DIFFERENCES IN VITALITY OF THE LEAVES OF FOUR VARIETIES OF OATS AS CONNECTED WITH THE YIELD

BY

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(CONTRIBUTION FROM THE INSTITUTE OF PLANTBREEDING).

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Introduction and method.

Repeatedly the difference in yield of the varieties of cereals has been connected with tillering, earforming, structure of the stalk, etc., but no attention has been paid so far to the relation between yield and vitality (continuance of function) of the assimitating parts, i. e. first of all the leaves. [1])

As long as the assimilation of a leaf in one day exceeds the respiration and the materials formed are not used for the construction of the leaf itself, generally speaking the yield will increase together with a longer vitality of the leaves. By this there is consequently a possibility that the greater yield of a certain variety as compared with other varieties, is partly due to the quality that the leaves have a longer life. In order to trace the relation between this quality and the yield, the following orientating investigation has been made with four species of oats: „Zegehaver" (Svalöf), „Gouden Regen" (Svalöf), „Zwarte President" (Mesdag) and „Evene" (Avena strigosa).

By the side of the three species first mentioned, that are of pure breed and of great value in practice, purposely an unproductive population („Evene") has been put to get an idea in which direction plantbreeding has executed its influence. The plants grew under circumstances perfectly equal to practice as regards tillage of the soil, manuring and distance. It must be remarked however that the soil consisted of heavy clay, whereas „Zwarte President" and „Evene" are mostly not cultivated on this soil.

The four fields, of some square Meters each, were situated close together, so that the circumstances were alike as much as possible. Originally, a second series of four fields had been laid out, but the investigation proved to take so much time that these had to be left out afterwards. Whereas at first it was intended to work with 200 plants of each variety, the number of plants was reduced later on to 100 and finally the „Evene" caused by its great number of sidestalks

[1]) H. MOLISCH: Die Lebensdauer der Pflanzen. 1929, in his chapter on „Blattdauer" does not mention a single investigation regarding cereals. According to him in Hangsging's book: Phyllobiologie, 1903 no mention is made of the vitality of leaves

so many difficulties that only 50 plants of this variety were followed in their development until harvest.

In four different places of each field a row (not the first or second) was taken, 25 plants out of which were chosen on the 26th. of April, in order to serve as objects for observation. In selecting attention was only paid to the stage of development, i. e. only plants, the second leaves of which were already visible, but not yet fully developed, were provided with a numbered label and the first leaf marked by *one* red dot on the top. Later on the second leaf got *two* red dots, the third three; the fourth leaf one black dot etc. In this way every leaf was provided with a mark of its own, by making use of different colours and a different number of dots.

Moreover every sidestalk got a distinctive mark of its own.

Now it is very difficult to decide when a leaf begins to supply assimilates and when it leaves off doing so. In order to have definite criterions, it has been assumed that a leaf begins to produce a surplus on the day when the following leaf — respectively panicle — appears, and that it stops doing so as soon as half of it is yellow. The period between these two dates is considered in this case to be the vitality of the leaf. Of course this renders only approximately the requested value.

According to the ripeness the harvestdates were: „Zwarte President" 27th July, „Gouden Regen" 6th August, „Zege" and „Evene" 7the August. Only those stalks that had produced an ear were harvested. The material harvested was dried in a temperature of 105 degrees C. and then the grains were rubbed out by hand and weighed.

The vitality of the leaves.

See fig. 1 and table 1.

The results can be best discussed on the basis of the curves. On the x-axis the leaves are indicated, numbered successively from below to above and on the y-axis the vitality of the leaves.

The rough course of the curves for the main stalk (Fig. 1) is the same for the four species. The first leaves have a relatively short vitality, which increases considerably from the third leaf onward and decreases after the 7th. or 8th. leaf. This shorter vitality of the top leaves is with regard to the last leaf somewhat deceptive in connection with the notation. Whereas with the bottom leaves the assumption: the leaf is full-grown when the next appears, will not give rise to serious

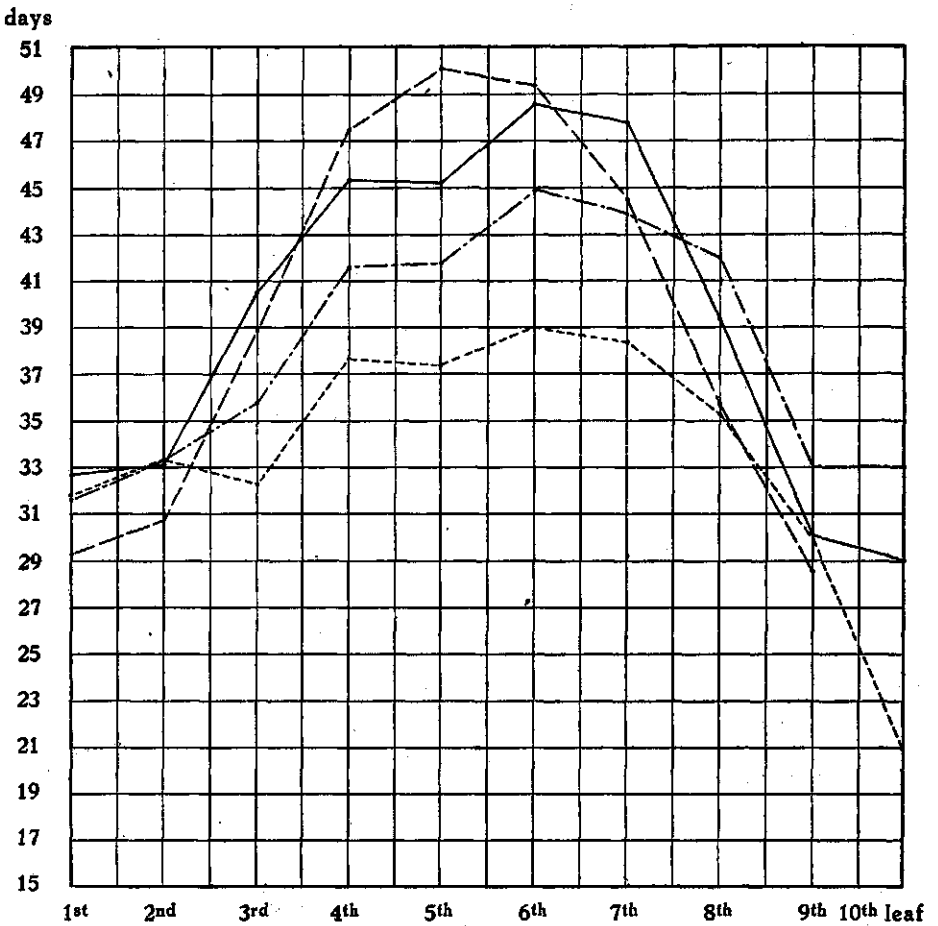

Fig. 1. Vitality of the leaves of the mainstalk.

