Ife J. Agric 1 (2) 172 - 182

A NOTE ON THE EFFECT OF SEED SIZE ON THE GROWTH OF TWO VARIETIES OF MAIZE

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Abstract

The effects of seed size on the growth of two varieties of maize (Kelvedon 75A and Inra 200) were studied in both glass-house and field. Large seeds produced greater dry matter and greater relative growth rate than small seeds during the seedling stage. However, in the field experiment, differences in dry matter production and relative growth rate between large and small seeds were not significant. Grain yield increased by 2.5% when large rather than small seeds were sown. It was concluded that there was no significant yield advantage in selecting large seeds for sowing.

Introduction

Interest in seed size is not new in agriculture; consequently there is a large amount of literature on the subject. Kidd and West (1918) suggested that the size of a seed was an indicator of conditions within the parent which affect seed potentiality and that there was no direct proportionality between food reserves in the seed and final yield. On the contrary, Black (1956, 1958) demonstrated that final yield was dependent on initial seed weight.

The effect of seed weight on seedling emergence has been studied by Erickson (1946) and Williams (1956) who concluded that large seeded species emerged from greater depths more than their smaller-seeded counterparts. This is, however, in contrast to the findings of Black (1956, 1959) who reported that with herbage legumes, emergence was not affected by seed size, regardless of depth of planting.

Hardwick (1968) showed that the relative growth rate of the aerial parts of three varieties of peas, whose seed sizes varied considerably did not vary after the seedling stage. However, in the sowing to establishment stage, the variety with the smallest seed appeared to have a faster growth rate than the other two. It will appear from this work therefore that seed size has an effect on final plant weight that is not proportional to the original seed weight and an "adjustment" stage appears to occur in the early stages of growth. It is therefore, valuable to investigate the effect of seed size on plant growth in the early stages of growth as well as on the final seed yield. This paper reports on two experiments designed to study the effect of seed size on the growth and yield of two varieties of maize.

MATERIALS AND METHODS

Experiment 1.

Seeds of two maize varieties, Kelvedon 75A and Inra 200 were selected according to weight. The first lot consisted of seeds weighing above 500 mg each (Large seeds) while the second lot consisted of seeds with weights below 250 mg each (Small seeds). The two seed size treatments were combined with the two varieties in a 2 x 2 factorial experiment. Planting was done in the glasshouse in plots arranged in randomised blocks and replicated four times. There were 120 pots per replicate. Watering was done daily with 50 cc per pot of a nutrient solution made of the following in a 45 litre drum: 60 g calcium nitrate, 43.2g sodium nitrate, 7.5g magnesium sulphate, 1.5g potassium phosphate; trace elements solution with 1.69g borax, 5mg zinc sulphate, 40 mg manganese chloride and 2g sodium molybdate.

Experiment 2.

Materials and experimental layout are essentially as in Experiment 1 except that planting was done in the field on 28th April 1969 at Wye College Farm, Kent. England (51^{o}E, 1^{c}E). Each plot measured 12m x 8m and received a single application of 100 kg/ha each of P_2O_5 and K_2O in the autumn and a single application of 125 kg/ha of nitrogen at seed-bed preparation. The seeds were sown by hand at a spacing of 30 cm x 30cm (108,000 plants/ha).

Sampling:

In the first experiment, 4 seedlings were selected randomly from each plot from the 9th day after sowing. Thereafter samples were taken at 3-day intervals until 8 samples had been obtained. For each sample, plants were separated into leaves, stems and roots and these component parts were dried at 90°C. In the second experiment, samples were taken fortnightly from each plot beginning from 8th week after sowing until 10 samples had been taken. At each sampling, all plants from an area $1m^2$ were cut at ground level. This was equivalent to 27 plants in a 100 per cent field establishment. The samples were then separated into plant components as above and dried to constant weight at 90°C. Leaf area in both experiments was measured using a modified air-flow plannimeter (Bell and Smith, 1965).

