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SESAME RESEARCH REPORT 1996-97 WET SEASON KATHERINE

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SESAME RESEARCH REPORT

1996-97 WET SEASON

KATHERINE

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CONTENTS

1. Introduction

History of sesame research and development in the Northern Territory

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 (cv.), sowing date, population, crop establishment, nutrition, weed control, disease monitoring, harvesting and seed maintenance experiments. Development of pure cv. Yori 77 seed and an improved cultivar for northern Australia has been given the highest priority. This research was jointly funded by the Grains Research and Development Corporation and the Rural Industries Research and Development Corporation.

A superior sesame genotype (Y1:44) was selected in 1992-93. Seed multiplication and demonstration areas of the new genotype were sown in January 1995. Significant differences in plant morphology and farmer adoption of zero tillage technology have highlighted the need to re-assess some agronomic practices, eg. the spacing of rows by population interactions for sesame.

In March 1995, the First Australian Sesame Workshop was convened in Darwin - Katherine. Twenty five papers were presented during formal sessions and have been reproduced in the *Proceedings of the First Australian Sesame Workshop.* During group discussions, strategies for a coordinated approach to the expansion of the Australian sesame industry were developed. Critical issues were identified.

These issues have been extensively covered in a strategic plan document for the Australian Sesame Industry and are currently being implemented.

The results of three experiments are documented in this report. The superior sesame genotype (Y1:44), now called cv. Edith described in the *Plant Varieties Journal Vol 9 Issue 3.*

2. General Methods

Sites and Soils

All three experiments were conducted at Katherine Research Station (14^0 28'S, 132^0 18'E) on either a Venn sandy loam or a Fenton clay loam (Lucas *et al.* 1985). Soil nutrient data for the 1996-97 field experiment are presented in Table 2.1.

Seasonal Conditions

The 1996-97 wet season was characterised by good rains in November and December 1996 for good land preparation. Due to extremely frequent and high rainfalls, sowing was delayed until 11 and 12 January, 1997. Follow-up rains in February maintained saturated soil conditions. Total rainfall for March was average, but was confined to the first 10 days of the month.

Total rainfall for the wet season -November 1996 to May 1997 - at Katherine was 1398 mm (Table 2.2). That wet season was the fourth wettest in 122 years of record keeping.

Land Preparation and Weed Control

Land preparation for the nitrogen experiment was by zero and conventional till techniques. The experimental site was slashed or cultivated three times during November and December before applying Round-up CT @ 3.0 l/ha on 7 January 1997, to kill the established plant cover and create an effective mulch for the sesame crop. The sesame crop was sown on the 11-12 January. Metoalchlor (Dual^R) @ 2.25 l/ha was sprayed pre-sowing to control potential grass weeds. Sethoxydin (Sertin^R) @ 2.0 l/ha was sprayed to control emerging grass seedlings on 13 January 1997.

Fertiliser Application

Details of the basal fertiliser applications are given in Table 2.3.

Insect Control

The experimental area did not require insect control.

Table 2.1 Soil nutrient data for paddock H10

Soil analysis	non-fallow 0-15 cm	non-fallow 15-30 cm	fallow 0-15 cm
Organic carbon (%)	1.12	-	1.23
pH	6.2	-	6.2
Avail. P (ppm)	5	4	4
Avail. K (ppm)	227	150	176
Avail Ca (ppm)	773	857	-
Avail. S (ppm)	5.8	15.7	6.1
Avail Mg (ppm)	170	177	-
Avail. Cu (ppm)	2.1	1.6	2.1
Avail. Zn (ppm)	1.3	0.5	0.6
Avail. B (ppm)	<0.2	<0.2	-

The fallow area of H10 had previously been paddock H8, which was sown to sesame in 1991-92.

Table 2.2 Rainfall, pan evaporation, radiation, mean temperatures and long term mean climatic data at Katherine

	Nov	Dec	Jan	Feb	Mar	Apr	May	
Monthly rainfall (mm)								**Total**
Katherine	91.5	404.6	492.5	268.8	141.0	0.0	0.0	1398.4
Long term mean	83.3	191.6	228.6	210.2	162.7	32.8	5.1	914.3
Mean maximum daily temperature (^{0}C)								
Katherine	38.1	35.5	32.6	33.9	35.0	34.8	32.9	
Long term mean	37.8	36.2	34.6	34.1	34.3	33.9	32.0	
Mean minimum daily temperature (^{0}C)								
Katherine	24.0	24.8	23.3	24.1	21.5	19.0	17.4	
Long term mean	24.3	23.9	23.7	23.4	22.3	19.5	16.2	
Mean daily radiation (MJ/m^2)								
Katherine	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	
Long term mean	24.6	24.2	21.9	22.5	21.7	21.7	22.0	
Mean monthly evaporation (mm)								
Katherine	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	
Long term mean	275	242	194	156	173	186	180	

N.A. Not available

Table 2.3 Fertiliser applications for paddock H10

Experiment	Fertiliser	Rate	Application date
Tillage nitrogen	Super phosphate plus copper & zinc	100 kg/ha (9 kg P/ha, 5 kg Cu/ha & 5 kg Zn/ha)	11 January
	Urea	0, 40, 80 & 120 kg N/ha	7 January

3. Effect of date of sowing on sesame growth and development

Introduction

The currently recommended sesame cultivar in the Northern Territory is Edith, which was released in 1996. Recent research has established that Edith flowers three days earlier than Yori (the previous commercial cultivar), while maturing 3 days later. This suggests that there was an opportunity to sow Edith earlier than the recommended sowing date for Yori at Katherine of 7 to 14 January. The recommended sowing date of 7 to 14 January represented a compromise between a high seed yield and high seed quality. Sowing on the 7 January results in the crop maturing in April when the probability of rainfall is low and seed quality can be expected to be high.

The optimum window for sowing now recommended for Edith at Katherine is between the 4 and 14 January. Sowing earlier than 9 January is better than sowing after that date if potential seed yield is to be achieved.

This paper documents the effect of sowing date on plant structure and light interception for the sesame cultivars Edith and Yori. These results will be used in the development of a sesame growth model. The effect of sowing date on sesame seed yield and yield components are presented in the Sesame Research Report, 1995 - 96 Wet Season.

Materials and Methods

Design, treatments and management

The experimental design was a split plot with 5 sowing dates (main plots), 2 sesame genotypes,Yori 77 and Edith (sub-plots) and 3 replicates. Plot size was 7.5 m long with 4 rows at 50 cm row spacing.

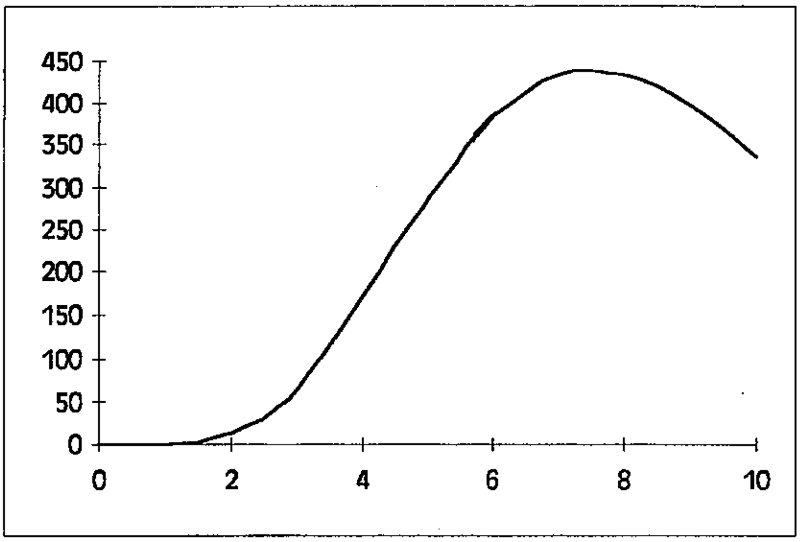
Plots were sown no-till on the 12 December 1995, 27 December 1995, 9 January 1996, 23 January 1996 and 6 February 1996. Plants were thinned to an intra-row spacing of 15 cm (equivalent to 133 000 plants/ha) at 14 days after sowing (DAS).

Data collection

During the season measurements of leaf number, leaf area, leaf weight, stem weight and capsule plus seed weight were made on two plants from each plot on a weekly basis. This data was modelled using *Hoerl's Special Function Equation.* Starting 3 weeks after sowing, light interception measurements were recorded at 3 locations in each plot. This data was modelled using *Quadratic Equation.*

Hoerl's Special Function is of the form $y=ax^be^{-cx}$ (where a and $x>0$)

- The term a is a constant - in our case for $x=0$, would represent the y-intercept, or in other words the size/number of the characteristic being measured at time (or x) 0, (in the seed) - and is usually 0 or very close to 0.
- the term x^b gives the initial rise (the first part of the curve below).
- and the term e^{-cx} gives the subsequent decline (the second part of the curve below).
- The shape will depend on the relative magnitudes of a, b and c. The rate of the rise and decline will depend on the values for b and c. For example, a large b and a relatively small c will look as below.



- Transforming $x_i=\ln(x)$ and $y_i=\ln(y)$ gives a linear multiple regression of the form $\ln y=\ln a+b\ln x_1-cx_2$ thus regressing $\ln y$ on x_1 ($=\ln x$) and x_2 ($=x$) allows the values of a b and c to be estimated, (or using computer iterative least squares estimation of the non-linear function.)

Results

Generally sowing date had no significant effect on the time to attain the various morphology stages. Therefore, in the following summary of the results a *mean description* of sesame plant development for the five sowing dates is given.

Details of the mean number of weeks to reach 50% and 90% of maximum plant development are presented in Table 3.1.

Green leaf number

Results are presented in Figure 3.3 and Table 3.2.

Maximum green leaf number was recorded 8 weeks after sowing with Yori producing between 30 and 40 more green leaves per plant than Edith. However Edith reached 50% of maximum leaf number one week earlier than Yori. Maximum green leaf number ranged between 80 and 105 leaves per plant for Edith and 110 and 180 leaves per plant for Yori for the various sowing dates.

Green leaf weight

Results are presented in Figure 3.2 and Table 3.3.

Maximum green leaf weight was recorded between 7 and 8 weeks after sowing. There was only a marginal difference in green leaf weight between the cultivars, usually less than 1 gram per plant. Development of green leaf number and green leaf weight resulted in similar growth curves. Green leaf weight ranged between 12 and 20 grams per plant for Edith and between 12 and 22 grams per plant for Yori for the various sowing dates.

Yellow leaf weight

Results are presented in Figure 3.3 and Table 3.4.

Maximum yellow leaf weight was generally recorded 11 weeks after sowing. At this time the difference in yellow leaf weight between Yori and Edith was 1.1 grams per plant. Yori maintained a larger weight of sesencing leaf material per plant than Edith throughout the growing season.

Total leaf area

Results are presented in Figure 3.4 and Table 3.5.

Maximum leaf area was measured 7 weeks after sowing with Yori producing a larger leaf area than Edith. Total leaf area ranged between 3300 and 5200 cm^2 per plant for Yori and between 2800 and 5000 cm^2 per plant for Edith for the various sowing dates.

Capsule and grain weight

Results are presented in Figure 3.5 and Table 3.6.

Maximum capsule plus grain weights were generally recorded between 12 and 14 weeks after sowing. Edith produced a larger capsule plus grain weight one week after that achieved by Yori. Capsule plus grain weights ranged between 23 and 40 grams per plant for Yori and between 24 and 43 grams per plant for Edith for the various sowing dates.

Stem and petiole weight

Results are presented in Figure 3.6 and Table 3.7.

Maximum stem and petiole weights were measured between 9 and 10 weeks after sowing with Edith having a lower stem and petiole weight than Yori. Stem and petiole weights ranged between 22 and 56 grams per plant for Yori and 19 and 56 grams for Edith for the various sowing dates.

Total plant weight

Results are presented in Figure 3.7 and Table 3.8.

Maximum total plant weights were measured between 10 and 11 weeks after sowing. Total plant weight ranged between 48 and 94 grams per plant for Yori, and 48 and 95 grams per plant for Edith for the various sowing dates.

Light interception

Both cultivars reached maximum light interception at 9 weeks after sowing. Edith generally developed a canopy which intercepted greater amounts of incoming radiation during the first 5 to 6 weeks.

Discussion

Modelling the growth and development of the two commercial sesame cultivars in the NT highlights why Edith is the preferred choice for the expansion of the sesame industry in north western Australia. The initial advantage of rapid emergence of Yori seedlings is lost as Edith develops a larger canopy structure in the first 5 to 6 weeks which is more efficient at intercepting light. During this time Edith has produced more leaves and a larger leaf area to utilise incoming radiation. After 6 weeks Yori develops more leaves and a larger leaf area than Edith, however there is no additional gain in percentage light interception. To support this larger canopy Yori develops a larger stem and petiole biomass while maintaining a larger senescing leaf area. This large plant structure for Yori does not produce a capsule plus grain biomass greater than that of Edith. By week 13 Edith has developed a larger capsule plus grain biomass on a smaller plant. This is achieved with fewer capsules per plant but with more seeds per capsule of higher individual seed weight. This also suggests that the optimum plant population for maximum seed yield for Edith might be higher than for Yori 77.

Acknowledgments

The authors are grateful to M Hearnden for data analysis.

