THE EFFECT OF HEAD PEDUNCLE BREAKAGE ON SEED SET IN SUNFLOWER

ALEXANDRINA VOINESCU and
A. V. VRÂNCEANU
Research Institute for Cereals and
Industrial Crops, 8264 Fundulea, Romania.

INTRODUCTION

During anthesis some sunflower inbred lines and hybrids exhibit the phenomenon of head peduncle breakage, more precisely the breakage of the upper part of the stem. In susceptible genotypes, this type of breakage could occur at an earlier stage in the first seven days from the onset of flowering. Other genotypes break approximately after 14, 20, 25, 30 days or even later.

Unlike the complete breakage of the basal part of the stem, which causes entire yield losses, the breakage of the head peduncle represents in fact the folding of the inner surface of the stem curvature at a variable distance from the head (20—40 cm), depending on the genotype (Figure 1).

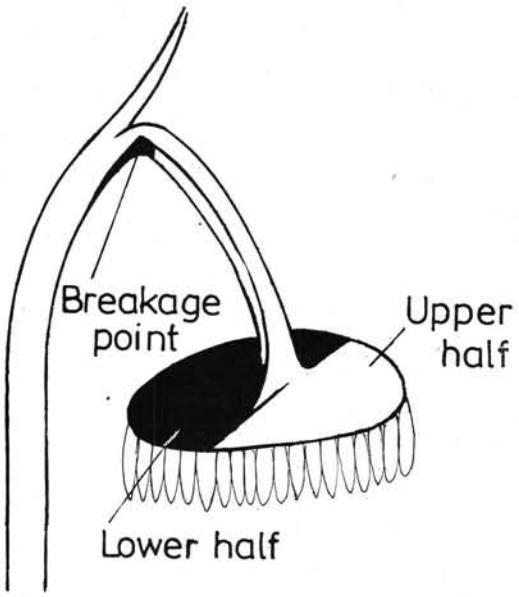

Fig. 1 — Sunflower plant with broken head peduncle

At present, investigations are being more and more undertaken to ascertain all the causes that determine the formation of blank or unfilled seeds which exerts a negative influence on sunflower yields (Donald et al., 1980; Piquemal & Mouret, 1980; Schelotto, 1978).

Starting from 1978, we have developed the first research works (Voinescu & Vrânceanu, 1980) regarding the consequences of head peduncle breakage, in order to explain whether it might affect the seed yield, to what extent and in what stage. The results have shown that this phenomenon is genetically controlled, that it hampers the process of translocation of carbon assimilates, without blocking it, and that the degree of the negative influence on seed yield depends on the genotype and the period of breakage. This paper presents the results of the investigations carried out during the period of 1978—1980 with regard to the effect of head peduncle breakange on seed setting.

MATERIALS AND METHODS

The experiments were conducted under field conditions, with open pollinated sunflowers. The study included inbred lines and single crosses differing widely in their susceptibility to breakage as well as in certain morphological characters such as stem height and thickness, head size, etc.

With a view to establishing more precisely the period in which peduncle breakage exerts a stronger influence on seed setting, artificial breakages were carried out at the beginning of flowering and afterwards every 7 days. In the case of susceptible genotypes, the control plants were sustained by supporters for preventing the natural breakage.

For being able to establish the region of negative influence on the head area, the setting of full and blank seeds was determined on the upper and lower half of the head, i.e. on the areas that correspond to the unbroken or respectively broken vascular bundles of the stem. The values regarding the head seed setting represent the mean of three plants.

In order to make more evident the region of negative influence of peduncle breakage, the heads of some plants had been cut longitudinally in two halfs, corresponding to the unbroken or broken section of the stem, at the same time with the artificial breakage. In this way, the assimilates from the upper region of the head were hindered to migrate into the lower one.

The following determinations were performed: seed formation and filling, weight of 1,000 seeds, number and location of seeds on the head, seed yield per plant and oil content.

RESULTS AND DISCUSSION

The results of this study show that no significant differences have been noticed between the effects of natural and artificial breakage, the degree of negative influence being dependent upon genotype and the period when the breakage occurs. The inbred lines were stronger affected by breakage than the single crosses.

