Influence of sowing date (autumn vs. spring) on crop development, yield and yield structure of wheat and triticale

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Scientific Background

- The sowing date is on of the most important management factors especially under Pannonian climate conditions

- In wheat, an increase of 1 °C during the grain filling period can result in a 570-620 kg/ha-1 yield reduction

- Drought or heat stress during the grain filling period negatively influence the movement of photosynthetic products to develop kernels and inhibit starch synthesis

- The sowing date influences the N accumulation in wheat during the grain filling period. Widdowson detected large differences in N accumulation in wheat due to different environmental conditions during the grain filling period

FACULTATIVE FORMS

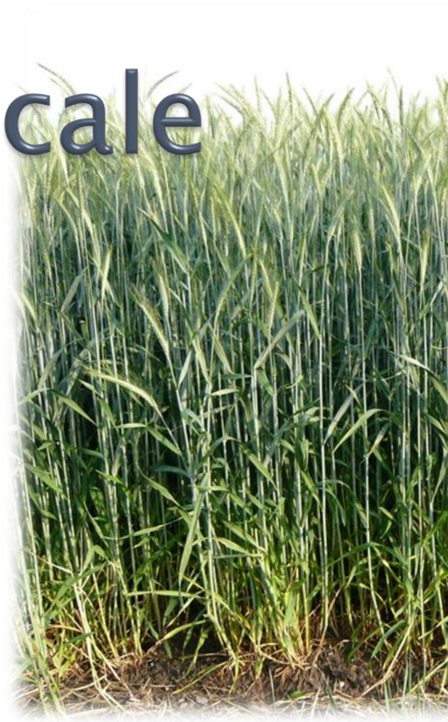
Facultative Forms

- Hardly any studies on the suitability of facultative forms in Austria
- Facultative forms are suitable for cultivation in areas that do not have heavy frost and do not require cultivars with high levels of hardiness
- Adequate alternative to common cultivars?
- Flexibility for farmers

Plant requirements – Wheat

- Cultivar XENOS
- Sowing depth: 2-4 cm
- Time from sowing to grain filling:
  - **autumn sowing:** approx. 230 days
  - **spring sowing:** approx. 90 days
- Optimum temperature for germination: 12-25 °C (min. 2-4 °C)
- Optimum sowing date in Austria
  - **autumn sowing:** beginning of October to beginning of November
  - **spring sowing**: as soon as possible (beginning of March)

Plant requirements – Triticale

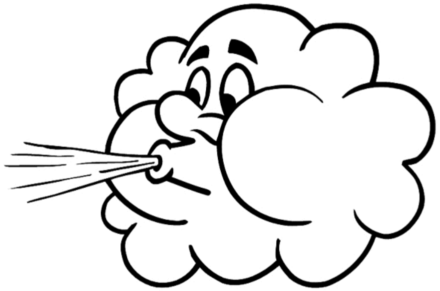


- cultivar AGRANO
- Sowing depth: 2-4 cm
- Time from sowing to grain filling:
  - **autumn sowing:** approx. 220 days
  - **spring sowing:** approx. 90 days
- Optimum temperature for germination: 15-30 °C (min. 2-3°C)
- Under stress conditions triticale is very competitive compared to other cereals species

MATERIAL & METHODS

Site

- Experimental farm Groß Enzersdorf in the Marchfeld basin
- Semi-arid Pannonian climate
  - cold winters
  - fluctuating heavy frost periods
  - irregular snow crusts
  - hot summers with intermittently drought



- Mean annual temperature: 10.6 °C
- Mean precipitation: 538 mm
- Above-average long vegetation period (middle of March to middle of November)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Nußdorf
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Kagran
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Teleforweg
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Brigittenau
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E49
Leopoldstadt
Stadlau
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3
Wien
227
A23
Teichweg
Wieden
Erdberg
Lobau
221
E58
E59
Favoriten
Oberhausen

