INBREEDING ASSESSMENT ON BRAZILIAN SUNFLOWER VARIETY EMBRAPA 122

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Summary: Sunflower has experienced substantial advance in some savanna regions of Brazil as a result of research and industry efforts. The knowledge on heterosis and inbreeding depression is important to help in the development of a hybrid program. In spite of that, the relative importance of inbreeding effects on sunflower populations available in the Brazilian germplasm collection remains unknown. To study the inbreeding effects on Embrapa 122, an open pollinated sunflower variety derived from Issanka, five half-sib families were obtained and submitted to sib and self-pollination to produce the S_0 to S_5 generations. Two experiments were carried out in a randomized complete block design with four replications in two seasons during 1999, at the Embrapa Field Experiment Station at Londrina, in northern Parana State. The inbreeding depression for days for beginning and final flowering and also for days for physiologic maturity were not significant (P>0.05). Some evaluated families showed positive, neutral and negative responses to inbreeding and the average result was the absence of significant responses. The seed oil content showed a non-significant (P=0.087) inbreeding depression rate (b= -0.697). Significant (P<0.01) inbreeding depression values were observed for traits: grain yield, plant height, stem diameter, head diameter and 1000 seeds weight. The greatest inbreeding depression occurred with the first generation of self-pollination. Grain yield showed the greatest rate, with an average decrease of 57,6%. The knowledge of the effect of inbreeding on these traits will be useful in the sunflower breeding program for the development of inbred lines and hybrids.

Introduction

Sunflower has experienced substantial area increase in some Savanna regions of Brazil as a result of research and industry efforts. Many commercial hybrids developed by diverse private companies are available. These hybrids were all introduced from Argentina and show good yield in Brazil.

The Brazilian Agricultural Research Corporation through its National Soybean Research Center is developing locally a sunflower breeding program aiming to produce early maturing and high oil content hybrids. The knowledge about heterosis and inbreeding depression is important to determine the success of a hybrid program. Unrau and White (1944), have found that seed yields can decline by as much as 35% after one generation, and 60% after four generations of inbreeding by self-pollination. According to Kovacik and Skaloud (1974), the most significant inbreeding effects were observed on seed yield and seed weight with minimum values for most characters being attained after four or five generations. Velkov and Stoyanova (1974) obtained similar results for yield, seed weight and plant heght. They additionally observed that a few inbred lines showed reduced inbreeding depression, keeping the same yield of the initial varieties.

The relative importance of inbreeding effects on the sunflower populations available in the Brazilian germplasm collection remains unknown. The objective of this study was to determine the inbreeding effect on the sunflower variety Embrapa 122.

Materials and methods

Five half-sib families were obtained from Embrapa 122, an open pollinated variety derived from Issanka. The families were submitted to sib /and self-pollination to produce the S_0 to S_5 generations used in the inbreeding depression study. Reserve seeds of these generations were multiplied by sib-pollination in the summer of 1998, to preserve the seed and plant vigor and allow evaluations of the different generations in the 1999 winter and summer seasons.

Two experiments were carried out in a randomized complete block design with four replications in two 1999 seasons, at the Embrapa Experiment Field Station at Londrina, in northern Parana State, Brazil. The first one was planted on march 20 (winter season) and second on august 20 (summer season). The experimental unit was a single-row 6 m long plot. Plots were machine-planted spaced at 70 cm and early thinned to 45.000 plants per hectare. One single-row plot was used as border to reduce the intergenotypic competition between the different inbred generations. Supplementary irrigation was used when necessary to maintain optimal growth conditions. Days to flowering, final plant height, head and stem diameter, yield, 1000 seeds weight and seed oil content were evaluated for the winter season. Except 1000 seeds weight and seed oil content all other traits were evaluated in the summer. Days to the beginning and final flowering (R4 and R6), and days to physiologic maturity (R9), were assessed according Schneiter and Miller (1981); final plant height (cm), head diameter (cm), and stem diameter (mm) were evaluated as average of five competitive plants in the plot; yield (g/plot) was obtained by weighting grains of plants in the 5 m trimmed row, after exclusion of 50cm in each end as borders; 1000 seeds weight (g) and seed oil content (%) were obtained from a random sample of the shelled grain from each plot. The seed oil content was determined by a NMR analyzer.

