for incorporation of sorghum stubbles to soybean crop had the highest soybean production. The above tillage treatment might have provided better soil physical and chemical environment for increased yield. (Anon, 1995).

The bulk density of the soil samples collected at post harvest stage of soybean (Table 3) which varied from 1.27 to 1.48 Mg m^{-3} was not influenced either by the addition of organics to the I crop or by tillage treatments. However, the total porosity was significantly increased by the addition of composted as well as raw coir pith as compared to control (Table 4). Disc ploughing and incorporation of sorghum stubbles had higher porosity when compared with other tillage treatments. This might be due to the incorporation of stubbles slightly to deeper depth and better soil aeration. The disc ploughing for stubble incorporation increased the hydraulic conductivity over the other tillage treatment (Table 5). The reason again attributed could be increased capillary and non capillary porosity of the soil.

Though there was not much variation in hydraulic conductivity among the organic manures, application of organics improved the hydraulic conductivity as compared to control without any organic matter addition.

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HETEROSIS FOR SEED YIELD AND ITS COMPONENTS IN SUNFLOWER (*Helianthus annus.* L.)

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ABSTRACT

Heterosis for seed yileld and ilts components was estimated in 56 crosses obtained by crossing 4 cytoplasmic male sterile lines with 14 testers in L x T fashion. Co 4 and KBSH-1 were used as checks. The positive heterosis value ranged from 18.11 to 93.28 and 13.68 to 96.97 for seed yield respectively over mid parent and better parent. About 10 hybrids are recommended for further breeding work. It is inferred that parents with high mean values give high heterosis in combination.

KEYWORKS: Heterosis, Sunflower, Yield

The phenomenon of hybrid vigour has been exploited extensively for plant improvement in many crops. Though sunflower cultivation has gained momentum in India due to its wider adaptability, short duration and anti-cholestral properties, it has not attained its anticipated growth. This may be because of lack of yield potential in varieties. One of the ways to achieve quantum jump in crop yields is to utilize the dominance and over dominance gene effects

Table 1. Average performance of Parent, F1's and heterosis for nine characters of sunflower

S.No.	Characters under study	Parents	F1's	Heterosis
1.	Days to 50 per cent flowering	56.43	56.71	0.496
2.	Plant height	98.93	121.17	22.48
3.	Stem girth	4.66	5.75	23.39
4.	No. of leaves per plant	20.74	25.44	22.67
5.	Head diameter	9.00	11.27	25.22
6.	100 achene weight	3.10	3.55	14.52
7.	Husk content	29.15	27.38	-6.07
8.	Oil per cent	33.39	37.09	1.92
9.	Yield per plant	31.96	41.55	30.01

through heterosis breeding. The information on heterosis in sunflower has been provided by many workers (Putt 1964, Vranceanu et al. 1973, Seetharam, 1980). The present investigation was taken up with the aim to estimate heterosis for yield and its components in 56 top crosses of sunflower to ascertain their utility in practical breeding programme.

MATERIALS AND METHODS

The material comprised of four cytoplasmic male sterile lines viz., CMS F, CMS I, CMS PET-2 and CMS PF and 14 testers of sunflower. The 14 testers were crossed with each of four CMS lines in Rabi 1996. The resulted 56 Hybrids, together with 18 parents and two checks KBSH-1 (Hybrid check) and Co 4 (Varietal check) were raised in a randomised block design with three replications at TNAU, Coimbatore during Kharif 1997. Each entry was grown in single row plot of 4m length with a spacing of 60cm x 30 cm and was randomised separately in each block. Observations were recorded at appropriate stages on five randomly selected competetive plants in each row for nine characters such as days to fifty per cent flowering, plant height (cm), number of leaves per plant, stem girth (cm), head diameter (cm), 100 achene weight (g), husk content (per cent), oil content (per cent) and yield per plant (g). Oil content was determined by using Nuclear Magnetic Resonance Spectrometer (NMR) Oxford 4000 series. Heterosis was worked out over mid parent, better parent and over check based on the formula suggested by Liang et al. (1972).

