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STUDIES ON HOLLOW SEEDEDNESS IN SUNFLOWER

By

K.K. Jain, D.P. Vaish, H.K. Gupta and S.S. Mathur
Sunflower Research Station
University of Udaiput,
Kota (Raj.) India

Summary

Hollow seededness was observed sometimes as high as 50% in certain seasons and cultivars. This problem was studied in a number of ways to determine its causes and solution. Self incompatibility was found to be of common occurence, though self compatibility did exist, which was found to be a varietal character. It was thus possible to reconstitute self compatible populations out of such strains.

Absence of sufficient insects population, slow movement of pollens, temperature, humidity, rainfall, heavy dose of Nitrogenous fertilizers, and size of the head had all been found to be responsible to a smaller or greater extent in causing hollow seededness. Varietal character also has been found to be responsible to some extent. The role of wind as a pollinator was however negligible.

The solution of this problem was discussed under four heads.

1. Search for self compatible lines, which would not be dependent on insect population for good pollination and seed set.

2. Adjustment of sowing dates in order to avoid low temperature ($10^{o}C$ and below) during flowering period, which adversely affect bee population.

3. Heavy dose of Nitrogenous fertilizers (above 60 kg N per ha) should be avoided.

4. Negative significant correlation was found to exist between head size and percentage of well filled up seed, when head diameter mean of the population was 17 cm. In case of another population with a mean diameter of 7 cm, this correlation was positive and highly significant. Thus the plant population should be manipulated by adjusting sowing distance (60 cm x 15 cm) in order to avoid development of large sized heads.

Sunflower is a recent introduction in the state of Rajasthan. Few Russian cultivars were introduced in 1971 for regular demonstrations and soon it was established that as a short duration crop, not season bound rich in oil content, and high productivity per unit of area, time and water, it is bound to become one of the members of traditional oilseed crops of this state. However, in its new habitat, it presents unique problems believed to be due to the fact that the crop recently been transferred from the temperate zones to the lower eleva-

tion of the tropics. Poor seed set is clearly the most serious problem due to which yield is drastically reduced (Putt, 1975).

A number of factors have been affecting this very complicated problem. For understanding this, a team of scientists is needed with capability in Anatomy, Physiology, Nutrition, Biochemistry, Cytology, Histology, Entomology, and Genetics (Putt, 1975). An attempt was also made to study this problem in a number of ways with an object to find out its solution and the result have been summarized under different heads.

Materials and Methods

Cultivar EC 68414 (Peredovik) was used as basic seed material in various experiments, except where several cultivars were needed. Statistical parameters were worked out as usual with standard methods, where quantitative data were involved.

Results

1. Seed setting under different systems of pollination in different cultivars. Seed setting under selfing, sibbing, and open pollination was studied in 108 cultivars. It was concluded that seed setting varied from cultivar to cultivar (Table 1).

The best seed setting was observed under open pollinated condition followed by sibbing. Few cultivars however showed poor performance even under open pollinated conditions. Under selfing the behavior was just the reverse. Few cultivars had good seed setting under selfing, while 61% of the cultivars showed seed setting below 20%. Thus it was concluded that in sunflower there was high degree of self incompatibility, but in few cultivars, self compatibility did exist.

2. Effect on seed setting in various seasons. Studies made in 108 cultivars under open pollinated conditions in three important seasons, namely Rainy season, (Temp. 18°C - 40°C), Winter season (Temp. 5°C - 28°C), and Summer season (Temp. 24°C - 46°C) revealed (Table 2) that good seed setting was observed in summer as well as winter seasons equally, but during rains the seed setting was poor probably due to lesser insect population at the time of flowering. The other reason of this poor seed set was washing of pollens due to rains.

3. Problem of pollen movement. It has been already observed that under selfing, the seed set was very poor, although the pollen was quite viable and stigma also normally remained receptive. The pollen movement thus may be very slow under selfing, due to absence of pollinating agencies which resulted in poor seed set.

With a view to study mechanism of pollen movement, which took place mainly due to insects, wind, and mechancial pressure exerted by another sac at the time of dehiscence, this experiment was taken up.

Details of experiments: Cultivars EC 68414 was selected for these studies. The pollen movement were caused by three methods artificially as follows:

a. Rubbing of pollen by camel hair brush gently on the capitulum immediately after dehiscence.

b. Hand shaking of the capitulum after dehiscence, which resembled shaking of the plant due to wind.

c. Puffing by an empty flit pump over a capitulum after dehiscence, which resembled movement of pollens due to gentle wind.

d. Selfing under cloth bag without disturbing the pollens (check).

e. Open pollination.

Under a to b treatments, no insects were allowed to take part in pollination due to constant bagging, except at the time of treatment, when the cloth bags were removed for treatment, and these were replaced as soon as the treatment was over. Under 4th condition cloth bag was allowed to remain constantly. Percentage of seed set under three treatments was worked out. (Table 3).

