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SESAME RESEARCH REPORT

1990-91 WET SEASON

KATHERINE

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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.

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1. Introduction

There has been substantial research in identifying crops which are possible alternatives to maize, soybean, mungbeans and sorghum for the Northern Territory.

One crop that has shown potential for the Katherine region is sesame. Intensive research with sesame was initiated in the 1987-88 wet season. Research since then has included cultivar, sowing date, population, crop establishment, nutrition, weed control, insect control, disease monitoring, harvesting and seed maintenance experiments.

During April 1990, sesame research and development projects were reviewed by Mr D. Beech (CSIRO). Various suggestions for technical improvement of experimental design and procedure have been implemented in this year's research. The authors gratefully acknowledge the assistance of Mr D Beech for his suggestions in this Technical Bulletin.

Four projects were implemented to provide farmers with commercial guidelines to sesame management and to develop a new genotype for the Northern Territory. Three of these projects were investigated jointly; Mr I McLeod with 'Effect of metolachlor on sesame seed yield' and Dr K Thiagalingam with 'Effect of nitrogen application on sesame seed yield and its interaction with sap nitrate and leaf nitrogen concentration' and 'Effect of nitrogen and phosphorus on sesame growth, seed yield and yield components'.

2. General Methods

2.1 *Sites and Soils*

This year's experiments were undertaken at Katherine Research Station (14^0 28"S, 132^0 18"E) Douglas Daly Research Farm (13^0 51'S, 132^0 12'E), Western Creek Station (15^0 35"S, 133^0 13"E). The soil type used at Katherine was a Fenton clay loam, (Lucas *et al.* 1985) while a Venn sandy loam was used at Douglas Daly and a Oolloo clay loam at Western Creek Station (Table 2.1).

2.2 *Seasonal Conditions*

At all sites the 1990-91 season was characterised by good land preparation rains in November and December. This was followed by twice the monthly mean rainfall for January and February with a very low rainfall for March. Average rainfall figures were recorded for April (Table 2.2). Total rainfall at Douglas Daly, Katherine and Western Creek was 1257, 1244 and 1034 mm respectively. Soil conditions were generally saturated for the months of January and February.

2.3 *Land Preparation and Weed Control*

All sites were conventionally prepared in December, while any weed regrowth was controlled with an application of Round-up CT® 4.0L/ha.

Katherine site

Dual® 1.0L/ha and Round-up CT® 2.0L/ha were sprayed on 16 January 1991 (1 DAS). No herbicides were used on the 'metolachlor (Dual)® Residual Site'.

Douglas Daly and Western Creek sites

No herbicides were applied, and weed control was maintained by hand at these two sites.

2.4 *Fertiliser Application*

Katherine site

The research areas were fertilised with a basal application of single-superphosphate plus zinc, copper and molybdenum @ 216 kg/ha (approx. 18 kg P/ha, 2.2 kg Zn/ha, 2.2 kg Cu/ha and 0.05 kg Mo/ha, on 16 December 1990. Liquid fertiliser was applied on 17 December, equivalent to 1.1 kg Zn/ha, 1.8 kg Cu/ha and 0.3 kg B/ha.

Urea was incorporated @ 146 kg/ha (approx. 67 kg N/ha) on 24 December. No nitrogenous or phosphoric fertilisers were applied with the basal application to the sites for the 'Sesame Nutrition Experiments'.

Douglas Daly site

Research plots were hand fertilised with single-superphosphate plus trace elements at a similar rate to Katherine, on the 4 February 1991 (17 DAS). Urea was also incorporated @ 43 kg/ha (approx. 20 kg N/ha) on the same day. The area was top dressed with urea and muriate of potash @ 60 kg N/ha and 50 kg K/ha respectively on the 14 February (27 DAS).

Western Creek site

The area was fertilised with single-superphosphate plus trace elements @ 87.5 kg/ha (approx. 7.6 kg P/ha) on the 12 January 1991, with urea being incorporated @ 174 kg/ha (approx. 80 kg N/ha). The 'Cultivar Experimental Site' was top dressed with urea @ 20 kg N/ha on the 14 February (33 DAS). No basal fertiliser was applied to the 'Sesame Nutrition Experimental Sites'.

2.5 *Insect Control*

Heliothis caterpillars were sprayed twice during March with endosulphan @ 2.0L/ha at Douglas Daly and Katherine. Intensive rainfall at Western Creek made insect control impossible with only occasional site access.

Table 2.1 Soil nutrient status at Katherine, Western Creek Station and Douglas Daly

Soil analysis (0-15cm)	**Katherine**	**Western Creek Station**	**Douglas Daly**
Cond (ms/cm)	0.07	0.03	-
pH	7.12	6.5	6.8
Avail. P ppm	9.0	13	18
Avail. K ppm	353	106	69
Avail. Ca ppm	1253	424	320
Avail. Mg ppm	277	55	52
Avail. S ppm	16	7	2
Avail. Cu ppm	4.70	0.45	0.96
Avail. Zn ppm	1.6	1.5	1.3
Avail. Mn ppm	93	32	36
Avail. B ppm	0.36	0.30	<0.1
Total N (%)	0.12	0.06	0.02

Table 2.2 Rainfall, pan evaporation, radiation and mean temperatures at Katherine, Larrimah and Douglas Daly

	Nov	Dec	Jan	Feb	Mar	Apr	May	
Monthly Rainfall (mm)								Total
Douglas Daly	121.4	209.0	455.2	358.0	26.2	86.8	0.0	1256.6
Katherine	82.2	264.7	454.7	417.6	4.7	25.2	0.0	1244.1
Western Creek	11.9	155.5	284.5	506.5	17.0	58.5	0.0	1033.9
Mean (1)	108.5	142.9	269.2	303.2	253.6	46.6	7.5	1131.5
Mean (2)	83.3	191.6	228.6	210.2	162.7	32.8	5.1	914.3
Mean (3)	63	115	205	186	149	32	12	762.0
Mean Maximum Daily Temperature (°C)								
Douglas Daly	38.7	34.6	32.5	31.5	35.1	33.6	32.0	
Katherine	39.2	35.5	32.9	31.2	35.2	34.0	32.0	
Larrimah	40.1	37.6	34.5	N.A.	35.6	33.8	31.6	
Mean (1)	36.6	35.3	33.6	32.9	33.2	33.4	32.0	
Mean (2)	37.8	36.2	34.6	34.1	34.3	33.9	32.0	
Mean (3)	38.0	37.1	35.6	34.6	34.0	33.9	31.7	
Mean Minimum Daily temperature (°C)								
Douglas Daly	23.7	23.9	23.9	23.9	22.4	20.7	15.0	
Katherine	25.8	24.3	23.8	23.4	22.5	20.4	14.3	
Larrimah	26.7	25.4	24.5	23.7	22.7	20.7	16.0	
Mean (1)	24.2	24.0	23.7	23.7	23.0	20.6	17.1	
Mean (2)	24.3	23.9	23.7	23.4	22.3	19.5	16.2	
Mean (3)	24.4	24.5	24.1	23.7	22.7	19.8	16.6	
Mean Daily Radiation (MJ/m^2)								
Douglas Daly	29.1	28.5	21.3	19.6	31.7	27.7	27.6	
Katherine	24.2	24.3	19.4	16.6	25.0	21.5	21.0	
Larrimah	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A	
Mean (1)	24.5	24.2	22.4	21.4	21.7	22.6	21.1	
Mean (2)	24.6	24.2	21.9	22.5	21.7	21.7	22.0	
Mean (3)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A	
Mean Monthly Evaporation (mm)								
Douglas Daly	263	259	186	152	291	236	227	
Katherine	290	212*	155*	136*	184	164	171	
Larrimah	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A	
Mean (1)	252	226	168	146	N.A.	231	208	
Mean (2)	275	242	194	156	173	186	180	
Mean (3)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A	

* estimate
N.A. Not available
(1) Douglas Daly (2) Katherine (3) Larrimah

3. Evaluation of sesame genotypes in the 1990-91 wet season

Abstract

A range of sesame genotypes were evaluated at Douglas Daly, Katherine and Western Creek Station in the 1990-91 wet season. All genotypes produced their first flower by 46 DAS, while at Douglas Daly plants produced on 2nd flush of flowers between 87 and 94 DAS in response to late rainfall between 72 and 77 DAS. All genotypes reached physiological maturity by 109 DAS.

During the first 35 days of plant growth the saturated soil conditions were conducive to denitrification and poor root development. As a result, plant development was poor and seed yields were low. Highest seed yields were recorded by Selection PA:45 at Douglas Daly and Western Creek Station and Selection Y1:44 at Katherine these being 1527 kg/ha, 969 kg/ha and 1263 kg/ha respectively. Both genotypes will be evaluated again next year.

Introduction

Sesame is considered a potential crop in the semi-arid tropics of north west Australia. Extensive genotype evaluations were undertaken in the Ord River Irrigation Area (ORIA) during the 1981-83 wet seasons. The best material from ORIA were evaluated in the Northern Territory in 1986-87 wet season. Three cultivars indicated potential suitability for the Katherine region. These were Hnan Dun, Yori 77 and Pachequino.

Since then further introductions from the University of Western Australia have been tested against Yori 77 for yield potential, seed quantity and resistance to shattering.

Generally, characteristics of the sesame ideotype considered suitable for growing in the Northern Territory include:

a) Mature by late April for crops planted in early January.

b) Tolerate sesame leaf roller, *Antigastra catalaunalis*.

c) Tolerate to diseases caused by *Corynespora cassiicola* and *Cercospora sesamicola*.

d) Grow no taller than 1.5m, set capsules from approximately 30cm above the ground and develop 2 branches.

e) Capsules should be long and narrow, though not crowded on the central stem or branches, while the apex gap of capsules should be narrow.

f) The seed should be large, white and have a high oil content. The seed must not have a bitter taste.

Materials and Methods

Design, treatments and management

Experimental design was a randomised complete block with 4 replications of 7 genotypes. Genotypes were Hnan Dun, Yori 77, Pachequino and the Selections, P3:63, PA:45, Y1:44 and DD:6. Plot size was 3 rows x 4.0 m long. Row spacing was 32 cm and 16 cm at Douglas Daly.

The experiment was sown by hand at 3 sites. The sites and dates of sowing as follows

- Douglas Daly Research Farm - 18 January 1991
- Katherine Research Station - 16 January 1991
- Western Creek Station - 12 January 1991.

Plants were thinned to an intra-row spacing of 10 cm (equivalent to 300 000 plants/ha and 550 000 plants/ha at Douglas Daly).

Recordings and Data collection

During the season phenological data was recorded. These included date of first flower, date of 50% plants flowering and date of physiological maturity (95% capsules yellow).

At Katherine, leaf number, leaf area and plant weight were measured on 2 plants from each plot at 50% plants flowering and completion of flowering.

At physiological maturity, 5 plants were selected from the end of the centre row from each plot for yield component analysis. The following were recorded:

a) Plant height
b) Height of lowest capsule
c) Number of branches
d) Node of lowest capsule
e) Node of lowest branch
f) Number of capsules on central stem
g) Number of capsules on branches
h) Internode length (middle third reproductive stem)
i) Capsule length (middle third reproductive stem)
j) Capsule width (middle third reproductive stem)
k) Apex gap of capsule
l) Oven dry stem weight
m) Oven dry capsule weight
n) Oven dry seed weight

From this data, harvest index and seed weight/total capsule weight were calculated. All characteristics were scored on a scale of 0 to 10. Various characteristics were given a positive or negative weighting, according to their importance (Appendix 1). Genotypes with the highest scores will be tested further, and the rest discarded.