RESULTS AND DISCUSSION

The mean values for achene yield (per plant value) in case of the female parents ranged from 26.09 (g) in Line CMS F to 38.67(g) in CMS PET-2. Similarly in pollen parent, it ranged from 22.66 (g) in M-130 to 44.58 (g) in 343B, whereas the hybrid combinations exhibited a wide range of 22.63g (CMS PF x RLC204) to 57.30g (CMS PFx 302 B).

Regarding heterosis, the average heterosis (Table 1) indicated considerable degree of heterosis for yield per plant (30.01) followed by head diameter (25.22), stem girth (23.39), number of leaves per plant (22.67), plant height (22.48) and 100 achene weight (14.52). Hence yield improvement will be drastic with these parents. Similar observations were seen in reports of Govindaraju et al. (1992). The analysis revealed that, in general the degree of heterosis vary considerably in each genotype for yield and other attributing traits, and is mainly dependent upon the specific cross combinations. About 34 crosses has significant positive heterosis for achene yield ranging 18.11 (CMS I x BC–31R) TO 93.28 (CMS I x BLC 175) and 13.68 (CMS PET-2 x BC-3-IR) to 96.97 (CMS I x BLC175) over better parents and mid parents respectively. Similarly the performance of the hybrids was compared with both hybrid check KBSH-1and the varietal check Co 4. The crosses exhibiting high magnitude of heterosis over checks for achene yield was identified (Table 2). The hybrids CMS PF x 343B (51.51, 38.64) and CMS I x RLC 215 (47.25, 34.74) conferred high percent of heterosis over the checks Co 4 and KBSH-1 for achene yield.

For oil content, (Table 2) three cross combinations namely CMS PF x BLC178 (15.74), CMS PF x RLC204 (13.55) and CMS F x RLC 215 (12.98) recorded significant positive standard heterosis values over the varietal check Co 4. Hence these crosses can be exploited for getting genotypes with high oil content and no genotype exceeded the hybrid check KBSH-1 in oil content ie. Standard heterosis over KBSH-1. For head diameter, significant positive effects were

Table 2. Comparison of Mean, heterosis for the selected 10 hybrids For yield per plant

Hybrids	Mean	Heterosis over mid parent	Heterosis over better parent	Heterosis over check KBSH-1	Heterosis over check Co 4
CMS PF X 343 B	57.30	42.10	28.53	38.64	51.51
CMS PET-2 X RLC 215	54.36	43.43	40.57	31.53	43.73
CMS I X RLC 215	55.69	75.77	49.99	34.74	47.25
CMS I X BLC 178	55.02	96.43	84.75	33.12	45.48
CMS F X RLC 215	52.90	43.43	40.57	31.53	43.73
CMS I X T10	52.67	96.97	93.28	27.44	39.26
CMS PET-2 X BLC 178	51.04	49.12	31.99	23.49	34.95
CMS PET-2 X M-140	50.64	26.81	22.91	22.53	33.89
CMS PF X T9	05.45	56.31	39.87	22.67	33.39
Parents (Average)	31.69	-	-	-	-
Hybrids (Average)	41.55	-	-	-	-

observed in twenty hybrids for standard -heterosis over the variety Co 4 and with the hybrid check KBSH-1 three cross combinations, CMS 1 x BLC178, CMS 1 x BC-3-IR and CMS 1 x BLC175 were significantly positive. Only one cross, expressed hybrid vigour over the hybrid check KBSH-1 for the trait 100 achene weight.

According to Borle et al. (1992), high heterotic expression of the hybrids were directly related to the high mean performance of the parents, similar conclusion can be drawn from this experiment as the mean expression of inbreds CMS PET-2 (38.67g), CMS PF (36,70g),RLC 215 (37.13g), 343B(44.58g) and M-140 (41.20g) (these inbreds become the parents for many superior cross combinations) is high for the trait achene yield.

Finally considering the mean expression and heterotic effects for seed yield 10 hybrids were selected. It is suggested that these 10 cross combinations may be utilized for further selection to develop superior populations with high yield and other attributes. Such superior populations could be further used to derive inbred lines for heterosis breeding.

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