set among limbs in the same treatment in 1973 and the strong biennial tendency of 'Early McIntosh' (5). As a result, only the combination of 200 ppm ethephon and SADH, among the treatments applied 30 days after FB, induced greater bloom in 1974 (Table 3).

June drop was complete 44 days after FB and the ethephon and SADH treatments appeared to have no effect on fruit abscission and fruit size (Table 3). Contrary to our findings with 'Mutsu' (Table 2), SADH alone or in combination with ethephon at either timing caused no fruit flattening. The spray combinations of ethephon and SADH did enhance flower-but formation.

Under Washington conditions, June drop was probably completed 5 weeks after bloom when ethephon caused no thinning, but not by 4 weeks after bloom when thinning occurred following an application of this growth regulator (8). Therefore, it may be possible to avoid thinning from ethephon by waiting until the completion of June drop and still induce flower-bud initiation with spray treatments of ethephon and SADH. Williams (9) suggested this possibility and the data in Table 3 support his theory. However, further trials are necessary before the usefulness of ethephon and SADH sprays for flower-bud initiation on bearing apple trees can be fully determined.

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Nitrogen, Phosphorus, and Potassium Fertilization of Southernpeas for One-time Harvest on a Sandy Soil[1]

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Abstract. Different rates of N, P, and K on southernpea *Vigna unguiculata* (L.) Walp. grown for one-time harvest during 4 years in field experiments on Alaga sand (Typic Quartzipsamments) soil showed that N had the greatest effect on yield of mature green southernpeas. Pea yields increased to a maximum of 67 kg/ha of N. Soil test P ranged from high to extremely high in the untreated soil; therefore, fertilizer P did not affect yield. Yields were increased by K only in the location-year in which soil-test K was low. At 35 days there was an increase in leaf N concentration as the rates of N were increased from 34 to 101 kg/ha; at 49 days the N concentration was lower and was not affected by N rates. Increasing fertilizer rates of K increased leaf concentration of K at both 35 and 49 days. Fertilizer P did not affect N, P, or K concentration.

The southernpea is adapted to a wide range of soils and is mechanically harvested in the mature green stage. Since the development of mechanical harvesters, plantings in AL have increased.

Earlier research reported variable responses of southernpeas to applications N, P, and K. Duggar (2), Stewart and Reed (8), Halsey (3), and Worley et al. (10) reported increased yields from N applications. Hammett (4) obtained an increase from N with plant spacing of 30.5 cm in row but none at closer spacing. Paterson (5) reported an increase in yield from N at first harvest, but not for the total harvest. Stewart (7) did not obtain a yield increase from N. Most yield increases were obtained from applications of 34 to 47 kg N/ha. As early as 1902 Duggar (2) obtained a yield response from applied P on land in Alabama not liberally fertilized previously. He obtained no response to application of P and K on land that had previously been liberally fertilized. On land testing high in P, Campbell et al. (1) and Worley et al. (10) obtained an increase in yield from P application, but Stewart (7) did not. Stewart and Reed (8) and Paterson (5) obtained response to applications of P when soil test P was low. They did not obtain a response from application of K on soil testing high or medium in K.

Our objectives were to determine effects of rates of N, P, and K on yield of southernpeas for a one-time harvest and on levels of nutrients in leaf tissue at different stages of growth and in the harvested peas grown on an Alaga sand (Typic Quartzipsamments) soil.

Materials and Methods

This experiment was conducted 4 years (1969-1971) at the Main Station at Auburn on Alaga sand, a sandy soil in which certain plant nutrients are subject to leaching during periods of heavy rainfall. The test was conducted on a different area in the field each year. Soil was sampled each year before planting and analyzed by the Auburn University Soil Testing Laboratory (Table 1).

Fertilizer treatments consisted of 4 rates of N, and 5 rates of P and K, applied in a randomized complete block design with 4 replications (Table 2). All fertilizer was broadcast and incorporated before planting the crop. In 1969 and 1970, 2.24 millier per ha (1 ton/a) of dolomitic limestone was applied before planting. Trifluralin at the rate of 0.56 kg/ha for weed control was incorporated with the fertilizer.