——————— Zege (73)

—·—·—·— G. R. (75)

— — — — — Zw. Pr. (74)

---------- Evene (23)

TABLE 1.

VITALITY OF THE LEAVES OF THE MAINSTALK IN DAYS.

	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th.	10th. leaf.
Zege. (73)	32.7	33.1	40.5	45.3	45.2	48.6	47.8	39.3	30.1	29.0
G. R. (75)	31.7	33.3	35.8	41.6	41.8	44.9	43.9	42.0	33.0	33.0
Zw. Pr. (74)	29.3	30.7	38.9	47.5	50.1	49.4	44.5	35.7	28.5	—
Evene. (23)	31.8	33.3	32.3	37.6	37.4	39.0	38.4	35.3	29.9	21.0

mistakes, the panicle is so long in appearing that the last leaf is noted too late as full-grown and therefore too short a vitality is reckoned.

After all it would probably have been better to take an other salient point for the determination of the „birth-date", e.q. the appearence of the ligula, but allowing for the fact that the vitality of the last leaf was taken too short, the curves clearly show differences between the various varieties. Furthermore it must be kept in view that naturally not all mainstalks (and this holds good as well for the sidestalks) produce the same number of leaves. The average number of leaves of the mainstalk is with the „Evene" 9, with the „Gouden Regen" 8.5, with the „Zege" 8.4 and with the „Zwarte President" 8. (Fig. 7.) But also within the varieties occur great individual differences in this respect, viz. with the „Zege" from 7 to 10 leaves, with the „Zwarte President" 6—9 leaves, with the „Gouden Regen" 7—10 leaves and witt the „Evene" 8—10 leaves. Of course the considerable deviations from the average number of leaves occur but seldom, but yet the consequence is that the average vitality calculated from the last leaves is founded on less data and is consequently less trustworthy. The most distinctly indeed this is shown with the vitality of 10th leaf of the „Zege"; with the „Zege" only one stalk with 10 leaves occurred namely, and this accounts at the same time for the irregularity in the curve in this place.

But all the same the whole shows with sufficient reliability that as regards vitality of the leaves there are distinct differences between the 4 varieties of oats in this sense that the leaves of the „Evene" (Dutch population of Avena Strigosa) live the shortest and next those of the „Gouden Regen", whereas the leaves of the „Zege" and the „Zwarte President" have a longer vitality. The differences between the last two varieties are of a somewhat different nature. The highest vitality is reached by the 5th and 6th leaves of the „Zwarte President" but thereupon a fall sets in already, whereas the highest vitality of the „Zege" (as well as of the „Gouden Regen" and the „Evene") only sets in with the 6th and 7th leaves and the entire curve of the „Zwarte President" shows a much narrower top than that of the „Zege", where the top is broader as a consequence of the fact that there is not so suddenly a considerable difference between the successive leaves as in the case of the „Zwarte President".

Generally speaking differences in vitality noticed in the mainstalk are found back in the side-stalks. (Fig. 2, 3, 4. Table 2, 3, 4.)

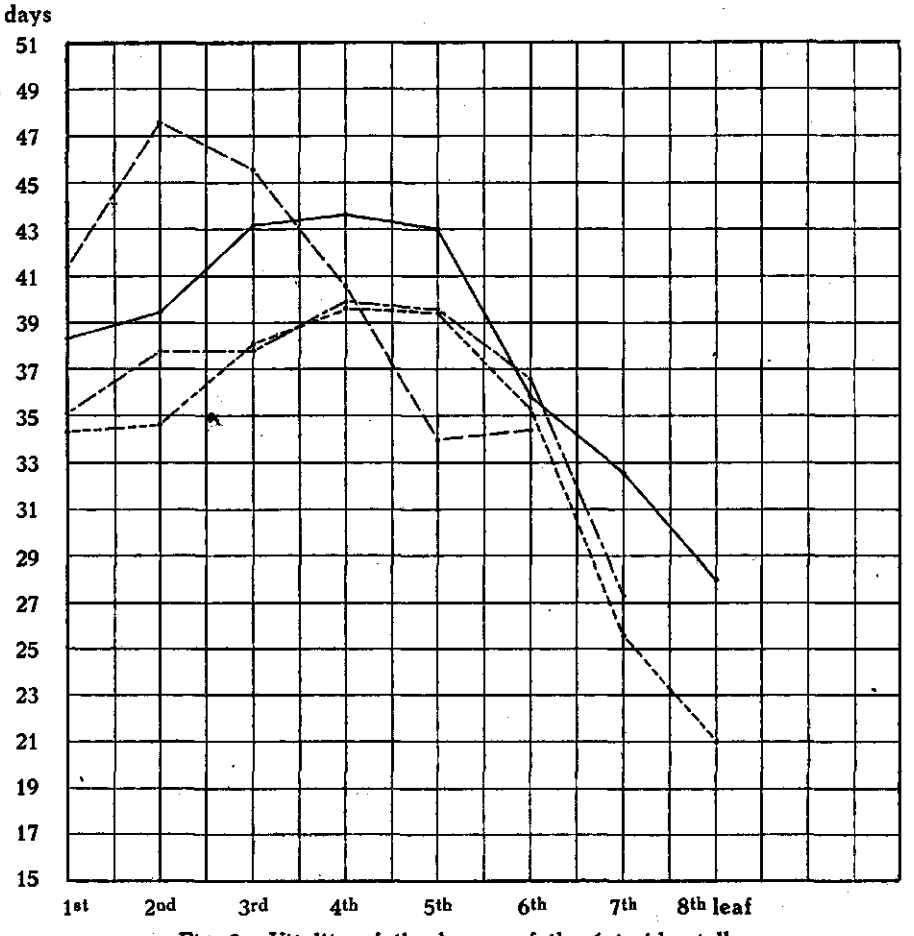

Fig. 2. Vitality of the leaves of the 1st side-stalk.

——————— Zege (29)

—.—.—.— G. R. (20)

— — — — Zw. Pr. (49)

---------- Evene (20)

TABLE 2.

VITALITY OF THE LEAVES OF THE FIRST SIDE-STALK IN DAYS.

