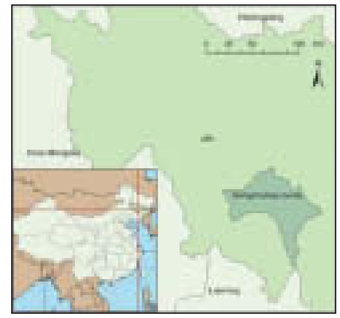
Does Potassium or Chloride Play a Dominant Role in Suppression of Corn Stalk Rot?



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Corn stalk rot is a serious and widespread disease in the main corn production areas of China. Previous research has indicated that KCl plays a significant role in suppression of corn stalk rot. This study compared the effects of K and Cl nutrition, and showed that K played an important role in the suppression of the disease.

Stalk rot is a disease of increasing importance to corn production in China. The average annual yield loss in China due to stalk rot infection is approximately 20% and in individual fields may reach 50%. Potassium has long been the nutrient most associated with plant disease reduction. Potassium fertilizer application is one of the few effective measures to suppress corn stalk rot. A 12-year fixed site field trial in Jilin Province showed that KCl application decreased the incidence of corn stalk rot by 48% (Liu et al., 2007). However, insufficient attention has been paid to the question of which element in KCl plays the dominant role in the suppression of corn stalk rot…an inadequacy addressed by this research.

Jilin is designated the "Corn Belt" of China due to its top ranking in annual sown area (Jia, 2004). A field experiment was conducted in the Gongzhuling region of Jilin in 2005 using a set of treatments consisting of a check (CK) and six combinations of K and Cl (K_{120}, K_{240}, $K_{120}Cl_{90}$, $K_{240}Cl_{180}$, Cl_{90}, and Cl_{180}) laid out in a randomized complete block design with four replicates. All treatments had equal applications of N and P. Plot area was 40 m^2. Soil pH and nutrient status at the 0 to 20 cm depth are shown in **Table 1**. Available nutrients in the soil were determined by ASI soil analysis methods (PPI/PPIC Beijing Office, 1992). Based on soil test results, applications of S, Zn, and Cu were done before sowing, at rates of 20, 10, and 1.0 kg/ha, respectively. Since soil Ca concentration was abundant and crops in the region have not responded to Ca fertilization, $CaCl_2$ was used to evaluate the effect of Cl on corn yield and disease severity. Potassium chloride was used to study the combined effect of K and Cl. Potassium nitrate was used to study the effect of K alone. The amounts of fertilizer used in the treatments are given in **Table 2**. The study used two commercial corn hybrids including Jidan 180, which is moderately resistant to stalk rot, and Jidan 327, which is considered susceptible to stalk rot. The plant density was 50,000 plants/ha. The incidence of corn stalk rot was investigated prior to harvest.

The treatment created obvious differences in growth between resistant and susceptible varieties at plant jointing stage (**see photos**). Prior to harvest of both varieties, significant reductions in stalk rot incidence, as well as yield increases, occurred in response to K and KCl, but not to Cl alone (**Table 3**). All K and KCl treatments reduced disease severity by 50 to 64%, and increased yield by 13 to 23% in Jidan 327. In Jidan 180, stalk rot was decreased by 44 to 60% and yield was increased by 20 to 29% compared to the CK. Thus, stalk rot was more effectively suppressed in the susceptible variety, but yield was enhanced to a larger degree with the resistant variety.

Effects of K, Cl and KCl on the growth of Jidan 180 (top) and Jidan 327 (bottom) corn hybrids at jointing stage.

No significant differences in disease incidence and yield were observed between the two fertilization rates of KCl and

Table 1. Initial soil characteristics at the experimental site, Jilin.

OM	NH_4^+	P	K	Ca	Mg	S	B	Fe	Mn	Cu	Zn	Cl	pH
%	----- mg/kg -----			--- g/kg ---		--------------- mg/kg ---------------							
2.4	8.6	5.9	42.4	3.0	0.4	12.9	1.8	102.5	12.8	2.7	1.0	30.2	5.8

Abbreviations and notes for this article: K= potassium; Cl = chloride; KCl = potassium chloride; KNO_3 = potassium nitrate; K_2SO_4 = potassium sulfate; S = sulfur; Zn = zinc; Cu = copper; Ca =calcium; N = nitrogen; P = phosphorus; ASI = Agro Services International.

The corn leaves in the left rows received no K fertilizer and appeared dull gray-green, while the leaves in the right rows with K application were still green.

Cl. Stalk rot was reduced with the addition of K, regardless of source.

For Jidan 180, when K (as KNO_3) application increased from 120 to 240 kg/ha, stalk rot incidence was unaffected, but grain yield decreased. The degree of yield loss in other K and KCl supplying treatments may have been partially influenced by stalk rot incidence, but it appears nutrient imbalance may have exerted a larger effect. Ash and Brown (1991) found a similar result showing that increased disease did not correlate with yield losses, but N fertilizer application rate had a large influence on the yield-loss relationship.

Table 2. Nutrient application rates for the set of treatments.

	$Ca(NO_3)_2$	$Ca(H_2PO_4)_2$	KNO_3		KCl		$CaCl_2$
Treatment	N	P_2O_5	K_2O	N	K_2O	Cl	Cl
CK	200	120	–	–	–	–	–
K_{120}	158	120	120	43	–	–	–
K_{240}	114	120	240	86	–	–	–
$K_{120}Cl_{90}$	200	120	–	–	120	91	–
$K_{240}Cl_{180}$	200	120	–	–	240	182	–
Cl_{90}	200	120	–	–	–	–	91
Cl_{180}	200	120	–	–	–	–	182

Stalk lodging and ear dropping are the typical symptoms of corn stalk rot. Stalk rot in plots without K application (top) was more severe than that with K application (bottom) in September.