The strongest negative effect on yield components was brought about by the earliest breakage that might take place at the beginning of flowering. In this stage, the artificial breakage resulted in a drastic seed yield decrease of 40—60% in comparison with the control unbroken plants (Figure 2). When the

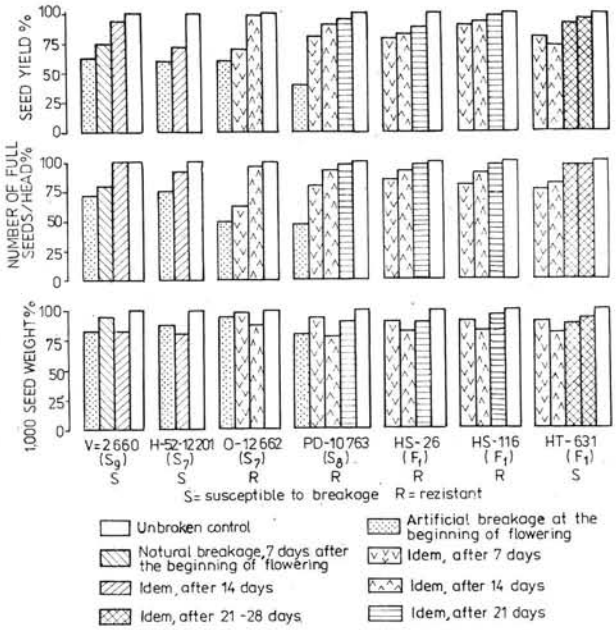

Fig. 2 — Seed yield, seed number per head and 1,000 seed weight (% from the control) as a function of the breakage stage

breakage occurred after 7 days from the beginning of flowering (the stage of natural breakage of susceptible genotypes), the seed yield suffered a reduction of 20—25%. If the breakage took place after 14 days from the beginning of flowering (the end of flowering), the seed yield diminished by 10—23%, as a function of genotype. After 18—21 days, the breakage exterted a weaker influence on seed yield, which decreased only by 5—10% as compared to the control plants.

Examining the values presented in Figure 2, one may observe that the earlier the peduncle breakage occurred, the more accentuated were the negative effects on yield components. In early stages, the breakage influenced mostly the number of full seeds per head. Thus, when the breakage took place at the beginning of flowering, the number of full seeds per head was reduced by 25—50% as compared to the control. The weight of 1,000 seeds was also lower but in this case the negative influence of breakage was weaker.

After 7 days from the beginning of flowering, the breakage contributed to the reduction of the number of full seeds by 20—24%. When the breakage occurred after 14 days, the seed filling was more obviously affected, the weight of 1,000 seeds being much lower. Generally, the higher was the number of the formed seeds on the head at the breakage moment, the stronger was the influence of breakage on 1,000 seed weight. We may say also that the shorter the period of seed setting, the smaller is the influence of peduncle breakage at a certain moment. This might be one of the explanations of the differentiated effect of breakage as a function of genotype.

The negative influence of breakage on seed yield was therefore due mainly to the reduction in number of full seeds per head and the proportional increase of empty seeds. The oil yield was affected as a result of the reduction of seed yield per plant and not of the oil percentage (Table 1).

Table 1

The influence of head peduncle breakage on oil accumulation in sunflower seeds of three inbred lines

Treatments	Stages of breakage	Oil at harvest	
		%	g/pl
V-2660(S_9)-susceptible inbred			
Natural breakage	beginning of flowering	45.0	19.2
Natural breakage	after 7 days	46.0	28.0
Natural breakage	after 14 days	46.7	31.0
Natural breakage	after 21 days	44.5	31.0
H-52-12201(S_7)-susceptible inbred			
Artificial breakage	beginning of flowering	51.0	13.0
Artificial breakage	after 7 days	48.0	25.0
Artificial breakage	after 14 days	44.0	26.5
Natural breakage	after 20 days	44.0	27.0
Natural breakage	after 27 days	47.0	33.0
Natural breakage	after 30 days	40.0	31.0
O-12662(S_7)-resistant inbred			
Artificial breakage	beginning of flowering	48.0	26.0
Artificial breakage	after 7 days	45.8	27.5
Unbroken		47.5	49.0

Comparing the seed set on the upper and lower part of the head, it appears evident that the lower part corresponding to the broken vascular bundles of the stem, was much more

affected, presenting a great number of empty seeds (Figure 3). This phenomenon was more evident when the head was artificially sectioned

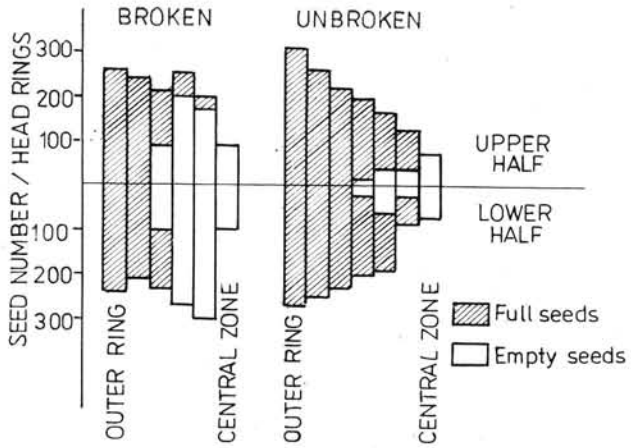

Fig. 3 — Location of full and empty seeds on the head of broken control plants (HS-40) (determinations on rings of 1 cm width)

at the breakage moment. In this case, the migration of assimilates from the upper part of the head being interrupted, the lower part developed to a less extent than the control and the upper part of the head and full seeds were formed only on the first four marginal rings of the head (Figure 4).

