SUNFLOWER DESICCATION BEFORE COMBINE HARVESTING AND ITS EFFECT ON QUALITY AND QUANTITY OF GRAIN YIELDS AND NUTRITIONAL VALUE OF OIL MEAL

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Under Polish climatic conditions sunflower seeds ripen as late as the end of August or beginning of September. Fleshy receptacles contain then about 80% of water and so do the green leaves and stems. Autumn chill as well as the high relative air humidity make it difficult to dry the plants in the field to such an extent that it proves impossible to trash the heads by a combine. All manual ways of harvesting known up to the present are too laborious and costly even if the harvest is partly mechanized by the use of thrashers. Unless the process of cultivation and harvesting is mechanized, introducing and wide use of any cultivated plants is hardly possible today. Under Polish climatic conditions the main barrier in mechanizing sunflower harvest was not only the late ripening of seeds, but, first of all, because the heads would not dry sufficiently.

Attempts to hasten the process of sunflower ripening by means of growth activators, undertaken in Poland in the 1950s, gave no positive results. Attempts to shorten the vegetation period by means of defoliating flowering plants or shortly after flowering, failed as well because they caused a considerable decrease in the quantity and quality of grain yields. In this situation any further attempts to hasten the process of ripening were given up in favour of artificial drying of the harvest bulk by means of desiccation. Comparison drawn on the effectiveness of Reglone and Gramaxone and of herbicides belonging to the DNOC group, proved Reglone most effective.

In 1967 and 1968 two experiments were carried out which involved spraying with Reglone concentration of 3 l per hectare on four dates, i.e. on the 14th, 21st, 28th and 35th day following the end of flowering (table 1). This way the fourth desiccation was performed soon after the achenes reached the technical ripeness, the third date was simultaneous or almost simultaneous with technical ripeness whilst the

Table 1

Effect of desiccation time with Reglone on the quantity and quality of grain yield

Days following cessation of flowering	Grain yield q/ha		n=2				
	n=2	n=4	Fat content %	Fat yield kg/ha	1000 grain weight g	Fruit hull content %	Germination capacity %
Control	19.4	21.2	45.0	880	74,8	31.1	82
14	15.4	—	41.6	647	67,6	36.0	—
21	18.5	—	44.1	820	72,8	32.9	—
28	18.3	19.7	44.9	822	74,6	31.9	90
35	19.9	21.0	45.2	903	78,0	29.6	85
LSD at P = 0,05	2.59	—	1.13	128.1	3.93		

first and second dates preceded the technical ripeness by one or two weeks. Each delay of the desiccation date, when related with the earliest date, i.e. 14 days after the cessation of flowering, increased the grain yield and 1000 grain weight, and gave at the same time a considerable increase of the fat content in achenes. The increase of fat yield was therefore relatively higher than the increase of grain yield. Quantity and quality of grain yield obtained when desiccation was employed on the 35th day after the cessation of flowering, i.e. when the achenes reached the full ripeness, were similar to those obtained in the control combination without desiccation. Therefore in the next two years the two earlier dates of desiccation were left out in favour of the two later ones, i.e. on the 28th and 35th day after the cessation of flowering. The difference between the two desiccation dates, expressed in terms of grain yields, favour the last desiccation date by 1.3 q per ha. The difference was insignificant, however, the general tendency is clearly visible and this allows to draw a conclusion that sunflower can be desiccated with Reglone not until the achenes reach the stage of technical ripeness. Germination capacity of sunflower achenes desiccated on the 28th day after the plants ceased flowering was slightly higher than in that desiccated later or left without desiccation, probably on grounds of the limited contamination of plants by diseases. Still, the smaller grain yield obtained when desiccation was applied on the 28th day after the cessation of flowering, suggests to delay the desiccation, particularly when seeds are harvested for industrial purposes.

