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INFLUENCE OF BRANCHING AND SPACING ON POLLEN PRODUCTION IN SUNFLOWER.

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Résumé

Trois lignées mâles (RHA 274 et les formes branchées et non-branchées dúne lignée locale RO 20) ont été plantées à quartre écartements entre les lignes dans deux expériences. Les diamètres des têtes furent mesurés et la surface produisant le pollen (p.p.s.) fut calculée sur les têtes primaires, sur le total de toutes les têtes secondaires et le total par plante. Le nombre de jours d'émission de pollen fut également déterminé. Les plantes à tête unique montrèrent une p.p.s. totale considérablement plus grande que les plantes branchées mais fleurirent durant une période beaucoup plus courte. La prolongation de la période de production de pollen due au branchement était de 4,8 jours sous des conditions de tension et de 5,8 jours sous irrigation et il y avait des effets négligeables de prolongation causés par l'écartement. La p.p.s. totale par plante augmentait de maniére significative avec un espacement plus large et dans les types branchés ceci était entièrement dû à une augmentation de la surface des têtes secondaires. Par conséquent la période de production maximale de pollen était considérablement prolongée par un espacement plus large. La prise en compte de la p.p.s. par unité de surface planté indique qu'il y avait des réductions considérables dans la surface des têtes primaires. Ce qui induisait une réduction significative, de la p.p.s. totale mais la p.p.s. des têtes secondaires restait constante sur une base de surface plantée.

Abstract

Three restorer lines (RHA 274 and the branched and unbranched forms of a local line RO 20) were planted at four within row spacings in two trials. The head diameters were measured and the pollen producing surface (p.p.s.) calculated on primary heads, secondary heads and total per plant. The number of days of pollen shedding was also recorded. Single headed plants had a considerably larger total p.p.s. than branched but flowered for a considerably shorter period. The extention of the pollen producing period due to branching was 4.8 days under moisture stress conditions and 5.8 days under irrigation and there were negligible extention effects due to spacing. The total p.p.s. per plant increased significantly with wide spacing and in branched types this was due entirely to an increase in secondary head surface. Consequently the period of peak pollen production was considerably extended by wider spacing. Consideration of the p.p.s. per square metre indicates that there were drastic reductions in primary head surface and this led to a significant reduction in total p.p.s., but the p.p.s. of the secondary heads remained constant on an area basis.

Introduction

Before the concept of producing hybrid sunflowers by use of the cytoplasmic male sterility plus fertility restoring system became a reality, hybrids were produced using genetic male sterility and even at that early stage recessive branched lines were used as male parents, the most well-known line being HA 61. The primary reason for the use of this type of line is obviously the extended period of pollen production which makes choice of planting dates of parents somewhat less critical, as was advised by Putt (1964). The vigour of secondary branching is apparently controlled by a number of modifying genes but experience has shown that within-row spacing also has an extremely strong influence.

Apparently breeders are using the b gene, also designated bl by Fick and Zimmer (1975) and not the double recessive system described by Hockett and Knowles (1970). No previous research on the effect of spacing on branching and pollen production could be found and in most references it is taken for granted that branched males are advantageous, as for example Fick et al (1974) and Dedio (1980). On a practical level many seed producers who do not have sophisticated planters have problems obtaining the correct population with the small seeded male line. The most common fault being overplanting. If very close spacing has a severe negative effect it might be worth while for the seed producer to go to some expense, as for example by seed-pelleting, to ensure correct populations.

This research is an attempt to quantify some answers under conditions of commercial seed production.

Materials and Methods

Three fertility restoring lines were planted at various spacings in two trials. The one trial was irrigated to maintain optimal moisture conditions and the dryland trial developed moisture stress under very low rainfall conditions which prevailed. These two trials gave essentially the same results and the results from the stress trial will only be mentioned where it differs from the one under irrigation. A constant inter row spacing of 0,91 meters was used throughout and the single rows of male parents were separated by three rows of HA 89 to simulate a commercial seed production situation.

The lines used for the trial were RHA 274, a well-known restorer line from the U.S.A.; RO 20(s) and RO 20(b) which are single headed and branched isolines respectively. This pair of isolines was developed from a population segregating for branching by selection of single headed plants, selfing them and then again selecting single headed plants from those progeny rows segregating for branching. This process was continued up to the S6 generation at which stage pure-breeding BB and bb lines were isolated. At this stage the lines could be considered practically isogenic except for the branching gene. The within row spacings used under irrigation were 15, 30, 45 and 60 cm while under moisture stress conditions 22 cm replaced the 15 cm spacing.
The following data were recorded from three randomly chosen representative plants in each plot: date of first pollen shedding on primary head, first pollen on secondary heads, last pollen on primary head and last pollen on secondary head. From this was calculated the period of pollen shedding by the primary head and total period of pollen shedding. The flowers were then allowed to develop and mature normally. After maturity the flowers were cut and allowed to dry down completely, the diameter of the floret bearing area measured and the pollen producing area calculated. This was done on both primary and secondary heads and the number of secondary heads determined.

Statistical analyses were carried out on the number of days of pollen production on main heads, and on the total number of days of pollen production. The measurements and counts taken were used to calculate pollen producing surface (p.p.s.) on both a per plant and per unit area basis and analyses made on number of secondary heads, primary head p.p.s., secondary head p.p.s.

and total p.p.s.

