



August 3, 1970

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I am submitting herewith a dissertation written by Jonas Patterson Shugars entitled "The Influence of Soil Levels of Nitrogen, Phosphorus and Potassium and Methods of Application on the Growth, Quality and Nutrient Composition of Snap Beans, Phaseolus vulgaris L." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Plant and Soil Science.

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THE INFLUENCE OF SOIL LEVELS OF NITROGEN, PHOSPHORUS AND POTASSIUM
AND METHODS OF APPLICATION ON THE GROWTH, QUALITY AND NUTRIENT
COMPOSITION OF SNAP BEANS, PHASEOLUS VULGARIS L.

A Dissertation
Presented to
the Graduate Council of
The University of Tennessee

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

by
Jonas Patterson Shugars

August 1970

ACKNOWLEDGMENT

With great indebtedness, the author wishes to acknowledge the direction and assistance of the following persons:

Dr. H. D. Swingle, Major Professor, under whose guidance and supervision this research was conducted and the dissertation written.

Dr. B. S. Pickett, Head of the Horticulture Department, for serving on the graduate committee, for counsel and guidance during the entire course of graduate study, and for reviewing the manuscript.

Dr. D. L. Coffey, for serving on the graduate committee, for assistance in the laboratory determinations and statistical analysis during the research period, and for reviewing the manuscript.

Dr. G. E. Hunt, for serving on the graduate committee and for reviewing the manuscript.

Mr. C. W. Marr, for his assistance in the laboratory determinations and statistical analysis during the research period.

Miss Lynda Cole, secretary of the Berea College Agricultural Department, for typing the rough drafts of this manuscript.

Sue, Nancy and Peggy Shugars for their encouragement during the entire period of graduate study.

ABSTRACT

The response of snap beans to high soil levels of nitrogen, phosphorus and potassium, applied by different methods, was evaluated. The factors evaluated were: plant stand, nutrient content of the plants at two weeks after germination and at harvest, yields, pod sieve size distribution, percentage seed, pod color, pod length, pod fiber and nutrient content.

A standard band treatment of 40 pounds of N, 80 pounds of P_2O_5 and 40 pounds of K_2O per acre respectively served as the control. Other treatments generally included multiples of three and six times the standard amount of fertilizer. These other treatments were applied by broadcast and incorporation over the entire plot area and by similar methods with fertilizer omitted from a six inch area where seeds were to be drilled. Supplemental narrow bands of small amounts of N and P_2O_5 were also superimposed on two of the treatments with omitted fertilizer areas.

As fertilizer amounts increased plant stand decreased; however, method of application altered the rate of decrease.

The yield and nutrient content of snap bean plants were generally not significantly higher when amounts of fertilization exceeded 120 pounds of N, 480 pounds of P_2O_5 and 120 pounds of K_2O per acre respectively.

The P and K content of plants at harvest time, resulting from the standard band treatment, indicated these elements may be limiting

the growth and development of the plants at this level and method of fertilization.

The percentage seed, pod length, pod color, pod fiber content and pod sieve size distribution were not generally significantly different due to treatment.



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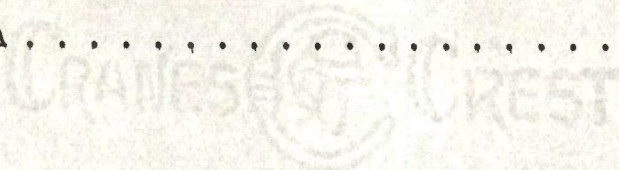
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CHAPTER I

INTRODUCTION

The snap bean, Phaseolus vulgaris L., is one of the most extensively grown vegetable crops in the United States both commercially and in home gardens.

The value of snap beans produced for both fresh market and processing in the United States in 1969 was 99,220,000 dollars. Fresh market and processing growers in Tennessee in 1969 harvested 11,200 acres of snap beans with a value of 2,745,000 dollars (53).

It is generally recognized as desirable for most vegetable crops to obtain a rapid and vigorous start, thus enabling the plant to produce sufficient leaf area as a photosynthetic base for continued growth. To obtain this and to sustain continued growth the nutrient requirements of the plant must be readily available in the soil in sufficient quantities.

Snap beans require a relatively short period of time to reach maturity, usually about 55 to 60 days. A crop of snap beans will require nutrients at a much faster rate than crops which mature over a longer period of time.

The response of snap beans to fertilization is variable and frequently does not result in improved growth of the plant or quality of the pods. The poor response of snap beans to fertilization may, in many instances, be related to soil and climatic factors that alter the potential of fertilizers to supply nutrients to plants.

There is a general trend toward higher levels of fertilization for higher yields of vegetable crops. Generally as the amount of fertilizer applied to snap beans is increased, unfavorable effects are encountered. The unfavorable effects are frequently related to changes in soil pH, increased soluble salt levels, and toxicity of elements.

Band applications and other fertilizer placement methods which avoid contact with the germinating snap bean seeds may permit the application and more effective use of higher than commonly applied amounts of fertilizers.

These studies were initiated to evaluate the response of snap beans to different methods of placement of higher than commonly used amounts of nitrogen, phosphorus and potassium.

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CHAPTER II

LITERATURE REVIEW

I. GENERAL ASPECTS OF VEGETABLE CROP NUTRITION

The problems of mineral nutrition in horticultural crops are concerned with deficiencies, excesses and interactions of nutrients as they relate to vegetative growth, flowering, fruiting and quality of produce (57).