		1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th. leaf.
Zege.	(29)	38.3	39.4	43.1	43.6	43.0	35.8	32.6	28.0
G. R.	(20)	35.1	37.7	37.8	39.9	39.6	36.6	27.3	—
Zw. Pr.	(49)	41.4	47.6	45.6	40.6	34.0	34.4	—	—
Evene.	(20)	34.2	34.6	38.1	39.6	39.5	35.3	25.6	21.0

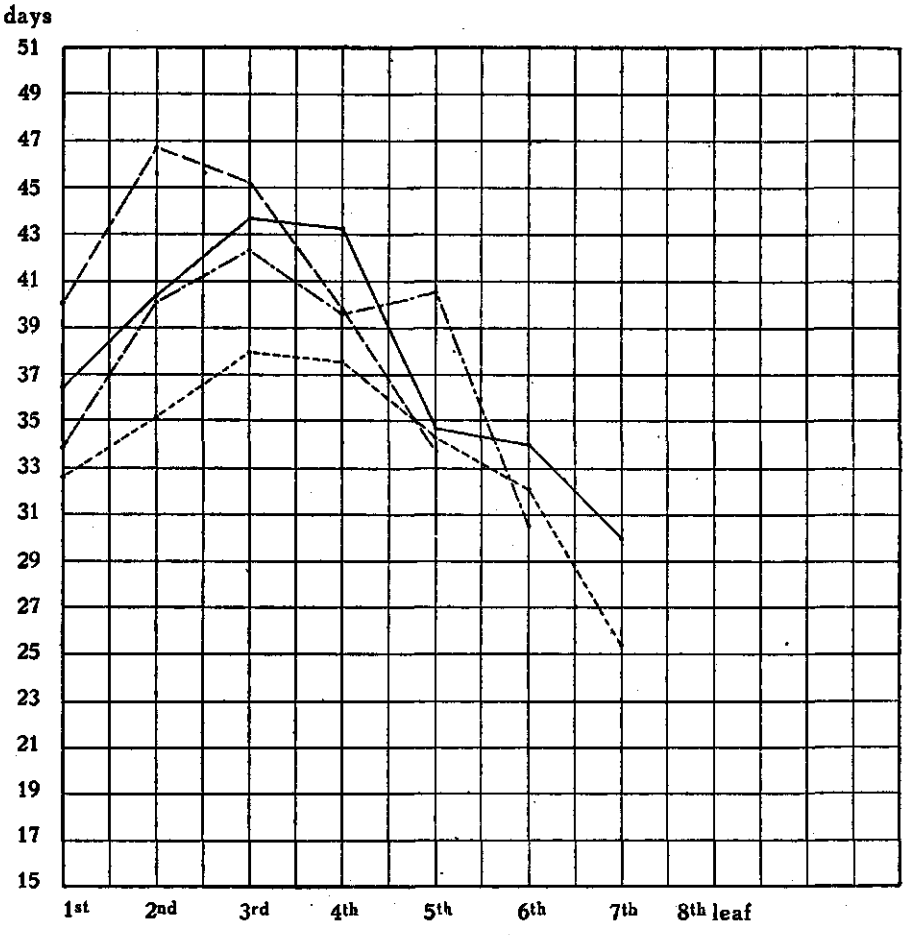

Fig. 3. Vitality of the leaves of the 2nd side-stalk.

———— Zege (20)

—·—·— G. R. (14)

— — — — Zw. Pr. (41)

····· Evene (16)

TABLE 3.

VITALITY OF THE LEAVES OF THE 2ND. SIDE-STALK IN DAYS.

	1st.	2nd.	3rd.	4th.	5th.	6th.	7th. leaf.
Zege. (20)	36.5	40.4	43.7	43.3	34.7	34.0	30.0
G. R. (14)	33.9	40.1	42.3	39.6	40.5	27.5	—
Zw. Pr. (41)	40.1	46.7	45.2	39.8	33,7	—	—
Evene. (16)	32.7	35.1	38.0	37.6	34.3	32.1	25.4

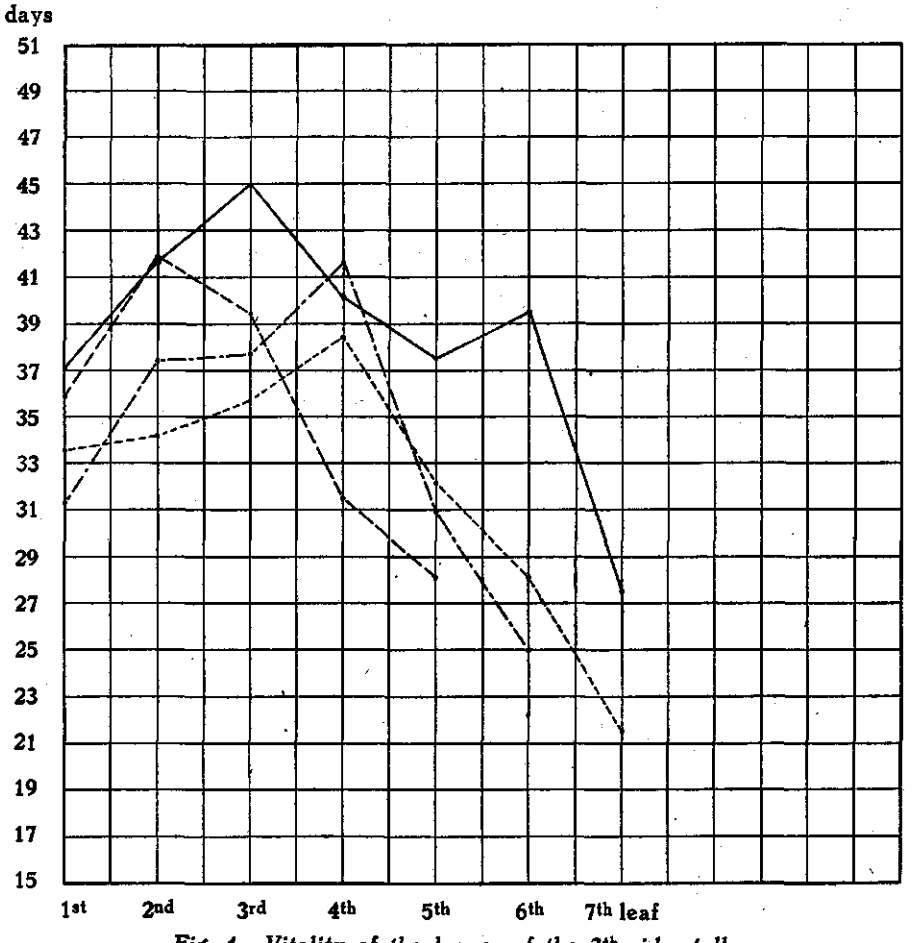

Fig. 4. Vitality of the leaves of the 3th side-stalk.

———— Zege (9)

—·—·—·— G. R. (7)

— — — — Zw. Pr. (30)

····· Evene (11)

TABLE 4.

VITALITY OF THE LEAVES OF THE 3RD. SIDE-STALK IN DAYS.

	1st.	2nd.	3rd.	4th.	5th.	6th.	7th. leaf.
Zege. (9)	37.1	41.7	45.0	40.1	37.5	39.5	27.5
G. R. (7)	31.3	37.4	37.7	41.6	30.9	25.0	—
Zw. Pr. (30)	35.9	41.8	39.4	31.5	28.2	—	—
Evene. (11)	33.6	34.2	35.7	38.4	32.1	28.1	21.5

The number of side-stalks is not so large as the number of mainstalks. In order to make it easier to judge of the reliability, the number of data on which the average is founded, has everywhere been given between brackets. Moreover so as to permit a judgement of the reliability of the differences observed the calculation of the probable error of the mean (E_M) has been used in calculating the vitality of the leaves.