'Pinkeye Purple Hull' was planted in rows 61 cm apart at the rate of

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50 to 55 kg of seed per ha on June 14, 1968, May 27, 1969, April 20, 1970, and May 12, 1971. In 1968 and 1969 the crop was harvested 56 and 55 days after planting and in 1970 and 1971, with earlier planting dates, the crop was harvested 77 days after planting. Plots were 3 rows wide and 36.6 dm long. The middle row was harvested for records. One-time harvest was made when some of the pods began to dry and records were obtained on yield in the pod, percent of dry pods, percent shell-out, and dry wt of shelled peas. The shelled peas were analyzed for N, P, K, Ca, and Mg content. Plant samples of recent mature leaves plus petioles were analyzed for nutrient content at 2 stages of growth (average of 35 and 49 days after planting) in 3 years of the test. Nitrogen was determined by the semi-micro-Kjeldahl procedure. For other elements, samples were dry ashed; P was determined colorimetrically and K, Ca, and Mg by atomic absorption spectrophotometry. Sprinkle irrigation was used as needed to supplement natural rainfall.

Results and Discussion

Yields. Average yields for the 4 years showed a high response to fertilizer N (Table 2). Yields were increased as the rate of N was increased to 67 kg/ha. A further increase to 101 kg of N with constant P and K resulted in a decrease in yield. The high rate of N caused a greater vine growth and delayed maturity; therefore, more immature pods or snaps were on plants at harvest than on those grown with lower rates of N.

There was no significant increase in yield from the addition of fertilizer P. A yield increase from fertilizer P was not expected since the soil-test P ranged from "high" to "extremely high." This data adds confidence to the Auburn University soil test rating system in which soils testing "high" in an element are not expected to respond to application of that element. Stewart (7) also found no response to applied P in a soil which tested high in P.

Only in 1971 was there a significant increase in yield from the addition of K fertilizer. In 1971 there was a trend for yield increase with rate of K and a significant increase over the control from the addition of 149 kg of K/ha. The over-all average showed that 112 kg of K/ha increased yields over no K treatment, but was not significantly different from yields produced from 37 and 74 kg of K/ha. A benefit from K fertilizer was expected in 1971 since the soil test values indicated a K level of "low". In the 3 years when the soil test K was medium (67–134 kg K/ha), no response was obtained. Our results agree with those of Stewart and Reed (8) and Paterson (6).

Yields were low in 1971 compared to yields for the other 3 years. The reason is uncertain; however, there was a higher than normal amount of rainfall early in the season and excessive leaching of N and K may have occurred. During that year a severe K deficiency appeared in leaves of plants in the no K plots with some deficiency symptom at the 37 kg rate. This deficiency symptom was not present in plants the other 3 years. Split application of fertilizer should be used to prevent deficiency in heavy rainfall seasons. Ware and Johnson (9) showed that during periods of high rainfall in the early growth period of vegetable crops it was necessary to split the application of fertilizer to increase the yield on this soil type. If the rainfall was heavy in both early and late growing periods the yields were low even with split applications. The southernpea, a legume, usually does not require high amounts of fertilizer N for good production, but when grown on a sandy soil low in organic matter such as Alaga sand the young plants need added N for early plant growth until nodules form on the roots to fix and supply N.

Dry pods, shellout, and dry wt peas. Although differences were small, there was a consistent decrease in percent of dry pods, shellout, and percent dry wt of peas as N rates were increased. There was a general trend for the percent of dry pods to decrease as rates of K increased. This indicates that both N and K fertilizer delayed maturity. The rates of P had no effect on percent dry pods, shellout, or dry wt at harvest.

Harvest was made at the time of greatest concentration of mature peas which means that there were some dry pods. The crops in 1968 and 1969 had the latest planting dates (June 14 and May 27) and were harvested 56 and 55 days after planting. Therefore, there was a good concentration of mature peas with a low percentage of dry pods (a range of 4.5 and 9.7 percent) for these 2 years. In 1970 and 1971 peas were planted earlier (April 20 and May 12) and harvested 77 days after planting. Dry pods at harvest for these 2 years ranged from 28.4 to 36.3 percent with the higher percent from the low N rate. Sistrunk et al. (6) found that maximum yield of shelled peas of 2 cultivars was found to be at 20 to 30 percent dry pods. They also found that large differences between maturity levels of fresh peas were reduced during processing.

