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THE ROLE OF LEAVES IN THE PROCESS OF KERNEL YIELD AND OIL CONTENT FORMATION IN SUNFLOWER

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INTRODUCTION

It is known that the formation of organic matter and yield in plants depends almost exclusively on the leaf apparatus, which has therefore been the subject of many studies, but mostly from a physiological aspect.

Individual leaves or groups are not formed simultaneously, their area, thickness of tissue, position in relation to the stem, content and quantity of pigment etc. are not the same, and they differ consequently also in respect of their vital activities. These facts have been often investigated in the past. We on our part were interested in the role of leaves in the creation of organic matter and yield in the sunflower from a biological, purely practical aspect. Since various groups of leaves suffer during the growing season from various diseases, hail, lack of moisture in the soil and other adverse factors, we wished to find out the actual percentage of reduction in kernel yield, oil percentage and other values thus caused.

In order to achieve this aim, we started our researches six years ago.

METHOD OF WORK

Researches were conducted from 1966 to 1971 in the Rimski Sancevi experimental field with the VNIIMK 8931 variety. The first crop was wheat, the type of soil - chernozem of the following chemical composition : 0,16 % N, 18 mg P_2O_5 and 23 mg N_2O per 100 g of soil. During the growing season, fertilizers were applied in the following ratio : 65 kg/ha active Nitrogen, 80 kg P_2O_5 and 70 kg K_2O per hectare. The method of application of fertilizers was to plough in one half of the total quantity of P and K, while the other half was applied in the course of planting. Of the Nitrogen, 1/4 of the total quantity was ploughed in, 1/4 applied in the course of planting, and 1/2 as top dressing at the stage of development of 7-8 pairs of leaves.

Determination of the oil percentage was performed according to the Soxhlet method.

Leaves were removed as soon as they reached in their development the stage of separation from the rosette. Thus, in the combination in which all leaves were removed in the stages from the beginning of vegetation to flowering, only the rosette was left (undeveloped leaves at the top of the stem).

Actually, leaves are removed from the plant as soon as they reach a certain size according to this method, which differs from the method applied by some other authors, according to which individual leaves are removed in certain stages of development only - mostly after flowering. But since the vital function of the lower leaves ends in that stage of development, and correct data on their role in the creation of kernel yield and oil content cannot be obtained, we decided in favour of the removal of leaves as soon as they separate from the rosette.

DATA ON CLIMATIC CONDITIONS

Climatic conditions during the growing season have not been extremely adverse for the growing of sunflower in any one of the years investigated. The least favourable were the conditions in 1967, since there was too much rainfall in June and July of that year - 131 resp. 169 mm, so that attacks of diseases increased in intensity

Annual Data on Precipitations in mm

Month	1966	1967	1968	1969	1970	1971
April	49.6	61.6	14.7	25.1	50.4	26.2
May	45.4	61.1	23.5	23.7	70.2	40.3
June	73.5	131.4	38.6	136.1	106.9	43.8
July	121.1	169.0	69.7	54.4	90.7	20.8
August	46.2	8.1	114.9	76.1	52.9	40.0
Total	336.1	431.2	261.4	315.4	371.1	171.1

Mean daily temperatures ranged : in April, from 10 to 13°C ; in May, from 14 to 19°C, June 18 to 20°C, July 20 to 22°C and August 19 to 22,5°C, depending on the actual year.

Relative humidity of the air favoured successful development of the plants. In the years investigated, it ranged from 64 to 78 % in June, 59 to 76 % in July and 64 to 75 % in August.

RESEARCH RESULTS

In the researches, the two extreme combinations were plants stripped of leaves, i.e. with only the rosette left by the beginning of flowering, and the check plants, from which all the leaves were left on. The highest 6-year average yield was obtained from the check plants - 35,5 q/ha, and the lowest from the combination with all leaves removed - only 77 kg/ha, i.e. 2,2 % average for the period investigated. In the worst year, however, the yield was only 15 kg as opposed to 155 kg/ha obtained in the best year. In the years in which maximum daily temperatures exceeded 30°C after the removal of the rosette, petasl on the head remained fres for 5 to 7 days only, and reversely, at lower temperatures, the plants continued to vegetate without leaves for up to 17 days. In the USSR, Zdanova obtained very similar yields - 1,8 q/ha after the removal of all leaves in the flowering stage.

The results of our researches show that the removal of the lowermost 10 leaves caused a decrease in kernel yield (Table 1). For the period investigated, the average decrease reached up to 11,3 %. These results lead us to the conclusion that the role of the lower leaves in the creation of yield is small, and that their loss due to hailstorms, diseases or drought does not affect the kernel yield seriously. The removal of the lowest two leaves reduced the yield by 1,4 % resp. 47 kg/ha, which is still within the limits of significance, the removal of the lowest 4 leaves by 4,6 %, of the lowest 6 leaves by 6,7 %, of the lowest 8 leaves by 8,4 % and the removal of the lowest 10 leaves reduced the kernel yield by 11,3 %, resp. 3,7 q/ha. Positively significant is the yield by 11,3 %, resp. 3,7 q/ha. Positively significant is

the yield decrease caused by the removal of 6, 8 resp. 10 leaves.