Table 3.1 Mean number of weeks to reach 50% and 90% maximum levels for various plant attributes

	Mean number of weeks			
	>50% maximum		>90% maximum	
Character	**Yori**	**Edith**	**Yori**	**Edith**
Green leaf number	6	5	7	7
Green leaf weight (g)	6	5	7	7
Yellow leaf weight (g)	10	10	11	11
Total leaf area (cm²)	5	5	7	7
Capsule and grain weight (g)	10	10	12	12
Stem and petiole weight (g)	7	7	9	8
Total plant weight (g)	7	7	9	9
Light interception	5	5	8	7

Table 3.2 Effect of sowing date on the development of sesame green leaf number

Model: Green leaf number = a* (week no. ^{b}) * exp (c* week no.)

Cultivar	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**
TOS	All	All	1	1	2	2	3	3	4	4	5	5
Coefficient a	0.0001	0.0145	0.0006	0.1313	0.0012	0.0639	0.0000	0.0097	0.0001	0.0001	0.0016	0.0044
Coefficient b	13.4675	8.4670	11.3893	6.4948	10.9253	7.1442	26.8084	8.5020	13.7571	12.8745	11.2953	10.1412
Coefficient c	-1.6947	-1.1061	-1.4135	-0.8515	-1.3918	-0.9592	-3.1761	-1.0820	-1.7553	-1.5971	-1.5467	-1.3900
r^2	0.72	0.71	0.88	0.74	0.75	0.73	0.73	0.66	0.94	0.78	0.88	0.82

Table 3.3 Effect of sowing date on the development of sesame green leaf weight

Model: Green leaf weight = a * (week no. ^{b}) * exp (c * week no.)

Cultivar	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**
TOS	All	All	1	1	2	2	3	3	4	4	5	5
Coefficient a	0.0000	0.0005	0.0000	0.0001	0.0011	0.0187	0.0000	0.0003	0.0000	0.0000	0.0005	0.0003
Coefficient b	12.8096	10.1162	13.5554	11.5784	9.8295	6.8263	29.0560	10.5702	12.8687	12.7843	10.6554	10.7703
Coefficient c	-1.7029	-1.3597	-1.7805	-1.5159	-1.3658	-0.9648	-3.5173	-1.4117	-1.7343	-1.6850	-1.5150	-1.4731
r^2	0.71	0.71	0.87	0.83	0.79	0.75	0.71	0..77	0.85	0.84	0.88	0.80

Table 3.4 Effect of sowing date on development of sesame yellow leaf weight

Model: Yellow leaf weight = a * (week no. ^{b}) * exp (c* week no.)

Cultivar	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**
TOS	All	All	1	1	2	2	3	3	4	4	5	5
Coefficient a	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Coefficient b	28.6350	32.7060	27.4755	26.6129	29.8408	28.0000	29.2027	31.7997	32.5535	28.0000	30.3602	30.4077
Coefficient c	-2.5203	-2.9275	-2.2978	-2.2583	-2.6050	-2.0000	-2.5768	-2.7721	-2.9423	-2.0000	-2.9815	-2.9205
r^2	0.35	0.24	0.46	0.42	0.36	0.02	0.56	0.17	0.48	0.12	0.46	0.31

Table 3.5 Effect of sowing date on development on total leaf area of sesame

Model: Total leaf area = a * (week no. ^{b}) * exp (c* week no.)

Cultivar	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**
TOS	All	All	1	1	2	2	3	3	4	4	5	5
Coefficient a	0.1318	0.3303	0.0576	0.3041	2.1495	4.4565	0.0000	0.0505	0.0003	0.0005	0.2864	1.1428
Coefficient b	10.4734	9.5724	11.4031	9.7407	7.5344	6.8601	18.6759	10.8052	17.0869	16.3955	11.1927	8.8876
Coefficient c	-1.4337	-1.3321	-1.5399	-1.3197	-1.0062	-0.9610	-2.2904	-1.4210	-2.4030	-2.2889	-1.7834	-1.3516
r^2	0.67	0.72	0.89	0.84	0.73	0.80	0.73	0.78	0.85	0.86	0.84	0.82

Table 3.6 Effect of sowing date on development of capsule and grain weight of sesame

Model: Capsule and grain weight = a * (week no. ^{b}) * exp (c* week no.)

Cultivar	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**
TOS	All	All	1	1	2	2	3	3	4	4	5	5
Coefficient a	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Coefficient b	13.0708	9.8289	16.1523	14.0378	14.7135	12.2577	21.4497	12.3273	10.8126	7.1651	20.3461	10.9590
Coefficient c	-1.0140	-0.7276	-1.2640	-1.0524	-1.1671	-0.9901	-1.8600	-0.9727	-0.7955	-0.4844	-1.8150	-0.9120
r^2	0.81	0.84	0.92	0.91	0.81	0.86	0.81	0.82	0.94	0.85	0.78	0.93

Table 3.7 Effect of sowing date on the development of sesame stem and petiole weight

Model: Stem and petiole weight = a * (week no. ^{b}) * exp (c* week no.)

Cultivar	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**
TOS	All	All	1	1	2	2	3	3	4	4	5	5
Coefficient a	0.0002	0.0014	0.0000	0.0000	0.0010	0.0009	0.0000	0.0045	0.0113	0.0211	0.0034	0.0061
Coefficient b	9.5038	7.9893	15.1457	13.0289	8.5579	8.7257	16.2635	7.1192	5.7485	5.2300	7.1832	6.5475
Coefficient c	-0.9926	-0.8449	-1.5550	-1.3488	-0.9115	-0.9655	-1.7568	-0.7833	-0.5583	-0.5189	-0.7767	-0.7041
r^2	0.67	0.59	0.86	0.89	0.76	0.80	0.81	0.77	0.88	0.74	0.82	0.84

Table 3.8 Effect of sowing date on total plant weight of sesame

Model: Total plant weight = a * (week no. ^{b}) * exp (c* week no.)

Cultivar	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**
TOS	All	All	1	1	2	2	3	3	4	4	5	5
Coefficient a	0.0020	0.0125	0.0000	0.0009	0.0079	0.0138	0.0000	0.0156	0.0183	0.0401	0.0037	0.0071
Coefficient b	7.8058	6.3012	11.7936	8.5958	6.7806	6.4367	13.3196	6.0880	5.6003	5.0241	7.4364	6.8368
Coefficient c	-0.7506	-0.5992	-1.1440	-0.8268	-0.6415	-0.6400	-1.3670	-0.5805	-0.4939	-0.4421	-0.7645	-0.6940
r^2	0.73	0.73	0.93	0.89	0.78	0.83	0.79	0.78	0.91	0.79	0.77	0.88

Table 3.9 Effect of sowing date on light interception by sesame

Model: Percentage light interception = a + b (week no.) + c(week no.^{2})

Cultivar	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**	**Yori**	**Edith**
TOS	All	All	1	1	2	2	3	3	4	4	5	5
Coefficient a	-0.5261	-0.4110	-0.6215	-0.3304	-0.4870	-0.3908	-0.5603	-0.5259	-0.6385	-0.7542	-0.7830	-0.7750
Coefficient b	0.3804	0.3466	0.4083	0.3303	0.3692	0.3390	0.3883	0.3749	0.4100	0.4434	0.4838	0.4917
Coefficient c	-0.0235	-0.0216	-0.0250	-0.0203	-0.0222	-0.0204	-0.0239	-0.0231	-0.0256	-0.0282	-0.0324	-0.0340
r^2	0.81	0.73	0.92	0.87	0.86	0.84	0.89	0.86	0.90	0.91	0.81	0.87

Figure 3.1 Development of green leaf number for Yori and Edith (mean of five sowing dates)

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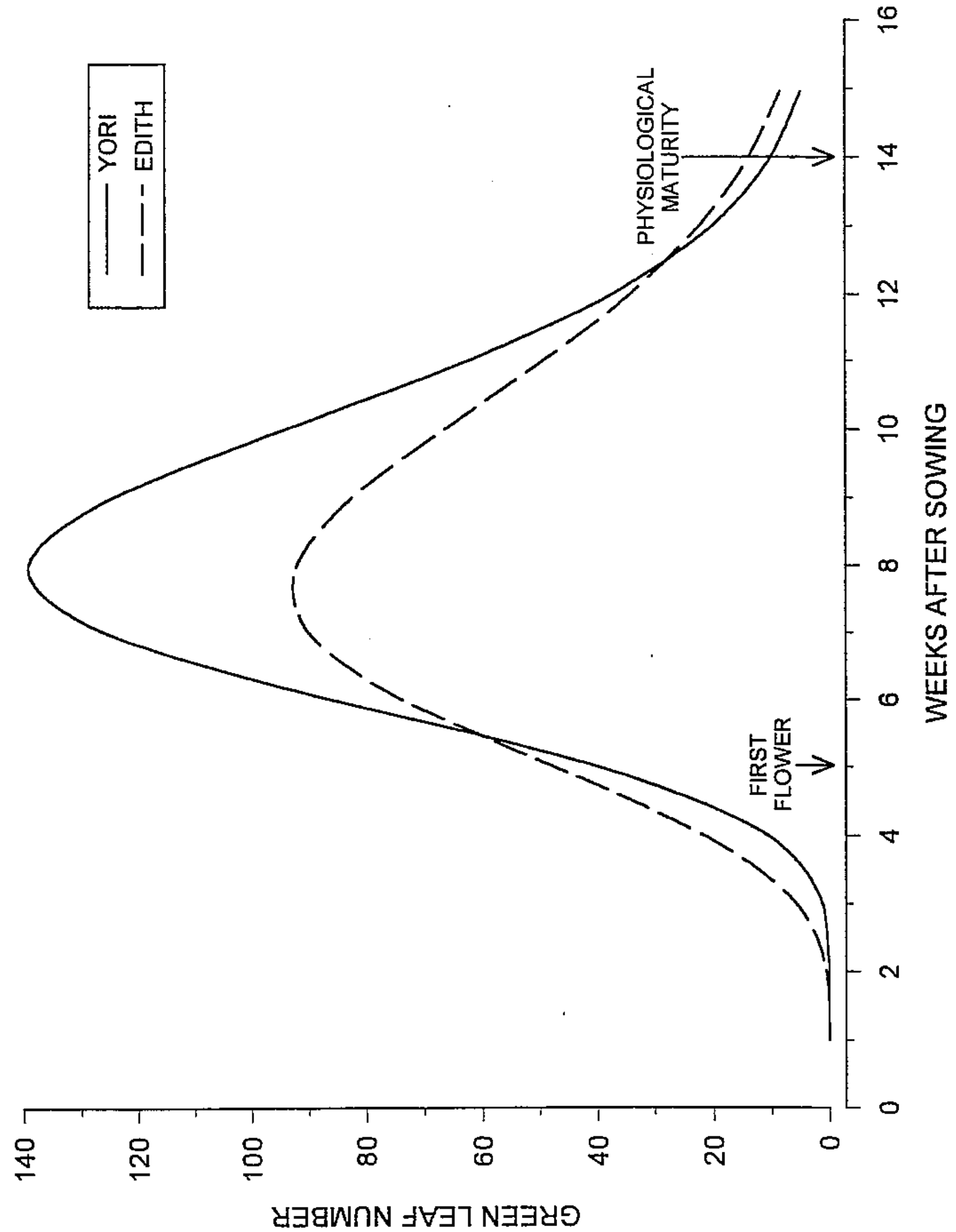

Figure 3.2 Development of green leaf weight for Yori and Edith (mean of five sowing dates)

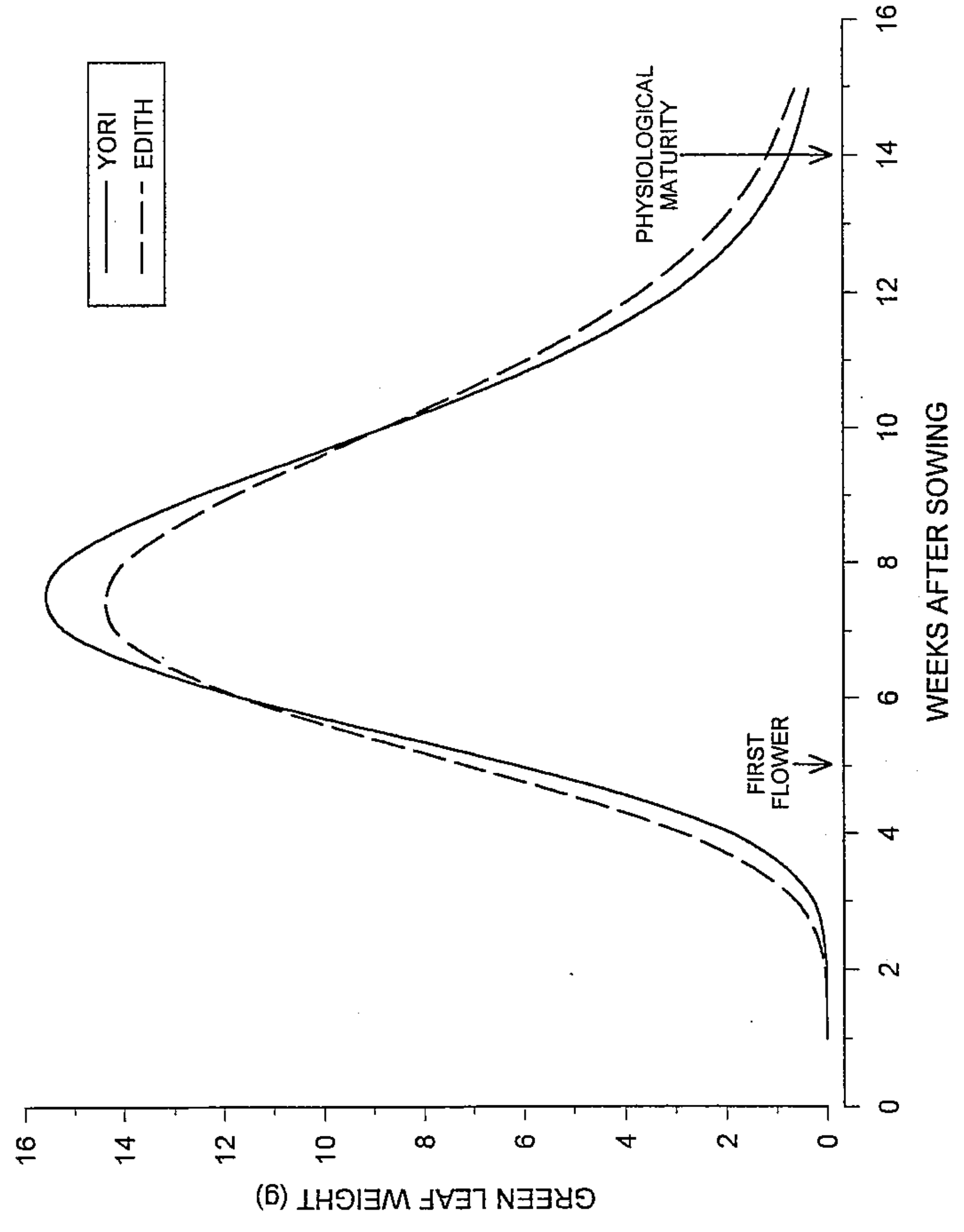

Figure 3.2 Development of green leaf weight for Yori and Edith (mean of five sowing dates).

