr
Maturity (days)	140	135	120	120-140	100	100
Planting	1 Dec	10 Dec	10 Dec	17 Dec	17 Dec	28 Dec
Harvesting	20 Apr	23 Apr	9 Apr	26 Apr	28 Apr	8 Apr
Super-phosphate (kg/ha)	200	250	200	*135-250	200	135
Ammonium sulphate (kg/ha)	100	100		*100		
Gypsum (kg/ha)	300	500		*300-500		
Rotation	Maize	Maize/TS	Maize	Sorghum *Maize	Sorghum	Sorghum Millet
Sowing Rate (kg/ha)	34	34	34	*34-60	56	56
Row Spacing (cm)	60-90	60-90	60-90	60-90	30-90	30-90
Plant Spacing (cm)	60-45	60-45	60-45	*45-25	30-10	30-10
Yield N.I.S. (t/ha)	1.0	2.0	1.8	*1.5-3.0	1.5	1.0

* When supplementary irrigation available to improve and extend growing season.

N.B. kg/ha = g/10 m^2 t/ha = kg/10 m^2

PLANTING

Peanut kernels are dressed with a 50/50 mixture of PCNB and captan fungicide at a rate of 1 g/kg seed. This poisonous dust reduces seedling rots and improves emergence. For ease of cultivation and digging, peanuts are sown in rows 90 cm apart at a depth of 5 cm. Row spacings of 30 - 60 cm may however producer higher yields. Taking account of the germination percentage, seeds are placed to produce a plant spacing within rows of 10 cm for Spanish and 25 - 45 cm for VB. The seeds should be pressed firmly into moist soil. On medium to heavy soils, water-logging damage is reduced and digging facilitated by slight ridging at planting.

CROP GROWTH

Peanut seedlings emerge 5 - 7 days after planting. The crop grows slowly for the first few weeks as the tap root extends and pre-formed leaflets expand. Yellow flowers appear after 3 - 4 weeks and the pegs of fertile flowers begin to grow down from the fruiting branch nodes. As the pegs penetrate the ground the tips begin to swell and within sixty days have developed into peanuts. The bushes continue to flower and set nuts as long as the moisture is adequate. Most flowers are produced in the period five to nine weeks after planting. At this stage the bushes are growing rapidly and soon cover the rows so weeding must be completed before this stage. Weeds do most harm in the first three weeks.

WEED CONTROL

For efficient peanut production good weed control is essential. Weeds not only compete with the crop and thereby reduce yield, they can also make commercial digging slow if not impossible. Inter row cultivation always damages the crop and should not be used for weed control unless herbicides are ineffective.

Correctly applied Treflan^{R} will give up to 6 weeks control of most annual grasses and small seeded broadleaf weeds such as pigweed *(Portulaca oleracea)*. For control of this and other broadleaf weeds including goathead *(Acanthasperum hispidum)*, hyptis *(Hyptis suaveolens)*, bellvine *(Ipomoea plebeia)* and morning glory *(I. purpuea)*, 2,4D,B or M.C.P.A. applied at 1.5 L of the 40% product/ha is recommended. These selective hormone sprays are most effective when applied to young vigorously growing weeds. Thorough coverage of the weed foliage followed by several hours without rain is necessary for a good kill. Some slight distortion of the crop may occur and the weeds may take several weeks to completely die. Basagran^{R} is all-effective on small sida but less effective against hyptis.

When soil compaction is likely to make digging difficult, systematic ridging of hilling up of the rows with successive cultivation may be necessary. Care should be taken to avoid damaging or throwing dirt over the plants as this increases the incidence of crown rot.

VERMIN

Galahs, wallaby and pigs can be a serious nuisance to peanut growers. Birds will attack peanuts as they emerge and after digging. The use of scare guns and systematic shooting at these times will reduce losses.

Before planting a crop it is advisable to erect a pig-proof netting and electric fence. Pigs can do a lot of damage as peanuts begin to mature. Likewise, wallabies will dig up the nuts and heavily graze the tops.

MATURITY

To determine the optimum time for harvesting the crop, a few plants may be pulled and dried in the sun. If the majority of the shells are brittle and stained dark inside and the kernels do not shrivel, then the crop is ready to dig.

For a precise estimate of digging time, a sample of five representative plants is taken regularly as the crop matures. From each sample the mean individual kernel weight (MIKW) is calculated on kernels dried at 80°C for sixteen hours in an oven.

$$\text{M.I.K.W.} = \frac{\text{OVEN DRY WEIGHT OF KERNELS}}{\text{NUMBER OF KERNELS SAMPLED}}$$

When the M.I.K.W. reaches a constant value for successive samples, the crop is at peak maturity.

As heavy soils reduce the M.I.K.W., samples should be consistently taken from the same soil type. M.I.K.W. is calculated on kernels retained by a 5 mm sieve.

DIGGING

The bushes are cut about 10 cm below the ground, lifted and windrowed and left to dry.

HARVESTING

After about 4 - 5 days of fine weather, the nuts are threshed from the bushes and the pegs or tails are removed. These are then put into silos and dried to a safe moisture level.

STORAGE

Peanuts keep best in the shell when stored at less than 10% moisture content. Once shelled, they require cool storage. To prevent weevil infestation, peanuts may be sprayed with malathion in a 40 ppm solution at a rate of 5 L per 3 tonnes of nuts in shell. Dichlorvos (Shelltox) strips are effective if uninfected peanuts are kept in a confined space.

DISEASES OF PEANUTS

by R.N. Pitkethley
Plant Pathologist, Darwin

The following diseases have been observed in experimental and small commercial peanut crops in the Northern Territory.

LEAF SPOT

This is caused by the fungus *Cercospora arachidicola* and is the most common disease of peanuts. It is seen in most crops, but only occasionally reaches severe proportions. Build up of the disease is favoured by warm, humid weather and spread is favoured by wind and rain. The fungus can survive in crop residues in soil. Another somewhat similar leafspot, caused by *Cercosporidium personatum*, is not known to occur in the N.T.

Symptoms

Brown to black roughly circular spots, reaching an average diameter of about 5 mm. The spots are sometimes surrounded by a yellow halo. If spots are numerous, leaf death may occur.

Control

Avoid continued cropping with peanuts. Spray with chlorothalonil (Bravo^{R}) at recommended rates which depend on the method of application.

RUST

Rust is caused by the fungus *Puccinia arachidis*. The disease first appeared in Australia in 1973, probably as a result of spores carried by wind from Asia. Rust is now rarely seen in the N.T. possibly because of the inability of the fungus to survive the dry season during which peanuts have not been grown. The fungus appears to need living peanut plants for survival between seasons. The disease is favoured by warm, wet weather.

Symptoms

Small raised rust-red spots or pustules on the underside of leaves. If pustules are numerous, leaf death may result.

Control

Rust can be controlled by spraying with chlorothalonil (Bravo^{R}) as for leafspot.

PYTHIUM WILT

This wilt disease, one of several that affect peanuts, is caused by the fungus *Pythium myriotylum*. It has been seen affecting only isolated plants in crops in the N.T., but the disease may have the ability to build up to the extent where significant loss is caused. The fungus survives in the soil and invades plants through the roots or lower stems. The disease is favoured by warm weather and high soil moisture.

Symptoms

Wilt of leaves on one to all branches of a plant. Leaves have a dry, scorched appearance. Internally, tissues of the lower stem have a brown discolouration and may later appear shredded or fibrous as softer tissues are broken down. Superficially, symptoms of pythium wilt may resemble those of bacterial wilt (see below) or termite attack.

Control

No practicable control measures are known for wet season crops at present.

SCLEROTIUM STEM ROT AND LEAF SPOT

Caused by the fungus *Sclerotium rolfsii*, these diseases have been seen only occasionally. They are associated with particularly wet and humid weather. The same fungus can attack a wide range of plant species given the right conditions.

Symptoms

Stem rot is accompanied by white fungal growth on the lower stem. Later, white spherical structure (sclerotia), about pin head size, appear on the fungal growth. These structures turn pale brown as they mature and are the means by which the fungus survives between crops. Fungal growth may appear on other plant parts which are close to the growth. Occasionally brown spots about 1 cm in diameter develop on the leaves. These spots have a concentric ring pattern.

Control

Does not appear to be warranted.

ASPERGILLUS CROWN ROT

This disease, caused by the fungus *Aspergillus niger*, has been seen only rarely in the N.T. The disease is more commonly known elsewhere as a pre-emergence or post-emergence rot of seedlings. The few cases seen in the N.T., however, have been on near mature plants. The fungus is a common soil inhabitant and spores are always present in the air.

Symptoms

Rotting of the lower stem near the soil line, also upper root system. The rot is accompanied by black powdery spore masses of the fungus. Pods may also be affected.

Control

Apparently not warranted.

BACTERIAL WILT

Has been seen very rarely in peanuts. It is caused by *Pseudomonas solanacearum*, the same bacterium that causes bacterial wilt in tomatoes and many other crops. Bacterial wilt is unlikely to be a problem in commercial peanut cropping areas.

Symptoms

Sudden wilting of the plant, accompanied by internal brown discolouration of the lower stem. A white bacterial exudate will be seen diffusing from the cut ends of a piece of lower stem if placed in water.

Control

No control is known and unlikely to be warranted.

PEANUT MOTTLE

Is caused by peanut mottle virus and has only been seen occasionally in the N.T. The disease is seed borne and is spread within a crop by aphids. The same virus can affect soybeans and several other legumes.

Symptoms

A mottle of dark green areas on the normal green leaf background. Seed quality can be reduced.

Control

None available.

ASPERGILLUS POD MOULD

The fungus *Aspergillus flavus* can occur inside pods. Little is known about the method of invasion of the pods, but the fungus may only occur following invasion by other organisms. The significance of *Aspergillis flavus* is that it is capable of producing substances known as aflatoxins which are toxic to humans and livestock. Maximum permissible levels of aflatoxins have been set, above which the nuts are unsaleable.

Symptoms

Yellow green mould growth may be present on or in pods, but is not always evident. Dangerous aflatoxin levels may be present in nuts with only slight discolouration which may only be seen when individual nuts are split open.

Control

1. Maintain vigorous plants by general disease and insect control.
2. Do not leave pods in the ground after they are mature.
3. Take care to avoid damaging pods during harvesting.
4. Dry the harvested pods as quickly as possible, consistent with maintenance of nut quality.

INSECT PESTS OF PEANUTS

by J.D. Gillett, Entomologist, Darwin

INTRODUCTION

Peanuts grown in the N.T. are relatively free of major insect pest infestations. Periodically, *Heliothis armiger* (Hubn.), *Spodoptera litura* (F.), *Etiella behrii* (Zell.), and tetranychid mites occur in numbers which necessitate control.

Additionally a complex of termites of the genera *Microcerotermes*, *Heterotermes* and *Mastotermes* have been encountered.

HELIOTHIS CATERPILLAR (*Heliothis armiger*)

In low numbers *Heliothis armiger* is mainly a foliage feeder and causes little damage. In large numbers, flowers are consumed and feeding occurs below the crop canopy, damaging pegs.

The adults are pale brown moths of about 40 mm in wing span, usually active around sunset, Cream coloured, spherical eggs about the size of a pin head are laid individually over the plant. The larvae which hatch are cream coloured but quickly change from yellow to green to dark brown (sometimes with a slight purple tinge). Mature larvae are around 40 mm in length.

Chemical control can be effective. Timing of spraying is important as the effectiveness of spraying is greater with small larvae. The damage threshold usually accepted is 12 larvae/metre of row. Spraying should commence as soon as numbers approach this figure.

