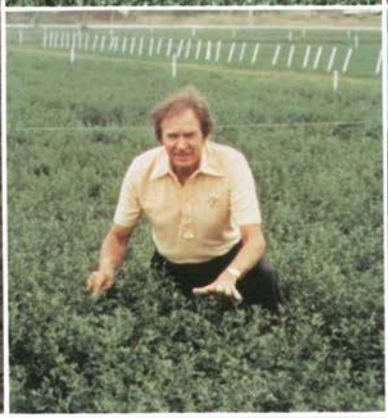
RESEARCH PPI EDUCATION

BETTER CROPS
with plant food

SPRING 1983



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BETTER CROPS with plant food

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Grain Sorghum Response to Starter Fertilizers

By J.T. Touchton and W.L. Hargrove

THE NEED FOR STARTER FERTILIZERS with spring planted grain crops is a widely debated subject. Most everyone will agree that these fertilizers will improve early plant growth in cool soils, but there is some doubt as to whether or not the early plant vigor will translate into higher grain yields.

The response to these fertilizers will most likely occur on soils testing low to medium in extractable P, and when seeds are planted in cool soils. During the past decade there has been a trend in the southeastern United States toward early planting dates and no-tillage or reduced tillage systems, both of which are associated with relatively cool soils during initial periods of plant growth.

For several years we noted that early planted no-tillage grain sorghum grew at a slower rate than did conventional tillage sorghum. Not only would the no-tillage sorghum grow slower, it would often show severe N and P deficiencies, even on soils testing high in extractable P.

Several studies were initiated in 1978 to help find a solution to the early plant growth problems in the no-tillage systems. One of these studies included starter fertilizer applications. These studies were conducted in Georgia and Alabama. Soil P, K, Ca, and Mg levels (**Table 1**) were high enough that yield responses to applied nutrients, except N, would not be expected. Previous summer crops were grain sorghum on the Greenville and Cecil soils and peanuts on the Dothan soils.

Grain sorghum was planted into the previous summer crop residue with a no-tillage, in-row subsoiler planting unit. A conventional tillage (disk-plow-disk) treatment was also included on the Dothan soils. Subsoil depth was approximately 12 inches and the starter fertilizers were dropped directly into the

Table 1. Experimental locations, soil series, initial test values, sorghum planting dates.

Location	Soil	Soil test values[1] pH	P	K	Ca	Mg	Planting date
		-----lb/A-----					
Plains, GA	Greenville	6.0	59	232	1,165	108	3/28
Experiment, GA	Cecil-1 & 2[2]	6.0	48	219	943	188	4/19
Headland, AL	Dothan-1[3]	6.0	74	132	730	90	5/5
	Dothan-2	5.8	70	133	540	30	3/13

[1] Double acid extractions were used to determine soil P, K, Ca, and Mg levels.

[2] The Cecil soils are the same experimental location. The 1 and 2 are used for 1979 and 1980, respectively; the soil test data are for 1979.

[3] The Dothan soils are from different experimental locations.

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subsoil track at planting. The fertilizer was mixed with the surface 6 to 8 inches of soil within the subsoil channel. Starter fertilizer rates were:

80 lb/A 18-46-0 (granular) on the Greenville and Cecil soils;
120 lb/A 10-34-0 (solution) on the Dothan-1 soil;
100 lb/A 23-28-0 on the Dothan-2 soil.

The grain sorghum hybrids 'Funks 522 DR' on the Greenville and Cecil soils, 'Pioneer 8311' on the Dothan-1 soil, and 'Chemnut 1334 BR' on the Dothan-2 soil were planted between mid-March and early May (**Table 1**). Sidedress N was applied at rates of 0, 40, 80, 120 lb/A on the Greenville, Cecil, and Dothan-1 soils and 150 lb/A on the Dothan-2 soil 3 to 5 weeks after plant emergence.

Early plant growth responses to the starter fertilizers were obvious within a week after emergence. Plant weights taken 3 to 6 weeks after emergence are listed in **Table 2**. The starter fertilizer increased early plant weight on all soils. However, on the Dothan soil, where a conventional tillage treatment was included, the starter fertilizer did not increase plant weights as great as those obtained with the conventional tillage system.

Table 2. Starter fertilizer effect — dry weights of whole plant 3 to 6 weeks after emergence.

Starter fertilizer	Soil and Tillage				
				Dothan-1	
	Greenville[1]	Cecil-1	Cecil-2	No-till	Till
	whole plant weight, lb/A				
No	165	291	139	145	240
Yes	560	382	174	215	335

[1] Conventional tillage treatments were not used on the Greenville and Cecil soils.

At the early bloom stage, leaf N increased as rates of applied N increased. But starter fertilizer applications did not influence leaf N except on the Greenville soil (**Table 3**). At all rates of applied N on the Greenville soil, leaf N levels were higher when starter fertilizer was applied.

Nitrogen in the grain at maturity also increased as sidedress N rates increased, but grain N was not affected by starter fertilizer. Grain weights ranged from 25.1 to 28.4 g/1000 grains, but grain weights were not consistently affected by applied N or starter fertilizer.

Table 3. N concentrations in the sorghum leaf as affected by applied N and starter fertilizer.[1]

Starter fertilizer[2]	Sidedress N, lb/A			
	0	40	80	120
lb/A	leaf N, %			
0	1.74	2.03	2.63	2.80
80	1.81	2.40	2.76	3.23

[1] Greenville soil
[2] Starter fertilizer: 18-46-0.

On each soil except the Cecil-2, grain yields were increased by the starter fertilizer application (**Table 4**). On the Greenville soil it appears that the starter fertilizer corrected a N deficiency, because yield responses to the starter fertilizer occurred at the 120 lb rate only when N was not applied.

On the Cecil-1 and both Dothan soils, yield responses were found within all N rates (**Table 4**). It appears that the starter fertilizers increased yield potentials. On the Cecil-1 soil, responses to N rates exceeding 40 lb/A were not found, but response to the starter application, when averaged over the 40, 80, and 120 lb/A N rate was 18 bu/A. On the Dothan-1 soil, grain yields did not respond to N rates exceeding 80 lb/A. But response to the starter fertilizer in the no-tillage treatments at the 80 and 120 lb/A N rates ranged from 13 to 16 bu/A.

Table 4. Grain sorghum yields as affected by starter fertilizers and sidedress N.

							Dothan-1				Dothan-2			
Applied	Greenville		Cecil-1		Cecil-2		No-tilled		Tilled		No-tilled		Tilled	
N	Yes[1]	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
lb/A	bu/A													
0	32	32	54	34	92	77	50	39	55	44	—	—	—	—
40	41	31	79	64	85	91	72	62	73	71	—	—	—	—
80	46	39	88	70	89	84	85	72	83	81	—	—	—	—
120	47	42	88	68	99	97	92	76	88	81	59	28	63	52
LSD .05[2]	7		14		16		10				8			

[1] Addition or exclusion of starter fertilizer.
[2] Least Significant Difference

Since seed size (weight per individual grain) was not consistently affected by the starter fertilizer, the yield increases obtained from the starter applications may have been due to more seed per head, especially since head formation is initiated at approximately 30 to 40 days after emergence.

Tillage comparisons were included only on the Dothan soils. **The greatest yield response to the starter fertilizer was in the no-tillage system**. At the 120 lb/A N rate, yield increases due to the starter fertilizer on the Dothan-1 soil were 16 and 7 bu/A for the no-tillage and conventional tillage treatments, respectively. Increases were 31 and 11 bu/A on the Dothan-2 soil.

Placement?

There is a possibility that yield responses obtained were due to fertilizer placement rather than to a starter effect. When compared to planting without subsoiling, in-row subsoiling often results in more intensive root development. Root growth in the surface soil, however, is often restricted to the subsoil channels.

The increased yield potential associated with the massive root development within the subsoil channels may be restricted because of localized nutrient deficiencies unless starter fertilizers are placed in the subsoil channels.

Regardless of reasons for yield increases, data from these studies suggest that starter fertilizers should be applied when planting grain sorghum with an in-row subsoiler planting unit. They should, however, be applied with caution. Excessive fertilizer rates or even low rates applied too close to the seed can result in seedling damage and severe stand losses.

We have not experienced stand losses with dry fertilizers but have noted damaged seedlings with improperly applied liquid fertilizers. The safest method of applying these fertilizers is to place them as deep in the subsoil track as possible, making certain that high concentrations of fertilizers are 2 or more inches away from seed. ■

10 Tons Alfalfa Without Irrigation – A New Record Research Yield?

DR. M.B. TESAR, Professor in the Department of Crop and Soil Sciences, Michigan State University (MSU), recorded a two-year average yield of 10 tons/A with one alfalfa variety for the 1981-82 seasons. Achieving alfalfa yields of 10 tons/A/year has been compared to producing corn yields of 300 bu/A.

"It appears that this is the highest documented two-year average research yield for nonirrigated alfalfa in the U.S. and in the world," notes Dr. Tesar. "This is three times the regional average for the North Central States."

Many factors working together contributed to the 10-ton yield, a goal in the project since 1968. Yields are based on alfalfa hay at 12% moisture.

The top variety in 1982 and for the two-year average was Cal West 938. It has high genetic yielding ability, adequate winterhardiness, fast recovery after cutting, and resistance to three diseases – bacterial wilt, *Phytophthora* root rot, and anthracnose.

In 1981, fertilizer application rates for the high-yielding plots were: nitrogen (N), zero; P_2O_5, 160 lb/A; K_2O, 760 lb/A; and boron (B), 4 lb/A. The 1982 rates were: N, zero; P_2O_5, 100 lb/A; K_2O, 400 lb/A; and B, 2 lb/A. For the two years, crop removal averaged 12 lb of P_2O_5 per ton of alfalfa and 58 lb of K_2O per ton.

