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Course of Growth and Development of Spring Barley

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Abstract. The barley variety "Browarny P.Z.H.R." was grown in pots. Experiments on the course of development were conducted for two years. The increase in the dry weight of roots, leaves, stems and grain was recorded. The assimilation area of the plants was measured periodically and the rate of respiration in detached leaves was determined. Photographic records were kept of growing point and ear development.

The dynamics of growth and development were studied during the whole vegetation period.

The present results are similar to those previously obtained for spring wheat. The short period of leaf activity is the chief factor limiting barley growth.

A number of investigations have been made on the development (ANDERSEN 1952, BONNET 1935, BRENCHLEY 1912) and on photosynthesis and growth (ARCHBOLD 1942, GREGORY 1926, HEATH and GREGORY 1938, MILTHORPE 1956, PORTER, PAL and MARTIN 1950, STREBEYKO, DOMAŃSKA and NELKEN 1961, WATSON and NORMAN 1939) in spring barley. The present experiments had a similar aim to those on growth and development in spring wheat reported previously (STREBEYKO, WISŁOCKA and KRZYWACKA 1963).

Material and Methods

Spring barley variety "Browarny P.Z.H.R." was grown in pots. The experiments were conducted over a two-year period (1960, 1961). Each pot contained 8 kg. sand and the following quantities of mineral nutritients added in the form of agricultural fertilizers 0·5 g. N, 0·5 g. K_2O and 0·25 g. P_2O_5. Trace elements were added as Hoagland A—Z nutrient solution. The sand moisture content was kept at the 60 per cent level of its capillary water-holding capacity.

A sample of 5 pots was removed every 4 to 5 days during the experimental period and measurements of the course of growth and development were taken. Determinations of the dry weight of roots, stems, leaves and grain were carried out. The assimilating surface area of leaves and stems was calculated. Records of growing point and ear development were kept. The rate of respiration was measured on detached leaves at 25° C using the Warburg apparatus.

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1960 Experiments

The important dates marking the different phases of the developmental cycle are given below:

Sowing — April 22nd. Emergence — May 2nd. Going into ear, followed by flowering — June 15th. Grain milky stage — July 6th. Grain doughy stage — July 15th. Full maturity — July 28th.

The vegetation lasted 98 days from the date of sowing and 87 days from the date of emergence. There were 17 successive harvests from the beginning of the generative phase up to full maturity i.e. within the period May 9th. to July 28th. The time sequence of growth and development was recorded. Total leaf dry weight increased up to June 7th (Fig. 1.) The dry weight of green leaves began decreasing from June 3rd (beginning of pollen formation) due to yellowing and drying in

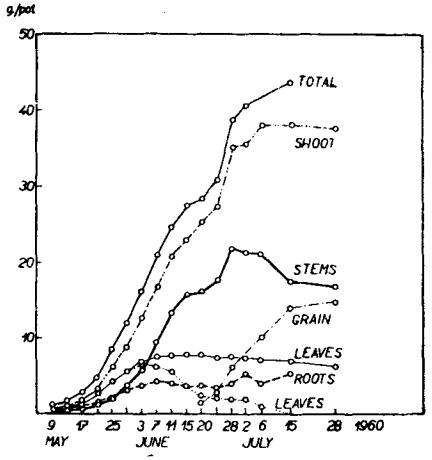

Fig. 1. Increase of plant dry weight in 1960.

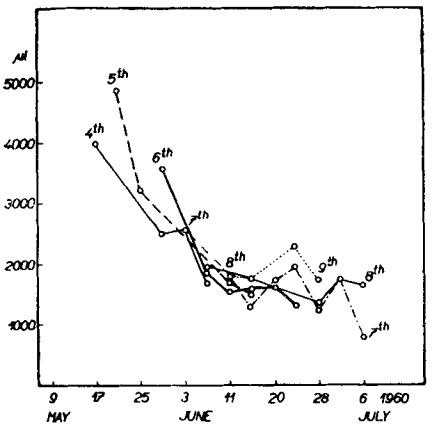

Fig. 2. Intensity of leaf respiration expressed by oxygen absorbed per 1 g. of dry weight per hour.

the lowest leaves. The rapid rise in stem weight which usually accompanies the change in the course green leaf dry weight increase began on May 30th and continued over a period of 4 weeks up to June 28th. Root growth stopped at the time when leaves ceased growing (June 7th). The stem assimilation area tended towards its maximum at this time being equal to the decreasing leaf area. The photosynthetic area of the ear was not measured.