Recommended chemicals:

- endosulfan at 740 g active constituent per hectare.
- trichlorfon at 840 g active constituent per hectare.
- carbaryl at 1100 g active constituent per hectare.

CLUSTER CATERPILLAR (*Spodoptera litura*)

Spodoptera litura is responsible for extensive defoliation in peanut crops. In crops with high Spodoptera populations, extensive peg chewing and resulting yield loss is encountered.

Adult moths have wings with a brown and cream mottled appearance. The brown colour is much darker than is the case of the Heliothis moth. The moths are of similar size. Eggs are laid in clusters with up to 200 larvae emerging from one cluster. Larvae grow to about 50 mm with similar background colouring to Heliothis larvae. They can be distinguished by black longitudinal stripes and black half-moon markings, which are not present in Heliothis larvae.

Some biological control is exercised on Spodoptera larvae by tachinid flies. However chemical control will be needed if numbers approach 12 larvae per metre row. The recommended chemicals are the same as for Heliothis and should be applied at the same rate.

LUCERNE SEED WEB MOTH *(Etiella behrii)*

The lucerne seed web moth *Etiella behrii* is a sporadic pest of peanuts. It has been encountered as a serious problem on two occasions in the N.T.

Eggs are laid singly or in small groups on flowers and pegs. Larvae are reddish pink in colour. Emerging larvae feed on flowers and kernels. The mechanism by which larvae enter the kernelsis not known at this stage.

A major problem in growing peanuts in the tropics is the possibility of infection by aflatoxin - producing fungi. The lucerne seed web moth may act as a transmission agent of these fungi. This has yet to be proved.

A chemical control program can be initiated if the lucerne seed web moth becomes more of a problem with increased plantings, especially if it is implicated in the transmission of aflatoxim. Spraying carbaryl or endosulfan, initially 10 days after first flowering to protect developing pods should be carried out.

Recommended chemicals:

- endosulfan at 740 g active constituent per hectare.
- carbaryl at 1100 g active constituent per hectare.

TETRANYCHID MITES

Red spider mite *Tetranychus sp.* can cause economic losses. Most damage occurs to young plants which have experienced a long spell of dry weather.

Eggs are laid on the underside of leaves or on strands of silken web spun by the adults. Adults are barely visible to the naked eye. Silk on the underside of leaves is usually the easiest way to detect mite presence. Mite activity is indicated by a gradual yellowing of leaves initially between the main veins. As the damage is restricted to young plants under severe moisture stress chemical control is unjustified.

TERMITES

Three species of termites, *Mastotermes darwiniensis*, *Microcerotermes sp.* and *Heterotermes sp.* have been found to attack both the nuts and the tap root of peanut plants. The problem is usually accentuated in newly cleared land where there is a lot of debris in the soil.

In small plot situations, control using persistant soil insecticides may be effective and of benefit. However, on a commercial scale, control of termites using soil insecticides is not justified.

PRELIMINARY RECOMMENDATIONS FOR SOYBEAN PRODUCTION IN THE DOUGLAS - DALY AREA OF THE NORTHERN TERRITORY

by A.L. Garside, Agronomist (Crops), Darwin

Soybean is traditionally a crop of sub-tropical and temperate climates where it is grown as a summer crop. The world's largest producer is the U.S.A.

Until recently, successful production had not been achieved in tropical areas of Australia. However the combination of new varieties bred by Dr D. Byth of Queensland University for tropical conditions and agronomic research conducted by CSIRO Division of Tropical Crops and Pastures and the Western Australian Department of Agriculture in the Ord River Irrigation Area has shown that successful production is possible in low latitude tropical areas.

As yet very little research has been conducted on soybean in the Douglas-Daly area so the recommendations discussed below are based on research results from the Ord River area and the author's experience with the crop.

One point should be made clear from the outset. Soybean is not an easy crop to grow as many factors can dramatically affect yields. However, providing growers are prepared to manage their crops intensively, reliable yields in the order of 2 - 3 t/ha can be achieved.

SOILS

Two main soil types likely to be considered for soybean production in the initial development period are the Tippera and Blain soils. Successful crops have been grown on the Tippera soil and it appears quite suitable for soybean production. However, at this stage growers should not contemplate production on the Blain soil until further research elucidates nutrient problems that exist. A third soil type in this area, the yellow podzolics, are unsuitable for crop production with current technology due to severe water-logging problems during the wet season.

All further discussion in this paper refers to crops grown on Tippera soils only.

VARIETIES

A range of varieties have been tested over a number of years in the Ord River Irrigation Area. The varieties range from early to late maturity with growing seasons ranging from 100 - 140 days. Given that initially crop production will be based on wet season dryland sowings, it will be essential to use varieties that can complete their growth during the period of adequate moisture availability.

In this respect the early maturing types are likely to be the most suitable.

The variety Ross has been released for some 10 years and has been successfully grown in this region. Its major drawback is that it is slightly late maturing and is likely to give reduced yield of poor quality seed in seasons when rainfall ceases early.

Buchanan is a variety just released for irrigated cropping in the Ord River Valley. It is an early maturing type (about 10 - 14 days earlier than Ross) with good yield potential. In the season just completed when rainfall ceased in early March, Buchanan produced a good yield of high quality seed. From a mid-December sowing, it was mature in early April.

Fitzroy, a variety similar to Buchanan, has shown good potential in the tropics and further testing of this variety will continue.

At this stage Buchanan is the recommended variety.

SOWING TIME

Sowing should be carried out between mid-December and late January as weather permits. The second half of December is the most suitable time.

PLANT POPULATION

For December sowing, growers should aim for a plant production of 400 000 plants/ha and this should be increased to 500 000 plants/ha for sowings after mid-January. Recommended row spacing is 15 cm (6").

It is absolutely essential that a good plant population be achieved for both weed control and potential yield.

To calculate the seedling rate required to obtain a particular plant population, it is necessary to know seed size and germination percentage and to make an allowance for field loss. The following example shows how to calculate seeding rate for a December sowing.

Assuming 100 seed weight = 15g
Assuming germination = 75%
Allowance for field loss = 5%

At 100% germination:-

15 g seed produces 100 plants
X g seed produces 400 000 plants

Therefore

$$X = \frac{15 \times 400\ 000}{100}$$

$$= 60\ 000 \text{ g or } 60 \text{ kg}$$

However, we only expect to end up with 70% of sown seeds producing plants (25% reduction due to germination and 5% due to field losses).

Therefore, if we require 60 kg at 100% establishment, we will require X kg at 70% establishment.

$$X = \frac{100 \times 60}{70}$$

$$= 86 \text{ kg/ha}$$

= required seeding rate

FERTILIZER

It is recommended that phosphate, sulphur and zinc be applied to soybean on the Tippera soil. Being a legume, soybean can produce its own nitrogen.

Applications of single superphosphate at 250 kg/ha will supply 23 kg/ha phosphorus and 25 kg/ha sulphur. Zinc can be applied as zinc sulphate monohydrate in order to obtain an application of 5 kg/ha zinc. This will necessitate applying 14 kg/ha zinc sulphate monohydrate (36% Zn). The easiest method to apply zinc will be to mix it with the superphosphate.

INOCULATION

To permit the crop to produce its own nitrogen, it is absolutely essential that effective nodulation is achieved.

The Rhizobia that infect soybean roots do not occur naturally in our soils, so it is essential that seed be inoculated prior to sowing to facilitate nodule formation.

Commercial inoculant is available from several sources and the addresses of these suppliers can be made available. Inoculant should be stored in a refrigerator until required.

Inoculation should be carried out immediately before sowing (within 4 hours) and inoculated seed should be kept out of the sun.

There are various methods and a range of gum adhesive that can be used for inoculation. Reasonable success has been achieved by applying the inoculant dry or with a little water. Mixing, by turning on a cement floor, is quite suitable.

A most important aspects is to use plenty of inoculant. Standard packs of inoculant suggest the contents are sufficient to inoculate 100 kg of seed. We recommend inoculant be applied at four times the suggested rate, i.e. four packs per 100 kg of seed. Inoculant is cheap and is a good insurance against nitrogen deficiency. Once a well nodulated soybean crop has been grown in an area it should not be necessary to inoculate the following years. Once established, the rhizobia will persist in the soil indefinitely.

I have noticed previously that inoculated crops have failed to nodulate satisfactorily early in the season. I believe this is due to hot dry soil conditions killing a large percentage of the rhizobia. By inoculating at the higher rate, a greater number of rhizobia will survive and result in better nodulation.

When ordering inoculant, specify soybean inoculant strain CB 1809. Inoculants suitable for other legumes are not suitable for soybean.

WEED CONTROL

Firstly, it should be said that the best method of weed control is to have a good even plant stand at the recommended plant population.

Soybean is a good weed competitor once established, but is susceptible to weeds during early growth.

Grass weeds can be controlled by trifluralin (Treflan^{R}) at 2 - 3 L/ha of the product applied as a pre-planting herbicide. It is essential that Treflan^{R} be incorporated immediately after application as any exposure to sunlight will reduce its effectiveness. Another pre-planting herbicide which has been successfully used it pendamethalin (Stomp 330E^{R}) at 2 - 3 L/ha. Like trifluralin, it requires incorporation. The main grass weeds likely to be encountered are *Chrysopogon sp.* and *Brachiaria sp.*

A range of broadleaf weed species are likely to occur in soybean crops. The degree to which these will be a problem is very dependent on the plant population of the crop. The main broadleaf weeds are likely to be *Hyptis suaveolens*, *Sida sp.*, and *Alysicarpus vaginalis* (buffalo clover). Bentazone (Basagran ^{R}) at 2 L/ha of the product sprayed post-emergent at the 3 - 4 tri-foliate leaf stage will give good control of *Hyptis sp.* and *Sida sp.* but will not control buffalo clover. Bentazone will cause some leaf burn to soybean but the crop readily recovers. It is advisable to apply bentazone late in the afternoon to limit leaf burn. In addition, it should not be applied when the crop is flowering. For best results apply bentazone when the crop and weeds are young.

HARVESTING

After growing a good crop of soybean, many growers ruin their product by poor harvesting techniques. Soybean is very susceptible to mechanical damage and extreme care is required with harvesting, particularly if the crop is destined to be used for seed.

The recommended moisture content for harvesting is 12%. Losses can be expected due to shattering and to pods left on the stems. These losses can be minimised by a slow ground speed of 4 - 5 km/hr and the cutter bar as close to the ground as possible.

Soybean can be readily damaged during harvesting as the seed coat is thin and the radicle which is just below the surface is very vulnerable to damage. A slow drum speed of 300 rpm will minimise the damage. Seed with a low moisture content requires a slower drum speed than seed with a higher moisture content. Drum speed is extremely critical if the seed is to be used for sowing.

GENERAL COMMENTS

From the limited amount of research conducted to date, there are indications that soybean will be a suitable crop for the Douglas-Daly region. Experiments in the current (1980/81) season have been very encouraging, with good yields in a season where rainfall ceased very early. The best varieties in a variety experiment are expected to yield in excess of 3 t/ha. A 3 ha area of Buchanan, which had a low plant population (approximately 200 000/ha) and severe weed competition, yielded 1.7 t/ha.

Although I am confident that soybean can be successfully grown in the area, farmer expertise will play an important part in commercial success. Good management is absolutely essential for successful production.

DISEASES OF SOYBEANS

by R.N. Pitkethley
Plant Pathologist, Darwin

The following diseases of soybeans are those which have been observed in experimental plantings in the Northern Territory. There has been no commercial soybean production in the N.T. and the signifigance of the diseases in such situations is not known.

BACTERIAL PUSTULE

This disease is caused by the bacterium *Xanthomonas phaseoli* var *sojense*. It is the most common disease of soybeans in the N.T. and can be serious in certain varieties. The bacterium can survive in crop residues and the disease is favoured by wet weather.