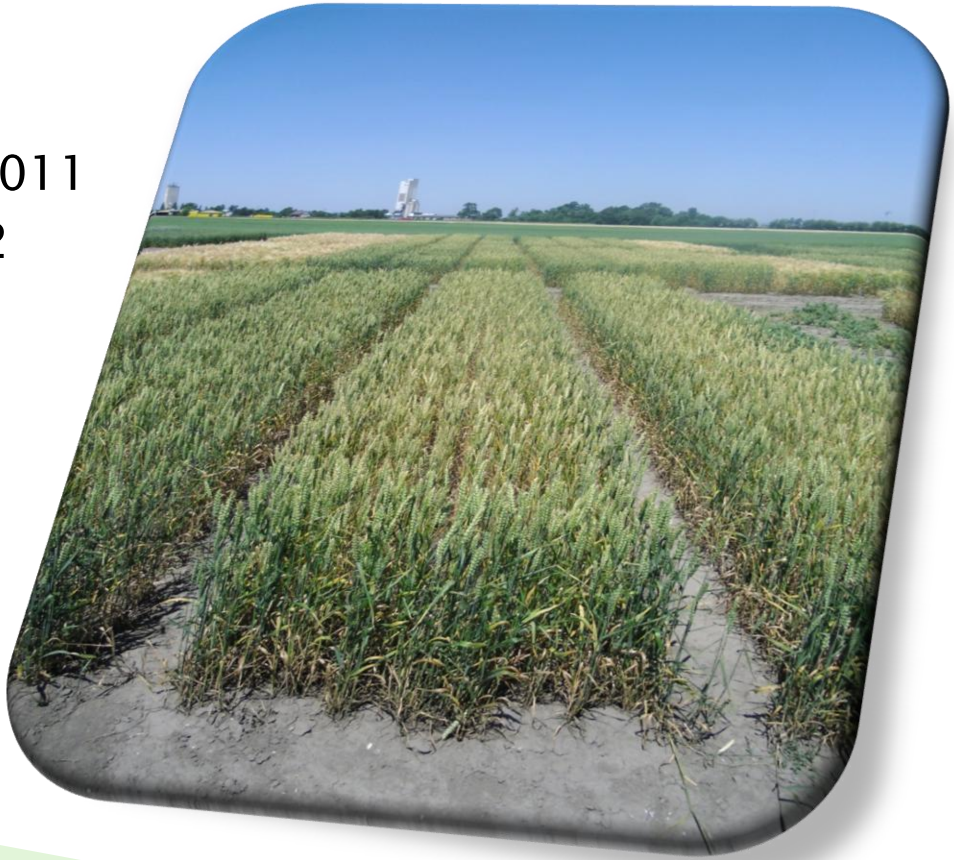
Soil types

- Chernozem with varying levels of loam and loess
- High lime contents
- At Experimental station: chernozem of alluvial origin
  - silty-loam which is rich in calcareous sediments
  - pH 7.6
  - organic substance: 2.2 – 2.3%

Experimental Design

- Split-plot design
  sowing date was assigned to the main plot
  cultivar was assigend to the sub plot

- 4 replications
- Sub plot: 10 x 1.5 m
- Autumn sowing: October 18th, 2011
- Spring sowing: March 13th, 2012
- 300 germinable seed per m^{-2}
- 12.5 cm rowing space
- Sowing depth 3-4 cm



Crop management

- Field preparation
  - field cultivator (15 cm working depth)
  - short disc harrow (10 cm working depth)

- N-fertilization: 100 kg ha^{-1} Nitramoncal (27 % N) in two equal splits (March 15th, May 5th)

- Manual weed control

Measurements

- Phenological development stages
- Development of crop stand height and above-ground biomass