It is evident that with this calculation separate groups had to be formed of stalks with the same number of leaves. The calculation of the probable error has been applied to mainstalks with 8 leaves and mainstalks with 9 leaves. The number of mainstalks with 6, 7 and 10 leaves was too small for this method and for the same reason a similar division and calculation of the probable error was neither possible for the side-stalks.

TABLE 5.

VITALITY IN DAYS OF THE LEAVES OF MAINSTALKS WITH 9 LEAVES.

	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th. leaf.
Zege 33 plants.	32.5	31.8	39.5	44.5	45.4	48.3	49.7	45.2	29.7
	± 0.9	± 0.6	± 0.8	± 0.6	± 0.7	± 0.7	± 0.6	± 0.8	± 0.7
G.R. 42 „	30.1	32.8	34.7	41.8	41.1	45.3	46.5	43.8	31.4
	± 0.9	+ 0.5	± 0.6	± 0.5	± 0.7	± 0.6	± 0.4	± 0.6	± 0.5
Zw. Pr. 17 „	24.9	27.2	33.9	46.5	50.2	50.6	48.9	43.1	28.5
	± 1.4	± 0.9	± 0.5	± 0.8	± 1.3	± 0.6	± 0.5	± 0.3	± 0.8
Evene 13 „	32.4	33.4	30.9	37.8	36.7	38.2	39.8	36.5	26.5
	± 1.0	± 1.1	± 0.9	± 0.7	± 1.4	± 1.8	+ 1.4	± 2.0	+ 1.2

Table 5 gives the vitality of the leaves of the mainstalks with 9 leaves and the probable error calculated if $E_M = 0.6745 \sqrt{\frac{\Sigma x^2}{n(n-1)}}$.

The value of E_M remains in general under one day, except with the „Evene" where E_M is greater as a consequence of the smaller number of objects and moreover because it is a population and therefore genetically heterogeneous.

Expressed in percents the probable error is somewhat under 2 %. This error is rather important, but then it is to be expected when we consider that in every series occur one or more leaves that deviate

very considerably from the average, which most probably has to be imputed to:

1. damage of such a leaf caused by wind;
2. damage caused by the repeated handling;
3. the difficulty of determining the final date.

For an example the complete figures concerning the vitality of the 8th leaf of the „Evene" are subjoined. With this leaf we find the greatest value of E_M as appears from the table, viz. $E_M = 2.0$.

Number of the plant . . .	302	303	306	308	310	321	322	323	352	359	360	362	375	
Vitality . . .	41	39	30	33	33	37	9	33	52	46	46	33	43	Mean = 36.5
x	4½	2½	6½	3½	3½	½	27½	3½	15½	9½	9½	3½	6½	
x^2	20¼	6¼	42¼	12¼	12¼	¼	756¼	12¼	240¼	90¼	90¼	12¼	42¼	$\Sigma x^2 = 1337.25$

As appears from this calculation the one great deviation of N°. 322 contributes more to Σx^2 than all the others together. But for this plant the E_M would be half as great.

TABLE 6.

VITALITY IN DAYS OF THE LEAVES OF MAINSTALKS WITH 8 LEAVES.

	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th. leaf.
Zege (33)	32.1	34.5	41.1	45.9	46.7	50.6	48.5	32.9
	± 1.0	± 0.7	± 0.6	± 0.7	± 1.0	± 0.5	± 0.6	± 0.6
G. R. (14)	34.6	34.6	36.2	40.1	40.5	43.2	43.5	31.9
	± 1.6	± 1.0	± 1.4	± 0.7	± 1.5	± 0.8	± 1.1	± 0.6
Zw. Pr. (47)	29.9	30.6	38.7	48.0	50.3	50.9	45.0	33.0
	± 0.7	± 0.5	± 0.7	± 0.6	± 0.8	± 0.5	± 0.6	± 0.6
Evene (4)	33.0	36.8	39.5	36.5	41.8	44.0	40.0	25.8
	± 1.8	± 1.0	± 1.8	± 3.0	± 4.0	± 3.6	± 2.7	± 2.5

Table 6 gives the vitality of the leaves of the mainstalks with 8 leaves. Here also E_M has about the value of 1.0, except with the „Evene", of which only 4 mainstalks with 8 leaves were available, the average of which is consequently little reliable. This appears for that matter from the fig. 5 and 6, which have been added to show that the general appearance of the curve has undergone no change by dividing the objects of each variety into groups according to the number of leaves and by comparing those groups of the different varieties. It is

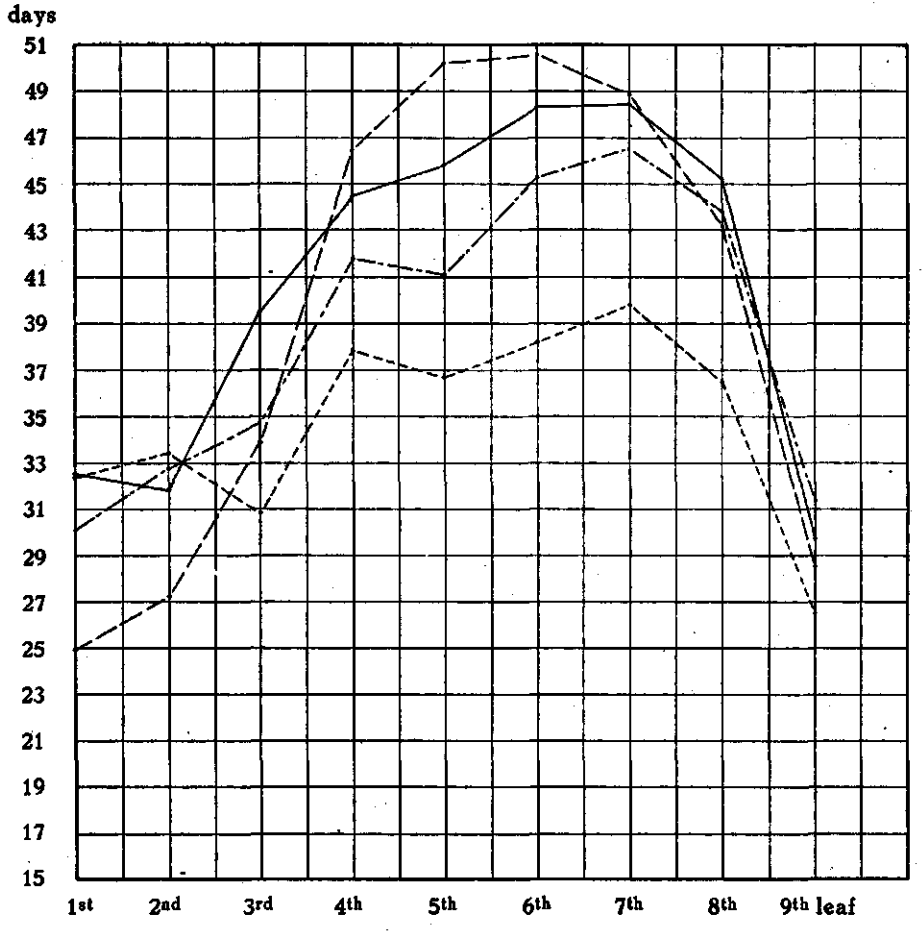

Fig. 5. Vitality of the leaves of the mainstalks with 9 leaves.