Symptoms

Minute irregular shaped spots on leaves, about 1 mm in diameter. On the underside of the leaf the spots (pustules) are slightly raised. The spots are brown and surrounded by a yellow halo. In severe infections, spots may merge to produce partial or total leaf death.

Control

Plant resistant varieties where possible, rotate with other crops.

RUST

Rust, caused by the fungus *Phakopsora pachyrhizi*, appeared in the N.T. in 1974 despite quarantine measures. The disease has not been seen in recent years. As few soybeans have been grown, it is not known whether the disease is still present in the N.T. The soybean rust fungus can infect several other legume species. Spread and infection is favoured by rainy weather. Spores of the fungus can be carried as external contaminants on seed.

Symptoms

Small spots on leaves, with raised pustules mainly on the under side of the leaf. The symptoms are very similar to those of bacterial pustule. Microscopic examination may be required to distinguish the two diseases.

Control

Rotate soybean crops with other crops particularly non-legumes. If infection does occur, spray with Mancozels.

SCLEROTIUM STEM ROT AND LEAF SPOT

Caused by *Sclerotium rolfsii*, the fungus which causes similar disease in peanuts and many other plants. The disease is seen only occasionally in soybean, during periods of high rainfall or humidity.

Symptoms

Stem rot is accompanied by white fungal growth on the lower stem. Later, white spherical structures (sclerotia), about pinhead size, appear on the fungal growth. These turn pale brown as they mature. They are the means by which the fungus survives in the soil between crops. Occasionally spots up to 1 cm in diameter appear on the leaves. These spots consist of alternate light and dark brown rings.

Control

Does not appear to be warranted.

INSECT PESTS OF SOYBEANS

by A.J. Allwood, Senior Entomologist, Darwin

Soybeans as a crop in the Northern Territory, is relatively new. Consequently it is difficult to predict what effect the insect pest complex occurring here is likely to have on overall production. Experience from other legumes such as mung bean and cowpea, indicates that insect pests will play a very significant role in production of soybeans. Interstate experience, especially in sub-tropical and tropical areas, has demonstrated that without some form of insect management in soybean, yields will be reduced.

With few exceptions, insect problems in soybeans can be efficiently and economically managed by the judicious use of insecticides. Losses in yield due to insect attack can be reduced providing applications are made at the correct time. To do this, growers have to be familiar with the insects involved and have to be able to recognise early signs of damage or build-up in population. This means that crops have to be inspected regularly, at least twice per week and preferably more frequently.

In making the broad statement that chemical control is effective in all insect situations, it is also important to recognise that beneficial biological agents may also be working to our advantage. Where possible, it is imperative to preserve these parasites and predators by the use of "softer" insecticides such as endosulfan and trichlorfon.

The complex of insects which attack soybean is diverse and includes Heliothis caterpillar or corn earworm, cluster caterpillar, green vegetable bug, other pod-sucking bugs, various loopers, lucerne crown borer and mites.

HELIOTHIS CATERPILLAR OR CORN EARWORM *(Heliothis armiger)*

Heliothis caterpillar is probably the most important pest of soybeans. It has the ability to feed on foliage, terminals, flowers and pods and has the potential to build-up to large populations on native and other cultivated hosts. For example, populations of Heliothis on hyptis, a weed throughout the Top End, possibly plays a part in infestation of late crops. Populations of Heliothis on maize early in the wet season and pigeon pea later could easily be tied to populations on soybean.

The eggs of Heliothis are spherical, about 0.5 mm in diameter, cream when laid but turning brown as they approach hatching. Black or grey-black eggs are parasitised by tiny wasps. Eggs hatch in 2 - 4 days. Females lay up to 1 000 eggs during their life.

Larvae are variable in colour (yellow, green, brown, pink, black) and have obvious lighter longitudinal stripes. Fully grown, they are 35 - 40 mm long. The larvae pass through 6 moults (instars), taking 14 - 24 days. It is during the final two instars that the larvae eat most food and cause most damage.

The larvae burrow into the soil to pupate, the adult moth emerging in 10 - 14 days.

The adult is a brown nocturnal moth with a wing span of about 40 mm. Its forewings are basically brown but do vary in colour to pink or a creamy-brown. The hind wings are light coloured with dark outer margins.

Throughout the world, its pest status in soybeans is well recognised. Evidence from other areas in Australia and elsewhere in the world indicates that Heliothis caterpillars are primarily foliage feeders in soybean and that damage to fruit parts is largely restricted to either the perimeter of the crop or to more open areas within the crop. Thus economic pod injury could be related to the degree of closure of the crop canopy. Should this be the case, it is important to ensure that plant populations are correct, that the crop is grown well and that foliage feeding insects (such as cluster caterpillar and loopers) do not reach damaging populations. The N.T. situation is that Heliothis damage foliage and flowers and pods. It is likely, as the soybean plant can withstand between 35 - 40% leaf damage, that the most significant damage here will be to flowers and pods.

Queensland work suggests that 2 pod-feeding larvae per metre of crop warrants application of insecticides. Chemical control can be obtained by using:-

1. endosulfan at the rate of 735 g active constituent per hectare.

2. trichlorfon at the rate of 840 g active constituent per hectare.

3. carbaryl at the rate of 1.1 kg active constituent per hectare.

4. methomyl at the rate of 350-450 g active constituent per hectare. Methomyl should be used only if the larvae are large.

Heliothis larvae are easier to control if they are small (less than 12 mm long) so it is important for growers to recognise them at an early stage. Biological control agents have been recorded in N.T. Heliothis populations but at low levels. *Trichogramma sp.* parasitise Heliothis eggs (1-10%) and tachinid flies and wasps parasitise larvae at levels up to 10%. Diseases caused by viruses and fungi are not common. Predatory bugs, wasps and ants account for the deaths of some larvae.

CLUSTER CATERPILLAR *(Spodoptera litura)*

Cluster caterpillar is the most damaging foliage feeder of soybean and other grain legumes. In the wet season of 1973/74, enormous populations caused almost total defoliation of sections of a large scale cowpea crop at Willeroo Station. During the wet season of 1980/81, cluster caterpillars caused significant defoliation of soybean at Douglas Daly Experiment Station but only in small areas.

Eggs are laid in rafts of 100-300 and are covered by scales from the females abdomen. These hatch in 2 - 7 days into larvae which are black-green with a black band on the first abdominal segment. For a while, they are gregarious, feeding on the same leaf as the eggs were laid. The larvae are fully grown in about 20 days and are smooth, dull greyish or blackish-green with yellowish dorsal and lateral stripes. The stripes are bordered dorsally with half-moon black marks on each segment. The larvae are basically nocturnal and can be found during the day on the ground under leaf litter. This is important when assessing cluster caterpillar populations in a crop.

Pupation takes place in the soil. Adults emerge in 6-7 days. The moth has a wingspan of 35-40 mm, with forewings that are brown with white markings and hindwings that are grey. The life cycle is complete in about 30 days.

In small plots of soybean cluster caterpillar is easily recognised by leaf damage. However, in large areas which are not always accessible during the wet season, it is not as easily recognisable until populations have reached plague proportions and severe defoliation has occurred.

As with Heliothis, parasites and predators are present in the N.T. Larval parasites (tachinid flies, wasps), predators (wasps, ants, spiders) and diseases (virus, fungus) account for death of up to 10% of the population.

Control can be achieved by using any of the following insecticides. Again, it is important to control larvae when they are small.

1. endosulfan at the rate of 735 g active constituent per hectare.

2. trichlorfon at the rate of 840 g active constituent per hectare.

GREEN VEGETABLE BUG *(Nezara viridula)*
REDBANDED SHIELD BUG *(Piezodorus rubrofasciatus)*

These two shield or stink bugs cause damage to soybeans and other legumes by sucking sap from terminals, flowers and pods. Potentially, they are two of the most damaging bug pests of soybeans.

Green vegetable bug (GVB) is a sporadic pest and tends to occur more frequently in the coastal areas. Redbanded shield bug (RBSB) occurs throughout the areas which grow legumes. It survives just as happily on native legumes. Both species tend to become pests of legumes late in the legume growing season. RBSB migrates from native legumes as the native scrub and legumes dry out. Most damage occurs therefore at or after pod-filling. Damage can be done even after pods appear dry.

The two bugs are similar in shape and colour - basically triangular and green respectively. GVB is 13-17 mm long and has 3 cream-coloured spots on the anterior margin of the shield-shaped second body segment behind the head. RBSB is pale yellow to green and about 10 mm long, with a pinkish red streak across the body segment behind the head.

GVB lays about 80 cream, barrel-shaped eggs in rafts nearly always on the underside of leaves. Eggs turn pink-orange before they hatch into nymphs which are brightly coloured. The first stage nymphs remain near the egg mass. After moulting, they disperse. They go through five moults (instars). The life cycle takes between 5 - 8 weeks.

RBSB lays about 25 eggs in each raft in two rows on top of the leaves or pods. The eggs are black and white when freshly laid but turn pink later. RBSB has a similar number of instars, which like GVB are coloured differently to the adult. Total life cycle is similar.

Biological control agents are present. *Trissolcus basalis* and *Xenoencyrtus megymeni* are small wasps which parasitise eggs of GVB and presumably RBSB. Predators include the "Singapore ant", *Solenopsis geminata* and the long-horn grasshopper, *Conocephalus sp.*

Chemical control can be obtained by using any of the following insecticides:

1. endosulfan at the rate of 750 g active constituent per hectare.

2. methomyl at the rate of 340 g active constituent per hectare. Note that the use of endosulfan is preferable to that of methomyl.

It is important not to spray unless it is absolutely necessary. Infestations are normally patchily distributed so it is essential to survey the whole field to assess bug incidence and distribution. Another factor which must be considered before applying chemical is the stage of crop development and so time to harvest. Feeding during the early stage of seed formation results in deformed, small seeds while feeding at a stage when seeds are large but still green, will result in pitted seed.

In the latest stage as the pod is drying out, feeding results in reduced oil content and quality. Care must always be taken in apportioning insect and pysiological damage to seeds. Pinched seed could be due to insect damage or lack of moisture during the feed filling stage.

Chemicals should not be applied unless an average of 1 adult bug per metre of row or or 1 egg mass or cluster of early nymphs per row is found.

OTHER POD-SUCKING BUGS

Other pod-sucking bugs include *Riptortus sp.*, *Melanacanthus sp.*, *Myctis profana*, and *Dictyotus sp.* These bugs are potentially dangerous to soybean cropping but are probably more important to other legumes such as mung bean. The first two species are the most important at this point of time.

Both bugs are elongate, much narrower than long, brown in colour with lighter markings laterally. Both feed on terminals, flowers and pods. *Riptortus sp.*, in particular, occurs in large numbers during the wet season. It is less prevalent during the dry season.

No work has been done on their life cycles or economic significances but, from field observations, it appears that both species could affect yield and quality of soybeans.

Control is the same as that for GVB or RBSB.

LOOPERS

A complex of loopers occur on soybeans; these include *Chrysodeixis sp.*, *Utethesia pulchelloides* and others.

The eggs of *Chrysodeixis sp.* are slightly flattened, white, about 0.5 mm in diameter and are laid on the undersides of leaves. The young larvae feed on the lower surface only, resulting in a window effect. The final stage caterpillar eat up to 5 times the leaf area eaten prior this stage. Pupation occurs in sheltered sites on the plant or on the soil. The adult has a wingspan of about 30 mm and is bronze-brown with a pair of silvery white spots on each wing.

U. pulchelloides larvae cause similar damage to that of *Chrysodeixis sp.* The adults are white with red and black dots on its forewings; its hindwings are white with dark margins.