The fertilizer cost based on 1983 prices was $9 per ton. "Ninety dollars for fertilizer, plus good management practices, is economical for a 10-ton yield," Dr. Tesar says.

The Conover-Brookston loam soil of the test site is highly productive, with superior tile drainage and a high water-holding capacity of about two inches

DR. M.B. TESAR of Michigan State University is seeking maximum alfalfa yields in research.

per foot. The soil pH was 6.9. Soil test levels before the study were: P, 55 lb/A; K, 125 lb/A.

All varieties were clear-seeded (without oats cover crop) on May 8, 1980. Eptam herbicide was applied preplant for broadleaf weed control. Seeding rate was 16 lb/A, with inoculated seed. Over five tons of hay per acre was harvested in the seeding year.

Insecticide gave excellent control of alfalfa weevil and leafhopper. Four hay cuttings were made each year. Cutting dates were: early June, July 10-15, August 16-26, and October 15-30.

Precipitation was well distributed and only one inch above normal. The total was 34.01 inches in 1981 and 32.64 inches in 1982, for a two-year average of 33.32 inches.

Table 1 shows yields of the 13 best varieties in the study. The top variety produced 10.79 tons of hay in 1982, and 11 varieties yielded more than 10 tons/A. Eight varieties yielded over 9.5 tons/A/year for the two-year period. All were resistant to either one or two diseases — *Phytophthora* root rot or anthracnose.

Table 1. Yield of 13 best varieties, 2-year average, compared to Vernal variety. East Lansing, Michigan.

	Yield, tons/A[1]			
Variety	**1981**	**1982**	**2-year avg.**	**% Vernal**
CW 938	9.21	10.79	10.00	125
Hiphy	9.62	10.25	9.94	124
Armor	9.35	10.36	9.86	123
Funks G2815	9.50	9.20	9.78	122
Duke	9.17	10.38	9.78	122
O's Gold 777	9.08	10.29	9.68	121
Voris A77	8.96	10.36	9.66	121
WL 313	8.94	10.29	9.62	120
74-5T9 (NK)	8.68	10.29	9.48	118
Epic	9.07	9.84	9.46	118
O's Gold 78	8.66	10.11	9.38	117
CW 925	8.52	10.23	9.38	117
Futura	8.22	10.16	9.19	115
(Vernal-Check)	(7.73)	(8.25)	(7.99)	(100)

[1]12% moisture

Next Steps

"The new yield goal is 12 tons per acre of alfalfa hay by 1987," Dr. Tesar says.

Two new research projects were started in 1982 with the higher yields as a goal. Variables include: (1) plowdown fertilizer; (2) three high-yielding varieties; (3) variable rates of P_2O_5 (150 and 225 lb/A/year) and K_2O (400, 800, and 1600 lb/A/year); (4) variable dates of first and second cuttings; (5) minor elements and (6) irrigation on selected high PK treatments.

The annual Michigan precipitation of 32 inches — with 22 inches in the April to October period — is adequate for a 12-ton yield if rainfall is well distributed in summer.

No weed killers are used after the seeding establishment year in the Michigan State studies. "Excellent stands and drainage, high pH, proper cutting management and high fertilization are the best weed control measures," Dr. Tesar says.

"With similar inputs, farmers will probably harvest 8 to 9 tons, on a large acreage, instead of 10 tons. This is because of variable soil and greater harvest losses. Low moisture silage is a 'must' to save the growth produced," he points out. ■

More Corn Per Acre

By Larry Shepherd

WE KNOW a lot about growing corn. But many farmers are not putting this knowledge to work and are losing bushels and profits.

Three factors determine net profit: corn price received, cost of production, and yield. The corn price cannot be controlled — only slightly improved by timely selling. Most production costs are fixed immediately when the decision is made to grow corn. Yield is the profit factor over which a farmer has the most control. Producing a higher yield per acre is the best way to keep income ahead of increasing production costs.

Six things must be done right to get the most bushels per acre. All are equally important; overlooking any one of them can result in crop failure at worst or average production at best.

(1) Provide good drainage. A poorly drained soil is later to be planted, requires more nitrogen (N), encourages diseases and causes sloppy, late harvests. The cost of tile drainage has not increased as fast as land prices. Farmers seldom regret tiling their ground because of the long term improvement in productivity.

If hardpans are present, deep tillage should be considered to improve drainage and root growth.

(2) Select a good hybrid. Look in **Table 1** at the differences between the worst and best hybrids tested by Ohio State University. Use proven hybrids on most of the farm and restrict use of unproven hybrids to small acreages.

Table 1. Select corn hybrids that consistently yield high in field comparisons.

	Four Best Hybrids bu/A	Four Worst Hybrids bu/A	Yield Difference bu/A
SW Ohio	167	146	21
NW Ohio	164	137	27
NE Ohio	148	125	23

Ohio State University, 4-year average, 1978-81.

(3) Plant early. Getting the plants off to an early start allows them to take full advantage of the longer days in spring. This builds yield potential.

April planting consistently yields highest in Ohio State University research. **Figure 1** shows that at least **one bushel per acre per day** is lost when planting is delayed past May 1.

Don't be overly concerned about frost damage. The growing point of a corn plant is not above ground until the six-leaf stage. Frost damage to plants with the growing point below the ground will usually not kill the plant or lower yield. The potential **loss of yield from late planting** is greater than from frost damage to early-planted corn.

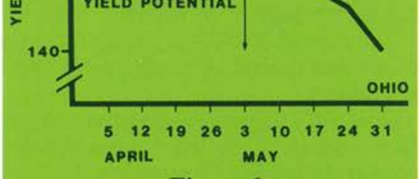

Figure 1

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(4) Control weeds and insects. Chemicals are now available which can economically control most major corn pests. They will work only if they are used and used correctly.

(5) Use a high plant population. It takes a final stand of at least 24,000 plants/A in Ohio for maximum corn yields. **Table 2** shows that yields plateau in the 24,000 to 30,000 range. If the right hybrid is chosen and the fertility program is good, neither a reduction in yield nor lodging need be a problem at high plant populations.

The final population is usually 10 to 20% less than the seeding rate. Planting 15% more seeds than the desired final population is a good rule.

Check the population at harvest and compare with the seed drop. Most farmers end up with a lower plant population than they think they have.

Higher populations require higher fertility levels, especially nitrogen. For best results **both** N rate and plant population should be increased together.

Table 2. A final stand of 24,000 plants/A or more required for maximum yields.

Yield bu/A	Seed Drop seeds/A	Final Stand plants/A	Stand Loss %
129	18,000	15,300	15%
141	20,700	18,500	11
155	24,500	21,200	13
162	27,300	23,700	13
164	35,000	28,400	19

Ohio State University Avg. = 14%

Table 3. Corn response to nitrogen.

Nitrogen lb/A	Yield bu/A	Profit from N* $/A
0	63	--
60	93	47
120	126	99
180	152	138
240	164	149
300	170	149

* Profit from extra bushels over check after costs: corn = $2.25/bu; N = 20¢/lb; 30¢/bu harvesting cost deducted. OSU, 12 year-average.

(6) Adequate fertility a must. Corn requires large amounts of nutrients for maximum yields. High corn yields simply are not possible if the farmer does not make these nutrients available through soil buildup or annual fertilizer additions.

Nitrogen is the engine that pulls the corn train. OSU recommends 200 lb/A of N for a 140 bu/A yield goal. **Table 3** shows that 240 lb/A of N was economically the optimum rate in a 12-year study using a corn price of $2.25/bu and N price of 20¢/lb. For the grower serious about achieving corn yields of 160 to 200 bu/A, a N rate of 300 lb/A is necessary.

P and K needs are best determined through soil tests and selection of challenging, realistic yield goals. OSU makes fertilizer recommendations for building soil P and K levels to optimum levels – in addition to making recommendations for annual applications.

Once the soil has been fertilized to the optimum soil test level it should be kept there with annual maintenance applications. Banding the P and K at planting is a good method of getting on maintenance amounts and is good insurance when planting early into cold soils.

An essential part of a high yield corn program is taking ear leaf samples annually for nutrient analysis. Ear leaf analysis gives an additional check on the adequacy of the N, P and K fertilizer programs. For many of the secondary and micronutrients, ear leaf analysis is the **only** good way to determine nutrient deficiencies and the need for corrective action the next year.

Conclusion

Higher corn yields and profits are possible for most farmers using technology available now. But no factor affecting yield can be overlooked. The corn farmer serious about producing outstanding yields must become a perfectionist in all aspects of crop management. ■

Higher Yields Help Combat Narrow Profit Margins

By W. Donald Shurley

WITH NARROW PROFIT margins, tight cash-flow and insufficient funds for debt repayment, many farmers must adjust crop production practices to meet these challenges.

Corn Budgets

For many farmers, debt service is by necessity their number one priority. Yield level is one of the most important controllable factors which determine debt servicing ability.

Table 1 shows estimated costs and returns at three corn yield levels. With higher yields, total costs increase but cash cost per bushel remains fairly constant – thus increasing net returns.

Net return above cash expense is the amount available to service debt and to reward land and management. For purposes of illustration, assume all net return is used for debt repayment. **Table 2** shows the debt servicing ability at various yields and interest rates. A net return of $124/A, for example, at the 120 bu/A yield level would support $451 of debt (amount borrowed) at 12% interest for five years.

Table 2 reveals two reasons why higher yields are so important. First, at a given rate of interest, higher yields provide greater debt servicing ability. Second, as interest rates increase higher yields are required to maintain the same level of debt service.

Table 1. Estimated per acre costs and returns for corn, 1983.