——— Zege (33)
—·—·— G. R. (42)
– – – – Zw. Pr. (17)
····· Evene (13)

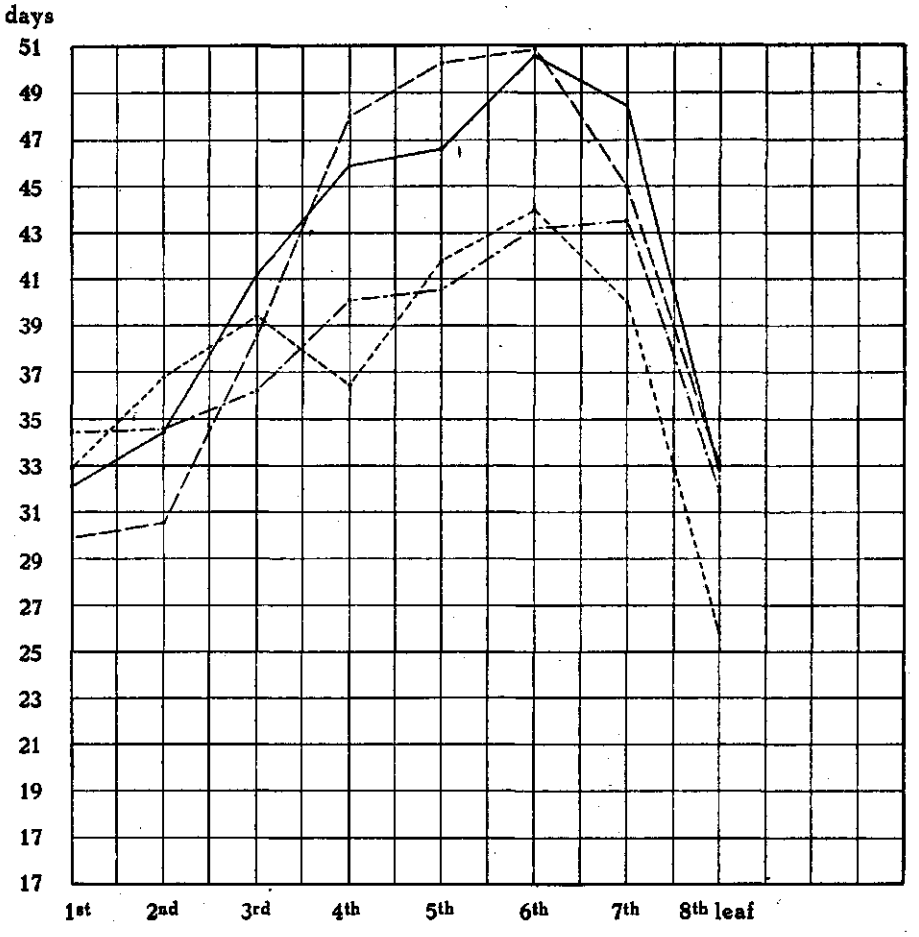

Fig. 6. Vitality of the leaves of the mainstalks with 8 leaves.

——— Zege (33)
—·—·— G. R. (14)
— — — Zw. Pr. (47)
····· Evene (4)

evident that the comparison of stalks with an equal number of leaves is more exact but as mentioned before this could not be carried through everywhere as the number of individuals in each group would become too small.

The vitality of the leaves as connected with the yield.

The following table shows the average yield of mainstalk and first three side-stalks.

TABLE 7.

YIELD OF MAINSTALK AND FIRST THREE SIDE-STALKS.

	Mainstalk.	1st.	2nd.	3rd. side-stalk.
Zege	2.304 Gr.	1.501 Gr.	1.580 Gr.	1.293 Gr.
G.R.	1.834 „	1.119 „	1.372 „	0.997 „
Zw. Pr.	1.981 „	1.298 „	1.387 „	0.933 „
Evene	0.898 „	0.733 „	0.611 „	0.615 „

As is proved hereby, for the mainstalk as well as for each of the side-stalks the yield decreases in the succession „Zege", „Zwarte President", „Gouden Regen" and „Evene". This is consequently entirely parallel to the vitality of the leaves.

The only difference is that as regards yield it is proved more clearly that the „Zege" is leading and the „Zwarte President" approaches more the „Gouden Regen". We will probably have to look for an explanation of this in the fact that with the „Zwarte President" the maximal vitality of the leaves lies more to the left in the curves (especially clear with the side-stalks) whereas with the „Gouden Regen" the top of the curve has been shifted more to the right. The upshot is consequently that the top leaves of the „Zwarte President" which are likely to have a greater influence on the yield of grains (proved for wheat) [1]) relatively speaking do not live so long as those of the „Gouden Regen". The most correct comparison we can again make in the curves that concern the mainstalks with the same number of leaves. Of the stalks with 9 leaves, with the „Zwarte President" the fourth leaf from the panicle reaches the greatest vitality, with the „Gouden Regen" the second leaf. Of the stalks with 8 leaves it is with

[1]) A. E. H. R. BOONSTRA: Invloed van de verschillende assimileerende deelen op de korrelproductie bij Wilhelminatarwe. Med. Landbouwhoogeschool, Deel 33 Verh. 3.

the „Zwarte President" the third leaf and with the „Gouden Regen" the second.

From the unequal values the different leaves have for the seedyield it follows, that we cannot take the sum of the vitalities of all the leaves of a certain stalk in order to determine the correlation thereof with the yield of grains. This is indeed possible of each seperate leaf, but we can see beforehand that the correlation of the vitality of one leaf with the seedyield will not be very considerable as the latter may be governed by many other influences. In a few cases however the trouble has been taken to determine this correlation to get an idea of its size. See table 8.

TABLE 8.

CORRELATION OF THE VITALITY OF THE RESPECTIVE LEAVES WITH THE SEEDYIELD.

	Zege (33)	G. R. (42)	Zw. Pr. (47)
9th. leaf . . .	+ 0.41	+ 0.07	—
8th. „ . . .	+ 0.18	+ 0.13	+ 0.09
7th. „ . . .	+ 0.32	+ 0.09	— 0.04
6th. „ . . .	+ 0.07	— 0.12	+ 0.11
5th. „ . . .	+ 0.31	+ 0.19	+ 0.05
4th. „ . . .	+ 0.26	+ 0.08	+ 0.04
3rd. „ . . .	+ 0.05	— 0.03	+ 0.05
2nd. „ . . .	+ 0.21	+ 0.16	+ 0.28

From the table it can be deduced with probability that there exists a weak positive correlation. Of course this cannot be proved with certainty seeing that we have to go by so few data. The probable error of r. amounts to about 0.100.

