STUDIES ON THE PERFORMANCE OF HYBRIDS DEVELOPED, THROUGH DIVERGENT POLLEN MIXTURES AND HYBRID MIXTURES/BLENDS IN SUNFLOWER (*Helianthus annuus* L.).

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ABSTRACT

Hybrid mixtures or varietal blends are genetically heterozygous which can perform better in an adverse situations and impart more plasticity and insurance against diseases as compared to growing monohybrid cultures. The hybrids are generally uniform and have the advantages of stability over diverse environment. The intention of the present study was to understand the extent of pollen complementation in hybrid blends in realising higher seed and oil yield by growing hybrid mixtures. Eleven hybrids developed from pollen mixtures and other 11 hybrid mixtures synthesied were compared with the respective monoculture hybrids (pure stand hybrids) for its seed yield performance. The pollen mixture hybrids and hybrid mixtures on the whole differed significantly from pure stand hybrids for most the seed characters. In general, two component pollen mixture hybrids/hybrid mixtures found to be better than three or four component mixtures. Among pollen mixed hybrids, the two component hybrid '**AB**' [CMSDSF 15A X (R-857 + R-X13)] and '**ab**' [(CMSDSF-15A X R-857 + CMSDSF-15A X R-X13)] hybrid mixtures showed increase in plant yield and it was 20.26 % and 32 % respectively, as compared to their respective expected yield based on the average of the component hybrids in pure stand. The significance of these mixtures is the stability in yield and less vulnerability to major diseases. In the present study in general the pollen mixed hybrids have plant yield slightly less than the hybrid mixtures, but from the seed production point of view they would be more economical.

Key words : Pollen mixture hybrids, hybrid mixtures, monoculture hybrids.

INTRODUCTION

In allogamous crop like sunflower, pollen source and maternal influence assume greater importance in determining seed and oil yield. The importance of foreign pollen is of great practical significance in obtaining good seed set. In sunflower, the reports pertaining to identification of competitive pollen parents and utilization of their pollen on the performance of hybrids are rather limited. The hybrids developed through pollen mixtures and hybrid mixtures assumes practical importance. Kini (1992) reported a significant improvement in seed yield and other seed characters. Vander Kloet (1991) in his studies of mixed pollination on seed set in Vaccinium corymbosum reported that the mixture of two compatible pollen from different donors significantly increased seed set and increased the time of berry maturation by five days. Snow and Spira (1991) also reported that male fecundity can be influenced by pollen competitive ability when mixed pollen loads occur on stigmas. In cross pollinated crops different types of populations can be synthesised. These include the synthetics or composites and population buffering in the form of deliberately compounded mixtures of single crosses, mixtures of double crosses and mixtures of open pollinated cultivars (Allard and Hansche, 1964). The mixed genotypes in the form of multilines in self pollinated crops as put forth by Jensen (1952) in wheat are also known to delay the disease development and have been commercially exploited in oats and wheat (Browning and Frey, 1969). The present investigation was made to know the effect of pollen complementation on hybrid performance in pollen mixed hybrids and hybrid mixtures in comparison with the monoculture hybrids.

MATERIALS AND METHODS

The study involved two experiments for comparison, experiment number1 and 2.

Experiment : 1. Synthesis of pollen mixture hybrids :

To study the effect of pollen mixtures on hybrid performance four pollen parents viz., R-857, R-X13, R-6D-1 and RHA-274 abbrevated as '**A**', '**B**', '**C**', and '**D**' respectively and a CMS line CMSDSF-15 A were selected. From these four pollen parents a total of 15 hybrids, which include 11 pollen mixture hybrids and four monohybrids were synthesized in all possible combination by mixing equal quantity of pollen by volume and by weight and pollinated on CMS line. The mixture hybrids Viz., six hybrids of two component pollen mixtures (**AB**, **AC**, **AD**, **BC**, **BD**, **CD**) four hybrids of three component pollen mixtures (**ABC**, **ABD**, **ACD**, **BCD**), one hybrid of four component pollen mixtures (**ABCD**) and four mono hybrids (**A**, **B**, **C** and **D**).

Experiment : 2 Synthesis of hybrid mixtures :

To study the effect of pollen complementation in hybrid mixtures, four hybrids were selected derived from the similar parents as involved in the experiment. 1 Viz., CMSDSF-15A X R-857, CMSDSF-15A X R-X13, CMSDSF-15A X R-6D-1 and CMSDSF-15A X RHA-274, abbrevated as '**a**', '**b**', '**c**' and '**d**' respectively. From these four hybrids, 11 hybrids mixtures were synthesized in all possible combinations by mixing equal quantity of seed (**ab**, **ac**, **ad**, **bc**, **bd**, **cd**, **abc**, **abd**, **acd**, **bcd** and **abcd**). In all a total of 15 hybrids were constituted for the study.