	Farm yield level, bu/A		
	120	150	180
Crop returns[1]	$300	$375	$450
Cash expenses			
Fertilizer[2]	47	67	85
Seed[3]	16	18	20
Chemicals[4]	20	24	28
Machine Operation[5]	30	34	37
Drying	17	21	25
Hauling	18	23	27
Hired Labor[6]	8	8	8
Taxes and Insurance	9	10	11
Operating Interest[7]	11	13	16
Total cash expense	$176	$218	$257
Per bushel cash expense	$1.47	$1.45	$1.43
Net return to land, management and debt service	$124	$157	$193

[1] Expected corn price of $2.50 per bushel.
[2] Rates of 120-55-55, 180-75-75, and 240-90-90 of N-P_2O_5-K_2O at 120, 150, and 180 bushels per acre, respectively. N priced at 20¢ per pound, P_2O_5 at 27¢ per pound, and K_2O at 14¢ per pound.
[3] Assumed higher seeding rate at higher yield levels.
[4] Includes insecticide at higher yield levels.
[5] Fuel, oil, and repairs.
[6] Assumed one-third of total requirement at $6 per hour.
[7] 13% annual percentage rate on all cash expense for 6 months.

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Table 2. Debt service[1] per acre of corn at various yields and interest rates, 1983.[2]

	Interest Rate, %				
bu/A	10	12	14	16	18
120	$481	$451	$422	$399	$375
150	606	570	536	504	475
180	747	703	659	622	585

[1] Assumes full amount of net return from Table 1 used for debt repayment.

[2] Based on $2.50 corn price and 5-year repayment period.

Combating Higher Costs

Higher costs and their adverse effect on debt servicing ability can be offset in part by achieving higher yields. **Figure 1** shows the increase in corn yields needed to combat higher cash costs over a five year period. The yield increases shown would be necessary to offset higher fuel, fertilizer, seed, and chemical prices while maintaining the ability to pay existing debts and keeping net returns in line with increased prices of depreciable assets.

For example, if the price of corn remains at $2.50/bu and costs increase 9% per year, in five years the yield would have to be 45% higher in order to maintain the present level of debt service ability. With $3/bu corn, yields would have to be 21% higher in five years, given a 9% annual cost increase (see dashed lines).

With $3/bu corn, higher yields will be needed in five years if costs increase more than 4% per year (see dotted lines).

CHANGE IN CORN YIELDS NEEDED IN FIVE YEARS TO MAINTAIN 1983 LEVEL OF NET RETURNS AND DEBT SERVICE

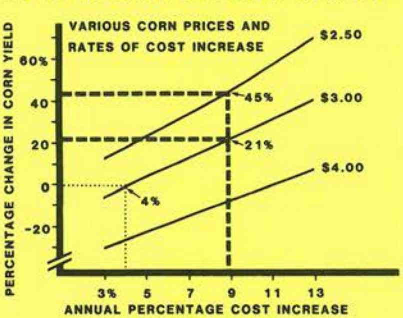

Figure 1

Profit Maximization Basics

Higher yields are crucial for those farmers needing to actually improve rather than just maintain their financial condition. In periods of narrow profit margins, however, highest priority is often given to reducing expenses.

Fertilizer and chemical costs are usually targeted first by "cost cutters." But this approach is often no more than economic tunnel vision. In most cases reducing fertilizer and chemical rates leads only to more mismanagement.

The key to higher profits is not lower total costs but **lower cost per unit of production.**

The profit equation is:

Profit = (Price × Yield) – Operating Costs-Overhead Costs

A key relationship in this equation is that between yield and inputs – operating costs being determined by the level of input use. The benefit of reducing costs is often more than offset by the concomitant drop in yield. Cutting costs results in higher profits only if yields can be maintained. Increasing costs can also result in higher profits if the yield increase is enough to offset added costs.

Managing for Higher Yields

Aside from weather, the two most limiting economic factors in crop production are soil and management. Soil productivity can be improved through investments in lime, drainage, and fertilizer. Management factors include hybrid selection, plant population, timeliness, pest control, proper tillage for the soil, and crop rotation.

A total "systems" approach is needed. Each input must receive close attention.

Conclusions

Higher yields can improve net returns, debt repayment ability and cash-flow. Higher grain prices can further enhance the benefits of higher yields. ■

Understanding Alfalfa Nutrient Uptake

By L.E. Lanyon, J.E. Baylor, and W.K. Waters

TO MAINTAIN high yielding, profitable alfalfa stands, it is essential to understand the uptake of plant nutrients from the soil. Recent information from Pennsylvania's Alfalfa Growers Program can contribute to this understanding.

In the program, plant samples are collected for each harvest from growers' fields. The fields are a minimum of five acres and are managed for top production. This article is based on five years of data compiled by yield groups for these top growers.

Nutrient Uptake

There is a wide range in uptake of plant nutrients by alfalfa, depending on the characteristics of the nutrient and its availability in the soil. Substantial increases in uptake occur as higher yields are achieved **(Table 1)**.

Table 1. Nutrient uptake by alfalfa (1977-1981).

Yield Group	lb/A N	P_2O_5	K_2O	Ca	Mg	S
tons/A[1]						
up to 4	203	51	229	88	15	16
4 - 5	226	66	301	108	19	20
5 - 6	313	78	352	132	24	25
6 - 7	373	92	423	145	26	29
7 - 8	429	108	503	167	30	34
over 8	499	124	585	202	35	42

[1] 10% moisture

In general, the crop uptake of nitrogen (N) and potash (K_2O) is the greatest of all the nutrients. Of course, alfalfa is a legume and is among the most efficient fixers of N from the air. Thus, N rarely limits alfalfa production. Alfalfa can also build soil N to be used by other crops, such as corn, that follow in a rotation. Potash, which is taken up in even larger quantities, must come from the soil.

If soil fertility and alfalfa production are to be maintained, these heavy demands for potash must be anticipated and incorporated into the soil fertility practices on the farm.

Phosphate (P_2O_5) is also very important to profitable alfalfa production. Even though uptake by alfalfa is only one-fifth as much as for N and K_2O, phosphate should be provided for plant use through effective fertility management.

Alfalfa also takes up calcium (Ca), magnesium (Mg), and sulfur (S) in substantial quantities. The amounts in the harvested forage more than double as the top yields are achieved.

These nutrients have often been indirectly maintained in sufficient quantities for alfalfa through other crop management practices. For instance, if the soil is adequately limed, Ca and Mg will normally be maintained through the addition of lime. Alfalfa is very effective in the uptake of these two nutrients, especially Mg, when compared to the forage grasses. As a result, deficiencies are rare.

In the past, sulfur has been added to many soils when ordinary super-

Dr. Lanyon is a Research Agronomist and Dr. Baylor is an Extension Agronomist at The Pennsylvania State University; Mr. Waters is an Area Farm Management Specialist in Pennsylvania.

Table 2. Soil test results from high yielding fields (1978-1981).

Yield Group	pH	Avail. P	Exchangeable K			Ca	Mg	CEC
tons /A[1]		lb/A	lb/A	meq/100 g	% sat	---	meq/100 g	---
up to 4	6.46	154	363	0.46	3.8	7.48	1.12	11.8
4 - 5	6.62	112	375	0.48	4.2	7.99	1.26	11.7
5 - 6	6.64	134	387	0.50	4.2	7.78	1.54	11.8
6 - 7	6.68	145	399	0.51	4.5	7.82	1.34	11.4
7 - 8	6.73	114	472	0.61	5.4	7.78	1.46	11.5
over 8	6.56	148	544	0.70	6.1	6.76	1.34	11.2

[1] 10% moisture

phosphate was applied. On many farms this source of sulfur may no longer be significant. Sulfur status may be important to watch on coarse-textured, low organic matter soils or those that do not receive manure.

Soil Tests

Soil test results from many of the fields indicate a high level of fertility **(Table 2)**. These soil tests reflect the emphasis that the Pennsylvania growers place on ensuring adequate soil fertility as the first step in attaining high yielding crops.

In a survey of the soil fertility practices by the 1981 participants in the program, we found that very few of the growers indicated that they treated the field in the program in a special way. This is further evidence that a strong soil fertility program is considered as the foundation for a productive alfalfa crop by these growers.

Micronutrient Uptake

The uptake of micronutrients by alfalfa **(Table 3)** is considerably less than for major nutrients in **Table 1**.

Table 3. Micronutrient uptake by alfalfa (1977-1981).

Yield Group	lb/A B	Cu	Zn	Mn	Fe
tons /A[1]					
up to 4	0.20	0.05	0.16	0.36	0.97
4 - 5	0.25	0.06	0.21	0.47	1.04
5 - 6	0.30	0.07	0.24	0.51	1.41
6 - 7	0.33	0.08	0.28	0.66	1.57
7 - 8	0.37	0.09	0.30	0.80	1.61
over 8	0.43	0.11	0.36	0.78	1.92

[1] 10% moisture

However, no matter how small the amount in the crop, these nutrients are still essential for growth. As with the other plant nutrients, the uptake of these nutrients doubles in most cases as the yields increase.

Boron (B) is the only nutrient of this group that needs to be applied to many soils, especially in the Northeast, to achieve maximum alfalfa production.

Economic Factors

Alfalfa yield and plant nutrient uptake are closely related. Yield is also important to production costs. Of course, as production increases, some costs do also. For instance, machine operation, labor, fertilizer and other miscellaneous costs depend on the amount of alfalfa produced.

However, other costs such as stand establishment, machinery, and land ownership do not change. The result: As yields increase, the net return per acre increases while the cost per ton of alfalfa produced decreases significantly. For the yield group exceeding 8 tons/A, costs are significantly lower both on a per acre and per ton basis. This underlines the fact that perhaps the best individuals in producing alfalfa from an agronomic standpoint are also the best all-around farm managers.

The need for achieving high alfalfa yields increases each year as the costs of production climb. Results from the Pennsylvania program show that the break-even yields have increased by 8% per year in the five year period. ■

Decision-Making for the 1983 Season

THE 1983 CROPPING season has a character all its own. Normally, farmers and industry are faced with the uncertainties of weather and the changing economy. This year, however, the Payment in Kind (PIK) program adds a new dimension to both production and marketing.

