Grain Sorghum in the Markham Valley

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Sorghum is a crop of increasing importance in Papua New Guinea because of its suitability for food for cattle, pigs and poultry. A feed mill in Lae now produces feed for pigs and poultry with an output of 1,500 *tons per year, so a reliable market exists for sorghum in the Markham Valley. Because of the increasing importance of sorghum, research work has commenced at the Agricultural Experiment Centre Bubia, near Lae.*

1. VARIETY TRIALS

IN the past, six different varieties have been grown commercially in the Markham Valley. No one variety has gained general acceptance. At present, some growers tend to prefer the pure line Alpha rather than hybrids, as the seed may be produced locally. The hybrids have to be imported from Australia, so the supply is less reliable. Three variety trials have been completed now, two at Mutsing and one at Mr J. Reid's plantation at Erap. Fourteen varieties have been compared. They include the six varieties previously grown in the valley, namely Dekalb's E57, Yate's NK220Y, Pioneer's Texas 608, Texas 610, 846 and Alpha and eight additional ones, Dekalb's X255, C44C, C42, X896, X897, E55e, X249 and Pioneer's Texas 626. All are hybrids except Alpha.

One of the main reasons for a poor yield in sorghum appears to be attack by the sorghum midge, and to a lesser extent by the sorghum head caterpillar. To minimize damage by these pests a variety must have two characteristics, firstly that the flower heads be open rather than compact and secondly that the flowering period be as short as possible.

In the case of the sorghum head caterpillar, a compact head makes a much safer home for the caterpillar than an open head. The food supply is closer and the caterpillar is much better protected from insecticide spray. A compact head will have a much higher humidity. When the grain is damaged, it is more prone to attack by fungus, and high humidity further encourages the growth of the fungus.

The advantages of a short flowering period with respect to minimizing midge damage are discussed in the next section.

In variety trials the problem of insect control is accentuated by the different flowering times of the varieties. Pests may build up in numbers on the early-flowering varieties and then attack the later-flowering varieties. All trials have been sprayed regularly in an attempt to minimize damage.

All trials received adequate nitrogen fertilizer.

Results of the three trials are given in the following tables. The 'time of heading' is the time when 50 per cent of the heads have emerged. Time of heading and time of maturity are each expressed as the number of days after sowing.

The *Mutsing wet season trial* was sown on 7th January, 1971. Rainfall recorded during the trial was 40 to 98 inches which was fairly evenly distributed. All hybrids gave better yields than Alpha but E57, Texas 608 and C44C were not much better.

The *Mutsing dry season trial* was sown on 13th May, 1971. Rainfall recorded during the trial was 5.17 inches. Only the hybrids X896, C42, Texas 626, Texas 610 and E55e gave significantly better yields than Alpha. All varieties had a flowering period of 12 days or less which would be considered acceptable to minimize midge damage.

The *Erap wet season trial* was sown on 26th March, 1971 at Mr J. Reid's property. Rainfall for the duration of the trial was 12.43 inches; 7.5 inches fell in April and this followed the very wet conditions of January, February and March (20 inches total rainfall). Although soil conditions were considered adequate at sowing time the continual rain in April led to waterlogging of the trial area on this poorly drained loam soil. This resulted in

