

## Impact of Different Methods of Pollination on Seed Yield and Quality of Sunflower Hybrid, NDSH 1

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Sunflower is the country's premier oilseed crop cultivated in an area of 21,65,000 ha with a production of 12,28,000 ton and a productivity of 567 kg ha<sup>-1</sup> (2006-07). The cytoplasmic - genetic male sterility in sunflower paved the way for commercial hybrid development. Hybrids have high yield potential, suitable to intensive management conditions, uniform in maturity, high autogamy per cent and resistant to diseases like rust and downy mildew and tolerant to *Alternaria* leaf spot. Due to these reasons, area under sunflower hybrids is comparatively more than open pollinated varieties. Hybrid seed production in sunflower is based on three line (CGMS) system, where CMS (A) line, maintainer (B) line and restorer (R) lines are involved. At present, block method is being followed in hybrid seed production plots of sunflower to reduce contamination of restorer and hybrid seed during harvesting time. In sunflower, seed setting is the major production constraint owing to many factors. Therefore to overcome this problem several measures are being adopted. One such important measure for good seed setting in hybrid seed production plot is, resorting to manual hand pollination besides open pollination. This involves maximum investment towards labor. On the other hand, honeybees are observed to be efficient pollinators to promote seed setting and seed yield in commercial sunflower fields. However, pollen loss by honeybees is observed since honeybees take away pollen and rarely visit female lines resulting in poor seed set. Low

yields obtained with bee pollination could be attributed to high mortality of bees during early stages of the placement of the bee hive within the cage. Further, the bees tend to assemble at the corners of the cage instead of visiting flowers. Hence, a study was conducted to find out the impact of different pollination methods on seed yield and quality of sunflower to minimize investment on regular hand pollination.

The experiment was conducted during *rabi*, 2007-2008 in hybrid seed production plot of sunflower hybrid, NDSH 1 at Seed Research and Technology Center, Rajendranagar, Hyderabad. The parental lines of NDSH 1 viz., RHA 859 (R-line) and CMS 234 A (A-line) were sown in block method in 3:9 ratio. The experiment was laid out in a randomized block design with three replications each. The size of each plot was 36 m<sup>2</sup> with a spacing of 60 x 30 cm. Eight treatments viz., open pollination, open pollination + hand pollination on alternate days, daily hand pollination, bee pollination (4 frames), bee pollination (8 frames), bee pollination + hand pollination, net pollination and spraying of sugar spray at 25, 50 and 75 per cent flowering were imposed in hybrid seed production plot of NDSH 1 wherein the parental lines viz., RHA 859 and CMS 234A were taken up in block method (3:9 ratio).

Significant differences were noticed among the treatments under study (Table 1). Seed yield ranged from 2.08 q ha<sup>-1</sup> (net pollination) to 12.64

q ha<sup>-1</sup> (open pollination coupled with hand pollination on alternate days). Of the 8 treatments imposed, high seed yield of 12.64 q ha<sup>-1</sup> was reported by open pollination supplemented with hand pollination on alternate days and was significantly on par with bee pollination coupled with hand pollination (11.28 q ha<sup>-1</sup>).

However, open pollination coupled with hand pollination on every alternate day differed significantly from open pollination coupled with daily hand pollination which resulted in an yield of 9.96 q ha<sup>-1</sup>. Open pollination coupled with hand pollination on every alternate day resulted in a yield advancement by 26.91 per cent compared to open pollination + daily hand pollination. Daily pollination resulted in less yields compared to hand pollination on every alternate day. The injury to the stigmatic surface with daily hand pollination might have led to poor seed set development. Further, there would have been delay in seed development process leading to poor accumulation of photosynthates in the seed. All these disturbances might have affected pollen viability and stigma receptivity. Consequently leading to poor seed set, seed yield, and other quality attributes as compared to hand pollination on every alternate day [1]. Similarly, increased seed yield and seed number were reported with pollination on every alternate day [2]. Decrease in the number of seeds head<sup>-1</sup> with increase in the intervals of hand pollination has been reported [3].

On the other hand, highest yield in open pollinated plots was found to be significantly on par with hand pollination on every alternate day or 3 days. While daily hand pollination recorded low yield levels [1].