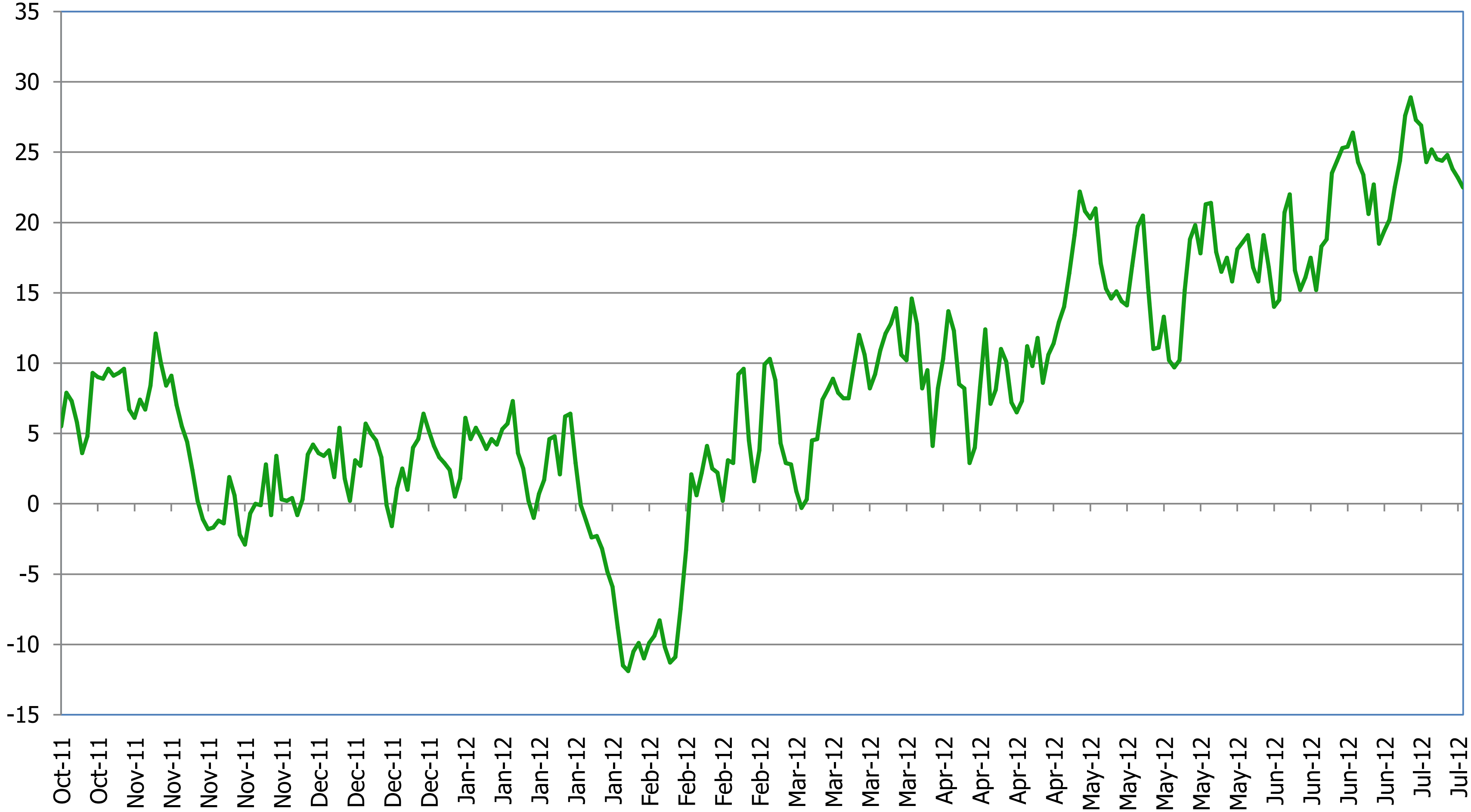
AFTER HARVEST

- Stand height
- Dry matter production
- Ears m^{-2}
- Kernels m^{-2}, kernel per ear
- TKW
- Hectolitre weight

RESULTS

Temperature (°C)