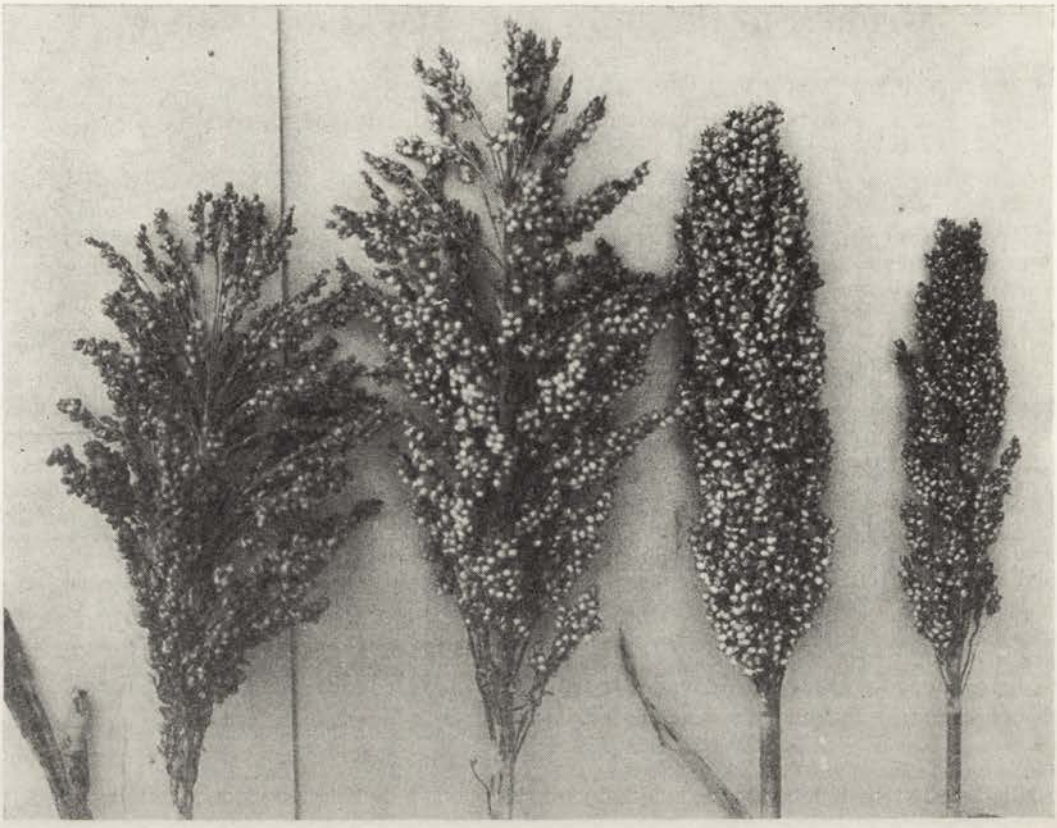

Plate I.—On the left are varieties X249 and E57, the open-headed type; on the right are Texas 610 and Alpha, compact-headed varieties

Table 1.—Results of Mutsing Wet Season Trial

Variety	(Days of Sowing)		Yield (lb/acre)	% Crude Protein Content of Grain	Head Type
	Time of Heading	Time of Maturity			
X249	43	82	2950	9.8	Open
Texas 610	50	90	2950	10.2	Closed
X896	46	82	2800	9.7	Semi-open to open
NK 220Y	46	90	2800	10.2	Semi-open
Texas 626	49	90	2750	10.3	Closed
Pioneer 846	50	95	2750	9.8	Closed to semi-open
E55e	48	91	2600	8.1	Closed to semi-open
C42	45	91	2500	10.4	Semi-open
X255	49	95	2350	10.0	Semi-open to open
X897	46	82	2350	9.9	Semi-open to open
E57	49	95	2200	8.7	Open
Texas 608	50	90	2200	10.4	Closed to semi-open
C44C	50	95	2000	9.5	Semi-open
Alpha	51	90	1700	10.4	Semi-open

Table 2.—Mutsing Dry Season Trial

Variety	(Days of Sowing)		Yield (lb/acre)
	Time of Heading	Time of Maturity	
X896	41	82	2700
C42	48	92	2700
Texas 626	48	92	2600
Texas 610	49	92	2450
E55e	48	88	2400
X897	41	82	2150
E57	51	92	2100
Pioneer 846	53	92	2050
NK220Y	48	92	2000
Texas 608	49	88	1950
Alpha	48	88	1850

Table 3.—Erap Wet Season Trial

Variety	Yield (lb/acre)
Pioneer 846	425
X255	360
Texas 608	350
X897	315
Alpha	300
X896	260
Texas 626	250
E55e	235
Texas 610	195
NK220Y	190
C44C	175
C42	100
E57	55

retarded and uneven growth, prolonged flowering periods and severe insect damage. The time of heading for all varieties was very late, occurring at 80 to 90 days after sowing. Varieties were harvested at 116 and 123 days after sowing. Yields for all varieties were very low.

Variety evaluation will be a continuing process in the valley. A fourth trial will be completed at Markham Farming Co., Erap, in October, 1971. Five additional varieties have also been included in this trial. They are Dekalb's F64a and Pacific's 303, 007, 222 and Mini Milo I.

2. INSECT PEST CONTROL

More than a dozen species of insect pests on sorghum have been recorded in the Markham Valley since June, 1968. The most serious one is the sorghum midge (*Contarinia sorghicola*), which may be one of the most destructive insect pests of sorghum in the world. It has only recently been recorded in Papua New Guinea, although it has been known in other parts of the world for many years.

