Ife Journal of Agric. Vol. 3, Nos. 1 & 2. (1981)

Estimating Kernel Weight in Maize

M.A.B. FAKOREDE & S.S. ORISADARE,
Department of Plant Science,
University of Ife,
Ile-Ife, Nigeria.

Abstract

In an experiment involving 20 maize (*Zea mays* L.) cultivars and five sample sizes (100,500,750 and 1000 kernels) replicated four times, it was found that sample weight increased linearly (r^2 = 0.81) as sample size increased. This suggests that mean weight/kernel did not differ significantly among sample sizes.

In similar trials involving 21 S_1 lines developed from two maize cultivars (FARZ 23 and FARZ 27) but utilising sample sizes of 25, 50, 75, 100 and 125, mean weight/kernel showed a curvilinear response to increased sample size with the point of inflection at approximately the sample size of 100 kernels. This suggests that mean weight/kernel was variable for sample sizes less than 100 kernels.

It seems, therefore, that kernel weight in maize can be estimated from small sample sizes (e.g. 100 and 125) kernels in order to save time and expenses when evaluating a large number of lines in a breeding programme.

Introduction

The capacity for grain yield in maize *(Zea mays* L.) can be expressed as: Yield = (No. ears/unit land area) x (No. kernel/ear) x (weight/kernel). Increase in any of these yield components may result in increased grain yield, if the other two components do not decrease. The first two components are easily determined. The number of ears per unit land area can be counted easily, and the number of kernels per ear can be estimated indirectly from the number of kernel rows, ear length, ear diameter, and kernel depth. Although kernel weight has been shown to have a positive, linear relationship with yield (r = 0.54) in maize (Pollmer *et al.*, 1978), studies involving estimates of kernel weight are not so common in the literature probably because its determination is tedious and time consuming.

In an attempt to determine kernel weight, most agronomists and plant breeders usually large numbers of maize kernels manually. Counting large numbers of kernels takes a long time to accomplish even in countries with advanced technologies where electronic seed counters are used. For this reason, maize researchers have used different sample sizes to estimate kernel weight. Sample sizes of 100 kernels (Cornelius *et al.,* 1961), 300 kernels (Crosbie *et al.,* 1978; Fakorede and Mock, 1978), and 1,000 kernels (Pollmer *et al.,* 1978) have been found in the literature. However no scientific basis appeared to have been established for using these sample sizes to estimate kernel weight. In grain sorghum *(Sorghum bicolor* L.) Ross and Kofoid (1978) found that 125 seed samples would be adequate for estimating seed weight.

The objective of this study, therefore, was to determine the minimum sample size necessary for estimating kernel weight in maize.

Materials and Methods

The 20 maize cultivars used in experiment 1 (Table 1) were grown at the University of Ife Teaching and Research Farm during the early cropping season of 1978. Each cultivar was sib mated for seed increase and the grain obtained from the mating was used in this study. The ars were harvested dry, further dried in a dryer, shelled, and stored at approximately 13% moisture content. Aluminium phosphide.[1] tablets were added into the bags containing each cultivar to prevent infestation by weevils. For this study, sample sizes (100, 250, 500, 750 and 1,000 kernels) were replicated 4 times for each cultivar. The kernels were counted manually on a flat surface for each sample size and weighed subsequently. From the data obtained, weight per kernel and weight per 1,000 kernels were computed with use of appropriate coefficients (for example, weight of a 100 kernel sample was divided by 100 to obtain weight/kernel and multiplied by 10 to obtain 1,000–kernel weight).

These data were analysed as 20 x 5 factorials with cultivars and sample sizes as the factors (Table 2). Furthermore, regression analysis was performed to determine whether sample weight increased linearly as sample size increased. The following linear model was used for the regression analysis:

$$Y_{ij} = m + bX_i + e_{ij}$$

where Y_{ij} = weight of sample in g, m = overall experiment mean, x_i = samples size; i = 100, 250, 500, 750, and 1,000, b = coefficient of linear regression, and e_{ij} = residual effects.

1 Formulated as Phostoxin tablets (Degesch, Frankfurt).

To test whether sample sizes fewer than 100 would be sufficient in estimating kernel weight, experiment 2 involving 10 and 11 S_1 lines developed from FARZ 23 and FARZ 27 respectively, was run. These lines were planted in yield trial experiments during the late season of 1978. Sample sizes of 25, 50, 75, 100 and 125 kernels were replicated four times for each line, and the data were analysed as in experiment 1.