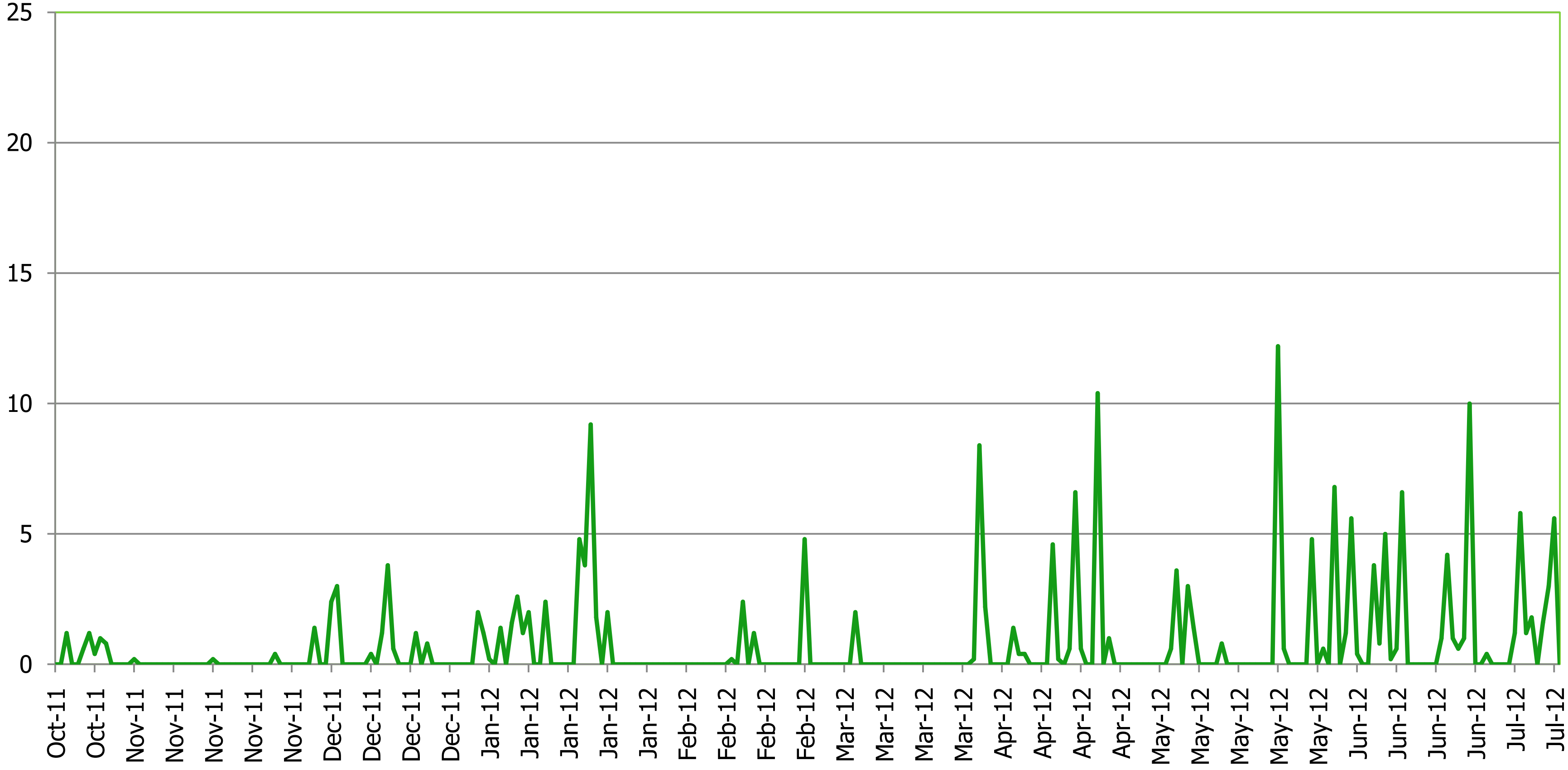
October 18th, 2011 to July 11th 2012