Further studies were thus limited to simply illustrate the action of the graded Reglone doses, i.e. to 1, 2 and 3 l per hectare, applied on the 35th day after the end of flowering. Estimates shown in table 2 represent the average of four experiments (n = 4). The results indicate that desiccation bore no harmful effect on the yield, its structure and technological value as well as on the germination capacity of seeds. It has lowered, however, the water content in achenes by 3.4—4%. Water

Table 2

Effect of Reglone doses applied 35 days after cessation of flowering on the quantity and quality of grain yield /n = 4/

Doses of Reglone l/ha	Grain yield q/ha	Fat content %	Fat yield kg/ha	1000 grain weight g	Fruit hull content %	Germination capacity %	Water content %	
							in capitula	in achenes
0	21.2	47.2	1005	66.1	28.5	81	78.6	17.4
1	20.1	46.4	938	66.5	28.9	83	58.4	13.5
2	21.6	46.1	995	69.3	29.0	84	54.7	14.0
3	21.2	47.1	999	68.7	28.7	84	41.6	13.4

content in heads was also considerably lowered, due to the growing dosages of Reglone. Drastic examples show 41.6% of water when Reglone dose of 3 l per hectare was applied, comparatively to 78.6% of water occurring in the undesiccated variant. The optimal effect of desiccation was thus obtained at 3 l per hectare. Harvest and combine threshing is easy provided the water content in heads is lowered to the level from 30 to 45 per cent. The fast action of Reglone has to be stressed. Leaves started to fade away as soon as in two hours and were completely brown after two days. Desiccated plants were left in the field for about 10 days. They dried primarily in result of the conducting tissue necrosis, plants being thus disconnected from taking water from the soil. They could easily take water from rainfalls, however, owing to the combined action of weathering (such as wind and sunshine action), they were soon back at a loss. Reglone doses of 3 l per hectare was thus considered sufficient to dry the sunflower bulk before combine threshing provided Reglone was applied about 5 weeks after the dryness of ligulate flowers, generally speaking when the achenes were ripe. Practically one can qualify the technical ripeness when observing the external symptoms of ripening, e.g. yellowing of the bottom part of the heads, yellowing of the lower leaves and hardening of fruit hull, the latter commonly known as husk. The seed is then well developed and hard whereas the husk coloured so as the variety it comes from.

Investigations on the possible residues of diquate (as active ingredient of Reglone) in achenes of desiccated sunflower, were carried out on material derived from six plantations (see table 3). Residues were determined according to the Calderbank and Yuen's method (1966). Zeiss USV-1 spectrophotometer was used for measurements and the detection limit of diquate found was 0.03 ppm. Results presented in table 3 show the highest concentrations of diquate in fruit hull, lesser in seeds and no residues in oil. The technological process in oil-mills includes removing the hull from achenes prior to extracting oil ; diquate residues in seeds are then reduced to 0.10—0.17 ppm. After the extraction of oil from seeds 0.25—0.50 ppm of diquate may be expected in oil meal either from hulled or unhulled achenes.

Table 3

Content of diquate (in ppm) in various parts of sunflower achenes desiccated with 3 l/ha Reglone

Experimental station and state farms	Whole achenes	Extracted achenes	Fruit hull	Seeds without hull	Extracted seeds	Oil
A_1	0.25	0.49	0.67	0.12	0.42	not detected
A_2	0.16	0.31	0.19	0.12	0.35	not detected
B	0.16	0.31	0.25	0.13	0.43	not detected
C	0.15	0.28	0.21	0.11	0.34	not detected
D	0.21	0.40	0.30	0.17	0.49	not detected
E	0.15	0.27	0.22	0.10	0.26	not detected
Mean	0.18	0.34	0.31	0.12	0.38	—

Extracted oil meal of sunflower desiccated with Reglone, derived from unhulled achenes at an industrial oil mill, and later assigned to feeding experiments, showed approximately 0.20 ppm of diquate, i.e. less than in the experimentally-extracted achenes. It is observed that the technological process of oil extraction involves some losses of diquate. The above mentioned oil meal was fed then to milk cows and wethers. A feeding test on two 3-year-old cows of Lowland Black and White race as well as on three 1-year-old wethers of Polish Morino race were carried out in 1979/71.