Chemical content of leaves and shelled peas. The leaf concentrations of N, P, K, and Mg were higher at 35 days than at 49 days, but Ca concentration was higher at 49 days (Table 3). At 35 days there was an increase in concentration of N as the rates of N were increased, but at 49 days the N concentration in leaves was not consistently affected by rates of N. Rates of N, P, and K had no effect on P concentration. There was an increase in leaf concentration of K as rates of fertilizer K were increased at both 35 and 49 days. At 49 days there was a decrease in K content as rate of N was increased from none to 34 kg. Fertilizer N increased and fertilizer K decreased Mg concentration in the leaves.

Application of N, P, or K rates had little to no effect on the concentration of N, P, K, Ca, or Mg in shelled peas (Table 4). The highest rate of N increased the N concentration over lower rates and N fertilizer decreased K slightly. The first increment of K fertilizer increased K in peas. The needs of the seed may be genetically specific and the amounts needed are provided through translocation unless there is a severe deficiency. Concentration of N and P were higher in shelled peas than in leaves while the concentrations of K, Ca, and Mg were lower.

Potassium effect on leaf spot diseases. Plants were sprayed at

Table 1. Soil test values for different areas planted to southernpeas.

Field areas and year	pH	Soil content per ha			
		P	K	Ca	Mg
		Kg	Kg	Kg	Kg
1—1968	6.2	157 (VH)[y]	95 (M)	582 (H)	109 (H)
2—1969	5.5[z]	420 (EH)	90 (M)	197 (M)	27 (L)
3—1970	5.5[z]	90 (H)	84 (M)	412 (H)	60 (H)
4—1971	7.1	112 (VH)	52 (L)	—	87 (H)

[z] Dolomitic limestone applied at the rate of 2.24 millier/ha (1 ton/a).
[y] Fertility levels: low (L), medium (M), high (H), very high (VH), and extremely high (EH).

Table 2. Yields of in-shell southernpeas from different rates of N, P, and K.

Fertilizer kg/ha			Total yields of in-shell peas (kg/ha)				
N	P	K	1968 Area 1	1969 Area 2	1970 Area 3	1971 Area 4	Av
Rates of N							
0	39	74	5,154b[z]	3,872c	4,967a	1,936ab	3,983d
34	39	74	5,570ab	5,842ab	5,136a	2,223ab	4,693bc
67	39	74	6,311a	6,362a	5,531a	2,257ab	5,115a
101	38	74	5,747ab	5,236b	4,842a	2,332ab	4,539bc
Rates of P							
34	0	74	5,137b	5,824ab	4,993a	2,660ab	4,554bc
34	20	74	5,684ab	5,996ab	5,122a	2,417ab	4,805ab
34	39	74	5,570ab	5,842ab	5,136a	2,223ab	4,693bc
34	59	74	5,477b	6,159ab	5,484a	2,570a	4,922ab
34	78	74	5,910ab	6,082ab	5,283a	2,306ab	4,896ab
Rates of K							
34	39	0	5,279b	5,490ab	4,827a	1,789b	4,347c
34	39	37	5,594ab	5,893ab	5,078a	2,120ab	4,672bc
34	39	74	5,570ab	5,842ab	5,136a	2,223ab	4,693bc
34	39	112	5,746ab	6,212ab	5,495a	2,264ab	4,929ab
34	39	149	5,516b	5,480ab	5,419a	2,505a	4,730abc

[z] Means, within columns, separated by Duncan's multiple range test at the 5% level.

Table 3. Effects of rates of N, P, and K on levels of N, P, K, Ca, and Mg in leaves of southernpea.