The total assimilation area of the plants had the highest value between June 3rd and June 11th. At the time of earing and flowering, a drop in the assimilation area was observed which was due to yellowing and drying of the older leaves. The plants continued growing up to the doughy stage (July 15th). The rate of respiration in detached leaves, measured as oxygen uptake, decreased gradually (Fig. 2). The highest dry weight figure reached during the vegetative phase was 44 g. per pot and consisted of 15 g. grain, 24 g. straw, 5 g. roots.

1961 Experiments

The dates marking different phases in development were as follows:

Sowing — March 28th, Emergence — April 7th. Going into ear — June 2nd. Flowering — June 6th. Milky stage of grain — June 14th. Doughy stage of grain — June 28th. Full maturity — July 7th.

The vegetation lasted 101 days from the date of sowing and 91 days from the date of emergence. Samples of plant material for growth analysis were collected in 19 successive harvests in the period April 13th to July 7th. Total leaf dry weight increased up to May 20th (Figs. 3 and 4) but the green leaf dry weight and area gradually decreased from May 16th onwards when the first lower leaves began yellowing and drying. The rapid increase in stem weight began on May 8th and continued over 33 days up to June 10th.

The green area of the stems reached a maximum value at the time when plants began going into ear (June 2nd). It was then equal to the decreasing green leaf area. The highest figure for total plant assimilation area was attained on May 24th, a week before going into ear.

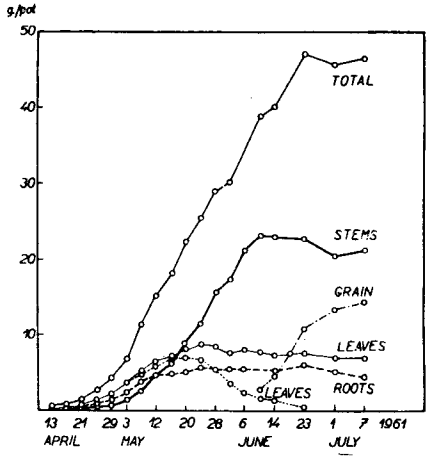

Fig. 3. Increase of plant dry weight in 1961.

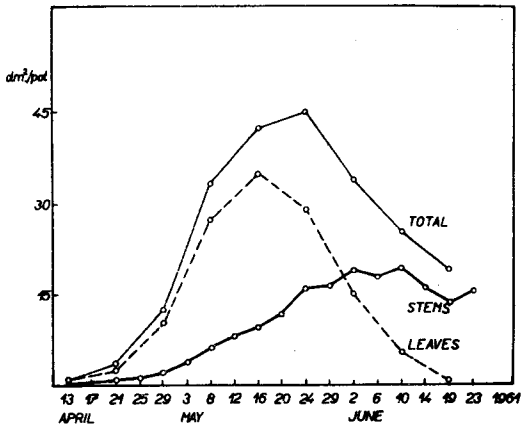

Fig. 4. Increase of assimilation (green) area in 1961.

At the time of earing and flowering the total plant assimilation area values decreased due to the drying and yellowing of the older, lower leaves. Plants continued growing until the doughy stage (June 23rd). The final average dry weight per pot attained was 47 g. and consisted of 14 g. grain, 28 g. straw, 5 g. roots.

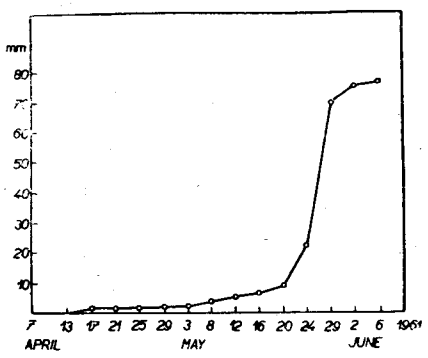

Fig. 5a. Ear length (1960).

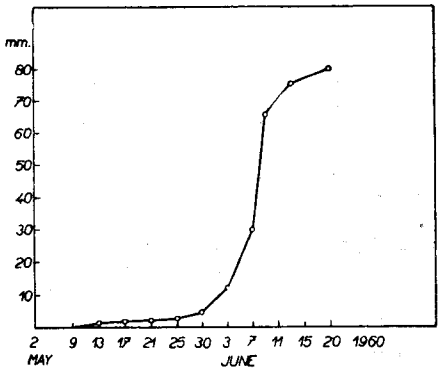

Fig. 5b. Ear length (1961).

Results and Conclusions

In spite of 25 days difference in the time of sowing in the two years (April 24th in 1960 and March 28th in 1961) the length of the vegetative phase, growth and the final plant weight attained were similar.

Some regularities in the course of growth and development in the tested variety of spring barley did emerge.