In this relation the three cases in which r. is negative can be accounted for just as the considerable fluctuations. The table for the matter of that has no other value than an indicative one.

From the above I think we are allowed to deduce that the vitality of the leaves is an important factor and deserves more attention than has been paid to it so far; this holds good especially for plant-breeding. The great difficulty in taking notice of such physiological qualities is however the great quantity of time that is taken up.

The data collected during the investigation provide an opportunity of pointing out at the same time some other qualities, in which the 4 varieties of oats differ more or less. As these data do not directly bear upon the purpose proper of the investigation they have been united without an ample explanation in an appendix.

APPENDIX.

TABLE 9.

	Zege (83 pl).	G.R. (88)	Zw. Pr. (88)	Evene (37)
Average number of stalks p. plant	3.64	3.31	4.16	7.49
„ „ „ panicles „	1.72	1.46	2.80	3.14
Number of stalks that produce a panicle	47 %	44 %	67 %	42 %
Average yield per plant . . .	3.298 Gr.	2.351 G.	4.118 G.	1.953 G.
„ „ „ panicle . .	1.914 G.	1.614 G.	1.373 G.	0.623 G.

Striking is the great number of side-stalks that the Evene produces and the small percent of these side-stalks that comes to panicle-forming. It is just the „Zwarte President" that excels in these two qualities and which therefore comes first as regards the yield per plant, though in practice (and then mostly not grown on heavy clay, as has been done in this case) it comes only in the third place. Furthermore the small yield per panicle of the „Evene" is remarkable.

TABLE 10.

Average yield of:	mainstalk.	1st.	2nd.	3rd.	4th.	5th. side-stalk.
Zege	2.304 Gr.	1.501 Gr.	1.580 Gr.	1.293 Gr.	1.402 Gr.	1.045 Gr.
G. R.	1.834 „	1.119 „	1.372 „	0.997 „		
Zw. Pr.	1.981 „	1.298 „	1.387 „	0.933 „	0.964 „	0.765 „
Evene	0.890 „	0.733 „	0.611 „	0.615 „	0.434 „	0.294 „

The side-stalks have been numbered according to the succession in which they appear. The side-stalks of a higher order yield less in general, which is in accordance with the observation of Schribaux, [1]) on which is founded the latter's thesis that we must breed cereals with small tillering-power.

About this thesis in itself the data given state nothing of course.

TABLE 11.

AVERAGE YIELD PER PANICLE OF PLANTS WITH DIFFERENT NUMBER OF PANICLES.

Plants with.	1	2	3	4	5 panicles.
Zege	1.708 Gr.	1.854 Gr.	2.078 Gr.	2.479 Gr.	
G. R.	1.462 „	1.735 „	1.638 „		
Zw. Pr. . . .	1.176 „	1.084 „	1.450 „	1.579 „	1.938 Gr.
Evene. . . .	0.650 „	0.582 „	0.580 „	0.468 „	0.549 „

[1]) i.a. Recherches expérimentales sur le tallage des céréales. Paris 1900.

Except for the „Evene" it appears from this table that the yield per panicle increases as the plant produces more panicles. On the strength of this phenomenon Rörig [1]) impugns Schribaux' thesis. It is evident as here the figures have reference to the same plants that they are two entirely different phenomenons and discordance is out of the question.

Fig. 7 gives: 1. average leaf development (number of leaves) of the mainplant as a function of the time.
2. average tillering per plant as a function of the time.
3. panicle development as a function of the time.

As regards leaf-development of the mainstalk the differences are not very considerable. The „Zwarte President" is an early-ripe variety and therefore comes first where leaf-development is concerned.

The tillering continues for a very long time with the „Evene" and (as appeared already from table 9) reaches a great height.

With the panicle development we see very clearly that the „Zwarte President" is an early-ripe variety and moreover that the „Evene" forms new panicles until the end of its career in which panicles naturally only few grains have been produced at harvesttime.

TABLE 12.

RELATION BETWEEN YIELD AND NUMBER OF LEAVES WITH THE MAIN STALK.

mainstalk with:	10	9	8	7	6 leaves
Zege	2.460 Gr. (1)	2.744 Gr. (33)	2.187 Gr. (33)	0.103 Gr. (5)	—
G. R.	2.086 „ (5)	2.190 „ (42)	1.379 „ (14)	0.876 „ (11)	—
Zw. Pr. . . .	—	2.185 „ (17)	2.158 „ (47)	0.901 „ (7)	0.060 Gr. (6)
Evene. . . .	0.666 „ (6)	0.782 „ (11)	0.793 „ (4)	—	—

From fig. 7 it has appeared already in connection with the yield that it is certainly not right that varieties with a great number of leaves have a greater yield than varieties with a smaller number of leaves. The above table shows that the same holds good also within the variety, although here we may assume that the surface of the foliage increases in proportion to the number of leaves.

Fig. 8 gives the development of the green parts in course of time. It is a pity that it was not possible in the busy time to measure the

[1]) Ill. Landw. Zeit 22 1902.