Both experiment 1 and 2 having 15 treatments each were laidout in RBD with a plot size of 3.0 x 3.0 replicated thrice (comprised of five rows of ten plants each) with a spacing of 60x30 cm^2. The experiment was conducted at Regional Research Station, Raichur during 1995-96. Standard package of cultivation practices were adopted in raising the crop. Since pollen control between treatments was the primary requirement, all the heads were covered with cloth bags before anthesis pollination with in the treatment (i.e., pollination of hybrids in pure stand and inter cross pollination between component hybrids in case of mixtures) were done by gently rubbing the head with a

soft cloth as and when florets attain receptivity. Extreme care was taken to prevent pollen contamination from other treatments. The cloth bag was removed as soon as the fertilization in all the florets of capitulum was completed. The observations were recorded for day to 50 percent flowering, plant yield, 1000 seed weight, oil content, volume weight, seed density and hull percent.

The mean values for different characters in case of hybrids in pure stand and in mixtures were recorded. The expected mean values in respect of different pollen mixture hybrids and hybrid mixtures were computed by averaging the observed mean value of their component hybrids in pure stand. The increase or decrease in the observed mean values of the mixtures over the expected mean values were expressed in terms of percentages.

$$\text{Expected yield of the pollen mixture hybrid/hybrid mixture} = \frac{\text{Sum total of the observed yield of the component hybrids grown in pure stand}}{\text{No. of pollen mixture in the hybrid or No. of hybrids mixed.}}$$

The test of significance for mixtures was worked out by using non-orthogonel contrasts. (Sundararaj et al. 1972).

RESULTS AND DISCUSSION

Both pollen mixture hybrids and hybrid mixtures in general differed significantly from the four hybrids grown in pure stand for most of the seed characters. The characters viz., plant yield, 1000- seed weight, oil content, seed density, volume weight and hull percent differed significantly from the average value of their component hybrids in pure stand. No significant differences were noticed for days to 50 percent flowering, as the hybrid selected were of uniform flowering duration.

The observed and expected mean values of different characters for the pollen mixture hybrids along with percentage increase/decrease over the expected values are presented in Table 1. Two and three component pollen mixture hybrids **AB**, **AC**, and **ABC** recorded substantial increase in plant yield over the expected values and the percent increase was 20.2, 14.1 and 16.8 respectively. Similarly the two component pollen mixtures hybrids **CD** recorded 8.7 percent more oil content, **AD** showed 14.1 percent increase in 1000 seed weight, **AC** recorded 12.6 more in volume weight and **BC** exhibited favourable reduction of -1.2 per cent in hull content 12.5 percent more in seed density.

The observed and expected mean values of different characters for the hybrid mixtures along with percentage increase/decrease over the expected values are presented in Table 2.

Here also the two and three component hybrids mixtures **ab**, **bc**, **abc** recorded substantial increase in plant yield over the expected values and the percent increase was 32.0, 26.7 and 18.1 respectively. The two component hybrid mixtures "**bc**" showed 6.6 percent increase in oil content followed by three component hybrid mixture "**abc**" (6.69%). **ab**, **bc** and **abc** hybrid mixtures recorded 13.6, 19.3 and 18.6 percent increase in 1000 seed weight. The hybride mixtures "**ab**" and "**ac**" showed 10.9 and 10.8 percent increase in seed density. The hybrid mixture "**ab**" exhibited 13.5 percent increase in volume weight and "**bc**" and "**bd**" showed -1.00 and -2.1 less hull content, indicating that these characters are influenced due to pollen complementation in mixtures.

The exploitation of pollen influence through varietal mixtures was studied to a limited extent in oliferous brassicae by Asthana and Singh (1973). In sunflower Kini (1992) reported significant increase in plant yield upto 6.26 per cent compared to monohybrids and also reported the superiority of two component hybrid mixtures

among various mixtures. These results are in conformity with the present studies made.

The comparison of high average performance of hybrid mixtures and pollen mixed hybrids and per cent increase or decrease over the pure stand hybrids have been presented in Table 3. The two component mixtures in general out yielded in both pollen mixed hybrid and hybrid mixtures. Among two component hybrid mixtures, the hybrid blend "**ab**" [(CMS DSF -15A X R-857) + (CMS DSF 15A X R-X13)] gave 32 per cent increase in plant yield compared to pollen mixed hybrid "**AB**" [CMS DSF-15A X (R-857 + R-13)] i.e., 20.26 % over the expected mean values of pure stand hybrids. The hybrid blends showed better performance compared to hybrids developed from pollen blends.