For both varieties, 120 kg K_2O/ha seemed most appropriate, and 240 kg K_2O/ha excessive, to maintain high yields at this site. No positive interactions between K and Cl were detected at the 120 kg/ha rate, but there was evidence that Cl may help to moderate the yield-dampering effects of the 240 kg K_2O/ha rate applied to Jidan 180.

Heckman (1998) found that the incidence of corn stalk rot was 67% lower with KCl application, compared to K_2SO_4 application at an equivalent K rate. This result suggests that

Table 3. Effects of K and Cl^- on the stalk rot incidence and yield of corn.

	Jidan 180				Jidan 327			
Treatment	Disease incidence, %	Disease control,%	Yield, kg/ha	Yield increase, %	Disease incidence, %	Disease control,%	Yield, kg/ha	Yield increase, %
CK	24.6 a[1]	—	7,114 c	—	34.1 a	—	6,925 c	—
K_{120}	13.7 b	44.4	9,162 a	28.8	17.1 b	50.0	8,544 a	23.4
K_{240}	12.4 b	49.6	8,546 b	20.1	12.3 b	63.8	7,839 ab	13.2
$K_{240}Cl_{90}$	10.8 b	55.9	8,615 ab	21.1	13.8 b	59.7	8,164 a	17.9
$K_{240}Cl_{180}$	9.9 b	59.8	9,050 ab	27.2	12.4 b	63.6	8,252 a	19.2
Cl_{90}	17.1 ab	30.3	7,373 c	3.6	31.8 a	6.8	6,340 c	-8.5
Cl_{180}	17.3 ab	29.8	7,166 c	0.7	30.4 a	10.8	6,509 c	-6.0

[1]Means within a column followed by different letters are significantly different (LSD Test, $p<0.05$).

Steven B. Phillips Joins Staff of IPNI as Southeast Region Director

Dr. Steven B. Phillips

Dr. Steven B. Phillips joined the staff of IPNI as Southeast Region Director effective June 1, 2007. He has responsibility for agronomic programs of the organization in the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, and Tennessee.

"We welcome Steve Phillips to the staff of IPNI and know he will be a great asset to the programs of this new organization," said Dr. Terry L. Roberts. "He has a strong background in research and extension programs focused on applied soil fertility and plant nutrition as related to production agriculture. His record of both academic and extension publications and presentations is impressive."

Dr. Clifford S. Snyder of Conway, Arkansas, served as Director of the Southeast Region and previously the Midsouth Region of IPNI (formerly the Potash & Phosphate Institute) since 1995. He was recently appointed to the new position of Nitrogen Program Director and coordinates IPNI efforts dealing with environmental issues associated with N fertilizer use in agriculture, both in North America and internationally.

A native of Oklahoma, Dr. Phillips holds a B.S. degree (1993) from Cameron University in Lawton, and M.S. and Ph.D. (1999) degrees from Oklahoma State University at Stillwater. From 1999 until June 2005 he was Assistant Professor, Soil Fertility and Plant Nutrition, Department of Crop and Soil Environmental Sciences, Eastern Shore Agricultural Research and Extension Center (AREC), Virginia Tech.

He became Associate Professor in July 2005 and maintained a 75% research/25% extension responsibility. The majority of his research dealt with efforts to improve the fertilizer use efficiency of various field and vegetable crops. A portion of this work focused on developing an optical sensor-based fertilization system to be used for winter wheat and corn production. Another area of Dr. Phillips research was broiler litter management.

The extension component of his work involved dissemination of production-related information to growers, industry, and county extension personnel, including soil fertility recommendations, assisting with soil test interpretations, and various presentations of research results. Dr. Phillips also carried responsibility for advising graduate students. In recent years, Dr. Phillips has been involved in several international workgroups and collaborative research projects with scientists in Argentina, Mexico, India, and other countries.

His professional affiliations include membership in the Soil Science Society of America, American Society of Agronomy, Crop Science Society of America, and others. BC

Cl played an important role in the suppression of the disease. In contrast, this research indicates that Cl plays a less important role in stalk rot suppression than K. This inconsistency may be due to differences in nutrient status of the test soils. Sanogo and Yang (2001) reported that soil amendment with KCl when the soil was not deficient in K resulted in 36% decrease in the severity of soybean sudden death syndrome (SDS), a soil-born disease. Conversely, disease severity was increased by 43% with K_2SO_4 application, and by 45% with KNO_3, compared to the study's controls. Thus, Cl was helpful in reducing SDS and K application was not found beneficial. A comparison of the available K concentration (0 to 20 cm depth) between this research and Heckman's U.S. study finds the initial K fertility in the U.S. study to be 92 mg/kg, which is over twice the level measured in this work (**Table 1**). Additionally, soil Cl in the 0 to 30 cm soil layer was only 6 mg/kg (low) in Heckman's experiment, while this study's soil Cl concentration in 0 to 20 cm layer was 30 mg/kg. Therefore, under conditions of soil K deficiency and Cl sufficiency, the influence of K nutrition on corn stalk rot was much more strongly pronounced than the influence of Cl. Apparently the result is opposite under soil K sufficiency and Cl deficiency.

In conclusion, the role of K and Cl in disease suppression must be examined in conjunction with the soil nutrient status. Therefore, whether K or Cl play the dominant role in corn stalk suppression will depend on the K and Cl status of the soil. A well-balanced fertilization strategy is necessary for both yield increases and disease control. BC

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