Some aspects of the supernumerary spikelets formation in wheat - from the viewpoints of physiology and genetics.

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Abstract

To attain an understanding of the spikelets formation, differentiation and development of wheat, I approached to elucidation of the physiological and genetical step involved in the supernumerary spikelets differentiation process of wheat. From the viewpoints of physiology and genetics on spikelets formation, I cultured some parents and crossbred of wheat by gibberellic acid, nucleic acids, its metabolite, anti-metabolite and phosphoric compounds extracted from young seedlings of wheat that have the supernumerary spikelets(Extracts).

The results of these experiments provide some information on the role of chemical metabolism related to genetic background and daylength conditions in the induction of the supernumerary spikelets differentiation, and indicate that the endogenous phosphoric compounds (phosphatide or derivative nucleic acids-like substances), exogenous Extracts, GA and nucleic acids may be directly involved as essential step in process of induction of the supernumerary spikelets differentiation. But the action of Extracts on the supernumerary spikelets differentiation and on the heading is independent.

Media summary

From the viewpoints of morphological character, the supernumerary spikelets of wheat are anomalous. But the characteristics of the supernumerary spikelets are one of growth factors.

Key words

spikelets differentiation, Gibberellic acid, Extracts, chemical metabolism. heading stage

Introduction

The elucidation of the physiological and biochemical steps in spikelets formation process of wheat and the application of chemicals to wheat are approaches to process of the induction of heading in wheat. The role of the induction of supernumerary spikelets is related to genetic backgrounds, daylength conditions and degree of winter habit at spikelets formation stage. In this presentation, some chemicals and Extracts from young seedlings of wheat which have the supernumerary spikelets were applied to the parents and its crossbreed, and from the analysis of responses to the chemicals and the Extracts, the role of these substances in the flowering process in wheat was estimated, and the supernumerary spikelets differentiation, development and heading process is discussed from the viewpoints of physiology and genetics.

Materials and methods

For the purpose of studying the effects of chemicals upon spikelets formation, S52 and crossbred were cultured by chemicals and some substances extracted from young seedlings of S52 on ear formation stage.

Wheat cultivars: Some winter habit-types, some spring habit-types, S52 (a mutant of Norin52 (spring-habit types) which have some side-type spikelets), D (2)-7 (S52 x Aobakomugi (winter-habit types) in which double type spikelets occur. SD (8)-2 (Aobakomugi x S52) in which double-type spikelets occur. The degrees of spring habit of each cultivars or line are as follows;

Norin52; S52; SD(8)-2; D(2)-7; Aobakomugi;

Chemicals: The used chemicals are as follows, and its concentration differs each time.

Gibberellic acid (GA), some nucleic acids and its metabolite or anti-metabolite, some Extracts.

The action of the chemicals to D (2)-7, SD (8)-2 and S52 compared with each control plot and Aobakomugi or Norin52. The experiment about comparison of action nature to chemicals was conducted 2 or 4 times repeatedly. The concentrations had been found to be most effective in preliminary experiment.

Time of chemicals application for effectiveness: After the expansion of the third leaf (spring sowing), or before double-ridge formation (autumn sowing), plants were treated by chemical substances with foliar spray.

Duration of the short-day or vernalizing low temperature treatment (spring sowing): After the emergence of the third leaf, plants were treated with 8 hours for 20 days (short-day treatment), or after the expansion of the first leaf, plants were vernalized for 15 days (low temperature treatment).

Method of extraction of endogenous substances: The extractions for endogenous substances from young seedling of mutant at ear formation stage were performed by changing the organic phosphoric acid compounds division method or nucleic acids division method.

Heading stage was defined as number of day from sowing of seed to heading. Means of each character were tested by the least significant difference test(LSD).

The experiments reported here were conducted in 1967-1998 in glass house.

Results

I investigated the types of supernumerary spikelet, number of spikelet/ear, length of ear, ear density and the heading time on each cultivar or line under growing different conditions.

In spring sowing, GA applied to young seedling of SD(8)-2 was found to be apparently effective on the supernumerary spikelets differentiation with short-day treatment, and prolong the length of ear in D (2)-7 and Aobakomugi which is female parent of D (2)-7. D(2)-7 grown with vernalizing low temperature did not show to develop the supernumerary spikelets in elongated ear, but heading stage was promoted. S52 and its crossbred grown with vernalizing low temperature in combination with Extracts (Phosphatide fraction) application plot heated earlier associated with the increase of the supernumerary spikelets.

