QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
DIVISION OF PLANT INDUSTRY BULLETIN No. 687

NATURAL CROSSING IN GRAIN SORGHUM

By W. GILLIERON, D.D.T.S.A. (Holland)

SUMMARY

The percentage of natural cross-pollination in grain sorghum was investigated at Biloela Research Station, central Queensland, over a 2-year period. Dominant red-pericarp colour was used as a marked gene.

There was 4·4% to 8·0% outcrossing of single white-pericarp coloured plants in a stand of red-pericarp plants and 2·9% to 8·0% outcrossing of a 6 metre row of white-pericarp plants in a red-pericarp stand.

In most of the tests, the upper one-third of the panicle had a higher incidence of outcrossing than the lower two-thirds. In the remaining tests, there were no significant differences in outcrossing between portions of the head.

I. INTRODUCTION

Cross-pollination in grain sorghum is reported to be about 5 or 6%, although the percentage may be much higher or lower (Doggett 1970; Quinby *et al.* 1958).

One study has been reported by Maunder and Sharp (1963) in which outcrossing occurred two to four times more often in the upper quarter of the panicle than in the lower three-quarters.

Such a difference can be important to sorghum plant breeders. A high amount of outcrossing might be desirable in population breeding, whereas for pedigree selection or single seed descent, a minimum of outcrossing is sought.

Information on the percentages of outcrossing in the top, middle and bottom portions of the head was sought at Biloela Research Station using the cultivar Alpha.

II. MATERIALS AND METHODS

The marker gene used in this study was the dominant red-pericarp colour gene (YY) (Stephens 1951). Alpha, the cultivar used, normally is red-seeded (red-pericarped). A white-seeded plant (yy) was discovered in an Alpha certified seed block near Gayndah. It probably arose by mutation, as the "white" and "red" Alphas are otherwise apparently identical.

An acre field of "red" Alpha was used in which a 6 m row of "white" Alpha and a small number of randomly sited "white" Alpha seeds were hand-planted. The row spacing was 1 m and plant spacings in the row 7·5 cm.

All tillers on the "white" Alpha plants were removed, so that each "white" Alpha plant had only one (main) head.

As the "red" and "white" Alphas flowered at the same time, "white" Alpha heads were exposed to cross-pollination. This was achieved on four occasions by planting twice (26.ix.69 and 19.ix.70) and by two ratoon crops after slashing both plantings.

The progeny tests from the first crop of the 19.ix.70 planting were ruined by excessive rain shortly after emergence. Therefore, data from three tests only were available.

Progeny from single plant heads were used to indicate the natural out-crossing occurring. Any outcrossing onto a "white" Alpha plant grown in a "red" Alpha field would be shown by production of red-seeded progeny.

At maturity, the "white" Alpha heads were hand-harvested and cut in three equal parts by length: top, middle and bottom. These parts were separately threshed and the seed planted in progeny rows. When the grain on their heads had coloured, numbers of red-seeded plants and white-seeded plants were counted for each progeny row.

The percentages of red-seeded plants in the progeny rows correspond with the percentages of outcrossing in the original single "white" Alpha plants.

For plants from the row of "white" Alpha, however, the relation could deviate slightly because of neighbouring "white" Alpha plants (cross-pollination with white pollen).

As weather conditions at flowering may influence cross-pollination, weather data are given in Table 1.

TABLE 1

WEATHER DATA AT FLOWERING TIMES

Trial	Flowering Time	Mean Daily Humidity	Mean Daily Temperature (°C)	Mean Daily Evaporation (mm)	Mean Daily Windspeed (km/hr)	Rainfall (mm)	No. of Days of Rain
I	Last week Nov. 1969	73·5	25	8	9	7	1
	First week Dec. 1969	70	28	9	11	15	2
II	Last week Feb. 1970	78·5	28	7	7·5	6	4
	First week Mar. 1970	76·5	26	8	6	10	1
III	3rd week Nov. 1970	59·1	24	6	8	30	3
	Last week Nov. 1970	52·6	25	7	8	8	1
IV	Last week Feb. 1971	62·3	23	4	10	23	3
	First week Mar. 1971	60·4	25	4·5	9	3	2

The number of "white" Alpha plants used and the number of plants counted in their progeny are given in Table 2.