Fertilizer, kg/ha			Percent concentration in leaves on dry basis taken at an average number of days after planting (Average for 1968, 1970, 1971)									
			N		P		K		Ca		Mg	
N	P	K	35	49	35	49	35	49	35	49	35	49
Rates of N												
0	39	74	4.41d	3.84a[z]	.57a	47a	2.94c	2.51ab	2.34a	3.21a	.59g	.39cde
34	39	74	4.52cd	3.60cd	.58a	.49a	2.79c	2.31cd	2.66a	3.39a	.68cd	.42bc
67	39	74	4.79b	3.61bcd	.58a	.49a	2.88c	2.25d	2.51a	3.30a	.67cde	.43b
101	39	74	5.12a	3.81ab	.58a	.49a	2.86c	2.21d	2.56a	3.38a	.73b	.50a
Rates of P												
34	0	74	4.68bc	3.48d	.56a	.47a	2.84c	2.23d	2.33a	3.19a	.65cdef	.41bcd
34	20	74	4.69bc	3.62bcd	.58a	.48a	3.00bc	2.30d	2.35a	3.15a	.65cdef	.41bcd
34	39	74	4.52cd	3.60cd	.58a	.49a	2.79c	2.31cd	2.66a	3.39a	.68cd	.42bc
34	59	74	4.56bcd	3.59cd	.57a	.49a	2.89c	2.18d	2.48a	3.47a	.64cdef	.44b
34	78	74	4.61bcd	3.75abc	.58a	.52a	3.02bc	2.26d	2.55a	3.40a	.63defg	.42bc
Rates of K												
34	39	0	4.79b	3.61bcd	.58a	.53a	1.92d	1.63e	2.60a	3.41a	.78a	.53a
34	39	37	4.68bc	3.53d	.57a	.53a	2.48d	1.99e	2.54a	3.36a	.69bc	.44b
34	39	74	4.52cd	3.60cd	.58a	.49a	2.79c	2.31cd	2.66a	3.39a	.68cd	.42bc
34	39	112	4.67bc	3.60cd	.56a	.48a	3.27ab	2.49abc	2.40a	3.25a	.62efg	.38de
34	39	149	4.66bc	3.51d	.56a	.50a	3.43a	2.54a	2.46a	3.15a	.60fg	.37e

[z] Means, within columns, separated by Duncan's multiple range test at the 5% level.

Table 4. Effects of N, P, and K on levels of N, P, K, Ca, and Mg in southernpeas.

Fertilizer, kg/ha			Percent concentration in shelled peas on dry basis (4-year average)				
N	P	K	N	P	K	Ca	Mg
Rates of N							
0	39	74	4.03bc[z]	.65a	1.51a	.13a	.21a
34	39	74	3.99bc	.64a	1.47abc	.13a	.21a
67	39	74	4.08b	.64a	1.44bc	.12a	.22a
101	39	74	4.18a	.65a	1.44bc	.13a	.20a
Rates of P							
34	0	74	4.00bc	.62a	1.43bcd	.12a	.21a
34	20	74	3.97c	.62a	1.43bcd	.12a	.21a
34	39	74	3.99bc	.64a	1.44bc	.13a	.21a
34	59	74	4.01bc	.63a	1.42cd	.13a	.20a
34	78	74	3.98bc	.65a	1.43bcd	.13a	.21a
Rates of K							
34	39	0	4.01bc	.64a	1.39d	.12a	.20a
34	39	37	4.06bc	.64a	1.44bc	.12a	.20a
34	39	74	3.99bc	.64a	1.44bc	.13a	.21a
34	39	112	4.00bc	.65a	1.45bc	.12a	.20a
34	39	149	4.04bc	.65a	1.48ab	.13a	.21a

[z] Means, within columns, separated by Duncan's multiple range test at the 5% level.

weekly intervals for leaf spot diseases and for insect control. In 1968 and 1969 leaf spot diseases were noticeable in the no K plots. Without fertilizer K the rating for leaf spot was 5.4 from no fertilizer K as compared to 1.9 and 1.3, respectively, from addition of 37 and 149 kg of K/ha on a rating scale of 1-none to 10-severe disease on all plants. The least amount of leaf spot diseases was found in plots with 101 kg of N plus 74 kg/ha of K, which also had the most vigorously growing plants.

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