Corn and wheat acres removed from production by the PIK program will influence fertilizer, seed, and pesticide use the most. Cutbacks in area planted to sorghum, rice and cotton will also have strong regional impact. Thus, many farm leaders are recommending that farmers fertilize and manage for a maximum economic crop yield for those fields staying in production in 1983. In a similar manner, they are recommending that farmers protect their idled acres from erosion and weed seed buildup. How? By planting a cover crop and then fertilizing and managing that crop to **build** soil productivity.

The Maximum Economic Yield Approach

What is the maximum economic crop yield system? In simple terms, maximum economic yield (MEY) is the point on the yield curve where the last dollar invested in an input will provide the farmer a net return of one dollar. It will probably be less than the absolute maximum yield possible in a field.

MEY crop production is the best management approach for this season. As the PIK program is designed to help reduce surpluses, the MEY approach is designed to help farmers produce profitably.

We know that crop yield goal will vary from farm to farm and from one field to another. Dr. Frank Congleton, University of Georgia soil fertility specialist, offers this advice: "The critical requirement that any farmer should address before he sets his yield goal is that he make a realistic appraisal of the yield potential for each of his fields. Then it is much easier to lay out a production package that should make the most corn for the least cost per bushel."

Achieving the least cost per bushel is best accomplished with the MEY crop production system. It provides the farmer the best opportunity for profit when grain prices are low. Critics say this only adds to grain surplus. Top farmers will be quick to respond that unless they increase yields to lower unit costs, they will no longer be farmers.

Other benefits develop from MEY farming. For example, higher crop yields in 1983 can develop a higher farm yield base. This might pay dividends with future PIK and/or other government programs. Also, striving for MEY yields in 1983 can help establish good production practice habits. Farmers can harvest these benefits year after year. And perhaps the least understood benefit from

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Condensed from a paper presented by Dr. Noble R. Usherwood at the annual meeting of The Fertilizer Institute. Dr. Usherwood is Vice President of the Potash & Phosphate Institute.

maximum economic yield systems is protection of the soil and environment. Properly managed, high yield systems help reduce erosion and can build soil productivity at the same time.

Fertilizer, A Key Input

It is well known that in 1982, farmers cut back on fertilizer use. This cutback teamed with record high levels of crop production could hurt 1983 crop yields. Dr. Royce Hinton, University of Illinois agricultural economist, recently addressed this issue. He stated that last year many farmers did not apply adequate fertility to sustain the yields which they produced. Excellent yields extracted large amounts of P and K from the soil. Without an adequate fertilization program in 1983, yields are almost certain to be lower than they would be with adequate fertility.

Fertilizer is a key team member of the maximum economic yield approach. We hear much about fertilizer being a large percentage of the total crop production cost, but this can be misleading. In general, fertilizer contributes 30 to 40% of crop yield . . . but only about 15 to 20% of the total crop production cost. Farmers invest in fertilizer not to keep industry in business, but to keep themselves in business.

In Illinois, for example, cost estimates for growing 125 bushel per acre corn show that fertilizer is about 16% of the total cost. Even if this amount was doubled, it would represent less than 28% of total production cost. It is for this reason that many farmers recognize it is usually more profitable to overfertilize by 10 to 15% than to underfertilize by that amount.

Decision Making Time

With fewer acres being planted, management attention per acre can be improved in 1983. As farmers strive for maximum economic yields on planted acres, careful consideration is needed in the areas of timing and rates of fertilizer use, genetic selection, weed control, pest management, and the proper timing to achieve positive interactions between production practices.

A crop production system with a weak fertilization program falls short of its potential . . . both in yield and profit. A good fertilizer recommendation is the product of field-by-field evaluation utilizing soil test results, crop nutrient uptake numbers for the desired yield goal, previous cropping and fertilization history, production practices to be utilized, as well as consideration for the local climatic conditions. Such information is available through research, good farm records, and from production specialists with university, industry and lending institutions. ■

PIK Top Profit Practices

THE government's reduced acreage and payment in kind (PIK) programs present some special considerations as U.S. farmers face management decisions in 1983.

A new folder from the Potash & Phosphate Institute, "PIK Top Profit Practices," encourages farmers to strive for maximum economic yields on acres in production and to manage set-aside land properly.

Single copies and quantities of the publication are available. The cost: 15¢ each (10¢ each for members of PPI, contributors to the Foundation for Agronomic Research (FAR), to universities and government agencies.

For more information, contact: Potash & Phosphate Institute, 2801 Buford Hwy., Atlanta, GA 30329. Phone: (404) 634-4274.

Building Maximum Economic Yield Systems to Meet World Food Needs*

IN A WORLD where the Food and Agriculture Organization (FAO) of the United Nations and other experts say that three-fourths of future increases in food production must come from present croplands, it is rather clear that more output per acre or hectare is key to feeding the world. The difference between average yields and maximum economic yields is the world's greatest food reserve.

This reserve can be developed. It will be the major factor in feeding a global population that is projected to double in the next 35 years and that authorities tell us will require more food than has been produced in all history.

The greatest food production challenge is in developing nations, where three-fourths of the world's population will live by 1990 and where demand for food is rising fastest.

New Heights in Yields

Most parts of the world could double current production per unit area per unit time. Most farms operate at 50 percent capacity or less. Few businesses can survive for long at such low operating levels.

The new maximum yield research effort . . . which had its real beginning about four years ago in the U.S. and is now spreading to developing nations . . . is building a solid base for vertical expansion in food and feed production. In 1982, research by Dr. Roy Flannery showed that 338 bu/A (21.2 T/ha) of corn is achievable in the United States, where the highest national average yield is 114 bu/A (7.2 T/ha), recorded only last year and about double what it was 20 years ago.

DR. R.E. WAGNER

Farmer yields of over 300 bu/A (20 T/ha) have been reported. Scientists have calculated the theoretical maximum to be in the range of 500 to 600 bu/A (31 to 37 T/ha).

Early Stages of Maximum Yield Research

What are the potentials in the developing nations where food needs are most crucial? Only research with a maximum yield focus will provide meaningful information on production potentials. A minimum input approach in research does not provide the kinds of answers needed in most parts of the world at this particular time in history.

Maximum Yield Research Defined

Maximum yield research has been identified as a study of one or more variables and their interactions in a *multidisciplinary system* that strives for the highest yield possible for the soil and climate of the research site. The objective is to build systems in which the components of a total package of practices interact positively.

*Summary of a paper prepared by Dr. R.E. Wagner for FAO/FIAC Technical Sub-Committee Meeting, April 14, 1983, Rome, Italy. Dr. Wagner is President of the Potash & Phosphate Institute (PPI) and the Foundation for Agronomic Research (FAR).

This concept can be just as appropriate and useful for the developing world as for developed countries. Already it is being tailored so the results can be adapted to small farms in Brazil, China, Ecuador, and Peru, and it is spreading to other countries.

Maximum Economic Yields for the Farmer

Maximum yields are not meant to be for the farmer. Maximum **economic** yields are for him. But there is no way to design a maximum economic yield goal for the farmer until research establishes levels of maximum yield potentials.

A maximum economic yield is that point at which **economic returns** per acre or hectare are maximized or are at their highest possible level.

Because soils and climates of the world are highly diverse, it follows that there would be wide variation in maximum economic yields.

Wherever they are, maximum economic yields created from maximum yield research have a number of attributes, but two very basic ones. The first is that they are the farmer's best profit control. The second is that they are the best insurance of a dependable food supply for the world.

Some critics would suggest that maximum economic yield systems are inefficient or "wear out the soil." On the contrary, a properly managed system is more efficient and actually conserves or builds soil.

While more yield usually requires more expenditure per hectare, the real key is that it cuts the cost per tonne or other unit.

Servicing the Debt Load

An attractive feature of maximum economic yields, especially in times of heavy borrowing to keep farm operations going, is that they can be very helpful in servicing the debt load. Still another plus to higher yields is that they expand the profit zone.

Positive Interactions in Maximum Economic Yield Systems

Positive interactions are the key to success in building maximum economic yield systems. Such interactions occur when the response to two or more inputs used together is greater than the sum of their individual responses. These interactions can be translated into significant economic returns.

Interactions can involve all components of the total production system in combinations of two or more. Research examples from many sources have illustrated this. However, many interactions are not completely understood, and need to be identified through maximum yield research.

Progress has been exciting in the short time maximum yield research has been underway. Record research yields achieved by Dr. Flannery and other pioneers have opened the way for more breakthroughs.

Promises for the Future

Maximum yield research, though still in its infancy, is building a factual base for a maximum economic yield agriculture of the future. Maximum economic yields can mean greater and more efficient production . . . which the individual farmer needs . . . which the total farm economy needs . . . which the world needs to feed its people . . . and which the general economy needs to help control inflation. These great promises will be realized to the extent research at maximum yield levels is given support. ■

"We are on the leading edge of a production front powered by maximum economic yields with the potential to restore the world's agriculture to economic health and to be the major factor in assuring adequate food supplies for the world's hungry people for many years to come. Will we make it happen?"

– Dr. R.E. Wagner

Research Shows More Profit from High-Yield Irrigated Corn

AGRONOMISTS and economists working together are figuring how farmers can practically and economically adopt proven high-yield techniques.

At the University of Florida, Dr. Fred Rhoads, Dr. David Wright, and Dr. R.L. Stanley have conducted high-yield research for over a decade. Mr. Mark Eason, agricultural economist, provides the economic evaluation. What they've found may be surprising to some. It confirms the importance of maximum yield research for providing improved production practices and systems for maximum economic yields on the farm.