Results and Discussion

Summary of the analysis of variance for 1,000–kernel weight in experiment 1 is presented in Table 2.. As expected, there were highly significant differences among cultivars for this trait. Means ranged from 195.97g for FARZ 27 to 324.25g for MSC–Y with overall experiment mean of 280.22g (Table 1). Similarly, weight per kernel ranged from 0.20 to 0.32g for the cultivars, with an overall average of 0.28. Significant genotypic differences for kernel weight in maize have been reported previously (Helm *et al.*, 1867; Hicks *et al.*, 1977; Pollmer *et al.*, 1978; Fakorede and Mock, 1978). Results of this study corroborate those reported earlier.

Mean squares for sample size and size x cultivar interactions were not significant for weight per kernel and 1,000–kernel weight (Table 2). Persual of the means for the two traits (Table 3) revealed very small differences among treatments (only 0.005 and 5.03g, respectively). Therefore, one could use any one of the five sample sizes in experiment 1 to estimate kernel weight in maize. This inference was valid regardless of the cultivar being considered. The largest difference between actual and estimated 1,000–kernel weight was less than 6g (Table 3). It seems, therefore that one does not necessarily require 1,000–kernel samples for determination of kernel weight in maize.

Furthermore, regression of sample weight on sample size in experiment 1 was linear ($r = 0.90$ and $r^2 = 0.81$) with the observed and predicted values in close agreement (Figure 1). This shows that weight per kernel was constant regardless of sample size used for its estimation.

In experiment 2, weight per kernel demonstrated a curvilinear response to increased sample size with the point of inflection occuring at approximately the sample size of 100 kernels (Figure 2). This suggests that mean kernel weight was variable for sample sizes less than 100 kernels. In order to save time and expenses, therefore, sample sizes of 100 and 250 kernels may be used to determine kernel weight in maize. These results are in agreement with those of Ross and Kofoid (1978) who found that 125–seed samples were adequate for estimating seed weight in sorghum.

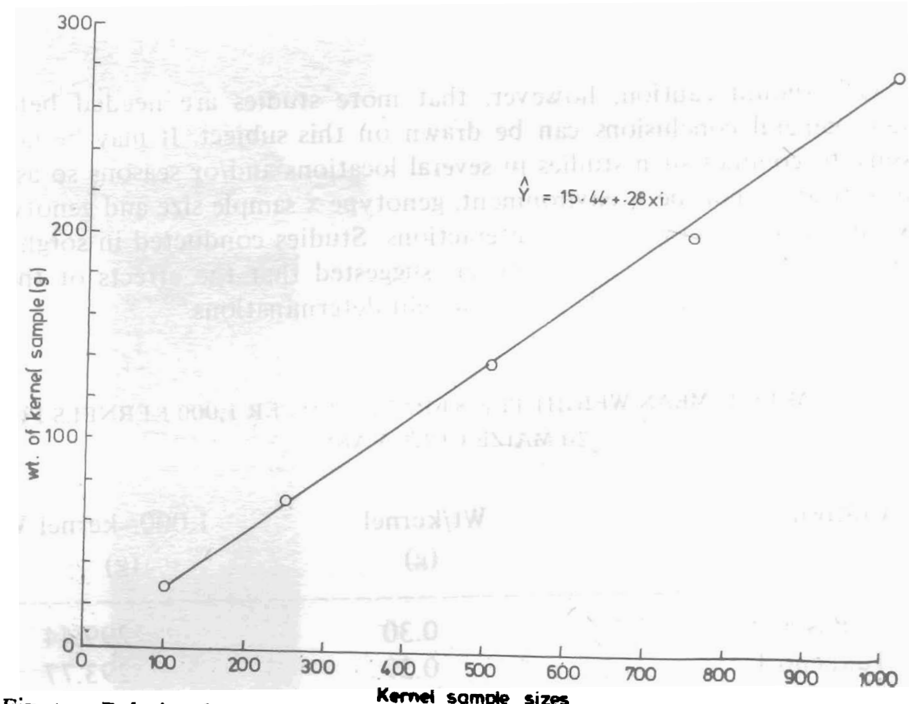

Fig 1. Relationship between sample size and sample weight for 20 cultivars of maize.