Source: BOKU, 2012

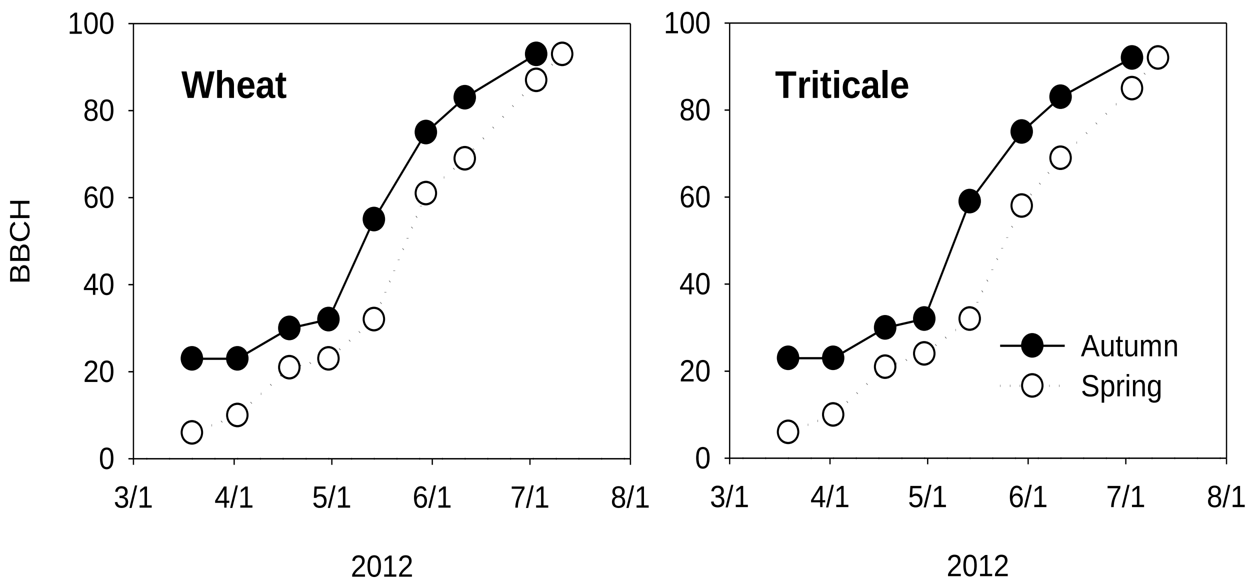
Precipitation (mm)

