Potassium Application Methods

Potassium is a monovalent cation and is readily adsorbed by the soil's cation exchange sites. It is not generally considered to be mobile in soil. Thus, the K available to plants is that in close proximity to the roots. Placement of supplemental K close to the plant is important for improving uptake and use efficiency under certain conditions. Research is currently focusing on identifying when such placement provides benefits beyond those attained from maintaining higher soil test K levels.

> Crop responses to placement of potassium (K) fertilizer are receiving more attention. Current research efforts focus upon identifying soil characteristics or growing conditions that may warrant placement of high concentrations of K in the vicinity of developing plant roots.

Methods

Researchers have explored a number of K application methods including: (1) surface broadcast with and without incorporation; (2) direct seed placement; (3) row placement (banded) – including all combinations of distances below and to the side of the seed; (4) plow sole placement; (5) deep or knife placement; (6) surface strip applications; (7) fertigation; (8) high pressure injection; (9) point injection; and (10) combinations of the various methods.

All of these application methods can be considered variations or combinations of two basic placements: (1) banding in high concentrations with a minimum of soil contact and (2) broadcasting.

Results

Responses to K placement vary among crop types, soil and environmental conditions, and tillage practices.

Corn. Soil characteristics can have significant effects on how corn responds to K application methods. Corn on three Illinois soils, low to medium in soil test K, responded differently to broadcast and banded K. Banded K was more effective on all three soils tested. Even at high rates of application, broadcast K was not as effective as that banded near the seed on two of the three soils.

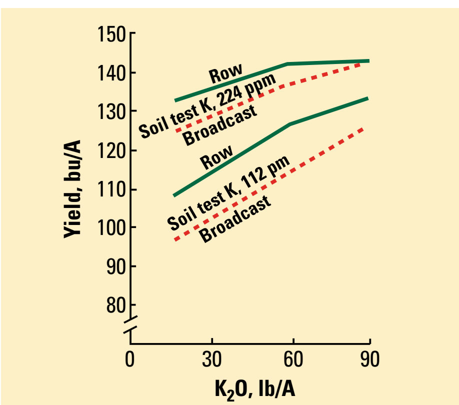

Figure 1. Differences between K application responses are smaller as K test rises (Tennessee); ppm=parts per million.

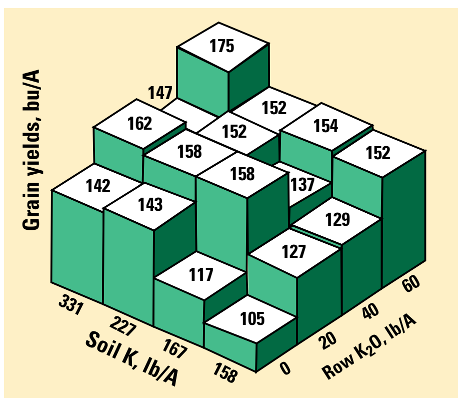

Figure 2. Starter K can be effective even at high soil test levels (Wisconsin).

Differences among the methods of K application usually diminish as K soil test values rise and as rates of application increase (**Figure 1**). The relationship of starter K response to soil test K can vary with soil type and with year. Starter K continued to increase corn yields even at the highest soil test level in a Wisconsin experiment (**Figure 2**).

Tillage is an important factor for determining the responsiveness of corn to applied K. Potassium deficiencies are being observed in the upper Midwest on soils testing very high in K. Although all of the causes for this phenomenon have yet to be revealed, stratification of K in soils under reduced tillage is an important factor. Potassium supplies near the surface may be inaccessible by roots under drier conditions, when roots proliferate deeper in soil. Data from Minnesota show that K banded below the seed boosts yields in ridge-till systems even when soil test K levels are high (**Table 1**). Iowa research has recently shown that deep-banded K consistently produces modest yield increases in no-till systems under optimum to very high soil test K levels (**Figure 3**).

Compacted, cold or extremely dry soil conditions may favor K starter responses due to slowed diffusion of soil K to plant roots, even on high K soils. Large amounts of surface residue leading to lower soil temperatures and higher soil bulk density under reduced till conditions may require starter K

TABLE 1. Corn responds to banded K in ridge-till systems at a high soil test level of 156 ppm (Minnesota).