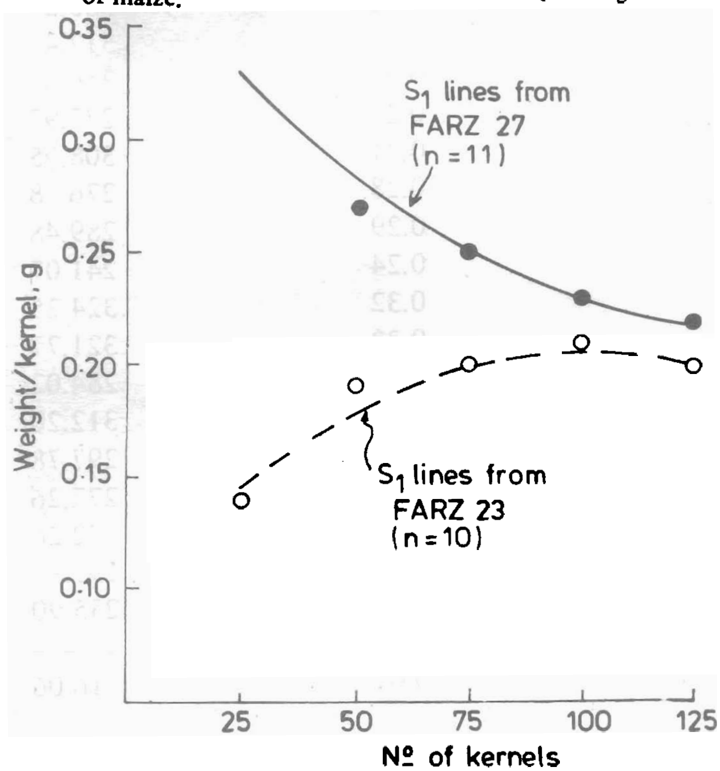

Fig. 2. Relationship between sample size and mean weight per kernel for 21 S_1 lines of maize.

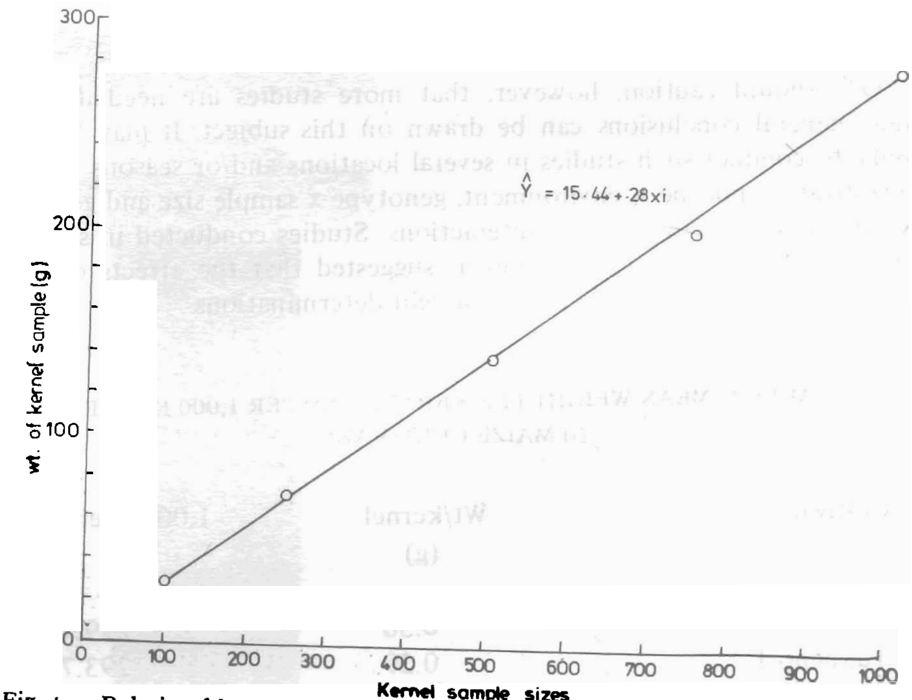

Fig 1. Relationship between sample size and sample weight for 20 cultivars of maize.