Treatments involving bee population (8.40 q ha<sup>-1</sup> with four frames and 9.29 q ha<sup>-1</sup> with eight frames) also resulted in less yield compared to hand pollination (9.96 q ha<sup>-1</sup>). Similarly, better productivity was also reported with hand pollination compared to bee pollination, open pollination and plots caged without bees [4]. On the other hand, significantly higher yield of sunflower with open pollination compared to supplementary hand pollination was reported suggesting that the available honey bee

population in the nature is adequate to pollinate the hybrid seed production plots [5]. Sharp decrease in seed yield capitulum<sup>-1</sup> was noticed with bee pollinated plots and hand pollination compared to open pollination [6].

Open pollination recorded more head diameter (16.7 cm) followed by bee pollination with 8 frames (16.4 cm). Seed setting percentage was high with bee pollination coupled with hand pollination (60.46) followed by open pollination coupled with hand pollination on alternate days (57.04), daily hand pollination (55.83) and bee pollination with eight frames (50.18). While net pollination (1.16) and open pollination (10.23) recorded low seed setting. On the other hand, Singh *et al.* [1] reported highest number of hybrid seeds per capitulum in open pollinated plots followed by daily hand pollination. Increased number of filled achenes per capitulum in supplementary hand pollination than open pollination could be attributed to increased proportion of fertilized ovules in supplementary hand pollination. This shows superiority of supplementary hand pollination which could be attributed to the efficient pollination and fertilization effected by manual transfer of pollen during anthesis.

Net pollination recorded more test weight (11.0 g) followed by spray of sugar solution on heads of female line at 25, 50 and 75% flowering (9.42 g). While minimum test weight was observed with open pollination coupled with hand pollination on every alternate day (7.73 g per 100 seeds). From the data it is clear that test weight is not in tune with seed yield plant<sup>-1</sup>. Decrease in test weight with increase in frequency of hand pollination was reported by Ganapathi *et al.*, [7] who further reported higher achene weight in open pollinated plot than hand pollination. Increased test weight in net pollinated plot could be due to minimum seed setting per cent and as a result all the available photosynthates might have been translocated to the limited sinks; consequently, resulting in higher seed weight compared to rest of the treatments. This is in accordance to the findings of Ganapathi *et al.*, [7]. On the other hand in open pollination coupled with hand pollination on alternate days,

due to increase in sink number as reflected by seed setting per cent, all the available photosynthates would have been distributed equally and as a result the seed weight decreased.

Bee pollination with four frames (8.89 g) and bee pollination with eight frames (8.20 g) were found to be significantly on par with each other w.r.t. test weight but differed significantly from bee pollination + hand pollination (7.92 g). On the other hand, Singh and Sinha [8] reported no significant differences in filled seeds head<sup>-1</sup>, seed setting per cent and test weight in bee pollination, open pollination, hand pollination and supplementary pollination at daily, alternate days, 2-days and 4-days interval. Rajagopal *et al.*, [9] reported maximum number of filled seeds in plots pollinated by both hand and bees followed by open pollination by bees, and hand pollination.

It is interesting to note that the use of honey bees as pollinating agents resulted in more oil

content compared to all other treatments. Honey bees get attracted to the florets for nectar in the morning hours. This coincides with the peak pollen dehiscence and stigma receptivity period. Thus there is a great possibility for transfer of viable and healthy pollen by honey bees [4]. This could be one of the reasons for obtaining hybrid seed with good oil content. Among all the treatments, bee pollination coupled with hand pollination (39.56%) had high oil content and was significantly different from bee pollination with eight frames (37.10%) and bee pollination with four frames (36.73%). Minimum oil content was recorded with net pollination (31.63%) followed by daily hand pollination (34.46%). High oil content with hand pollination + insect pollination and low oil content in cages without insect pollination was observed [10]. Similarly, hybrid seed obtained through honey bee pollination had increased oil yield [11, 12] than hand pollination. Abrol [4] reported significantly higher oil content in bee pollination and open pollination compared to supplemental pollination.

Table 1. Impact of different methods of pollination on seed yield of sunflower hybrid, NDSH 1

