FERTILIZER PLACEMENT EFFECTS ON YIELD AND NUTRIENT CONTENT OF WINTER WHEAT IN OKLAHOMA

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ABSTRACT

Efficient fertilizer applications are essential to achieve maximum economic yield. Many different fertilizer application methods are being used in wheat production systems in Oklahoma. Methods include broadcast, band, topdress, placement under V-blades and behind thin knives, dribble, split application, and varying combinations of methods that are compatable with clean-, reduced-, and no-till systems. Increases in yield and nutrient uptake have been primarily due to N and P fertilization. Differences in yield and nutrient uptake due to method of fertilizer application have varied with soil nutrient availability indices and favorableness of the growing season.

Depressed market prices for wheat, increased production costs and declining land values have resulted in low profit margins and renewed interest in efficiency of placement of fertilizers in winter wheat production systems.

Leikam et al. (1983) showed that dual injection bands of N and P 15 to 20 cm deep increased grain yield of winter wheat and increased P concentration in leaf tissue. Maxwell et al. (1984) reported increased dry matter production and P concentration in plants grown in rows directly over dual injection bands compared to plants in rows 13 to 25 cm away from the band. Westerman and Edlund (1985) reported the positive effect of increased grain yield due to deep placement of N and P in bands diminished with continued fertilization in the same plots and at the end of the 4 yr study broadcast applications were more efficient. Band application of P with seed at planting was shown to be a very efficient method of application many years ago. More recently, other methods such as fertilizer placement under the V-blade, and dribble applications have been receiving attention. Therefore, the objective of this paper is to discuss the effect of different methods of fertilizer placement on yield and nutrient content of winter wheat.

Additional index words: Triticum aestivum L., Anhydrous ammonia, ammonium nitrate, UAN, ammonium polyphosphate, broadcast application, dual placement, dribble, banded with seed.

MATERIAL AND METHODS

Wheat experiments involving methods of fertilizer placement, and fertilizer sources and rates have been conducted at numerous locations throughout the state. Soils pH at these locations ranged from 5.0 to 7.5 and soil test P availability indices ranged from 9 to 48 μg P g^{-1} of soil using Bray and Kurtz No. 1 (1:20) extraction. Soil available N levels ranged from deficient to adequate.

Plots were harvested for grain yield using a modified Gleaner combine and subsamples of grain were taken and analyzed for N and P.

RESULTS AND DISCUSSION

Comparisons of broadcast vs. deep band application of N, P, and N plus P effects on grain yield and nutrient uptake are shown in Table 1. Data reported are means averaged over 3 to 4 years at each location. Fertilizers were applied to the same plots annually. Three locations with varying available nutrient indices were selected for the study; Altus (N-deficient and P-adequant), Stillwater (N-deficient and P-deficient), and Haskell (N-adequate and P-deficient).

Nitrogen fertilization increased yield and N uptake in grain at Altus but P fertilization had no effect. There were no differences in mean yield and N uptake in grain due to method of application. However, in the first year of the study, broadcast application of ammonium nitrate disked in preplant resulted in higher yield and N uptake in grain than obtained with anhydrous ammonia applied behind thin shank knives with 45 cm spacings (data not shown). The first year of the study at Altus was dryer throughout the growing season than subsequent years. Apparently under moisture stress conditions, deep band application of N in 45 cm intervals is less efficient than broadcast application.

Nitrapyrin had no effect on yield or nutrient uptake in grain during the 4 yr study at Altus.

Yield and uptake of N and P in grain averaged over years were increased with P fertilization at Stillwater, but there were no differences due to method of application. An adjacent N, P, K experiment on the same soil indicated a yield response to applied N. During the initial year of the study, there was a substantial increase in early forage growth when N and P were dual injected behind thin shanked knives in comparison to broadcast applications. The increase in forage growth also resulted in higher yield and N and P uptake in grain. However, with continued fertilization in the same plots with subsequent years, the positive effect of fertilizer in deep bands diminished, and broadcast applications were more efficient.

At Haskell, the increase in yield and N uptake in grain was due to p fertilization. There were no differences in 3 yr average yields or nutrient uptake due to method of applications. However, broadcast applications were more efficient than deep band applications in later years of the study. Nitrapyrin had no effect on yield and nutrient content of winter wheat.

