

POLLEN USE EFFICIENCY OF SUNFLOWER (*Helianthus annuus* L.) LINES cms 234 A AND RHA 6D-1

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SUMMARY

A field experiment was conducted at Agricultural Research Station, Bhananisagar, Tamil Nadu Agricultural University, Coimbatore, India during *rabi* (Sep-Oct) seasons of 2000 and 2001 to study the pollen use efficiency of sunflower lines cms 234 A and RHA 6D-1. The experiments consisted of four treatments, 100% pollen (T_0), 75% pollen plus 25% borax as filler material (T_1), 50% pollen plus 50% borax as filler material (T_2) and 50% pollen and 50% flour of finger millet (*Eleusine coracana* L.) (T_3). The results showed that the treatments were significantly differed from each other. All the traits studied recorded superior performance only at 100% pollen availability; the seed yield was very much increased only with an assured availability of sufficient pollen for fertilization. The mean comparison of the treatments for all the characters was $T_0 > T_1 > T_2 > T_3$. Though the seed yield was reduced to some extent while supplementing pollen with filler material, it was concluded that 75% pollen with 25% borax filler material may be used instead of 100% pollen, without affecting the economic yield much in the case of pollen scarcity /pollen insufficiency/ in locations where "pollen theft" is common. Borax can be used as supplement at the time of pollination. The use of flour of finger millet as the filler material in the case of pollen insufficiency during pollination does not have any effect on the seed yield and yield attributing characters. In that case the yield was affected only below 50% of pollen availability.

Key words: borax, filler material, finger millet flour, pollen use efficiency, sunflower

INTRODUCTION

Sunflower is a global oilseed crop of economic importance, which ranks third next to soybean and groundnut as a source of edible oil in the world. In India, sunflower was introduced in early seventies and holds as a potential oilseed crop. In

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allogamous crops like sunflower, pollen source and maternal influence assumes greater importance in determining seed yield as well as oil yield (Shankar Goud, 2000). The sporophytic type of self-incompatibility mechanism in sunflower has been reported by Habura (1957). This mechanism makes the ovule parent to accept foreign pollen in preference to its own pollen thus encouraging cross-pollination.

Though the crop has gained important place among farmers, the productivity of sunflower in India is much lower than the world's average. The seed production yield in sunflower is largely dependent on the proper pollination. Poor seed setting in sunflower is often considered to be a major reason for low yield. Some of the reasons for poor seed setting are self-incompatibility, absence of pollen vectors, insufficient nutrition and competition among developing seed themselves (Sindagi, 1979). In majority of the cases the pollination is very much inadequate or not properly followed, the pollen theft by honey bees in the early morning before pollination leading to non-availability of pollen to stigma resulting in poor seed set. Andrei (1998) reported that different amounts of pollen was released by the restorer lines in different seasons. Under this condition to avoid and/or manage the non-availability of pollen in sufficient quantity, pollen theft and economic use of pollen that is available in limited quantities and to increase the seed parent rows by reducing the pollen parent rows the study was carried out using the filler materials.

MATERIAL AND METHODS

The experiment was set up during *rabi* (September-October) seasons of 2000 and 2001 at an experimental farm of Agricultural Research Station, Bhavanisagar, Tamil Nadu Agricultural University, Coimbatore, India. The experiment was laid out in randomized complete block design with four replications. The parents of the sunflower hybrid KBSH-1, *cms* 234 A and RHA 6D-1, were raised in 3:1 ratio with a plot size of 5 x 2.4 m. To attain synchronization of flowering, female parent (*cms* 234A) was sown 5 days earlier than the male parent (RHA 6D-1). The parent seeds were dibbled at a spacing of 60 x 30 cm. The four treatments consisted of control, 100% pollen (T_0), 75% pollen plus 25% borax as filler material (T_1), 50% pollen plus 50% borax as filler material (T_2) and 50% pollen with 50% finger millet (*Eleusine corocana* L.) flour (T_3).

Hand pollination was carried out from the first ray floret opening for each treatment and continued up to 8 days. The pollination was done on alternate days. Pollen and filler materials were mixed on weight basis. During pollination care was taken to minimize the damage to the stigma by using soft muslin cloth to rub the pollen on heads. Each plant was covered with brown paper cover to assure the treatment effects. Ten plants were selected at random in female parent (*cms* 234 A) for recording the observations on nine quantitative traits, days to 50% flowering, days to maturity, head diameter (cm), seed weight per head (g), yield of raw seed (kg/plot), yield of processed seed (kg/plot), seed husk ratio and five quality charac-

ters, seed moisture at harvest (%), seedling length (cm), germination percentage, seed vigor index and oil content (%). The data were statistically analyzed using statistical methods suggested by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Effect of borax on seed number

Statistical analysis showed significant differences among all the treatments for head diameter and seed number per head. Seed filling percentage showed no significant effect between treatments T₂ and T₃ (Table 1) in both seasons.