A plant nutrient deficiency can be defined in relation to yield as follows: a plant is deficient in a certain element if supplying that element in a suitable form causes an increase in yield, this effect being specific for the element in question (17).

An excess of an element may also be defined in terms of yield, i.e., when an element either produces no further increase in yield or leads to a decrease (57).

Interactions between plant nutrients occur both in the soil, affecting absorption by the roots, and within the plant affecting their translocation and function (17).

The ultimate measure of the effectiveness of a critical level for a given nutrient in plants may be measured in terms of a major quality factor such as size, color, shape, firmness and appearance. With most vegetable crops a compromise between maximum yield and acceptable quality seems necessary (24).

II. SOIL EFFECTS

The potential fertility of a soil is partly determined by the rate of release of soil minerals and the ability of the soil to retain added fertilizer nutrients.

Several soil characteristics influence the availability of nutrients. The principal factors determining the characteristics of a soil are origin, profile and drainage. Among the more important characteristics of a soil are: the soil reaction, fixation of nutrients and aeration.

Numerous correlations have been established in respect to soil reaction. Among these are exchangeability of calcium and magnesium, solubility of trace elements, the availability of phosphorus and the activity of microorganisms (8).

Progressive fixation of phosphorus by soils, especially those high in calcium and clay content, decrease the efficiency of phosphates for a considerable period of time following their application to the soil. Fixation refers to any chemical or physical interaction between soluble plant nutrients and the soil whereby the nutrients become less available to the plants. Phosphorus fixation occurs most readily in soils with a low pH in which insoluble iron and aluminum phosphate compounds are formed (20).

Drainage and aeration are interrelated and can be considered together. Drainage affects both water content of the soil and the volume and composition of the soil atmosphere. The soil water may directly affect the supply of nutrients by its solvent properties and by its

movement through the soil mass. The water occupying the pore spaces of the soil also determines whether or not conditions will be aerobic or anaerobic (57).

III. TRENDS IN FERTILIZATION

In recent years there have been marked changes in the amounts of fertilizer used, materials, concentrations and placement practices. In general, larger quantities of all the primary nutrients are being used for vegetable crops (32).

IV. SNAP BEAN STUDIES

Physiological and Morphological Characteristics

Fertilizer programs for vegetable crops are dependent on both physiological and morphological characteristics of the various crops. Peas, snap beans and lima beans all belong to the legume family and as such are frequently assumed to have low nitrogen fertilizer requirements. However, among these crops symbiotic nitrogen fixation is apparently more efficient for peas than for either species of bean. For this reason higher rates of nitrogen fertilization may be necessary for snap and lima beans than for peas. The root system of snap beans can recover only 1 to 6 percent of the applied phosphorus, whereas other vegetables may recover 12 to 18 percent. In terms of mineral removal snap beans require a higher phosphorus fertilization than some other crops (32).

Nutrient Content

Within limits, the total content of any one soil-derived element in a plant is proportional to the quantity of that nutrient that was available to the plant in soluble form. Plants will absorb much larger amounts of nitrogen and certain other nutrients than may be required for optimum growth. This is especially true of potassium, which tends to accumulate in the plant at the expense of calcium and magnesium (24).

The content of nutrients in snap beans has been found to vary according to the salinity of the soil (33), soil moisture (34), variety and environment (27), age and position of the plant part sampled (49) and the soil fertility level (5,33,48,50).

Mackay and Leefe (34) indicate the optimum concentration of nitrogen, phosphorus and potassium in snap bean leaves to be 5.1, 0.40 and 2.0 percent respectively. In this work yield response was greatest at these nutrient levels and resulted from applications of 120 pounds per acre of nitrogen, and 600 pounds per acre of P_2O_5 . Yield and nutrient content of the leaves did not vary appreciably from potassium applications in the range of 0 to 480 pounds per acre of K_2O .

Thomas et al. (50) reported a range of concentrations of nutrients in the leaves of snap beans as follows: nitrogen--150-237 percent, phosphorus--0.20-0.28 percent, potassium--1.17-2.20 percent, calcium--5.38-6.39 percent, and magnesium--0.50-0.99 percent. These values were obtained by the analysis of the first leaves from the base of the plants, taken 55 days after planting. These investigators also indicate the optimum concentration relative to yield was: nitrogen--1.86 percent,

phosphorus--0.22 percent, potassium--1.93 percent, calcium--5.75 percent, and magnesium--0.66 percent. The optimum values were obtained from a fertilizer application of 667 pounds per acre of a 4-16-4 analysis fertilizer.

Fertilizer Ratio and Rates

Research results and recommendations of experiments stations generally indicate a moderate application of nitrogen and potash and a higher amount of phosphorus to be desirable for snap beans. This is frequently accomplished by using a fertilizer with a 1-2-1 ratio of primary nutrients (2,28,30,46,56,59).

Recommendations vary greatly from one area to another and are normally based on the known requirements of the soil. These recommendations generally fall in the range of 25 to 75 pounds per acre of nitrogen, 50 to 150 pounds per acre of P_2O_5 and 25 to 150 pounds per acre of K_2O (28,30,41,51).