Looper larvae and pupae are parasitised by tachinid flies and wasps but this is not sufficient to control the pest populations.

However, as soybeans can tolerate a leaf area loss of 35-40%, chemical treatment of soybeans is not often recommended. If it is required, the recommendations for control of cluster caterpillars are applicable.

LUCERNE CROWN BORER *(Zygrita diva)*

Lucerne crown borer is the larva of a longicorn beetle. It is relatively prevalent in most areas of northern Australia. It has been recorded from soybean, mung bean, guar and *Sesbania* in the N.T. Although a serious problem in small areas of soybean production on the Ord River area, it has not appeared as a significant problem in legumes in the N.T. The exception to this statement is the infestation in guar grown at Elsey Station in 1978. In this case, significant losses of plants did occur but, as in the Ord, losses were in small plots.

Eggs are laid in November - March with a peak in December, the commencement of egg-laying depending on the start of rain. Eggs are laid in the stems, often near a branch. They emerge 5 - 6 days later. The larvae, which are legless and creamy-yellow, tunnel down the stem. On reaching the root zone, the larva girdles the plant stem just above the soil and plugs the exposed end with frass. The girdling appears to aid in survival during the dry season. The larva remains in a quiescent stage for 6 months, pupates and emerges as the orange and black adult beetle after 9 - 10 days pupation.

In *Sesbania*, its native host, one generation occurs per year. In soybean in the Ord River area, three generations during the growing season can occur. Under these conditions severe damage can result, particularly if the plants are girdled during pod development. Infested plants which are not girdled, do not appear to suffer a large yield loss although seed quality is reduced and uneven crop maturity results.

Chemical control is not economical nor is it in the best interest of beneficial insects of pests. Biological control agents are present in the Ord River area but do not influence overall populations.

It appears that the only way to avoid high levels of damage is to adjust planting times to skirt the period of peak emergence of adults.

This insect is not considered a pest in the N.T. but it has the potential to develop. Planting of large areas of soybeans may reduce its importance. This occurs in Queensland.

(Note: Most of the information here was provided from G.R. Strickland (1979). - *Zygrita diva* in Soy Beans at the Ord - in Working Papers of the Workshop on Tropical Agricultural Entomology, Mareeba, Q. October, 1979.)

MITES *(Tetranychus sp.)*

Tetranychiid mites are microscopic organisms (about 0.5 - 1 mm long) and vary in colour from greenish-grey to cream with dark markings. They infest the undersides of soybean leaves and feed under webbing that they spin.

Damage is in the form of mottling initially but will progress into total yellowing and a wilted appearance under high infestations.

Though not of great importance in large scale plantings, mites have caused some problems in small plots and in screenhouse/ shadehouse situations. Hot, dry conditions toward the end of the wet season is favourable to mite development.

Control is probably not warranted.

GROWING COWPEAS IN THE NORTHERN TERRITORY

by A.G. Cameron, Agronomist, Darwin

The cowpea *(Vigna unguiculata)* is an herbaceous annual legume which has a number of plant types and uses.

Cowpea can be used as a green bean (Snake Bean), a pulse (Black-eye peas) or as a fodder, forage and cover crop.

This note deals with the cowpeas which can be used as a forage crop for grazing animals, but are generally grown as a cover (green manure) crop or a fodder (hay) crop. This type of cowpea can also be grown as a seed crop.

VARIETIES

The varieties which are suitable for Katherine and areas north to Darwin are Brandon, Meringa and Palmyra. All three varieties have a prostrate and twining growth habit and grow to a height of 50 - 100 cm.

SOILS

The recommended varieties will grow on a wide range of soil types. Although they will tolerate intermittent waterlogging, these cowpeas will not grow well if the soil is waterlogged for extended periods.

SEED BED PREPARATION

Land preparation prior to sowing is identical to that for other field crops. After an initial ploughing early in the wet season, cultivate when necessary to control weeds until the crop is sown.

SOWING

Cowpeas can be sown during the wet season between early December and early February near Darwin, but should be sown between mid December and mid January near Katherine to avoid the risk of crop failure.

A seeding rate of 20 - 30 kg/ha should be used to obtain a population of 150 000 - 250 000 plants/ha, which is needed to obtain optimal dry matter and seed yields. The seed can either be broadcast or planted with a combine seed drill in 18 or 40 cm rows.

Seed can be inoculated with cowpea inoculum CB756 before sowing to ensure effective nodulation for nitrogen fixation, but this is not necessary if cowpea or other legumes (Mung beans, Peanuts, Stylos) have previously been grown in the area to be used.

Seedlings will begin to emerge from the soil 3 - 5 days after sowing.

It is important to use only seed of good quality. Ask for a Seed Analysis Statement with the seed, or have the seed tested before sowing.

FERTILIZER

Superphosphate at 100 - 200 kg/ha and muriate of potash at 50 - 100 kg/ha should be applied at sowing, or immediately prior to sowing. It is generally not necessary to apply muriate of potash when sowing on Tippera soils as this soil type has a high available potassium supply. The application of trace elements such as Zinc, Copper and Molybdenum may be necessary with some soils.

WEED CONTROL

Pre-planting cultivation is an adequate control measure for hay and green manure crops, as cowpeas are vigorous twining legumes which smother and choke out weeds at the recommended sowing rates in well established crops.

When growing cowpea as a seed crop, it is advisable to apply either Treflan^{R} or Dacthal^{R} at recommended rates to control grasses and some broad-leaf weeds which would reduce the seed yield by competing with the cowpeas for water, nutrients and light.

HARVESTING

1. Hay Crops The ideal time to cut a cowpea crop for hay is at peak flowering, which occurs 70 - 90 days after sowing. Crude protein levels in hay cut at this stage can be 17 - 20 percent of dry matter.

Quality of hay declines as the crop matures, with crude protein decreasing to 10 - 15 percent at mid pod filling, the stage at which dry matter yield reaches its maximum. After this stage, 80 - 110 days after sowing, delays in cutting for hay results in reduced dry matter yield and much reduced quality, caused by the dropping of leaves as the crop matures.

Most cowpea crops will mature at the same time whether sown early or late.

Those crops sown earlier have the opportunity to produce higher hay yields because of a longer growing season.

Cowpea hay crops grown in the Top End should be cut between mid March and mid April to ensure good quality hay.

Hay yields are generally 3 000 - 5 000 kg/ha, equivalent to 100 - 165 standard bales/ha.

2. Cover Crops This type of crop can be incorporated at any time when sufficient green material available, but it is best done at the time of peak flowering when the material is of high quality and will break down quickly in the soil.

3. Seed Crops Seed crops should be ready to harvest 120 - 150 days after sowing. Yields range from 100 - 1 000 kg seed/ha, but are generally in the range 200 - 600 kg/ha.
Drum speed of the header must be low - 250 - 350 rpm to avoid seed damage. Harvesting should be carried out when seed is not overdry as this also helps avoid damage.

DISEASES OF COWPEA

by B.D. Conde, Plant Pathologist, Darwin

Cowpeas have not experienced any serious problems in the Northern Territory to date. The following are the diseases recorded in the N.T.

POWDERY MILDEW

Powdery mildew caused by *Oidium sp.* is quite common especially towards the dry season.

Symptoms

A greyish-white powdery growth on the surface of the leaves.

Control

Not necessary or practicable.

CERCOSPORA LEAF SPOT

Caused by the fungus *Cercospora cruenta*

Symptoms

Irregular shaped leafspots 1 mm to 3 mm in diameter, grey in colour with a red-brown margin. Spores are produced on the undersurface of the leaf in humid weather.

Control

Has not been necessary.

COWPEA APHID BORNE MOSAIC VIRUS

Appeared in the N.T. in 1979. The virus is transmitted by aphids and apparently the strain in the N.T. is seed borne. Reports in Australia indicate seed production in cowpea crops infected by cowpea aphid borne mosaic virus can be reduced.

Symptoms

Mottling, interveinal chlorosis and vein banding of leaves. Leaf cupping and further leaf distortion can occur.

Control

Control is not necessary in crops grown for hay or forage purposes. Where cowpeas are grown for seed production, ensure that the source of planting seed is free from cowpea aphid borne mosaic virus and that there are no infected crops growing nearby.

RUST

Caused by the fungus, *Uromyces appendiculatus* has not been a serious problem for cowpeas in the N.T.

Symptoms

Rust affected cowpea plants have small raised light brown pustules, usually less than 1 mm in diameter, over the leaf surface.

Control

The disease has never been severe enough in the N.T. to warrant control.

LEGUME LITTLE LEAF

This virus - like disease is caused by a simple bacterium, *Mycoplasma sp.* and is transmitted by a small leaf hopper, *Orosius argentatus*.

Symptoms

Leaves and leaflets are much reduced in size, internodes are shortened and branching is increased, producing a noticeably different clumping type of growth.

Control

Incidence of legume little leaf is usually low and does not warrant control.

OTHER DISEASES

Instances of root knot caused by the nematode, *Meloidogyne javanica*, root and stem rot caused by *Colletotrichum sp.* and base rot caused by *Sclerotium rolfsii* have been recorded in the N.T.

INSECT PESTS OF GRAIN LEGUMES

by A.J. Allwood, Senior Entomologist, Darwin

In this text, grain legumes refer to mung bean (green and black gram), cowpea, pigeon pea, guar and lablab. A separate Agnote has been compiled on insect pests of soybeans.

Grain legumes grown in the N.T. harbour a complex of insects which is probably comparable only to the complex which occurs on cotton in sub-tropical areas. To control the complex presents certain difficulties. Whilst it appears quite simple to control foliage or general pod feeders, it is difficult to control pod borers once they become protected by leaves, flowers and pods which are webbed together. Too little information is available here or overseas on economic pest densities of the various insects for these crops. Unlike soybeans, the compensatory potential of these legumes to insect damage is virtually unknown. This shortage of technical information makes recommendations for insect management that much more difficult.

Attempts are being made in the N.T. to obtain data on the economic pest density of Heliothis and the compensatory ability of mung bean to artificial de-flowering and de-podding. However, at this stage, recommendations can be made only by extrapolation from the work done on soybeans, from interstate and overseas experiences and from local field observation.

The major insect pests of grain legumes in the N.T. include Heliothis caterpillar or corn earworm, cluster caterpillar, bean pod-borer, other pod borers, various loopers, green vegetable bug, rebanded shield bug, several other species of pod-sucking bugs, lucerne crown borer, bean fly and thrips.

HELIOTHIS CATERPILLAR OR CORN EARWORM *(Heliothis armiger)*

Appearance and Biology

The adult is a moth with a wingspan of about 40 mm. Its forewings are basically brown but vary in colour from pinkish-brown to creamy brown with darker markings. The hindwings are lighter with dark out margins.

Eggs are laid on foliage, flowers, buds and pods. They are spherical, about 0.5 mm in diameter, cream in colour when first laid but change to brown prior to hatching. Eggs hatch in 2-4 days. Females lay up to 1 000 eggs during their life. Larvae are variable in colour (yellow, green, brown, pink, black) and have obvious lighter longitudinal stripes. Fully grown the larvae are 35-40 mm long. They pass through 6 moults (instars) which takes 14-24 days. During the final two instars, the larvae eats most food and causes most damage.

Pupation occurs in the soil and adults emerge in 10-14 days.

Pest Significance

Heliothis is a serious pest of many crops including grain legumes in all areas of the world. It occurs more frequently on pigeon pea and mung bean than on cowpea, guar and lablab. Pigeon pea, in particular, hosts very large numbers of Heliothis and of all the legumes, appears to be the favoured host. At Douglas Daly Experiment Station in the wet season of 1980/81, almost 100% loss of flowers of pigeon pea resulted from Heliothis attack. This is not surprising as Heliothis reached a density of 10 per square metre.