By adjusting only a few variable expenses, these scientists have been able to produce over 200 bu/A of corn more economically than they could grow 150 bu/A under less intensive management.

"Too many farmers have the idea that it is too costly to set a yield goal of 200 to 225 bu/A. They try instead for maybe 150 bu," Dr. Rhoads says. "In many cases, they are cutting back on the high cost items like fertilizer and irrigation when all they may have needed was a little extra of a low-cost item, like a micronutrient, to make their higher yield goal practical."

In slashing production expenses and reducing yield goals, some farmers are sacrificing both yields and profits, the Florida researchers point out.

In the South, some farmers have reduced yield goals believing that high summer temperatures will severely limit or reduce yields.

However, Dr. Rhoads says there's no proof that temperatures as high as 115 degrees Fahrenheit will reduce yields – if corn has the nutrients and water it needs.

"I was told 12 years ago that 125 bu/A was the maximum attainable yield in Florida because of high temperatures. But even with high temperatures, we have never failed to produce over 200 bu/A where we did everything else right," the specialist explains.

"The point we need to get across is this: Farmers should concentrate on producing maximum yields for the least cost per bushel," he emphasizes.

Mr. Eason encourages farmers to prepare their own estimated production costs in a budget form. Dividing total costs by anticipated yield will give the break-even price needed.

"Our sample budgets show break-even prices at various yield levels with various production costs. As we add more fertilizer and seed, of course, the cost per acre increases. But as yields increase, the cost per bushel decreases, up to a point. It is that point we are seeking," Mr. Eason says.

Figure 1 shows an example of yield response for irrigated corn to increasing levels of nitrogen (N) and a mixed fertilizer. **Table 1** lists break-even corn prices with various inputs and yields.

Big Differences

"Many of the mistakes that cost farmers yields may actually seem like very minor problems," Dr. Stanley says. For example, plant population and row spacing can vary only a slight amount and make the difference in profits and losses.

In Florida research, spacing and population didn't seriously affect yields up to 150 to 160 bu/A. But for higher yields, more uniform stands become increasingly important.

"We recommend 26,000 to 30,000 plants per acre in 30-inch rows for the best success," Dr. Stanley says.

Dr. Rhoads and Dr. Wright agree. They estimate that maximum yields with 15,000 plants per acre would be only about 130 bu/A. But with the same management and 30,000 plants per acre, consistent yields over 200 bu/A are possible.

Low cost inputs that can make or break a corn production program are zinc, boron, manganese, copper and sulfur. Dr. Rhoads suggests having at least 2 lb/A of boron and 10 lb/A of zinc available. Sulfur is also important – plants will absorb one pound of sulfur for each 10 lb/A of nitrogen (N).

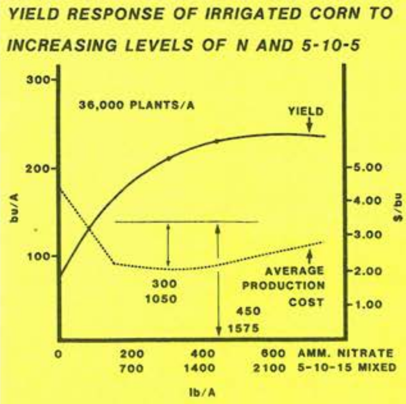

Figure 1

Table 1. Break-even corn prices with various inputs and yields.

Population Seeds/A	Total Cost	Yield bu/A	Prices $/bu
24,000	$273.70	100	$2.74
24,000	322.23	151	2.13
24,000	370.75	179	2.07
24,000	419.28	202	2.07
24,000	516.33	196	2.63
30,000	347.75	76	4.58
30,000	418.90	149	2.81
30,000	561.20	240	2.34
36,000	280.93	65	4.32
36,000	353.72	164	2.16
36,000	426.50	210	2.03
36,000	499.28	231	2.16
36,000	644.85	231	2.79

$$\text{Break-even price} = \frac{\text{Total cost}}{\text{Yield}}$$

"We need to maintain a high level of phosphorus. If you don't have phosphorus there, plants simply will not take up the N," he explains.

Nitrogen management is critical. Optimum would be several applications between one and eight weeks after corn emerges.

Plants should never be allowed to show any nutrient deficiency symptoms. Even if a deficiency is diagnosed and corrected, some yield reduction is already accomplished, the researchers caution.

Irrigation

"Irrigation systems should be designed to handle the time of maximum water need," Dr. Stanley says. "When temperatures hit high levels, corn may need an inch of water every three or four days. A system that will apply one inch of water per week will be **inadequate to avoid plant stress.**"

It may be more profitable to plant only the number of acres that can be properly managed rather than stretching the acreage too much for a system, the researchers say. ■

For Top Yields

Soybean Row Width More Important Than Plant Spacing Within Row

By W.L. Parks

SOYBEANS are perhaps the most light sensitive of the major farm crops produced in present day agriculture. The crop is particularly responsive to quality and quantity of sunlight since it affects plant height, branching, leaf area, time of flowering, lodging and maturity.

The photosynthetic rate of soybean leaves is almost directly proportional to the relative percentage of full sunlight intensity. Dry matter production has been linearly related to percent radiation interception. The leaves near the top of a fully developed soybean canopy intercept over 90% of the incoming radiation; less than 2% of the incoming radiation reaches the soil surface. This soybean canopy characteristic greatly reduces soil moisture losses through evaporation and thereby permits a larger percentage of the soil moisture to be utilized through the plant in photosynthetic and metabolic processes.

Generally, 10 inch rows will form a complete canopy about 60 to 65 days after planting; 20 inch rows will canopy about 10 to 12 days later. Wider row spacings take 90 to 120 days to canopy and in these cases much soil moisture is lost through evaporation, and the plant is subjected to higher surface soil temperatures that are not conducive to promoting the type of growth that leads to high yields.

One might wonder if this dense canopy that is produced by narrow rows would create a carbon dioxide (CO_2) deficit within the canopy. Our results indicate CO_2 sinks of no more than 70 to 75 parts per million (ppm) have been observed.

In order to evaluate the effect of row spacing and within row plant density on soybean yield, we conducted experiments with row spacings of 40, 30, 20 and 10 inches as the main plot and 12, 10, 8, 6, 4 and 2 plants per foot of row as split plots. There were four replications with Essex variety soybeans on a Sequatchie soil at Knoxville. The pH was 6.4 with high levels of phosphate and potash.

To obtain the desired plant population, 18 to 20 seeds were dropped at planting. When the soybeans reached about the third trifoliate stage, they were thinned to the desired population.

Table 1 shows the number of plants per acre for each treatment of the experiments.

Table 1. Soybean plants per acre.

Plants per foot of row	Row spacing in inches			
	40	30	20	10
	Plant population in thousands			
12	156.8	209.1	313.6	627.3
10	130.7	174.2	261.4	522.7
8	104.5	139.4	209.1	418.2
6	78.4	104.5	156.8	313.6
4	52.3	69.7	104.5	209.1
2	26.1	34.8	52.3	104.5

Dr. Parks is in the Department of Agronomy, University of Tennessee, Knoxville, TN.

The soybean yields obtained for the 1979, 1980 and 1981 crop years as well as the three-year average are presented in **Table 2.** In these experiments, irrigation was used to correct moisture deficiencies. However, for the 1980 crop year moisture levels fell shortly below optimums due to excessive demands on the irrigation system by other research projects. The 1979 crop year was one of above normal rainfall and much cloudy weather; 1980 was a hot, dry, droughty year; 1981 was a good crop year with rainfall somewhat above normal.

Table 2. Soybean yields at four row spacings and six within-row plant densities — 1979, 1980, 1981 crop years and three-year average.

1979 Yields

Plants per ft. of row	Row spacing in inches 40	30	20	10	Mean
	----	----	bu/A	----	----
12	63	65	64	69	65
10	61	63	61	72	64
8	60	61	67	77	66
6	59	58	64	77	64
4	59	58	62	72	63
2	48	53	49	79	57
Mean	59	60	61	75	—

1981 Yields

Plants per ft. of row	Row spacing in inches 40	30	20	10	Mean
	----	----	bu/A	----	----
12	53	60	63	82	64
10	57	62	64	87	68
8	54	62	64	93	68
6	52	60	62	86	65
4	55	60	69	85	67
2	44	54	50	77	56
Mean	53	60	62	85	—

1980 Yields

Plants per ft. of row	Row spacing in inches 40	30	20	10	Mean
	----	----	bu/A	----	----
12	50	55	55	55	54
10	49	50	66	71	59
8	52	56	61	70	59
6	51	53	52	65	55
4	41	45	47	74	52
2	32	38	54	59	46
Mean	46	49	56	66	—

Three-Year Average

Plants per ft. of row	Row spacing in inches 40	30	20	10	Mean
	----	----	bu/A	----	----
12	55	60	60	69	61
10	56	58	64	77	64
8	51	60	64	80	64
6	54	57	59	76	62
4	52	54	59	77	61
2	41	48	51	72	53
Mean	52	56	60	75	—

The soybean yields **(Table 2)** indicate that as row spacing was decreased from 40 to 30 to 20 inches, yields increased. These increases were greater in years of better radiation distribution. In the wet, cloudy year of 1979, the yield increase was only 2 bu/A. It was 10 bu/A in 1980 and 9 bu/A in 1981. The three-year average was 8 bu/A.

The greatest yield increase per unit of row spacing occurred when the spacing decreased from 20 to 10 inch rows. Yields in narrow rows tended to be lower at 2 and 12 plants per foot of row. The average yield increase from 20 to 10 inch rows over 10, 8, 6 and 4 plants per foot of row was 11, 14, 23 and 16 bu/A for 1979, 1980, 1981 and the three-year average, respectively.

These values help explain the effect of the microenvironment on the yield of soybeans. Overall, the highest yielding treatment (80 bu/A) was 10 inch rows with 8 plants per foot of row or 418,000 plants per acre.