Table 1: Effect of filler materials in cms 234A sunflower

Treatment	Head diameter (cm)		Mean (cm)	Seed filling percentage		Mean	Seed number per head		Mean
	2000	2001		2000	2001		2000	2001	
T ₀	14.28	15.12	14.70	89.55	90.35	89.95	386.05	390.75	388.40
T ₁	12.93	13.20	13.07	87.35	88.38	87.87	333.95	330.88	332.40
T ₂	11.65	12.56	12.11	85.18	86.23	85.71	260.90	266.40	263.70
T ₃	10.50	11.22	10.86	84.30	85.36	84.83	214.70	212.03	213.40
SEd	0.264	0.341	0.717	0.752			2.011	3.97	
CD 5%	0.596	0.771	1.623	0.701			4.55	8.99	

Pollination with 100% pollen recorded highest seed number per head due to higher seed filling percentage and head diameter (Figures 1 and 2) followed by 75% pollen and 25% of borax. The availability of pollen grains for pollination was entirely fulfilled when 100% pollen used and hence the fertilization might be maximum resulting in high seed filling percentage in turn it reflected in the high seed number per head.

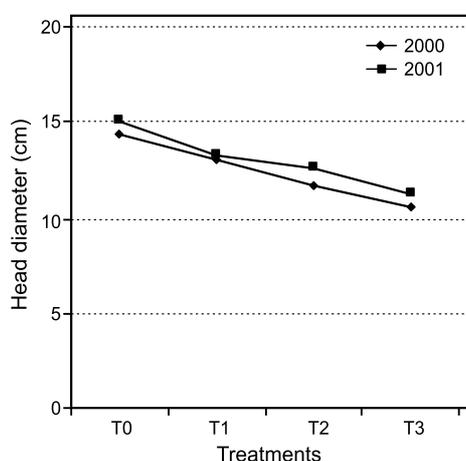


Figure 1: Effect of filler materials on mean of head diameter in sunflower

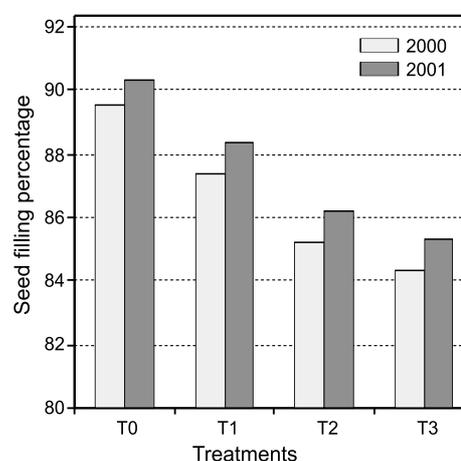


Figure 2: Effect of pollen and borax on mean of seed filling percentage in sunflower

It is evidenced from the results that when the pollen percentage declined to 75 and 50% the seed number was also declined, (Figure 3), since the availability of the pollen is insufficient to pollinate all the stigmas. The mean comparison of the treatments was $T_0 > T_1 > T_2 > T_3$. Seventy-five percent pollen with 25% of borax gave 86% seed number as on control. Borax is known to improve the pollen viability and fertilization and thereby improving the number of filled seeds. Narkhede and Patil (1989) reported that borax application alleviated the nutrient stress and increased the seed filling percentage.

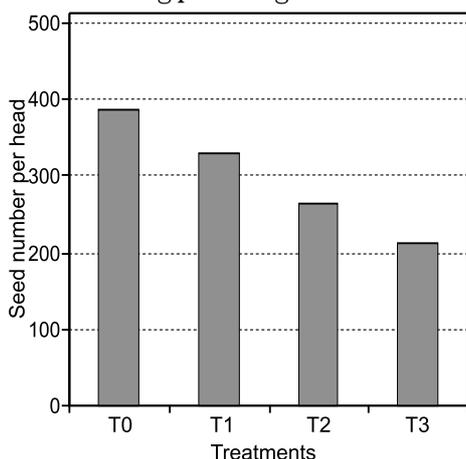


Figure 3: Relationship between pollen and filler materials on overall mean of seed number per head in sunflower