In the past, severe loss of flowers and pods of mung bean have occurred in the Katherine - Willeroo Station area. The combined effects of Heliothis, bean pod borer and probably thrips on mung beans at Willeroo Station in 1973/74 resulted in lowered yields.

Control

Biological control agents such as the egg parasite (*Trichogramma sp.*) larval parasites (tachinid flies, wasps) and predators (spiders, wasps, ants) occur at low levels, insufficient to control Heliothis population.

Chemical control can be obtained by using any one of the following insecticides:-

(i) endosulfan at the rate of 735 g active constituent per hectare

(ii) trichlorfon at the rate of 840 g active constituent per hectare

(iii) methomyl at the rate of 350-450 g active constitient per hectare. Methomyl should only be used if the larvae are large.

Heliothis larvae are easier to kill if they are small so it is important to regularly inspect the legume crops - at least twice per week and preferable more frequently.

Unlike soybeans where some data on economic pest densities are available, little or no data are available for any of the legumes mentioned here. Thus, recommendations for control are more difficult to make. An important factor to be considered is whether the crop is to be used for seed/grain production or fodder production. In the case of mung beans, if grain is to be used for bean sprouts, a further factor has to be considered i.e. germination has to be at least 95%.

The potential for grain legumes, especially indeterminate types, such as mung bean, cowpea and lablab to continue to produce flowers after severe flower or pod loss is high providing moisture is available. In the Katherine area in 1979/80, mung bean crops were heavily attacked by Heliothis, resulting in severe flower and pod loss. Late rains resulted in a second flowering and an acceptable crop was produced.

Pigeon pea also has the ability to produce a second flowering, especially as moisture is less likely to be limiting because of its deep root system.

At this stage, if grain legumes are being grown for seed, it is suggested that insecticides be applied if Heliothis larvae exceed two per metre of row. In the case of forage crops, it is not economical to control Heliothis.

CLUSTER CATERPILLAR *(Spodoptera litura)*

Appearance and Biology

The adult is a moth with a wingspan of 35-40 mm. The forewings are brown with white markings; the hindwings are grey. The female lays eggs in rafts covered with scales from its abdomen. Each raft contains 100-300 eggs, usually in 2 layers. Eggs hatch in 2-7 days.

Larvae which are green-black with a black band on the first abdominal segment, are gregarious for the first instar. They then disperse and become dull grey or blackish green when mature. Yellowish dorsal and lateral stripes are bordered by half-moon black marks on each segment of the body. The larvae feed at night and hide during the day on the ground under leaf litter. When mature, they are 45-50 mm long. Pupation occurs in the soil under the crop. Total life cycle is about 30 days.

Pest Significance

Cluster caterpillar is the most damaging foliage feeder of grain legumes. It will, though less commonly, feed on buds, flowers and pods.

Heavy infestations severely defoliated crops of cowpea at Willeroo Station (1973/74) and lablab at Katherine (1980/81).

Like soybean, grain legumes can probably sustain a reasonable loss of leaf area (say 35-40%) before loss of grain yield occurs. Leaf area loss is more important to forage crops. Not having data on economic pest densities for cluster caterpillar on grain/seed or forage crops, it is suggested that insecticides be applied when the average population reaches 12 larvae per square metre. As for Heliothis and other caterpillars, insecticides must be applied when the larvae are small.

Larval parasites (tachinid flies, wasps), predators (wasps, ants, spiders) and diseases (virus, fungi) account for up to 10% of the population.

If chemical control is required, any one of the following can be used:-

(i) endosulfan at the same rate as that for Heliothis

(ii) trichlorfon at the same rate as that for Heliothis

LOOPERS

Appearance and Biology

The two loopers which are most regularly found on grain legumes are *Chrysodeixis sp.* and *Utethesia pulchelloides*. The adult of the former species is a moth with a wingspan of 30 mm. Its forewings are bronze-brown with a pair of silvery white spots on each wing. Its hindwings are light brown.

The adult of the later species is a moth with a wingspan of 30-35 mm, with forewings that are white and spotted with black outer margins.

Young larvae of both feed on the lower surface resulting in a window effect. Latter instar larvae eat far more food than earlier instars so it is important that, if control is contemplated, it is done when the larvae are small.

Pest Significance

The combined effect of infestations of these and cluster caterpillars can cause significant defoliation in a very short time. On no occasion in the N.T., has it been necessary to chemically control loopers on their own.

Control

If control is required, recommendations for control of cluster caterpillar apply.

BEAN POD-BORER *(Maruca testulalis)*

As there are a number of pod-borers in grain legumes, it is recommended that, as Heliothis has become a common name through usage, Maruca should also be used instead of the accepted common name of bean pod-borer. This should apply to technicians and growers alike.

Appearance and Biology

The adult is a moth with wingspan of 30-35 mm. Its forewings are yellowish-brown with several translucent spots. The hindwings are translucent white with brownish margins.

Eggs are extremely difficult to locate in the field. They are deposited on flower buds, flowers, terminal shoots, pods, leaf axils and even on leaves in batches of 2-16. Total number of eggs varies, but is about 8-150. The eggs are slightly elongate (0.65 x 0.45 mm), yellow, translucent and have fine reticulation on the outside. They hatch in 2-3 days.

The larvae is cream with dark plates on each segment in rows. They pass through 5 larval stages (instars) and mature in 10-14 days. The larval period is followed by a two-day prepupal period during which feeding ceases. The pupa is greenish-brown in colour initially but darkens. The adult emerges in 6-9 days.

The total life varies but is of the order of 20-27 days.

Pest Significance

Overseas Maruca is considered to be the most important pest of grain legumes. In cowpea, for example, in South Africa it is recognised as a key pests as its attack is serious, perennially occurring and dominates control practices as populations remain above economic pest density. In southern Nigeria, it has been held responsible for total crop failure by causing 50% damage to flowers and over 60% damage to green pods of cowpea.

Its greatest asset as a pest is that it establishes itself very early in the crop. Young growing tips of cowpea are susceptible. The flower bud stage is probably the most favoured period of the crop for egg laying. Feeding by larvae causes flower bud shedding which was obvious in mung bean at Willeroo Station in 1973/74. Once established at this stage, it progresses to flowers and finally to pods. This progression to protected sites makes chemical control difficult.

Larvae are not restricted to one flower. It is likely that movement from one flower to the next is via silken webbing and probably done at night. Between 4-6 flowers can be damaged by one larva. Larvae of the 3-5th instars are capable of feeding on pods and stems. Cowpeas at Katherine in 1980/81 season showed signs of feeding in the stem.

In all cases, typical symptoms of damage are flowers, pods and leaves webbed together and racemes devoid of flowers or pods. The latter symtom can be confused with flower thrip damage.

Its significance is more far-reaching than its damage to grain legumes. As it is so difficult to control once established, unless alternate methods of control to chemicals are investigated, any idea of an integrated control program for grain legumes insect control could be jeopardised by the need to regularly spray for Maruca control.

Control

As in overseas instances, control of Maruca in the N.T. is warranted in cowpea, mung bean and pigeon pea. Nothing is known of Maruca in lablab or guar. It is essential to commence control early i.e. at flower bud formation. From limited field observations in 1980/81 season, it seems that applications of insecticides have to be maintained on a weekly basis from the flower bud stage until pod set.

It has to be kept in mind that should the first flowering of mung bean, cowpea and pigeon pea be severely damaged by Maruca, a second flowering is possible providing moisture is available.

For chemical control, any one of the following insecticides can be used at the same rate as for Heliothis control

1. endosulfan
2. trichlorfon
3. methomyl

OTHER POD BORERS

Included amongst other pod-borers are the lycaenid butterfly, *Euchrysops njeus nidas*, and the noctuid moth, *Eublemma dimidialis*. These two were first recorded in the Berrimah area. Eublemma has since been recorded from Douglas Daly Experiment Farm in mung bean in 1980/81. Little is known of their biologies.

Eublemma is similar to Maruca in appearance but does not have the darkened dorsal plates. It develops in the later stages faint pink longitudinal lines down its body. It has longer setae (hairs) on its body than Maruca.

Euchrysops is slug-like in shape and often feeds on pods with some of its body protruding. This is unlike either Eublemma or Maruca.

By themselves, they are unlikely to be of economic significance and so would not require control. They would be controlled with treatment for Maruca.

GREEN VEGETABLE BUG (GVB) *(Nezara viridula)*

RED BANDED SHIELD BUG (RBSB) *Piezodorus rubrofasciatus)*

Appearance and Biology

Green Vegetable Bug (GVB)	Red Banded Shield Bug (RBSB)
1. 13-17 mm long, basically triangular in shape, green	1. 10 mm long, yellowish green green, triangular in shape.
2. 3 cream spots on anterior margin of shield-shaped second body segment behind head	2. Pinkish-red streak across body segment behind head
3. Lays 80 eggs (which are cream, barrel-shaped) in rafts on underside of leaves	3. Lays 25 eggs (which are black & white) in two rows on the tops of leaves and pods.
4. Eggs turn pink-orange before hatching	4. Eggs turn pink before hatching
5. Nymphs have 5 instars - brightly coloured	5. Nymphs have 5 instars - brightly coloured

Pest Significance

Both bugs have the potential to cause damage to all grain legumes. GVB is sporadic but this could alter with grain legumes being grown more regularly over larger areas. It appears to occur more often in coastal areas. RBSB occurs throughout grain legume areas in the N.T.

Both species appear to be pests of legumes late in the growing season, usually after native legumes and other hosts have dried off.

Feeding in the early stage of the crop's growth results in deformed, small seeds while feeding at later stages will result in pitted seed, often of lower oil content and germination. The viability of the seed of mung bean, in particular, is important if beans are supplied for the sprout industry - at least 95% germination is required.

Control

Based on information pertaining to soybean, chemical control is warranted if an average of 1 adult bug per metre of row or 1 egg mass or cluster of early nymphs per 3 metres of row is found.

Anyone of the following chemicals will give adequate control:-

1. endosulfan at the rate of 750 g active constituent per hectare

2. methomyl at the rate of 340 g active constituent per hectare. The use of endosulfan is preferable to methomyl.

Because parasites and predators can influence populations, it is important to spray only when necessary. The stage of the crop at which insects attack must also be considered.

OTHER POD-SUCKING-BUGS

Riptortus sp., *Melanacanthus sp.*, *Myctis profana*, and *Dictyotus sp.* are regularly observed in grain legume crops in all areas in the N.T. The first two species rate as importantly as GVB and RBSB.

Both bugs are elongate and narrow about, 10-12 mm long and are brown with pale yellow-cream markings laterally. Eggs are laid singly on leaves, flowers and pods and are black.

At this stage, no work has been done on economic pest densities but, from field observations and because of the large populations that develop, it is likely that reduced yield and quality of beans would occur.

Control is the same as that for GVB and RBSB.

LUCERNE CROWN BORER *(Zygrita diva)*

Appearance and Biology

The adult is a longicorn or long-horn beetle, basically orange in colour with paired black markings on the wing covers. Eggs are laid in stems. They hatch into legless, cream larvae which tunnel down the stems. When they reach the root zone, the larvae girdle the stems just above the ground and plug the stems with grass and stem debris. Under native conditions i.e. in the native host *Sesbania sp.*, the larva enters a resting stage which lasts for 6 months. The adult emerges after 9-10 days pupation.

In Sesbania, lucerne crown borer goes through one generation per year. In soybeans and probably the legumes mentioned here, it has the potential for several generations (up to three) per year.