K_2O placement	K_2O rate, lb/A	Corn grain yield, bu/A Hybrid A	Hybrid B
—	—	54	59
Fall band	40	92	102
Fall broadcast	40	57	68

TABLE 2. Seed-placed K increased barley yield over band or broadcast on K deficient soils (Alberta).

K_2O, lb/A	Application method	Yield increase, bu/A 6 tests	13 tests
15	Broadcast	8.6	
15	Banded	12.8	6.2
15	With seed	18.8	10.7
30	Broadcast	17.0	
30	Banded	18.8	8.0
30	With seed	21.0	12.2

TABLE 3. Chloride contained in muriate of potash can produce yield and kernel weight increases in small grains (Montana).

Rate of chloride (from muriate of potash), lb/A	WB881 durum wheat yield, bu/A	WB881 durum wheat kernel weight, g/1,000 kernels
0	49.2	38.2
40	60.2	40.4

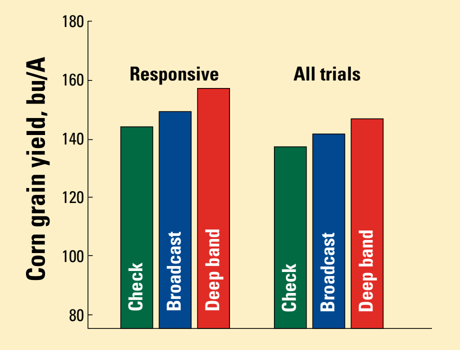

Figure 3. Corn responds to deep band placement of K on soils testing high to very high in K (Iowa).

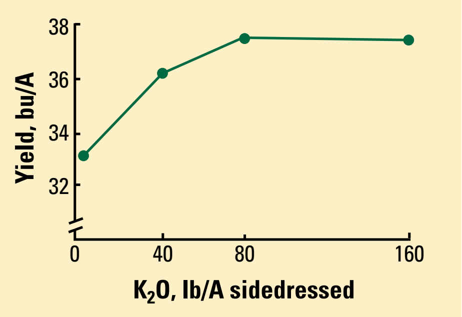

Figure 4. Soybeans respond to K sidedressed at early flower (Alabama).

TABLE 4. Fertilizer K boosts cotton yields (Mississippi).

K_2O rate, lb/A	Lint yield, lb/A	Boll mass, g/boll	Lint, %	Seed mass, mg/seed
0	1,061	4.1	38.6	90
120	1,169	4.4	39.3	94
Increase from K, %	9	7	2	4

TABLE 5. Fertilizer K improves cotton fiber quality (Mississippi).

K_2O rate, lb/A	Strength, g/tex	Elongation, %	Span, 2.5% (cm)	Length, 50% (cm)	Uniformity ratio	MIC	Maturity, %
0	21.1	7.97	2.82	1.35	48.0	3.7	74.1
120	20.7	8.25	2.82	1.37	48.7	4.1	78.3
Increase from K, %	0	3	0	1	1	10	5

for most profitable yields. Starter K significantly increased corn yields on compacted soils in a Wisconsin study and continued to improve yields as K soil tests increased.

Soybeans. Soybeans require high K availability for best yields and profitability. Soybeans generally do not respond differently to broadcast or banded K applications. Responses to applied K have been good on deficient soils, whether broadcast or banded. Banded applications may be appropriate in cool soils or soils with low K fertility. Soybeans are easily injured by contact with salts, so no K fertilizer should be placed in direct contact with the seed. Foliar applications of K have produced modest yield increases in some cases, but predictable increases have not yet been proven.

Potassium should be applied early for soybeans, but research from the Midsouth has shown that K can be applied as late as early pod development and still produce significant yield increases when moisture is adequate (**Figure 4**).

Alfalfa. High yield alfalfa has one of the highest K needs of any crop, frequently exceeding 60 lb K_2O per ton of hay. Broadcasting and incorporating K to build nutrient levels before seeding and then topdressing for maintenance is the best approach. This makes K applications more efficient, allowing consistently higher yields to be attained at lower annual application rates (**Figure 5**).

