

# Yield formation in wheat (*Triticum aestivum* L.) in ecological agriculture

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# Introduction

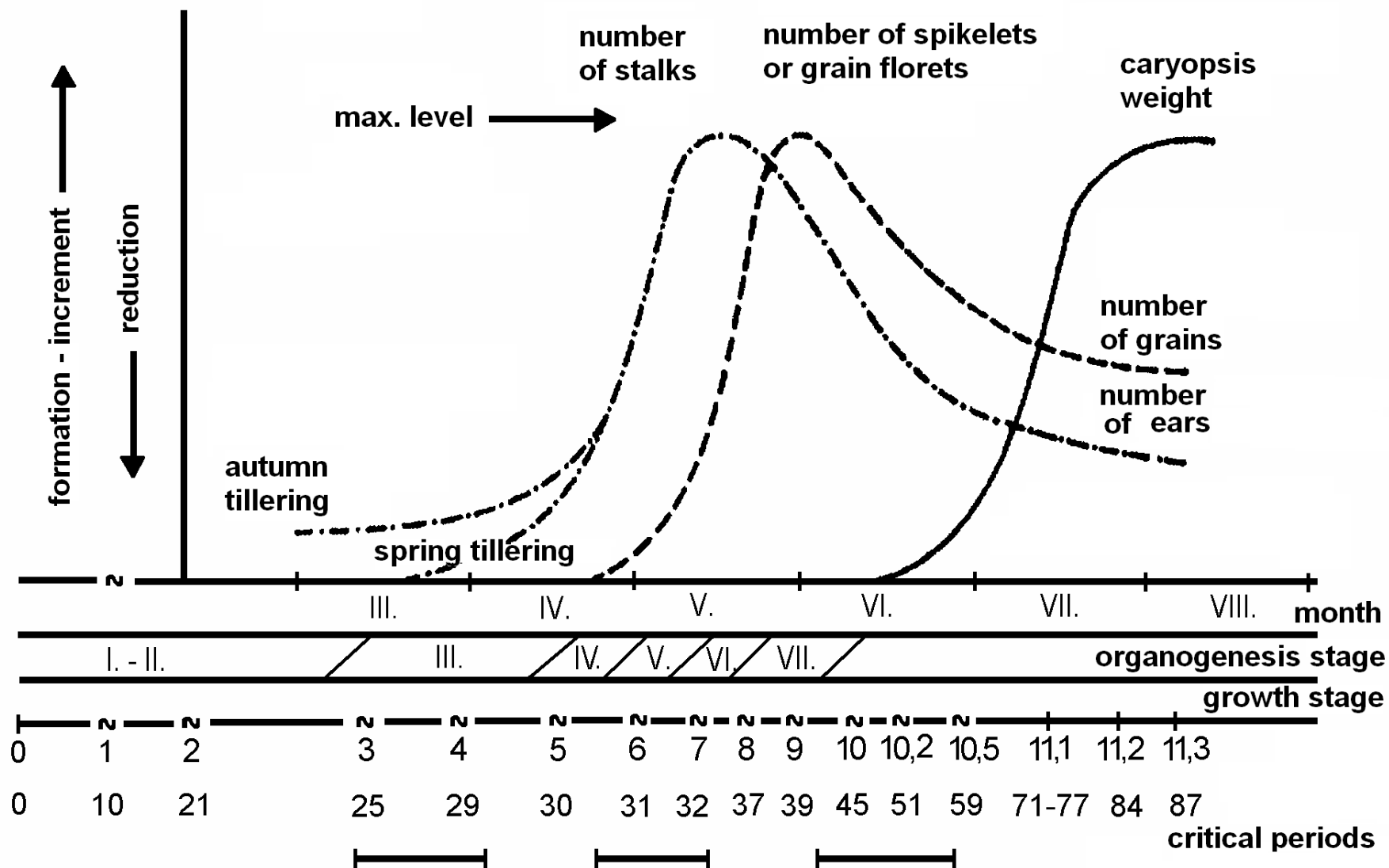
The formation of the cereals yield is a dynamic process, which starts with the establishment of the crop stand, performance of the stand, nutrients and treatment of the stand.

A specific feature of the organic method of growing is the supply of nutrients, which is based on nutrients from organic fertilizers and, if necessary, from permitted natural mineral resources.