The recommendations for snap beans in Tennessee for soil testing medium to low in available nutrients is: nitrogen--45 pounds, P_2O_5 --60-90 pounds and K_2O --30-60 pounds per acres respectively (56). The higher amounts of P_2O_5 and K_2O are recommended for soils having low readings.

Yields

The yield results of fertilizer experiments with snap beans, reported in the literature, are frequently different and conflicting due to soil type, fertility level, fertilizer placement, moisture, season and variety differences.

According to Ware and McCollum (59) snap beans may be placed in the group of vegetable crops least responsive to fertilization.

In most instances where fertilizer studies have shown increases in yield of snap beans they were associated with increased rates of nitrogen and phosphorus (14,16,22,34,42).

The response to potash fertilization has been varied and seems to be related to the amount available in the soil and interactions with other elements (12,14,26,34,37,43).

It has been indicated that additional applications of potash to snap beans may not be beneficial if medium to high amounts are available in the soil. Where soil potassium was low there was a considerable increase in yield from the application of 40 pounds per acre of potash (43).

Phosphorus at 80 pounds of P_2O_5 per acre has been noted to induce or accentuate potassium deficiency when applied to snap beans, on soils low in potassium and to increase yields from soils already high in phosphorus and potassium (42).

Gilmore (16) compared several different analyses of fertilizers at the rate of 600 pounds per acre and reported increased yields from treatments with high phosphate levels.

Yields of snap beans have been increased by applications of nitrogen up to 150 pounds per acre in certain experiments (58) while others have shown no response to over 50 to 60 pounds per acre (22).

Grown on soils testing high in primary nutrients, no significant increases in yields of snap beans were obtained in Texas from applications

of nitrogen, phosphorus, potash, zinc and iron alone or in combination. Twenty-two different fertilizer combinations were used in this study (9).

Janes (25) reports no increased yield of snap beans from applying one and one-half times the normal amount of fertilizer applications.

Fertilizer Placement

Phosphorus compounds applied to the soil tend to move very little. On the other hand potassium and to a greater extent nitrogen tends to move from their zone of placement. This movement is largely in a vertical direction (36).

Nitrogen and potash cannot be safely concentrated near the seed because of their movement and the danger of salt damage. Since phosphorus moves only short distances and tends to be fixed it should be placed where it can be efficiently utilized by plants (8).

McVickar (36) gives the following reasons for localized placement of fertilizer near the seed: restricted contact of the fertilizer with the soil lessens fixation of phosphorus and potash, the plant food is placed within easy reach of the roots, possibility of injurious concentrations are minimized, the effect of fertilizers are not diluted by mixing with a great volume of soil and nutrients placed in bands do not furnish nourishment to weeds growing between the rows.

It has been recognized for some time that snap beans seeds and seedlings are very susceptible to fertilizer injury (4,33,45). By placement of fertilizer in bands the injury can be reduced (11,35,38, 39,45).

Zimmerley (60) found that fertilizer applied to snap beans in bands two to three inches on each side of the seed and one to two inches below the level of the seed was less injurious to germination and gave higher yields than other methods of application.

Colditz (10) indicated no significant differences in yields of snap beans from several different methods of placement of 800 pounds per acre of a 5-10-5 analysis fertilizer.

Nitrogen and potash not to exceed 90 pounds per acre and P_2O_5 at from 60 to 150 pounds per acre banded three inches to the side and two inches below the seed level is reported to be most effective with snap beans in Oregon (35).

Mortenson (38) reported the application of 125 and 150 pounds per acre of nitrogen and P_2O_5 respectively in bands three inches to the side and three inches below the level of the seed to be more effective in increasing yields than broadcasting the same amounts. He further indicates that "pop-up" (small quantities in row) fertilization of nitrogen and P_2O_5 were not effective in increasing yields when used in conjunction with bands but were with broadcast applications.

V. QUALITY FACTORS

Fertilizer studies with snap beans have been for the most part concerned with the effect on yields. With the exception of sieve size distribution, little work has related to the effect of fertilization on other quality factors such as color, fiber content, percentage seed and pod length.

The quality of snap beans has been studied in terms of the effect of variety (19), stage of maturity (18), storage and defects (23) and other factors such as climate (27).

Gould (18) indicates the most important single factor affecting the quality of snap beans is maturity. He refers to maturity in terms of the degree of development of pods and seeds and the tenderness of the pods.

According to Guyer and Kramer (19) varietal characteristics largely determine the color and shape of snap beans as well as their potential fibrousness. They also indicate that with the exception of size and shape, the quality of snap beans may be determined by measurements of seed content, fibrousness and color.

Peck et al. (42) reported banded applications of phosphorus to snap beans resulted in increased vegetative growth and a higher percentage of small pods.

Burleson et al. (9) reported no differences in color, length, shape, fiber or flavor of snap bean pods as a result of fertilizer treatments.

Colditz (10) indicates that the method of placement of nitrogen and phosphate in bands may influence the length of snap bean pods.

Kaldy (27) determined that snap beans were significantly more fibrous when grown at warmer rather than cooler temperatures. He further indicates that fiber content appears to be a varietal characteristic that is greatly influenced by temperature and humidity.

CHAPTER III

MATERIALS AND METHODS

I. GENERAL PROCEDURES

These experiments were conducted during the summer of 1968 and the spring of 1969 at the University of Tennessee Plant Sciences Farm, Knoxville. Procedures used for the application of treatments, collection of samples and analysis of samples were identical for both years. The experiments were designed as randomized complete blocks containing eight treatments (Table I).