At maturity, plant population and seed yield were recorded by harvesting 2.4 m from the central row of each plot. Samples were threshed and cleaned, sub-samples were set aside for 1000 seed weight, seed colour, seed palatability, seedling vigour, % oil % N, and germination determinations.

Results

The intensive rainfall during January and February resulted in access to Western Creek Station (WC) being very limited, hence some measurements could not be recorded.

Phenology

All genotypes at Douglas Daly (DD) and Katherine (KT) produced their first flower between 31 and 46 DAS, 50% plants flowering between 38 and 49 DAS, and completion of flowering between 63 and 73 DAS (Table 3.1).

At Douglas Daly all genotypes produced a second flush of flowers between 87 and 94 DAS. This is in response to rainfall (57.6 mm) between 72 and 77 DAS. The last significant rainfall (>6 mm) before then had been at 38 DAS. This flush of flowers and capsules delayed physiological maturity by approximately 14 days for all genotypes except Hnan Dun. Hnan Dun had already reached physiological maturity before the 2nd flush flowers occurred.

At Douglas Daly, Hnan Dun was earliest to reach physiological maturity (84 DAS) and Pachequino, DD:6 and Yori 77 were the latest at 107, 108 and 109 DAS respectively.

Note, sesame at both Katherine and Douglas Daly received only minimal rain during flowering (38.9 mm and 25.8 mm respectively).

Leaf number, leaf area and plant biomass at 50% plants flowering - Katherine.

Yori 77 and DD:6 produced approximately twice the number of leaves, leaf area and plant biomass of the other genotypes. Hnan Dun produced the smallest plant structure compared with Yori 77 which had more than twice the biomass, leaf number, and about 3 times the leaf area and 4 times the dry matter (Table 3.2).

Leaf number, leaf area and plant biomass at completion of flowering - Katherine

DD:6 produced the largest number of leaves, while there was no significant difference in leaf area and plant biomass between the genotypes.

During the 24 days between 50% plants flowering and completion of flowering, mean leaf number increased from 32 to 46, mean plant biomass increased from 4.8 g to 12.9 g, while mean leaf area decreased from 60.5 cm^2 to 44.0 cm^2.

The decrease in leaf area is associated in the change in leaf design as sesame flowers. Large broad leaves are found below the reproductive stem while long thin leaves are found attached to the reproductive stem. As sesame flowers it develops a larger number of narrow leaves and the broader lower leaves undergo senescence.

Plant population

Mean genotype populations at Douglas Daly, Katherine and Western Creek Station were 523, 294 and 273 x 10^3 plants/ha respectively (Table 3.3).

At Western Creek Station DD:6 was not harvested due to poor establishment.

Potential seed yield

Mean seed yield over all genotypes at Douglas Daly, Katherine and Western Creek Station were 1327, 1025 and 797 kg/ha respectively (Table 3.3). Highest seed yields were recorded by Selection PA:45 at Douglas Daly and Western Creek Station and Selection Y1:44 and Katherine, 1527 kg/ha, 969 kg/ha and 1263 kg/ha respectively. Lowest seed yields were recorded for Hnan Dun (DD) and Pachequino (KT and WC) @ 756 kg/ha, 818 kg/ha and 476 kg/ha respectively.

Plant height

Hnan Dun was the shortest in stature at all sites, while none of the genotypes were too tall (>1.5m) to make mechanical harvesting difficult. Mean plant height for Hnan Dun was 90 cm. (Tables 3.4, 3.6 and 3.8).

Height of lowest capsule

Hnan Dun and Selection PA:45 were significantly shorter in height to the lowest capsule compared with the other genotypes (Tables 3.4, 3.6 and 3.8). However neither of these two genotypes approached what is considered optimum height of lowest capsule, that is 30 cm, which is sufficiently high for insertion of the harvester's cutter bar.

Branching habit

Hnan Dun, Selection DD:6 and Yori 77 exhibited a branching habit (Tables 3.4, 3.6 and 3.8), while the remaining genotypes were characterised as single-stem types. Branching is a desired seed yield and compactness of maturity characteristic with the optimum number of branches being 2 per plant.

Node of lowest capsule

Hnan Dun commenced setting its capsules at a lower node than the other genotypes. Genotypes which set capsules at a lower node number, as long as the height of the lowest capsule is greater than 30 cm, have a more desirable plant structure. Mean node of lowest capsule for Hnan Dun was 5.5 (Tables 3.4, 3.6 and 3.8).

Node of lowest branch

All genotypes that produced a branch, developed it below the lowest capsule on the central stem (Table 3.4, 3.6 and 3.8). Genotypes that develop branches at the top of the central stem tend to be very late maturing (>140 days) and therefore unsuitable for the Northern Territory.

Number of capsules on central stem/branches

Generally single stem genotypes produce more capsules on the central stem than branching types and vice-versa. However, both Yori 77 and Selection DD:6 (both branching types) developed large numbers of capsules on the central stem as well as on branches (Tables 3.5, 3.7 and 3.9).

Mean internode distance between capsules and capsule length.

Mean internode spacing ranged from 27 to 42 mm for Selection Y1:44 and Hnan Dun respectively (Table 3.5, 3.7 and 3.9 respectively). Distance between internodes is important in relation to capsule length. Genotypes with capsules 10 mm shorter than internode length are inefficient in use of reproductive stem, while genotypes with capsules 10 mm longer than internode length develop capsules at a more obtuse angle to the central stem hence are more likely to scatter larger quantities of seed on disturbance.

No genotype developed capsules longer than their internode length. However Hnan Dun and Selection DD:6 were not efficient in their use of reproductive stem (Table 3.10).

Hnan Dun developed the longest capsules while Selection DD:6 developed the shortest being 26 and 22 mm respectively (Tables 3.5, 3.7 and 3.9). (Note, the percentage of seed lost from long capsules should be less than that from shorter capsules if the apex gap of the capsule is similar).

Capsule width

Selection DD:6 developed the narrowest capsule width while Pachequino generally had the widest capsule width, mean 5.1 mm and 5.9 mm respectively (Tables 3.5, 3.7 and 3.9). Capsule width is related to seed size and therefore is an important character.

The narrower the capsule width or the larger the seed size in relation to each other the 'tighter' the fit of seed inside the capsule. This tends to reduce the likelihood for seed to scatter with disturbance of the plant (Table 3.10).

Hnan Dun had the poorest ratio ('loose' seed arrangement), while Pachequino the best ratio or tight seed arrangement.

Apex gap of capsule

The larger the apex gap when the capsule has matured the greater the seed loss when the plant is disturbed. Selection Y1:44 capsules generally had the smallest apex gap while Selection P3:63 capsules generally having the wider apex gap, mean of 5.8 mm and 6.8 mm respectively (Table 3.5, 3.7 and 3.9).

Seed weight

Yori 77 and Hnan Dun generally produced the lightest seed at all sites with means of 2.8 and 2.9 g/1000 seed respectively. The heaviest seed was produced by Pachequino with a mean of 3.5 g/1000 seed (Tables 3.11 and 3.12). Generally the larger, heavier sesame seed (>3.5 g/100 seed) being more acceptable to market requirements.

Seed germination at harvest

All genotypes except Yori 77 and Selection DD:6 contain a high proportion of fresh ungerminated seed (Table 3.11). The fresh ungerminated seed is an indication of the level of seed dormancy. This is a favourable characteristic at maturity as seed dormancy prevents seed from germinating in the capsule on the event of a late storm. As the seed ages in storage the percentage of fresh ungerminated seed decreases. Generally by the start of the next season, there is little or no fresh ungerminated seed. Percentage fresh ungerminated seed ranged from 79.0 to 0.0 for Hnan Dun and Selection DD:6 respectively.

Seed colour and taste

Market requirements for sesame are, a uniform white seed with no bitter after taste (i.e. unpalatable).

The taste of sesame seed is associated with the level of phenols and oxalic acid, normally found in the seed testa. Dark coloured seed genotypes have phenols plus a higher oxalic content than white seed genotypes. Selecting white seed genotypes avoids these phenols, however there is a considerable range of oxalic acid content within the white seed genotypes.

Yori 77 produced white seed of good taste (taken as the standard for these characteristics), while Hnan Dun produced brownish/yellowish white seed also of reasonable taste. None of the genotypes produced bitter tasting seed (Table 3.11).

Some dark seeds were found in Selection PA:45.

Seed oil and nitrogen content

Generally genotypes grown at Katherine produce seed with a higher oil content than that of Western Creek. Sesame at Douglas Daly produced seed with the lowest oil content (Table 3.11 and 3.12). At all sites, Hnan Dun produce seed with the highest oil content while Pachequino produced seed with the lowest oil content. Oil contents ranged from 56.1% to 48.6% for Hnan Dun (KT) and Pachequino (DD) respectively. Nitrogen content of sesame seed ranged between 3.72 and 4.08% for Hnan Dun and Pachequino respectively (Table 3.11).

Seedling vigour

Seedling vigour is a score based on radicle length measured 48 hours after seeds have been germinated at three temperatures, 20°-30°C, 25°-40°C and 25°-45°C. Selection DD:6 produced the most vigorous seedling with a score of 15 while Pachequino scored the lowest with 6.5 (Table 3.11 and 3.13).

Harvest index at maturity

Hnan Dun generally produced the highest harvest index (33.5%), for all sites, while Selection DD:6 the lowest at 27.8% (Table 3.14). The higher the harvest index the more efficient the genotype is in partitioning assimilate to the capsules.

Seed weight/total capsule weight

Hnan Dun and Selection P3:63 had the highest seed weight/total capsule weight ratio, 52.2% while Yori 77 the lowest 48.5% (Table 3.14). The higher the seed weight/total capsule weight ratio the more efficient the genotype is in partitioning assimilates between seed and capsule wall.

Plant diseases - Cercospora sesamicola

All genotypes developed an infection of *Cercospora sesamicola*. Yori 77 and Selection DD:6 were severely defoliated while Selections P3:63 and PA:45 only developed mild leaf spots. Order of severity of infection: Selection DD:6, Yori 77, Pachequino, Hnan Dun, Selections P3:63 and PA:45.

Capsule damage by Heliothis

Mean percentage of capsules damaged by heliothis at Western Creek Station was 20.6%, however levels varied between 7.5 and 41.5% for Hnan Dun and Yori 77 respectively (Table 3.15). Similar magnitudes of capsule damage between genotypes have been observed in previous seasons.

Score

Most of the characteristics recorded were scored on a scale of 0 to 10. Various characteristics were given a positive or negative weighting according to importance. Scores ranged between 45 and 77 for Selection DD:6 and Pachequino respectively (Table 3.16). The higher the score the more suitable the sesame genotype for Northern Territory conditions.

Discussion

In sesame, seed yield is determined by the number of capsules per plant, number of seeds per capsule and single seed weight (Delgards and Yermanos 1975) number of capsules per plant being the most important yield component. Kandasamy et al. (1989) revealed that dry matter production, harvest index and plant height were positively correlated with seed yield. Also correlations between number of primary and secondary branches and total number of capsules per plant were recorded by Ansari et al. 1988. Hence emphasis has also been given to these characters when selecting a sesame genotype suitable for the Northern Territory. A problem occurs because some of these characteristics, number of capsules per plant and possibly seed per capsule have a low heritability.

This year, correlations between seed yield and total capsule number were not successful at any of the sites, however high seed yields were positively correlated with plant biomass at Katherine. The low seed yields at all sites is attributed to the extensive rainfall during January and February and minimal rainfall during grain fill. During the first 35 days of plant growth the saturated soil conditions were ideal for denitrification (Stevenson, 1982) and poor root development (Weiss, 1983). Leaf samples collected from Yori 77 at 42 DAS in the adjacent Nitrogen Experiment indicated nitrogen concentrations for the youngest fully expanded leaf of between 2.8 and 3.1%, well below those recommended as adequate 3.8% (Bennett et al. 1991).