The potentiality of hybrid mixtures/pollen mixed hybrids depends on the precision by which component of mixtures chosen for their compatability with reference to pollen effect. The significance of hybrid mixtures and pollen mixed hybrids is the stability in yield over diverse environments and less vulnerability to major diseases.

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Table 1 : Observed and expected mean values for seven seed characters in hybrids derived from pollen mixtures.

Pollen mixture hybrid combina – tion	Days to flowering			Plant yield			Oil content			1000 seed weight			Seed Density			Volume weight			Hull content %		
	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values
A	58.33	–	–	44.62	–	–	36.19	–	–	50.81	–	–	0.652	–	–	37.02	–	–	31.10	–	–
B	57.10	–	–	49.85	–	–	39.71	–	–	55.36	–	–	0.644	–	–	35.40	–	–	29.45	–	–
C	58.28	–	–	42.13	–	–	40.51	–	–	47.67	–	–	0.561	–	–	36.85	–	–	30.22	–	–
D	60.13	–	–	39.47	–	–	38.47	–	–	48.40	–	–	0.538	–	–	34.45	–	–	31.05	–	–
AB	57.33	57.71	-0.65	56.80	47.23	20.26	38.18	40.11	-4.81	57.50	53.08	8.3	0.705	0.648	8.79	39.40	36.21	8.80	34.80	34.27	1.54
AC	58.33	58.30	0.05	49.50	43.37	14.13	39.10	38.35	1.95	53.10	50.24	5.6	0.670	0.606	10.56	41.60	36.93	12.64	31.60	30.66	3.06
AD	59.33	59.23	0.16	43.30	42.04	2.99	37.50	37.33	0.45	56.60	49.60	14.1	0.585	0.595	-1.68	36.80	35.73	2.99	32.30	31.07	3.95
BC	58.00	57.69	0.53	48.15	49.99	4.69	42.85	40.11	6.83	58.30	52.51	11.0	0.680	0.602	12.95	40.30	36.12	11.57	29.55	29.83	-0.93
BD	59.00	58.61	0.66	45.85	44.66	2.66	39.25	39.09	0.40	58.50	51.88	12.7	0.645	0.591	9.13	34.50	34.92	-1.20	29.90	39.25	-1.15
CD	58.00	59.20	-2.02	42.34	40.80	3.77	42.95	39.49	8.76	51.00	49.03	4.0	0.562	0.549	2.36	36.40	35.65	2.10	32.05	30.63	4.63
ABC	57.00	57.90	-1.55	53.20	45.53	16.84	40.63	38.80	4.72	57.40	51.94	10.5	0.665	0.619	7.42	37.35	36.42	2.50	30.50	30.25	0.82
ABD	58.00	58.52	-0.88	43.40	44.64	-2.77	38.36	38.12	0.62	53.30	51.52	3.4	0.652	0.611	6.71	36.80	35.62	3.33	30.70	30.53	0.55
ACD	60.00	58.91	1.85	43.60	42.07	3.63	38.22	38.39	-0.44	51.76	49.62	4.3	0.605	0.583	3.77	35.55	36.10	-1.52	31.05	30.79	0.84
BCD	58.00	58.50	-0.85	45.72	43.81	4.35	41.61	39.56	5.18	54.40	51.14	6.3	0.660	0.581	13.59	37.30	35.56	4.89	30.80	30.24	1.85
ABCD	59.33	58.46	1.48	46.38	44.01	5.38	38.50	38.72	-0.56	55.50	51.06	8.6	0.630	0.598	5.35	38.65	35.93	7.57	30.95	30.45	1.64

Note : Pollen parents A=R-857, B=R-X13, C=R-6D-1 and D=RHA-274.

Table 2 : Observed and expected mean values of component hybrids and hybrids in mixture for seven seed characters.