The removal of the 10 middle leaves (10 to 20) affects considerably the kernel yield. Our results show that a yield of 18,2 q/ha, i.e. 54,3 % in comparison with the check, was achieved. That means that the removal of the 10 middle leaves reduced the kernel yield by 45,7 %. It is known that the middle leaves have the largest area, followed by that of the upper leaves, while the area of the lower leaves is the smallest, but the mentioned yield decrease is nevertheless significant. These results lead us to the conclusion that the 10 middle leaves are the actual yield bearers.

The removal of the top 10 leaves (above the 20th) has reduced the yield by 5,7 q/ha, resp. 17,2 %. These results indicate that upper leaves influence the yield more than the lower ones, but less than the middle 10 leaves. These results can be explained by the fact that neither the leaf area nor the thickness of leas tissue is the same in these three groups of leaves. Prokofkjev and Djakov have found that the lowermost leaves are the thinnest, that the middle ones are thicker by 28 % and the upper leaves by 42 % compared with the lower leaves.

Beside the part the various groups of leaves play in the creation of yield, our results show that the leaves remaining after the removal of particular groups compensate the removed leaves to some extent. Combination 6 showed that the removal of the 10 lowermost leaves reduced the kernel yield by 11,3 %, and Combination 10 that the removal of the top 10 leaves reduced the kerner yield by 17,2 %. Mathematical addition produces a 28,5 % yield decrease. However, in Combination 8, after removal of both groups of leaves, the yield was reduced by 42 %, and not by 28,5 %. The difference between these two figures represents the degree of compensation of the leaves remaining on the plant - 13,5 %. The removal of particular groups of leaves caused a decrease in oil percentage in the kernels too. Plants divested of leaves, i.e. with only the rosette left up to the stage of flowering, had an oil content of only 30,5 % compared with 48,1 % in the check.

The removal of the 10 lowest resp. uppermost leaves did not affect considerably the oil content. The oil content was reduced by 0,6 % and 0,4 % respectively, which is within the limits of significance. After the removal of the 10 middle leaves, the oil percentage was reduced by 5,6 %, i.e. it amounted to 42,5 %. However, after the removal of both the 10 lowermost and uppermost leaves, the oil content was 46,2 %. By removing all leaves in the flowering stage, L.P. Zdanova obtained a 40,2 % oil content in the kernels. Converted to kernel yield, this is very close to our own results. The date obtained lead to the conclusion that the middle 10 leaves are not only kernel yield, but oil content bearers too.

Table 3 shows per hectare oil yields resulting from the kernel yield and oil percentage. The decrease in oil yield is in most combinations identical to the decrease in kernel yield, with the exception of Combinations 7 and 8, in which the percentage of decrease in oil yield is much lower than the decrease in the kernel yield.

The husk percentage is affected by several factors - the duration of the husk formation period, the variety, abiotic factors, etc... Our results show that there is no great difference between various combinations, except 1 and 7. We consider that the kernel formation period was shortened in the first combination, in which all leaves were removed, because of the interruption of vegetation thus caused, so that the husk percentage was lower too. In Combination 7, the 10 middle leaves were removed. In our opinion, several factors caused the reduction in husk percentage.

One of the components of the yield is the weight per 1 000 kernels. This quantitative characteristic varied greatly in the components investigated. The check hat the largest resp. heaviest kernels - 71,4 g, and combinations where all leaves have been removed the lightest ones - 23,6 g. After removing all leaves in the flowering stage, Zdanov, found that 1 000 kernels weighed 34 g. After the removal of the 10 lowest leaves, kernels weighed less by only 2,4 % ; after removal of the middle leaves, the weight was reduced by 47 %, and of the uppermost by 66,2 g i.e. they were lighter by 7,3 % than the check. These results are correlated with the kernel yield so that the same laws can be deduced, i.e. the same findings as those reached in analysing the kernel yield.

CONCLUSION

The results of six years of researches showed :

1 - That all leaves do not play the same part in the formation of kernel yield, oil content and weight of kernels ;

2 - That the 10 middle leaves have the most important role in the formation of yield and oil percentage in the VNIIMK 8931 variety. With their removal, the kernel yield decreases by 45,7 %, the oil content by 5,6 % and weight per 1 000 kernels by 47 % compared with the check, which is a six year average ;

3 - The role of the 10 uppermost leaves in the forming of yield is obviously smaller than that of the middle leaves, but greater than that of the lower leaves. Their removal causes a 17,2 % yield decrease, 0,3 % oil content decrease, which is not significant, and a 7,3 % decrease in the weight per 1 000 kernels, compared with the check.