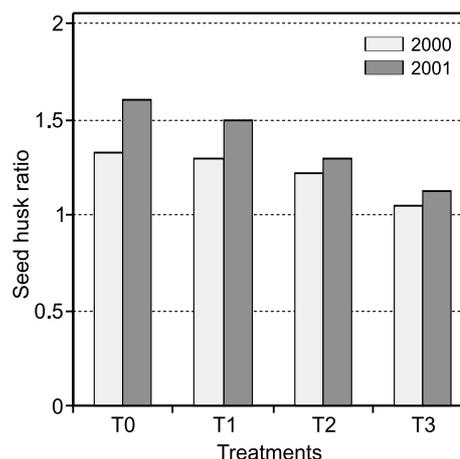


Figure 4: Effect of pollen and filler materials on mean of seed husk ratio in sunflower

Table 2: Effect of pollen on seed husk ratio, yield and oil content in cms 234A sunflower

Treatment	Seed husk ratio		Mean	Single plant yield (g)		Mean	Oil yield (g)		Mean
	2000	2001		2000	2001		2000	2001	
T ₀	1.33	1.60	1.47	14.23	15.45	14.84	5.67	6.26	5.97
T ₁	1.29	1.50	1.40	12.65	13.33	12.99	4.93	5.29	5.11
T ₂	1.22	1.29	1.26	10.84	10.23	10.54	4.18	4.00	4.09
T ₃	1.05	1.13	1.09	9.10	8.53	8.82	3.54	3.35	3.45
SEd	0.052	0.031		0.386	0.403		0.314	0.232	
CD 5%	0.118	0.070		0.873	0.912		0.710	0.524	

Effect of borax on seed yield and oil content

Significant differences were observed between the treatments for seed husk ratio (Figure 4), seed yield and oil content (Table 2). Pollination with 75% pollen and 25% borax gave next highest yield (12.99 g) to control (14.84 g) (Figure 5). The reason may be that borax plays a major role in membrane integrity and cell wall development and it helps in pollen tube growth. The treatment 50% pollen and 50%

borax filler materials also recorded significantly higher yield though pollen availability was reduced to 50%. Increased seed yield due to borax application was reported by Patil *et al.* (1983) and Sutaria and Golakiya (1990) in groundnut. The effect on oil yield was also increased by increasing the percentage of pollen (Figure 6).

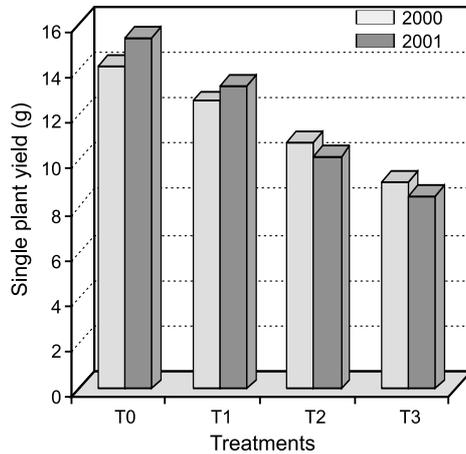


Figure 5: Effect of pollen and other filler materials on mean of plant yield in sunflower

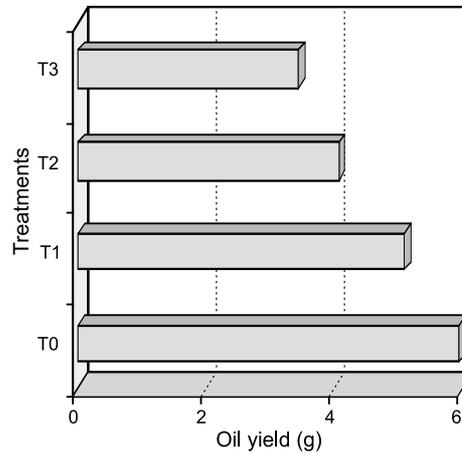


Figure 6: Effect of pollen and Borax on overall mean of oil yield in sunflower

Fifty percent of pollen with 50% of finger millet flour recorded the lowest yield. The finger millet flour is an inert matter and it doesn't have any chemical/biological effect on the pollen may be the reason for the lower yield.

Mean comparisons of the pollen treatments are: $T_0 > T_1 > T_2 > T_3$

Effect of pollen and borax on seed quality characters

The seed quality characters, seedling length, germination percentage and seed vigor index, were affected by the mixtures of pollen and filler materials. All these three treatments were significantly different from each other (Table 3).