Pest Significance

Though a serious pest of soybeans grown in small hectareages in the Ord and the N.T., lucerne crown borer does not assume the same pest status in mung bean, pigeon pea, cowpea or lablab. Indications are, from preliminary work, that it could be a more serious pest of guar.

Control

Control of this pest is not warranted. It may become more or less important as larger areas of grain legumes are grown. Basically, it is wait-and-see situation.

BEAN FLY *(Ophyomyia phaseoli)*

Appearance and Biology

The adult is a small (3-5 mm long) shiny black fly. It lays its eggs singly into holes made on the upper surface of leaves usually near the petiole. The eggs are slender, white eggs, almost 1 mm long.

The larvae hatch in 2-3 days, are maggot-like, cream and tunnel through the leaf, down the petiole, and into the stem. Pupation takes place in the stem just above the ground. Brown pupae can be seen through ruptures in the epidermis.

The total life cycle is completed in 14-21 days.

Pest Significance

Bean fly has not been recorded as a serious pest of guar, lablab or pigeon pea. It does affect establishment of mung bean, cowpea and soybean.

Egg laying causes yellow spotting or strippling at the site of the punctures. Larval feeding results in weakened petioles and stems, a water stressed appearance of plants and finally yellowing and death.

From initial field observations, it appears that cowpea suffers more damage than mung beans. This is the reverse to the situation in many Asian countries where they are dealing with a complex of species of *Ophyomyia*.

Control

At this stage, chemical control is the only avenue open. Dimethoate at the rate of 330 g active constituent per hectare applied 3 days after the plants emerge, 4 days later and then weekly until flowering will give adequate control.

The possibility of varieties resistant to bean fly is being investigated elsewhere in Australia.

THRIPS

Appearance and Biology

The adult thrip is little more than 1 mm long and less than 0.5 mm wide. It is black when mature and has 2 pairs of wings which are fringed with hairs.

Eggs are presumably laid in the flowers where both nymphs and adults feed.

The life cycle is completed in 10-14 days.

Pest Significance

No concrete data is available on the pest significance of thrips. They occur in large numbers in the flowers of all legumes i.e. soybean, mung bean, cowpea, guar, pigeon pea, lablab and *Canavalia sp.*

It is suspected that high populations can cause flower abortion in the N.T. Abortion has occurred when neither Maruca nor other pod-borers are present but thrips are there in large numbers.

Control

Any of the following chemicals will give control:-

1. dimethoate at the rate of 330 g active constituent per hectare

2. endosulfan at the rate of 400 g active constituent per hectare

LABLAB RECOMMENDATIONS FOR THE NORTHERN TERRITORY

by P.G. Harrison, Agronomist (Seeds), Darwin.

Lablab, *(Lablab purpureus)* which is sometimes called dolichos or hyacinth bean is an annual forage legume or pulse crop. It occurs widely throughout tropical Africa and India, Central and South America and sporadically in South East Asia.

In India and Africa particularly, it is commonly used as a pulse crop and the beans eaten, with livestock use for grazing often secondary. In Australia, the reverse applies with lablab being used throughout the sub-tropics and tropics as an important annual forage crop, both for direct grazing by livestock and fodder conservation.

DESCRIPTION

Lablab is very large seeded (1 - 1.5 cm long) with seeds ranging in colour from white to speckled through brown to black. Commercial cultivars are brown and black seeded, both with a distinct white ridge around one half of the seed. The seedlings are large-leaved and vigorous, growing quite rapidly to produce a crop 1 - 2 metres high. The trifoliate leaves are 10 - 15 cms long, smooth above and slightly hairy underneath. Stems can be 1 - 1.5 cms diameter in a mature stand and it is usual to see the crop thickly intertwined.

The inflorescence is many flowered and quite loose. Pods are broad, slightly curved, about 60 - 100 mm long and contain two to six seeds. Seeds weigh about 4 000/kg.

AREAS SUITABLE

Within the Northern Territory lablab is probably best suited to areas receiving 900 -1300 mm of rain annually, if the crop is to be grown as a dryland crop. If irrigation is available, it could be used as a summer annual forage throughout the N.T. Although it grows satisfactorily in regions with more than 1300 mm of rain, e.g. Adelaide River to Darwin, more care is needed in choice of soil to ensure a good crop, as lablab can be susceptible to waterlogging on poorly drained soil.

Choice of soil type is not critical, except with respect to waterlogging, as lablab tolerates a wide range of soil types from alkaline clays through to highly acid sands. It is very well adpated to clay loams and sandy loams, e.g. Tippera and Blain in the Tipperary Land System, with a slightly acid pH. Most soils suitable for cultivation within the Northern Territory would be satisfactory for growing lablab.

USE

Lablab is quite palatable and can be highly productive, giving a large bulk of high protein feed when well fertilized.

There are a number of methods of using lablab:

1. As a standing fodder crop either by holding a paddock and then opening the gate or by strip grazing using electric fencing.

2. To make silage, a method not widely used commercially in the N.T.

3. As a pioneer legume in newly cleared country, either singly or together with other legumes or grasses including verano, pearl millet or forage sorghum.

4. For hay production. Use of a conditioner is recommended to assist with drying of the thick stems.

5. As a green manure crop for horticulture.

Yields of lablab have generally been from 6 - 10 tonnes/ha of dry matter, although some considerably higher yields have been recorded. It may be mixed with other forage species e.g. forage sorghum and millet for a mixed forage crop. Total yield may be higher (of the crop) but quality usually is lower due to the admixture with grass.

LAND PREPARATION AND SOWING

Sowing is best done as early as possible. This could be from mid November in the Darwin area to mid December in Katherine. Late sowing significantly reduces yield. Usual cultural practices would include two soil workings before sowing. Initial ploughing would be with a heavy disc or chisel plough to a depth of 10 - 15 cms followed by a disc harrow or tyned cultivator to control emerging weeds. Care needs to be exercised in all soil workings to avoid erosion by working on the contour or leaving grass strips.

Sowing is by drill or combine, which also provides a final soil preparation. Seeding rates of 15 - 25 kg/ha in 20 cm or 40 cm rows are preferred. Rates as high as 40 kg/ha may be used if a very quick cover is required. A sowing depth of 1.0 -2.0 cm is suitable and inoculation with the cowpea type (CB756) rhizobia is recommended for new areas only as a precautionary measure.

When planting with forage grasses or an undersown permanent pasture (e.g. Verano stylo) the lighter sowing rate of 10 - 15 kg/ha are recommended.

Lablab is tolerant of the usual herbicides for use with legumes such as trifluralin, chorthal and pendimethalin at recommended rates, but for a forage area these would not usually be necessary unless the area was particularly weedy. A small increase in sowing rate is a cheaper means of ensuring a quick cover and thus smothering weeds.

Lablab has been successfully established on some very rough seedbeds in newly cleared country with the use of only a heavy disc plough and broadcasting, followed by light discing. For this to be successful, timing is critical and it is generally recommended for lablab that more care be taken in soil preparation and sowing than this, if possible.

Emergence takes from 4 to 10 days after sowing.

Early sowing on some of the red sandy soils e.g. Blain and Kiluppa can be a problem if they are cleared and cultivated. High soil temperatures are a major problem. For these it is recommended that you sow later when cloud cover lowers soil temperature or to consider the use of minimum tillage techniques.

FERTILIZER

Lablab is very responsive to fertilizer. Recommended rates are 100 -200 kg/ha of superphosphate, although as high as 400 kg/ha have been used. Potassium as muriate of potash is recommended for most soils at 50 - 100 kg/ha (not Tipera). Sulphur is essential, but would not be needed if standard superphosphate is used. There is considerable evidence that minor elements such as zinc are also needed on both Tippera and Blain soils. This can be applied at 10 kg/ha of zinc sulphate mixed with the fertilizers above. Nitrogen is not normally applied.

GROWTH AND DEVELOPMENT

Flowering is late - from mid May to June, depending on variety and will continue if moisture is available. If being used for hay, it should be made at this time.

SEED QUALITY

For sowing, farmers should insist on seeing an analysis report of the purity and germination of the line they are interested in buying. Although a legume, lablab is not hard seeded and germination tests for the species should be high. Values of 80% germination or higher are normally expected. Purity values are in excess of 90%. Also take care not to be purchasing weeds. Check what weeds are in the line from the label or analysis result.

Where germination or purity values are lower than expected, recalculate your sowing rate. Rates quoted are based on a purity of 100% and a germination of 100%. Don't skimp on seed - you will not get the result you wanted.

If in doubt about seed quality have it tested before sowing. Allow approximately 3 weeks for the analysis to be completed.

CULTIVARS AVAILABLE

Two cultivars are available - Rongai and Highworth. Both are satisfactory, although Highworth is definitely preferred for the lower rainfall areas.

Rongai was the original lablab variety available in Australia and was registered as a cultivar in 1962. It is late flowering, with profuse white flowers and produces brown seeds. It is somewhat higher yielding than the other cultivar when a longer growing season is available.

Highworth was selected from a range of southern Indian material for early flowering, high seed yield and satisfactory dry matter production. In the Top End of the N.T. it flowers 3 to 4 weeks earlier than Rongai, with flowers being a distinct purple colour. Pods are borne above the canopy and this makes seed harvesting easier. It is higher seed yielding than Rongai, although not quite as productive. Seeds are black, slightly smaller than Rongai.

SEED PRODUCTION

It is possible to produce seed of these cultivars in the Northern Territory and demand for seed is steady. Seed can be produced satisfactorily in the Tipperary/Adelaide River region without irrigation. It may be necessary to irrigate once or twice in lower rainfall areas to ensure a satisfactory seed crop.

For seed production, sowing and fertilizer rates should be at the higher levels as recommended to ensure a good stand.

It is recommended that attention be given to insect problems at flowering and seed set. It may be necessary to spray to achieve adequate insect control to obtain a good seed crop. The recommendations currently are as for all grain legume crops - trichlorfon or endosulfan (Dipterex® or Thiodan®). Tall growing grasses or weeds may be controlled late in the season with a rope wick application of glyphosate.

Harvesting is by conventional header at slow drum speeds to avoid damage, 200 - 300 rpm is recommended, with a wide cylinder clearance.

DISEASES OF LABLAB

by R.N. Pitkethley, Plant Pathologist, Darwin

Lablab has not been affected by serious disease in the Northern Territory. The only disease recorded is a leaf spot caused by the fungus *Sclerotium rolfsii*. This soil inhabiting fungus can attack a wide range of crop species under conditions of extreme humidity. It usually attacks the lower stem, but leaves can be affected particularly if they are close to the ground. The disease is rare in lablab and does not warrant control.

PRODUCTION OF SEED CROPS IN THE TOP END OF THE NORTHERN TERRITORY

by P.G. Harrison, Agronomist (Seeds), Darwin

Seeds are an integral part of any agricultural system and the production of seed by specialist producers or sometimes by "catch croppers" is a modest but important industry in local agriculture.

The combination of reliable wet growing season and long dry season suitable for harvest are attractive climatically for seed production of a wide range of species. Historically, and at present, production of seed of a range of legume and grass species has been practised in the Top End between Katherine and Darwin. Species include Townsville, Caribbean and Shrubby stylos, Siratro, cowpea, lablab, pearl millet, urochloa and uniflorum. Many more could be grown if use of irrigation was more widespread. Some limited production of seed for crops and vegetables has also occurred.

This latter area could be expected to increase as demand rises with the expansion of agriculture. The potential also exists for specialised production in the dry season of irrigated seed crops such as vegetables, hybrid seed and seed increase areas of experimental lines for commercial firms. Irrigation facilities would also enable the successful production of "long season" pasture species which require late wet season irrigation to ensure a good season finish and high yields.