The lack of rainfall during March and April would not have been a problem if sesame root development had not been retarded by anaerobic soil conditions in the previous months. The higher seed yields at Douglas Daly are possibly due to the fewer occasions of a saturated soil profile on a sandier soil type, and more extensive root development which allowed greater access to soil nitrogen and available soil moisture during March and April.

There are three other problems in selecting a sesame genotype suitable for the Northern Territory. Firstly, potential seed yield and seed yield in the bin are not equivalent. Seed in the bin is affected by plant structure in relation to harvesting, level of capsule dehiscence and susceptibility to diseases and insects. Secondly, seed yield is useless if the seed is not of high quality. High quality sesame seed being large, white, of high oil content and palatable. Hence some effort has been made to measure all these characteristics as well. Thirdly, if seedlings are not vigorous in radicle development, a sesame crop has little chance of successfully establishing and developing a high yield under adverse environmental conditions. Therefore seedling vigour is also measured. To quantify the effect of these characteristics they were given a weighted score. Those scoring well being further investigated.

Unfortunately the lowest yielding genotypes Hnan Dun and Pachequino scored the highest. With the other genotypes, Selections Y1:44 and PA:45 were a compromise between high seed yields and high scores. These genotypes will be tested next year in larger plots.

Table 3.1 Phenology of sesame genotypes

Genotype	Days after sowing										
	First flower			50% Plants flowering			Completion flowering		Physiological Maturity		
	DD	KT	WC	DD	KT	WC	DD[2]	KT	DD	KT	WC
Hnan Dun	31	31	31	39	38	-[1]	63	64	63	84	84
Yori 77	46	43	-	50	50	-	69	73	105	97	86
Pachequino	37	38	36	48	46	-	66	69	108	95	88
Sel P3:63	38	38	35	45	45	-	66	68	107	94	88
Sel PA:45	37	35	34	44	44	-	64	69	106	94	89
Sel Y1:44	36	36	34	44	42	-	66	68	109	94	88
Sel DD:6	45	42	-	49	49	-	67	72	106	97	86
LSD (5%)	1.4	2.4	-	2.0	3.3	-	2.8	2.1	2.1	3.6	-

1 not measured as site inaccessible
2 2nd flush of flowers between 87 and 94 DAS

Table 3.2 Mean leaf number, leaf area and plant biomass at 50% plants flowering and completion of flowering for sesame at Katherine

Genotype	Leaf number		Leaf area (cm^2)		Plant weight (g)	
	50FL[1]	CFL[2]	50FL	CFL	50FL	CFL
Hnan Dun	22.3	46.8	32.9	38.1	2.1	12.8
Sel P3:63	19.4	41.8	40.6	43.3	3.1	12.0
Sel PA:45	20.9	31.9	44.6	38.1	3.2	11.3
Sel Y1:44	25.5	35.8	59.0	46.2	4.1	13.9
Pachequino	25.1	33.6	58.8	46.1	4.7	11.5
Sel DD:6	57.8	74.6	93.2	51.8	7.9	15.9
Yori 77	54.4	60.0	94.2	44.5	8.6	12.6
LSD (5%)	12.6	20.9	25.4	N.S.	1.8	N.S.

1 50FL = 50% plants flowering
2 CFL = Completion of flowering

Table 3.3 Sesame populations and seed yields

Genotype	Population (x10^3)			Seed yield (kg/ha)		
	DD	KT	WC	DD	KT	WC
Hnan Dun	336	316	285	756	1093	854
Sel P3:63	507	295	279	1179	1021	689
Sel PA:45	556	268	279	1587	906	969
Sel Y1:44	635	326	255	1527	1263	889
Pachequino	507	305	276	1122	818	476
Sel DD:6	569	262	PE	1540	1103	PE
Yori 77	570	285	262	1493	970	890
Mean	523	294	273	1327	1025	797
LSD (5%)	125.7	N.S.	N.S.	N.S.	N.S.	N.S.

PE = poor establishment

Table 3.4 Morphology of sesame genotypes at Douglas Daly

Genotype	Plant height (cm)	Height lowest capsule (cm)	Number of branches	Node of lowest capsule	Node of lowest branch
Hnan Dun	79.7	39.8	1.1	5.5	3.7
Sel P3:63	97.2	64.0	0.0	7.1	-
Sel PA:45	94.5	55.1	0.1	7.5	-
Sel Y1:44	89.7	57.2	0.0	7.7	-
Pachequino	92.8	58.9	0.3	7.9	-
Sel DD:6	93.3	61.0	1.2	7.7	6.6
Yori 77	96.6	65.5	1.1	7.6	6.7
LSD (5%)	9.68	9.15	0.73	0.77	-

Table 3.5 Morphology of sesame genotypes at Douglas Daly

Genotype	Capsule no. (central stem)	Capsules per branch	Av. internode distance (mm)	Capsule length (mm)	Capsule width (mm)	Apex gap capsule (mm)
Hnan Dun	17.0	5.4	40.8	26.5	5.8	4.6
Sel P3:63	23.8	0.0	33.7	24.0	5.7	7.4
Sel PA:45	31.8	1.0	33.0	24.7	5.7	7.3
Sel Y1:44	28.2	0.0	26.7	23.8	6.0	6.0
Pachequino	26.8	3.1	28.1	23.2	5.8	6.7
Sel DD:6	33.8	6.3	32.9	22.2	5.3	7.5
Yori 77	27.8	5.7	29.5	22.4	5.1	7.4
LSD (5%)	N.S.	N.S.	5.52	2.28	0.49	1.56

Table 3.6 Morphology of sesame genotypes at Katherine

Genotype	Plant height (cm)	Height lowest capsule (cm)	Number of branches	Node of lowest capsule	Node of lowest branch
Hnan Dun	89.1	41.5	1.0	5.2	4.2
Sel P3:63	93.1	56.4	0.2	6.9	-
Sel PA:45	97.4	46.0	0.0	5.9	-
Sel Y1:44	98.0	58.8	0.0	6.9	-
Pachequino	94.7	51.4	0.5	6.4	-
Sel DD:6	99.1	68.3	1.3	7.8	6.9
Yori 77	102.7	74.1	1.4	8.5	7.2
LSD (5%)	N.S.	12.32	0.73	1.44	-

Table 3.7 Morphology of sesame genotypes at Katherine

Genotype	Capsule no. (central stem)	Capsules per branch	Av. internode distance (mm)	Capsule length (mm)	Capsule width (mm)	Apex gap capsule (mm)
Hnan Dun	17.2	7.7	41.6	26.1	5.7	5.6
Sel P3:63	30.3	2.5	34.0	25.3	5.5	6.1
Sel PA:45	40.7	0.3	35.6	25.5	5.9	5.6
Sel Y1:44	27.1	0.0	34.1	24.7	5.8	5.6
Pachequino	32.6	0.8	32.3	25.4	6.0	5.3
Sel DD:6	29.1	3.9	40.1	22.1	4.8	4.8
Yori 77	28.4	6.8	32.2	22.6	5.1	5.0
LSD (5%)	N.S.	2.89	6.08	0.96	0.49	N.S.

Table 3.8 Morphology of sesame genotypes at Western Creek Station

Genotype	Plant height (cm)	Height lowest capsule (cm)	Number of branches	Node of lowest capsule	Node of lowest branch
Hnan Dun	101.4	47.2	1.3	5.9	4.3
Sel P3:63	104.8	64.0	0.1	7.9	-
Sel PA:45	104.3	57.0	0.1	7.1	-
Sel Y1:44	106.8	67.4	0.0	8.5	-
Pachequino	107.0	65.2	0.2	7.7	-
Sel DD:6	110.2	64.3	2.2	6.9	5.5
Yori 77	109.4	63.2	1.9	6.8	5.5
LSD (5%)	N.S.	11.08	0.48	0.60	-

Table 3.9 Morphology of sesame genotypes at Western Creek Station

Genotype	Capsule no. (central stem)	Capsules per branch	Av. internode distance (mm)	Capsule length (mm)	Capsule width (mm)	Apex gap capsule (mm)
Hnan Dun	21.4	8.5	41.9	25.2	5.4	8.5
Sel P3:63	27.1	4.0	32.9	23.1	5.8	6.9
Sel PA:45	29.8	10.8	34.2	23.8	5.5	7.2
Sel Y1:44	27.4	0.2	29.0	23.0	5.6	5.9
Pachequino	30.2	1.0	33.1	23.5	5.8	7.1
Sel DD:6	42.8	10.2	36.6	22.0	5.2	5.7
Yori 77	35.5	10.8	40.0	21.6	5.3	6.8
LSD (5%)	10.32	N.S.	7.55	1.57	N.S.	N.S.

Table 3.10 Comparison of internode length versus capsule length and capsule width versus 100 seed weight

Genotype	Capsule length in relation to internode length[1]	Ratio of capsule width versus 100 seed weight[1]
Hnan Dun	Very short, waste of stem	19.6 (poor)
Sel P3:63	OK	18.7
Sel PA:45	OK	17.4
Sel Y1:44	good	18.2
Pachequino	good	16.6 (excellent)
Sel DD:6	Very short, waste of stem	18.3
Yori 77	Short, waste of stem	18.1

1 mean for all sites

Table 3.11 Seed characteristics of genotypes grown at Katherine

Genotype	Germination		Seed colour[1]	Seed taste[2]	Oil content (%)	Seed nitrogen (%)	Seedling vigour (rating)
	Normal	Fresh ungerm.					
Hnan Dun	20.0	79.0	1	4.0	56.1	3.72	9.5
Sel P3:63	50.3	44.3	4	6.0	53.9	3.98	9.0
Sel PA:45	52.0	43.7	4	5.5	54.1	3.96	7.0
Sel Y1:44	59.7	36.3	2	6.5	53.9	3.92	7.0
Pachequino	40.7	56.3	3	3.5	53.2	4.08	6.5
Sel DD:6	99.0	0.0	5	4.5	54.1	*.**	15.0
Yori 77	98.0	2.0	5	3.5	54.4	3.97	13.0

1 Seed colour 1 = brownish white 5 = white
2 Seed taste 0 = tasteless 10 = bitter
3 Seedling vigour 5 = slow 20 = vigorous

Table 3.12 Seed characteristics of genotypes grown at Douglas Daly and Western Creek Station

	1000 seed weight (g)			Seed colour[1]		Oil content (%)	
Genotype	KT	DD	WC	DD	WC	DD	WC
Hnan Dun	2.7	3.3	2.6	1	1	51.7	55.7
Sel P3:63	2.8	3.4	2.8	2	4	49.7	52.3
Sel PA:45	3.2	3.5	3.2	4	4	49.8	51.1
Sel Y1:44	3.0	3.4	3.1	2	2	50.2	50.4
Pachequino	3.9	3.6	3.1	2	2	48.6	49.8
Sel DD:6	2.8	2.9	2.6	5	3	51.3	55.6
Yori 77	2.7	3.2	2.6	5	5	51.3	53.7

1 Seed colour 1 = brownish white 5 = white

Table 3.13 Seedling vigour

Genotype	Radicle development at 48 hours 20°-30°C	25°-40°C	25°-45°C	Score
Hnan Dun	2.0[1]	5.5	4.0	9.5
Sel P3:63	1.3	4.5	4.5	9.0
Sel PA:45	1.0	4.0	3.0	7.0
Sel Y1:44	0.5	3.0	4.0	7.0
Pachequino	1.0	3.0	3.5	6.5
Sel DD:6	2.5	7.0	8.0	15.0
Yori 77	2.0	7.0	6.0	13.0

1 Rating, where 0 for nil germination, 1 for a 2mm radicle length, 2 for a 4mm length, rising up to 9 for a radicle length greater than 18mm.