Table 3: Effect of pollen and borax on quality traits of sunflower

Treatment	Seedling length		Mean	Germination percentage		Mean	Seed vigor index		Mean
	2000	2001		2000	2001		2000	2001	
T ₀	29.62	31.25	30.44	95.15	96.95	96.05	2819.05	3029.3	2924.18
T ₁	26.07	28.88	27.48	91.28	93.53	92.41	2378.90	2700.3	2539.6
T ₂	23.68	24.08	23.88	86.90	87.53	87.22	2057.83	2107.5	2082.67
T ₃	19.43	19.38	19.41	83.70	82.50	83.10	1626.08	1598.8	1612.44
SEd	0.545	0.643		0.691	0.681		48.44	50.84	
CD 5%	1.23	1.46		1.56	1.54		109.58	115.0	

The effect of decreased percentage of pollen and increased percentage of filler materials was reflected clearly on these quality traits (Figures 7, 8). The control per-

formed well with 100% pollen, followed by 75% of pollen and 25% percent of borax. High vigor index was recorded with 100% pollen (Figure 9); since pollination was practically complete, the higher seed setting was reflected on seed yield.

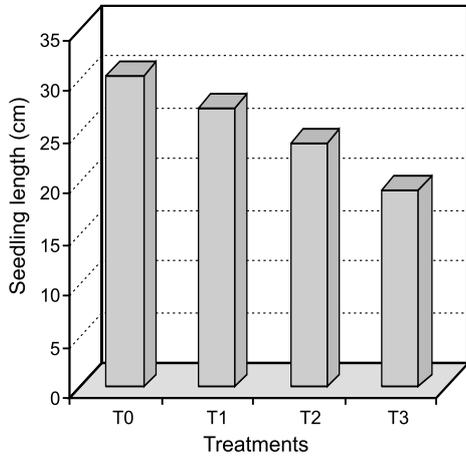


Figure 7: Relationship between percent of pollen on over all mean of seedling length in sunflower

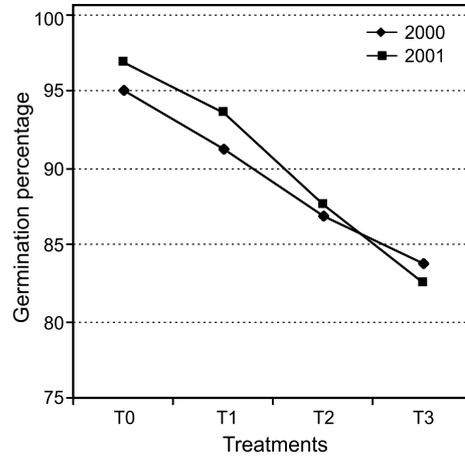


Figure 8: Effect of pollen and Borax on mean of percent germination in sunflower

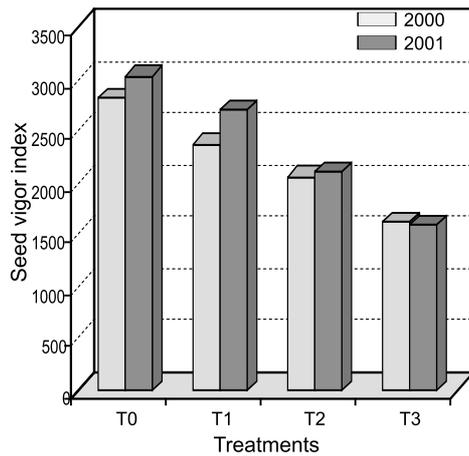


Figure 9: Relationship between percent of pollen on mean of seed vigor index in sunflower

These quality traits were much affected by the treatment with 50% pollen and 50% finger millet flour because the latter did not have any biological effect on pollination.

CONCLUSION

Although further investigations are needed to ascertain present result, a definite conclusion may be drawn from these findings. This study clearly indicates that the treatments were significantly different from each other. All the traits studied

recorded superior performance only at 100% pollen availability; the seed yield increased only with an assured availability of sufficient pollen for fertilization. The mean comparisons of the treatments for all the characters was $T_0 > T_1 > T_2 > T_3$. Though the seed yield was not increased to that much extent while supplementing with filler material, it is concluded that instead of 100% pollen 75% pollen with borax as filler material may be used without affecting the economic yield much in the case of pollen scarcity/pollen insufficiency/ pollen theft. Borax can be used as a supplement at the time of pollination. Use of filler material helps in uniform spreading of pollen on the stigma and economic use of pollen grains in case of pollen theft, especially in tropical/subtropical countries like India where bee activity is brisk from early morning and before pollination.