Both experimental cows, after a few days of adaptation, were fed on 5 kg sunflower oil meal daily. This feed-stuff, together with a small amount of wheat bran, was fed two times a day. The animals were additionally fed on green forage in summer, and on hay, straw and silage in winter. One of the cows received 925 kg of sunflower oil meal averaging 185 mg of diquate, reckoning from the beginning of the experiment up to the end of lactation period (185 days altogether), the other one — 875 kg averaging 175 mg of diquate (table 4). The last one, although dried on 27th November 1970, was still fed on sunflower oil meal. Up to the time when her calf was 7-day-old and slaughtered, she received 1276 kg of sunflower oil meal at averaging 255 mg of diquate.

Analyses of milk, faeces and urine, aimed at examining the ways of diquate excretion were carried out. Moreover, kidneys and liver of the slaughtered calf were tested in order to find out whether diquate penetrated into the foetus. The calf itself was fed on mother milk up to the slaughtery while its mother continuously on sunflower oil meal.

Wethers have been fed on sunflower oil meal for 141 days. Daily intakes averaged 0.5 kg per head; the whole quantity of oil meal, i.e. 70.5 kg contained 14.1 mg of diquate. Diquate residue determinations were made in their livers and kidneys.

Table 4

Amount of the oil meal of desiccated sunflower used for cow feeding and results of milk analysis for diquate content

No of the analysis	Date	Since 21.IV.1970 each of the investigated cows has eaten			Diquate content
		No of days	of oil meal in kg	of diquate in mg	
1	May 4	13	56	11.2	not detected
2	May 11	20	91	18.2	not detected
3	Jun. 24	52	260	50.2	not detected
4	Aug. 11	100	500	58.2	not detected
5	Aug. 25	114	570	112.2	not detected
6	Sept. 2	122	610	120.2	not detected
7	Oct. 6	156	780	154.2	not detected
8	Oct. 16	166	830	164.2	not detected
9*)	Nov. 4	185	925*)	183.2	not detected

*) on Nov. 4 milk samples were taken only from one cow because milking of the other cow was stopped on 27 Oct. 1970

Diquate residues in milk, urea, faeces, kidneys and livers of the experimental animals were determined according to the Calderbank and Yuen's method modified by Blanck (1966).

The sampling system employed was the following : 250 ml milk samples were taken from the morning milking and from the evening milking, respectively ; as well as 250 ml urea samples, 50 g faeces samples, 250 g liver samples and 250 g kidney samples. Detection limit measured by the USV-1 Zeiss Spectrophotometer was the following : 0.01 ppm in milk ; 0.01 ppm in urea ; 0.03 ppm in liver and 0.03 ppm in kidneys.

No residues have been found in milk samples taken from the morning milking made 10 hours after the last feeding as well as no residue have been found in the evening milking which took place 1.5 hours after the last feeding. Likewise, no diquate residues were found in faeces- and urea samples, as well as in the liver and kidney samples of the calf born by the cow fed on desiccated sunflower oil meal. Nor were residues found in liver and kidney samples from wether fed on the same feed-stuff. Results obtained, confirmed by those obtained by Blanck et al., manifest a considerable decomposition of the tested substance in the rumen.

However, Stevens and Walley (1966) report on traces of diquate in milk, urea and faeces as well as in meat tissues in cattle, but the diquate doses fed for one time were from fifteen to forty times higher than thosee fed in the reported experiments. Although one of the experimental cows has been fed on sunflower oil meal derived from plantations desiccated with Reglone in the amount of 3 l per hectare,

for 257 consecutive days and the wethers for 141 days respectively, neither penetration of diquate into milk nor accumulation of diquate in kidneys and livers of the tested animals, have been found.

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