Table 3.14: Harvest index at maturity and seed weight/total capsule weight ratio

Genotype	Harvest index (%)			Seed weight/total capsule weight (%)		
	DD	KT	WC	DD	KT	WC
Hnan Dun	14.7*	33.2	33.7	26.9*	50.5	53.9
Sel P3:63	31.9	37.1	28.1	51.8	54.9	50.0
Sel PA:45	33.3	36.7	28.8	52.0	52.3	48.8
Sel Y1:44	34.1	35.3	25.4	51.1	53.7	45.4
Pachequino	34.5	34.5	25.9	53.0	51.2	48.7
Sel DD:6	32.0	25.5	25.8	50.2	42.5	45.2
Yori 77	33.5	27.1	25.3	52.6	45.2	47.8
LSD (5%)	-	4.10	5.72	-	4.97	7.74

* Low value, as seed was lost.

Table 3.15 Level of capsule damage by Heliothis at Western Creek Station

Genotype	Percentage of capsules damage[1]
Hnan Dun	7.5
Sel P3:63	21.7
Sel PA:45	29.2
Sel Y1:44	11.2
Pachequino	13.3
Sel DD:6	19.9
Yori 77	41.5

1 mean for 2 plants per plot and 4 reps

Table 3.16 Final score for sesame genotypes at Katherine in 1990/91 wet season

Genotype	Score
Hnan Dun	75.4
Sel P3:63	54.7
Sel PA:45	62.6
Sel Y1:44	56.5
Pachequino	76.9
Sel DD:6	45.2
Yori 77	53.7

4. Evaluation of sesame selections in the 1990-91 wet season

Introduction

A wide range of sesame plant types are found in commercial crops grown in the Northern Territory. This diversity provides scope for selection of better genotypes with higher yield potential and improved seed quality.

In the 1988-89 season "reference" seed and seed from individual plant selections of Yori 77 and Pachequino were sown. Eleven potentially improved lines were identified for inclusion in the 1989-90 evaluation of superior selections. Three of these selections have advance to the 1990-91 genotype evaluation. During 1989-90 eight improved lines were identified for inclusion in the 1990-91 evaluation of superior selections.

Materials and Methods

Design, treatments and management

Experimental design was a randomised complete block with 3 replicates of 8 sesame selections. The experiment was sown at 2 sites, Katherine and Western Creek Station on the 16 January and 12 January 1991 respectively.

The selections were coded as follows; PB:64, YA:69, Y5:83, PA:40, PA:45/3, P3:63/3, YS:18/6 and PB:56.

Plot size was 3 rows x 4.0 m with a row spacing of 32 cm. Plants were thinned to an intra-row spacing of 10 cm (equivalent to 300 000 plants/ha).

Recordings and Data collection

During the season phenological data was recorded. This included date of first flowering, date of 50% plants flowering and date of physiological maturity (95% capsules yellow).

At Katherine, leaf number, leaf area and plant weight were measured on 2 plants from each plot at 50% plants flowering and completion of flowering.

At physiological maturity, 5 representative plants were selected from the end of the centre row from each plot for yield component analysis. The following were recorded:

a) Plant height
b) Height of lowest capsule
c) Number of branches
d) Node of lowest capsule
e) Node of lowest branch
f) Number of capsules on central stem
g) Number of capsules on branches
h) Internode length (middle third reproductive stem)
i) Capsule length (middle third reproductive stem)
j) Capsule width (middle third reproductive stem)
k) Apex gap of capsule
l) Oven dry stem weight
m) Oven dry capsule weight
n) Oven dry seed weight

From this data, harvest index and seed weight/total capsule weight were calculated. All characteristics were scored on a scale of 0 to 10. Various characteristics were given a positive or negative weighting, according to their importance (Appendix 1). Selections with the highest scores will be tested further, the rest discarded.

At maturity, plant population and seed yield were recorded by harvesting 2.4 m from the central row of each plot. Samples were threshed and cleaned, sub-samples were set aside of 1000 seed weight, seed colour, seed palatability, seedling vigour, % Oil and % N determinations for samples from the Katherine site.

Results

Phenology

Katherine

All selections produced their first flower by 45 DAS, 50% plants flowering by 52 DAS, completed flowering by 75 DAS and reached physiological maturity by 100 DAS (Table 4.1).

There was a large variation in the phenology of the selections, however all reached physiological maturity with 7 days of each other. Sesame maturity was influenced by the lack of soil moisture.

Leaf number, leaf area and plant biomass - Katherine

At the period of 50% plants flowering plant development was extensive in YA:69 and P3:63/3 at the time they had reached 50% of plants flowering (Table 4.2). Both selections were late to flower. Generally plant biomass reflected time to 50% plants flowering. The later the selection is to flower the more leaves, leaf area and biomass are produced. Mean leaf number, leaf area and plant biomass was 30.6, 60.6 cm^2 and 4.8g.

Completion of flowering

For all selections except P3:63/3, leaf number increased during the period from 50% plants flowering to completion of flowering, while leaf area generally decreased. The decrease in leaf area is associated with the change in leaf design as the plants flowers (broad leaves to narrow leaves) and the senescence of the large lower leaves. Plant biomass increased with time (Table 4.2). Mean leaf number, leaf area and plant biomass was 43.0, 42.9 cm^2 and 13.7g.

Plant population

Mean selection population at harvest was 273 x 10^3 and 281 x 10^3 plants/ha at Katherine and Western Creek Station respectively (Table 4.3). There was no significant difference between sesame populations.

Potential seed yield

Mean sesame seed yield at Katherine and Western Creek Station was 1012 kg/ha and 1053 kg/ha respectively (Table 4.3). The Selection Y5:83 produced the highest mean seed yield of 1223 kg/ha, while YA:69 produced the lowest mean seed yield of 888 kg/ha.

Morphology

Morphological characteristics of the superior selections are present in Tables 4.4, 4.5, 4.6, 4.7 and 4.8.

Score

The three superior selections that scored the highest ratings were PA:40, PA:45/3 and YA:69 at Katherine, and PA:40, YA:69 and Y5:83 and Western Creek.

Discussion

The sesame ideotype suitable for the Northern Territory has been discussed in the section for genotype evaluation. Basically the plant has to grow no taller than 1.5 m, set capsules from approximately 30 cm above the ground and develop 2 branches. Capsules should be long and narrow, though not crowded on the central stem or branches, while the apex gap of the capsules should be small.

The seed produced should be large, white and of high oil content (>3.5g/1000 seed and > 55% oil). The seed must not be unpalatable and produce a vigorous seedling.

The top four superior Selections PA:45/3, PA:40, Y5:83 and PB:64 (compromise between yield and score) are to be further tested in the Genotype Evaluation Trial in 1991-92.

Table 4.1 Phenology of sesame selections

Selection	Days after sowing					
	First flower		50% plants flowering	Completion flowering	Physiological maturity	
	KT	WC[1]	KT	KT	KT	WC
PB:64	38	34	44	68	95	89
YA:69	43	-	52	75	99	87
Y5:83	36	33	40	68	96	89
PA:40	38	-	45	71	95	90
PA:45/3	35	35	41	69	93	89
P3:63/3	45	-	52	74	100	87
Y5:18/6	34	33	38	63	97	89
PB:56	39	35	46	70	97	89
LSD (5%)	2.8	-	3.3	1.7	3.7	-

1 site inaccessible

Table 4.2 Leaf number, leaf area at plant biomass of sesame selections at Katherine

	Leaf number		Leaf area (cm^2)		Plant biomass (g)	
Selections	50FL[1]	CFL[2]	50FL	CFL	50FL	CFL
PB:64	21.8	38.7	40.7	52.1	3.0	14.7
YA:69	49.5	59.5	71.8	39.6	6.5	20.4
Y5:83	17.8	41.2	43.7	52.8	2.4	13.7
PA:40	22.0	39.0	52.6	42.7	4.0	12.4
PA:45/3	21.5	36.6	62.5	50.4	4.9	14.2
P3:63/3	59.7	50.3	96.0	31.5	8.5	9.4
YS:18/6	20.0	DL	49.1	DL	3.1	DL
PB:56	27.8	34.8	75.3	38.9	6.1	12.1
LSD (5%)	15.68	14.9	N.S.	N.S.	3.4	N.S.

DL Data lost
1 50FL = 50% plants flowering
2 CFL = Completion of flowering

Table 4.3 Sesame populations and seed yields

Selection	Population ($x10^3$)		Seed yield (kg/ha)	
	KT	WC	KT	WC
PB:64	296	292	1157	1102
YA:69	249	247	831	945
Y5:83	273	306	1168	1278
PA:40	268	243	1090	890
PA:45/3	273	321	1355	829
P3:63/3	267	277	927	1168
YS:18/6	245	264	1005	1372
PB:56	306	288	867	1210
Mean	273	281	1012	1053
LSD (5%)	N.S.	N.S.	N.S.	N.S.

Table 4.4 Morphology of superior selections at Katherine

Selection	A	B	C	D	E	F	G	H	I	J
					Character					
PB:64	93.8	56.1	0.1	7.1	-	33.8	0.3	30.0	25.4	5.9
YA:69	96.0	67.9	1.2	8.3	7.2	27.8	6.3	30.4	22.9	5.1
Y5:83	97.3	55.2	0.1	6.5	-	29.3	3.7	32.3	24.6	5.6
PA:40	98.5	57.5	0.1	7.3	-	34.2	1.3	32.9	26.0	6.2
PA:45/3	109.5	63.5	0.0	6.5	-	39.6	0.0	36.6	25.8	5.8
P3:63/3	100.1	69.7	1.4	8.1	6.8	32.0	8.2	32.0	22.8	5.6
YS:18/6	93.6	51.5	0.0	6.3	-	26.0	0.0	39.1	25.0	6.0
PB:56	92.2	55.9	0.0	7.2	-	26.9	0.0	39.7	25.6	6.1
LSD(5%)	N.S.	8.60	0.46	N.S.	-	N.S.	3.43	N.S.	0.12	

A: Plant height (cm)
B: Height of lowest capsule (cm)
C: Number of branches
D: Node of lowest capsule
E: Node of lowest branch
F: Number of capsules on central stem
G: Number of capsules per branch
H: Internode length (mm)
I: Capsule length (mm)
J: Capsule width (mm)

Table 4.5 Morphology of superior selections at Katherine

Selection	K	L	M	N	O	P	R	S	T	Score
PB:64	5.5	32.8	49.2	4.27	8.0	4	52.4	4.04	5	67
YA:69	5.1	30.7	49.9	2.77	3.5	5	54.5	3.58	14	70
Y5:83	5.8	37.2	57.6	3.27	5.5	2	52.5	4.12	6.5	69
PA:40	5.3	39.2	57.0	2.90	5.5	3	52.9	3.88	7	78
PA:45/3	5.2	39.0	58.1	3.00	4.5	3[a]	53.6	3.88	6	72
P3:63/3	4.3	33.7	51.7	2.80	7.5	5	53.5	3.97	13	63
YS:18/6	6.8	31.6	49.4	3.43	8.5	1	53.0	4.18	10.5	45
PB:56	5.7	36.1	54.6	2.93	7.0	2	52.9	3.98	5.5	59
SD(5%)	0.90	5.42	5.43	-	-	-	-	-	-	-

K: Apex gap of capsule (mm)
L: Harvest index (%)
M: Seed weight/total capsule weight (%)
N: 1000 seed weight (g)
O: Taste (0 = tasteless, 10 = white)
P: Seed colour (1 = brownish white, 5 = white)
R: Seed oil content (%)
S: Seed nitrogen content (%)
T: Seedling vigour (5 = slow, 20 = vigorous)
a: Some black seeds

Table 4.6 Morphology of superior selections at Western Creek Station

	Character						
Selection	**A**	**B**	**C**	**D**	**E**	**F**	**G**
PB:64	114.1	64.8	0.0	7.3	-	38.5	0.0
YA:69	114.8	63.1	1.8	6.9	6.1	48.1	11.3
Y5:83	123.8	66.5	0.2	7.5	-	41.3	7.5
PA:40	112.0	68.6	0.2	7.9	-	31.3	5.3
PA:45/3	108.7	63.5	0.0	7.1	-	32.5	0.0
P3:63/3	DL	DL	DL	DL	DL	DL	DL
YS:18/6	115.3	64.3	0.0	7.7	-	40.9	0.0
PB:56	127.9	69.1	0.1	7.5	-	46.3	3.3
LSD(5%)	N.S.	N.S.	0.53	N.S.	-	N.S.	N.S.