Results and discussion

The growing conditions were considered normal in both seasons. The influence of a short drought occurred in the summer was minimized with a supplementary irrigation.

Inbreeding depression effects were estimated by linear regression for the eight traits in the two seasons. Heterosis and inbreeding depression depend on the number of divergent loci controlling the trait and their degree of dominance. In general, the results obtained in this paper are in agreement with the dominance ratio reported in the literature for each trait.

The inbreeding depression rates for days for beginning and final flowering and also for days for physiologic maturing, were not significant (P>0.05). The evaluated families showed positive, neutral and negative responses to inbreeding and the average result was the absence of significant responses. These results were expected because the additive genetic nature of control of these traits (Roath et al., 1982; Miller et al., 1980). Dominance and epistasis were non-significant.

The seed oil content showed a non-significant (P=0.087) inbreeding depression rate ($b= -0.697^{n.s.}$). This value, however, can be considered of relatively high magnitude. Although additive and non-additive genetic effects participate on the control of this trait, the additive genetic effect was observed to be the most important controlling the oil content on seeds (Putt et al, 1969; Skoric, 1976; Miller et al, 1980).

Significant inbreeding depression values (P<0.01) were observed for the traits: yield, plant height, stem diameter, head diameter and 1000 seeds weight (Table 1). The greatest inbreeding rate occurred after the first generation of self-pollination (Figures 1). Grain yield showed the greatest depression rate, with an average decrease of 57,6%, varying from 40,2% to 71,3% among the five families. The high degree of dominance involved in the control of this trait explain the highly significant response to inbreeding. After the second self-pollination, the inbreeding effect decreased and the families stabilize their yield. Some of these families stabilized their yield at a level that put them as an interesting source of inbred lines for the hybrid program.

The inbreeding depression effect on plant height resulted in plants 27,53% shorter comparatively to the original population (Table 1). Similar inbreeding effects were observed for stem diameter (-22.56%), head diameter (-19.15%) and 1000 seeds weight (-21.74%). For all these traits, a strong participation of genetic dominance effects must be present to result in these inbreeding depression magnitudes. This is in line with some literature reports (Unrau and White,1944; Velkov and Stoyanova, 1974).

The knowledge of the magnitude of the inbreeding depression effects on these traits will be useful in the sunflower breeding program during the development of inbred lines and hybrids.