Figure 3.3 Development of yellow leaf weight for Yori and Edith (mean of five sowing dates)

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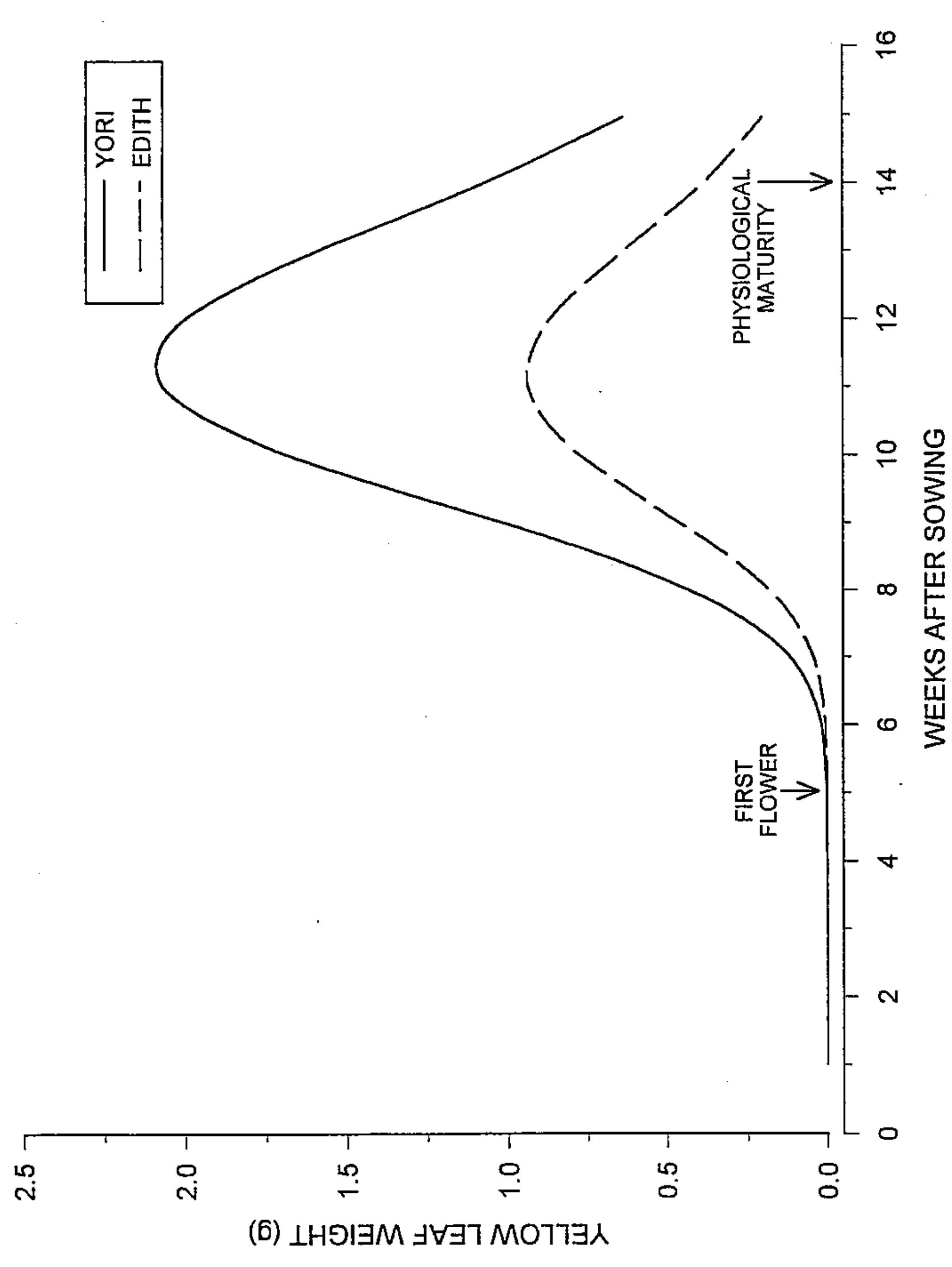

Figure 3.4 Development of total leaf weight for Yori and Edith (mean of five sowing dates)

Figure 3.4 Development of total leaf area for Yori and Edith (mean of five sowing dates).

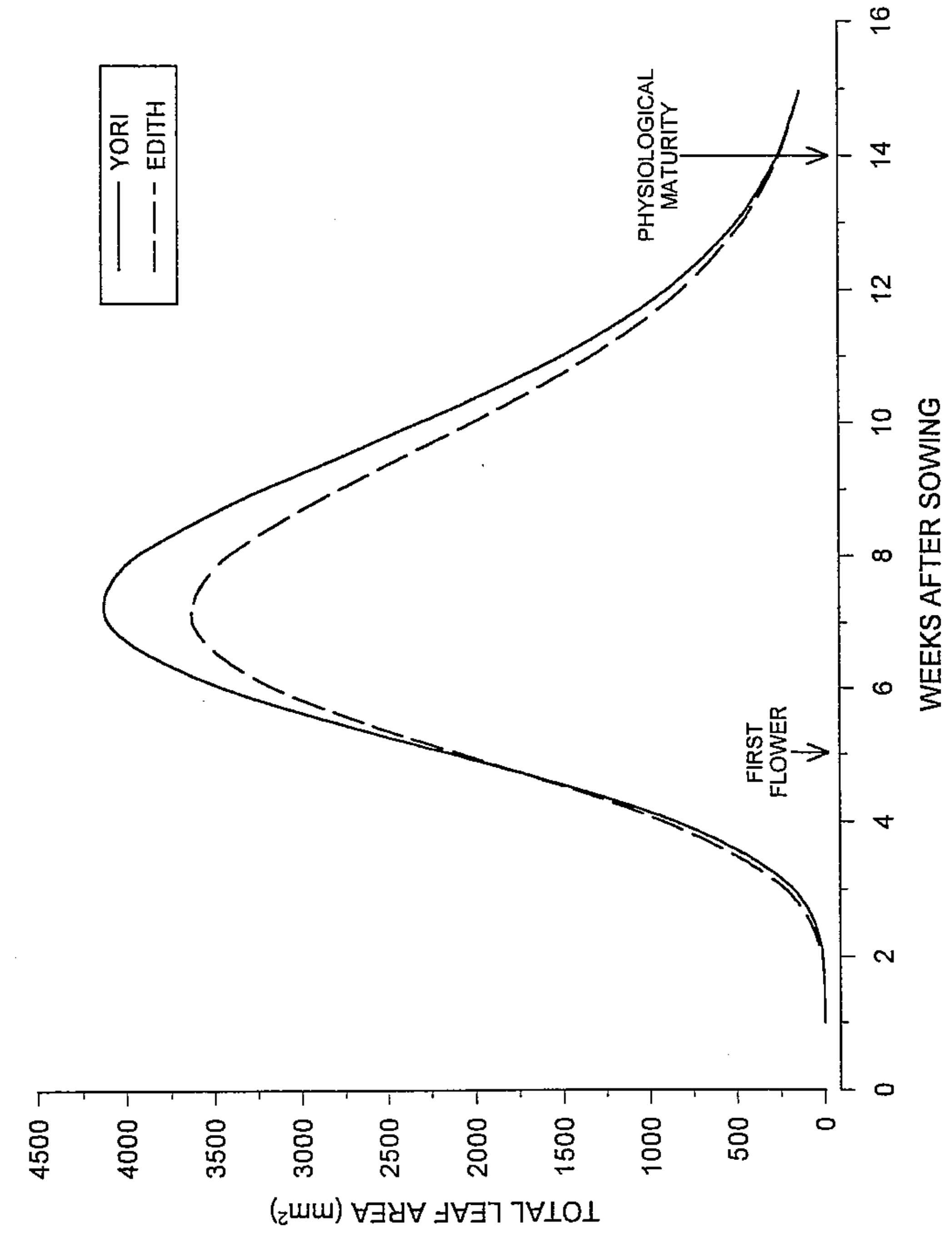

Figure 3.5 Development of capsule and grain weight for Yori and Edith (mean of five sowing dates)

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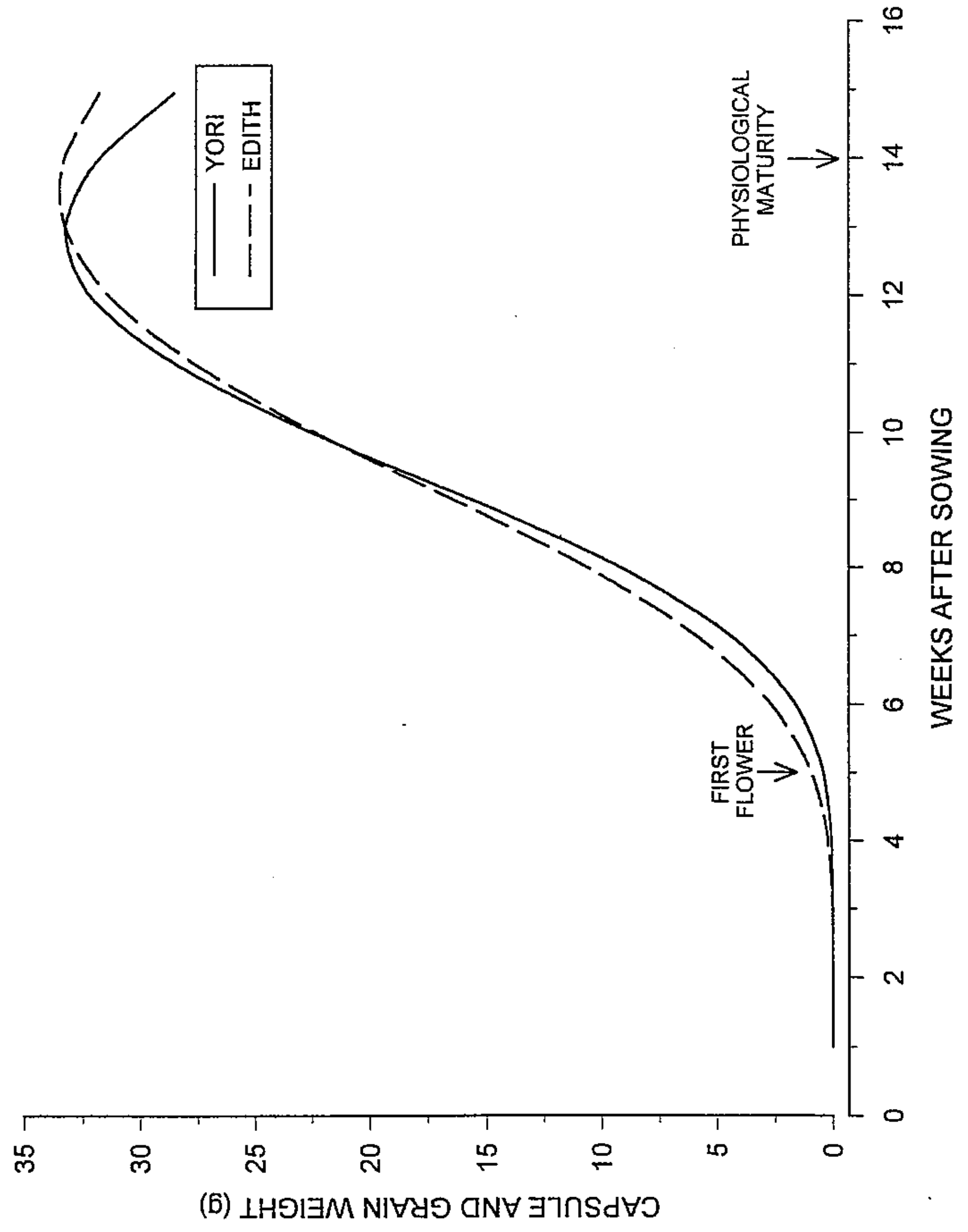