DL = Data lost

A: Plant height (cm)
B: Height of lowest capsule (cm)
C: Number of branches
D: Node of lowest capsule
E: Node of lowest branch
F: Number of capsules on central stem
G: Number of capsules per branch

Table 4.7 Morphology of superior selections at Western Creek Station

Selection	H	I	J	K	L	M	Score
PB:64	31.1	23.8	6.0	6.5	30.0	50.0	40
YA:69	30.0	22.0	5.7	2.6	27.7	46.6	45
Y5:83	28.3	24.1	5.9	6.8	29.0	50.1	44
PA:40	27.0	23.8	6.2	5.9	28.9	48.3	46
PA:45/3	30.6	23.8	5.8	7.5	30.5	52.5	32
P3:63/3	DL	DL	DL	DL	DL	DL	DL
YS:18/6	29.1	24.9	6.2	7.8	24.5	41.7	33
PB:56	33.0	24.3	5.9	6.9	31.7	53.8	39
LSD (5%)	N.S.	N.S.	N.S.	2.09	N.S.	N.S.	-

DL = Data lost

H: Internode length (mm)
I: Capsule length (mm)
J: Capsule width (mm)
K: Apex gap of capsule (mm)
L: Harvest index (%)
M: Seed weight/total capsule weight (%)

5. Effect of nitrogen application sesame seed yield and its relationship to sap nitrate and leaf nitrogen concentration

Abstract

Effect of split application of nitrogen on plant growth, leaf nitrogen content, sap nitrate level, seed yield and yield components of sesame grown on red earth soils (Alfisols) was evaluated in three field experiments in the semi arid tropics of the Northern Territory.

Sap nitrate and nitrogen concentration of the youngest fully expanded leaf at 42 DAS was less than 3700 ppm and 3.8% respectively, which are considered adequate for sesame growth.

Seed yields increased with higher levels of nitrogen applied at sowing. While there was no advantage of split applications of urea in above-average rainfall season.

Introduction

Preliminary research into the effect of split applications of nitrogen on sesame growth and seed yield have been presented in a paper currently in press. This year's research completes the study by investigating sap nitrate concentration, leaf nitrogen concentration and its interaction with seed yield.

Monitoring of leaf nitrogen has proved to be a practical guide to the nitrogen status of the soil for many crops. Nitrogen content of the leaf blade or petiole at early flowering have been used as diagnostic criteria for fertility requirements of sesame. Reddy and Narayanan (1983) found that maximum leaf nitrogen percentage ranged between 3.5 to 4.2 percent at 6 weeks after sowing. Nitrogen concentration of the youngest fully expanded leaf has been recorded at 3.7% (Eagleton unpublished data) and 3.8% (Bennett et al., In press) This is required to produce 95-100% maximum seed yield. However leaf sampling is not rapid enough in 'turn-around' time to provide a result to assist farmers in deciding whether to top-dress with nitrogen fertiliser.

The use of sap nitrate tests as a means in monitoring crop nutrition, is well accepted by the horticulture industry Sap nitrate tests are quick and reliable, and provide the information instantaneously. This experiment provided an opportunity to monitor sap nitrate and leaf nitrogen concentration in relation to nitrogen fertiliser applications and sesame growth and seed yields.

Materials and Methods

Design, treatments and management

Two experiments were undertaken at Katherine Research Station while the third experiment was at Western Creek Station.

For all trials, experimental design was a randomised complete block with 6 nitrogen treatments and 4 replications. Treatment details are presented in Table 5.1., nitrogen was applied in the form of urea. All experiments were sown on 15 January 1991.

Plots consisted of 4 rows 9m long with 32 cm row spacing, while plots at Western Creek were 3.5 m long. Sesame population was thinned to 30 plants per m^2 at 14 DAS.

Recordings and Data Collection

During the season the following were measured in Experiment 1 and 2:

- Leaf number and leaf area at 28, 42, 49 and 63 DAS on 2 plants per plot.
- Plant biomass at 28, 49 and 63 DAS on 2 rows x 1.0 m.
- Thirty youngest fully expand leaves were collected at 42 and 60 DAS for total N and S concentration.
- Thirty leaf petioles from the youngest fully expanded leaves were collected at 42 DAS to determine sap nitrate levels using Merchoquant test strips and a Nitracheck meter.

At physiological maturity (97 DAS), 2 rows x 1.2 m long were harvested for plant population and seed yield. In experiment 1, five representative plants were harvested to determine plant height and capsule number. Seed from each replication was combined for 1000 seed weight, oil and nitrogen content determinations. In experiment 2, two representative plants were harvested, plant height measured and then partitioned in plant components: non-reproductive stem, branches and top, middle and bottom third of reproductive stem. The following were measured: number of capsules, weight of plant components, seed and 1000 seed. Nitrogen and oil content of seed, was also determined. For experiment 3, 2 rows x 1.2 m were harvested at physiological maturity (98 DAS) to determine plant population and seed yield.

Results

Leaf number and leaf area at 28 DAS

There was no significant difference in leaf number at 28 DAS for either experiment (Table 5.2). Mean leaf number was 10.3 and 10.4 for experiments 1 and 2 respectively. Leaf area in Experiment 1 was not affected by level of nitrogen application, while in Experiment 2 there were significant differences. Nil nitrogen treatment produced the lowest leaf area (11.8 cm^2) and N80 the highest leaf area, 27.8 cm^2 (Table 5.2).

Leaf number and leaf area at 42 and 49 DAS

There was no significant difference in leaf number or leaf area at 42 and 49 DAS for either experiment (Table 5.3 and 5.4). Mean leaf number and leaf area at 42 DAS was 39.4 and 74.0 cm^2 for Experiment 1 and 37.6 and 76.3 cm^2 for Experiment 2 respectively.

Mean leaf number and leaf area at 49 DAS was 55.4 and 91.6 cm^2 for Experiment 1.

Leaf number and leaf area at 63 DAS

There were significant differences in leaf number and leaf areas for the various nitrogen treatments. The lowest leaf number and leaf area was produced by N0 and N40, while N120 produced the greatest number of leaves while N80 the largest leaf area (Table 5.4).

Plant population at 30, 49 and 63 DAS

Mean plant population at 30, 49 and 63 DAS for experiment 1 was 312, 292 and 289 x 10^3 plants/ha, with experiment 2 it was 321, 307 and 302 x 10^3 plants/ha (Tables 5.5 and 5.6). There was no significant difference between plant population for the various treatments at any time during the experiments.

Plant biomass at 30 DAS

In both experiments there was no significant difference in plant biomass for the nitrogen treatments however N0 produced the lowest biomass and N120 the highest (Table 5.5. and 5.6). Mean plant biomass was 236 kg/ha and 272 kg/ha for Experiment 1 and Experiment 2 respectively.

Plant biomass at 49 DAS

In Experiment 1 there was no significant difference in plant biomass for the nitrogen treatments, however N0 produced the lowest biomass (1204 kg/ha) and the N80, as a split application the largest biomass, 2288 kg/ha (Table 5.5). In Experiment 2, the N0 was significantly less than N80 (Table 5.6), the N0 producing 1173 kg/ha and N80 2457 kg/ha respectively.

Plant biomass at 63 DAS

In both experiments split applications of nitrogen produced a larger sesame biomass (Table 5.5 and 5.6). The N120 split application of nitrogen producing a larger biomass than N80 split application of nitrogen.

Leaf tissue - nitrogen concentration

Nitrogen concentration of the youngest fully expanded leaf ranged between 2.8 and 3.5% in both experiments (Table 5.7). There was an increase in nitrogen concentration with higher levels of nitrogen applied at sowing, while the highest nitrogen concentrations were associated with split fertiliser applications.

At 60 DAS nitrogen concentration of youngest fully expanded leaves were generally 1.1% lower than the 42 DAS sample (Table 5.7). This was to be expected; as the plant increases biomass the concentration decreases.

Leaf tissue - nitrogen/sulphur ratio

Mean N/S ratio at 42 DAS for experiment 1 and 2 was 10.4 and 10.8 (Table 5.8). At 60 DAS mean N/S ratios were 9.4 and 10.7 for experiment 1 and 2 respectively. Ratios less than 16 indicated adequate levels of sulphur for plant growth (Thiagalingham per comm.)

Petiole sap nitrate at 42 DAS

In both experiments petiole sap nitrates reached a plateau at approximately 3000 ppm with a nitrogen application of 80 kg N/ha (Table 5.9). Split applications of nitrogen tended to produce higher sap nitrates than applying the equivalent nitrogen at sowing. The highest sap nitrate recorded was 3818 and 3450 ppm for experiment 1 and 2 respectively.

Plant population at harvest

There was no significant differences in plant population for the various treatments for any of the experiments (Table 5.10). Mean population was 302, 303 and 286 x 10^3 plants/ha for experiments 1, 2 and 3 respectively.

Seed yield

For all experiments seed yields were not significantly different for the various nitrogen treatments (Table 5.10). However, seed yield increased with higher levels of nitrogen fertiliser applied at sowing. There was no advantage of equal split applications of nitrogen between sowing and before flowering as compared to applying all the nitrogen at sowing. A three way split in nitrogen application produced a similar seed yield as applying all the nitrogen at sowing. Seed yields ranged between 856 kg/ha for N0 and 1079 kg/ha for N40 40 40.

Yield components

Experiment 1

Plant height and capsule number

There was no significant effect of nitrogen application on sesame plant height and capsule number (Table 5.11).

However the following were observed: plant height increased with applications of nitrogen at sowing up to N80. Mean plant height was 111.0 cm. Capsule number increased with applications of nitrogen at sowing up to N120, while a split application of nitrogen equivalent to N80 produced similar numbers of capsule as N80. Mean number of capsules per plant was 34.9.

1000 Seed weight, oil and nitrogen content of seed

Mean 1000 seed weight, oil and nitrogen content of seed was 3.00 g, 53.7% and 4.25% respectively (Table 5.11).

Experiment 2

Generally no significant differences were recorded for any the yield component characteristics measured in Experiment 2. However the following trends were observed and are worthy of comment:

Plant height and capsule number

Mean plant height was 117.0 cm (Table 5.12). Plants receiving 80 kg N/ha either as a split application or at sowing were the tallest (121.2 cm). Capsule numbers ranged between 33.4 and 47.4 for N80 and N40 40 respectively (Table 5.12).

1000 Seed weight, oil and nitrogen content of seed.

Mean 1000 seed weight, oil and nitrogen content of seed was 2.97 g, 53.7% and 4.20% respectively (Table 5.12).