Midges attack only the flowering heads of the grain. The eggs are deposited within the flower and when the eggs develop into larvae, the larvae feed in the ovary, thus preventing the development of the seed. The full-grown larvae pupate in the eaten-out flower, and the adult midges emerge from the flower leaving their white pupal cases attached to the top of the seed coverings. They mate within a few minutes of emerging and the females start to lay eggs in half an hour. The adult midge lives only a day or two, during which time a female will lay up to 100 eggs. The adult midge is a small fly, smaller than a mosquito, and much harder to see. It has an orange abdomen and fine transparent wings.

Under the climatic conditions of this country, it seems that the midge breeds continuously all the year and passes many overlapping generations a year.

The whole life cycle lasts only 2 or 3 weeks, so if the flowering period of the sorghum is spread over many weeks, a few generations of midge could do a great deal of damage to the crop.

The time of sowing should therefore be as short as possible. If the seed is sown over a period of weeks, the flowering stage will spread over a similar time, which gives the conditions most suitable for a big increase in the midge population.

Suggestions for Control

1. Burn or plough in the remains of the crop after harvest. To prevent the survival of larvae and pupae, burning is recommended.

2. Obtain seed of uniform flowering open-headed variety.

3. Prepare a good seed bed by thorough cultivation to ensure even flowering.

4. Avoid planting near earlier-flowering sorghum or near any wild sorghum plants (such as *Sorghum nitidum*), which would act as alternate hosts for the midge until the main crop was ripe.

5. Plant the late-flowering variety up-wind of the earlier-flowering varieties, to limit the spread of adult midges.

6. Cut out early volunteer and ratoon sorghum. The cutting out must not be done at the time of the flowering of the main crop, however, as this would encourage the egg-laying adult midges to go to the sorghum crop.

7. Remove "out-of-season" flowering heads in the sorghum crop to prevent the midge getting established in the crop just before the flower heads emerge.

Chemical Control

Some farmers in the Markham Valley have sprayed their crop with DDT at intervals of 3 to 7 days during the heading stage.

Although sorghum is not produced for direct human consumption in this country, chemical control must be viewed with some caution because of the danger of pesticide residues being carried over into stock food and eventually into meat for human consumption. Cultural and mechanical control for midge is preferable. Furthermore, chemical control is expensive and is unlikely to be effective unless reasonable attention is given to the cultural methods described above.

3. WEED CONTROL IN GRAIN SORGHUM

The main weeds in sorghum in the Markham Valley are *Rottboellia exaltata* and *Brachiaria reptans* (both grasses) and the broadleaf weeds Tah Vine (*Boerhaavia erecta*), Tridax daisy (*Tridax procumbens*) and milkweed (*Euphorbia prunifolia*).

All weeds compete with the crop for nutrients and water and some also compete for light. Rottboellia grows taller than sorghum and is capable of smothering the crop if it becomes well established. When this happens, mechanical harvesting is often not possible. *Brachiaria reptans* is the main grass species encountered. This is a low-growing species so it does not compete for light, but it certainly competes for nutrients and moisture.

The broadleafed weeds and Brachiaria can be controlled with herbicides, but Rottboellia is best controlled by cultivation practices. This is because Rottboellia is very similar botanically to sorghum itself. Any chemical that kills Rottboellia is likely to kill the sorghum too.

So Rottboellia must be attacked in a different way. Its weaknesses are that its seeds are not easily distributed by natural means, and they only have a short dormancy period. It does however, produce many seeds (one estimate is 3,000 seeds per plant), so the best way to control it is to slash or hand-weed before the seeds are formed.

Although the seeds are not easily distributed by natural means, vehicles and agricultural implements can easily carry them. Growers must therefore ensure that road verges are kept clean and that machinery is thoroughly cleaned before moving it from an infected area.

For the broadleafed weeds and Brachiaria the weedicide atrazine (trade name: Gesaprim) seemed to offer good prospects. Three main field trials were therefore laid down. Each trial tested four rates of atrazine—1, 2, 3 and 4lbs of active ingredient per acre in comparison with a 'hand-weeded' control and a 'not hand-weeded' control. The time of application of the herbicide differed in each trial. In trial 1, the herbicide was sprayed on to bare ground after the crop had been sown but before either weeds or crop had emerged. In trial 2, the herbicide was sprayed on the growing crop when it had reached the 2 to 4 leaf stage, and in trial 3 when 4 to 6 leaves of the sorghum had appeared. The herbicide was applied as a blanket spray in 15 gallons of water to the acre. There was no evidence that the spray damaged the sorghum at all.