Although the seed yield per total head was lower in the broken plants, the upper half of the sectioned head developed better and

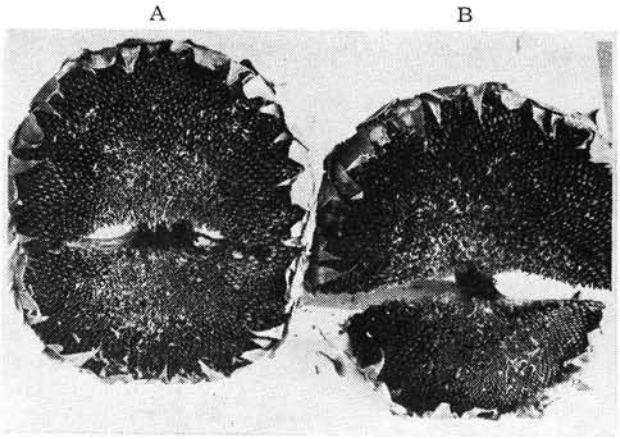

Fig. 4 — Location of full and empty seeds on the sectioned heads (HS-40); A — unbroken control; B — artificially broken plant at 7 days after beginning of flowering

formed much more full seeds, possibly due to the diminution of nutritive competition of the affected parts (Table 2). It has thus been established that the region of negative influence of peduncle breakage is situated in the central part of the head with large spreadings in its inferior half.

Table 2

The influence of artificial breakage on seed distribution on sunflower heads sectioned longitudinally at the breakage moment (single hybrid HS-40)

Seed location on the head	Broken plant						Control — unbroken plant					
	no. of seeds		dry matter, g				no. of seeds		dry matter, g			
	full	empty	head & seeds	head without seeds	full seeds	empty seeds	full	empty	head & seeds	head without seeds	full seeds	empty seeds
I. On the upper half of the head												
1st marginal ring *	360	—	40.6	17.6	23.0	—	370	—	25.4	6.7	18.7	—
2nd ring	340	—	32.7	12.2	20.5	—	345	—	25.3	9.3	16.0	—
3rd ring	340	70	26.5	7.9	18.5	0.05	220	50	16.3	5.4	10.6	0.30
4th ring	156	124	13.8	6.0	7.2	0.60	125	80	10.3	3.0	7.0	0.30
5th ring	57	110	4.3	1.7	2.2	0.40	60	100	8.6	2.5	5.9	0.15
Central zone	28	30	1.0	0.5	0.5	0.01	30	50	1.7	1.0	0.7	0.01
Total half head	1,281	334	118.9	45.9	71.9	1.06	1,150	280	87.6	27.9	58,9	0.76
II. On the lower half of the head												
1st marginal ring	198	258	22.8	8.8	12.8	1.20	283	160	30.3	11.6	18.7	—
2nd ring	—	661	6.0	4.8	—	1.20	308	130	35.4	10.0	25.0	0.40
3rd ring	—	350	3.9	3.5	—	0.50	218	124	21.4	5.0	16.0	0.40
4th ring	—	150	1.4	1.2	—	0.30	38	300	5.7	3.0	2.0	0.70
5th ring — central zone							6	88	1.8	1.0	0.5	0.30
Total half head	198	1,419	38.1	18.3	12.8	3.20	853	802	94.6	30.6	62.2	1.80
Total head	1,497	1,753	157.0	64.2	84.7	4.26	2,003	1,082	182.2	58.5	121.1	2.56

*) The width of each ring = 2 cm.

CONCLUSIONS

The effect of breakage of the top end of sunflower stem is dependent upor the genotype and the period when this phenomenon takes place. The earlier the breakage occurs, the more accentuated is its negative effect, going up to a reduction of seed yield of about 30—50%. If breakage occurs after 7—14 days from the onset of flowering, the seed yield is lowered by 20—25%. In early stages, the breakage affects mainly the number of full seeds per head, and after the end of flowering the complete filling of achenes. After 21 days from the onset of flowering, the peduncle breakage do not influence negatively the seed and oil yield.