Seed weight per plant.

There was no significant effect of nitrogen application on seed weight per plant. Mean seed weight per plant was 3.77 g (Table 5.13).

Partitioning of biomass-tops

There was no significant effect of nitrogen application on total plant weight, however the following trends were noted. Increasing levels of nitrogen application at sowing increased weight of non-reproductive stem. The split application prior to flowering produced the most non-reproductive stem. Increasing levels of nitrogen application at sowing did not effect the weight of reproductive stem, while split applications did increase the weight of reproductive stem. Split application of nitrogen before flowering produced the greatest weight of capsule and seed.

Mean biomass for non-reproductive stem, reproductive stem and capsules case were 5.20, 1.97 and 4.30 g respectively (Table 5.13).

Partitioning of capsule number

There was no significant effect of nitrogen application on capsule number within the various partitions of the reproductive stem, however the following was observed. Split application of nitrogen prior to flowering increased number of capsules on the branches and bottom third of the central stem. The additional nitrogen after flowering did not further increase capsule numbers.

Mean capsule number for top, middle and bottom thirds plus branches was 2.4, 13.9, 16.9 and 5.5 respectively (Table 5.14).

Partitioning of seed weight per plant

Generally there was no effect of nitrogen application on seed weight per plant (Table 5.15). However the following trends were observed. The higher the level of nitrogen application at sowing the greater the seed weight in the bottom third of the reproductive stem while seed weights decreased for the middle and top thirds of the reproductive stem. Mean seed weight was 0.17, 1.40, 1.63 and 0.54 g for top middle, bottom and branches respectively.

Partitioning of 1000 seed weight

There was no significant effect of nitrogen application on 1000 seed weight.

Seed size decreased with increasing height on the reproductive stem, while seed produced on branches was of equivalent size to that found in the middle portion of the reproductive stem. Mean 1000 seed weight was 2.00, 2.83, and 3.03, and 2.73 g for top, middle, bottom and branches respectively (Table 5.16).

Discussion

No significant results were recorded for sesame seed yield this year. Both sap nitrates and nitrogen concentration of youngest fully expanded leaves at 42 DAS indicate less than adequate nitrogen for successful plant growth, even at the highest levels of nitrogen application. Previous research has indicated that for the youngest fully expanded leaf at 42 DAS 3.8% N is the critical concentration, while monitoring commercial sesame crops generally found that sap nitrates greater than 3700 ppm during flowering were adequate for crop growth. These levels were not achieved in this experiment.

The low nitrogen levels recorded in plant tissue are a result of denitrification of the nitrogen fertiliser before plant uptake. High levels of denitrification were associated with the extensive rainfall during the 44 DAS of crop growth.

The preflowering application of nitrogen was applied at approximately 28 DAS, was subjected to extensive denitrification due to heavy rainfall and waterlogging conditions and while the post flowering nitrogen fertiliser was applied at approximately 50 DAS when soil surface conditions were dry. A large percentage of the post flowering nitrogen was probably lost through volatilisation as there was insufficient rainfall to leach the nitrogen into the soil profile.

The response of sesame to nitrogen was not significant though the following were observed; plant height and biomass, capsule number and seed yield reached a plateau with nitrogen application of up to 80 kg/ha at sowing.

The additional preflowering application of nitrogen (40 kg/ha) increased plant height, plant biomass, capsule number and seed yield. The split application of nitrogen, (total of 80 kg N/ha), produced similar seed yields and plant biomass as applying 80 kg N/ha at sowing. The number of capsules produced by the split application of nitrogen was approx, 20 percent higher then applying 80 kg N/ha at sowing.

The additional nitrogen applied post flowering did not increase capsule number, plant biomass or seed yields.

Table 5.1 Time and rate of nitrogen application (kg N/ha)

Experiment 1

Treatment	Pre-sowing[1]	Pre-flowering[2]	Post-flowering[3]	Total
1	0	0	0	0
2	40	0	0	40
3	40	40	0	80
4	40	40	40	120
5	80	0	0	80
6	120	0	0	120

1 - 11 DAS
2 28 DAS
3 52 DAS

Experiment 2 and 3

Treatment	Time of application			Total
	Sowing	Pre-flowering[1]	Post-flowering[2]	
1	0	0	0	0
2	40	0	0	40
3	40	40	0	80
4	40	40	40	120
5	80	0	0	80
6	120	0	0	120

1 Katherine @ 28 DAS Western Creek @ 30 DAS
2 Katherine @ 49 DAS Western Creek @ 52 DAS

Table 5.2 Leaf number and leaf area at 28 DAS

	Leaf number		Leaf area (cm^2)	
Treatment	**Exp 1**	**Exp 2**	**Exp 1**	**Exp 2**
1	10.4	9.9	15.0	11.8
2	10.3	10.4	17.7	19.7
3	10.3	9.9	15.0	17.7
4	10.3	10.3	15.5	19.5
5	10.5	10.3	16.5	27.8
6	10.0	11.3	18.3	23.4
Mean	10.3	10.4	16.3	20.0
LSD (5%)	N.S.	N.S.	N.S.	8.66

Table 5.3 Leaf number and leaf area at 42 DAS

	Leaf number		Leaf area (cm^2)	
Treatment	**Exp 1**	**Exp 2**	**Exp 1**	**Exp 2**
1	29.4	30.8	60.1	47.7
2	33.3	33.4	59.3	80.9
3	44.1	38.9	83.0	85.3
4	40.5	47.0	79.3	98.2
5	43.4	39.5	77.4	75.9
6	45.9	36.0	84.6	69.5
Mean	39.4	37.6	74.0	76.3
SD (5%)	N.S.	N.S.	N.S.	N.S.

Table 5.4 Leaf number and leaf area at 49 and 63 DAS for Experiment 1

		Leaf number		**Leaf area (cm^2)**	
Treatment	**DAS**	**49**	**63**	**49**	**63**
1		39.8	60.0	58.9	54.0
2		54.9	60.4	77.1	51.7
3		59.1	71.1	105.5	89.6
4		60.8	72.4	101.4	72.7
5		60.3	78.8	102.4	105.5
6		57.3	88.6	104.3	80.0
Mean		55.4	71.9	91.6	75.6
LSD (5%)		N.S.	19.11	N.S.	25.69

Table 5.5 Plant biomass and population for Experiment 1

		Population ($x10^3$)			**Biomass (kg/ha)**		
Treatment	DAS	30	49	63	30	49	63
1		281	281	270	182	1204	2520
2		316	293	289	258	1505	2932
3		309	281	313	247	2288	3971
4		328	309	301	231	2276	4911
5		324	297	266	235	1774	3706
6		312	289	297	261	1726	2921
Mean		312	292	289	236	1795	3494
LSD (5%)		N.S.	N.S.	N.S.	N.S.	N.S.	1481

Table 5.6 Plant biomass and population for Experiment 2

		Population (x10³)			Biomass (kg/ha)		
Treatment	**DAS**	**30**	**49**	**63**	**30**	**49**	**63**
1		332	324	285	210	1173	2636
2		311	285	305	230	1603	3081
3		313	273	301	300	1982	4203
4		332	281	313	293	2063	4228
5		324	324	309	267	2457	4104
6		316	352	301	302	2304	3771
Mean		321	307	302	272	1931	3670
LSD (5%)		N.S.	N.S.	N.S.	N.S.	749.7	N.S.

Table 5.7 Nitrogen concentration (%) of youngest fully expanded leaf at 42 and 60 DAS

		Experiment 1		Experiment 2	
Treatment	**DAS**	**42**	**60**	**42**	**60**
1		2.8	1.8	2.8	1.8
2		2.9	1.8	2.9	1.9
3		3.4	2.2	3.5	2.5
4		3.5[1]	2.1	3.5[1]	2.8
5		3.1	1.9	3.2	1.9
6		3.1	2.1	3.3	1.9
LSD (5%)		0.30	N.S	0.31	0.50

1 equivalent to treatment 3 as last nitrogen application has not been applied

Table 5.8 Nitrogen/Sulphur ratio of the youngest fully expanded leaf

		Experiment 1		Experiment 2	
Treatment	**DAS**	**42**	**60**	**42**	**60**
1		8.7	7.6	9.5	8.0
2		9.6	7.0	9.6	9.8
3		12.1	11.0	12.3	13.8
4		11.2	11.7	11.5	12.9
5		10.0	9.2	10.9	9.8
6		10.8	10.1	11.0	9.9
Mean		10.4	9.4	10.8	10.7

Table 5.9 Petiole sap nitrates at 42 DAS

	Sap nitrates (ppm)	
Treatment	**Exp 1**	**Exp 2**
1	594	388
2	1800	1567
3	3710	3450
4	3818[1]	2628[1]
5	2735	3193
6	2973	3443
Mean	2589	2536

1 Equivalent to treatment 3 as last application of nitrogen has not yet been applied

Table 5.10 Plant population and seed yield

		Population ($x10^3$)				Seed yield (kg/ha)			
Treatment	**Exp.**	**1**	**2**	**3**	**Av.**	**1**	**2**	**3**	**Av.**
1		322	309	300	*310*	924	860	785	*856*
2		300	300	293	*298*	950	926	801	*892*
3		290	278	326	*298*	978	982	1038	*999*
4		319	319	277	*305*	1225	1094	919	*1079*
5		287	306	244	*279*	1072	1003	985	*1020*
6		293	306	277	*292*	1075	947	1181	*1067*
Mean		302	303	286		1049	969	941	
LSD (5%)		N.S.	N.S.	N.S.		N.S.	N.S.	N.S.	

Table 5.11 Yield components of sesame in Experiment 1

Treatment	**Plant height (cm)**	**Number of capsules**	**1000 Seed weight (g)**	**Oil content seed (%)**	**N content seed (%)**
1	104.8	28.5	3.10	54.9	3.91
2	108.3	29.8	3.07	52.8	4.31
3	110.6	37.9	2.97	53.7	4.23
4	113.4	36.1	2.87	53.1	4.47
5	115.8	37.7	3.07	53.3	4.39
6	112.9	39.3	2.90	54.2	4.18
Mean	111.0	34.9	3.00	53.7	4.25
LSD (5%)	N.S.	N.S.	–	–	–

Table 5.12 Yield components of sesame in Experiment 2.

Treatment	Plant height (cm)	Number of capsules	1000 Seed weight (g)	Oil content seed (%)	N content seed (%)
1	114.9	33.8	2.97	54.4	4.08
2	113.3	40.5	3.00	53.5	4.08
3	121.1	47.4	2.83	53.2	4.18
4	117.0	42.4	3.00	54.1	4.43
5	121.3	33.4	2.93	53.6	4.18
6	114.8	36.3	3.00	53.3	4.25
Mean	117.0	39.1	2.97	53.7	4.20
LSD (5%)	N.S.	N.S.	-	-	-

Table 5.13 Yield components of sesame in Experiment 2.

Treatment	Non reproductive stem (g)	Reproductive stem (g)	Capsule wall (g)	Seed weight (g)	Total plant weight (g)
1	4.33	1.74	3.96	3.79	13.81
2	4.66	1.74	4.53	4.06	14.99
3	6.10	2.31	5.25	4.27	17.93
4	5.70	2.46	4.52	3.54	16.20
5	5.03	1.91	3.49	3.41	14.23
6	5.38	1.70	4.07	3.57	14.69
Mean	5.20	1.97	4.30	3.77	15.31
LSD (5%)	N.S.	N.S.	N.S.	N.S.	N.S.

Table 5.14 Partitioning of capsule numbers.