From the data of total plant dry weight and leaf area, net assimilation rate and relative growth rate were calculated according to the formulae reported by Williams (1946) Watson (1952) and Radford (1967).

RESULTS

Dry matter production

In the glass-house experiment, seedling emergence was faster for the large-seed treatment. A 100 per cent emergence was obtained with large seeds in three days as compared to five days for small seeds. Dry matter production in both varieties was significantly greater at every harvest date in the large than in the small seed treatments (Fig. 1). At the last harvest (Day 30), total dry matter was 40 percent higher in the large than in the small seeds. Averaged over the seed-size treatments, dry matter production was higher in Inra than in Kelvedon.

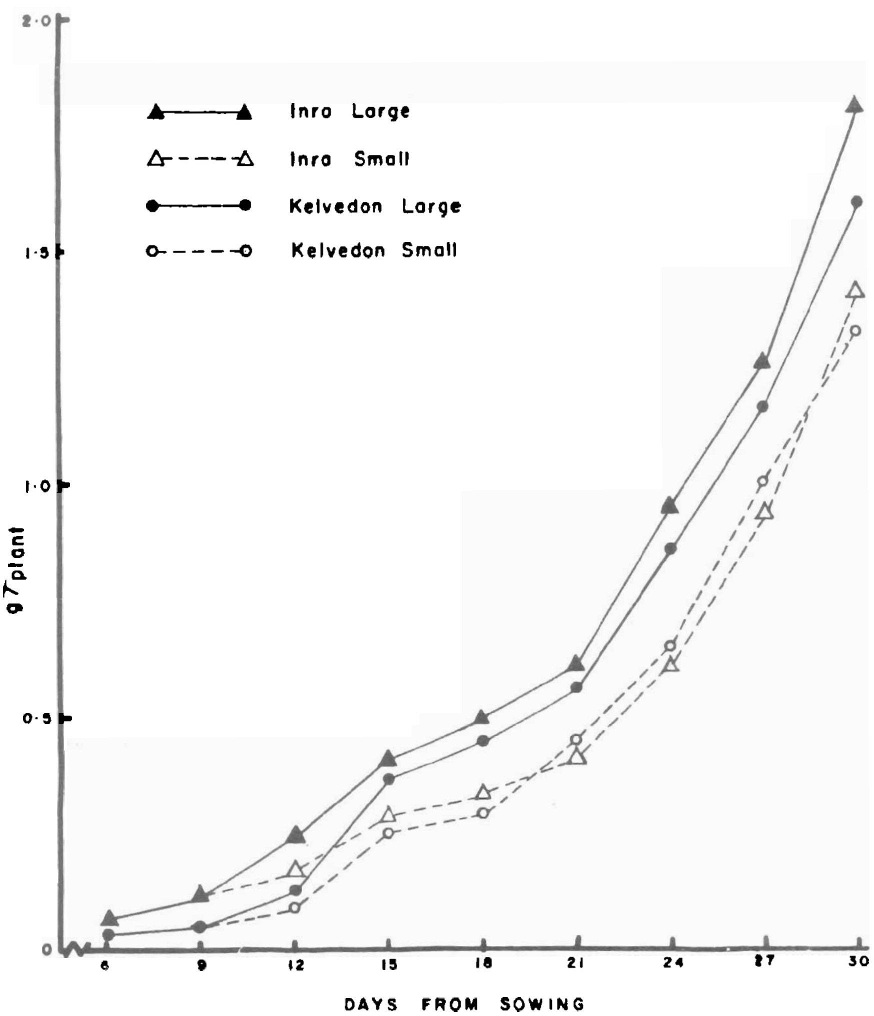
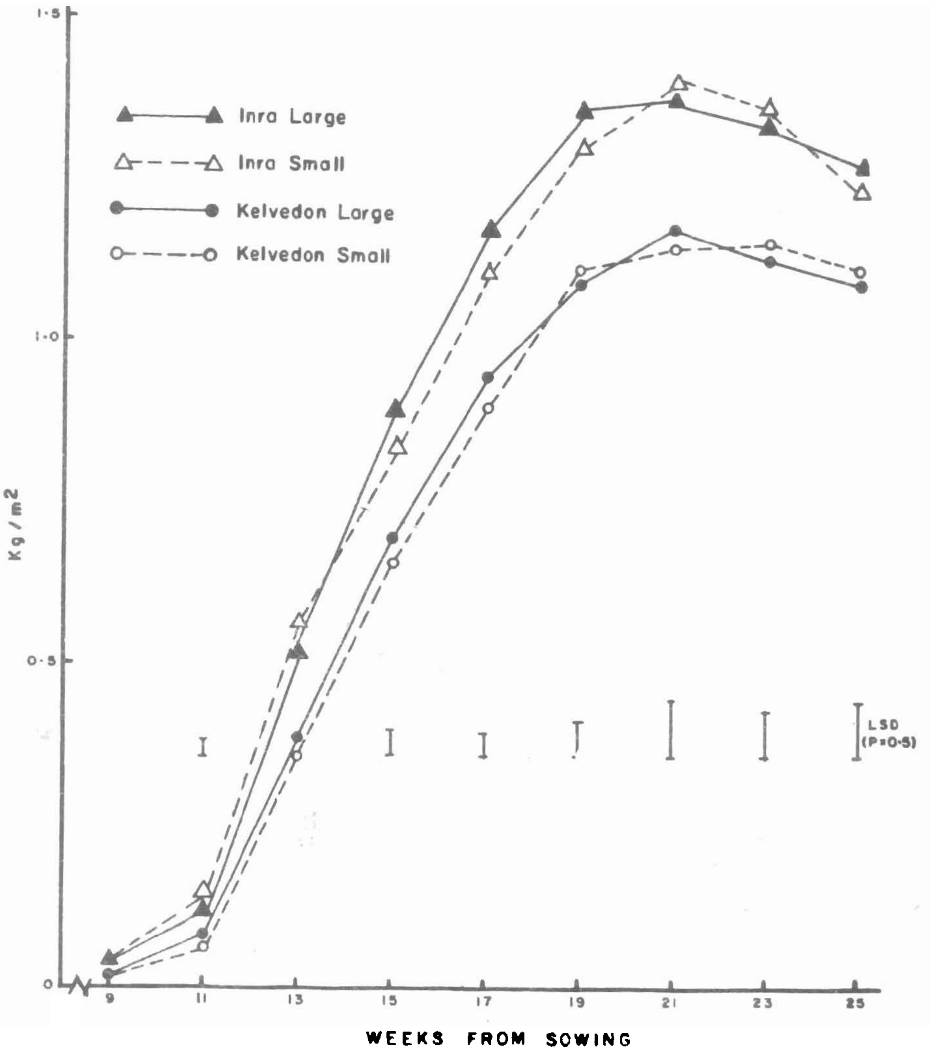


