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SELF–INCOMPATIBILITY AND AUTOGAMY OF SUNFLOWER (*Helianthus annuus* L.) CULTIVARS

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SUMMARY

The autogamy and self–incompatibility of four sunflower cultivars namely NK–262, NK–265, NK–281 and Sundak were investigated under six pollination treatments. The pollination treatments were natural self–pollination, manipulated self–pollination, assisted self–pollination, foreign pollination, cross–pollination. It appeared that sunflower cultivar NK–262 was self–compatible. Whereas, the efficacy of these pollination treatments in NK–265, NK–281 and Sundak were affected due to the ratio of seedset and autogamy exhibited by these sunflower cultivars. However, Sundak was self–incompatible. Maximum seedset (96.25%) was recorded in sunflower cultivar NK–262 under open–pollination. The minimum seed set of 12.14% resulted in Sundak when assisted self–pollination was adopted.

Estimates for percent autogamy of NK–281 were higher (92.64%) under cross pollination. However, the autogamy for the other pollination treatments was minimum. There were significant differences among the sunflower cultivars for the percent modified autogamy. NK–262 and Sundak exhibited maximum and minimum modified autogamy of 101.45% and 28.70%, respectively.

Key words: Sunflower, autogamy, self–incompatibility, pollination treatments.

INTRODUCTION

Sunflower being a cross–pollinated crop, honey bees are major source of its pollination. Their acitivity is seriously impeded by adverse weather conditions. Under such conditions seed setting reaches its lower limit, particularly in self–incompatible sunflower varieties (Birch et al., 1985). Contrarily to this, increased seed set percentage in bagged capitulum of sunflower has been reported by Leclereq (1980). Pertaining to such reports four sunflower cultivars were evaluated for their self–incompatibility and autogamy characters by using six different pollination treatments. Besides this, a value which may be called "modified autogamy" was also calculated in this paper.

MATERIALS AND METHODS

Three commercial sunflower hybrids, namely, NK–281, NK–262, and NK–265, and an open pollinated variety, Sundak, were chosen for this study. These will be referred to as cultivars in the reminders of this text. Among the cultivars, Sundak has a low self–fertility.

To evaluate self–fertility among the sunflower cultivars in the absence of honey bees, a technique using cotoon bags was adopted. These cotton bags are used because they are

lighter, cooler and keep the disk florets intact. They also permit better air penetration, which is important in reducing any adverse effects of high temperature especially during hot weather (Low and Pistillo, 1986).

Six pollination treatments were applied to each sunflower cultivar. The treatments were:

1. **Natural self–pollination (N):** Sunflower heads were cloth bagged before flowering. The bagged heads were allowed to self–pollinate under natural conditions and were not disturbed until harvest.
2. **Manipulated self–pollination (M):** Sunflower heads were bagged with cloth bags before flowering. During flowering, the heads were rubbed through the bags on alternate days to ensure self–pollination. The cloth bags remained on the sunflower heads until harvest.
3. **Assisted self–pollination (A):** Prior to flowering, the heads were cloth bagged then at flowering, plant's own pollen was collected and re–distributed over the head.
4. **Foreign–pollination (F):** Before flowering, the heads were bagged with cloth bags. During flowering the pollen was collected from maize (*Zea mays* L.) plants and dusted over the face of the sunflower heads. This treatment was meant to stimulate open–pollination in bagged environment.
5. **Cross–pollination (C):** Before flowering, the heads were bagged with cloth bags. At flowering, mixtures of pollen from unrelated sunflower genotypes were collected and applied to sunflower heads on alternate days.
6. **Open–pollination (O):** Sunflower plants were left uncovered to open–pollinate and were not disturbed.

Each pollination treatment was applied to five randomly selected plants from each cultivar in a replication. The sunflower cultivars were planted in the experimental area of the Department of Plant Breeding & Genetics, University of Agriculture, Faisalabad, on March 10, 1988. Plant to plant and row to row distance were kept at 23 cm and 60 cm, respectively. The experiment was laid out in a randomized complete block design with split–plot arrangement in three replications. The four sunflower cultivars and the six pollination treatments were placed in the main and sub–plots, respectively. The main plot consisted of six rows of sunflower cultivars which were planted with the help of a dibbler.