Treatments

The treatments were designed to evaluate the effects of fertilizer placement when nitrogen, phosphate and potash were applied in greater than commonly used amounts.

A standard band application of 40 pounds of nitrogen, 80 pounds of P_2O_5 and 40 pounds of K_2O per acre was made at planting by applying a narrow band of fertilizer approximately two inches wide and three inches from the seed on each side. These bands were applied using the fertilizer attachment of a tractor planter and were placed at a depth of three inches. This is the commonly used method in Tennessee at present and is the recommended amount based on the soil test.

Broadcast applications were made prior to planting using a two wheel Gandy fertilizer spreader. The broadcast applications were

TABLE I
TREATMENT RATES AND METHOD OF FERTILIZER APPLICATION

Treatment number	Amount pound/acre			Method of application
	N	P ₂ O ₅	K ₂ O	
1	40	80	40	Band
2	120	240	120	Broadcast
3	120	480	120	Broadcast
4	240	480	240	Broadcast
5	120	480	120	Broadcast ^b
6	240	480	240	Broadcast ^b
7	130	500	120	Broadcast ^{a,b}
8	250	500	240	Broadcast ^{a,b}

^aRate includes a banded application of 10 lb. of N and 20 lb. of P₂O₅.

^bSix inch center area of plant row free of fertilizer.

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incorporated into the soil to a depth of six inches with a garden type rototiller.

Treatments with fertilizer omitted from a six inch area where the seeds were to be drilled were made by closing the center holes of the Gandy spreader. The fertilizer thus applied was incorporated into the soil in the same manner as the broadcast treatments.

Supplemental narrow bands, approximately three inches wide, containing 10 pounds of nitrogen and 20 pounds of phosphate per acre were superimposed on two of the treatments with omitted center areas (Treatments 7 and 8). These applications were made prior to incorporation by placing the fertilizer on both sides of the plot row much as the standard band application.

Multiples of three and six times the standard amount were used in general as the basis for the higher applications.

Combinations of commercially prepared forms of ammonium nitrate, 20 percent superphosphate and a 5-10-5 analysis fertilizer were used in formulating the treatments.

Planting and Harvesting

Tendercrop cultivar of snap beans was planted each year in 38 inch rows at the rate of 90 pounds per acre. All plots were harvested with a Chisholm Ryder two row mechanical harvester.

Plant Stands

Treatment effect on plant stand was determined by plant counts in four randomly selected three foot lengths of each plot. Plant stand is reported as number of plants per 100 feet of row.

Yield

Treatment effect on yield was determined. The total pods produced on each plot were weighed. The yield data is reported as bushels per acre.

II. ANALYTICAL PROCEDURES

Soil Analysis

Initial fertility, pH, and soluble salt content of the surface (0-6 inch depth) of the soil was determined for the experimental areas prior to application of treatments. After a two week equilibration period following treatment, soil samples from each plot row were taken and analyzed for total nitrogen, available phosphorus, available potassium and soluble salts.

Total nitrogen was determined by the macro-Kjedahl method as described by Bremner (7). Soil nitrogen is reported as percent total nitrogen.

Available phosphorus was determined using a Bausch and Lomb Spectronic 20 spectrophotometer according to the procedure outlined by Bray and Kurtz (6). Soil phosphorus is reported as pounds of available P_2O_5 per acre.

Available potassium was determined using a Perkin-Elmer, Model 290 atomic absorption spectrophotometer according to the procedure of David (13). Soil potassium is reported as pounds of available K_2O per acre.

Soil pH was determined using a glass electrode pH meter according to the procedure described by Peech (44).

Soluble salt content of the soil was determined by measuring the electrical conductivity of an extract of moisture saturated soil samples according to procedures developed at the U. S. Soil Salinity Laboratory (55). The electrical conductivity was determined using a RD-12 Solubridge (Industrial Instruments, Inc., Jersey City 5, N. J.). The electrical conductivity is reported as mmhos per cm.

Plant Analysis

Plant samples were taken from each plot two weeks after germination of the seed and again at harvest time. The above ground portions of the plants were rinsed with tap water, dried at 70°C. and then ground in a Wiley Mill.

Samples of the dried plant material were wet ashed with sulfuric acid and hydrogen peroxide and the nitrogen content determined by Nesslerization (52).

Duplicate samples of the dried material were wet ashed with nitric and perchloric acid (15). The phosphorus content was determined by a phosphomolybdate reduction method (3).

The potassium, calcium, magnesium, iron, zinc and manganese was determined by atomic absorption spectrophotometry (1).

The nitrogen, phosphorus, potassium, calcium and magnesium content of the plant material is expressed as percentage of dry matter. The zinc, manganese and iron content of the plant material is expressed as parts per million (ppm) of dry matter.

Pod Analysis

A random sample of sieve size number 5 pods from each plot was subjected to the same analyses as the plant material.

Quality Factors

A random sample of sieve size number 5 pods was taken from each plot to determine the treatment effect on selected quality factors. The quality factors chosen were sieve size distribution, percentage seed, pod length, pod color and fiber content.

A one pound sample was used to determine sieve size distribution. It was separated into sieve sizes 1, 2, 3, 4, and 5 according to the size dimensions established by the U. S. Department of Agriculture (54).

