

SPIKELET STERILITY INDUCED BY NITROGEN FERTILISATION AND LOW TEMPERATURE IN RICE

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Abstract

Exposure to low temperature during panicle development increased spikelet abortion thus decreased fertile spikelets. High N increased total spikelet differentiated but decreased fertile spikelets. This increased sterility under high N and low temperature was associated with decreased pollen number per anther.

Key words: sterility, temperature, nitrogen

Introduction

Grain yield of rice (*Oryza sativa* L.) is reduced by high spikelet sterility. Spikelet sterility is increased by low temperature (< 12°C) during panicle development in rice (4,5). The microspore genesis stage, particularly the early microspore stage from tetrad formation (Stage 17) (3) to the time of primary shrinkage of the microspore (Stage 18), is most sensitive to low temperature (6). Low temperature damage at this stage is greatly exacerbated by increased N application (1,2). The mechanisms responsible for increase in sterility under high N and low temperature are not understood. The effects of low temperature on spikelet sterility induced by N during the panicle development in rice were studied under control temperature conditions in the glasshouse of The University of Queensland, St Lucia.

Material and methods

Three controlled environment experiments were conducted. In Exp. 1, six cultivars were exposed to two temperature treatments (*i.e.* 19.3/14.4 and 27.7/23.7 °C) for a 7 - days period at first meiotic division of pollen mother cells (Stage 15). In Exp. 2, two and three rates of nitrogen (N) (*i.e.* 0, 150 and 0, 75, 150 N kg/ha) were applied at the three - leaf stage and at panicle initiation (PI), respectively. Temperature treatments were as in Exp. 1 imposed at the same stage of panicle development. In Exp. 3, two nitrogen rates (0 and 150 N kg/ha) at both the three - leaf and PI stages were applied then 5 - days temperature treatments (19.0/13.7 and 27.7/22.9 °C) were imposed at the second meiotic division (Stage 16). The effects of nitrogen and temperature imposed at each development stage on spikelet sterility were studied in these three experiments.

Results and discussion

In all three experiments, high temperature increased the number of total and fertile spikelets per panicle in all cultivars and N levels while low temperature increased sterile spikelets (Table 1). The increased number of fertile spikelets at high temperature was associated with both an increased total number of spikelets and a reduced number of sterile spikelets. Because spikelet differentiation is complete at the second meiotic division of pollen mother cells, the increased number of sterile spikelets resulting from low temperature could be attributed to increased spikelet abortion.

High N at three - leaf stage increased the number of total and sterile spikelets per panicle for both temperature regimes (Table 2). However, the number of fertile spikelets decreased with N fertilisation at PI. The effect of low temperature on number of fertile spikelets was small at zero N whereas the effect was greater at 150 kg N/ha for both times of application but more so with 150 kg N/ha at three - leaf stage. However, the effect of low temperature on number of fertile spikelets was greatly exacerbated with 300 kg N/ha. While high N at three - leaf stage may increase spikelet sterility, the number of fertile spikelets or grain yield per panicle was not reduced by high N. In fact yield increased by 1.8 and 4.8 g/plant with 150 kg N/ha at three - leaf stage in low and high temperature conditions respectively. Higher

sterile spikelets produced with high N and low temperature was associated with reduced pollen number per anther. Low temperature and 150 kg N/ha at the three - leaf or PI stages reduced the number of engorged pollen grains per anther from 800 to 500 and 400, respectively. Therefore, this result indicated that fertilisation is affected by low temperature and high N by reducing pollen number.

Table 1. The number of total, fertile and sterile spikelets per panicle as affected by low and high temperature imposed for a 7 - days period commencing at first or second meiotic division stage of pollen mother cells.

Experiment No.	Spikelets / Panicle					
	Total		Fertile		Sterile	
	Temperature (°C)					
	Low	High	Low	High	Low	High
1	101.2	121.6	72.7	101.9	28.5	19.7
2?	65.5	79.1	56.8	75.4	9.6	3.6
3	65.1	77.5	35.1	59.3	30.0	18.2

Table 2. The number of total, fertile and sterile spikelets per panicle as affected by the application of N fertilizer at low and high temperature imposed for a 5 days - period commencing at second meiotic division of pollen mother cells (Exp.3).

N (kg/ha) sowing		Spikelets / panicle					
Three leaf Stage	Panicle Initiation	Total		Fertile		Sterile	
		Temperature (°C)					
		Low	High	Low	High	Low	High
0	0	44.6	45.6	32.8	43.1	11.7	2.5
	150	42.1	50.5	26.0	42.7	16.1	7.7
150	0	78.4	99.5	50.8	80.0	27.6	19.5
	150	95.2	114.6	30.8	71.4	64.3	43.2
LSD _{5%}		7.8		7.5		5.2	

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