Two seeds were planted per hill. Plant population was thinned to one seedling per hill at the V2 stage (two leaf stage as explained by Schneiter and Miller, 1981). The normal cultural and agronomic practices were applied during the entire season of the crop. The data were recorded on the following traits:

1. *Head diameter (cm)*: The heads of five randomly selected plants from each pollination treatment, cultivar, and replication were separately harvested at physiological maturity. They were sun–dried and their diameter was measured in centimeters.
2. *Head weight (gm)*: Sunflower heads mentioned in trait 1 were separately threshed. The filled achenes were separated and weighed in grams.
3. *100–seed weight (gm)*: A sample of 100 filled achenes from each head was taken and weighed in grams.
4. *Number of unfilled achenes per head*: Unfilled achenes from each head were counted and recorded.

5. *Number of filled achenes per head*: Filled achenes from each head were counted and recorded.
6. *Total number of achenes per head*: Total number of unfilled and filled achenes per head were added and recorded.
7. *Seed set (percentage)*: Seed set percentage per head was calculated by using the following formula;

$$\text{Seedset (percentage)} = \frac{\text{Number of filled achenes}}{\text{Total number of achenes}} \times 100$$

8. *Autogamy percentage*: Mean weight of filled achenes from selfed plants and mean weight of filled achenes from open–pollinated plants was obtained. Autogamy percentage was calculated by the formula:

$$\text{Percent autogamy} = \frac{\text{Mean weight of filled achenes from selfed plants}}{\text{Mean weight of filled achenes from open–pollinated plants}} \times 100$$

9. *Modified autogamy*: Mean weight of filled achenes from cross–pollinated plants was obtained and the modified autogamy was calculated as:

$$\text{Percent modified autogamy} = \frac{\text{Mean weight of filled achenes from selfed plants}}{\text{Mean weight of filled achenes from crossed plants}} \times 100$$

10. *Oil Content (%)*: A seed sample from each harvested head was analysed for oil content. Determination of oil content was made with the help of a nuclear magnetic resonance apparatus.
11. *Fatty acids*: Two main poly–unsaturated fatty acids, namely linoleic and oleic acid, were determined from the seed sample of each harvested head by a gas liquid charomotography method.

STATISTICAL ANALYSES

The data collected for the above mentioned traits were statistically analysed through analysis of variance techniques (Steel and Torrie, 1980). Duncan's new multiple range test was applied to determine the significance of differences among treatments as well as cultivars.

RESULT AND DISCUSSION

Mean seed set, autogamy and modified autogamy averaged over pollination treatments for sunflower cultivars are present in Table 1. Sunflower cultivar NK–262 had the highest average seed set (79.11%) followed by NK–281 (77.98%) and NK–265 (71.05%). These three sunflower cultivars (NK–262, NK–265, and NK–281) did not differ statistically from each other (Table 1). However, Sundak had the lowest seed set (38.25%) and differed significantly from the other three cultivars.

Table 1. Mean percent seed set, modified autogamy and autogamy of four sunflower cultivars averaged over pollination treatments.

Sunflower cultivar	Seed set %	Autogamy %	Modified autogamy %
NK–262	79.11 a*	48.70 b	101.45 a
NK 265	71.05 a	44.09 b	91.29 a
NK 281	77.98 a	69.87 a	81.58 a
Sundak	38.25 b	37.25 b	28.70 a

* Means in a column followed by the same letter are not significantly different at the 5% probability level according to Duncan's new multiple range test.

The percent autogamy was maximum (69.87%) for NK–281 and it differed significantly from those for NK–262, NK–265, and Sundak. The latter three sunflower cultivars had the autogamy of 48.70, 44.09 and 37.25%, respectively, and they were non–significant among each other (Table 1). The percent modified autogamy of NK–281, NK–265, and NK–262 ranged from 81.58 to 101.45 percent. All these three sunflower cultivars did not differ significantly from each other (Table 1). However, Sundak had the lowest modified autogamy of 28.70% and it differed significantly from the other cultivars. These results confirm the findings reported by Robinson (1980) and George (1983).

The percent of seed set, autogamy and modified autogamy data for the different pollination treatments are presented in Table 2.

Table 2. Mean comparisons of various pollination treatments evaluated across sunflower cultivars for percent seed set, autogamy and modified autogamy.