Percentage seed was measured using 100 grams (fresh weight) of pods. The pods were split open, the seeds removed and the deseeded pods were weighed again. The difference in weight of the 100 gram sample was used as the seed weight in determining the percentage.

Pod length in centimeters was determined by measuring 15 randomly selected pods from each plot.

Color was measured using a Hunter Color and Color Difference Meter. The instrument was nulled using a white standard number D-25-230. The green standard, number D-25-233, was used in evaluating green color. The Hunter color values "L" (lightness), "-a" (green), and "+b" (yellow) were determined by placing a sample of pods directly on the test specimen window. The ratio of the "-a" value to "+b" value was determined and is referred to as the Hunter a/b color measurement.

Fiber content of number 5 sieve size pods was determined using the rapid method of Kramer (29).

III. STATISTICAL ANALYSIS

Randomized complete block designs were used. The analysis of variance method was used to study the data (47). Significant treatment mean differences at the .05 level were determined by Duncan's Multiple Range test (31). These analyses were conducted on the 360/65 computer at The University of Tennessee Computing Center.

IV. PROCEDURE 1968

The soil type of the experimental area in 1968 was Whitwell loam. This is a deep moderately well drained soil. Initial soil test indicated a pH of 5.2, total nitrogen at 0.045 percent, available P_2O_5 at 10 pounds per acre, available K_2O at 130 pounds per acre and a soil conductance level of 0.45 mmhos per cm.

The individual plots consisted of four rows, 42 feet long. The two center rows were used for harvest and sample collection.

Snap beans were planted on August 6th and harvested on October 4th. Climatological data for the period of the 1968 experiment is given in Figures 1 and 2. The recorded rainfall of 3.43 inches was supplemented with 3.75 inches of water by irrigation, giving 7.18 inches total water.

The total degree days accumulated prior to harvest in 1968 amounted to 1,345.

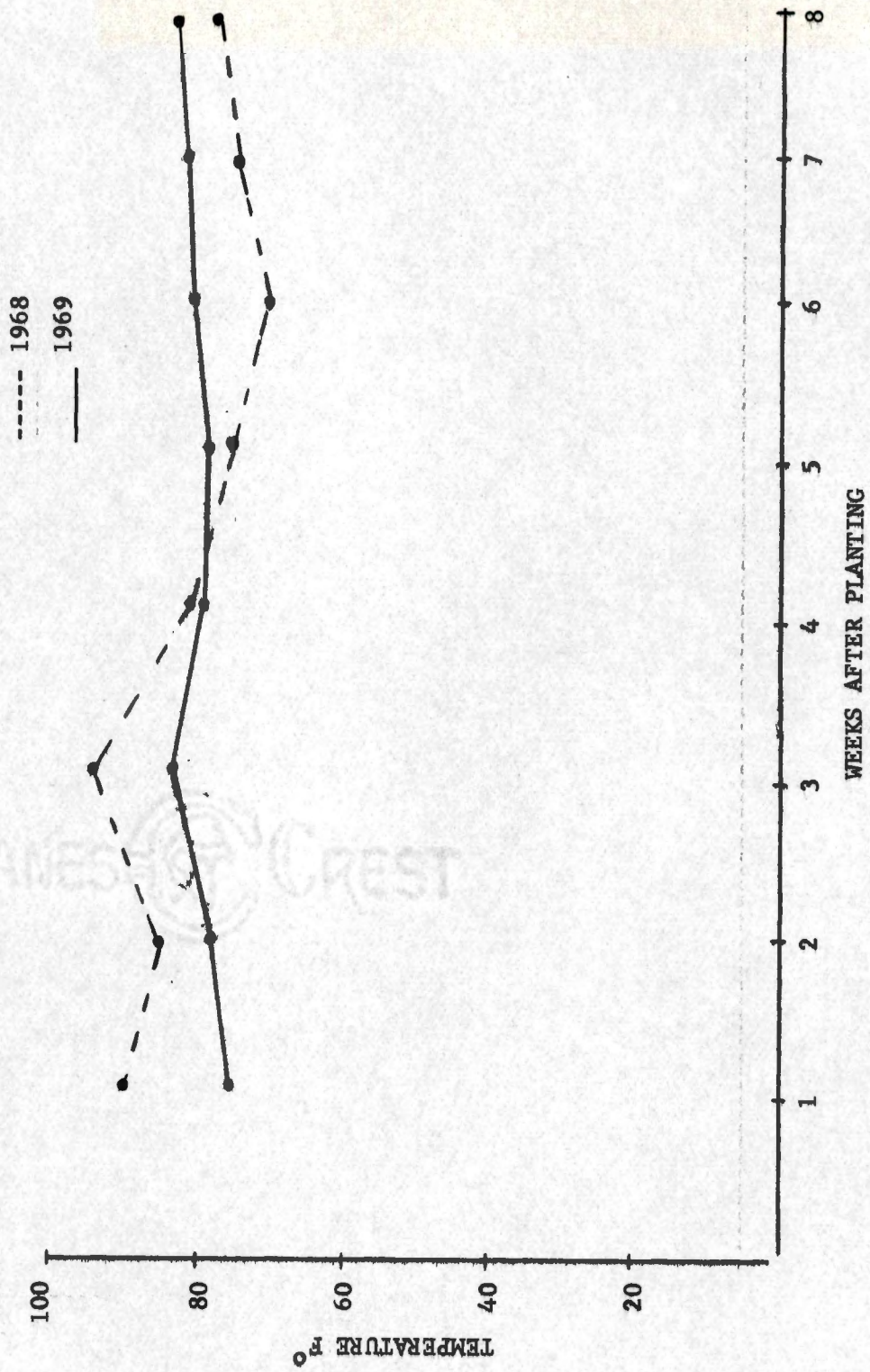


Figure 1. Mean weekly temperature during the snap bean growing seasons.