Treatment	Plant position	Capsule number Top	Middle	Bottom	Branches
1		4.3	15.1	10.6	3.4
2		4.0	14.8	16.6	5.1
3		2.6	15.3	20.3	9.3
4		0.6	16.1	18.3	7.4
5		2.3	10.4	16.6	2.8
6		0.9	11.6	19.0	4.8
Mean		2.4	13.9	16.9	5.5
LSD (5%)		2.54	N.S.	N.S.	N.S.

Table 5.15 Partitioning of seed weight.

Treatment	Plant position	Weight of seed (g) Plant position Top	Middle	Bottom	Branches
1		0.30	1.83	1.34	0.33
2		0.25	1.69	1.54	0.59
3		0.19	1.53	1.65	0.92
4		0.02	1.25	1.63	0.64
5		0.19	0.99	1.78	0.29
6		0.08	1.25	1.91	0.50
Mean		0.17	1.40	1.63	0.54
LSD (5%)		N.S.	0.491	N.S.	N.S.

Table 5.16 Partitioning of 1000 seed weight.

	1000 seed weight (g) Plant position			
Treatment	**Top**	**Middle**	**Bottom**	**Branches**
1	2.43	2.97	3.13	2.70
2	2.07	2.87	3.00	2.73
3	2.17	2.70	2.83	2.77
4	1.83	2.83	3.20	2.53
5	1.80	2.83	3.00	3.03
6	1.60	2.80	2.93	2.93
Mean	2.00	2.83	3.03	2.73
LSD (5%)	N.S.	N.S.	0.064	N.S.

6. Effect of nitrogen and phosphorus fertiliser on sesame growth, seed yield and yield components

Introduction

Sesame is one of the new commercially cultivated crops in the Northern Territory having considerable potential as a major crop on the red earth (Alfisols) soils. Successful production of sorghum and maize on these soils require high inputs of nitrogen and phosphorus fertilisers. It is expected that high inputs of fertilisers will also be required for good sesame seed yields. The high costs of fertilisers in the Northern Territory emphasises the need to determine suitable fertiliser recommendations.

Current recommendations are based on rates of phosphorus and nitrogen applications developed for sesame grown at Kununurra (WA) on Cununurra clays and Cockatoo sands i.e. 20 kg P/ha and 60 kg N/ha. This paper presents the effects of nitrogen and phosphorus on growth, nitrogen content, seed yield and yield components of sesame in the Northern Territory.

Materials and Methods

Design, treatments and management

This experiment was sown at 3 sites, Douglas Daly, Katherine and Western Creek Station. This paper will discuss the results of the latter 2 sites.

Experimental design was a randomised complete block with a factorial combination of 4 levels of nitrogen and 4 levels of phosphorus fertiliser. There were 4 replications. Levels of nitrogen (urea) were 0, 30, 60 and 120 kg N/ha and phosphorus (triple superphosphate) were 0, 20, 40 and 80 kg P/ha. Fertiliser was applied by hand -11 and 7 DAS at Katherine and Western Creek Station respectively.

The sesame cultivar Yori 77 was sown on the 15 January 1991 at both sites. Plot size was 4 rows x 5.0 m long and 4 rows x 3.0 m long at Katherine and Western Creek Station respectively, with 32 cm between rows. Plants were thinned to an intra-row spacing of 10 cm (equivalent to 300 000 plants/ha).

Recordings and data collection

Katherine site

At 43 DAS, thirty youngest fully expanded leaves were collected from each plot for %N and %P analysis.

At physiological maturity (97 DAS), 5 representative plants were selected from each plot for yield component analysis - plant height and weight, number of capsules and seed weight per plant.

Plant population and seed yield were recorded by harvesting 2 rows x 1.2 m long. Seed from each replication was combined for 300 seed weight, and % oil content determination.

Western Creek Station

Western Creek Station was generally inaccessible during the wet season. Plant population and seed yield were recorded by harvesting 2 rows x 1.2m long at 98 DAS.

Results

Leaf analysis at 43 DAS

There was no significant difference in nitrogen or phosphorus concentration for the various levels of nitrogen fertiliser. Mean nitrogen and phosphorus percentage were 2.68 and 0.337 respectively (Table 6.1).

There was no response in nitrogen concentration to increasing levels of phosphorus fertiliser, while the P80 level of fertiliser recorded a significantly higher phosphorus concentration in the youngest fully expanded leaf.

Plant population and seed yield

There was no significant differences between plant population for the various fertiliser treatments. Mean population was 290 and 283 x 10^3 plants/ha at Katherine and Western Creek Station respectively (Table 6.2).

There was no response in seed yield to applications of nitrogen or phosphorus fertiliser at both sites. Mean seed yield was 783 and 748 kg/ha at Katherine and Western Creek Station respectively (Table 6.2).

Yield components - Katherine

Plant height, capsule number and harvest index

There was no significant response to fertiliser application for any of the yield components (Table 6.3). Mean plant height, capsule number and harvest index was 99.4cm, 27.5 and 31.2 respectively.

1000 seed weight and oil content

There was no response for 1000 seed weight and oil content to fertiliser applications (Table 6.4). Mean 1000 seed weight and oil content were 3.00 g and 53.7%.

Phosphorus and nitrogen concentration of seed.

Higher levels of nitrogen fertilizer increased nitrogen concentration of seed but not phosphorus concentration. Concentration of nitrogen or phosphorus in sesame seed was not effect by level of phosphorus fertilizer (Table 6.4). Mean phosphorus and nitrogen concentration of seed was 0.50 and 3.88% respectively.

Discussion

No significant differences between treatments were recorded for seed yield in this experiment. Nitrogen concentration of youngest fully expanded leaf at 42 DAS indicate that it was less than adequate for successful plant growth even at the highest level of nitrogen application. Previous research has indicated that 3.8%N is the critical nitrogen concentration. The highest nitrogen concentration in this experiment measured was 2.8%.

The low nitrogen levels recorded in plant tissue are possibly the result of denitrification of the nitrogen fertiliser before plant uptake. High levels of denitrification were associated with extensive rainfall in January and February. During this period only 6 days recorded no rainfall in Katherine while mean daily rainfall was 14.8 mm. Mean daily rainfall at Western Creek Station was 13.4 mm.

Table 6.1 Nitrogen and phosphorus content of leaf tissue at 43 DAS

Nitrogen level (kg/ha)	N%	P%
0	2.6	0.33
30	2.6	0.34
60	2.7	0.36
120	2.8	0.32
Phosphorus level (kg/ha)		
0	2.7	0.31
20	2.6	0.32
40	2.7	0.32
80	2.6	0.41
Overall Mean	2.68	0.337

Table 6.2 Plant population and seed yield

	Plant population ($x10^3$)		Seed yield (kg/ha)	
Nitrogen level (kg/ha)	**KT**	**WC**	**KT**	**WC**
0	283	295	666	742
30	298	287	826	793
60	290	273	780	763
120	291	277	841	683
LSD (5%)	N.S.	N.S.	N.S.	N.S.
Phosphorus level (kg/ha)				
0	282	282	758	756
20	296	291	744	773
40	280	274	762	749
80	304	283	851	701
Overall Mean	290	283	783	748
LSD (5%)	N.S.	N.S.	N.S.	N.S.

Table 6.3 Plant height, capsule number and harvest index for sesame at Katherine

Nitrogen level (kg/ha)	Plant height (cm)	Capsule number	Harvest index (%)
0	98	26	31.4
30	99	28	31.5
60	98	26	31.1
120	101	29	30.9
LSD (5%)	N.S.	N.S.	N.S.
Phosphorus level (kg/ha)			
0	99	25	32.1
20	95	28	31.1
40	103	30	30.8
80	99	27	31.0
Overall Mean	99.4	27.5	31.2
LSD (5%)	N.S.	N.S.	N.S.

Table 6.4 1000 seed weight and oil content for sesame at Katherine

Nitrogen level (kg/ha)	1000 seed weight (g)	Oil content (%)
0	2.97	53.8
30	3.00	53.8
60	3.00	53.3
120	3.03	53.7
Phosphorus level (kg/ha)		
0	3.00	53.8
20	3.00	53.2
40	3.00	54.2
80	3.00	53.4
Overall Mean	3.00	53.7

7. Effect of row spacing and sesame population on seed yield and weed competition under low herbicide (metolachlor) input.

Introduction

Weeds commonly encountered in sesame crops in the Northern Territory are summer grasses (*Brachiaria sp., Digitaria sp. and Urochloa sp.*) pigweeds (*Trianthema portulacastrum and Portulaca oleracea*) and Buffalo clover (*Alysicarpus vaginalis*). Currently sesame farmers rely on pre-sowing cultivation and herbicides for weed control. However tillage exacerbates the problem of soil erosion while the need to incorporate trifluralin complicates land preparation when rain frequently interferes with land preparations.

A further problem with weed control in sesame is that rates of chemical application that would be effective against some of these weeds increase the risk of crop damage by the chemical. More effective weed control could be applied by a smothering approach. Sesame populations could be selected which minimise competition from weeds through shading without reducing seed yields. However there may be a problem between populations suitable for smothering and those appropriate for minimising local drought risk.

Current recommendations for the Northern Territory to ensure maximum seed yields are to establish a uniform population of 300 x 10^3 plants/ha. Research in 1986 indicated that 290 x 10^3 was the most successful (populations less than 290 x 10^3 were not evaluated). While experiments in 1987 indicated no significant difference in seed yield for populations between 100 and 300 x 10^3 plants/ha. Maximum seed yields were found at 48 cm row spacing.

In south east Queensland Schrodter and Rawson, (1986) recomended a plant population of 200 x 10^3/ha using 33 cm row spacing while Tiangtrong (1984) found 400 x 10^3 plants/ha at 16cm row spacing to be successful. At Kununurra in Western Australia Eagleton *et al* (1986) indicated that 350 x 10^3 plants/ha on various bed arrangements to be ideal or maximum seed yield production.

This paper presents the effect of row spacing and population on seed yield and weed development when using a low herbicide (metolachlor) application rate.

Materials and Methods

Design, treatments and management

Experimental design was a randomised complete block with 4 row spacings - 16, 32, 48 and 64 cm and 4 populations - 200, 300, 400 and 500 x 10^3 plants/ha. There were 4 replications, metolachlor was applied @ 1.0L/ha at 1 DAS.

All plots were 4 rows x 5.0 m long. Sesame cv Yori 77 was sown with a small plot combine on 15 January 1991, then thinned to their appropriate populations and row spacings 16 DAS.

Recordings and data collection

Dry matter production and plant numbers were measured at 41 and 65 DAS. On each occasion a sample of 2 rows x 1.2 m long was collected from each plot. All material was identified and divided into sesame, grasses, legumes and broadleaf weeds. These components were dried and weighed.

Foliage projected cover was also estimated on 41 and 65 DAS.

At maturity (98 DAS), sesame plant population and seed yield were recorded by harvesting 2 rows x 1.2 m long.

Results

Sesame population at 41 and 65 DAS

The difference between treatment population and number of plants recorded at 41 DAS increased with treatment population with the mortality rate for seedlings increasing with higher population density (Table 7.1). At the highest treatment population (50 plants/m^2), 11% of plants had died. This mortality increased with time and by 65 DAS 20% of plants in the highest treatment population had died.

The influence of row spacing on sesame population was to increase plant mortality at wider row spacings (Table 7.1). The higher mortality rate was associated with a higher intra-row plant competition and this increased with time.

Leguminous weeds at 41 and 65 DAS

The principal legume weed was *Alysicarpus vaginalis.*

There was no significant effect of sesame population on number of legume weeds in the plots at both sample dates. However, row spacing affected number of legume plant numbers. The narrow row spacing increased the number of weeds (Table 7.2). The mean number of legume plants was 49.5/m² and 40.9/m² at 41 and 65 DAS respectively.