Pollination treatment	Seed Set %	Autogamy %	Modified autogamy %
Natural self–pollination	48.13 d*	43.10 b	70.10
Manipulated self–pollination	61.87 c	40.76 b	65.90
Assisted self–pollination	61.37 c	54.69 ab	97.61
Cross pollination	77.82 b	68.86 a	–
Foreign pollination	59.61 c	42.48 b	69.41
Open pollination	91.96 a	–	–

* Means in a column followed by the same letter are not significantly different at the 5% probability level according to Duncan's new multiple range test.

The seed set percentage under open–pollination treatment was highest (91.96%) and it differed significantly from the other pollination treatments. The lowest seed set of 48.13% was observed in sunflower cultivars when natural self–pollination treatment was applied (Table 2). This treatment differed significantly from the other pollination treatments. Non–significant differences were observed among manipulated self–pollination, assisted self–pollination, and foreign pollination treatments having 61.87%, 61.37%, and 59.61% seed set, respectively. However, cross–pollination treatment in-

creased significantly the percent of seed set of sunflower cultivars up to 77.82%. These results are in accordance with the findings of Asthana (1973).

The percent of autogamy was highest from cross–pollination (68.86%) followed by assisted self–pollination (54.69%). Both these pollination treatments were mutually non–significant (Table 2). However, The lowest percent of autogamy (40.76%) was recorded in manipulated self–pollination. This pollinations treatment did not differ significantly from natural self–pollination (43.10%), assisted self–pollination (54.69%), and foreign pollination (42.48%) for the percent of autogamy (Table 2). The modified autogamy ranged from 65.90 to 97.61 percent for manipulated self–pollination and assisted self–pollination, respectively (Table 2).

The percent seed set data of sunflower cultivars for different pollination treatmets is presented in Table 3. There were no significance differences in seed set by using different pollination treatment for NK–262. Similar results were also reported by Leclereq (1980). In the cultivars NK–265 and NK–281, seed set percentage was lowest (37.46% and 69.14%, respectively) with natural self–pollination and foreign–pollination treatments. Whereas, the lowest seed set of 12.14% was obtained in Sundak under assisted self–pollination. Contrary to this, assisted self–pollination exhibited slightly increased self–seed set in sunflower cultivars NK–265 and NK–281 which indicates the inability of self–pollen to reach stigmatic surfaces which may contribute to reduced seed set in cultivar Sundak. Bagged sunflower heads in NK–265, NK–281, and Sundak indicated lower seed set than the open pollinated plants (Table 3).

Table 3. Mean percent of seed set of sunflower cultivars under various pollination treatments.

Pollination treatment	NK–262	NK–265	NK–281	Sundak
Natural self–pollination	62.44	37.46 d*	70.90 de	21.76 c
Manipulated self–pollination	86.09	65.90 c	74.18 cd	21.32 c
Assisted self–pollination	83.85	73.86 bc	75.63 c	12.14 d
Cross pollination	75.74	83.45 ab	83.75 b	58.35 b
Foreign pollination	75.10	73.55 bc	69.14 e	20.76 c
Open pollination	96.25	92.09 a	94.26 a	85.25 a

* Means in a column followed by the same letter are not significantly different at the 5% probability level according to Duncan's new multiple range test.

This implies that the bagging had a detrimental effect on seed setting, or that open–pollination has some beneficial effect on seed setting other than the pollen used for pollination.

There were non–significant differences in the percentage of autogamy among the pollination treatments for NK–262 and NK–281 (Fig.1). For Sundak, the autogamy of the crossed plants was greater than that of the selfed plants (N,M,A) and foreign pollinated plants. Whereas, autogamy percentage of NK–265 was maximum under assisted self pollination. Similar discrete estimates for the percent of autogamy were also reported by George (1983). Among the different modes of pollination studied, cross–pollination contributed significantly to the percent of autogamy.

There were no significant differences in the percent of modified autogamy among the pollination tretments for all four sunflower cultivars evaluated.