Figure 3.6 Development of stem and petiole weight for Yori and Edith (mean of five sowing dates)

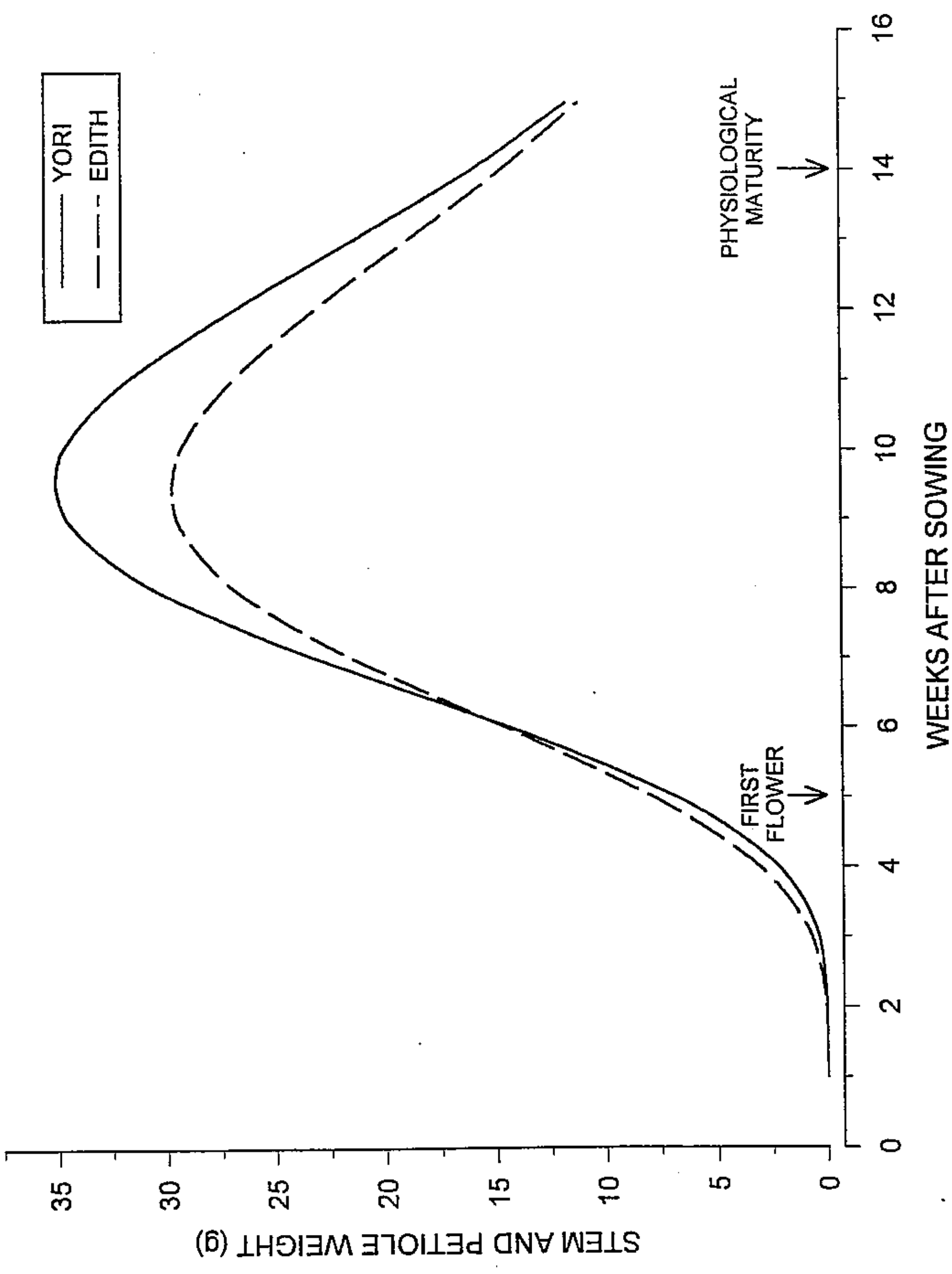


Figure 3.7 Development of total plant weight for Yori and Edith (mean of five sowing dates)

Figure 3.7 Development of total plant weight for Yori and Edith (mean of five sowing dates).

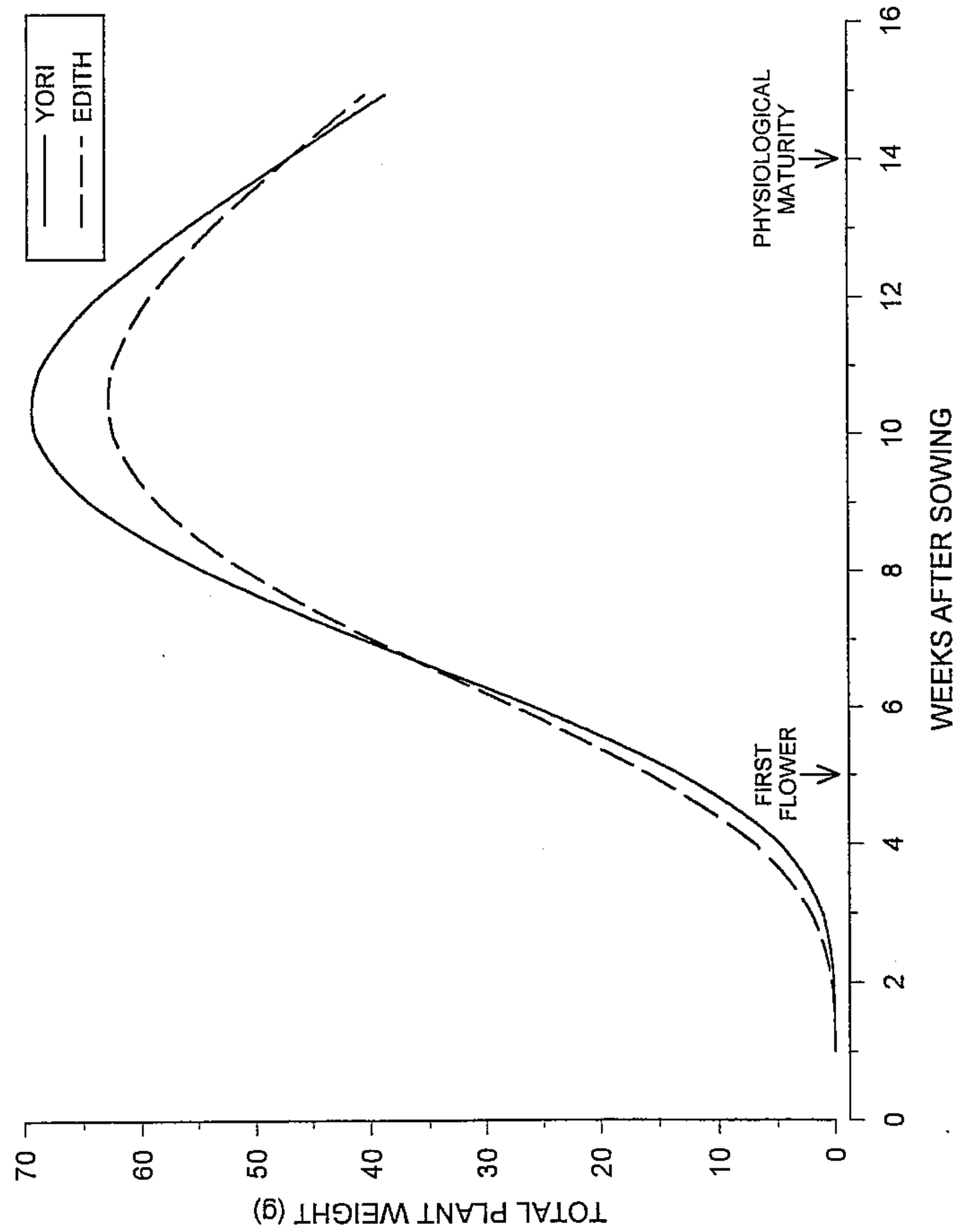
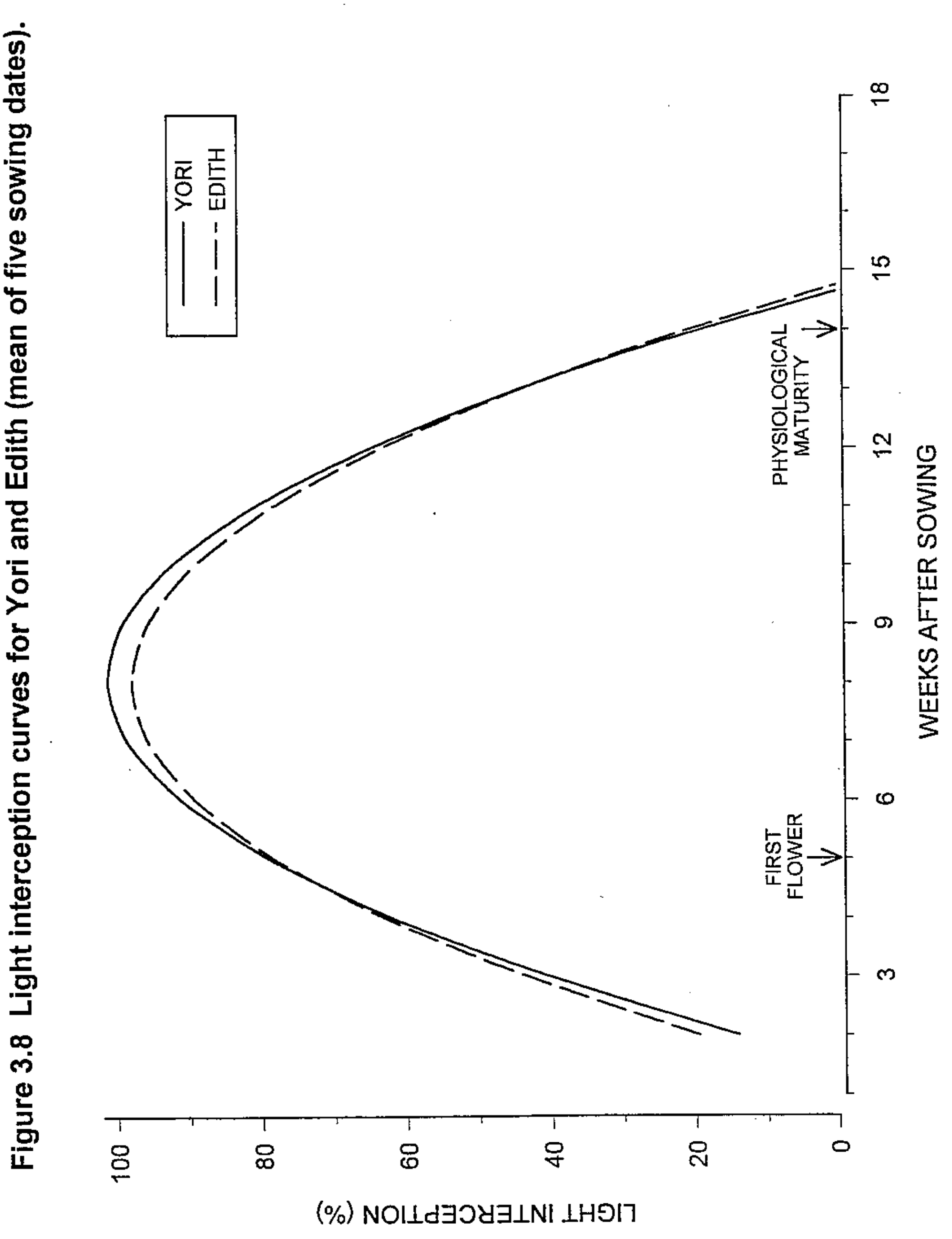


Figure 3.8 Light interception curves for Yori and Edith (mean of five sowing dates)



4. Effect of depth of sowing, temperature and sesame genotype on seedling emergence

Introduction

Successful crop establishment is essential to obtain the optimum plant densities necessary for high grain yields. This requires the seed for sowing to have high viability, vigorous germination, and to be sown at optimum sowing depth. Seedling establishment is also a function of the soil surface conditions with soil temperature and soil moisture as the most important factors.

Previous research has indicated that there is considerable scope to select sesame genotypes which are tolerant to either high or low temperatures (Bennett and Beech, 1996). At the lower end of the temperature range, Angus *et al.* (1981) established the threshold temperature for emergence of sesame to be 15.9°C and found that 21.3 day degrees were required for emergence from a depth of 30 mm.

Bennett and Gould (1995) noted that sesame seedlings were able to successfully establish in seed bed conditions in which daily soil temperatures were between 34°C and 45°C at 1400 hours. Soil cover and sowing depth also affect sesame establishment. Soil cover allowed the seed to imbibe adequate moisture to initiate germination, while a sowing depth of 30 to 45 mm was sufficient to reduce soil temperatures and moisture loss to allow successful seedling establishment.

This paper examines the effect of sesame genotype, sowing depth and soil type on sesame seedling emergence at Katherine in the Northern Territory. The experiment was conducted at five sowing dates throughout the year to observe the influence of temperature on seedling emergence.

Materials and methods

A series of greenhouse trials was conducted in 1990 to investigate sesame seedling emergence. The experimental design included two fixed factors, soil type and sesame genotype and one random factor, sowing depth. The experiment was analysed using a mixed model anova (model III). For analysis, all data were transformed using a square-root transformation (SQRT) and then a pair-wise comparison done on the SQRT scores. The seedling emergence scores presented in the tables are untransformed while emergence scores presented in the graphs are SQRT transformed.