As regards the seed setting on the head, the breakage causes an increase of the empty seed percentage in the central part of the head and its lower half, corresponding in fact to the inner broken curvature of the stem.

With the view of developing high yielding sunflower hybrids, it is necessary to take into consideration in the breeding works the resistance of inbred lines and single crosses to the breakage of head peduncle.

REFERENCES

Donald S., Fick G., Johnson F., Knowles P., 1980, *Seed Set in Sunflower,* The Sunflower, May—June, 10—12.

Piquemal G., Mouret J. Cl., 1980, *Contribution à l'amélioration génétique de la fructification du Tournesol (Helianthus annuus L.). Variation du taux de fructification des fleurs selon leur emplacement et leur orientation,* Ann. Amélior. Plantes, *30 (2),* 175—190.

Schelotto A. L. G., 1978, *Effects of artificial defoliation on the yield of sunflower* Sunflower Newsletter, *2, (1),* 19—22

Voinescu Alexandrina, Vrânceanu A. V., 1980, *Influența frîngerii pedunculului capitulului asupra formării recoltei la floarea-soarelui,* Analele I.C.C.P.T. — Fundulea, vol. XLVI, 389—397.

L'EFFET DU ROMPEMENT DU PÉDONCULE DU CAPITULE SUR LA FORMATION DES GRAINS CHEZ LE TOURNESOL

Résumé

Dans cet article on présente les résultats des recherches effectuées à l'Institut de Recherche pour les Céréales et les Plantes Techniques de Fundulea, Roumanie, au cours des années 1978—1980. On a étudié des lignées autofécondées et des hybrides qui diffèrent par leur degré de résistance au rompement de la partie supérieure de la tige. Parallèlement au rompement naturel, on a poursuivi aussi l'effet du rompement artificiel provoqué au début de la floraison et ultérieurement de 7 en 7 jours.

Les données obtenues indiquent que le rompement du pédoncule du capitule influence négativement le rendement en grains par la diminution du nombre de grains pleins et du poids de 1 000 grains. L'effet négatif se manifeste lorsque le rompement a lieu dans les premiers 21 jours dès le début de la floraison, étant plus fort au commencement de cette phase. Sous l'influence du rompement, le rendement en grains a diminué de 20—50%, en fonction du moment où cela a eu lieu et du génotype. Le rendement en huile a baissé comme suite de la diminution du rendement en grains et non pas du pourcentage de l'huile.

En analysant la position des grains sur le capitule, on a constaté une augmentation du pourcentage de grains vides au centre et dans la moitié inférieure du capitule, correspondant en fait à la courbure interne rompue de la tige.

On recommande de sélectionner les lignées et les hybrides de tournesol pour le caractère de résistance au rompement du pédoncule du capitule.

EFETO DE PARTIMIENTO DEL PEDÚNCULO DE LA CABEZUELA SOBRE LA FORMACIÓN DE SEMILLAS AL GIRASOL

Resúmen

En el artículo están presentados los resultados de las investigaciones efectuados en el Instituto de investigaciones para cereales y plantas técnicas de Fundulea durante el período 1978—1980. Se han estudiado líneas e híbridos que se han diferenciado por el grado de susceptibilidad al partimiento de la parte superior del tallo. Paralelamente con el partimiento natural se ha estudiado también el efecto del partimiento artificial efectuado al principio de la floraciôn e ulteriormente, de 7 a 7 días.

De los resultados presentados se ha destacado el hecho que el partimiento del pedúnculo del capítulo influye negativamente la producciôn de semilla ya que se reduce el número de semillas llenas y el peso de 1 000 granos.

El efecto negativo se manifiesta en el caso cuando el partimiento se da en los primeros 21 días desde el principio de la floraciôn, siendo más fuerte en la fase temprana de floraciôn. Bajo el influjo del partimiento, la producción de semilla ha disminuído a 20—50 por ciento, en funciôn del momento en que se ha producido y tambien del genotipo. La producción de aceite se ha reducido como consecuencia de la rebaja de la produciôn de semilla y no de la del contenido del porcentaje de aceite.

Analizando el amplazmiento de las semillas en el capítulo, se ha constatado un aumento del porcentaje de semillas secas en el centro y en su mitad inferior, correspondiente ésta a la curvatura interna partida del tallo.

Por lo consiguiente, en la selección de las líneas consanguinizadas parentales de los híbridos del girasol, se recomienda que se tenga en cuenta también el carácter de resistencia al partimiento del pedúnculo del calatidio.