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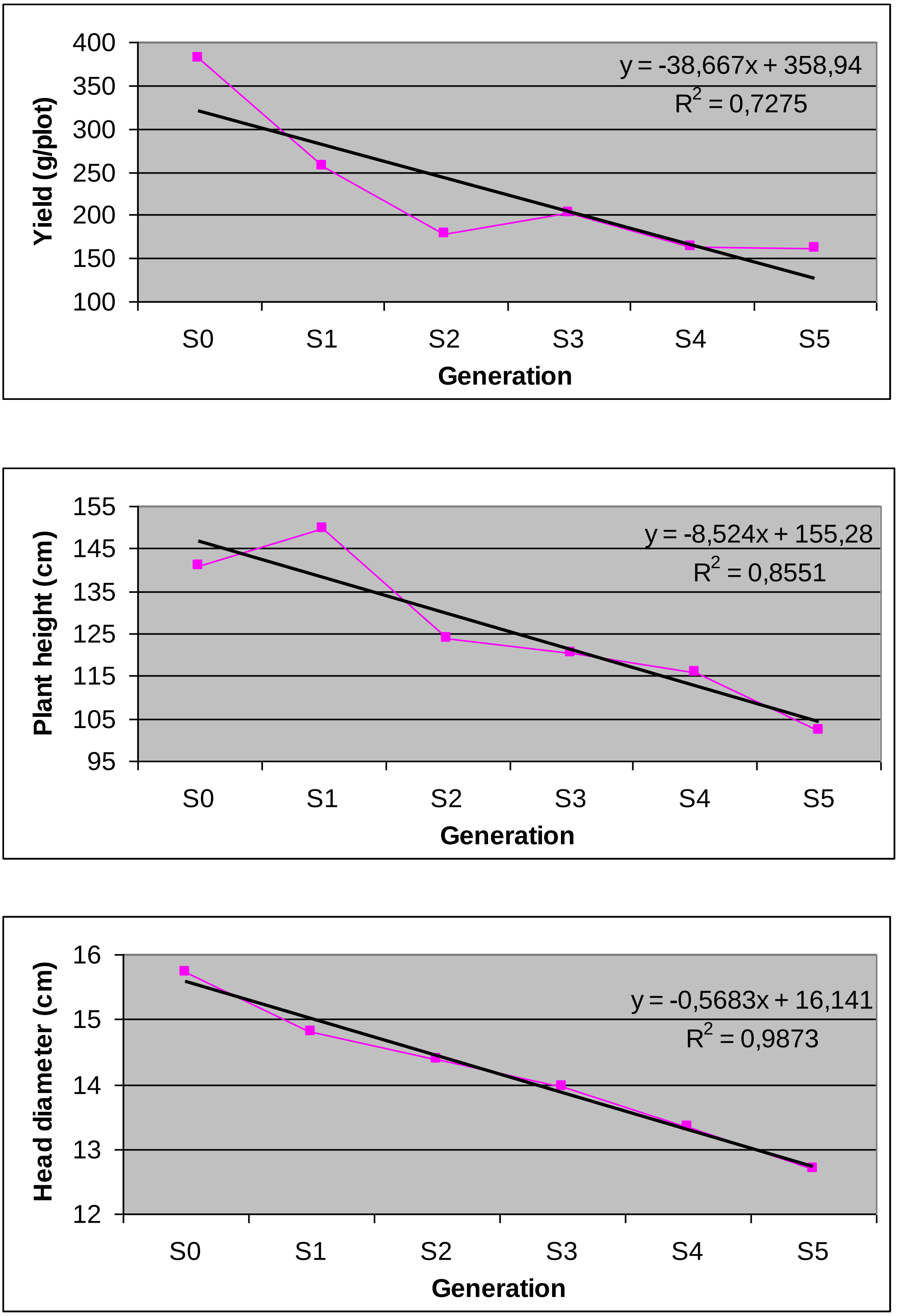
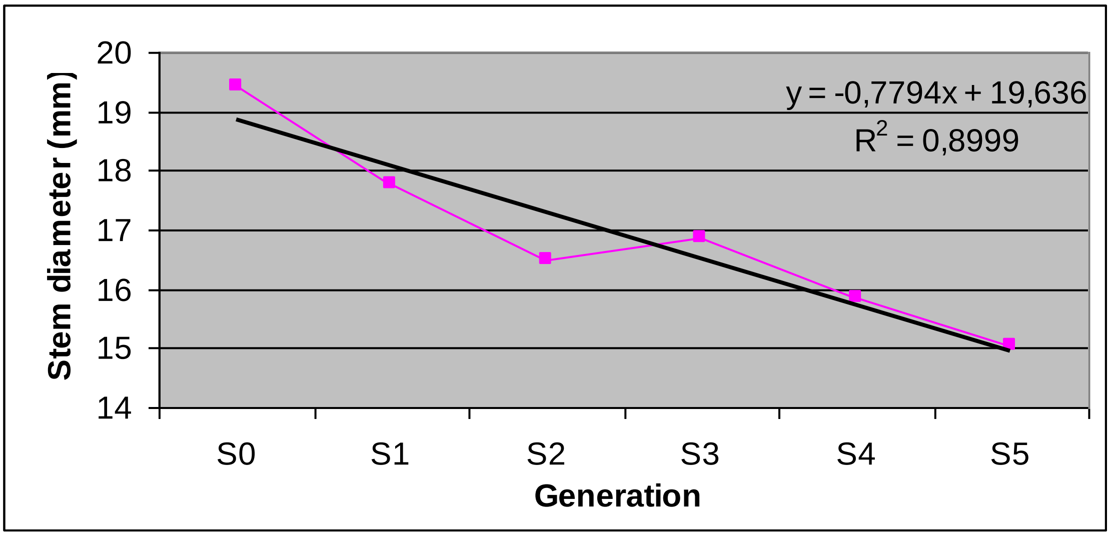


Figure 1. Inbreeding depression on the generations.