In autumn sowing, of the nucleic acids and their metabolites or anti-metabolites used, Uracil and Thymine were to be most effective in promotion of supernumerary spikelets. The former induced the differentiation of the side-type supernumerary spikelets and the latter do that of the double-type supernumerary spikelets.

In spring sowing, the number of spikelets of S52 and its crossbred were inhibited under the short-day treatment, but reaction to SD (8)-2 mean the inhibitory of the length of ear, whereas that to D (2)-7 show the character of the towering ear.

These results were shown typically (Table 1-5).

Table 1. Relationship of the occurrence of the supernumerary spikelets (side-type) in ear with application of chemical substances and cultivars or line under different growing conditions.

Sowing time	Norin52	S52	SD(8)-2	D(2)-7	Aobakomugi
Autumn sowing		Uracil, E A Thymine	Uracil, E A Thiouracil	E A	
Spring sowing (Short-day treatment)	E B	E B	GA	E A	Short-day, E B
Spring sowing (Vernalization Treatment)		Ver	Ver Thymine Thiouracil		

Note: E A; Extracts (phosphatide fractions), E B; Extracts (phosphoric compounds fractions) Short-day; short-day treatment plot, Ver; vernalization plot.

Blue color letters indicate the occurrence of the supernumerary spikelets (side type) on the increase, and red color letters indicate the occurrence of that on the decrease, compared with that of control plot. Significantly different at 0.05 level.

Color letters in following tables indicate the increase or the decrease on the characters of ear of wheat

Table 2. Relationship of the occurrence of the supernumerary spikelets (double-type) in ear with application of chemical substances and cultivars or lines under different growing conditions.

Sowing time	Norin52	S52	SD(8)-2	D(2)-7	Aobakomugi
Autumn sowing	Uracil	Uracil	Uracil	GA	GA, Uracil
Spring sowing (Short-day treatment)	E B	E B	GA	E A	GA
Spring sowing (Vernalization treatment)		Uracil			Ver, GA

Table 3. Relationship of the enhancement of heading stage with application of chemical substances and cultivars or lines under different growing conditions.

Sowing time	Norin52	S52	SD(8)-2	D(2)-7	Aobakomugi
Autumn sowing		E A			
Spring sowing (Short-day treatment)	Short-day		E B	GA	E B, Short-day
Spring sowing (Vernalization treatment)				E A	Ver, GA

Table 4. Relationship of the number of spikelet/ear with application of chemical substances and cultivars or lines under different growing conditions.

Sowing time	Norin52	S52	SD(8)-2	D(2)-7	Aobakomugi
Autumn sowing	Uracil			GA	
Spring sowing	Short-day	Short-day	GA	Short-day	
(short-day treatment)	E A				
Spring sowing	E B		GA	Ver, GA	
(vernalization treatment)					

Table 5. Relationship of length of the ear with application of chemical substances and cultivars or lines under different growing conditions.

Sowing time	Norin52	S52	SD(8)-2	D(2)-7	Aobakomugi
Autumn sowing				GA	
Spring sowing	Short-day	Short-day	Short-day	GA	GA
(short-day treatment)					
Spring sowing			GA	GA	Ver, GA
(vernalization treatment)					

Discussion

I considered that there were some gene to occurrence of the supernumerary spikelets by the segregation in crossbreeding, and the gene of side-type spikelet induction differed from that of double-type spikelet induction, but some common chemical substances might be action on the occurrence of the supernumerary spikelets formation in these types.

The effects of exogenous GA and nucleic acids on the supernumerary spikelets differentiation indicated on the role of chemical metabolism at the spikelet formation stage, and phosphoric compounds and derivative nucleic-like substances might exert their effect on the supernumerary spikelets differentiation and rachis-branch development.

The results of these experiments provide some information on the role of chemical metabolism related to the genetic factors and daylength conditions in the induction of the supernumerary spikelet differentiation, and indicate that endogenous GA-like substances and derivative nucleic acids-like substances, and phosphatide, whose biosynthesis is overproduced in mutant of Norin52, and exogenous GA and nucleic acids may directly play a part in the supernumerary spikelets formation.

It may be concluded that the effects of chemicals on spikelets differentiation and that on rachis-branch differentiation are independent, and that acid-soluble phosphoric compounds and derivative nucleic acids-like substances on the supernumerary spikelet formation may be involved as a co-factor in process of the induction of flowering.

The supernumerary spikelets of wheat are anomalous from the viewpoints of characters. But as the results of the experiment, the characteristics of the supernumerary spikelets are one of growth factors.

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