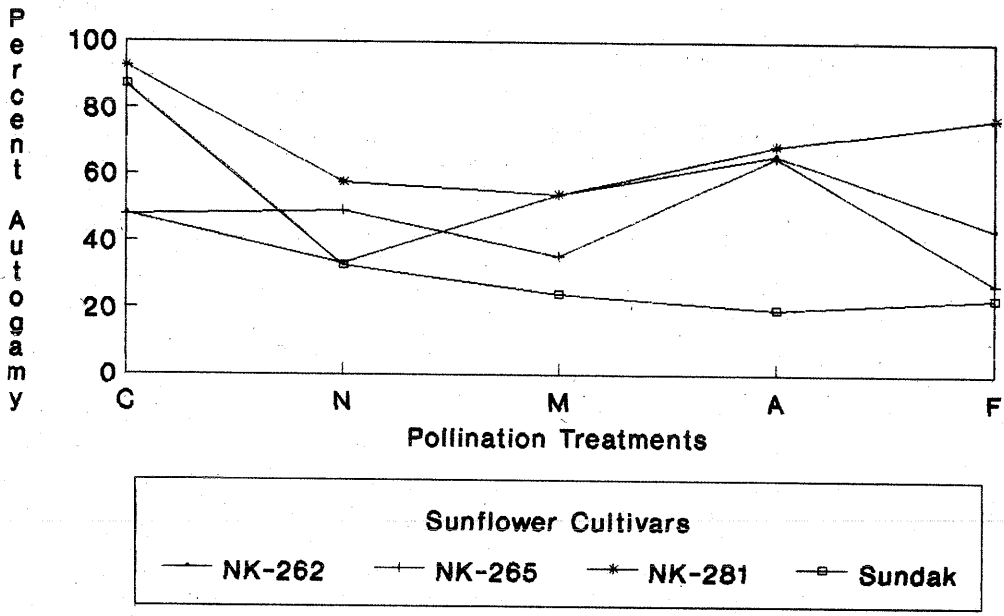

Fig.1. Mean percent autogamy of four sunflower cultivars evaluated under five pollination treatments.

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AUTOINCOMPATIBILIDAD Y AUTONOMIA DE CULTIVARES DE GIRASOL (*Helianthus annus* L.)

RESUMEN

La autogámia y autoincompatibilidad de cuatro cultivares de girasol, NK–262, NK–265, NK–281 y Sundak fué investigada en seis tratamientos de polinización. Los tratamientos de polinización fueron autopolinización natural, autopolinización manipulada, autopolinización asistida, polinización con polen foráneo, polinización libre. Los resultados sugieren que el cultivar NK–262 es autocompatible mientras que la eficacia de los tratamientos de polinización NK–265, NK–281 y Sundak fueron afectados debido a la proporción de semilla producida y autogamia que mostraron estos cultivares. Sin embargo, Sundak fue autoincompatible. La máxima producción de semilla (96.25%) se registró en el cultivar NK–262 bajo polinización libre; mientras que la producción mínima de semilla de 12.14% se produjo en Sundak cuando se adoptó la autopolinización asistida.

La estimación del portentaje de autogámia de NK–281 fueron más altos (92.64%) bajo polinización libre. Sin embargo la autogámia para otros tratamientos de polinización fué mínima. Existieron diferencias significativas entre cultivares para el porcentaje de autogamia modificada. NK–262 y Sundak mostraron un porcentaje máximo y mínimo de autogámia modificada da 101.45 y 28.70% respectivamente.

AUTOINCOMPATIBILITÉ ET AUTOGAMIE DE DIFFÉRENTS CULTIVARS DE TOURNESOL

RÉSUMÉ

L'autogamie et l'autoincompatibilité de quatre cultivars de tournesol (NK 262, NK 265, NK 281 et Sundak) a été etudiée au travers de six modalités de pollinisation. Ces modalités étaient l'autopollinisation naturelle, l'autopollinisation manuelle, l'autopollinisation assistée, la pollinisation par du pollen etranger et la pollinisation en croisement. Il apparait que le cultivar de tournesol NK 262 est autocompatible, tandis que sur NK 265, NK 281 et SUNDAK, les traitements de pollinisation voient leur efficacitée en relation avec la quantité de graines et l'autogamie. De plus, Sundak apparait autoincompatible. La quantité de graines maximale (96.25%) a été enregistrée sur le cultivar de tournesol NK 262 en pollinisation libre, tandis qu'un minimum de 12.14% a été observé sur Sundak en autopollinisation.