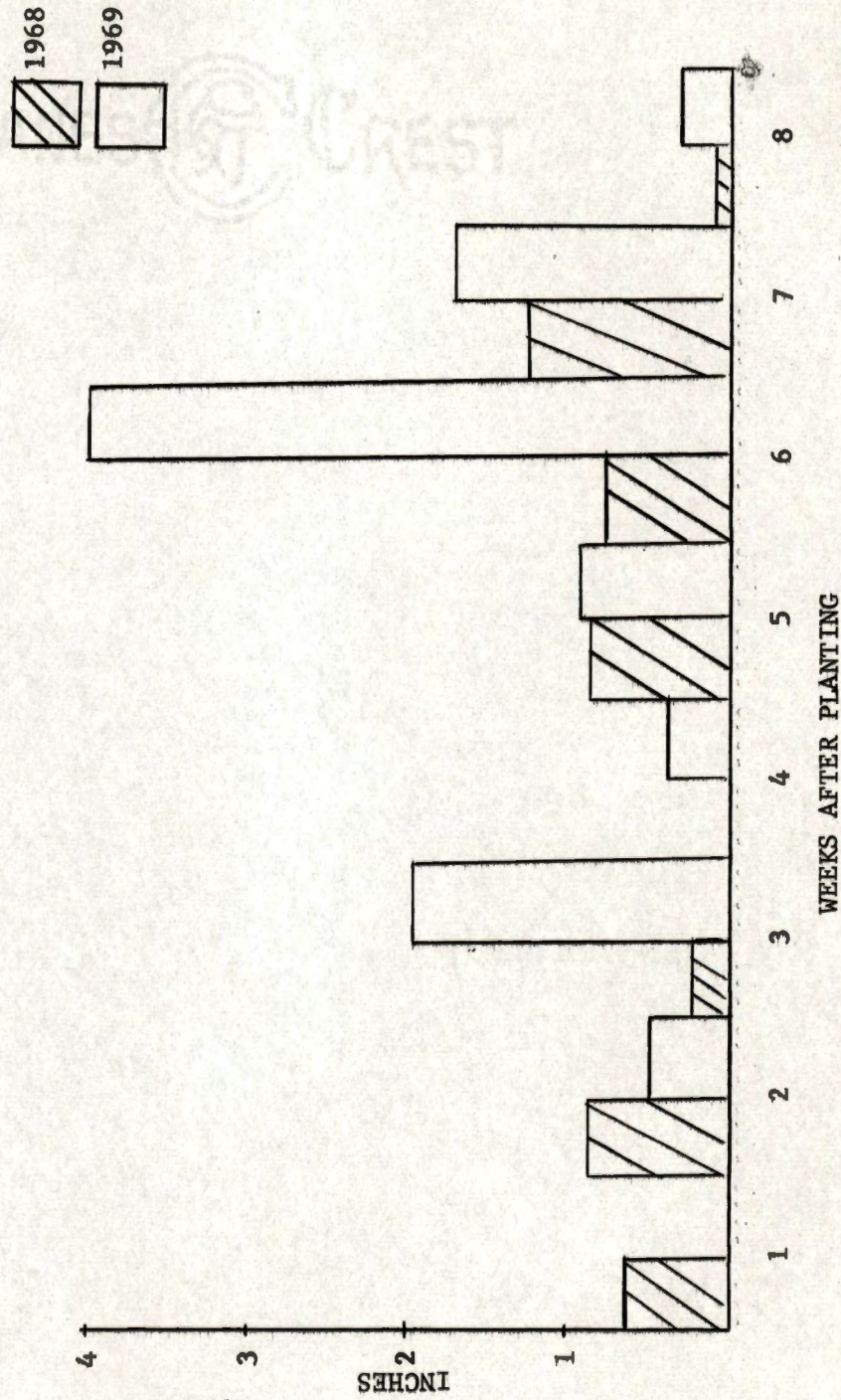


Figure 2. Inches of rainfall during the snap bean growing seasons.

V. PROCEDURE 1969

The soil type of the experimental area in 1969 was Sequatchie loam, which had been modified by land leveling. This is a deep and well drained soil. Initial soil test indicated a pH of 5.9, total nitrogen at 0.045 percent, available P_2O_5 at 19 pounds per acre, available K_2O at 212 pounds per acre and a soil conductance level of 0.31 mmhos per cm.

The individual plots consisted of four rows 30 feet long. The two center rows were used for harvest and sample collection.

Snap beans were planted on May 15th and harvested on July 7th. Climatological data for the period of the 1969 field experiment is given in Figures 1 and 2. The recorded rainfall of 8.09 inches was supplemented with 0.5 inches of water by irrigation giving 8.59 inches total water.

The total degree days accumulated in 1969 amounted to 1,295.

