Effects of Potassium on Plant Diseases

Disease resistance in crops is genetically controlled. However, natural disease resistance mechanisms can be enhanced by plant nutrients. Potassium deficiency symptoms such as thin cell walls, weakened stalks and stems, smaller and shorter roots, sugar accumulation in the leaves, and accumulation of unused nitrogen (N) encourage disease infection. Each of these reduces the ability of the plant to resist entry and infection by fungal, bacterial and viral disease organisms. A healthy plant, free from stress, is much more resistant to disease attack. Sound fertility management and fertilization practices provide assurance that stress induced by K deficiency is not a factor in crop production.

Of all the nutrients essential for plant growth and function, potassium (K) is most often associated with reducing disease severity. It should be recognized, however, that K does not work alone. The healthiest, most profitable crops are produced with balanced fertility management practices that minimize nutrient stress throughout the growing season.

Several factors influence the effectiveness of K fertilizer in reducing crop stress and disease incidence. These factors include K status of the soil, K rate and source, nutrient balance, variety/hybrid susceptibility, and disease organism virulence and population. The following are examples of K fertilization reducing disease pressure on various crops and the corresponding increases in crop yield and quality.

The incidence of leaf spot disease caused by *Cercospora*, *Stemphylium* and *Alternaria* in cotton has been related to K fertility. A Tennessee study demonstrated the importance of K fertilization in reducing the severity of *Alternaria* leaf spot disease in cotton on a soil testing low in K. This disease organism can cause significant yield reduction where premature plant defoliation is extensive. Potassium was broadcast and incorporated at the rate of 0, 30, 60, and 120 lb K_2O/A. There was also a foliar application component in this experiment. Partial results from this study are listed in **Table 1**.

Disease occurrence may be encouraged by an imbalance between N and K. As production levels are pushed higher, striving for maximum economic yields, K must be balanced with increased additions of N. The penalties from this and other nutrient imbalances can be rather severe. An Illinois study showed the benefits of K fertilization on a soil testing high in available K with 300 lb/A of N applied. Potassium increased yields over four growing seasons by an average of 21 bu/A. Lodging, frequently associated with stalk rot, was reduced in 3 of 4 years (**Table 2**).

Good K fertility is associated with strong cell walls that enhance disease resistance and the ability of the crop to maintain firm, healthy stalks. Therefore, a

TABLE 1. Effect of K fertilization on *Alternaria* leaf spot, defoliation, and cotton lint yields under conventional tillage and no-till conditions.

K_2O, lb/A	*Alternaria*[1]	Defoliation	Lint yield, lb/A
	Conventional tillage		
0	7.7	6.9	350
30	5.8	4.5	556
60	5.5	2.9	621
120	4.7	1.3	760
	No-tillage		
0	7.5	5.8	360
30	6.1	4.2	531
60	5.1	1.6	528
120	4.5	0.6	669

[1]*Alternaria* leaf spot and defoliation ratings, 0=none, 10=highest.

properly fertilized crop such as corn will have better standability until natural maturity is achieved. The data in **Table 3** illustrate the influence of K fertilization on corn stalk strength and rind thickness.

The incidence of stalk rot and lodging in grain sorghum may also be influenced by K fertilization. Two sources of K fertilizer increased grain yield and reduced severity of stalk rot at the higher levels of fertilization in a Kansas study (**Table 4**). In addition, a separate Kansas study showed that 75 lb/A K_2O increased grain sorghum yield by 11 bu/A and reduced visual signs of stalk rot from 6 to 5 nodes affected per plant.

In addition to higher yields and reduced disease susceptibility, good K fertility management often results in improved crop quality. A Wisconsin soybean study illustrated how building soil fertility in K and phosphorus (P) pays in higher crop yield, with less shriveled and diseased seed that results in less dockage at the elevator (**Table 5**).

The effect of soil K status on soybean stem canker infection and plant K concentration was demonstrated in a Mississippi study (**Table 6**). High fertility status (125 lb P/A and 250 lb K/A) was maintained on one half of the plots at each of 6 sites. The remaining low fertility plots were not fertilized.

Potassium fertilization can increase forage yield, stand longevity, and disease resistance. A Texas study demonstrated the influence of K fertilization on the occurrence of *Helminthosporium cynodontis* in Coastal bermudagrass at 2 sites (**Table 7**). Coastal bermudagrass production in Louisiana benefited where leaf-spot disease was evident and forage was infected with the fungus *Helminthosporium cynodontis* (**Table 8**).