TABLE 2

NUMBER OF "WHITE" ALPHA PLANTS USED AND THE TOTAL NUMBER OF PLANTS (WHIT AND RED) COUNTED IN THEIR PROGENY

For Single White Alpha Plants					For 6 m row of White Alpha				
Trial	No. Heads Single "White" Alpha	No. Counted Progeny			Trial	No. Heads Single "White" Alpha	No. Counted Progeny		
		Top	Middle	Bottom			Top	Middle	Bottom
I	5	268	275	223	I	4	305	318	246
II	4	272	292	238	II	4	322	317	225
IV	6	241	289	195	IV	8	302	305	238

III. RESULTS

The mean percentages of red-seeded Alpha progenies from the single "white" Alpha plants are given in Table 3.

TABLE 3

PERCENTAGE OF NATURAL CROSSING IN TOP, MIDDLE AND BOTTOM PARTS OF SINGLE "WHITE" ALPHA GRAIN SORGHUM HEADS AT THE BILOELA RESEARCH STATION IN THREE TRIALS

Trial	Part of the Head			F	Nec. Diff.	
	Top	Middle	Bottom		at 5%	at 1%
I	13·3	5·1	2·6	53·4***	2·5	3·6
II	7·3	2·5	3·4	1·97 n.s.d.	..	..
IV	7·9	8·0	8·1	0·008 n.s.d.	..	..

Outcrossing for entire heads varied from 4·4% (trial II) to 8% (trial IV).

The mean percentages of red-seeded Alpha progenies from the 6 metre row of "white" Alpha plants are given in Table 4.

TABLE 4

MEAN PERCENTAGE OF RED-SEEDED ALPHA PLANTS IN PROGENIES FROM "WHITE" ALPHA PLANTS TAKEN FROM THE 6 m ROW OF "WHITE" ALPHA

Trial	Part of the Head			F	Nec. Diff.	
	Top	Middle	Bottom		at 5%	at 1%
I	7·9	0·9	0	8·9*	2·6	..
II	6·5	3·4	2·7	19·9**	1·6	2·4
IV	6·4	7·5	10·1	0·843 n.s.d.	..	..

Outcrossing for entire heads varied from 2·9% (trial I) to 8% (trial IV).

IV. DISCUSSION

Maunder and Sharp (1963) found that outcrossing occurred 2½–4 times more often in the upper quarter of the panicle than in the lower three-quarters.

It has been general practice in sorghum plant breeding in Queensland since the above work was published to keep breeding seed from the bottom of the sorghum head, in an effort to minimize possible outcrosses.

Sorghum commences to bloom at the top of the head. Stigmas at the top of the head may not receive pollen from the same plant as early in their receptive life or in as great a quantity as stigmas lower down the head. Because of this, and for other possible reasons, outcrossing could differ in seed from different portions of the head.

Results from these reported trials suggest that, while sometimes there were no significant differences in percentage outcrossing among the top, middle and bottom parts of the head, there were in fact three occasions out of the six recorded measurements where differences did occur. When this happened the top of the head always exhibited more outcrossing than the lower portions. This suggests that it is essential that the present practice in selection work be continued.

V. ACKNOWLEDGMENTS

Suggestions and advice received from Dr. R. G. Henzell, Mr. R. F. Moore and Mr. K. G. Trudgian are gratefully acknowledged, as is the assistance of the staff at Biloela Research Station in connection with the trials.

REFERENCES

DOGGETT, H. (1970).—"Sorghum". (Longmans Green: London).

MAUNDER, A. B., and SHARP, G. I. (1963).—Localization of outcrosses within the panicle of fertile sorghum. *Crop Sci.* 3:449.

QUINBY, J. R. *et al.* (1958).—Grain sorghum production in Texas. *Bull. Tex. agric. Exp. Sta.* No. 912

SCHERTZ, K. F., and J. C. STEPHENS (1966).—Compilation of gene symbols, recommended revision and summary of linkages for inherited characters of *Sorghum vulgare* Pers. *Tech. Monog. Tex. agric. Exp. Sta.* Tech. Monograph No. 3.

STEPHENS, J. C. (1951).—The $YV_{11}G_2$ linkage group in sorghum. *Agron. J.* 43:382.

(Received for publication March 25, 1974)

The author is an officer of Agriculture Branch, Queensland Department of Primary Industries, stationed at Toowoomba.