CHAPTER IV

RESULTS

High levels of fertilization, placement methods and the subsequent levels of nitrogen, phosphorus and potassium in the soil were evaluated in relation to the response by snap beans. Evaluations were made in terms of the following factors: plant stands, nutrient content of the plants two weeks after germination and at harvest, yields, sieve size distribution, percentage seed, pod length, pod color, pod fiber content and nutrient content of the pods.

I. LEVELS OF SOIL NUTRIENTS AND SOLUBLE SALT

The influence of fertilizer treatments on the soil levels of N, P_2O_5 , K_2O , and soluble salts, determined after a two week equilibration period are reported in Table II.

In general increased rates of application resulted in higher levels of nutrients.

Some effects of placement are evident and indicate that lower levels of nutrients were associated with treatments which included an omitted center band.

The influence of quantity and placement of fertilizer is also indicated in the resulting soluble salt contents. Higher levels of broadcast applications resulted in increased soluble salt levels. Omitting a six inch center band resulted in lower soluble salt levels in the

TABLE II

LEVELS OF SOIL NITROGEN, PHOSPHORUS, POTASSIUM AND SOLUBLE SALTS

Treatment Pounds per acre		Total N %			P ₂ O ₅ Pounds per acre			K ₂ O Pounds per acre			Soluble salts mmhos/cm			
		1968	1969	Mean	1968	1969	Mean	1968	1969	Mean	1968	1969	Mean	
40	80	40	0.057	0.047	0.052	23	30	27	142	225	184	0.63	0.31	0.47
120	240	120	0.057	0.053	0.055	27	51	39	170	316	243	0.79	0.80	0.79
120	480	120	0.056	0.057	0.056	70	77	74	164	331	248	1.10	0.76	0.94
240	480	240	0.056	0.062	0.059	98	86	92	196	448	322	1.42	1.38	1.40
120	480	120 ¹	0.047	0.046	0.046	33	58	46	161	340	251	0.51	0.60	0.55
240	480	240 ¹	0.051	0.052	0.051	34	55	45	168	333	250	0.51	0.73	0.62
130	500	120 ^{1,2}	0.046	0.050	0.048	37	69	53	214	403	308	1.04	1.38	1.21
250	500	240 ^{1,2}	0.052	0.056	0.054	89	63	76	176	366	271	1.05	0.89	0.97

¹Broadcast with an omitted six inch center band.²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

vicinity of the plant roots. Supplemental band applications of nitrogen and phosphorus resulted in higher soluble salt levels.

II. PLANT STANDS

Treatment influenced plant stand (Table III). The standard band application of 40 pounds of N, 80 pounds of P_2O_5 and 40 pounds of K_2O per acre, serving as the control, resulted in significantly higher plant stands both years.

When the standard recommended rate (40-80-40) of fertilizer was tripled and applied broadcast, plant stands were reduced both years. When this larger application was again doubled, or six times the standard rate (240-480-240) and broadcast, plant stands were further reduced. The reduction was not as great when similar amounts were broadcast with a six inch center area along the seed row unfertilized. No significant change in stand was observed between this treatment and a similar one which included a small additional amount of N and P_2O_5 banded (10-20-0).

These data indicate that as fertilizer amounts increased plant stands decreased; however, method of application altered the rate of decrease.

III. NUTRIENT CONTENT OF SNAP BEAN PLANTS

TWO WEEKS AFTER GERMINATION

N, P and K

The content of primary nutrients in snap bean plants two weeks after germination is shown in Table IV.

TABLE III
EFFECT OF TREATMENT ON PLANT STANDS OF SNAP BEANS

Treatment Pounds per acre			Plant stand Number per 100 ft. of row		
N	P ₂ O ₅	K ₂ O	1968	1969	Mean
40	80	40	476a ³	566a	521a
120	240	120	306 bc	423 b	364 b
120	480	120	330 bc	430 b	380 b
240	480	240	290 c	236 c	263 c
120	480	120 ¹	383 b	440 b	411 b
240	480	240 ¹	383 b	436 b	409 b
130	500	120 ^{1,2}	363 bc	443 b	403 b
250	500	240 ^{1,2}	370 bc	463 b	416 b

¹Broadcast with an omitted six inch center band.

²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

³Values followed by a common letter or no letter are not statistically different at the .05 level of significance.

TABLE IV

EFFECT OF TREATMENT ON N, P AND K CONTENT OF SNAP BEAN PLANTS TWO WEEKS AFTER GERMINATION

Treatment		N			P			K			
Pounds per acre		%			%			%			
N	P ₂ O ₅	K ₂ O	1968	1969	Mean	1968	1969	Mean	1968	1969	Mean
40	80	40	3.37a ³	3.03 b	3.20ab	0.10	0.21 b	0.16 b	2.50	3.27	2.89
120	240	120	2.96 b	3.18 b	3.07 bc	0.11	0.25ab	0.18ab	2.49	3.45	2.97
120	480	120	2.50 cd	3.37ab	2.93 bc	0.11	0.31a	0.20a	2.33	3.64	2.98
240	480	240	2.46 cd	3.49ab	2.97 bc	0.12	0.30a	0.20a	2.49	3.75	3.12
120	480	120 ¹	2.46 cd	3.10 b	2.87 c	0.12	0.29a	0.20a	2.30	3.57	2.93
240	480	240 ¹	2.12	e 3.01 b	2.56 d	0.11	0.25ab	0.18ab	2.45	3.42	2.93
130	500	120 ^{1,2}	2.28	de 2.45 c	2.36 d	0.11	0.30a	0.20a	2.22	3.54	2.88
250	500	240 ^{1,2}	2.59 c	3.83a	3.37a	0.11	0.27ab	0.19 c	2.69	3.30	2.99

¹Broadcast with an omitted six inch center band.²Included 10 pounds of N and 20 pounds of P₂O₅ banded.³Values followed by a common letter or no letter are not statistically different at the .05 level of significance.