Results

Variation in espacement in the row had no effect what so ever on period of pollen production on the primary heads nor on total period of pollen production in the case of branched plants. These results are indicated in Tabel 1.

Table 1 Effect of within-row spacing on pollen production period of various lines (days).

Spacing	Primary Head				Total			
(cms)	20(b)	20(s)	274	Mean	20(b)	20(s)	274	Mean
15	9,75	8,42	7,50	8,56	13,5	8,4	12,7	11,5
30	9,17	8,00	7,17	8,11	14,2	8,0	12,8	11,6
45	9,67	8,33	7,17	8,39	14,3	8,3	13,2	11,9
60	9,50	8,33	7,42	8,42	14,1	8,3	12,1	11,5
Mean	9,52	8,27	7,31		14,0	3,3	12,7	
CV%				7,96				8,04
LSD (lines) 5%				0,479				0,674
LSD (spacings) 5%				1,40				7,43

It is, however, very interesting that the primary head of the branched version actualy shed pollen over a longer period than the single-headed isoline.

The number of secondary heads on the branched lines was very strongly influenced by spacing as is shown in Table 2, both on a per plant and per unit area basis.

Table 2 Effect of with-row spacing on number of secondary heads.

Spacing	Per plant			Per square metre		
(cms)	20(b)	274	Mean	20(b)	274	Mean
15	7,75	4,17	5,96	56,8	30,5	43,7
30	8,92	6,50	7,71	34,4	23,8	29,1
45	11,17	8,79	9,98	27,3	21,5	24,4
60	11,84	10,50	11,17	21,7	19,2	20,5
Mean	9,92	7,49		35,0	23,8	
CV%			15,41			24,29
LSD (lines) 5%			0,99			5,25
LSD (spacings) 5%			1,40			7,43

Pollen producing surface (p.p.s.) as indicated by area of floret bearing surface was strongly influenced by both branching and by within-row spacing. The figures are given in Tables 3, 4 and 5 and are respectively p.p.s. on primary heads of branched types, p.p.s. on secondary heads and total p.p.s.

Table 3. Effect of spacing on p.p.s. on primary heads of branched lines.

Spacing	Per plant			Per square metre		
(cms)	20(b)	274	Mean	20(b)	274	Mean
15	46,9	53,1	50,0	344	314	329
30	59,7	51,3	55,5	219	188	203
45	61,5	49,1	55,3	150	120	135
60	66,2	60,5	63,3	121	111	116
Mean	58,6	53,5		208	183	
CV%			13,6			18,2
LSD (lines) 5%			ns			ns
LSD (spacings) 5%			7,93			37,15

Table 4 Effect of spacing on p.p.s. on secondary heads of branched lines.

Spacing	Per plant			Per square metre		
(cms)	20(b)	274	Mean	20(b)	274	Mean
15	53,1	32,3	42,7	389	237	313
30	82,9	55,7	69,3	304	204	254
45	112,9	86,7	99,8	301	212	256
60	148,5	131,8	140,2	272	241	257
Mean	99,4	76,6		316	223	
CV%			28,94			43,77
LSD (lines) 5%			18,73			86,90
LSD (spacings) 5%			26,49			ns

Table 5 Effect of spacing on total p.p.s. of branched and single-headed lines.

Spacing	Per plant				Per square metre			
(cms)	20(b)	20(s)	274	Mean	20(b)	20(s)	274	Mean
15	100	109	85	98	732	799	626	719
30	143	161	106	137	533	591	392	501
45	174	201	136	171	425	492	332	416
60	215	281	192	229	393	515	352	420
Mean	158	188	130		518	599	425	
CV%				18,16				25,29
LSD (lines) 5%				21,3				95,7
LSD (spacings) 5%				24,6				108,1

Discussion

As far as the duration of pollen production was concerned, spacing obviously had no effect what so ever. The fact that primary heads of branched lines flower longer than the single-headed isoline could possibly be related to the fact that centre fill on the primary heads of branched lines was poorer than that on single headed isolines. The effect of branching on the average extented flowering by 5,8 days under irrigation while under moisture stress conditions this was slightly less at 4,8 days.

The number of secondary heads per plant was increased drastically by wider spacing (Table 2) but this was not sufficient to compensate for the reduction in population, resulting in an overall reduction in number of secondary heads per square metre. At narrow spacing, however, the average of the secondary head area was 7,17 sq. cms while at the wider spacing it is 12,55 sq. cms. This increase in size of secondary head resulted in the secondary head area per square metre planted remaining constant (see Table 4). Furthermore, at narrow spacing the contribution of the secondary heads to the total p.p.s. was 46%, increasing to 69% at wider spacing. This shows that wider spacing increased the period of peak pollen production. The overall p.p.s. was reduced with wider spacing but the extended period of high pollen production was considered to compensate for this loss. With single-headed plants wider spacing led to a decreased total p.p.s. without any compensation.

Recommendations from this investigation are that preference should be given to using a wide within row espacement for restorer lines with recessive branching. If single headed restorers must be used then close spacing will be advisable as this increases total pollen production. The implications for seed production are that if a male line is planted 45 cm apart in rows 91 cms apart and a female to male ratio of 3:1 and a 1 000-seed weight of 35 g. then the approximate seed requirement of the restorer line per hectare will be 250 g. The cost involved in pelleting this seed will be minimal compared with the advantages gained from reduced seed usage and a more controlled stand.

References

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