Hybrid mixture hybrid combina – tion	Days to flowering			Plant yield (g)			Oil content (%)			1000 seed weight (g)			Seed Density (g/cc)			Volume weight (g)			Hull content %		
	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values	Obs. Mean	Exp. Mean	% incr. Over exp. Values
a	58.33	–	–	45.91	–	–	36.57	–	–	52.32	–	–	0.678	–	–	37.52	–	–	30.08	–	–
b	57.33	–	–	53.27	–	–	39.85	–	–	55.23	–	–	0.660	–	–	36.34	–	–	29.67	–	–
c	59.00	–	–	43.80	–	–	38.28	–	–	46.37	–	–	0.619	–	–	37.80	–	–	32.21	–	–
D	57.66	–	–	37.65	–	–	35.42	–	–	43.12	–	–	0.664	–	–	34.05	–	–	33.45	–	–
ab	57.33	57.80	-0.81	60.10	49.55	32.00	38.45	38.21	0.60	61.10	53.77	13.63	0.742	0.669	10.91	41.92	36.93	13.51	29.95	29.87	0.26
ac	58.00	58.66	-1.12	46.30	44.85	3.20	37.78	37.42	0.36	54.40	49.34	10.25	0.718	0.648	10.80	40.42	37.66	7.30	32.01	31.14	2.79
ad	57.66	57.99	-0.56	40.52	41.78	-3.01	35.60	35.99	-1.08	49.31	47.72	3.33	0.660	0.671	-1.64	36.20	35.78	1.17	32.18	31.76	1.32
bc	58.33	58.16	0.29	61.47	48.53	26.70	41.63	39.06	6.57	60.65	50.80	19.38	0.681	0.639	6.57	39.57	37.07	6.74	13.63	30.94	-1.00
bd	57.00	57.49	-0.85	44.90	45.46	-1.49	38.09	37.63	1.22	55.15	49.17	12.16	0.655	0.662	-1.06	37.76	35.19	7.30	30.87	31.56	-2.16
cd	58.66	58.33	0.56	38.81	40.72	-4.69	36.20	36.85	-1.76	46.40	44.74	3.71	0.613	0.641	-4.36	36.98	35.92	2.95	33.11	32.83	0.85
abc	59.33	58.22	1.91	56.32	47.66	18.17	40.18	38.23	6.69	60.86	51.30	18.63	0.694	0.652	6.44	40.31	37.22	8.30	30.82	30.65	0.55
abd	57.33	57.77	0.76	44.20	45.61	-3.09	37.41	37.28	0.34	58.17	50.22	15.80	0.631	0.667	-5.39	35.64	35.97	-0.91	31.33	31.06	0.86
acd	58.33	58.17	0.89	40.80	42.45	-4.00	36.83	36.75	0.14	49.17	47.27	5.16	0.635	0.653	-2.75	38.35	36.45	5.22	32.61	31.91	2.19
bcd	58.00	57.99	0.01	43.13	44.90	-3.94	37.91	37.85	0.15	54.25	48.24	12.45	0.626	0.647	-3.24	36.53	36.06	1.30	33.42	31.77	5.19
abcd	57.00	58.08	-1.85	49.93	45.15	10.58	39.85	37.53	6.18	55.66	49.26	12.99	0.658	0.665	-1.05	38.29	36.42	5.13	33.26	31.35	6.09

Note : Hybrids a=CMSDSF-15A X R-857, b=CMSDSF-15A X R-X13, c=CMSDSF-15A X R-6D-1 and d=CMSDSF-15A X RHA-274.

TABLE 3 : Comparative statement of per cent increase or decrease over expected values of pollen mixtures hybrids and mixtures over component hybrids in sunflower.

Pollen mix hybrids/Hybrid mixtures	Plant yield (g)		1000 seed wt. (g)		Oil content (%)		Density (g/cc)		Volume Wt.(g)		Hull %	
	PMH	HM	PMH	HM	PMH	HM	PMH	HM	PMH	HM	PMH	HM
AB/ab	20.26	32.00	8.32	13.63	-4.81	0.60	8.79	10.91	8.80	13.51	1.54	0.26
AC/ac	14.13	3.20	5.69	10.25	1.95	0.36	10.56	10.80	12.64	7.30	3.06	2.79
AD/ad	2.99	-3.01	14.11	3.33	0.45	-1.08	-1.68	-1.64	2.99	1.17	3.95	1.32
BC/bc	4.69	26.70	11.02	13.98	6.83	6.57	12.95	6.57	11.59	6.74	-0.93	-1.00
BD/bd	2.66	-1.49	12.76	12.16	0.40	1.22	9.13	-1.06	-1.20	7.30	-1.15	-2.16
CD/cd	3.77	-4.69	4.02	3.71	8.76	-1.76	2.36	-4.36	2.10	2.95	4.63	0.85
ABC/abc	16.84	18.17	10.51	18.63	4.72	6.69	7.42	6.44	2.50	8.30	0.82	0.55
ABD/abd	-2.77	-3.09	3.45	15.80	0.62	0.34	6.71	-5.39	3.33	-0.91	0.55	0.86
ACD/acd	3.63	-4.06	4.31	5.16	-0.44	0.14	3.77	-2.75	-1.52	5.22	0.84	2.19
BCD/bcd	4.35	-3.94	6.37	12.45	5.18	0.15	13.59	-3.24	4.89	1.33	1.85	5.19
ABCD/abcd	5.38	10.58	8.69	12.99	-0.56	6.18	5.35	-1.05	7.57	5.13	1.64	6.09

PMH=Pollen Mixture Hybrids ; HM=Hybrid Mixtures