October 18th, 2011 to July 11th 2012



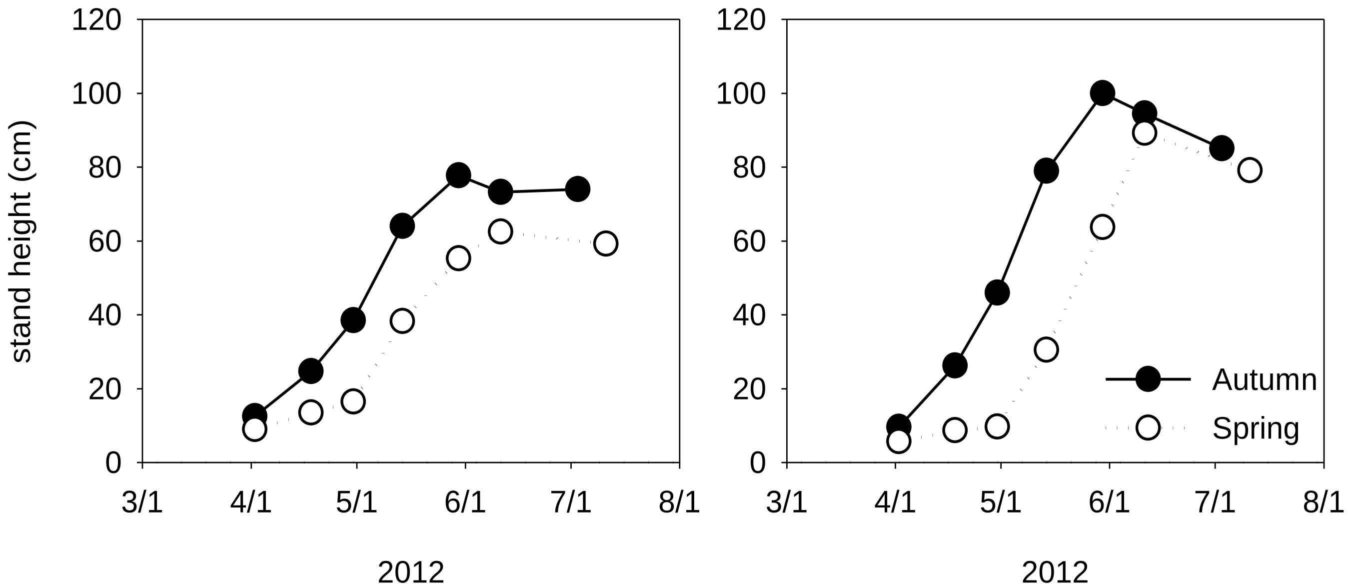
Source: BOKU, 2012

Phenological development



- On average the spring-sown corps lagged 10 days behind the autumn-sown crops during the whole trial period
- During the whole vegetation period the spring-sown crops were not able to make up this developmental edge

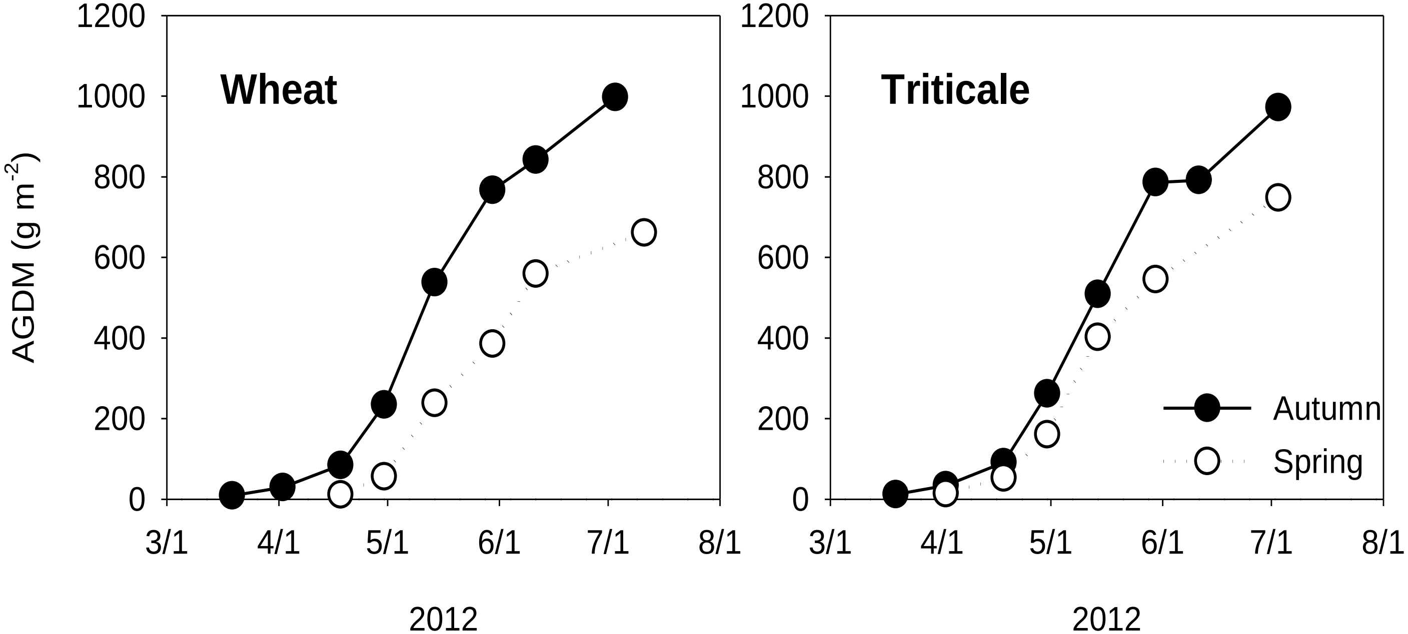
Stand height



- WHEAT
  Autumn-sown: maximum stand height of 78 cm (May 30th)
  Spring-sown: maximum stand height of 63 cm (June 11th)