Fixed factors
The soil types were Tippera clay loam and Blain sandy clay loam (Lucas *et al.* 1985); the sesame genotypes were Yori 77, Edith, Hnan Dun and P4:13 (a selection from Pachequino). The sowing depths were 15 mm, 30 mm and 45 mm. All sesame seed was covered with soil equivalent to its sowing depth.

Random factor
The five sowing dates were 24 July (1), 2 August 92), 18 October (3), 17 November (4) and 12 December (5).

Daily maximum and minimum ambient temperatures were recorded and are presented in Table 5.1.

Each seedling tray contained one soil type with the 4 cultivars sown at one depth. Forty seeds of each cultivar were sown in 4 replicates. Cultivars were randomly allocated in each replicate. Descriptions of sesame cultivar seed used are presented in Table 5.2.

The number of emerged seedlings was counted every day at 8.30am for 7 days after sowing. For the seedling to be counted as successfully emerged the cotyledons must have opened. All seedling trays were maintained in a moist condition.

Rate of seedling emergence score (S) was calculated as follows (Imrie, 1972):

$$S = \Sigma_i \ (P_i * {}^1/T_i)$$

where

P_i = percentage of viable seed which emerged in time interval $_i$.

T_i = time in hours from sowing to end of time interval $_i$.

This formula produces high scores (S > 3.0) for those sesame genotypes that rapidly develop emerged seedlings.

Results

There was no seedling emergence after 7 days for any sesame cultivar sown at any depth for sowing date 2 in which the mean maximum and minimum temperatures for the 7 days were 30°C and 7°C respectively (30°C/7°C). During this sowing minimum nightly temperatures were approximately 9°C less than the base temperature for sesame (Table 4.1).

Soil type

There was no significant effect of soil type on sesame seedling emergence (Table 4.3).

Sowing depth

There was no significant difference between the rate of seedling emergence from 15 mm and 30 mm for all sowing dates except for sowing date 4 (Table 4.4). For mean ambient maximum and minimum temperatures for the 7 day period of 41°C and 26°C respectively (41°C/26°C) seedling emergence is faster from the shallower sowing depth (15mm > 30mm > 45mm).

Sesame genotype

There were significant differences between cultivars in their rates of seedling emergence in cooler sowing conditions. For sowing dates 1 (31°C/16°C) and 3 (36°C/17°C) the order in rate of emergence was Yori 77 >Hnan Dun > Edith > P4:13 (Table 4.5).

As ambient temperatures increased the differences between cultivars diminished. For sowing date 5 (35°C/23°C) there was no significant difference in rate of emergence between Yori 77, Edith and Hnan Dun. The selection P4:13 was the slowest to emerge. Under high temperatures, (41°C/26°C) in sowing date 4 there was no significant influence of cultivar on rate of seedling emergence.

There was no correlation between sesame cultivar seed size and emergence score, or sesame seed germination and emergence score.

Sowing depth x cultivar interaction

a) *Cooler temperatures, sowing date 1 (31°C/16°C) and sowing date 3 (36°C/17°C).*
The trend was for Yori and Hnan Dun to be superior to Edith and P4:13 in seedling emergence at all sowing depths. However, the rate of seedling emergence for Yori and Hnan Dun decreased with depth. Seedling emergence for the sesame cultivars Edith and P4:13 tended not to be influenced by sowing depth (Table 4.6, Figures 4.1 and 4.2).

b) *Higher temperatures, sowing date 4 (41°C/26°C) and sowing date 5 (35°C/23°C).*
As ambient temperatures increased the influence of cultivar decreased. However, P4:13 always had a slower rate of seedling emergence than the other cultivars. This trend was observed at the three sowing depths but was significantly slower for the 45 mm sowing depth, (Table 4.6 and Figure 4.3).

Soil type x cultivar interaction

At sowing date 3, Yori 77 had a significantly higher emergence from Tippera clay loams than from Blain sandy loams regardless of sowing depth. All other cultivars had a poorer rate of seedling emergence from the Tippera clay loams, Table 4.7 and Figure 4.4.

Soil type x sowing depth interaction

For sowing dates 3, 4 and 5 the trend was for better emergence from the Blain sandy loam than from the Tippera clay loam and higher emergence levels for the 15 mm and 30 mm sowing depth than for the 45 mm sowing depth (Table 4.8 and Figures 4.5, 4.6 and 4.7). If sesame seeds are sown at 45 mm emergence tends to be better with the Tippera clay loam.

Discussion

Sesame is adapted to wet season production in the tropics, and to summer production in hotter temperate areas. This experiment indicates that seedling emergence is generally more rapid from a sandy loam than from a clay loam soil. A sowing depth of 15 mm to 30 mm is optimal, though if soil moisture conditions warrant a deeper sowing depth (45 mm), seedling emergence is better on clay loam soils.

The results also show significant variation between cultivars in seedling emergence if sown when minimum daily temperatures are close to 16°C.

The two cultivars Yori and Hnan Dun (though tropical in origin) were the most vigorous in seedling emergence at the lower temperatures experienced in this study. Seedling vigour is very important in temperate regions where soil temperatures can be expected to determine the earliest sowing date.

As minimum temperatures increase the variation in seedling vigour between sesame cultivars is less significant. One sesame cultivar P4:13 did not show vigorous emergence regardless of ambient conditions.

Acknowledgments
The authors are grateful to M Hearnden for data analysis.

Table 4.1 Maximum and minimum temperatures during the various sowing dates

Temperature (°C)	**Sowing dates**				
	1	**2**	**3**	**4**	**5**
Day = 0 (sowing)	34/13[a]	24/14	34/10	41/27	32/24
1 day after sowing (DAS)	34/16	24/5	35/14	40/26	31/22
2 DAS	35/18	26/4	35/16	41/25	32/24
3 DAS	32/20	29/4	36/20	41/25	36/24
4 DAS	34/16	32/7	37/19	42/26	32/20
5 DAS	31/14	34/7	37/19	43/28	38/24
6 DAS	27/16	24/10	36/16	40/25	38/25
7 DAS	24/14	34/15	36/17	39/28	36/22
Mean temperature range	*31/16*	*30/7*	*36/17*	*41/26*	*35/23*
Mean daily temperature	*24*	*19*	*27*	*34*	*29*

a = maximum / minimum daily temperatures

Table 4.2 Sesame seed size and germination of cultivars evaluated

Cultivar	**Seed characteristics** size (g / 1000 seed)	germination (%)
Hnan Dun	2.9	93
P4:13	3.7	98
Edith	3.2	94
Yori 77	3.0	86

Table 4.3 Effect of soil type on sesame seedling emergence score

Germination score	**Sowing dates**			
Soil type	**1**	**3**	**4**	**5**
Blain	0.7266	0.6668	3.2885	3.1656
Tippera	0.6552	0.5623	2.4851	3.1510
P level	ns	ns	ns	ns

Table 4.4 Effect of sowing depth on sesame seedling emergence score

Germination score	**Sowing dates**			
Sowing depth (mm)	**1**	**3**	**4**	**5**
15	0.905b	0.781b	3.779c	3.754b
30	0.746b	0.687b	2.852b	3.502b
45	0.413a	0.375a	2.030a	2.219a
P level	0.001	0.001	0.001	0.001

Numbers assigned the same letter are not significantly different

Table 4.5 Effect of cultivar on seedling emergence score

Germination score	Sowing dates			
Cultivar	**1**	**3**	**4**	**5**
Hnan Dun	0.903c	0.762c	1.720	1.817b
P4:13	0.180a	0.201a	1.282	1.380a
Edith	0.457b	0.383b	1.879	1.937b
Yori 77	1.253d	1.240d	1.694	1.819b
P level	0.003	0.006	ns	0.036

Numbers assigned the same letter are not significantly different

Table 4.6 The interaction of sowing depth and cultivar on seedling emergence score

Germination score		Sowing dates			
Depth (mm)	**Cultivar**	**1**	**3**	**4**	**5**
15	Hnan Dun	1.048e	0.926f	2.054	1.981cd
15	P4:13	0.097a	0.215b	1.461	1.616b
15	Edith	0.494c	0.464ce	2.089	2.131d
15	Yori 77	1.478g	1.379h	2.022	1.962c
30	Hnan Dun	0.993e	0.815f	1.670	1.946cd
30	P4:13	0.324b	0.350c	1.245	1.573b
30	Edith	0.463c	0.452cd	1.892	2.069d
30	Yori	1.266f	1.294h	1.712	1.847c
45	Hnan Dun	0.669d	0.544de	1.436	1.523b
45	P4:13	0.119a	0.039a	1.140	0.951a
45	Edith	0.413bc	0.233b	1.655	1.613b
45	Yori 77	0.997e	1.046g	1.350	1.649b
	P level	0.001	0.048	ns	0.012

Numbers assigned the same letter are not significantly different

Table 4.7 The interaction of soil type and cultivar on seedling emergence score

Germination score		Sowing dates			
Soil type	**Cultivar**	**1**	**3**	**4**	**5**
Blain	Hnan Dun	0.969	0.833c	1.883	1.8107
Blain	P4:13	0.215	0.255a	1.620	1.470
Blain	Edith	0.4586	0.529b	1.908	1.873
Blain	Yori 77	1.273	1.210d	1.694	1.762
Tippera	Hnan Dun	0.837	0.691c	1.5569	1.817
Tippera	P4:13	0.145	0.148a	0.9446	1.291
Tippera	Edith	0.456	0.237a	1.851	2.002
Tippera	Yori 77	1.221	1.269d	1.695	1.877
	P level	ns	0.033	ns	ns

Numbers assigned the same letter are not significantly different

Table 4.8 The interaction of soil type and sowing depth of seedling emergence score

Germination score		Sowing dates			
Soil type	**Depth (mm)**	**1**	**3**	**4**	**5**
Blain	15	0.774	0.825d	2.031c	2.010e
Blain	30	0.822	0.823d	1.943c	1.933de
Blain	45	0.591	0.471a	1.355a	1.248a
Tippera	15	0.785	0.666c	1.782b	1.835cd
Tippera	30	0.701	0.633b	1.316a	1.785c
Tippera	45	0.508	0.460a	1.435a	1.619b
	P level	ns	0.006	0.001	0.001

Numbers assigned the same letter are not significantly different

Figure 4.1 Effect of sowing depth and sesame cultivar on seedling emergence for sowing date 1

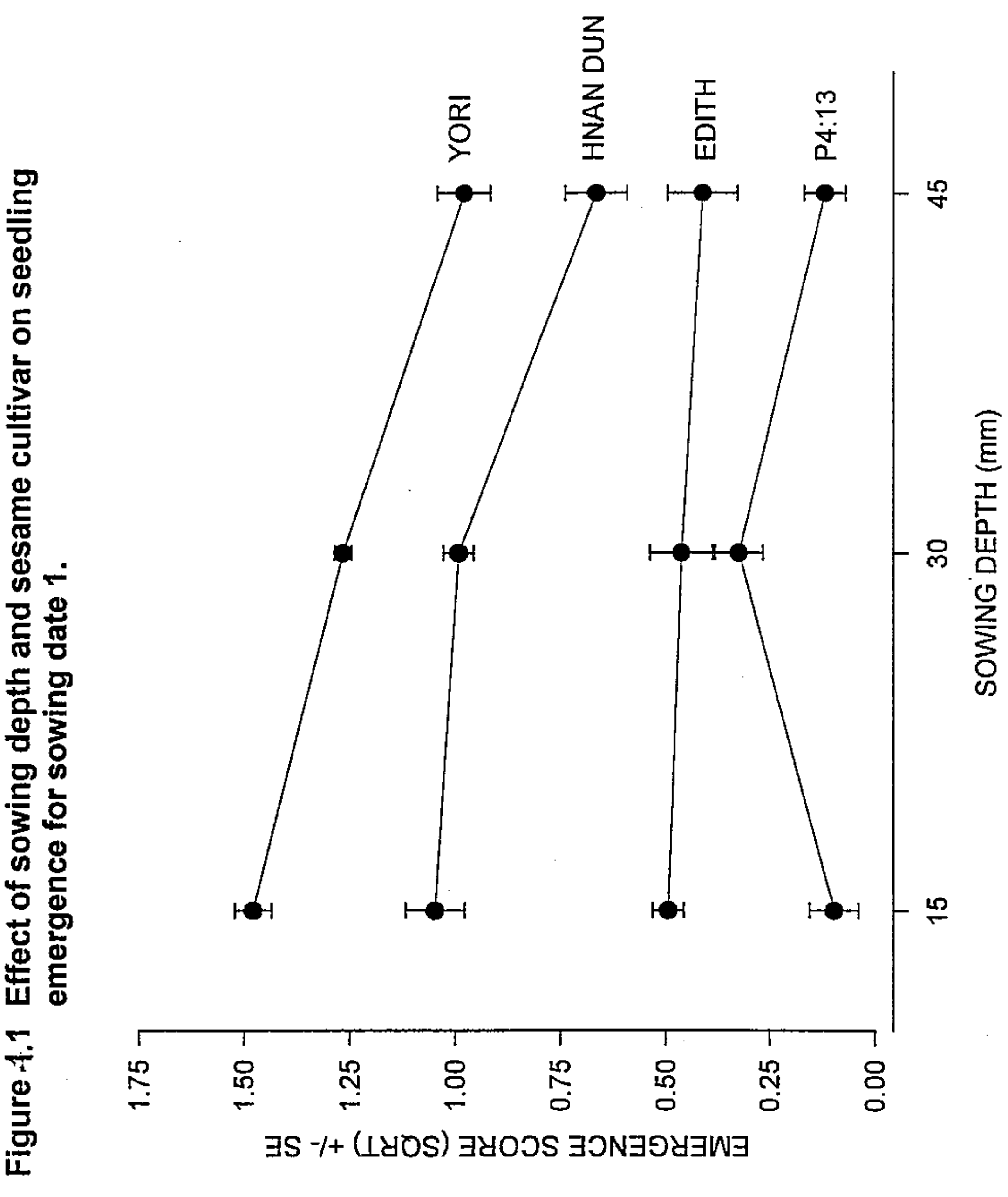


Figure 4.2 Effect of sowing depth and sesame cultivar on seedling emergence for sowing date 3