Yields and returns have been highly variable, given the widely varying ability of the farmers, the vagaries of weather and markets including the flucuating fortunes of the Northern beef industry and its involvement in improved pasture development. Many producers in the past have lacked the necessary skills and/or equipment to produce a top quality product which buyers demand.

The pasture seeds produced have been sold locally, interstate and overseas while much of the crop seed has been used locally. Potential exists in the industry for further development to substitute locally produced seed for that produced interstate, especially in forage seed. A need also exists for the development of skills used in modern seed production and processing by more producers to capitalize on this potential.

Seed certification schemes have been developed for many of the crop and pasture species grown locally to ensure genetic quality as well as some check on physical quality of the seed. Growers are generally keen to utilize such schemes for it is felt they provide a marketing advantage to them, as well as protection for the buyer. International accreditation of certification through OECD is available for many species produced locally.

A comprehensive seed laboratory can provide all the requisite seed testing services required for a seed production industry, and has been closely involved in the industry for many years. It is both nationally and internationally recognised.

Included in this summary are some tables illustrating the crops which may be/or are currrently grown detailing in simple form the relevant details of each species. It is a very simplistic exercise and barely outlines the requirements. It should be noted that where legume crops, other than stylos are being produced, difficulty with insects is to be expected. Spraying will be essential to ensure good seed yields. The two chemicals recommended are trichlorfon (Dipterex®) and endosulfan (Thiodan®) at the appropriate rates.

For more detail, interested persons are recommended to consult a booklet produced by the FAO, Rome entitled "Tropical Pasture Seed Production".

SEED CROPS

SPECIES	INITIAL FERTILIZER	SOILS	APPROX. YIELDS	RETAIL SALE PRICE/KG April 1981	HARVEST METHOD	PROBLEMS/ PROSPECTS
Stylosanthes hamata cv Verano	100-200 kg/ha Super K? Zn?	Wide range, not wet clays	100-1000 kg/ha 300 kg mean	$ 5-7	Direct or suction	Few problems. Good prospects.
S scabra cv Seca	100 kg/ha Super	Wide range	100 kg/ha	$ 12	Direct heading	Tall, can be difficult to harvest Relatively low seed yield. Prospects fair
cv Fitzroy	100 kg/ha Super	Wide range	200 kg/ha +	$ 8-10	Direct heading	Anthracnose. Suitable ONLY Katherine area or lower rainfall. Prospects very good
S. guianensis cv Graham	200 kg/ha Super K? Zn?	Wide range tolerant some heavier soils	400 kg/ha +	$ 5-8	Direct	Timing of heading. Prospects good. Use in 1200 mm AAR areas.
cv Cook cv Endeavour	} Not recommended for seed production in this area unless irrigated.					
Calopogium mucunoides	100-200 kg/ha Super	Very wide range	200-400 kg/ha	$ 5-8	Direct or suction (preferred)	No major problems Prospects good
Cenchrus ciliaris various cultivars	100 kg/ha Super K? Zn? 50 kg N or mixed with legume pasture	Not heavy clays Prefer lighter soils	30-200 kg/ha	$9-12	Simple front mounted bearer	Timing of harvest critical. Very easy to get some seed, difficult to get very good yields Prospects excellent

SPECIES	INITIAL FERTILIZER	SOILS	APPROX. YIELDS	RETAIL SALE PRICE/KG	HARVEST METHOD	PROBLEMS/ PROSPECTS
Urochloa mosambicensis cv Nixon	100 kg/ha Super K? Zn? 50-100 kg/ha N per harvest	Clay loams - loams	50-200 kg/ha per harvest	$ 5	Direct heading or simple beater	If harvested in the wet, may require drying. Prospects good
Pennisetum americanum cv Ingrid cv Katherine	100-200 kg/ha Super K? Zn? N - 50 kg/ha	Very wide range	100-800 kg/ha mean 400-600	$ 0.80-1.20	Direct, maize front very useful	Birds a problem. Prospects good. Annual field crop.
Lablab purpureus cv Rongai cv Highworth	100 kg/ha Super K? Zn?	Loams/clay loams Excellent in 1100-1200 mm AAR area	200-500 kg/ha	$ 0.40-0.80	Direct heading	No problem except some insect. Prospects good.
Vigna unguiculata various varieties	100 kg/ha Super K? Zn?	Not heavy clay soils	100-1000 kg/ha 300-600 mean Newer varieties higher	$ 0.55-0.65	Direct heading	Insect problems. Prospects fair - good
Paspalum notatum cv Argentine	200-400kg/ha P K? Zn? S? N - 50 kg +	Most, if not totally flooded	200 kg/ha +	$ 5-8	Direct heading	Lawn species. Strong growth prospects.
Macroptilium atropurpureum cv Siratro	200-400 kg/ha Super 100 " KCL Zn?	Most soils except heavy flooded black clays	100-1600 kg/ha 200-400 kg mean total over several harvests/ year	$ 20	Direct then followed by suction OR suction	Excellent prospects but not at that price Short lived crop - 2-4 years at most. Heading difficult due to volume of material and shattering

SPECIES	INITIAL FERTILIZER	SOILS	APPROX. YIELDS	RETAIL SALE PRICE/KG	HARVEST METHOD	PROBLEMS/ PROSPECTS
Macroptilium lathyroides cv Murray (phaey bean)	100-200kg/ha Super K? Zn?	Tolerates flooded areas Also grows on clays, clay loams	50-500 kg/ha	Not readily available for sale possibly $20	Direct or suction	Excellent prospects - demand good Difficult to get good yields. Susceptible to bean fly
Brachiaria decumbens cv Basilisk (signal grass)	200 kg/ha Super 100 kg/ha KCL 50-100 kg/ha Urea	Wide range, in areas receiving 1000mm rain or more	50-250 kg/ha per harvest, one or two harvests per year	$ 4-7	Direct	Requires careful harvest & drying for good quality seed. Demand excellent. Export demand.
Brachiaria mutica (para grass)	100 kg/ha Super 50 kg/ha KCL 50 kg/ha Urea	Requires wetter soil for good growth. Also need to get there for harvest	20-50 kg/ha	$ 40	Direct	Excellent sale prospects. Requires careful & skilled timing of N application & harvest. Drying necessary.
Brachiaria humidicola cv Tully (Koronivia grass)	100 kg/ha Super 50 kg/ha KCL 50 kg/ha Urea	Wide range. Tolerates poorly drained soil & short term flooding	50-200 kg/ha	?	Direct	Sale prospects good. Timing of harvest critical. Requires drying for good seed quality

This does not include all possibilities. Crop species such as mungbean, soybean and pidgeon pea are not included, nor are peanuts. There are also a range of other pasture species with smaller markets which would be suitable for use in the area or for seed production and sale elsewhere. Prospects for individuals to specialise in some vegetable seed production enterprises on a small scale, if irrigation is available, are excellent. Returns from these enterprises are good, if attention to detail is fulfilled.

PEARL MILLET RECOMMENDATIONS FOR THE TOP END

(*Pennisetum americanum* (L.) Leeke)

by P.G. Harrison, Agronomist, Plant Industry, Darwin

Pearl millet is cultivated widely in West Africa, India, Sudan and parts of North Africa mainly for grain and in the U.S.A. and Australia principally as an annual fodder grass. There is also interest for use in the bird seed trade. The value of pearl millet is its ability to grow under low rainfall in short wet seasons, rapid growth, good fodder quality, easy seed production and its capacity to regenerate after cutting. It is very deep rooted and can extract and use both moisture and fertilizer from considerable depths.

The plant is well adapted to the high temperature and variable moisture conditions experienced in the monsoon rain areas of the Northern Territory, yielding quite highly. Yields of 10-13 tonnes/ha are to be expected and yields of 20 tonnes/ha have been recorded. At flowering, protein levels of 7-12% are expected, although these can decline rapidly if left past this optimum time for fodder conservation or use.

DESCRIPTION

Pearl millet is a tillering (occasionally single stemmed) annual growing from two to four metres or more in height. The stems are solid, leaves 60-100 cm long and 2-10 cm broad. The infloresence is a dense spike 10-50 cm long and 2-4 cm in diameter usually cylindrical, but sometimes tapering at one or both ends. The spike has numerous bristles and the grain is tightly packed on the spike. The grain varies in colour from grey to white, yellow/green or even slightly bluish and in local varieties is about 3-4 mm in diameter.

Pennisetum americanum flowers only under short day conditions and the two cultivars recommended for use in the Northern Territory are both strongly photoperiodic, flowering at about the same time each year. Early planting of these cultivars is essential to obtain maximum yields. The species is not drought resistant (as compared to sorghum) but its tolerance to lower rainfall is due to its ability to grow rapidly when moisture is available.

AREAS SUITABLE

Pearl millet is suitable as a fodder crop in areas receiving from 500-1500 mm of rain annually, with a wet season of two to five months. Best yields have been obtained in those areas of a 3 - 4 month growing season of 850 - 1300 mm of rain.

The plant can be grown on a wide variety of soils, except those that are seasonally flooded or waterlogged during the plant growth period. Light loams, sandy loams or sandy soils are preferred to heavy clay soils where it develops more shallow roots. Most soils of the Tipperary Basin including Tippera clay loam, Blain and related soils are all suitable, as are most of the arable soils and river levees from Adelaide River north. It has no definite preference for acid or alkaline soils.

USE

Principal use of pearl millet in Australia has been as an annual fodder crop. Apart from the Northern Territory, it has proved of use in coastal Queensland and northern New South Wales as a safe substitute for sorghum hybrids as it is free of any possibility of prussic acid poisoning. Research work has also shown its usefulness as a late summer forage in central and south coastal New South Wales and as an irrigated crop around the Perth area of Western Australia.

Freedom from prussic acid can make the species attractive to land owners with more valuable stock (e.g. dairies and studs) as the possibility of stock losses is totally removed.

In the Northern Territory pearl millet yields extremely well, is well adapted to the region and has been used widely as a forage crop. Occasionally a legume such as lablab or cowpea may also be sown with it.

Several ways of utilizing the crop are:-

1. use during the wet on a rotational basis,
2. fodder conservation - hay or silage,
3. standing fodder crop, utilized by a single, totally destructive grazing,
4. seed or grain harvest for the bird seed trade/seed for sowing, or
5. pioneer cereal type crop on new less developed land

The third use has probably been the most common and has been practised for many years on a number of properties.

Highest yields of herbage - 13 tonnes/ha average over many seasons in Katherine, but at the expense of quality, are obtained by utilizing the crop at the end of the wet in one grazing. Timing is important for late use of the material results in considerably reduced quality of forage.

LAND PREPARATION AND SOWING

Establishment does not present any special difficulties, but seedlings are quite susceptible to a dry spell after sowing, which may necessitate resowing. No special care for seedbed preparation is necessary and a wide variety of practices have been used, from broadcasting to drilling.

It is suggested that at least one cultivation be given to both open the ground and kill weeds. Sowing can then be by broadcast or preferably, by a combine or drill. If broadcasting is used, higher sowing rates are recommended. Pearl millet has also been sown successfully using minimum cultivation techniques.

Early sowing enhances the prospects of high forage yields and is recommended. Late sowing reduces yield and plant height significantly and while desirable for seed production to ease harvest, forage yield is greatly reduced.

If sowing with a combine or drill, a sowing depth of 1-1.5 cm is recommended. Rows of 15-35 cm width are preferred for fodder crops. Successful sowing rates vary enormously. Recommendations from elsewhere range from 3-40 kg/ha. Rates in the N.T. for forage would be 10-15 kg/ha, 6-10 kg/ha for seed. Higher sowing rates give better early growth and greater competitive ability against weeds, but appear not to greatly influence final yield.