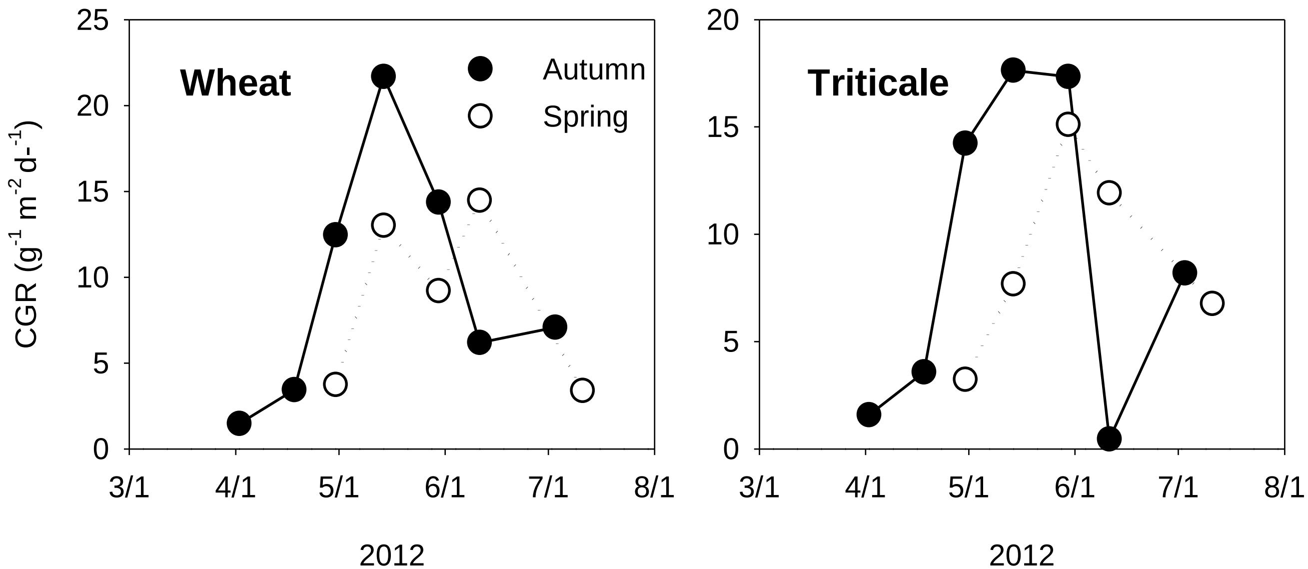
- TRITICALE
  Autumn-sown: maximum stand height of 100 cm (May 30th)
  Spring-sown: maximum stand height of 89 cm (June 11th)

Above-ground dry matter



- Autumn-sown wheat and triticale produced much higher above-ground dry matter than spring-sown variants (wheat: 997 vs. 662 g m-2; triticale: 972 vs. 748 g m-2)