The lowest leaves play the smallest part in the forming of the mentioned values. Their removal reduces the kernel yield by 11,3 %, the oil content by 0,6 %, which is within the limits of significance, and the weight per 1 000 kernels by 2,4 %.

In addition to the respective roles of the various groups of leaves in the forming of the mentioned values, our results show that the leaves remaining after the removal of various groups compensate to a certain extent the role of those that had been removed.

Table 1 - Seed yield with 13 % of moisture in mc/ha

Number	Research variant	Year						
		1966	1967	1968	1969	1970	1971	Average
1	Removing of all leaves	0,48	0,15	0,83	1,55	0,60	1,01	0,77
2	Control - without removing of leaves	37,16	19,55	37,18	33,19	30,37	44,07	33,58
3	Removing of the 4 lower leaves	35,12	18,20	36,09	32,28	27,90	42,74	32,05
4	Removing of the 6 lower leaves	34,66	17,25	36,62	30,42	27,24	41,86	31,34
5	Removing of the 8 lower leaves	34,78	15,21	36,83	30,51	26,34	40,98	30,77
6	Removing of the 10 lower leaves	33,70	14,16	36,25	29,26	25,86	39,66	29,81
7	Removing of 10-20 leaves	17,50	10,04	20,82	17,92	20,34	22,91	18,25
8	Removing of 1-10 and from 20th - till top	19,61	9,39	26,67	19,92	14,11	27,32	19,50
9	Removing from the 6th leave till top	0,67	0,19	1,20	1,58	0,64	1,67	0,99
10	Removing from the 20th till top	31,21	15,26	33,64	27,76	22,43	36,57	27,81
11	Removing of the 2 lower leaves	36,41	18,52	36,22	34,05	29,60	43,88	33,11

For seed yield LSD 5 % 213 kg/ha

Table 2 - Oil content in absolute dry grain

Variant n°	Year						Average
	1966	1967	1968	1969	1970	1971	
1	29,30	31,22	31,93	33,53	27,59	29,73	30,55
2	47,67	46,65	49,37	48,33	47,83	49,30	48,19
3	47,55	44,50	48,71	49,66	47,79	49,06	47,87
4	47,72	43,96	49,45	48,08	47,32	48,21	47,45
5	47,85	43,88	49,39	48,58	47,35	48,03	47,51
6	46,66	44,19	49,52	48,18	47,33	49,67	47,59
7	37,04	43,14	40,21	37,95	47,42	49,80	42,59
8	45,82	41,30	49,72	48,03	43,66	49,03	46,26
9	34,18	32,43	33,29	32,67	29,10	31,10	32,12
10	46,87	46,30	48,36	48,40	46,86	49,64	47,73
11	47,61	44,60	49,88	48,97	47,77	49,32	48,02

For % oil L.S.D.- 5 % - 1,62 %

Table 3 - Oil content in kg/ha

Variant n°	Year						Average
	1966	1967	1968	1969	1970	1971	
1	12	4	23	45	14	26	20
2	1 541	793	1 596	1 395	1 263	1 890	1 407
3	1 455	704	1 529	1 394	1 160	1 824	1 344
4	1 438	659	1 575	1 272	1 121	1 756	1 303
5	1 447	580	1 582	1 289	1 085	1 712	1 282
6	1 368	544	1 561	1 226	1 064	1 713	1 246
7	563	376	728	591	839	992	681
8	781	337	1 153	832	535	1 165	801
9	20	5	35	45	16	45	28
10	1 272	614	1 415	1 168	914	1 579	1 160
11	1 508	718	1 571	1 450	1 230	1 882	1 393

For yield oil LSD - 5 % - 104 kg/ha

Table 4 - Husk content

Variant n°	Year						Average
	1966	1967	1968	1969	1970	1971	
1	20,2	23,5	24,5	18,8	21,7	21,2	21,6
2	22,1	25,5	25,0	21,6	21,2	22,5	22,9
3	22,5	23,9	25,7	22,8	20,6	23,4	23,1
4	22,6	25,3	23,1	22,5	20,6	23,9	23,0
5	23,7	25,6	23,9	21,4	20,5	22,8	22,9
6	22,5	25,8	23,9	21,3	21,1	22,9	22,7
7	20,0	24,7	18,6	17,6	19,8	22,8	20,5
8	23,4	23,6	23,1	19,9	21,5	22,0	22,2
9	20,1	23,6	23,9	20,0	23,4	21,4	22,0
10	21,5	24,4	22,3	22,2	19,4	23,0	22,1
11	22,8	24,9	26,4	21,5	20,2	23,1	23,1