FIG. I TOTAL DRY MATTER ACCUMULATION (EXPT. I)

Accumulation of total dry matter in the field experiment is shown in Fig. 2. In both varieties, there were no significant differences in dry matter yield between the large and small seed treatments throughout the growth period. Peak dry matter production occurred in the 17th week after sowing in all treatments and thereafter declined through death and abscission of old leaves. Total dry matter yield was higher in Inra than in Kelvedon.



Leaf area

In Experiment 1, the rate of leaf emergence was more rapid for large than small seeds. Thus, throughout the seedling period, leaf area was larger in the large seed treatments (Fig. 3). The number of leaves at the last harvest was also significantly greater

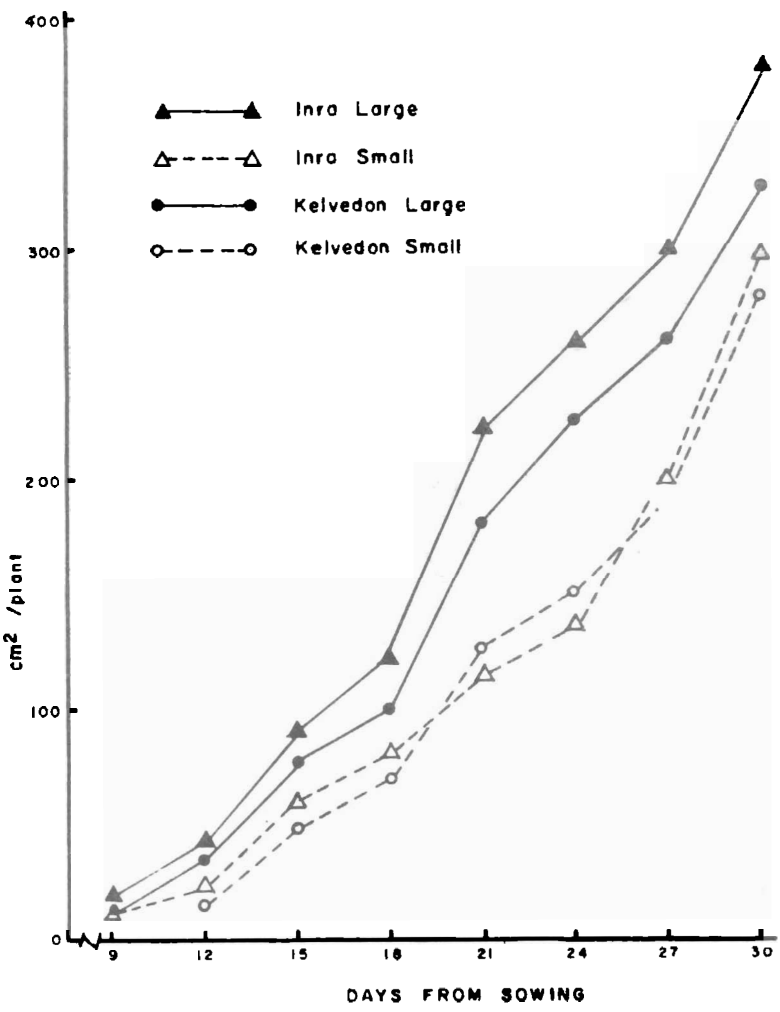


FIG.3 DEVELOPMENT OF LEAF AREA (EXPT. I)

for large seeds. As with the dry matter production, leaf area was greater in Inra than in Kelvedon.

Development of leaf area in the field followed the same pattern as dry matter production with Inra having higher leaf area at every harvest period. There were no significant differences between large and small seed treatments (Fig. 4). Similar leaf area indices were attained at both the peak and final harvest regardless of seed-size treatments.