Figures showing the course of plant development are given in Table 1. Due to limited space only the 1961 photographs of growing point and ear development are given in this Table. The figures refer to the number of leaves present and to plant weight expressed as a percentage of the final yield. The increase in ear length is shown in Fig. 5. The following conclusions were drawn on the basis of the results obtained:

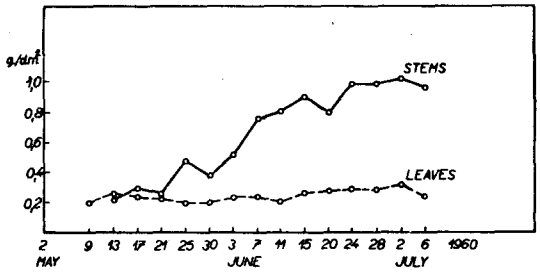

Fig. 6a. Ratio between the area and dry weight of green leaves and stems (1960).

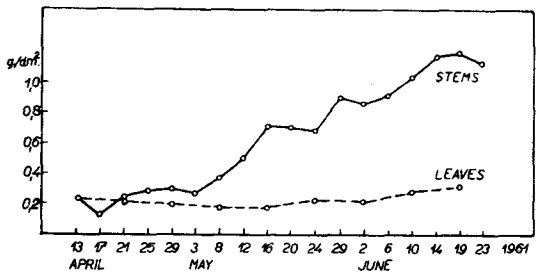

Fig. 6b. Ratio between the area and dry weight of green leaves and stems (1961).

1). In the spring barley variety tested "Browarny P.Z.H.R." the period of assimilatory activity in leaves is characteristically short. The lower leaves begin turning yellow and drying before the last leaf shoot is out.

2). The stem area reaches a maximum at ear formation. At this time leaf area values have begun decreasing and are close in magnitude to stem area values. Thereafter, due to the rapid drop in leaf area values, the percentage of the total assimilatory surface attributable to stems increases.

3). Leaf area forms the main component of the total assimilation area. The maximum leaf area per plant is 2 dcm² while the maximum stem area per plant is 1 dm².

4). Leaf growth lasts 5—6 weeks from emergence up to the time when the maximum for the assimilation area is reached. Thereafter the green leaf area decreases rapidly due to the dying of the older leaves.

5). In order to raise plant-mass yields the period of assimilatory activity of the leaves would have to be extended.

6). The rate of respiration in detached leaves, expressed as oxygen uptake, decreases gradually with age (Fig. 2).

7). Ear elongation is a striking phase of development. Ear length increases more than 6 times within a period of only 8 to 9 days (Fig. 5). Such rapid growth is attributable to cell elongation, which is accompanied by the formation of large vacuoles, rather than to cell division.

8). Growth in grain weight continues for about 4 weeks. At first it is entirely dependent on photosynthesis, but the translocation of organic compounds from the stem gains in importance.

9). Coefficients for the ratio of area to dry weight were calculated for both

Tab. 1. Development of plants in 1961

Harvest	Date	Days from emergence	Number of leaves	Dry weight attained (per cent of final yield)	
	28. III.				Seeding
	7. IV.				Emergence of seedlings.
1	13. IV.	6	2	1%	Formation of leaf primordia.
2	17. IV.	10	3	2	Beginning of growing point elongation.
3	21. IV.	14	4	3	Beginning of spikelet differentiation shown by double ridges on a young spike.
4	25. IV.	18	4	5	Double ridges formed.
5	29. IV.	22	5	9	Spikelet formation continued.
6	3. V.	26	5	15	Glume differentiation.
7	8. V.	31	6	24	Flower differentiation. Shooting.
8	12. V.	35	7	33	Flower differentiation finished.
9	16. V.	39	7	40	A rapid growth of glumes, awns, staminas and pistil.
10	20. V.	43	8	48	The growth of awns, staminas and pistil continued. Pollen mother cells differentiation.
11	24. V.	47	9	56	Spike rachis elongation.
12	29. V.	52	9	63	Stigma branches differentiation.
13	2. VI.	56	9	68	Stigma formation finished.
—	4. VI.	58	9	—	Earing.
14	6. VI.	60	9	79	Anthesis.
15	10. VI.	64	9	83	Grain formation.
16	14. VI.	68		85	Milky stage of grain.
17	1. VII.	85		99	Doughy stage of grain.
18	7. VII.	91		100	Full maturity of grain.

green leaves and stem (Fig. 6). It was aimed to arrive at a measure which would make it possible to deduce an approximate assimilation area given the dry weight only. Such coefficients may be useful in spite of the fact that the weight of unit stem area changes markedly during development while that of leaves does not.

The dry weight of 1 dcm^2 of leaf tissue is 0·2 g. and does not change much throughout the vegetation period.