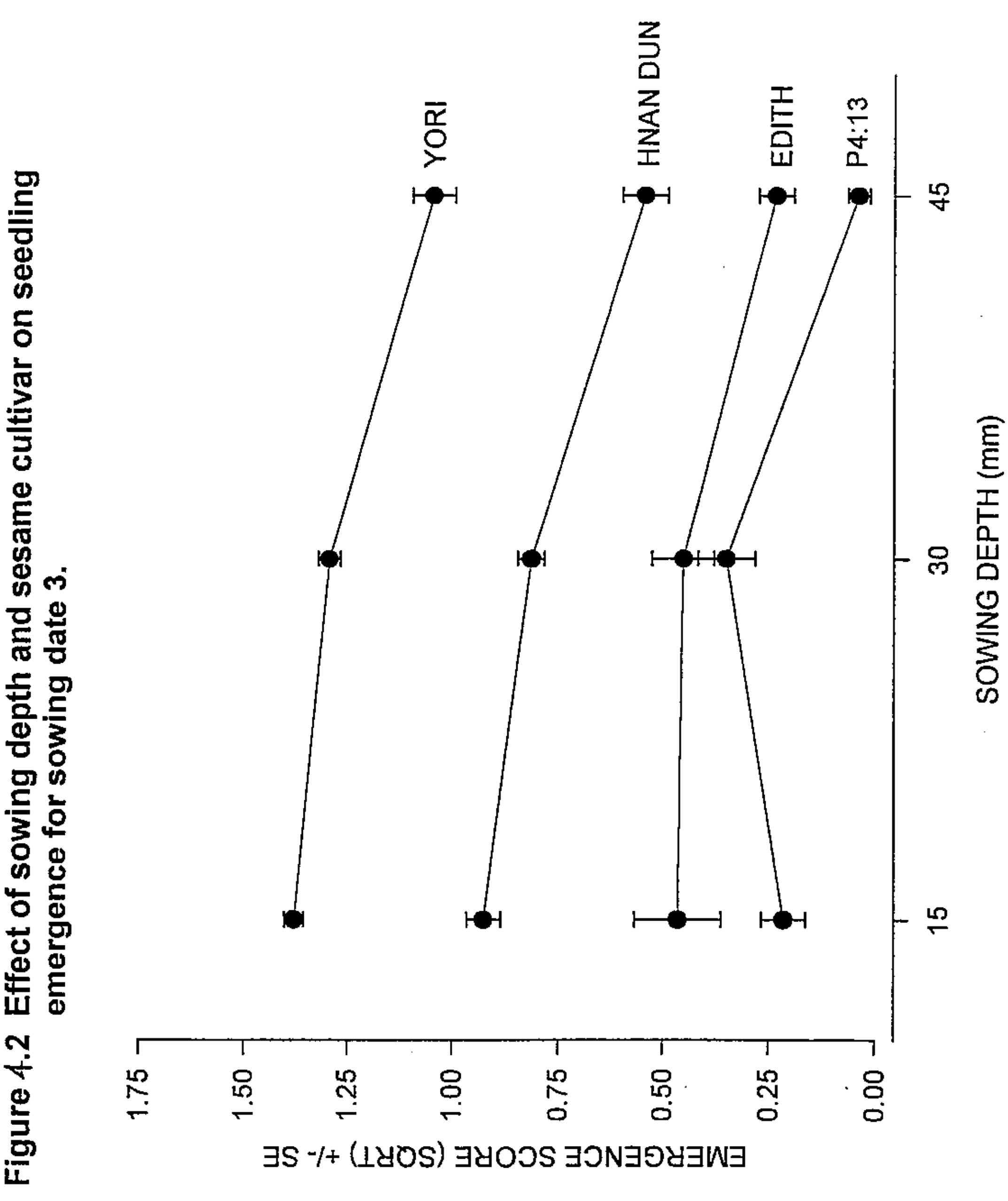


Figure 4.3 Effect of sowing depth and sesame cultivar on seedling emergence for sowing date 5

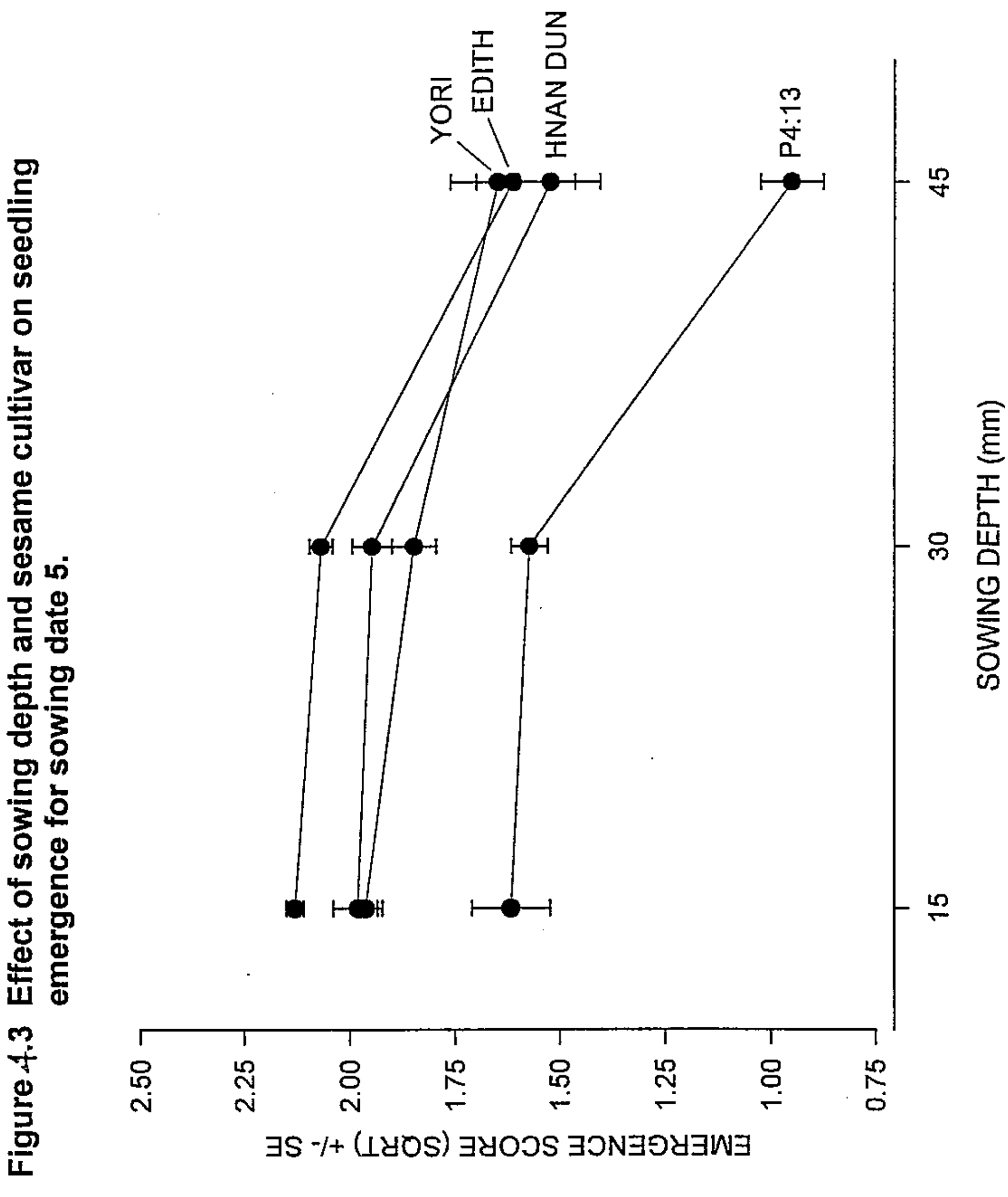


Figure 4.4 Effect of soil type and sesame cultivar on seedling emergence for sowing date 3

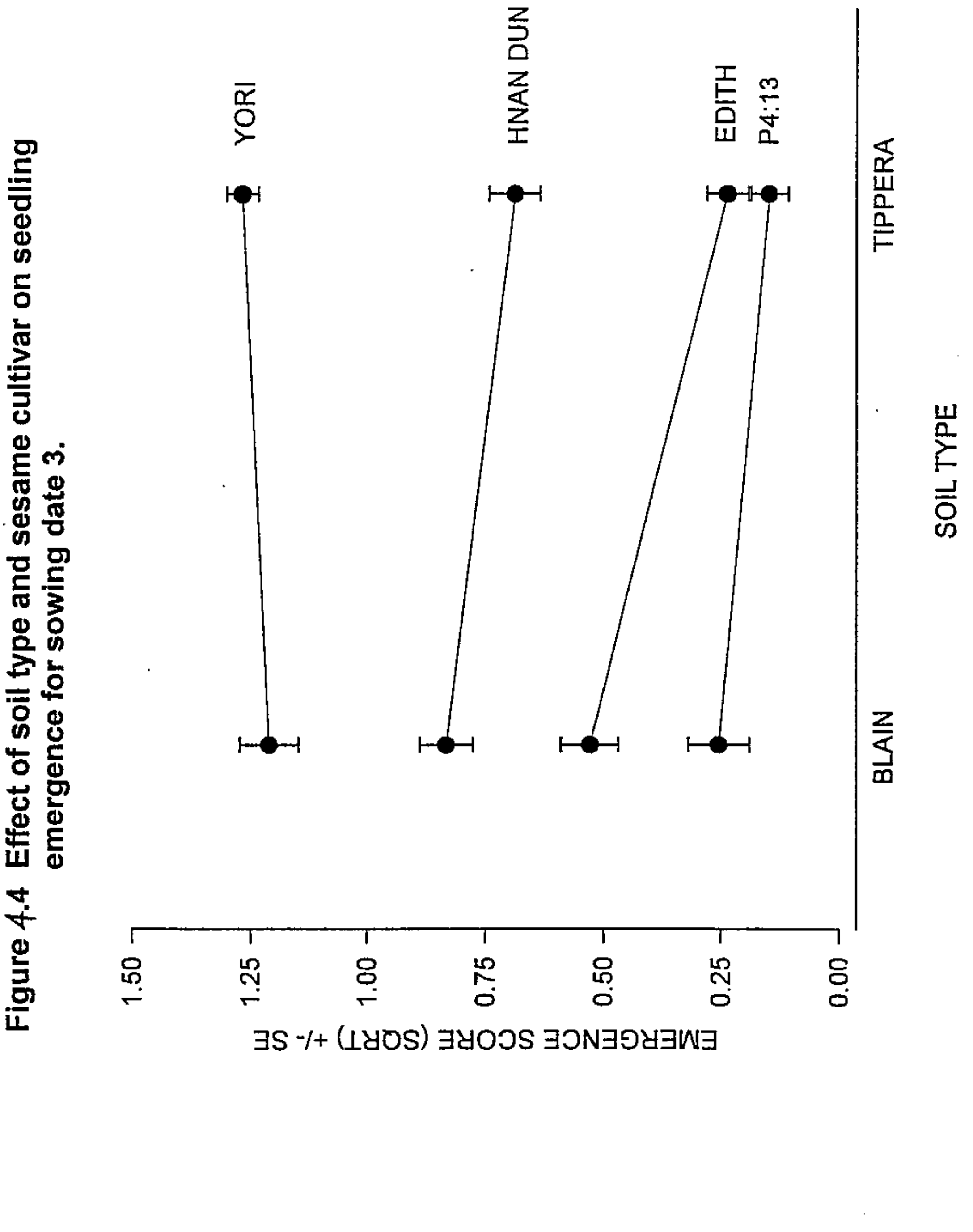


Figure 4.5 Effect of soil type and sowing depth on seedling emergence for sowing date 3