The soybeans near the apex of the plant are the largest soybeans on the determinate varieties. This is primarily because they are closest to the photosynthate reservoir. The soybeans located on lateral fruiting branches further down the stalk are generally smaller and fewer in number as row spacing decreases.

The large yield increase in going from 20 to 10 inch rows comes from the fact that the number of rows per unit area is twice as great in 10 inch rows. This essentially means that there are more beans per unit land area located near the apex of plants and thus closer to the photosynthate supply.

(continued on page 23)

Potash and Foliar Fungicides Team-Up to Increase Yields

IT'S WELL KNOWN that potash plays an important part in plant disease resistance. Results from two Tennessee studies strongly point out the need for potash in producing profitable soybean yields, plus added benefits when foliar fungicides are applied.

"There is a synergistic or add-on effect which increases soybean yields significantly," says Tom McCutchen, Superintendent of the University of Tennessee Milan Experiment Station. Two experiments conducted by Albert Chambers, University of Tennessee plant pathologist, show similar trends: **Potash alone or fungicide alone can boost soybean yields, but the combination of the two has given the most significant increases over several years.**

Here's a closer look at the two studies.

Figure 1 shows yield response for a trial initiated in 1976 on a Grenada silt loam soil. The soil was low in both potassium (K) and phosphorus (P) at the beginning of the study. Potash and phosphate application each year was based on University of Tennessee recommendations; pH was maintained near 6.5. Forrest soybean variety was planted in early May each year.

Foliar fungicides — Benlate 50W, Mertect 340-F, and Bravo 500 — were applied at early pod-set and two weeks later with a high clearance sprayer, using 20 gal/A total solution each year. Benlate 50W was applied in 1976-77-78 at 0.5 lb/A of material per application. Mertect 340-F was applied in 1979-80-81 at 8 fluid ounces per acre; Bravo 500 was applied in 1982 at 2 pints per acre.

Observations over the seven-year period indicated more *Septoria* brown spot and anthracnose in fungicide plots where no potash was applied than with the combination treatment. However, potash alone also reduced disease ratings. Annual incidence of disease ratings on 0 to 9 scale (with 9 being the most severe) generally averaged 8 to 9 in check (no fungicide and no potash) plots, 6 to 7 for potash alone, 4 to 5 for fungicide alone, and 3 to 4 for the combination.

The interaction or add-on effect on soybean yield is clear in **Figure 1. Potash alone increased yield 5 bu/A and fungicide alone 3 bu/A, while the combination boosted yield 9 bu/A.**

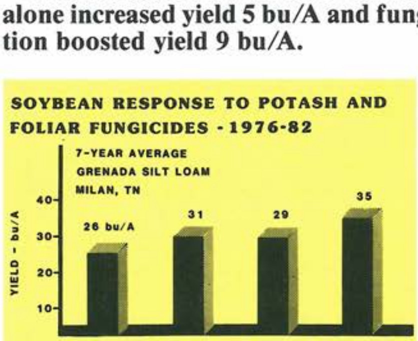

Figure 1

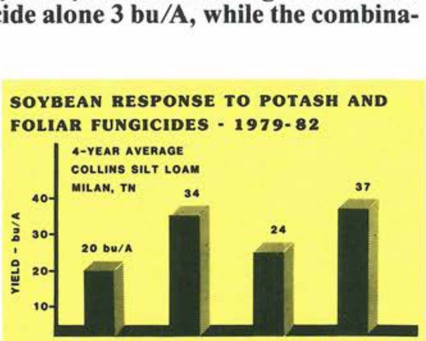

Figure 2

The second study began in 1979 on a Collins silt loam soil. Initial soil tests showed low K (60 lb/A) and high P (30 lb/A) soil tests. Annual applications of potash were 60 lb of K_2O/A each year until 1982, when 80 lb K_2O/A was applied. No phosphate was applied during the four years; soil pH was maintained at 6.0 to 6.5. Forrest variety was planted each year in early May.

Benlate 50W was applied in 1979-80-81 at the same time and rate as in the first study. Topsin M 70W fungicide was applied in 1982 at 0.5 lb/A of material per application.

Disease ratings followed the same general pattern, with *Septoria* brown spot and anthracnose the most prevalent. Frogeye disease was observed for the first time in 1982, and stem canker also appeared in late summer.

Each year there were visual deficiency symptoms where potash was not applied on the bottomland soil, but there was little or no stunting of plants.

Figure 2 shows the dramatic difference in yields over the four-year period. **There was a 14 bu/A increase for potash alone, while fungicide alone produced a 4 bu/A increase. But the two teamed-up to increase yield by 17 bu/A over the four years.**

Potash level where 60 lb K_2O/A was applied for three years increased slightly but remained low at 70 lb/A soil test. Where no K_2O was applied the level dropped to 50 lb/A.

Summing up, the Tennessee researchers say the interaction effect of potash and foliar fungicides helped achieve the highest yields and best disease control in these multi-year experiments. ■

(Soybean Row Width . . . from page 21)

These results indicate that row spacing is the critical factor and high yields are produced over a range of within row plant densities. In these cases, a plant population range of from 209 to over 418 thousand plants per acre produced the highest yields. The producer will want to use the lower half of this population range as he knows the probability of lodging due to adverse weather increases greatly at high plant populations. A lodged soybean canopy almost always reduces yield from 10 to 25 bu/A.

Let's examine the many factors relative to high yields in narrow row soybeans. The plus factors are:

1. Intercepts more radiation.
2. Reduced moisture evaporation.
3. Reduced stress on herbicide.
4. Equalizes root density over entire soil area.
5. Protects soil from dispersion by rainfall impact.
6. Reduces harvest losses as soybeans fruit higher.

The minus factors that could reduce yields include:

1. May complicate weed control problems.
2. Could induce lodging.
3. May use more water.

Narrow row soybeans, along with other good production practices, are the way to go for higher yields if nature provides a good crop production year. But narrow row soybeans do not necessarily ensure high yields.

If a hot, dry, droughty year such as 1980 occurs, yields will be low at all row spacings. The 1980 crop year proved that high soybean plant populations do not reduce yields during seasons of high moisture stress as the yields were the same (20 to 25 bu/A) in experiments for 40, 30, 20 and 10 inch rows respectively. This characteristic does not hold true for many other grain crops.

Before entering the narrow row soybean practice, a producer must either have fairly clean fields or know he can control weeds in narrow rows. ■

A Limiting Factor?

Sulfur and Crop Yields in the Eastern United States

By R.B. Reneau, Jr.

SULFUR (S) is normally considered a secondary nutrient even though plants require it in about the same quantities as phosphorus (P). In many instances, the philosophy used in S recommendations is comparable to that used for micronutrients.

There is reason, however, to believe that S may be more of a limiting factor today than in the past for several reasons:

- use of high-analysis, relatively S-free fertilizers and other soil amendments;
- the larger concentration of S removed from soils with higher crop yield;
- concern with atmospheric pollutants.

The need for S fertilization as indicated by research conducted during the past 40 years shows that the Eastern U.S. can be divided into two distinct zones with respect to S fertilization. The states south of Virginia have reported S deficiencies for cotton; red, black medic, crimson, white, and ladino clovers; bahiagrass; Coastal bermudagrass; tobacco; and corn. The fact that S research has received limited attention in the Southeastern U.S. during the past decade is surprising since crops respond to S application on many soils in this region.

The states north of Virginia have been considered to have adequate S inputs without specific recommendations for S application. Much of this S is from atmospheric sources. Current literature indicates (with the exception of a yield increase in the third year of an alfalfa experiment in Pennsylvania) no recent responses to S application for agronomic crops in this region.

Virginia served as a grey area between the relatively responsive Southeast and the relatively unresponsive Northeast, even though large areas of potentially S-deficient soils were present, until the mid to late 1970's when yield increases were observed for orchardgrass and corn.

In Virginia, 10 experiments conducted over a three-year period with corn in the Coastal Plain indicate conditions which favor yield increase: soils moderately well to well-drained; low in organic matter; fine loamy or coarse textured family of soils; acidic monocalcium phosphate extractable soil S concentrations of 6 lb S/A or less in the surface horizon.

This does not mean that subsurface S is not utilized by plants. But it reflects the distribution of extractable soil S present in the soils utilized for this study. Soils that had lower concentrations of S in the Ap (surface) horizon tended to have lower quantities of S in the subsurface horizon. The relationship between increase in yield with S application to soils containing various levels of extractable soil S is shown in **Figure 1.**

Dr. Reneau is an Agronomist at Virginia Polytechnic Institute and State University, Blacksburg, VA.

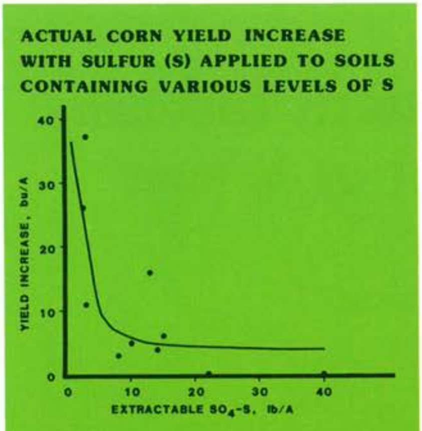

Figure 1

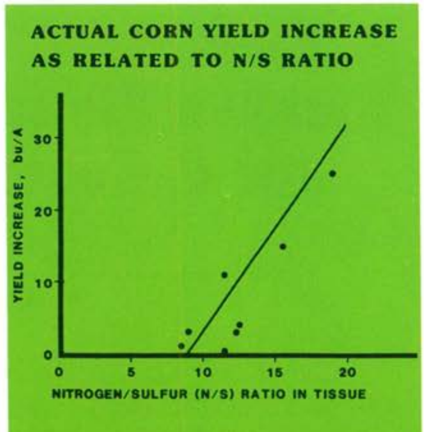

Figure 2

This figure shows increased yields with extractable soil S concentrations below 6 lb/A. With extractable soil S concentrations above 10 lb/A, only small increases in yields could be expected with added S. These data are in close agreement with S recommendations for corn on sandy Nebraska soils.