From these results, it was concluded that in sunflower the pollen movement was really a problem, when insects are absent as in treatments b and c. When the heads were shaken by hand daily after dehiscence, there was an improvement of seed setting to an extent of 48.7% as compared to check (28.5%). The best seed setting took place under upon pollination, as was expected followed by treatment a, in which the movement of pollen was affected by brush.

4. Studies on pollen movement under hand supplemented condition. Normally under natural condition the pollination is brought about by external agencies like insects and winds. It was also planned to see whether efficiency can be further increased if the pollen movement is supplemented with hand artificially together with these natural agencies. For this purpose, monthly sowings of the crop throughout the year were carried out. Average seed setting for the 12 sowings showed that under natural condition this percentage was 78.0 as compared to 81.8 under hand supplemented condition.

5. Effect of fertilizers on hollow seededness. Trial at one location indicated that increased dose of nitrogenous fertilizers increased hollow seededness significantly. Different levels of P and K did not have any effect on hollow seededness. (Table 4.)

6. Varietal differences. In order to study whether there were really varietal differences as regards hollow seededness was concerned, two trials with six replications consisted of 13 and 6 cultivars were conducted (Table 5).

Both these trials were marginally significant and indicated that environment was playing a major role in affecting hollow seededness. Varietal differences did exist. Observations taken on insects population indicated that during flowering period honey bees were completely absent (minimum temp. $8^{o}C$ to $14^{o}C$) but the other pollinators like flies and butterflies, present in the field were responsible for the pollination.

7. Effect of temperature, humidity and bee population on seed setting. Cultivar EC 68414 was sown all the year round each month in the year 1976-77 indicated that seed setting is affected to a certain extent by temperature, humidity and bee population (Table 6), which needed confirmation under controlled conditions.

Temperature: It is the mean minimum temperature which appeared to be a limiting factor affecting seed setting. With mean minimum temperatures varying from 10°C to 20°C. The average seed setting was 84% as against 73% with average temperature range of 21°C - 30°C.

Humidity: Lower mean humidity was found to be associated with better seed set. With mean humidity of 60-80, the seed set was 75.5% as against 80.5% obtained with mean humidity of 40 to 60.

Bee population: With mean bee population of 10-20, the seed set was 80.5% as against 75.5% under 0-10 bee population. It was further observed that, when bee population was nil, the seed setting was 77%. Looking to this situation, it was further concluded that apart from bee role of other insects in pollination was also very important.

8. Role of insects other than bees in seed setting. Sunflower is an entomophilous crop. In order to determine the role of various insects, an experiment was laid out by using cages of various meshes to allow selective insects to visit the capitulums. (Table 7.)

The following conclusions were drawn from the results (Table 7).

a. The hollow seededness was maximum under muslin cloth, where insects and winds were not allowed to take part in affecting pollination.

b. The insects other than bees also were responsible to bring about pollination to a great extent.

c. Wind also took part, but its role appeared to be very minor.

d. The foremost role of bees and butterflies taking part in pollination was amply clear, where control was compared with treatment a.

9. Effect of capitulum size on seed setting. It has been observed that larger the diameter of the capitulum, more is the percentage of empty seeds. In order to confirm this fact, two populations of EC68414 were studied for working out correlations existing between these two characters namely capitulum diameter and percentage of filled seeds. (Table 8.)

In both cases, correlations were highly significant, and it was concluded that in a population with smaller size of heads (Population I), percentage of filled seeds varied directly with the diameter of the capitulum, but this correlation became negative in another population, where capitulum size was big (Population II). Thus, in order to minimize the hollow seededness, the population was so adjusted by manipulating the planting distances, so that head size

may not be very big. The optimum spacing found was 60 cm x 15 cm, where head size can be controlled to a great extent.

Discussion

The extent of hollow seededness was observed from the year 1972 to 1976 in one single cultivar EC 68414 (Peredovik). (Table 9.)

During the last six years, hollow seededness varied from 5 to 50 percent with a mean of 14 to 30 percent. These figures were quite high and naturally yield was seriously affected. The solution of this problem can be discussed under four heads.

1. Search for self compatible lines: Sunflower is essentially a cross pollinated crop with high degree of self incompatibility existing in it. However, it was observed that self compatibility did exist, and it was possible to develop self compatible lines, which would not require help of insects to bring about pollination, resulting in good seed setting. This station had actually developed lines with more than 80 percent seed setting under selfing. Thus from these lines, self compatible population can be developed, which would not depend upon insects for pollination. By far, it appeared to be a practical solution for this problem.

2. Sowing dates: The adjustment of sowing dates should be such so that during peak flowering periods, low temperatures and heavy rainfall may not coincide, which otherwise would affect density of insect population which should be optimum.

3. Fertilizer application: Higher dose of nitrogenous fertilizers (above 60 kg N/ha) should be avoided under Rajasthan State conditions, which appeared to increase hollow seededness to some extent.