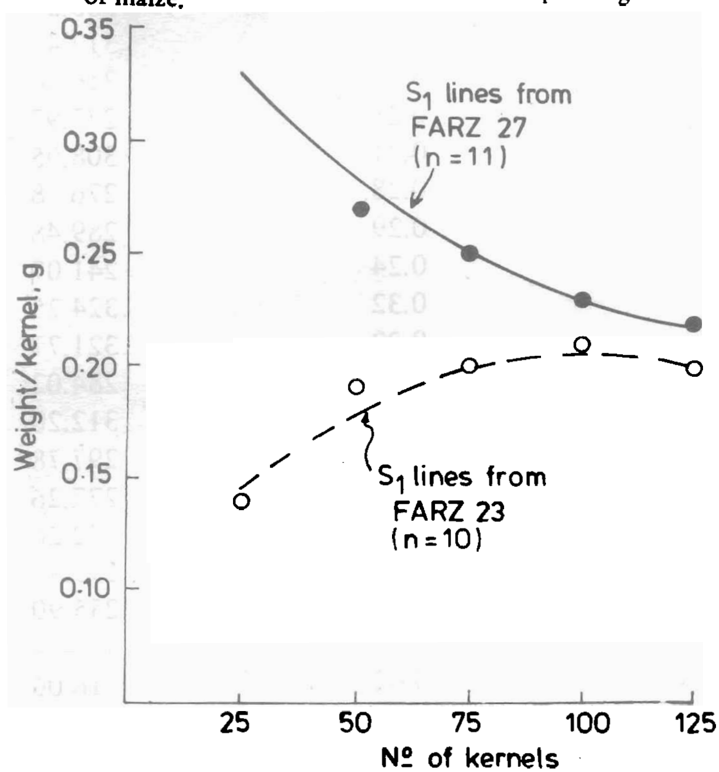

Fig. 2. Relationship between sample size and mean weight per kernel for 21 S_1 lines of maize.

One should caution, however, that more studies are needed before valid general conclusions can be drawn on this subject. It may be necessary to conduct such studies in several locations and/or seasons so as to investigate genotype x environment, genotype x sample size and genotype x sample size x environment interactions. Studies conducted in sorghum (Ross and Kofoid, 1978), however, suggested that the effects of these interactions were negligible in seed weight determinations.

TABLE 1: MEAN WEIGHT PER KERNEL AND PER 1,000 KERNELS FOR 20 MAIZE CULTIVARS

Cultivar	Wt/kernel (g)	1,000–kernel Wt. (g)
La Posta	0.30	299.44
Tuxpeno 1	0.29	293.77
Double Cross Hybrid	0.21	208.67
NS5	0.28	283.25
MSC – 4	0.32	317.42
TZPB (PR)C_3	0.32	316.28
NCB	0.28	277.97
MSRB–W	0.31	308.95
Yellow HEO_2	0.28	276.78
NCARB	0.29	289.48
Ugep White	0.24	241.07
MSC – Y	0.32	324.25
MSRB–Y	0.32	321.77
TZB	0.28	284.02
MSRB – 4	0.31	312.20
TZB (S_1) C_5	0.30	297.78
RSPH–Y	0.28	277.26
Sweet Corn	0.25	252.26
FARZ 27	0.20	195.97
FARZ 23	0.23	255.90
LSD 0.05	0.02	16.06

TABLE 2: ANALYSIS OF VARIANCE FOR 1,000–KERNEL WEIGHT.

Source of variation	DF		Mean squares
Replications	3		1298.67 NS
Treatments	99		5549.59 **
Cultivars (C)		19	28399.16 **
Sample sizes (S)		4	1608.00 NS
C x S		76	44.63 NS
Error	297		671.78
Total	399		1894.30

C. V. = 6.0%

NS = not significant.
** significant at 0.01 level of probability.

TABLE 3: WEIGHT PER KERNEL AND 1,000–KERNEL WEIGHT FOR FIVE SAMPLES SIZES OF MAIZE

Sample Size	Wt./kernel (g)	1,000–kernel wt. (g)
100	0.283	283.15
250	0.280	280.37
500	0.279	278.70
750	0.278	278.12
1000	0.281	280.88
LSD 0.05	NS	NS

References

Cornelius, P.L., Russell, W.A. and Woolley, D.G. 1961. Effect of topping on moisture loss, dry matter accumulation and yield of corn grain. *Agron. J.*, 53: 285-289.

Crosbie, T.M. Pearce, R.B., and Mock, J.J. 1978. Relationship among CO_2 exchange rate and plant traits in Iowa stiff stalk synthetic maize population. *Crop. Sci.*, 18: 87-90.

Fakorede, M.A.B. and Mock, J.J. 1978. Changes in morphological and physiological traits associated with recurrent selection for grain yield in maize. *Euphytica*, 27: 399-409.

Helm, J.L. Ferguson, V.L., Thomas, J.P. and Zuber, M.S. 1967. Effect of leaf removal on amylose content of endosperm. *Agron. J.*, 59: 257-258.

Hick, D.R., Nelson W.W., and Ford, J.H. 1977. Defoliation effects on corn hybrids adapted to northern corn belt. *Agron. J.*, 69: 387-390.

Pollmer, W.G., Eberhard, D., and Klein, D. 1978. Inheritance of protein and yield of grain and stover in maize. *Crop. Sci.*, 18: 757-759.

Ross, W.M., and Kofoid, K.D.,, 1978. Determining 1,000 – seed weight in grain sorghum, *Crop. Sci.*, 18: 507-508.