Apart from this, in hybrid seed production fields 25 percent of seed parent population can be increased to get more hybrid seed yield by increasing the ovule and pollen parent ratios from 3:1 to 4:1 in the case of KBSH-1 hybrid. The use of finger millet flour as the filler material during the pollination in the case of pollen insufficiency doesn't have any effect on the seed yield and yield attributing characters. In that case the yield was reflected, only for the 50% of pollen availability.

Regarding oil content the filler material borax does not have any effect on oil content. Instead, it affects oil yield by increasing the seed filling percentage and seed number per head.

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EFICIENCIA DE UTILIZACIÓN DE LAS LÍNEAS DE POLEN cms 234 A Y RHA 6D-1 DE GIRASOL (*Helianthus annuus* L.)

RESUMEN

El experimento de campo fue realizado en la estación de investigaciones en Bhavanisagar, Universidad de Agronomía Tamil Nadu, Coimbatore, La India, durante la temporada *rabi* (Sept.-Oct.) de 2000 y 2001, para estudiar la eficacia de utilización de polen de las líneas de girasol cms 234 A y RHA 6D-1. Los experimentos incluían cuatro tratamientos, 100% polen (T_0), 75% polen plus 25% bórax como medio complementario (T_1), 50% polen plus 50% bórax (T_2) y 50% polen y 50% de la harina de mojo (*Eleusine coracana* L.) (T_3). Los resultados mostraron que los tratamientos diferían significativamente. Todas las características estudiadas confirmaron la superioridad del tratamiento con 100% de polen; el rendimiento de la semilla era significativamente incrementado cuando para la polinización era accesible la cantidad suficiente de polen. Los valores medios de los tratamientos de todas las características establecieron la relación $T_0 > T_1 > T_2 > T_3$. Aunque el rendimiento de la semilla era disminuido en cierta medida por utilización del medio complementario, fue deducido que 75% de polen y 25% de bórax podían sustituir 100% de polen en los casos de carencia de polen en las localidades en las cuales "el robo de polen" está habitual. Bórax puede utilizarse como sustitución en la época de polinización. La utilización de la harina de mojo como cargador del material durante la polinización en el caso de carencia de polen, no tenía ninguna influencia en el rendimiento de semilla y otras características de rendimiento. En tal caso, solamente la cantidad de 50% de polen accesible, tuvo influencia en el rendimiento.

EFFICACITÉ DE L'UTILISATION DU POLLEN DES LIGNÉES cms 234 A ET RHA 6D-1 DU TOURNESOL (*Helianthus annuus* L.)

RÉSUMÉ

Une expérience sur le terrain a été effectuée à la Station de Recherche, Bhavanisagar, Tamil Nadu Agricultural University, Coimbatore, Inde durant les saisons de *rabi* (septembre-octobre) des années 2000 et 2001 dans le but d'analyser l'efficacité de l'utilisation de pollen des lignées de tournesol cms 234 A et RHA 6D-1. Les expériences consistaient en quatre traitements, 100% de pollen (T_0), 75% de pollen plus 25% de borax comme matériel complémentaire (T_1) et 50% pollen avec 50% de borax (T_2) et 50% de pollen et 50% de farine de millet (*Eleusine coracana* L.) (T_3). Les résultats ont démontré que les traitements différaient significativement les uns des autres. Toutes les caractéristiques étudiées ont confirmé la supériorité du traitement avec 100% de pollen; le rendement en graines était significativement augmenté quand une quantité suffisante de pollen était accessible pour la fécondation. La valeur moyenne des traitements était de $T_0 > T_1 > T_2 > T_3$ pour toutes les caractéristiques. Bien que le rendement en graines ait diminué dans une certaine mesure par l'ajout de matériel complémentaire, il a été conclu que 75% de pollen et 25% de borax pouvaient remplacer 100% de pollen dans les cas de manque de pollen dans les localités où le « vol de pollen » est fréquent. Le borax peut être utilisé comme remplacement lors de la pollinisation. L'utilisation de la farine de millet comme matériel complémentaire au cours de la pollinisation dans le cas de manque de pollen n'avait eu aucun effet sur le rendement de graines ni sur d'autres caractéristiques du rendement. Dans ce cas, seule la quantité de 50% de pollen accessible avait eu un effet.