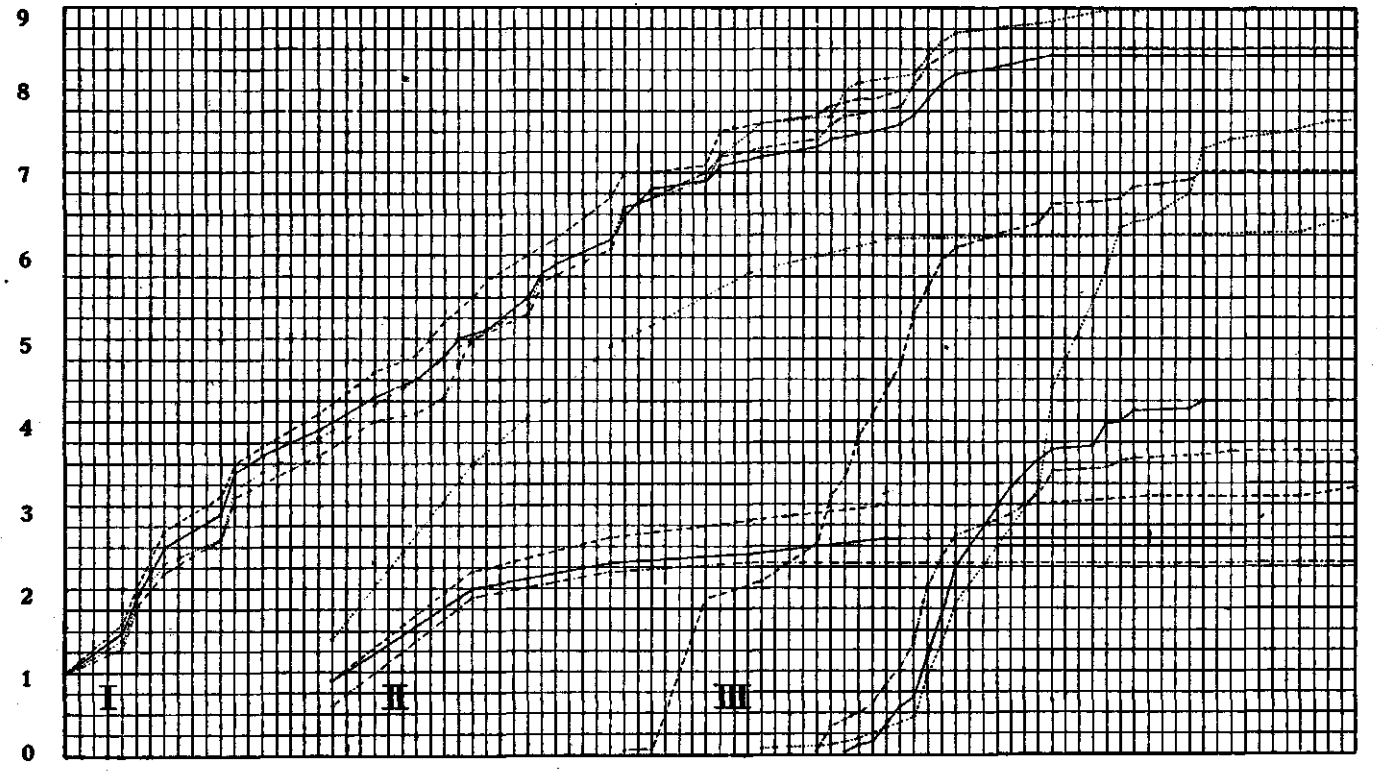

Fig. 7.

———— Zege haver.
—·—·—·— Gouden regen.
— — — — Zwarte President.
..... Evene.

I. Number of leaves of the main-stalk as a function of the time.
II. Tillering per plant as a function of the time.
III. Number of panicles per plant as a function of the time.

X-axis: Days of observation from the beginning of the experiment.
Y-axis; left: Number of leaves, respectively stalks; right: Number of panicles.

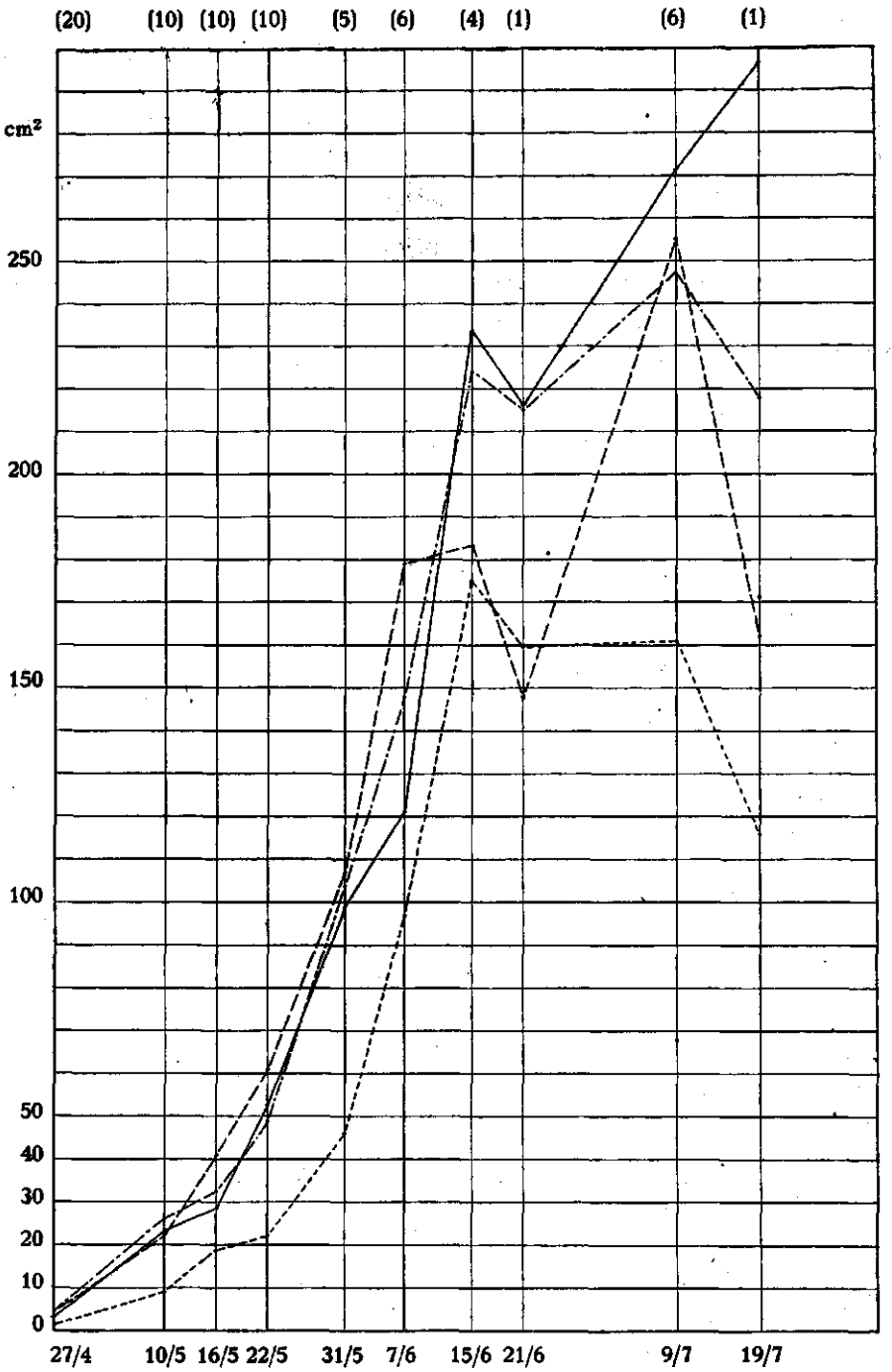

Fig. 8. Green surface of the plant as a function of the time.

——————— Zege

—·—·—·— G.R.

— — — — — Zw. Pr.

····· Evene

green surface of leaves and stalk of a great number of plants. The figures over the curves indicate on how many plants the average is founded. In general the differences of assimilating surface with the 3 good varieties are inconsiderable. The „Evene" deviates again strongly in an unfavourable sense.

From the staff of our institute Miss HEINSIUS took an important part in controlling the leaf-development, whereas Miss POSTUMA made the translation into English.

VERSCHILLEN IN LEVENSDUUR VAN DE BLADEREN BIJ 4 HAVERRASSEN IN VERBAND MET DE OPBRENGST.