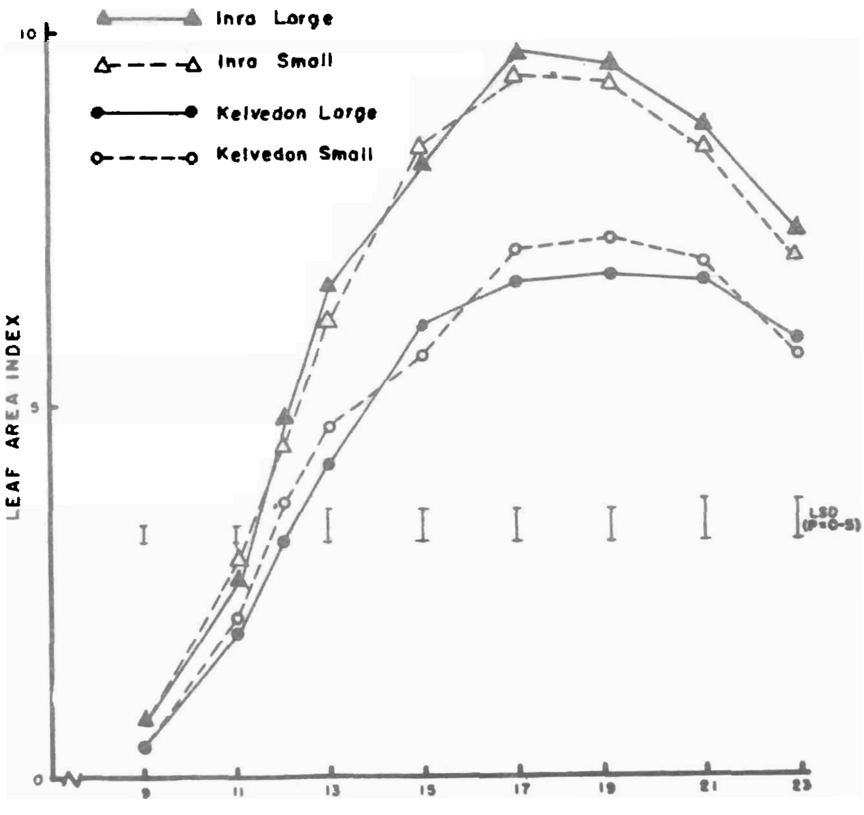


FIG.4 DEVELOPMENT OF LEAF AREA (EXPT. 2)

for large seeds. As with the dry matter production, leaf area was greater in Inra than in Kelvedon.

Development of leaf area in the field followed the same pattern as dry matter production with Inra having higher leaf area at every harvest period. There were no significant differences between large and small seed treatments (Fig. 4). Similar leaf area indices were attained at both the peak and final harvest regardless of seed-size treatments.

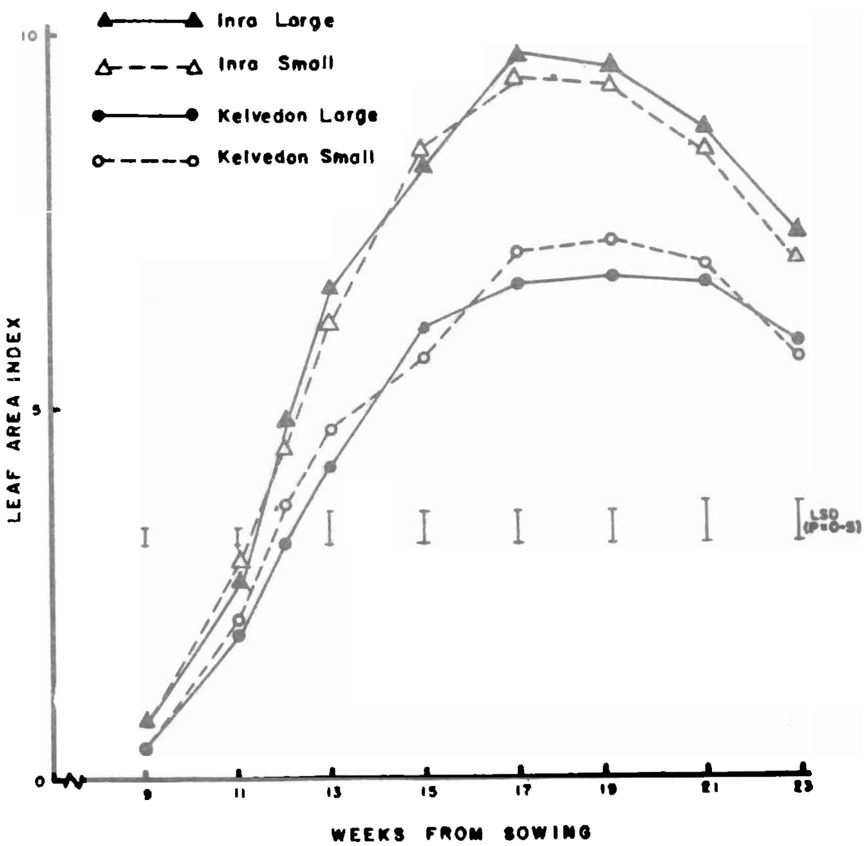


FIG.4 DEVELOPMENT OF LEAF AREA (EXPT. 2)