## The yield components

- the number of ears per unit area, which is given by the number of plants, and productive tillering, i.e. the number of fertile stalks
- the number of grains in the ear, which depends on the number of established spikelets and fertile florets
- the mass of caryopsis (i.e. the mass of 1000 grains)

# Dynamics of the yield components formation in cereals



# Materials and methods

- Winter wheat cultivars: Estica (quality group C) and Ebi (quality group A)
- Dates of sowing - late (about October 20<sup>th</sup>) and early (about September 20<sup>th</sup>)
- Sowing rates: (250 and 500 germinating grains per 1 m<sup>2</sup>).
- Arrangement of trials: split plot in 3 replicates
- Conditions of certified and checked Research Station for Ecological Agriculture in Uhrineves (in accordance with the Act 242/2000 Coll. and EHS 2092/91)
- RS is located in a fertile area with brown soil, good nutrient reserves and neutral pH.
- Clover was used as a preceding crop in both years.
- Number of plants, number of ears, number and mass of grains in the ear were observed during the vegetation.

| $N_{\min}$ content<br>in the depth of | $N_{\min}$<br>0 – 30 cm | $N_{\min}$<br>30 – 60 cm | Total N kg/ha<br>30 – 60 cm |
|---------------------------------------|-------------------------|--------------------------|-----------------------------|
| Organic area 2001                     | 19.10                   | 7.85                     | 86                          |
| Organic area 2002                     | 17.20                   | 9.75                     | 78                          |

Apart from the above described experiment, the structure of yield was also observed in varietal experiments using the same method, and the same varieties and seeds as those in the state varietal experiments of the National Office for Varieties of the Czech Republic. Every year a collection of 30 varieties has been tested. These experiments tested varieties considered suitable for organic agriculture.

# Results and discussion



## Yield structure of winter wheat from organic cultivation in 2001

| Variety | Sowing*<br>Rate/Time | 1   |     |     | 2   | 3   | 4  | 5    | 6    |
|---------|----------------------|-----|-----|-----|-----|-----|----|------|------|
|         |                      | A   | S   | H   |     |     |    |      |      |
| Ebi     | Lower/I.             | 310 | 238 | 190 | 462 | 1.0 | 19 | 53.2 | 4.69 |
| Ebi     | Higher/I.            | 566 | 328 | 226 | 436 | 1.2 | 23 | 52.5 | 5.29 |
| Ebi     | Lower/II.            | 336 | 190 | 172 | 475 | 0.9 | 17 | 52.3 | 4.12 |
| Ebi     | Higher/II.           | 572 | 334 | 311 | 570 | 0.9 | 18 | 51.1 | 5.21 |
| Estica  | Lower/I.             | 322 | 208 | 139 | 393 | 1.0 | 20 | 52.2 | 4.05 |
| Estica  | Higher/I.            | 504 | 189 | 157 | 469 | 0.9 | 17 | 51.5 | 4.22 |
| Estica  | Lower/II.            | 314 | 238 | 152 | 435 | 1.0 | 20 | 54.2 | 4.60 |
| Estica  | Higher/II.           | 500 | 322 | 224 | 517 | 0.9 | 17 | 52.6 | 4.72 |

\* I. early sowing, II. late sowing

Note: 1 – number of plants per m<sup>2</sup> (A – autumn, S – spring, H – harvest),

2 – number of ears per m<sup>2</sup>, 3 – mass of grain per ear (g),

4 – number of grains per ear, 5 - thousand grains weight (g), 6 – yield (t per ha)

## Yield structure of winter wheat from organic cultivation in 2002

| Variety | Sowing*<br>Rate/Time | 1   |     | 2   | 3   | 4  | 5    | 6    |
|---------|----------------------|-----|-----|-----|-----|----|------|------|
|         |                      | A   | S   |     |     |    |      |      |
| Ebi     | Lower/I.             | 271 | 216 | 498 | 1.1 | 26 | 41.8 | 5.46 |
| Ebi     | Higher/I.            | 417 | 326 | 575 | 0.7 | 15 | 46.3 | 6.73 |
| Ebi     | Lower/II.            | 0   | 181 | 472 | 0.9 | 22 | 40.4 | 4.28 |
| Ebi     | Higher/II.           | 0   | 183 | 495 | 1.2 | 28 | 44.4 | 6.22 |
| Estica  | Lower/I.             | 157 | 231 | 539 | 1.1 | 27 | 42.2 | 6.12 |
| Estica  | Higher/I.            | 432 | 303 | 541 | 1.3 | 29 | 43.1 | 6.88 |
| Estica  | Lower/II.            | 0   | 119 | 349 | 1.2 | 29 | 41.2 | 4.13 |
| Estica  | Higher/II.           | 0   | 299 | 466 | 1.3 | 30 | 44.3 | 6.29 |