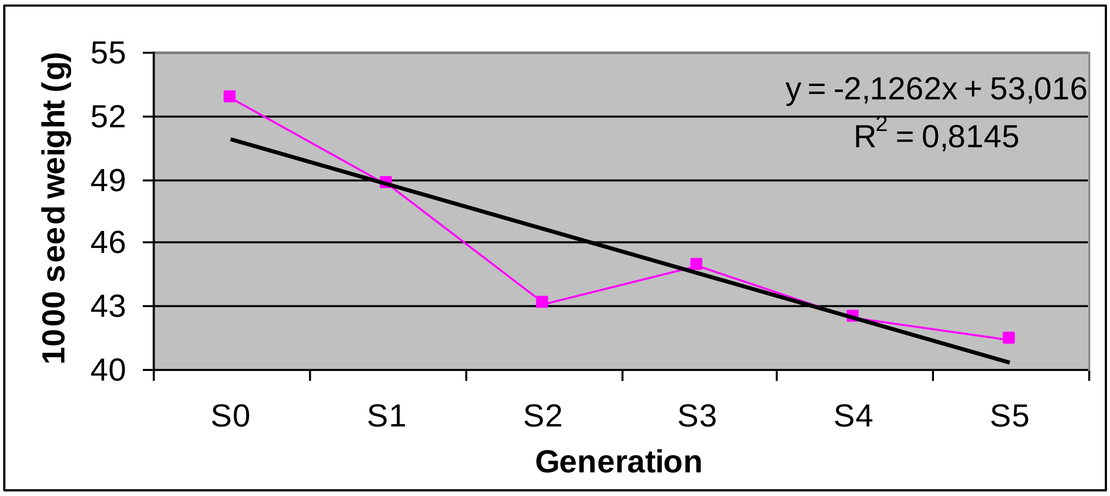


Figure 1 cont...

Table 1 – Overall and family means of the inbred generations derived from the Embrapa 122 variety.