4. Spacing: Negative correlation was found to exist between head size and percentage of well filled up seed. Size of the head depended to a great extent on spacing. A spacing of 60 x 15 cm was found to be optimum. With this spacing head size did not go beyond 10 to 15 cm, and thus hollow seededness was avoided to a great extent.

Reference

PUTT, E.D., 1975. Terminal report All India Coordinated Research Project for Dryland Agriculture, Hyderabad, India, pp. 1-23.

TABLE 1. Frequency Distributions of Percentage of Seed Setting in 108 Cultivars Under Different Systems of Pollination (Average of three seasons.)

System of Pollination	Percentage of Seed Setting											Total Cultivars
	Less than 1%	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	
Open Pollination	-	-	-	3	3	4	6	12	19	30	31	108
Sibbing	-	4	4	5	3	6	8	13	17	25	23	108
Selfing	32	11	19	7	5	6	4	5	5	7	7	108

TABLE 2. Frequency Distribution of Percentage of Seed Setting in 108 Cultivars Under Open Pollinated Conditions in Different Seasons.

Season	Percentage of Seed Setting											Total Cultivars
	Less than 1%	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	
Rainy	-	-	-	7	9	10	15	26	22	15	4	108
Winter	-	-	-	-	-	2	2	6	17	32	49	108
Summer	-	-	-	-	-	2	1	4	20	44	37	108

TABLE 3. Percentage of Seed Set Under Various Treatments Causing Movements of Pollens.

S.N.	Name of the Treatment	% of Seed Set	Insects Allowed to Bring About Pollination
1.	Brush	79.6	Insects not allowed
2.	Hand Shaking	48.7	Insects not allowed
3.	Puffing	27.9	Insects not allowed
4.	Selfing (Check)	26.5	Insects not allowed
5.	Open Pollination	87.3	Insects allowed

TABLE 4: Percentage of Seed Set Under Various Levels of N, P and K.

Treatments dose/ha in kg.		Percent Hollow Seeds
N	0	14.0
	60	20.4
	120	32.1
CD at 5%		10.9
P_2O_5	0	21.1
	75	25.2
	150	21.2
CD at 5%		10.9
K_2O	0	26.1
	60	20.5
	120	21.0
CD at 5%		10.9

TABLE 5. Percentage of Seed Set in Various Cultivars Under Open Pollinated Conditions.

S.N.	Name of the Cultivars	Average Percent of Hollow Seededness
1.	EC 101495	44.14
2.	EC 101494	24.50
3.	EC 101493	31.80
4.	EC 101492	41.72
5.	EC 101491	50.92
6.	EC 101490	43.94
7.	EC 101489	40.48
8.	EC 69874	38.07
9.	EC 68414	52.05
10.	Bulgarian Peredovik	19.12
11.	Romsun Record	35.51
12.	EC 101497	48.24
13.	EC 101496	37.01
	Mean 38.3%	CD at 5% 26.13
Experiments II		
1.	EC 110735	26.62
2.	EC 110736	23.48
3.	EC 110737	21.17
4.	EC 110738	27.50
5.	EC 69874	39.97
6.	EC 68414	29.08
	Mean 27.9%	CD at 5% 8.38

TABLE 6. Percentage of Seed Setting Under Open Pollination with Different Temperature, Humidity and Bee Population During 1976-77.

S.N.	Date of Sowing	Average Bee Population	Mean Temperature		Mean Humidity	% Seed Set
			Minimum	Maximum		
1.	1/7/76	2.00	24.81	32.31	80.87	55.2
2.	1/8/76	14.61	20.37	36.50	54.62	90.3
3.	1/9/76	20.66	20.82	33.41	62.28	81.0
4.	1/10/76	8.62	12.25	23.90	72.11	85.4
5.	1/11/76	0.55	10.62	24.41	63.09	82.6
6.	1/12/76	15.73	17.70	31.86	60.13	82.6
7.	1/1/77	20.00	23.80	39.10	43.40	70.3
8.	1/2/77	12.40	25.30	39.20	40.80	77.0
9.	1/3/77	12.60	25.80	41.40	50.80	81.8
10.	1/4/77	9.60	29.30	42.70	52.60	81.2
11.	1/5/77	8.10	26.30	36.30	78.00	71.8
12.	1/6/77	Nil	27.36	36.63	70.00	55.2

TABLE 8. Correlations Between Percent of Filled Seeds and Head Diameter in Two Populations.

Population	Mean Diameter of Capitulum	Range of Diameter	Correlation Coefficient
Population I	6.71 cm	3.0-16.5 cm	+ 0.8257
Population II	17.10 cm	3.0-32.0 cm	- 0.5580

TABLE 9. Hollow Seededness in Various Years.

Year	Mean Percent Hollow Seededness	Range of Percent Hollow Seededness
1972-73	26.5	5 - 50
1973-74	19.0	5 - 45
1974-75	14.5	5 - 25
1975-76	20.0	10 - 25
1976-77	21.5	15 - 50
1977-78	30.6	19 - 45