Growth analysis data

Mean relative growth rate (RGR) was significantly higher in the large than in the small seed treatments in the glass-house experiment only (Table 1). There were no significant treatment differences in net assimilation rate (NAR) in both experiments. RGR was slightly higher in Inra than in Kelvedon.

TABLE 1: MEAN RGR AND NAR IN ALL TREATMENTS AND IN EXPERIMENTS 1 AND 2

	Seed size	INRA	DELVEDON	X Treat-ment	S.E
Exp. 1	Large	0.188	0.158	0.157	
RGR mg/mg/day	Small	0.112	0.104	0.108	
	X (variety)	0.150	0.131		0.007
NAR	Large	0.61	0.52	0.565	
$mg/cm^2/wk$	Small	0.57	0.49	0.53	
	X (variety)	0.59	0.50		0.06
Exp. 2					
RGR	Large	0.48	0.38	0.43	
	Small	0.46	0.33	0.40	
	X (variety)	0.47	0.35		0.05
NAR	Large	4.6	4.2	4.4	
	Small	4.8	3.9	4.35	
	X (variety)	4.7	4.05		0.41

Please, express values, at least within same head, to same number of decimal places.

Grain yield

Data on grain yield and its components are presented in Table 2. Grain yield was higher with the large seed treatments in both varieties, but differences were not significant; the yield being increased by 2.5% in Inra, and 2.7% in Kelvedon. Similarly, number of cobs per plant, number of grains per cob and average grain weight were not affected by seed size. Variety X seed size treatment interactions were also not statistically significant.

TABLE 2: GRAIN YIELD AND ITS COMPONENTS IN ALL TREATMENT

	Seed size	INRA	KELVEDON	Treatment means	LSD (P=05)
Grain yield (g/m^2)	Large	540	608	574	
	Small	527	592	559	
	Variety means	534	600		102.7
No. of cobs $/m^2$	Large	10.2	11.	10.7	
	Small	9. 8	10.7	10.4	
	Variety means	10.0	10.9		1.6
No. of grains/cob	Large	225.8	231.5	233.6	
	Small	218.4	226.8		24.3
	Variety means	222.1	239.1		
Weight per grain (g)	Large	0.26	0.27	0.26	
	Small	0.22	0.24	0.23	
	Variety means	0.24	0.25		0.13

Please, express values, at least within same head, to same number of decimal places.

Discussion

The results obtained in the glass house showed that seed emergence was hastened when large seed were sown. This is in agreement with the result of Williams (1956) and Erickson (1946). This earlier emergence was probably due to a larger initial food reserve in large seeds. Probably, the food reserve was also responsible for maintaining a greater growth rate during the seedling stage as shown in the glasshouse experiment

However, in the field experiment, there were no significant differences in dry matter production between treatments throughout the growth period. Thus it will appear that the initial advantage shown in the seedling stage could not be sustained throughout the growth period as demonstrated in the field experiment. This is in agreement with the results of Hardwick (1968) with vinning peas. Inra produced greater dry matter than Kelvedon in this experiment even through the seeds sown were of similar weights emphasizing the basic genetic difference between the two varieties.

Relative growth rate was higher in the large than in the small seed treatment probably because of the initial food reserve advantage, but the efficiency of the photosynthetic apparatus as measured by NAR was similar in all treatments. Grain yield increased by only 2.5% when large seeds were sown and was not statistically significant. It can be concluded, therefore that there is no marked advantage in the choice of large seeds for sowing.

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