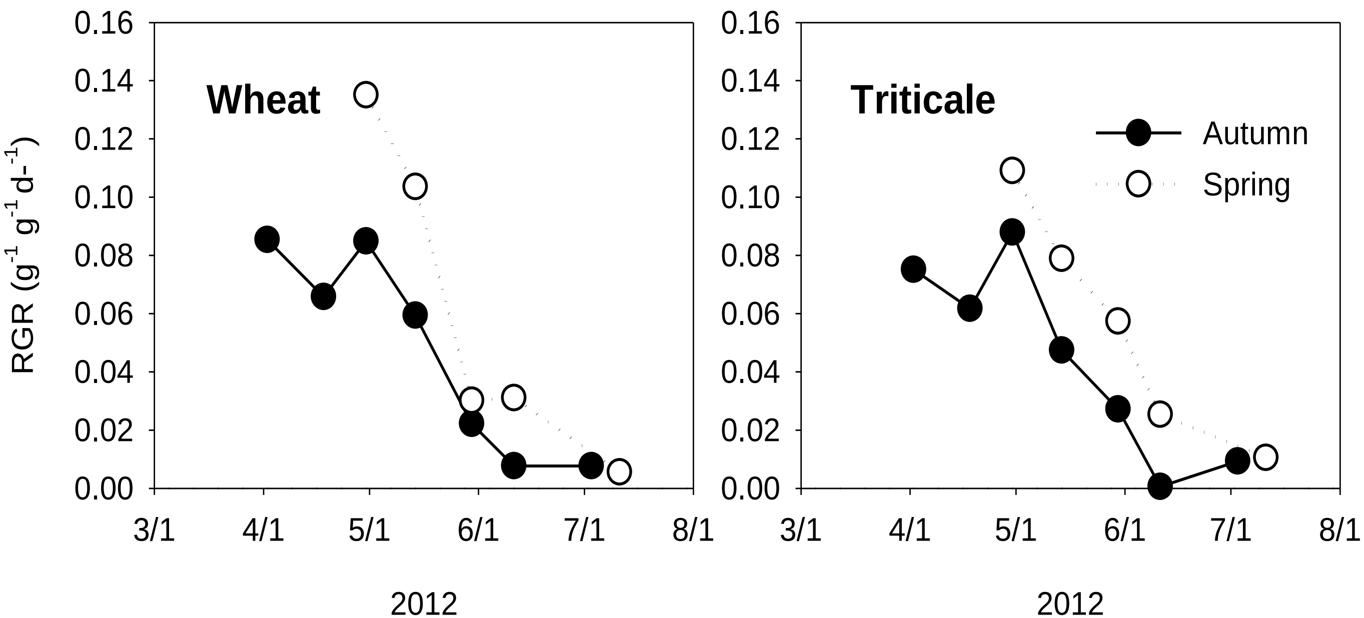
Crop growth rate



- **WHEAT**
  Autumn: substantial peak between BBCH macro stage 3 and 5 followed by a sharp decline
  Spring: fluctuating line with slight peaks at BBCH macro stage 3 and 6

- **TRITICALE**
  Autumn-sowing: high increase between BBCH macro stage 2 and BBCH macro stage 5
  Spring-sowing: strong increase of growth until BBCH macro stage 5

Relative crop growth rate



- The relative crop growth rate of the spring-sown crops was substantially higher than those of the autumn-sown wheat and triticale

Yield parameters

parameter	unit	wheat		triticale	
		autumn	spring	autumn	spring
grain	g m^{-2}	356[a]	204[b]	327[a]	220[b]
harvest index	%	0,43[a]	0,37[b]	0,40[a]	0,35[b]
ear density	m^{-2}	380[a]	313[b]	295[a]	320[b]
hectolitre weight	kg	81	76,64[b]	75,8[a]	68,98[b]
grains	ear^{-1}	24[a]	19[b]	28[a]	20[b]
grains	m^{-2}	8.950[a]	5877[b]	8.235[a]	6534[b]
TKW	g	43,00[a]	35,74[b]	41,13[a]	35,05[b]

- The yield parameters of the autumn-sown wheat and triticale are both, significantly higher than the yield parameters of the spring-sown wheat and triticale

Conclusion

- Autumn-sowing resulted in a faster development and faster ripening than spring sowing

- Spring-sown crops lagged approx. 10 days behind the autumn sown crops during the whole trial period

- Spring-sown crops showed substantial lower stand heights and above-ground dry matter leading to significantly lower yields and yield parameters

Reasons

- **Crops with longer development cycles could be able to produce higher dry matter and higher yield**

  >> more time to utilize available growth resources (light, nutrients, moisture etc.) which are used to produce and partition more assimilates to the sinks

- **Spike weight at anthesis is well correlated with kernel number, which is a prime determinant of grain yield**

  >> the longer the spike growth duration, the higher is the supply of photoassimilates to the spike
  Especially under dry conditions the yield of triticale greatly depends on translocation of per-anthesis assimilates to the grain

Reasons

- **High temperature after anthesis can dramatically reduce grain yield**

  >> as temperatures rises, photosynthesis reaches a maximum at about 20 °C while respiration continues to increase. This reduces the available assimilates for growth

- **Significant differences of environmental condition during grain filling**

  >> by changing the duration of the pre-anthesis period and the environmental conditions during the grain filling period, the sowing date significantly modifies the contribution of the post-anthesis dry matter to grain dry matter

DISCUSSION