S.No.	Treatments	Head diameter (cm)	Seed setting (%)	Seed yield (g pl <sup>-1</sup> )	Seed yield (kg plot <sup>-1</sup> )	Seed yield (q ha <sup>-1</sup> )	100 seed weight (g)	Oil content (%)
1	Open pollination	16.7	10.23	5.83	1.01	2.80 <sup>b</sup>	8.70	35.66
2	Open pollination+hand pollination on alternate days	15.3	57.04	28.69	4.55	12.64 <sup>a</sup>	7.73	35.03
3	Daily hand pollination	14.8	55.83	26.57	3.59	9.96 <sup>b</sup>	8.10	34.46
4	Bee pollination (4 frames)	15.8	47.01	23.04	3.02	8.40 <sup>b</sup>	8.89	36.73
5	Bee pollination (8 frames)	16.4	50.18	25.35	3.35	9.29 <sup>b</sup>	8.20	37.10
6	Bee pollination+hand pollination	15.3	60.46	30.11	4.06	11.28 <sup>a</sup>	7.92	39.56
7	Net pollination	15.5	1.16	0.77	0.75	2.08 <sup>b</sup>	11.0	31.63
8	Sugar spray on heads at 25, 50 and 75 % flowering	15.9	15.59	8.36	1.04	2.88 <sup>b</sup>	9.42	35.36
	Grand mean	15.71	37.186	18.59	2.67	7.41	8.75	35.70
	S.Em.	0.38	1.109	0.83	0.27	0.76	0.20	0.71
	S.Ed.	0.53	1.568	1.17	0.38	1.07	0.28	1.01
	C. D. (0.05)	1.14	3.356	2.51	0.82	2.29	0.60	2.15
	C.V. (%)	4.14	5.17	7.73	17.64	17.64	3.93	3.45

Table 2. Impact of different methods of pollination on seed quality of sunflower hybrid, NDSH 1

S.No.	Treatments	Field emergence index	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling dry wt (g)	Vigor index on seedling length basis	Vigor index on seedling dry wt basis
1	Open pollination	16.55	96(79)	14.27	10.21	2.25	2350.08	216.00
2	Open pollination + hand pollination on alternate days	18.72	98(81)	16.91	9.76	2.20	2613.66	215.60
3	Daily hand pollination	13.71	98(82)	15.58	9.37	2.10	2445.10	205.80
4	Bee pollination (4 frames)	15.13	93(75)	14.62	8.30	2.21	2131.56	205.53
5	Bee pollination (8 frames)	15.79	95(77)	15.13	9.50	2.18	2339.85	207.10
6	Bee pollination + hand pollination	14.26	99(85)	16.11	10.35	2.20	2619.57	217.80
7	Net pollination	12.36	95(77)	15.70	9.10	2.12	2356.00	201.40
8	Sugar spray on heads at 25, 50 and 75 % flowering	19.20	96(79)	15.37	8.83	1.97	2323.20	189.12
	Grand mean	15.72	96.0(79)	13.45	9.29	2.15	2393.38	207.29
	S.Em.	1.43	0.96(1.51)	0.47	0.55	0.08		
	S.Ed.	2.02	1.36(2.13)	0.66	0.77	0.11		
	C. D. (0.05)	4.32	2.90(4.57)	1.42	1.68	0.23		
	C.V. (%)	15.73	1.73(0.03)	6.03	10.24	6.21		

Values in parentheses are arc sine transformed values

The effect of different modes of pollination on seed quality parameters indicated that bee pollination coupled with hand pollination resulted in high germination (99%) followed by open pollination coupled with hand pollination on every alternate day (98%) and daily hand pollination (98%). Abrol [4] reported significantly higher germination per cent in bee pollination and open pollination compared to supplemental pollination. Singh *et al.* [1] reported maximum standard germination with hand pollination at 3 days interval.

The hybrid seed obtained with daily hand pollination gave germination below the certification standards [7]. In the present study, open pollination coupled with hand pollination on alternate days resulted in high vigor index

on seedling length basis (2613.66) followed by daily hand pollination (2445.10). While, bee pollination coupled with hand pollination resulted in more vigor index on dry weight basis (217.80) and is on par with open pollination + hand pollination (215.60). Prabhu *et al.* [13] reported more germination, root length, shoot length, seedling dry weight, field emergence and seedling vigor index with seeds obtained from hand pollination and spray of Bee-Q.

Open pollination of the seed parent coupled with hand pollination on every alternate day resulted in higher yield of the hybrid seed coupled with good quality (Tables 1 and 2). Seed obtained through daily hand pollination was found to be of poor quality w.r.t. to vigor index. Though germination was high, field emergence

index was very low indicating that the seed has less vigor compared to the seed obtained through other pollinating methods. The field emergence index was found to be high with spray of sugar solution on female heads at 25, 50 and 75 per cent flowering. The better quality of the hybrid seed obtained might be due to efficient translocation of the available photosynthates to the limited available sinks. As a result, more nutrients were made available to fewer seeds in the capitulum and further there was more space for seed development. All these factors might have contributed to good field emergence.

In conclusion, by resorting to hand pollination on every alternate day, farmers can not only realize good quality and quantity of hybrid seed, but can also save investment towards labor; thereby minimizing the cost of production.

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