It appears that soil test can be used successfully for Coastal Plain soils, but the effectiveness could be increased by considering such factors as soil organic matter and texture, crop produced, and S inputs from atmospheric sources. This is an area that needs to be studied in more detail.

Tissue analyses from these experiments indicate that the critical concentration for total S and N/S ratio in the tissue are 0.18% and 15, based on relative yield (data not presented). Critical concentrations were identified in this case as a 10% reduction in growth. The relationship between increased yield and N/S ratio indicates that S additions can result in increased yield over a large range in N/S ratios **(Figure 2)**.

Yields tend to increase with higher N/S ratios with the largest increases present at N/S ratios above 15. In Virginia, yield increase for corn and orchardgrass in the Appalachian region and soybeans in the Coastal Plain have also been observed.

In Virginia, it appears that corn yield increases with S application can be expected throughout the state for certain soils.

Responses for soybeans have been measured, but not with the consistency or magnitude which responses for corn have been documented.

Sulfur deficiency in winter wheat in Virginia does not appear to be widespread and may be related to combustion of sulfurous fuels used for heating purposes during a large part of the wheat production period.

The shallower rooted forage crops will respond to S application on some Virginia soils, but it's unknown how extensive the response might be. ■

On the Lighter Side

Three elderly women were discussing their lives. One of them said, "I have this problem. Sometimes when I go to the refrigerator I can't remember whether I'm taking something out or putting it in."

"That's nothing," said another. "I find myself standing at the stairs wondering if I'm going up or if I've just come down."

The third woman said, "Well, I'm thankful I don't have any such problems," and she knocked on wood. "Oh, oh," she said, "there's someone at the door."

Residual Phosphorus Increases the P Content of Wheat

By D.W.L. Read

THE RESIDUAL EFFECT from large applications of phosphate fertilizer has been shown to increase the yield of wheat for eight years after application. The persistence of the residual effect depends on the amount applied and the rate of use by the plants. There is some evidence that there is a downward movement of residual P in the soil by "bio-cycling," which is movement down through the plant.

There may also be chemical migration through the soil, especially when heavy rates of P are used. What effect does residual fertilizer phosphorus have on P content, or the percent P in the plant or grain?

Results from several studies show that the residual P is more effective in increasing the P content of the grain than P from "with-seed" applications.

A study at two locations in southwestern Saskatchewan consisted of single applications of 0, 205, 410 and 820 lb P_2O_5/A as residual applications and with-seed applications of from 0 to 102 lb P_2O_5/A applied over the original treatments.

The with-seed applications were never applied more than once to any location in the study. The P content of the wheat kernels from the different treatments (averaged over the 8 years of the test) shows that the residual P gave greater increases than even the 102 lb P_2O_5/A rate applied with the seed **(Table 1).** The benefit from the residual P on the P content of the grain persisted through to the eighth year after application.

Table 1. Percent phosphorus content in wheat kernels (8-year average).

Location	With-seed application lb P_2O_5/A	Residual application, lb P_2O_5/A				Mean
		0	205	410	820	
Swift Current	0	0.314%	0.349%	0.376%	0.402%	0.361%
Swift Current	20.5	.318	.360	.379	.413	.368
Swift Current	41.0	.323	.365	.384	.404	.369
Swift Current	102.0	.346	.374	.394	.411	.381
Mean		**.321**	**.362**	**.383**	**.408**	—
Cabri	0	.311	.322	.343	.366	.336
Cabri	20.5	.301	.324	.345	.362	.333
Cabri	41.0	.292	.324	.347	.355	.330
Cabri	102.0	.301	.330	.349	.368	.337
Mean		**.301**	**.325**	**.346**	**.363**	—

Mr. Read recently retired from the Research Branch, Agriculture Canada, Swift Current, Saskatchewan.

Another study conducted near Saskatoon, which compared residual treatments and repeated annual with-seed applications, shows similar results. This test has been conducted for three years with the annual seed-placed treatment receiving the indicated application each year with no residual treatment. The residual treatments received no seed-placed treatment; other plots received a combination of the seed-placed and residual treatments.

The results from this study in which wheat was the test crop indicate that there was a greater increase in the percent P in the grain from residual P than from seed-placed P **(Table 2).** A combination of seed-placed and residual application gave a higher percent P than any of the with-seed applications. There was some increase in the percent P in the plant tissue with increased P application but the increase was not as consistent as that in the grain.

Table 2. Percent phosphorus in wheat kernels grown on different fertilizer treatments.

Residual application lb P_2O_5/A	Seed placed application lb P_2O_5/A	Percent P in grain		
		1979	1980	1981
0	0	0.280%	0.270%	0.270%
82	0	.320	.290	.320
164	0	.320	.290	.340
328	0	.330	.310	.360
656	0	.370	.340	.440
0	10	.290	.260	.310
0	20.5	.290	.280	.290
0	41	.280	.270	.320
0	82	.290	.290	.360
164	41	.330	.310	.380

The same trends are shown in a study on spring wheat grown in a fallow-wheat rotation at Sidney, Montana. Here the residual P increased the P content of the grain and the effect was still present in the sixth crop.

How important is this increase in P content of the grain? The P content of the wheat samples received at the Saskatchewan Feed Testing Laboratory for the 1974 to 1978 period ranged from 0.23 to 0.47%, with the average being 0.34%.

For samples received from 1979 until May 1982 the average P content was 0.35% but the range was only from 0.32 to 0.38%. This average value is just about the minimum requirement for adequate animal nutrition, depending on the type of animal fed.

In all three studies the residual P increased the P content above the minimum requirement for animal feeding. However, the availability of the P in the grain to the animal is unknown. Is the portion of the P in the grain that came from the residual fertilizer equal, or more useful in animal nutrition than the P that is found in unfertilized grain?

Also of interest is the possible influence of high P concentration in grain on seed quality. Will high P concentration in seed increase vigor and growth of seedlings and compensate for stress conditions?

Research has shown some of the benefits that can come from residual P. More research is needed before we fully understand all the aspects of residual P, such as its effect on yield and P content, and movement of P through the soil by biocycling and chemical migration. More must also be learned about how long the effects of residual P last.■

Fertilizing Subclover-Grass Pastures

By Milton B. Jones

THE ANNUAL GRASSLANDS of California are characterized by low production during the winter months, rapid spring growth, and low forage quality during the dry summer and fall. These grasslands are very deficient in nitrogen (N) and are often deficient in phosphorus (P) and sulfur (S). Responses to potassium (K), molybdenum (Mo), and calcium (Ca) have been reported, but are not so widespread.

Nitrogen

Responses to N are striking when other nutrients are adequate, but in areas receiving more than 30 inches rainfall, leaching losses of fertilizer N make it very inefficient. These high rainfall zones are well adapted to subclover, which maintains a higher level of forage protein for the dry season than does N fertilized grass **(Table 1).**

There are several requirements for subclover to be highly productive:

- sow varieties adapted to the area
- inoculate with high counts of effective rhizobia
- supply adequate levels of P and S
- graze to control grass competition.

Phosphorus

The amount of P to be applied depends upon the previous history of the field and the availability of soil P. Availability can be determined by soil test. The $Bray_1$ test has a good relationship to pasture P uptake. The $NaHCO_3$ extractable P is also widely used.

Based on this and other data, phosphorus fertilization recommendations for one year's production can be made as follows:

If Bray 1 soil test P reads	Or, $NaHCO_3$ soil test P reads	P_2O_5 Needed to obtain 90% of maximum yields
---ppm---	---ppm---	---lb/A---
0 to 10	0 to 10	100
10 to 20	10 to 16	50
20 to 30	16 to 22	25
over 30	over 22	0

Table 1. Botanical composition, yield, and protein level of a grazed California pasture as affected by subclover and N fertilization. P and S applied to all treatments.

N applied	Botanical Composition*				Yield**	Protein*
	Hardingrass	Annual grasses	Native legumes	Subclover		
lb/A	--------	--------	--------	--------	lb/A	%
0	50	9	2	39	7,500	15
0	61	22	17	—	2,400	12
40	48	36	16	—	4,200	11
80	53	39	8	—	5,200	9
160	68	32	0	—	5,800	8

*Botanical composition and protein percentages at the third and final sampling in May when the pasture was mature.

**Cumulative forage production for three sampling dates.

Dr. Jones is with the Department of Agronomy and Range Science, University of California, Hopland Field Station.

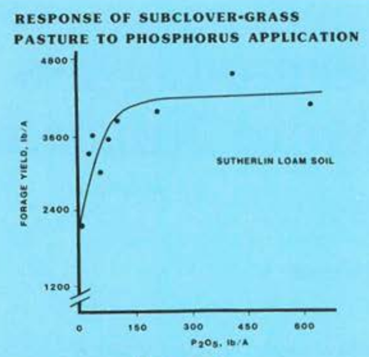

Figure 1

An example of a P response on a Sutherlin soil type (Bray 1 = 17 ppm) is shown in **Figure 1.** This field also received a uniform application of 80 lb/A of elemental S.

Phosphorus usually gives a long term residual effect as shown in **Figure 2** on a Josephine soil (Bray 1 = 2 ppm).