Where weeds are a major problem, atrazine at 1.8-2.2 kg/ha (active constituent) on light soils will assist control of some grasses and most broadleaved species including *Sida spp.* Due to its vigorous growth pattern, pearl millet soon produces a closed canopy which inhibits further weed development. Higher seeding rates may assist in better weed control.

Germination and emergence is rapid and seedlings should appear 4 - 6 days after sowing.

High soil temperatures are a problem with establishment on some soils in the area early in the growing season if they are clean cultivated. For these soils sowing may be delayed slightly or some form of cultivation which retains a mulch layer greatly assists establishment, as does zero tillage practices.

FERTILIZER

By way of its growth on lighter soils and an ability to be extremely deep rooted pearl millet can utilize fertilizer which has been leached down the profile from earlier crops or pasture leys. Phosphate is generally not effective when applied alone, but it does increase the effectiveness of applications of nitrogen or residual nitrogen and thus a light application is recommended - 5-10 kg/ha of P (equivalent to 50-100 kg of superphosphate) at sowing.

Application of from 50-100 kg/ha of N (equivalent to 100-200 kg/ha of urea) is desirable to achieve optimum yields. However, these nitrogen levels may exist in the soil if pearl millet follows a legume ley and applied nitrogen may not be necessary or could be reduced. There is evidence on many Northern Territory soils of deficiences of potassium and this would also be recommended at 50-100 kg/ha as muriate of potash. Sulphur is needed, but is generally supplied through the use of superphosphate.

Minor element deficiencies have been noted on a number of soils, in particular Blain and possibly Tippera. Zinc appears implicated, although there may be others also. Knowledge of the problems is incomplete, but as a precautionary measure the use of 10 kg/ha of zinc sulphate is suggested. One application may be sufficient for several years.

GROWTH AND DEVELOPMENT

Young plants grow fast and are not generally affected by pests and diseases. Infestations of northern armyworm *(Mythimna separata)* and day feeding armyworm *(Spodoptera exempta)* have been reported, but would not normally require spraying. A severe infestation of an as yet not identified beetle caused severe damage in 1981 and required spraying. No other instances requiring spraying are known. Corn earworms *(Heliothis spp)* can be a minor problem in attacking developing heads of grain but again spraying would not be contemplated unless seed or grain was to be produced.

Floral initiation begins in early March and rapid elongation and growth occurs during March. Extremely high rates of growth occur in this period, the plants often growing 2 to 3 metres during the period. Flowering occurs in late March-early April, depending on cultivar, and seed is mature some 40 - 45 days later.

Birds can be a major problem if seed or grain production is contemplated. A wide range of granivorous birds attack millet including white cockatoos, galahs, corellas, crimson wing parrots and lorikeets. Control has been by shooting or scaring devices, neither of which are particularly successful.

SEED QUALITY

Insist on seeing an analysis certificate detailing the cultivars and purity, germination and weeds present before you buy seed. Analysis results of 95% purity and 80% germination should be easily obtained. All sowing rates mentioned assume 100% purity and germination, so they may need to be adjusted to compensate for seed of lower quality. Do not use too low a seeding rate - you may not get the result you want.

Seed quality can be checked before sowing if required. A complete analysis will take about 14 to 16 days. The germination test figures on the analysis should be current i.e. no more than three to six months old; if not - have it retested before purchase.

Grain of pearl millet is susceptible to weevil damage during storage. This may be controlled by regular fumigation with phostoxin or by additives to the seed before storage. Recommended chemicals include fenitrothion and bioresmethrin.

CULTIVARS AVAILABLE

Two cultivars are recommended for use in the Northern Territory, both developed within the N.T. These are Katherine and Ingrid. Both cultivars have also performed well interstate.

Katherine pearl millet was selected from material originally imported from Ghana. It is an obligate short day plant, floral initiation occuring in a day length of 12-12½ hours. Leaves are dark green, flat and up to 8 cm wide and generally hairy. Infloresence about 30 cm long, with straw to purple coloured bristles, but not prominently so. The caryopsis is pearly white to grey, about 3 mm diameter.

Ingrid pearl millet was introduced from Senegal, West Africa in 1961 and subsequently tested against the cultivar Katherine. Leaves are far less hairy, wider and of a lighter green colour. The inflorescence is longer (up to 45 cm) and spikelet bristles more pronounced and longer. The caryopsis is smaller than Katherine and greenish/yellow grey and very tightly packed on the spike. Ingrid is slightly earlier flowering than Katherine (1-2 weeks) but not significantly different in total dry matter yields at Katherine. However, it makes more vigourous early growth and yields more seed. Forage quality (protein) is also slightly higher.

Because of its earliness and at least equal productivity, Ingrid is recommended for the Katherine area in preference to Katherine, while further north Katherine would be the preferred variety.

SEED PRODUCTION

Certified seed is available of both cultivars. Seed yields of Katherine pearl millet are generally lower than those of Ingrid. In the region, Katherine has averaged about 650 kg/ha for well grown crops, while Ingrid has been higher at 800 kg/ha. Yields of both cultivars substantially higher than these figures have been reported. (up to 1200 kg/ha).

For seed production, the crop should be well supplied with fertilizer. Superphosphate at 100-150 kg/ha and nitrogen at 100-150 kg/ha are required. Sowing rates may be slightly lower than previously recommended, 6-10 kg/ha being suitable, to allow for free tillering of the plants.

In the past, harvest of seed has been a problem due to excessive height of the crop. Use of a maize front assists in overcoming this problem. Height may also be controlled by late planting, or by judicious slashing of an early sown crop. Where this is practised, a conventional header can be used.

Markets exist for the seed locally and interstate, while development of a bird seed trade shows some promise.

DISEASES OF PEARL MILLET

by R.N. Pitkethley, Plant Pathologist, Darwin

Pearl millet has been almost entirely free from disease in the Northern Territory. Although a future increase in pearl millet growing would tend to favour disease build up, it is encouraging that disease has not been a problem in pearl millet elsewhere in Australia.

The only disease known in pearl millet in the N.T. is smut caused by the fungus *Tolyposporium penicillariae* which appeared in an experimental crop in 1974. This disease affects the head of the plant, causing some developing seeds to be replaced by a mass of smut spores. Smut has not been observed since the original outbreak in 1974.

DISEASES OF SIRATRO

by R.N. Pitkethley, Plant Pathologist, Darwin

Several diseases have been seen in Siratro in the Northern Territory. Most have appeared only on isolated plants. On the basis of reports from elsewhere some of these diseases have the potential of causing damage under wet or humid conditions.

RHIZOCTONIA LEAF BLIGHT

Is caused by a species of *Rhizoctonia*, a soil inhabiting fungus which commonly affects the roots and stems of a wide range of plants. Under wet conditions it affects the leaves of Siratro and can cause defoliation of some plants.

Symptoms

Irregular shaped pale brown spots on leaves, which may have a narrow dark margin. Spots can enlarge to kill whole leaves with breakdown of leaf tissue resulting in a leaf "skeleton". Brown, roughly spherical structures (sclerotia), 1-2 mm in diameter may form on the leaf surface. Sclerotia allow the fungus to survive from one season to the next.

Control

On past experience this disease only occurs occasionally in isolated plants under very wet conditions. Control does not appear to be necessary.

SCLEROTIUM LEAF BLIGHT

Is caused by the fungus *Sclerotium rolfsii* which generally causes somewhat similar types of disease to *Rhizoctonia* described above.

Symptoms

Large leaf spots, up to 1.5 cm in diameter with a pattern of concentric light and dark brown rings. Severely affected leaves die.

Control

Probably not warranted.

RUST

Caused by the fungus *Uromyces appendiculatus*, has only appeared recently in the N.T. in isolated mild infections. As the disease has caused severe loss elsewhere in the world, it should be closely watched in the N.T.

Symptoms

Minute pale spots on leaves which develop into raised rust red pustules on the underside of the leaf. In severe infections, leaves may die and fall.

Control

Fungicides are available for control but would not be economic for pasture crops.

LEAF SPOT

Two leaf spots have been seen, caused by two fungi: *Myrothecium roridum* and *Corynespora cassiicola*. They are somewhat similar in appearance and will be dealt with together. Their significance is not yet known.

Symptoms

Myrothecium roridum causes circular spots up to 1 cm in diameter with concentric rings of brown and pale brown. The outer margin of the spot may be a darker brown colour. Small black masses, consisting of spores, may appear on some spots.

Corynespora cassiicola causes smaller spots, usually less than 0.5 cm in diameter. There is some concentric ring pattern, but it is less obvious than in *Myrothecium* spots. Spots have a distinct outer red brown margin.

Control

Not warranted at this stage.

LITTLE LEAF DISEASE

Is caused by the same mycoplasma organism that causes a similar disease in *Stylosanthes*.

It is not considered a significant disease.

DISEASES OF STYLOSANTHES

by R.N. Pitkethley, Plant Pathologist, Darwin

A number of diseases have been observed in the Northern Territory which affect one or more *Stylosanthes* species. Those that are known to affect Verano (*S. hamata*) or shrubby stylos (*S. scabra*) will be described in most detail.

ANTHRACNOSE

This is the most important disease and is caused by the fungus *Colletotrichum gloeosporioides*. The disease is widespread, it is probably present to some extent in all *Stylosanthes* crops. Severity of the disease varies considerably but it can be serious in certain situations. Development of the disease is favoured by wet or humid conditions. It can survive in trash or perennial crops and can be carried in the seed.

Symptoms

Roughly circular spots, usually 1 to 1.5 mm in diameter, on the leaves. The centre of the spot is grey to brown and is surrounded by a red-brown margin. The centre of the spot may drop out to form a hole. Spots on the stems are similar in appearance to leaf spots but tend to be more elliptical in shape. Most damage is done when spots completely ring the stem, causing death of the stem above.

Control

On a field scale, the use of resistant cultivars is the only practicable control. None of the currently released cultivars are highly resistant. Verano has a fair degree of resistance. Of the shrubby stylos, Seca has good resistance to anthracnose whereas Fitzroy is susceptible. Agronomic factors, as well as disease resistance, must be considered when choosing a variety.

LITTLE LEAF DISEASE

This disease, caused by an organism of the mycoplasma group, affects a wide range of plant species, especially legumes. The organism is transmitted by a leafhopper, *Orosius argentatus*. Because the disease only affects isolated plants it is not considered to be serious.

Symptoms

Marked reduction in leaf size on part or all of a plant. Usually accompanied by proliferation of shoots which gives the plant an abnormally bushy, upright appearance. Floral parts may stay green, in which case they will be sterile.

Control

Not available, but does not appear to be warranted.

OTHER DISEASES

Several diseases which have been seen in *Stylosanthes* species other than *S. hamata* and *S scabra* will be mentioned briefly because of the possibility that they may affect these species.

Bacterial wilt, caused by *Pseudomonas solanacearum* - the same bacterium that causes wilt in tomatoes and many other crops. This disease is occasionally severe in Townsville stylos (*S. humilis)* and has been seen in odd plants of *S. mucronata.*

Root and stem rots, have been caused by two fungi, *Rhizoctonia* and *Fusarium.* They have occurred mainly in *S. humilis,* but also in *S. viscosa.* They have been seen only rarely.

DISEASES OF SABI GRASS

by R.N. Pitkethley, Plant Pathologist, Darwin

Only one disease has been seen on Sabi grass in the Northern Territory. This was leaf spot caused by the fungus *Drechslera urochloae*. Symptoms of the disease are small elliptical spots, chocolate brown in colour which occur on the leaves. Leaf spot is unlikely to be of importance and control should not be warranted.

A. B. CAUDELL, Government Printer of the Northern Territory