De varieteiten van onze landbouwgewassen geven in het algemeen een verschillende opbrengst. Eén bepaalde oorzaak is daarvoor niet aan te wijzen. Meermalen is getracht een verband op te sporen tusschen de opbrengst en uitstoeling, aarlengte, bouw van de halm, bladoppervlak e. a. Op de levensduur van de bladeren is, voor zoover ik weet, nog nooit gelet. Toch zal, zoolang voor een blad de assimilatie de ademhaling per 24 uur overtreft en de gevormde stoffen niet gebruikt worden voor de opbouw van het blad zelf, de opbrengst in het algemeen stijgen met een langere levensduur van het blad. Nu is het niet mogelijk om op eenvoudige wijze te bepalen, wanneer een blad begint met het afleveren van assimilaten en wanneer het daarmee ophoudt.

Eenvoudigheidshalve heb ik aangenomen, dat een blad hiermee begint, op die dag, dat het volgende blad, resp. pluim te voorschijn komt en dat het daarmee ophoudt, zoodra het voor de helft geel is. Het tijdsverloop tusschen deze twee data noem ik dan in dit onderzoek de levensduur van het blad. Natuurlijk geeft dit slechts bij benadering de gewenschte waarde weer.

Het onderzoek werd uitgevoerd met Zegehaver, Gouden Regen, Zwarte President en Evene (Populatie van Avena Strigosa). De planten groeiden onder omstandigheden geheel gelijk aan de practijk wat grondbewerking, bemesting en standruimte betreft. De 4 veldjes, elk van eenige vierkante Meters, lagen vlak naast elkaar. Op 26 April werden in elk veldje 100 planten uitgezocht, waarvan het tweede blad reeds te zien was, maar nog niet geheel ontwikkeld. Oorspronkelijk was het de bedoeling om de levensduur na te gaan bij 200 planten van elk ras, maar het onderzoek bleek te bewerkelijk om dit uit te voeren. Zelfs moest bij de Evene, die zeer sterk uitstoelt, het aantal nog beperkt worden tot 50.

Het eerste blad werd gemerkt met een roode stip aan de top van het blad. Later kreeg het tweede blad 2 roode stippen, het derde blad 3, het vierde blad een zwarte stip, en zoo werd door gebruikmaking van verschillende kleuren en een verschillend aantal stippen

elk blad van een eigen merk voorzien. Bovendien kreeg elke zijhalm een eigen kenteeken.

In verband met de rijpheid waren de oogstdata: Zwarte President 27 Juli, Gouden Regen 6 Augustus, Zege en Evene 7 Augustus. Alleen halmen die een pluim gevormd hadden werden geoogst. Het geoogste materiaal werd gedroogd bij 105°, het zaad met de hand uitgewreven en na eenige dagen aan de lucht blootgesteld te zijn geweest, gewogen.

De resultaten vallen het best te bespreken aan de hand van de curven. Op de x-as is het blad aangegeven, genummerd in de volgorde van onder naar boven en op de y-as de levensduur van de bladeren in dagen. De korte levensduur van het laatste blad is eenigszins misleidend in verband met de notatie. Terwijl bij de overige bladeren de regel: het blad is volwassen als het daarop volgende te voorschijn komt, niet tot groote fouten aanleiding zal geven, laat de pluim zoo lang op zich wachten, dat het laatste blad te laat als volwassen genoteerd wordt en daarvoor dus een te korte levensduur berekend wordt.

Uit fig. 1 blijkt, dat de bladeren bij de Evene het kortst leven en daarna bij de Gouden Regen, terwijl de Zege en de Zwarte President een langere bladlevensduur bezitten. De verschillen tusschen deze laatste twee rassen zijn van eenigszins andere aard. De langste levensduur bereiken bij de Zw. Pr. het 5e en 6e blad, terwijl deze bij de Zege pas bij het 6e en 7e blad bereikt wordt.

Fig. 2, 3 en 4 laten zien, dat de voor de hoofdhalm geconstateerde verschillen ook bestaan bij de zijhalmen. Omdat het aantal zijhalmen niet zoo groot is als het aantal hoofdhalmen, is overal tusschen haakjes aangegeven op hoeveel gegevens het gemiddelde berust.

Het aantal bladeren van de hoofdhalm is bij de Evene 8—10 (gem. 9,0), bij de G. R. 7—10 (gem. 8,5), bij de Zege 7—10 (gem. 8,4), bij de Zw. Pr. 6—9 (gem. 8).

Om een zuiverder vergelijking mogelijk te maken heb ik de hoofdhalmen met 9 bladeren onderling vergeleken en eveneens die met 8 bladeren (resp. fig. 5 en 6). Bovendien heb ik op deze groepen de foutenberekening toegepast (tabel 5 en 6). De waarschijnlijke fout is berekend als $E_M = 0.6745 \sqrt{\frac{\Sigma x^2}{n\,(n-1)}}$.

De aantallen hoofdhalmen met 6, 7 en 10 bladeren waren te gering om een eenigszins betrouwbaar gemiddelde te krijgen en om dezelfde reden was een splitsing in groepen met gelijk aantal bladeren bij de zijhalmen niet mogelijk.

Tabel 7 geeft de gemiddelde opbrengst van hoofd- en eerste drie zijhalmen. Hieruit blijkt, dat de opbrengst afneemt in de volgorde Zege, Zw. Pr., G. R., Evene, of dus in dezelfde volgorde als de bladlevensduur.

Uit de ongelijke waarde, die de verschillende bladeren hebben voor de zaadopbrengst volgt, dat we niet de som kunnen nemen van de levensduur van alle bladeren van een bepaalde halm om de correlatie hiervan met de korrelopbrengst te bepalen. Wel gaat dit van elk blad apart, maar het is te voorzien, dat de correlatie van de levensduur van één blad met de zaadopbrengst niet erg groot zal zijn, omdat die door zeer veel andere invloeden overheerscht kan worden. Voor een paar gevallen is echter de moeite genomen deze correlatie te bepalen om een idee te krijgen van haar grootte. Daarvoor is bepaald de correlatie van de levensduur van de bladeren van de hoofdhalm (bij Zege en G. R. met 9 bladeren, bij Zw. Pr. met 8 bladeren) met de zaadopbrengst. Zie tabel 8.

Deze tabel maakt het bestaan van een zwakke positieve correlatie waarschijnlijk. Het aantal gegevens waarop de correlatietabel berust is veel te klein om dit met zekerheid aan te toonen.

Uit het bovenstaande meen ik te mogen afleiden, dat de levensduur der bladeren een belangrijke factor is en meer aandacht verdient dan er tot dusver aan gewijd is. Vooral geldt dit voor het kweeken van nieuwe rassen.

In een aanhangsel zijn nog eenige andere eigenschappen van de 4 haverrassen vergeleken.

9 Aug. 1929.