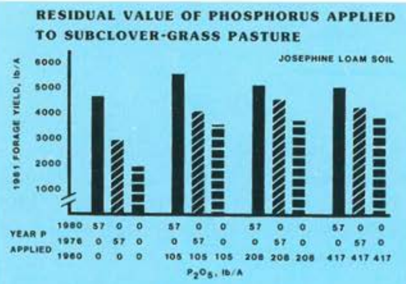

Figure 2

Where P was applied to a subclover stand in October 1960, yields in 1981 were increased for the 20th straight year after application, although total yields are now less than their maximum potential. As we would expect, the higher rates of fertilization gave the most residual benefit. A fresh application of P in October 1980 increased production over all the previous 1960 treatments. The five year residual P is also shown where P was applied in 1976. Yields were increased over the 1960 treatments, but were not as high as those when P was applied immediately prior to the growing season. These data suggest that even following a large build-up rate of P fertilization, annual or biannual fertilization is required to realize the growth potential of clover-grass mixtures under these conditions.

Sulfur

The sulfur requirements for subclover pastures can be met by using single superphosphate which usually contains 12% S as gypsum. This form of S is highly leachable, and in high rainfall areas (over 30 inches) elemental S is often recommended. Elemental S must be oxidized to sulfate before plants can utilize it. The rate of oxidation depends on soil bacteria, soil moisture and temperature, and particle size of the sulfur. A comparison of gypsum S and finely ground elemental S (finer than 300 mesh) is given in **Figure 3,** and the residual value of each in **Figure 4.**

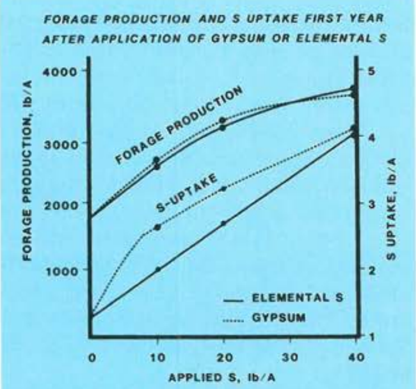

Figure 3

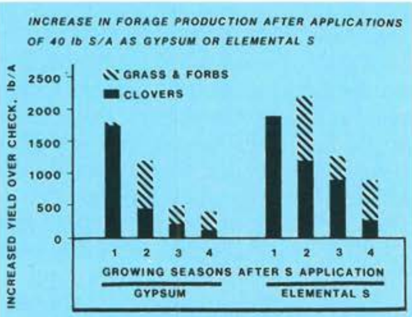

Figure 4

Commercial S usually has a range of particle sizes and is applied

(continued on page 31)

Higher Yielding Bermudagrass Varieties Require More Nutrients

By Marcus M. Eichhorn, Jr.

IMPROVED VARIETIES of bermudagrass are especially well adapted for pasture and hay production on Coastal Plain soils. Will the new cultivars of this warm season perennial grass require adjustments in management?

A three-year performance trial was conducted at the North Louisiana Hill Farm Experiment Station to determine fertilizer requirements of both released and promising bermudagrass cultivars. The study was on Typic Fragiudult fine sandy loam soil, with pH 6.4. Tests indicated that phosphorus (P) and potassium (K) were both low.

The trial included 21 cultivars which originated from the plant breeding programs at Oklahoma State University and Georgia Coastal Plain Experiment Station, and three cultivar selections from the Hill Farm Experiment Station. All 24 cultivars were planted in 1974.

We followed a recommended hay fertilization and management program for three years. Fertilization consisted of 100 lb N/A applied annually on April 1 and after each cutting except the final cut. Phosphate was applied at 150 lb/A on April 1. Potash was applied at 150 lb/A on April 1 and after the second cutting. Five cuttings were made annually when forage was in flag-leaf stage of development. Total fertilizer rate applied annually was 500-150-300 lb/A of N-P_2O_5-K_2O.

Yield performance of the 24 bermudagrass cultivars was not limited by unfavorable environmental conditions. **Figure 1** shows that mean forage yields ranged from 7.4 to 10.7 tons/A.

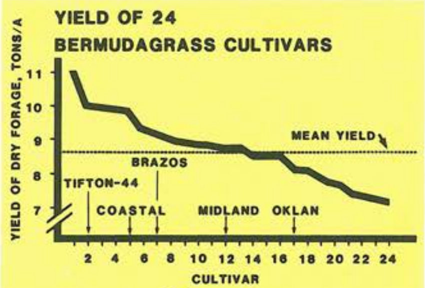

Figure 1

Mean forage yield of all cultivars was 8.7 tons/A. Yield differences among cultivars were highly significant. **The higher yielding cultivars took up and used more NPK.**

Uptake

Mean N uptake by cultivar ranged from 306 to 417 lb/A **(Figure 2).** Mean

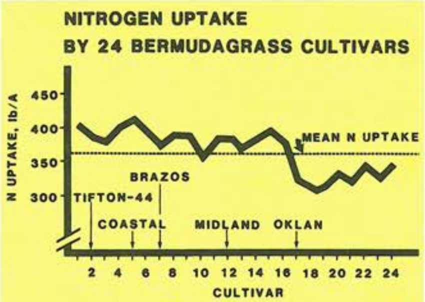

Figure 2

Dr. Eichhorn is an agronomist at the North Louisiana Hill Farm Experiment Station, Homer 71040, Louisiana Agricultural Experiment Station, LSU Agricultural Center.

N uptake for all cultivars averaged 361 lb/A, or 72.2% of the annually applied 500 lb/A of N. Three recently released varieties removed these percentages of annually applied N: Tifton-44, 75.6%; Brazos, 73.7%; and Oklan, 65.8%.

Mean P_2O_5 uptake by cultivar ranged from 78 to 112 lb/A **(Figure 3)**.

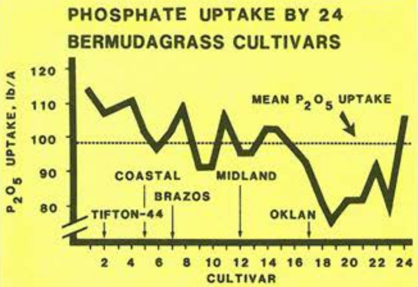

Figure 3

The P_2O_5 uptake by all cultivars averaged 99 lb/A – an amount equivalent to 66.3% of annually applied P_2O_5. Pecentages for the three new varieties were: Tifton-44, 68.7%; Brazos, 68.7%; and Oklan, 65.6%.

Mean K_2O uptake by cultivar ranged from 375 to 531 lb/A **(Figure 4). The K_2O uptake for all cultivars averaged 452 lb/A or 152 lb/A higher than the 300 lb/A of K_2O applied annually as fertilizer.** Uptake of K_2O by the new varieties was: Tifton-44, 513 lb/A; Brazos, 473 lb/A; and Oklan, 462 lb/A.

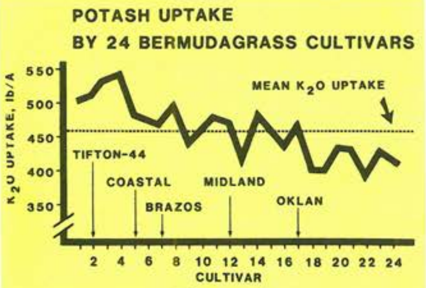

Figure 4

Summary

Results of this study strongly suggested that bermudagrass varieties grown for hay require **500 lb/A of N** in split applications of 100 lb/A per cutting; **150 lb/A of P_2O_5** applied six to eight weeks prior to the first cutting; and **500 lb/A of K_2O** in split applications of 250 lb/A, six to eight weeks prior to the first cutting and after the second cutting. **Under favorable environmental conditions, bermudagrass varieties can be expected to produce approximately 8 to 12 tons/A of hay from five cuttings.** ■

(Subclover . . . from page 29)

at 80 to 100 lb/A. It is expected to last for two or three years.

Soil tests for S are not very reliable for California grasslands. Plant analysis for total S or sulfate S can be useful if representative clover leaves are sampled during the spring period of rapid growth before wilting occurs. Subclover leaves should have at least 0.2% S or 200 ppm sulfate S to ensure adequate S for near maximum production. This assumes that other factors are not limiting.

Only a little work on potassium has been done on California grasslands; however, soil test recommendations for subclover pasture in Oregon appear to fit California conditions. If exchangeable K values range from 0 to 75 ppm, 60 to 100 lb/A of K_2O is recommended; if soil tests range from 75 to 150 ppm, 40 to 60 lb/A of K_2O is suggested. Where values are over 150 ppm exchangeable K, no K fertilizer should be applied.

There are some grassland soils of California derived from serpentine that are high in Mg and low in Ca that respond to Ca as a nutrient. Calcium response is expected when exchangeable Ca is less than 4.0 meq/100 g soil. The serpentine soils are also generally deficient in N, P, K, S, and Mo.

Our research results clearly show that the production potential and forage quality of California grasslands in the over 25-inch rainfall areas can be greatly increased by seeding subclover and fertilizing with P, S, and other nutrients as needed for proper plant nutrition. ■

Be A Winner

THE BIBLE says "God loves a cheerful giver." But nowhere does it say "God loves a cheerful loser." I have my reservations about a person who is a "good loser." He'll lie about other things, too.

Those who have the responsibility of feeding a hungry world cannot be expected to be "good losers." This applies to all phases of that wonderful profession we call "Agriculture." It includes the scientific probings of the researcher, the challenges that face the teacher in the classroom and the extension worker in the field, the ingenuity and energy of the salesman, and it certainly includes the wide variety of duties that confront our farmers. The world just cannot afford for them to be "losers."

Agriculture is a rather unique profession in that it is genuinely enjoyed by practically all who are fortunate enough to be a part of it. But it must be a "winner" – and that calls for knowledge, it calls for dedication, and it demands optimism.

To be a winner means producing at a yield level that can provide profits. Some call this MAXIMUM ECONOMIC YIELD. The scientific facts don't guarantee that you will always win. But they do say that your chances of success are much greater.

So – if you want to be a winner, tackle the task with know-how, with energy, and, above all, with optimism. It just might pay off.

– Dr. J.Fielding Reed

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