The sorghum variety used was Texas 610, and nitrogenous fertilizer was applied at planting at the rate of 40lb urea per acre. For each trial, conditions were ideal for spraying, with moist soil surface and follow-up rains to move the atrazine into the soil.

Results

Results of these trials were assessed in two ways—firstly by observing the effect of the herbicide applications on the weeds, and secondly by measuring the yield of grain under the different treatments.

Atrazine was very effective against the broadleafed weeds—Tah Vine, Tridax daisy and milkweed—even at the lowest rate of 1lb active ingredient per acre. At this low rate, atrazine was not effective against Brachiaria, but it was effective against it at 2lb per acre in trial 1 (pre-emergent spraying). It gave less control

of Brachiaria in trials 2 and 3 when the weeds had become established before the atrazine was applied.

In trial 2 (spraying at the 2 to 4 leaf stage) atrazine was particularly effective in controlling milkweed, which completely smothered the untreated plots.

The effects on yield of the various treatments are set out in *Table* 4. From these figures it is clear that weed control at all stages of growth will increase the yield of grain. Hand-weeding was less effective than spraying in all three trials.

Table 4.—Yield responses of grain sorghum following the application of atrazine for weed control

Trial No.	Treatment	Average Yield of Grain (lb/acre)	% Increase in Yield*
1	Not hand-weeded	3800	0
	Hand-weeded	4200	11
	Atrazine 1	4800	26
	(lb a.i./acre) 2	5400	42
	3	5400	42
	4	5600	48
2	Not hand-weeded	2900	0
	Hand-weeded	4000	38
	Atrazine 1	4700	62
	(lb a.i./acre) 2	5000	73
	3	4700	62
	4	4900	69
3	Not hand-weeded	4800	0
	Hand-weeded	5500	15
	Atrazine 1	5800	21
	(lb a.i./acre) 2	5400	13
	3	5800	21
	4	5900	23

Trial No. 1 Herbicide applied before crop and weed emergence

2 Herbicide applied soon after crop and weed emergence (sorghum at 2 to 4 leaf stage)

3 Herbicide applied later after crop and weed emergence (sorghum at 4 to 6 leaf stage)

*Increase over 'not hand-weeded' control.

In trial 1, broadleaf control at 1lb active ingredient per acre increased the yield by 1,000lb per acre, a rise of 26 per cent. Brachiaria was not controlled at this rate, but was controlled at the higher rates of application. At 2lb active ingredient per acre, there was a further yield increase of 600lb per acre.

The biggest increases in yield were seen in trial 2 (early post-emergent spraying) where the yield increases of the sprayed crop over the unweeded crop were 60 to 70 per cent. This was due to the very high incidence of milkweed in the unweeded plots.

Trial 3 (late post-emergent spraying) showed that while spraying at this stage is beneficial, it is too late to achieve most effective control of the weeds. This would, of course, depend on the kind of weeds present. It is certainly too late for Brachiaria.

From these trials it is clear that atrazine is effective in controlling weeds, and it is now being used on several properties in the Markham Valley. The usual practice is to blanket-spray the bare ground immediately after sowing and to follow this up with spot-applications as necessary when weeds appear. The recommended rate is 1 lb active ingredient per acre.

If Brachiaria is a major weed species, a higher rate may be needed, but this may lead to problems of atrazine residues in the soil. The weedicide remains in the soil after the crop has been harvested and can cause trouble if a different crop is planted there in the next season.

For spot-spraying, other weedicides may be used against specific weeds. Thus if milkweed is the only weed present, MCPA (trade name: Methoxone) is effective and cheaper. 2,4-D amine (trade name: Ammoxone) is also effective over a narrower range of weeds.

CONCLUSION

Variety trials will need to continue for some time yet before firm recommendations can be made regarding the best sorghum variety for the Markham Valley, but the initial trials have clearly demonstrated that the best hybrids are capable of much higher yields than Alpha. Sorghum midge constitutes a serious problem in sorghum production and growers will have to practise crop hygiene and choose varieties and cultural methods that will ensure a short flowering period, so as to prevent rapid build-up of this pest. Atrazine can be very useful for weed control but *Rottboellia exaltata* is resistant to atrazine and will have to be controlled by cultural practices.