Potassium fertilization reduces disease infection, increases yields, and enhances the quality of many other crops. For example, foliar application of K from several sources to the first true leaf of cucumber, before inoculation with powdery mildew, induced up to 94 percent systemic protection from this disease organism in a greenhouse study. Research in Oregon has shown that a well-managed K program resulted in increased total yields and reduced incidence of diseases such as stem soft rot, hollow heart, and brown center in potatoes. Potassium benefits the market quality of fresh fruits and vegetables and helps maintain quality in storage, with less rot and decay. In turfgrasses, K is associated with the

TABLE 2. Potassium fertilization effect on corn yields and lodging.

Year	Yield, bu/A		Stalk lodging, %	
	Control	120 lb/A K_2O	Control	120 lb/A K_2O
1st	148	164	56	60
2nd	148	164	30	25
3rd	151	187	30	16
4th	104	120	52	27

TABLE 3. Effect of K fertilization on corn stalk crushing strength and rind thickness.

K_2O rate, lb/A	Rind thickness, mm	Crushing strength, kg
0	0.91	254
60	0.97	349
120	1.00	374

TABLE 4. Effect of K fertilization on sorghum grain yield and stalk rot infection.

K_2O, lb/A	Grain yield, bu/A		Plants with stalk rot, %	
	KCl	K_2SO_4	KCl	K_2SO_4
0	52	52	22	22
40	61	75	20	35
80	72	74	26	19
160	76	78	16	20
320	83	86	4	9

TABLE 5. Effect of P and K fertilization on soybean yield and quality.

Fertilization*, lb/A		Soybean yield, bu/A	Shriveled & diseased seed, %
P_2O_5	K_2O		
0	0	35	20.8
400	0	29	12.5
0	400	38	1.8
400	400	52	1.3

*Applied only in first year of the five-year study. Soil test P and K levels - medium and low, respectively.

TABLE 6. The influence of reduced levels of soil P and K on soybean plant K concentration and stem canker infection level.

Site	Infection increase due to low fertility, %	Plant K decrease due to low fertility, %
1	16.6	23.0
2	36.5	33.0
3	34.1	33.1
4	20.7	15.6
5	41.1	37.8
6	0	11.8

TABLE 7. Influence of P and K fertilization on disease severity on Coastal bermudagrass.

P_2O_5 rate, lb/A Site 1	P_2O_5 rate, lb/A Site 2	K_2O rate	Disease scale[1] Site 1	Disease scale[1] Site 2
0	0	0	2.7	3.8
282	241	0	3.1	3.9
0	0	120	1.1	1.4
0	0	240	1.0	1.0
141	120	120	1.3	1.5
282	241	240	1.0	1.1

[1]Disease scale: 1=trace of leaf spot, 5=2 or more leaves dead from disease.

TABLE 8. Potassium fertilization improves yield and stand longevity of Coastal bermudagrass.

Annual K_2O rate, lb/A	Spring stand density estimates, % 1st year	2nd year	3rd year	Total change, %	Two year average yield, tons/A
0	57	46	39	-18	5.9
100	24	55	50	26	6.6
200	35	60	72	37	7.1
400	42	67	83	41	7.3
600	36	60	81	45	7.6

Soil test K level - low.

TABLE 9. Diseases suppressed by chloride.

Crop	Disease
Wheat	Take-all and common root rot, tan spot, Septoria, leaf rust, stripe rust
Barley	Common root rot, spot blotch, Fusarium root rot
Corn	Stalk rot
Rice	Stem rot, sheath blight
Potatoes	Hollow heart, brown center
Celery	Fusarium yellows
Pearl millet	Downy mildew
Coconut palm	Gray leaf spot

TABLE 10. Chloride decreases leaf rust and increases wheat yield.

Source	Cl rate, lb/A	Rust rating, %	Yield, bu/A
Check	0	67.5	35.4
NH_4Cl	40	26.3	41.7
KCl	40	27.5	42.0
$MgCl_2$	40	28.8	40.9

Rust rating-flag leaf coverage.

suppression of several disease organisms and also increases tolerance to stress and traffic.

Chloride (Cl), like K, is important in reducing the incidence of plant diseases in many crops (**Table 9**). Chloride interactions with crop diseases are well documented. However, the mechanisms involved are not well defined. Proposed mechanisms involve suppression of the pathogen or increased host tolerance.

Researchers in Texas found that Cl fertilization increases wheat yields in years with high leaf rust and *Septoria* pressure. The data in **Table 10** demonstrate the effect of Cl top-dress application on leaf rust severity and yield of winter wheat. Several Cl sources are available, and research has generally found that the various sources are equally effective.

Summary

A well-planned fertility program is essential to the production of healthy crops that produce optimum yields and maximize profits. Potassium is a critical component of any fertility program. Increasing the crop's ability to resist disease infection is only one of many important practical functions that K performs. The number of crops and associated diseases affected by K is extensive and not practical to list here.