Table 1. Fertilizer application method effects on grain yield and nutrient uptake averaged over years.

Source and method[†]	Rate N	Rate P	Rate NI	Yield[‡]	Uptake N	Uptake P
				kg·ha^{-1}		
Altus[§]						
Check	0	0	0	2050 a	44 a	11 a
AA - KF	112	0	0	2850 b	81 b	15 a
AN - BC + APP - BC	112	30	0	2870 b	74 b	16 a
AN - BC + APP - KF	112	30	0	2970 b	77 b	16 a
AA - KF + APP - BC	112	30	0	2730 b	82 b	16 a
AA - KF + APP - KF	112	30	0	2840 b	81 b	15 a
AA - KF + APP - KF + NI - KF	112	30	0.56	2760 b	81 b	15 a
No. of years in avg.				4	3	3
Stillwater						
AA - KF	112	0	0	1820 a	47 a	5 a
AN - BX + APP - BC	112	30	0	2430 b	58 b	8 a
AN - BC + APP - KF	112	30	0	2380 b	59 b	8 a
AA - KF + APP - BC	112	30	0	2380 b	59 b	7 a
AA - KF + APP - KF	112	30	0	2280 b	59 b	9 a
No. of years in avg.				4	4	4
Haskell						
Check	0	0	0	1680 a	42 a	5 a
AA - KF	112	0	0	1670 a	42 a	4 a
AN - BC + APP - BC	112	30	0	2450 b	59 b	7 a
AN - BC + APP - KF	112	30	0	2180 b	53 b	7 a
AA - KF + APP - BC	112	30	0	2510 b	64 b	7 a
AA - KF + APP - KF	112	30	0	2160 b	54 b	7 a
AA - KF + APP - KF + NI - KF	112	30	0.56	2170 b	58 b	7 a
No. of years in avg.				3	3	3

[†]Anhydrous ammonia (AA), ammonium nitrate (AN), ammonium polyphosphate (APP), and nitrapyrin (NI) were used as sources. Methods of application were knifed (KF) and broadcast (BC). All broadcast applications were disked in preplant.

[‡]Numbers in columns followed by the same letter within locations are not significantly different using LSD (0.05).

[§]Bray and Kurtz No. 1 (1:20) soil test P indices were 48, 10, and 9 μg P g^{-1}, respectively for Altus, Stillwater, and Haskell.

Table 2. Effect of methods of P fertilization on grain yield averaged over two years.

Rate†		Method	Yield‡	
			Stillwater	Haskell
N	P			
---kg ha^{-1}--			---------kg ha^{-1}----	
0	0		2020	1560
112	0	N B'Cast	2700	1720
112	10	N + P B'Cast	2450	2170
112	20	N + P B'Cast	2660	2130
112	10	N B'Cast; P banded w/seed	2660	2150
112	20	N B'Cast; P banded w/seed	2640	2130
112	0	N Knife preplant	2915	1915
112	10	N + P Knife preplant	2790	2250
112	20	N + P Knife preplant	2710	2130
112	0	N Dribble disked-in	2660	1800
112	10	N + P Dribble disked-in	2580	2260
112	20	N + P Dribble disked-in	2630	2360
112	0	N V-blade	2750	1660
112	10	N + P V-blade	2560	2210
112	20	N + P V-blade	2880	2280
LSD (0.05)			410	380

†APP (10-15-0) expressed as elemental P and UAN (28-0-0) were used as fertilizer sources.

‡Bray and Kurtz No. 1 (1:20) soil test P indices were 36 and 15 µg P g^{-1} for Stillwater and Haskell, respectively.

Data from another set of experiments designed to compare effects of methods of P fertilization on yield of winter wheat are shown in Table 2. Grain yields were not affected by method of P fertilization at two locations that varied markedly in soil test P indices. Phosphorus fertilization increased grain yield at Haskell, but there were no differences among broadcast, banded with seed, dual placement behind thin shanked knives, dribble or dual placement of N and P under the V-blade.

Varying methods of N and P fertilization have not resulted in substantial increases in grain yield and nutrient content of winter wheat in Oklahoma. Largest increases in grain yield have been the result of applying deficient nutrients in proper amounts based on calibrated soil tests.

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