The weight of 1 dcm^2 of stem tissue increases from 0·2 g. to 1 g. during the vegetation period.

Acknowledgement

Authors are greatly indebted to Mrs. T. Krzywacka for photographs of ear and growing point development.

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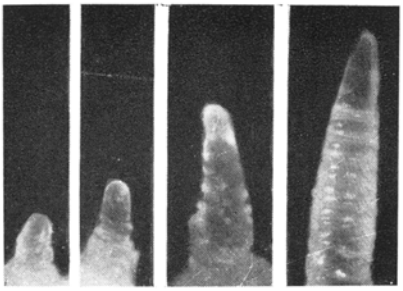
Development of the growing points and the spikes in harvest Nr. 1—15 (see Table 1)



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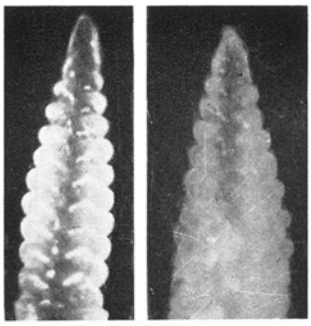

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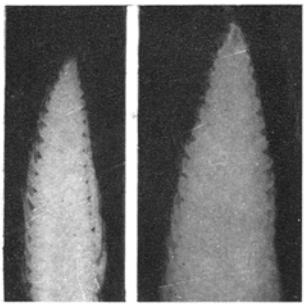

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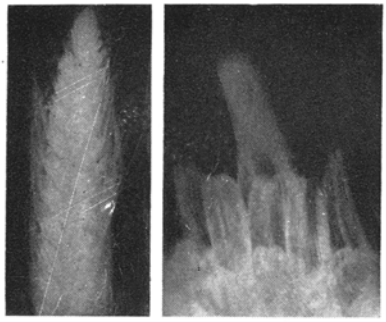

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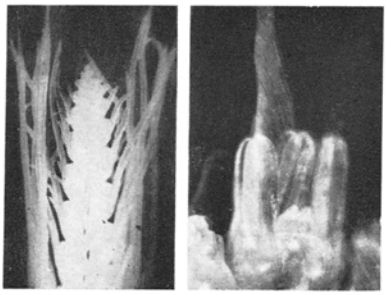

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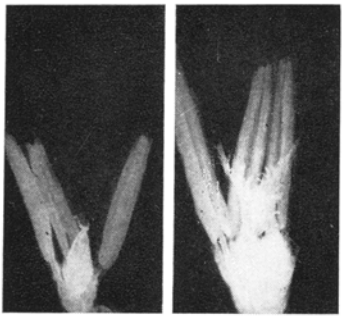

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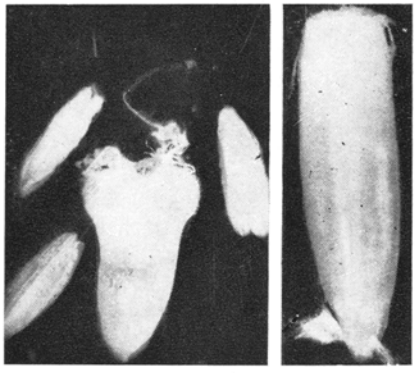

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Odrůda ječmene "Browarny P.Z.H.R." byla vypěstována ve vegetačních nádobách. Vegetační pokusy byly prováděny po dvě léta, kdy byl sledován přírůstek váhy sušiny, kořenů, listů, stonků a zrna, měřena asimilační plocha rostlin a byla stanovena intenzita dýchání odříznutých listů. Vegetační vrchol a vývoj klasu byly fotograficky registrovány.

Výsledky jsou analogické výsledkům obdrženým již dříve u jarní pšenice. Hlavním faktorem omezujícím růst ječmene je krátké období aktivity listů.

П. СТРЕБЕЙКО, Б. ГУРА, Институт физиологии растений, Варшавский университет и Институт растениеводства и акклиматизации, Варшава: **Рост и развитие ярового ячменя.** — Biol. Plant. 6 : 152—157, 1964.

Культивар ячменя «Броварны П.З.Г.Р.» выращивался в вегетационных сосудах. Вегетационные опыты проводились в течение двух лет и изучалось в них нарастание сухого веса корней, листьев, стеблей и зерна, измерялась ассимиляционная площадь растений и определялась интенсивность дыхания отрезанных листьев. Конус нарастания и развитие колоса регистрировались фотографическим путем. Результаты, полученные в этих опытах, соответствуют результатам, достигнутым раньше у яровой пшеницы. Основным фактором, лимитирующим рост ячменя, является короткий период активности листьев.