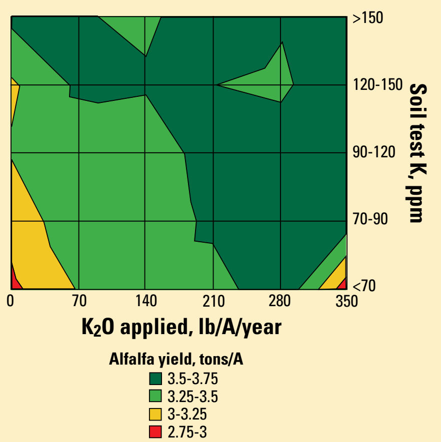

Figure 5. Applications of K to alfalfa become more efficient as soil test K increases (Wisconsin).

Deep and extensive root systems allow alfalfa to make good use of soil K. As the stand ages, large removals of K from past cuttings make alfalfa more dependent upon annual K applications. **Figure 6** shows that alfalfa established for several years can have greater yield responses to applied K than newly established stands.

Small Grains. Limited root systems, shorter growing seasons, and cooler temperatures enhance yield advantages of seed-placed over broadcast K for small grains. Barley data from Alberta showed a considerable advantage for K placed in direct seed contact at fairly low rates of application (**Table 2**). High rates of K in direct seed

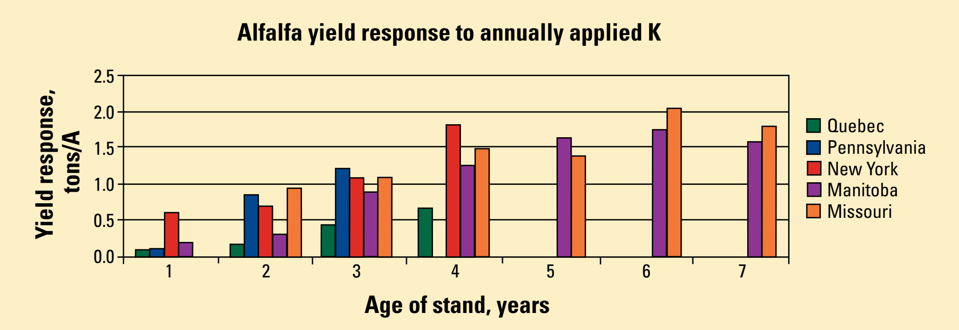

Figure 6. Yield response to K application gets larger as the alfalfa stand ages.

contact may cause germination damage when hoe or disk-opener drills are used.

Much of the wheat in the U.S. is grown in the Great Plains. Soils in this arid environment usually contain high levels of K. Consequently, K-containing fertilizers have not traditionally been applied. In some areas, lack of fertilization has resulted in a depletion of soil chloride (Cl) levels. Chloride is a mobile nutrient and can be leached from soils just like nitrate. Chloride is an essential nutrient and provides small grains with improved disease resistance or an improved ability to withstand disease. Muriate of potash (KCl) broadcast or applied near the seed has produced increases in yield and kernel weight in some cultivars when Cl nutrition has been inadequate (**Table 3**). Caution should be used to avoid salt injury when applying KCl near the seed.

Cotton. Low root length density compared to other major field crops makes cotton particularly sensitive to low soil K supplies. In fact, cotton can exhibit deficiency symptoms on soils not considered K deficient. Potassium is important for maximizing cotton lint yield and quality. Broadcast applications have been commonly used to boost cotton yield and fiber quality (**Tables 4** and **5**). Banded applications of K may be more efficient than broadcast applications in soils that fix large quantities of applied K.

Potassium is required by cotton throughout the growing season, but needs are greatest during boll set and development. Preplant or mid-season sidedress applications of K are commonly used to meet the K needs of cotton. However, even where soil test K levels are considered adequate, late-season K deficiencies have been observed throughout the Cotton Belt. Reasons for this phenomenon are still being investigated, but foliar applications of K have provided yield and quality increases in many cases (**Table 6**). Where appropriate, foliar fertilization should be used to supplement soil applications of K.

TABLE 6. Cotton responds to foliar application of potassium nitrate (California).

Foliar K application applied during the following weeks after first flower:	Lint yield, lb/A	Lint yield response, lb/A
Control	1,291	–
1 & 2	1,360	69
3 & 4	1,411	120
5 & 6	1,367	76
7 & 8	1,313	22

Summary

Potassium placement is receiving increasing attention in modern crop production. Proper placement and timing are essential for getting the most yield response from an application of K. While many issues remain unresolved, research will continue to reveal which management practices provide the most benefits to producers. BC