Broadleaf weeds at 41 and 65 DAS

At both sample dates populations of this group were very low and there was no significant difference in broadleaf weed numbers due to sesame population or row spacing (Table 7.3). Mean number of broadleaf weeds was between 1 and 2 plants/m². Principal broadleaf weed was *Trianthema portulacastrum.*

Grass weeds at 41 and 65 DAS

At both sample dates there was no significant difference in grass weed numbers due to sesame population or row spacings (Table 7.4). The principal grass weed was *Urochloa sp.*

Weed population and biomass at 41 and 65 DAS

Weed biomass was not effected by sesame population or row spacing with the mean weed biomass 4.1 kg/m² and 13.8 kg/m² at 41 and 65 DAS respectively (Table 7.5). Weed population was not influenced by sesame plant population; However, the narrower the row spacing the higher the weed population. Weed population decreased with time, from 52.6 pl/m² to 43.0 pl/m² at 41 DAS and 65 DAS respectively (Table 7.5).

Ground cover of sesame at 41 and 65 DAS

At 41 DAS there was significant differences in this ground cover between sesame population and row spacing. The higher the sesame population and narrower the row spacing the greater the foliage cover (Table 7.6). Sesame ground cover ranged between 33% and 57% for 64 cm row spacing and 50 plants/m² respectively. At 65 DAS there was no significant difference in ground cover for sesame at the various populations, however ground cover significantly decreased with wider row spacing (Table 7.6).

Sesame population at harvest (98 DAS)

There were marked differences between the sesame plant stand at thinning (16 DAS) and harvest population at 98 DAS. Plant mortality was greatest at the highest population and widest row spacing (Table 7.7). Mortality rates were as high as 37% for the season. Harvest populations were recorded between 19.8 pl/m² and 35.4 pl/m².

Seed yield

Seed yield was not significantly different between populations. Mean seed yield was 980 kg/ha, (Table 7.7). However, reducing row spacing significantly increased seed yield, with the highest yield (1180 kg/ha) being recorded for the narrowest row spacing (16 cm).

Discussion

Sesame growth was retarded by saturated soil conditions during January and February and then moisture stress from the end of March. Foliage cover was half that expected at 41 and 65 DAS (Garside et al., unpublished data).

The number of weeds was influenced only by row spacing. The narrower the row spacing the greater the soil disturbance in a unit area the greater the number of weeds. Regardless of weed numbers, weeds biomass was uniform across the experiment site.

The dominate weed was *Alysicarpus vaginalis* (40-50 p/m^2) with *Trianthema* and *Urochloa* (1-2 p/m^2) being regularly recorded.

Throughout the season sesame plant numbers continually reduced. Mortality was greatest at the highest plant density, due to row spacing or treatment population. Harvest populations ranged between 198 and 354 x 10^3 plants/ha. There was no significant differences in seed yield for sesame populations within this range, these results being similar to those found by Eagleton and Schrodter.

Row spacing significantly affected seed yield. Highest seed yields were recorded at the 16 cm and 32 cm row spacing. Previous experience has recorded yield depressions at 16 cm, hence future recommendations for row cropped sesame will be for a row spacing of approx 32 cm.

Table 7.1 Sesame plant populations measured at 41 and 65 DAS

	Recorded population (plants/m²)	
Treatment population (plants/m²)	**41 DAS**	**65 DAS**
20	20.5 (0.0)[1]	21.6 (+8.0)
30	30.1 (0.0)	28.1 (6.3)
40	35.9 (10.3)	35.5 (11.3)
50	44.5 (11.0)	39.9 (20.2)
LSD(5%)	3.57	2.56
Row spacing (cm)		
16	37.1 (0.0)[2]	35.2 (0.0)
32	35.0 (0.0)	34.0 (2.9)
48	30.9 (11.7)	28.8 (17.7)
64	28.1 (19.7)	27.1 (19.7)
LSD(5%)	3.57	2.56

1 Mortality rate as a percentage of the mean of row spacings.
2 Mortality rate as a percentage of 'mean' treatment population.

Table 7.2 Number of legume weeds counted at 41 and 65 DAS

	Legume population (plants/m²)	
Treatment population (plants/m²)	**41 DAS**	**65 DAS**
20	42.4	36.6
30	44.7	38.7
40	63.1	44.8
50	47.6	42.6
LSD(5%)	N.S	N.S.
Row spacing (cm)		
16	84.8	61.1
32	43.0	36.5
48	36.1	35.0
64	33.9	30.0
LSD(5%)	29.81	15.37
Mean	49.5	40.9

Table 7.3 Number of broadleaf weeds counted at 41 and 65 DAS

	Broadleaf population (plants/m²)	
Treatment population (plants/m²)	**41 DAS**	**65 DAS**
20	1.6	1.1
30	2.0	0.4
40	2.6	1.7
50	1.4	1.5
LSD (5%)	N.S	N.S.
Row spacing (cm)		
15	3.1	1.4
32	1.7	1.7
48	1.4	0.6
64	1.5	1.1
LSD(5%)	N.S.	N.S.
Mean	1.9	1.2

Table 7.4 Number of grass weeds counted at 41 and 65 DAS

	Grass population (plants/m²)	
Treatment population (plants/m²)	**41 DAS**	**65 DAS**
20	1.9	1.3
30	1.1	0.8
40	1.0	0.7
50	1.1	0.9
LSD(5%)	N.S.	N.S.
Row spacing (cm)		
16	1.0	1.0
32	2.0	0.6
48	1.1	1.0
64	0.8	1.1
LSD(5%)	N.S.	N.S.
Mean	1.2	0.9

Table 7.5 Total number of weeds and weed biomass measured at 41 and 65 DAS

Treatment population (plants/m²)	Total number of weeds (plants/m²)		Total weed biomass (plants/m²)	
	41 DAS	65 DAS	41 DAS	65 DAS
20	45.9	39.1	4.0	18.4
30	47.9	39.9	4.8	12.6
40	66.6	47.2	3.9	14.1
50	50.1	45.0	3.5	9.6
LSD(5%)	N.S.	N.S.	N.S.	N.S.
Row spacing (cm)				
16	88.9	63.5	6.0	17.4
32	46.7	38.8	4.0	10.9
48	38.7	36.6	2.8	11.1
64	36.2	32.2	3.5	15.3
LSD(5%)	31.5	15.76	N.S.	N.S.
Mean	52.6	43.0	4.1	13.8

Table 7.6 Estimated ground cover by sesame measured at 41 and 65 DAS

	Foliage projected cover (%)	
Treatment population (p/m²)	41 DAS	65 DAS
20	35	31
30	40	30
40	41	35
50	57	38
LSD(5%)	21.1	N.S.
Row spacing		
16	52	45
32	50	38
48	38	28
64	33	22
LSD(5%)	12.1	6.9

Table 7.7 Effect of sesame population and row spacing or seed yield

Treatment population (plants/m²)	Recorded population (plants/m²)	Seed yield (g/m²)
20	19.8 (1.0)[1]	99.4
30	26.7 (9.0)	91.4
40	30.7 (23.3)	94.5
50	35.4 (29.2)	108.6
LSD(5%)	3.56	N.S.
Row spacing (cm)		
16	33.3 (4.9)[2]	118.0
32	31.1 (11.1)	102.0
48	26.4 (24.6)	92.1
64	22.0 (37.1)	81.2
LSD(5%)	3.56	20.5

1 Mortality rate as percentage of the mean of row spacing treatment.
2 Mortality rate as percentage of the 'mean' treatment population.

8. Effect of metolachlor (Dual)® on sesame seed yield

Introduction

Alachlor, (Lasso®) had been used in sesame crops as a pre-emergent herbicide for the control of summer grasses and pigweeds in the Northern Territory. The withdrawal of this product from the market initiated research into alternative herbicides.

Metolachlor (Dual®) as a possible replacement was found not to induce visual symptoms of damage to sesame plants and provided at least temporary control of grasses and pigweed when applied at rates less than 2 l/ha.

As a result of these observations, a more detailed study was initiated to evaluate the effect of metolachlor on sesame seed yield. Measurements are required to determine chemical residual levels in soil, sesame seed and plant material to provide data for the registration of its use for sesame in the Northern Territory.

Materials and Methods

Experimental design was a randomised complete block with 4 herbicide treatments and 4 replications. The herbicide treatments were 0.0, 1.0, 2.0 and 4.0L metolachlor/ha. The experiment was sown and herbicides applied on 3 January 1991. The plots consisted of 7 rows 3 m long with 32 cm row spacing. Plants were thinned to 30 plants per m^2 at 18 DAS.

Plots received a top dressing of 20 kg N/ha as urea at 13 and 21 DAS.

Recordings and Data collection

Two representative plants from each treatment were collected at 38 DAS to examine the effect of metolachlor on root development.

At maturity 95 DAS, plant population and seed yield were measured by sampling 4 rows x 1.0 m long. All above ground material was collected, threshed and seed cleaned. Soil samples (0-15 cm) were collected from each plot. All material was then stored at 9°C until analysis for metolachlor residual levels. (Method of analysis was as per CIBA - GEIGY analytic procedure No. 146).

Results

Root development at 38 DAS

Sesame root development was affected by the level of metolachlor application (Table 8.1). The highest rate of metolachlor application 4.0 L/ha, reduced the weight of root material by 44.7 percent. However, sesame plants were never visually stressed for soil moisture.

Sesame population

Although there was no significant effect of metolachlor application on plant population (Table 8.2), there was a distinct trend an reduction of plant number with higher levels of metolachlor application. The linear relationship between plant population (y) and rate of metolachlor application (x) can be expressed as $y = 326.2 - 16.82\,x$, $r^2 = 0.82$.

Seed yield

There was no significant effect of metolachlor application on seed yield (Table 8.2). Mean seed yield was 1289 kg/ha.

Metolachlor residual - seed and stova.

Metolachlor residuals were not detected in sesame seed or stova. The method of analysis was based on the CIBA - GEIGY analytical procedure No. 146, limit of determination was 0.02 mg/kg.

Metalochlor residual - soil

Metolachlor residuals (equal to or less than 0.02 mg/kg) were detected in soil samples taken from plots receiving 2.0 and 4.0 L metolachlor/ha. The limit of detection was 0.01 mg/kg. It is expected that these residual levels will break down by the start of next cropping season.

Discussion

Metolachlor reduced sesame root development with higher levels of application. The reduction in root development did not result in moisture stress because plants received a mean daily rainfall of 14.8mm during January and February. Sesame was sufficiently well developed by March to cope with the lack of rainfall.

Sesame plant populations were reduced with increasing levels of metolachlor, however these reductions were not significant. Sesame seed yields were not significantly affected by metolachlor application, mean seed yield was 1287 kg/ha. Metolachlor residual were not detected in sesame seed or stova. This experiment needs to be repeated next season on two different soil types to confirm these results.

Table 8.1 Effect of metolachlor on sesame root development

Rate of metolchlor application (L/ha)	**Weight of root material (g)**
0.0	2.35
1.0	1.80 (76.6)[1]
2.0	1.50 (63.8)
4.0	1.30 (55.3)

1 Weight of root as a percentage of the control.

Table 8.2 Effect of metolachlor on sesame population and seed yield

Rate of metolachlor application (L/ha)	**Plant population ($x10^3$)**	**Seed yield (kg/ha)**
0.0	328	1263
1.0	320	1395
2.0	273	1139
4.0	266	1406
Mean	297	1287
LSD (5%)	N.S.	N.S.

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