\* I. early sowing, II. late sowing

Note: 1 – number of plants per m<sup>2</sup> (A – autumn, S – spring, H – harvest),

2 – number of ears per m<sup>2</sup>, 3 – mass of grain per ear (g),

4 – number of grains per ear, 5 - thousand grains weight (g), 6 – yield (t per ha)

## Results

- The plant numbers correspond with the aims of lower and higher rates of sowing
- The reduction of plants during the plants emergence about 20%
- A larger reduction of plants (about 45 – 55 %) after later sowing
- Higher sowing rate at the delayed sowing time softened the impact of these conditions on the final yield

## Results

- The reduction of plants number during overwintering varies according to the variety and mainly according to the weather conditions during winter
- Overwintering was poorer in late sowing
- The results from both experimental years show higher yields for early sowings in the second half of September
- The organic agriculture can carry only a certain number of plants per unit of area. Based on multi-year experiments, this would correspond to about 270 plants per m<sup>2</sup> after overwintering

## Results

- The number of ears is dependent on the dynamics of the release of nitrogen in the soil, apart from other external factors it influences the formation of tillers – in lower level of soil mineral nitrogen content it is not possible to expect greater tillering
- The number of ears and the number of grains per ear and their mass were decisive for the final yield. This would confirm the hypothesis that in organic agriculture the productivity of the ear is decisive for the yield of cereals.

## Structure of the yield in a seven year experiment with winter wheat in organic agriculture

| Year           | 1  | 2          | 3         | 4          | 5           | 6           | 7           | 8           |
|----------------|--|------------|-----------|------------|-------------|-------------|-------------|-------------|
| 2000           | 30   | 359        | 90        | 487        | 38          | 1.75        | 45.5        | 8.55        |
| 2001           | 30   | 299        | 71        | 414        | 29          | 1.48        | 50.7        | 6.16        |
| 2002           | 32   | 304        | 79        | 500        | 30          | 1.30        | 44.1        | 6.64        |
| 2003           | The crop stands were destroyed by the winter conditions of 2002/2003 |            |           |            |             |             |             |             |
| 2004           | 27   | 201        | 55        | 323        | 34          | 1.82        | 53.5        | 5.91        |
| 2005           | 36   | 289        | 90        | 375        | 38          | 1.82        | 47.8        | 6.85        |
| 2006           | 29   | 186        | 50        | 335        | 35          | 1.58        | 45.1        | 5.30        |
| 2007           | 35   | 267        | 85        | 368        | 40          | 1.78        | 43.9        | 6.55        |
| <b>Average</b> | <b>31</b>  | <b>272</b> | <b>74</b> | <b>400</b> | <b>34.8</b> | <b>1.65</b> | <b>47.2</b> | <b>6.56</b> |

*Note: 1 – number of varieties, 2 – number of plants per m<sup>2</sup> (in autumn) 3 – overwintering (%), 4 - number of ears per m<sup>2</sup>, 5 – number of grains per ear, 6 - mass of grain per ear (g), 7 – thousand grains weight (g), 8 – yield (t per ha)*

# Conclusions

- It proved to be most optimal to sow 400 grains per m<sup>2</sup>.
- When the sowing is late the sowing rate is increased in view of the higher risk of the plants loss.

# The evaluation of a seven year trial

- The yield structure from an average of 213 varieties and 650 plots was at 272 plants per m<sup>2</sup> after emergence and 201 plants after overwintering.
- The average number of ears was 400 per m<sup>2</sup>
- There were about 35 kernels with the mass of 1.65 g per ear.
- TKW was high, about 47.2 g.
- This structure brought yield of 6.5 tonnes per hectare on average in the described experiment.
- The attained yield and its structure are significantly influenced by pre-crops and the resulting quantity of the nitrogen released from the soil.



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## **Acknowledgments**

The study was supported  
by Ministry of Agriculture project QG 50034



**Thank You for attention!**