Family	Generation	Days to flowering (R4)	Days to flowering (R6)	Days to physiologic maturity	Head diameter (cm)	Stem diameter (mm)	Plant height (cm)	Grain yield (g/plot)	1000 seeds weight (g)	Oil content (%)
-	S0	50,37	65,80	92,87	15,71	19,41	140,79	380,82	52,87	45,50
-	S1	57,82	72,80	100,35	14,80	17,78	149,63	256,72	48,73	45,86
-	S2	54,47	69,72	96,67	14,39	16,49	123,90	177,37	43,07	43,75
-	S3	54,15	68,92	94,87	13,96	16,86	120,34	202,47	44,90	44,15
-	S4	51,62	65,90	91,95	13,33	15,86	115,96	162,60	42,47	42,26
-	S5	51,80	66,10	91,87	12,70	15,03	102,03	161,60	41,37	42,70
	b	-0.34^{ns}	-.057^{ns}	-0.91^{ns}	-0.57**	-0.78**	-8.52**	-38.67**	-2.13*	-0.70^{ns}
	R^2	5.50	14.48	26.74	98.73	89.99	85.51	72.75	81.45	81.10
372	S0	52,37	66,87	94.00	15,42	19,97	139,27	388,37	54,19	45,36
372	S1	60,62	75,87	103,50	15,90	18,97	169,05	293,37	50,56	48,76
372	S2	55,12	70,37	97,87	14,67	16,80	127,05	241,25	36,25	51,48
372	S3	53,25	68,50	97,75	15,97	17,85	131,72	310,62	44,88	51,30
372	S4	44,25	58.00	85.00	12,67	12,77	94,45	121,87	29,76	45,77
372	S5	44,25	57,37	84,25	12,32	12,22	79,45	111,25	29,15	46,80
	b	-2.62^{ns}	-2.94^{ns}	-2.98^{ns}	-0.68^{ns}	-1.61**	-14.81*	-52.31**	-5.11*	-0.06^{ns}
	R^2	58.44	57.87	52.76	62.24	86.68	73.95	79.45	80.35	0.15
375	S0	48,75	62,87	92,37	16,02	19,27	139,17	366,62	52,91	45,54
375	S1	56,75	73.00	99,25	15,45	20,47	153,02	236,50	49,44	45,45
375	S2	59,25	74,75	100,50	13,52	17.00	135,62	131,87	36,10	46,41
375	S3	61,75	76,75	101,62	13,80	20,82	141,52	233,75	51,53	45,54
375	S4	59,37	74,30	101,50	14,20	21,17	135,92	183,12	54,16	40,22
375	S5	60,62	76,12	102,25	13,42	18,72	124,05	219,16	44,07	43,13
	b	1.99^{ns}	2.07^{ns}	1.63^{ns}	-0.47*	0.09^{ns}	-3.46^{ns}	-22.73^{ns}	-0.42^{ns}	-0.82^{ns}
	R^2	62.53	56.99	68.99	66.18	1.16	47.15	29.50	1.31	43.60
376	S0	52,12	68,37	95,37	16,20	20,12	152,47	459,37	53,70	46,34
376	S1	54,62	69,62	96,12	14,85	14,85	135,25	245,62	49,19	43,07
376	S2	54,37	69,37	94,87	16,12	17,55	122,45	201,25	57,34	39,14
376	S3	50,50	64,25	88,87	12,82	14,10	112,57	151,25	49,68	43,63
376	S4	51,12	64,37	88,37	13,80	14,20	120,80	155.00	53,30	42,82
376	S5	50,62	64,25	87,75	13,27	14,45	104,37	174.00	58,13	39,87
	b	-0.63^{ns}	-1.19^{ns}	-1.93*	-0.60^{ns}	-0.97^{ns}	-8.39*	-49.96^{ns}	0.77^{ns}	-0.82^{ns}
	R^2	39.89	68.48	83.59	60.73	54.49	84.24	63.65	14.84	33.75
410	S0	51	68,75	92,75	16,07	20,57	140,10	308,75	49,35	44,31
410	S1	65,62	79.00	106,62	14,10	19,17	166,52	330.00	57,52	43,51
410	S2	58,37	74,87	103,50	14,50	19,27	140,22	198,75	48,30	37,14
410	S3	58,50	74,87	99,75	12,97	18,57	121,40	192,37	39,78	36,80
410	S4	56,12	71,62	97,62	12,92	18,47	125,62	196,25	38,64	36,89
410	S5	57,87	74.00	99,87	11,85	17,40	104,47	169,37	36,46	39,17
	b	0.17^{ns}	0.12^{ns}	0.14^{ns}	-0.75**	-0.53^{ns}	-9.13*	-31.56*	-3.70*	-1.31^{ns}
	R^2	0.46	0.41	0.30	89.13	89.65	65.48	74.58	73.36	51.16
414	S0	47,62	62,12	89,87	14,85	17,12	132,92	381.00	54,20	45,97
414	S1	51,50	66,50	96,25	13,72	15,42	124,32	178,12	36,94	48,50
414	S2	45,25	59,25	86,62	13,12	11,85	94,15	113,75	37,37	44,58
414	S3	46,75	60,25	86,37	14,22	12,95	94,50	124,37	38,64	43,47
414	S4	47,25	61,12	87,25	13,07	12,70	103,02	156,75	36,50	45,62
414	S5	45,62	58,75	85,25	12,65	12,37	97,82	134,25	39,065	44,53
	b	-0.61^{ns}	-0.91^{ns}	-1.14^{ns}	-0.34^{ns}	-0.88^{ns}	-6.83^{ns}	-36.78^{ns}	-2.16^{ns}	-0.48^{ns}
	R^2	25.75	36.99	44.19	59.49	63.32	58.74	46.87	35.37	27.21

b – regression coefficient.
R2 – coefficient determination.
ns, *, ** - indicates non significance and significance at the 5% and 1% level of probability.