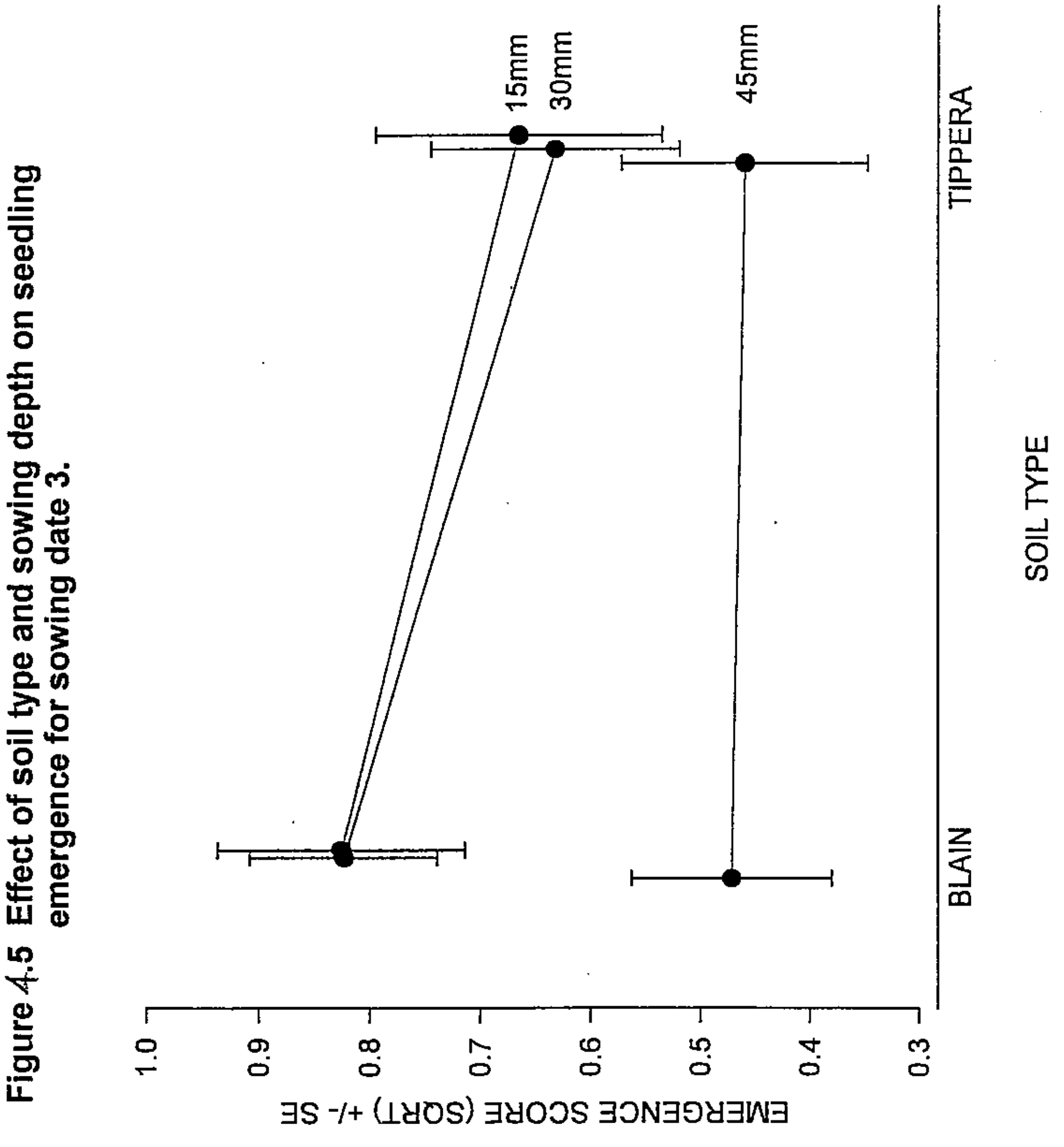


Figure 4.6 Effect of soil type and sowing depth on seedling emergence for sowing date 4

Figure 4.6 Effect of soil type and sowing depth on seedling emergence for sowing date 4.

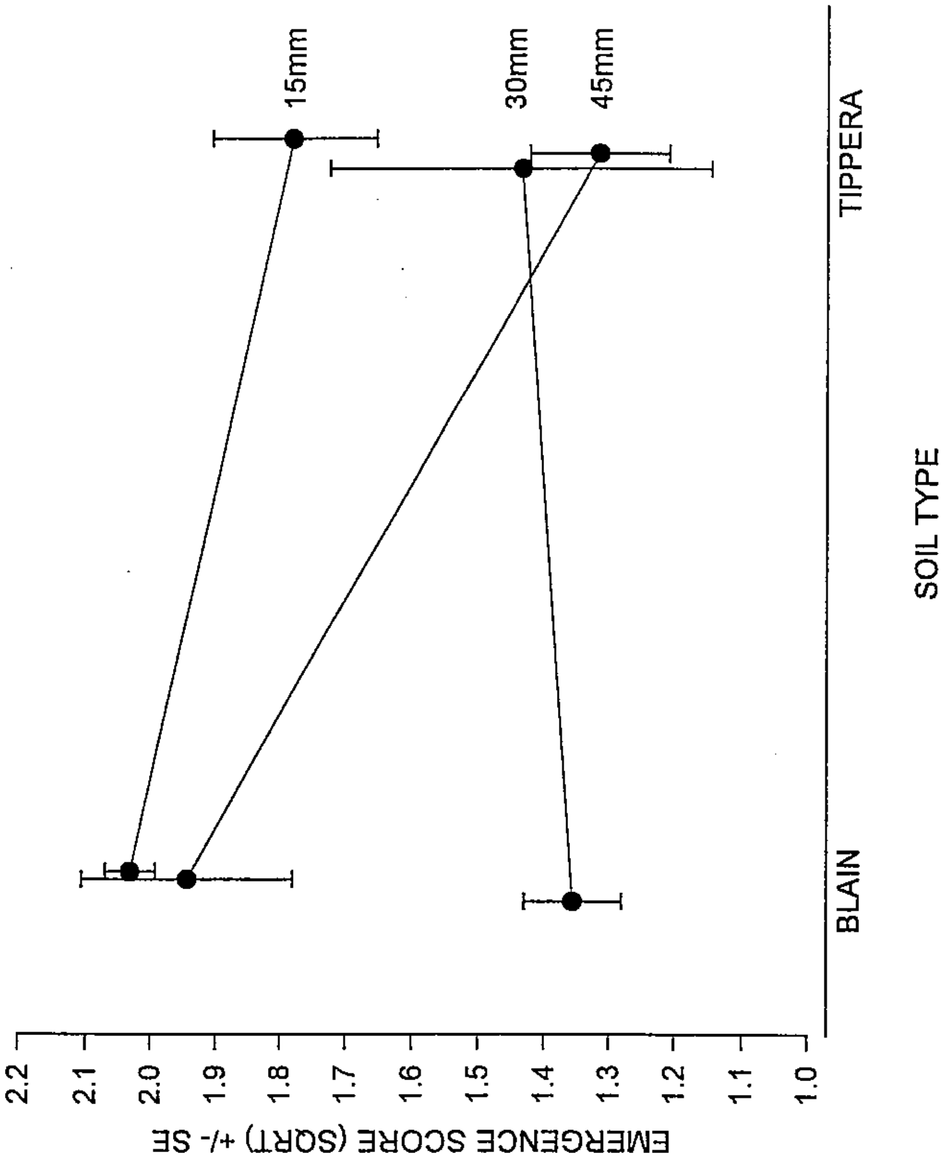
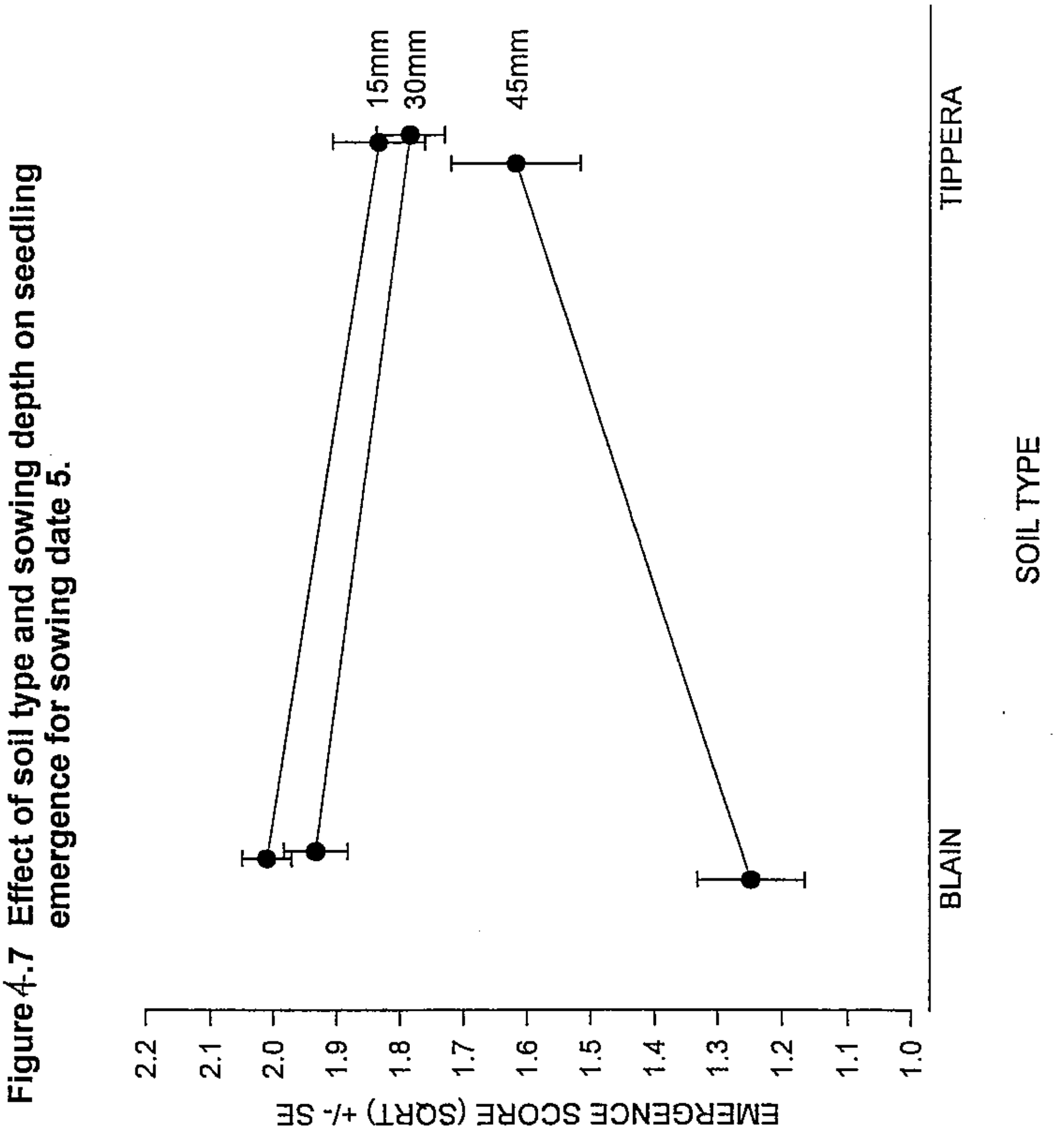


Figure 4.7 Effect of soil type and sowing depth on seedling emergence for sowing date 5



5. Effect of tillage treatment and rate of nitrogen application on sesame yield and yield components

Introduction

In the Northern Territory the adoption of conservation tillage farming systems has been shown to improve crop establishment and growth through the amelioration of the adverse effects of high soil temperature, soil crusting and rapid drying of the soil surface. Ideally, the conservation tillage farming system should include a pasture or grain legume phase to provide nitrogen (N) for the successive sesame crop. However, in many situations, instead of sowing sesame into a legume mulch, sesame is sown into a sorghum stubble or a summer grass mulch. The high C:N ratio of these mulches suggests that a higher N fertiliser application maybe required to satisfy the mineralisation of the mulch while providing adequate N levels for crop growth and yield.

This paper reports on the effect of tillage treatment and rate of nitrogen application on sesame growth and seed yield.

Materials and methods

Design, treatments and management

The experimental design was a split-plot with 3 replicates. Main plots were tillage treatment, no-till and conventional-tillage. Sub-plots were nitrogen rates (urea) of 0, 40, 80 and 120 kg N/ha. Plots were 42 m long and 11m wide.

Sesame, cv. Edith, was sown with a John Shearer Trash Culti-Drill at 3.3 kg/ha with 50cm row spacings. A basal application of single-super and trace elements was applied at the same time as sowing. Rates of fertiliser application are detailed in Table 2.3.

The experimental plants were sown on 11 January 1997 into a killed 2 year old Nixon sabi grass pasture (*Urochloa mosambicenis*). An adjacent 4 year Nixon sabi grass pasture joined on the southern edge of the experimental area.

Data collection

At 12 DAS, seedling emergence was determined by counting the number of plants in three 1.0m^2 quadrats in each plot.

At 28 DAS sesame biomass and weed biomass were determined by harvesting a 1.0m^2 quadrat from each plot.

By 34 DAS the effect of four years of previously fallow land was being expressed on the southern side of the experiment. This resulted in half of the treatments being divided into fallow and non-fallow plots each 20 m long and 11 m wide

At 34 DAS and 51 DAS, 30 youngest fully expanded leaves were collected from each non-fallow plot, dried at 40°C for 7 days and the leaf material analysed for nitrogen content.

At physiological maturity, 5 plants were selected from all plots (fallow and non-fallow) for yield component analysis. The following data were recorded:

a. plant height,
b. number of branches,
c. height of lowest capsule, and
d. number of capsules per plant.

Potential seed yield and plant population were determined by harvesting two 1.0 m^2 quadrants per plot. Seed was threshed and cleaned and later used for oil and nitrogen content determinations.

Results

Seedling emergence

Sesame seedling emergence was significantly higher at 12 DAS for plots sown no-till compared with the conventional-tillage treatment. The rate of N application did not significantly effect seedling emergence (Table 5.1). Mean seedling emergence for no-till plots and conventional-till plots was 34 plants/m^2 and 26 plants/m^2 respectively.

Sesame biomass at 28 DAS

Both tillage treatment and rate of N application significantly affected sesame biomass development. Increasing levels of N application up to 80 kg N/ha produced a significantly larger biomass. Sesame biomass in conventional-till plots was approximately twice that of the sesame biomass in no-till plots (Table 5.2). Mean sesame biomass at 28 DAS was 133 kg/ha and 228 kg/ha for no-till and conventional-till treatments respectively.

Weed biomass at 28 DAS

Data for total weed biomass and weed biomass components are presented in Tables 5.3, 5.4, 5.5 and 5.6.

Total weed biomass was significantly higher in sesame plots sown no-till. Level of N application did not affect total weed biomass development. The composition of weed species for the two tillage regimes was different. Pigweed (*Trianthema portulacastrum and Portulacea oleracea*) and Buffalo Clover (*Alysicarpus vaginalis*) were dominant in conventional-till plots while sabi grass (*Urochloa mosambicenis*) was dominant in no-till plots. Mean total weed biomass at 28 DAS was 81 g/m^2 and 51 g/m^2 for no-till and conventional-till plots respectively.

Leaf nitrogen content

At 31 DAS leaf nitrogen content of sesame plants in conventional-till plots was significantly greater than in no-till plots (Table 5.7). Mean leaf nitrogen content was 3.81% and 4.90% for no-till and conventional-till plots respectively.

At 51 DAS there was a significant difference in leaf nitrogen content between the no-till and conventional-till plots of 1.34 %. Mean nitrogen content was 2.43% and 3.77% for no-till and conventional-till plots respectively.

Harvest sesame population

At harvest there was no significant effect of N application on sesame population (Table 5.8). Conventional-till plots maintained a significantly higher number of plants than no-till plots. Mean number of plants per m^2 was 31 and 36 for no-till and conventional-till plots respectively.

Seed yield

Tillage treatment and rate of N application (Table 5.9) significantly influenced sesame seed yields. Conventional-till plots produced higher seed yields than no-till plots, mean grain yields were 1387kg/ha and 528 kg/ha, respectively. Sesame seed yields significantly increased with N applications, up to 80 kg N/ha.

The previously fallowed area produced higher sesame seed yields than the non-fallowed area. Seed yields on the fallowed area were 278 kg/ha and 67 kg/ha higher for the no-till and conventional-till treatments respectively than the non-fallowed land.

Yield components

Plant height

There was a significant effect of tillage treatment and rate of N application on sesame plant height. Plants were significantly taller in conventional-till plots and with increasing levels of N application up to 80 kg/ha (Table 5.10). Mean plant height was 97 cm and 126 cm for no-till and conventional-till plots respectively. The previously fallow area produced taller plants, regardless of treatment, than the non-fallow area.

Number of branches

The sesame cultivar Edith grown in this experiment produces a single stem genotype and the additional 0.1-0.2 branches per plant developed at the 80-120kg N/ha plus conventional-till treatments has no significance for commercial production (Table 5.11). There was no effect of fallowing on the number of branches.

Height of lowest capsule

Tillage treatment did not significantly affect the height of the lowest capsule. However, application of 40 -120 kg N/ha significantly increased the height of the lowest capsule (Table 5.12). Mean height of the lowest capsule was 72 cm and 74 cm for no-till and conventional-till treatments respectively. There was no effect of fallowing on the height of lowest capsule.

Number of capsules

There was a significant response in the number of capsules produced by both tillage treatment and rate of N application. The number of capsules significantly increased for N applications up to 80 kg/ha (Table 5.13). Mean capsule numbers for no-till and conventional-till plots were 13 and 40 capsules per plant respectively.

The number of capsules on the previously fallowed land was about 9 capsules/plant more than on the non-fallowed land.

Oil content of seed

Tillage treatment and rate of N application did not influence oil content of the sesame seed (Table 5.14). Mean oil content was 59.1% (non-fallow area) and 59.9% (fallow area).

Nitrogen content of seed

Nitrogen content of the sesame seed (Table 5.15) produced in the non-fallowed area was generally higher in plots using conventional-tillage, (3.1%), than in no-till plots (2.7%). However in the fallowed area, nitrogen content of sesame seed produced was higher in no-till treatments (3.3%) than in the conventional-till treatments (2.9%).

Discussion

In northern Australia, the advantages of zero-till or no-tillage farming practices are well established for sorghum, mungbeans and maize in drier years. There is very little research involving sesame and conservation tillage. This experiment investigated the effect of tillage treatment and rate of nitrogen application on sesame development. Two factors affected the results of this experiment. The first was the extremely wet conditions, the fourth wettest year in 122 years of recorded data, and the second was the effect of 4 years of fallow on part of the experiment.

In this above-average rainfall year the only advantage of zero-till was rapid crop establishment. However, by harvest the conventionally prepared sites had developed comparable plant populations. Total weed development was more extensive in the no-till, with grasses as the prominent weeds. In the conventional plots the prominent weed was pigweed.

Nitrogen application up to 80kg N/ha increased both sesame biomass and seed yield development. Sesame biomass and seed yields were significantly higher in the conventional-till areas than the no-till areas. The higher seed yield in conventional-till plots was a result of the lower weed biomass as compared to the lower seed yields and high weed biomass in the no-till treatments.

Leaf nitrogen contents greater than 3.8% at the first flower stage (34 days) of crop growth indicate adequate levels of nitrogen nutrition. Adequate levels of leaf nitrogen were recorded in the conventional-till treatments and the 80 and 120kg N/ha no-till treatments. Sesame grown with conventional-till treatments recorded significantly higher leaf nitrogen contents than no-till treatments.

Plant height and capsule development were greater in conventional-till plots than in no-till plots. Seed yields and nitrogen content of seed reflected the superior crop growth in the conventional-till plots.

Observations on the effect of 4 years of land fallow demonstrate the response to 'resting' the soil. The yield increase was 278 kg/ha and 67 kg/ha for the no-till and conventional-till treatments respectively. The increase in seed yields in the fallowed area was associated with increased availability of soil nitrogen.

Table 5.1 Effect of tillage treatment and rate of nitrogen application on sesame seedling establishment (plants/m^2)

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
No-till	37	28	29	41	*34*
Conventional	34	22	20	28	*26*
mean	*36*	*25*	*25*	*35*	

Tillage LSD (5%) = 7.1
Nitrogen application LSD (5%) = 10.0

Table 5.2 Effect of tillage treatment and rate of nitrogen application on sesame biomass (g/m^2) at 28 DAS

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
No-till	67	97	160	207	*133*
Conventional	149	197	255	310	*228*

Tillage LSD (5%) = 41.0
Nitrogen application LSD (5%) = 58.0

Table 5.3 Effect of tillage treatment and rate of nitrogen application on total weed biomass (g/m^2) at 28 DAS

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
No-till	64	78	77	103	*81*
Conventional	49	47	61	62	*55*

Tillage LSD (5%) = 23.6
Nitrogen application LSD (5%) = not significant

Table 5.4 Effect of tillage treatment and rate of nitrogen application on legume weed biomass (g/m^2) at 28 DAS

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
No-till	1.9	0.2	1.6	0.6	*1.1*
Conventional	6.4	3.8	3.4	2.5	*4.1*

Tillage LSD (5%) = 2.35
Nitrogen application LSD (5%) = not significant

Table 5.5 Effect of tillage treatment and rate of nitrogen application on grass weed biomass (g/m^2) at 28 DAS

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
No-till	51.8	68.1	46.1	83.0	*62.3*
Conventional	0.7	1.2	8.2	2.1	*3.1*

Tillage LSD (5%) = 27.66
Nitrogen application LSD (5%) = not significant

Table 5.6 Effect of tillage treatment and rate of nitrogen application on broadleaf weed biomass (g/m^2) at 28 DAS

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
No-till	10.5	9.7	29.4	19.5	*17.3*
Conventional	41.4	41.9	49.2	57.1	*47.4*

Tillage LSD (5%) = 16.49
Nitrogen application LSD (5%) = not significant

Table 5.7 Effect of tillage treatment and rate of nitrogen application on sesame leaf nitrogen content (%)

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
34 DAS:					
No-till	3.74	3.45	4.04	4.01	*3.81*
Conventional	4.54	5.21	4.76	5.09	*4.90*
mean	*4.14*	*4.33*	*4.40*	*4.55*	
51 DAS:					
No-till	2.41	2.35	2.53	2.44	*2.43*
Conventional	3.07	3.89	4.01	4.09	*3.77*
mean	*2.74*	*3.12*	*3.27*	*3.27*	

34 DAS
Tillage LSD (5%) = 0.35
Nitrogen application LSD (5%) = not significant

51 DAS
Tillage LSD (5%) = 0.25
Nitrogen application LSD (5%) = 0.35

Table 5.8 Effect of tillage treatment and rate of nitrogen application on sesame harvest plant population (plants/m^2)

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
No-till	36	37	34	35	*31*
Conventional	32	32	30	31	*36*

Tillage LSD (5%) = 3.1
Nitrogen application LSD (5%) = not significant

Table 5.9 Effect of tillage treatment and rate of nitrogen application on sesame seed yield (kg/ha)

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
Non-fallowed area:					
No-till	330	464	679	640	*528*
Conventional	935	1365	1640	1607	*1387*
mean	*633*	*915*	*1159*	*1123*	
Fallowed area:					
No-till	287	553	997	1387	*806*
Conventional	1152	1473	1628	1736	*1454*
mean	*720*	*1013*	*1313*	*1562*	

Non-fallowed area:
Tillage LSD (5%) = 94.6
Nitrogen application LSD (5%) = 133.7

[1] = fallowed area was not replicated

Table 5.10 Effect of tillage treatment and rate of nitrogen application on sesame plant height (cm)

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
Non-fallowed area:					
No-till	72	90	110	116	*97*
Conventional	113	128	133	129	*126*
mean	*93*	*109*	*121*	*123*	
Fallowed area[1]*:*					
No-till	80	105	129	129	*111*
Conventional	123	138	124	132	*129*
mean	*102*	*122*	*127*	*131*	

Non-fallowed area:
Tillage LSD (5%) = 5.8
Nitrogen application LSD (5%) = 8.1

[1] = fallowed area was not replicated

Table 5.11 Effect of tillage treatment and rate of nitrogen application on number of branches for sesame

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
Non-fallowed area:					
No-till	0.0	0.0	0.0	0.0	*0.0*
Conventional	0.0	0.0	0.1	0.2	*0.1*
mean	*0.0*	*0.0*	*0.1*	*0.1*	
Fallowed area [1]*:*					
No-till	0.0	0.0	0.0	0.0	*0.0*
Conventional	0.0	0.0	0.0	0.0	*0.0*
mean	*0.0*	*0.0*	*0.0*	*0.0*	

Non-fallowed area:
Tillage LSD (5%) = 0.08
Nitrogen application LSD (5%) = not significant

[1] = fallowed area was not replicated

Table 5.12 Effect of tillage treatment and rate of nitrogen application on height of lowest capsule (cm) for sesame

	Nitrogen application rate (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
Non-fallowed area:					
No-till	57	71	79	81	*72*
Conventional	73	74	73	75	*74*
mean	*65*	*72*	*76*	*78*	
Fallow[1]*:*					
No-till	59	67	87	74	*72*
Conventional	66	77	75	62	*70*
mean	*63*	*72*	*81*	*68*	

Non-fallowed area:
Tillage LSD (5%) = not significant
Nitrogen application LSD (5%) = 5.6

[1] = fallow area was not replicated

Table 5.13 Effect of tillage treatment and rate of nitrogen application on number of sesame capsules

	Nitrogen application rate (kg N/ha)				
Tillage	0	40	80	120	*mean*
Non-fallowed area:					
No-till	7	9	15	20	*13*
Conventional	23	40	60	39	*40*
mean	*15*	*25*	*38*	*29*	
Fallowed area[1]*:*					
No-till	8	15	28	33	*21*
Conventional	37	48	43	70	*50*
mean	*23*	*32*	*36*	*52*	

Non-fallowed area:
Tillage LSD (5%) = 7.3
Nitrogen application LSD (5%) = 10.4

[1] = fallow area was not replicated

Table 5.14 Effect of tillage treatment and rate of nitrogen application on sesame oil content (%)

	Nitrogen application (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
Non-fallowed area:					
No till	58.7	59.3	60.6	59.9	*59.6*
Conventional	57.2	58.7	59.5	59.1	*58.6*
mean	*58.0*	*59.0*	*60.1*	*59.5*	
Fallowed area:					
No-till	60.1	59.0	58.3	59.1	*59.1*
Conventional	60.2	59.8	60.8	61.5	*60.6*
mean	*60.2*	*59.4*	*59.6*	*60.3*	

Table 5.15 Effect of tillage treatment and rate of nitrogen application on sesame seed nitrogen content (%)

	Nitrogen application (kg N/ha)				
Tillage treatment	0	40	80	120	*mean*
Non-fallowed area:					
No-till	2.79	2.73	2.67	2.78	*2.74*
Conventional	3.23	3.22	3.01	3.00	*3.12*
mean	*3.01*	*2.98*	*2.84*	*2.89*	
Fallowed area:					
No-till	3.16	3.35	3.52	3.30	*3.33*
Conventional	2.89	2.85	2.88	2.85	*2.87*
mean	*3.03*	*3.10*	*3.20*	*3.08*	