These data indicate N and P content of the plants to be influenced by treatment, however, the results are not consistent for both years.

The nitrogen content in 1968 was highest in plants receiving the standard 40-80-40 band treatment, while the lowest N content was found in plants from one of the high N plots. The highest level of this element in 1969 occurred in plants from plots with the highest N application; but with an omitted center band.

The P content of plants in 1968 was not statistically different due to treatment but was low compared to 1969. Higher P content in plants did result from higher rates of application in 1969 although all high rates were not significantly different from the standard.

No significant differences were noted in the K content of the plants at this stage of growth.

Ca and Mg

With the exception of the Mg in 1969, the Ca or Mg content of snap bean plants (Table V) was not significantly different, due to treatment, two weeks after germination.

Fe, Zn and Mn

The Fe and Zn content was not significantly different in snap bean plants two weeks after germination in either year (Table VI).

The Mn content at this stage of growth in 1969 was significantly higher as a result of the 240-480-240 broadcast treatment when compared to the standard band treatment.

TABLE V
EFFECT OF TREATMENT ON Ca AND Mg CONTENT OF SNAP BEAN PLANTS TWO WEEKS AFTER GERMINATION

Treatment Pounds per acre		Ca %		Mg %	
		1968	Mean	1968	Mean
N	P ₂ O ₅ K ₂ O				
40	80 40	2.46	2.52	0.67	0.49 c ³ 0.58
120	240 120	2.74	2.26	0.69	0.53 bcd 0.61
120	480 120	2.60	2.36	0.66	0.59ab 0.62
240	480 240	2.81	2.39	0.67	0.50 cd 0.58
120	480 120 ¹	2.59	2.69	0.63	0.61a 0.62
240	480 240 ¹	2.75	2.75	0.69	0.60a 0.64
130	500 120 ^{1,2}	2.94	2.05	0.75	0.56abc 0.65
250	500 120 ^{1,2}	2.71	2.26	0.75	0.49 cd 0.62

¹Broadcast with an omitted six inch center band.

²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

³Values followed by a common letter or no letter are not statistically different at the .05 level of significance.

TABLE VI

EFFECT OF TREATMENT ON Fe, Zn AND Mn CONTENT OF SNAP BEAN PLANTS TWO WEEKS AFTER GERMINATION

Treatment			Fe		Zn		Mn	
Pounds per acre			ppm		ppm		ppm	
N	P ₂ O ₅	K ₂ O	1968	Mean	1968	Mean	1968	Mean
40	80	40	85	122	80	95	23	32 b ³
120	240	120	115	107	80	90	38	41ab
120	480	120	121	111	70	85	36	48ab
240	480	240	123	126	90	95	29	54a
120	480	120 ¹	108	119	80	105	25	48ab
240	480	240 ¹	116	133	80	100	23	44ab
130	500	120 ^{1,2}	128	114	90	95	39	40ab
250	480	240 ^{1,2}	97	108	90	100	29	47ab

¹Broadcast with an omitted six inch center band.²Included 10 pounds of N and 20 pounds of P₂O₅ banded.³Values followed by a common letter or no letter are not statistically different at the .05 level of significance.

IV. NUTRIENT CONTENT OF SNAP BEAN PLANTS AT HARVEST

N, P and K

The N, P or K content of snap bean plants at harvest (Table VII) was not consistently influenced by treatment in the two years. No significant differences were noted for N content in 1968 or for phosphorus and potassium in 1969.

In the years where differences were noted, broadcast treatments at rates three and six times the standard 40-80-40 band treatment did not result in significant changes in the N and P content of the plants.

Applying the higher rates in conjunction with a six inch omitted center band did not result in significant differences in N and P content of the plants.

When supplemental band applications of N and P were included in the treatments with omitted center bands, the results were varied but did significantly increase P content in 1968.

Significantly higher K content was obtained from the higher rates of application in 1968, and most treatments resulted in plants significantly higher in K than those fertilized with the standard rate.

Ca and Mg

The Ca and Mg content of snap bean plants at harvest (Table VIII) indicate significant differences due to treatment.

In general the standard band and the basic 120-480-120 treatments with omitted center bands resulted in higher content of these elements. Treatments with omitted center bands at the basic 240-480-240 rate resulted in generally lower levels of these elements.

TABLE VII

EFFECT OF TREATMENT ON N, P AND K CONTENT OF SNAP BEAN PLANTS AT HARVEST

Treatment Pounds per acre N P ₂ O ₅ K ₂ O	N %		P %		K %	
	1968	Mean	1968	Mean	1968	Mean
40 80 40	2.39	2.45ab ³	0.24 bc	0.30	2.21 b	2.64 c
120 240 120	2.76	1.81 b	0.22 c	0.26	2.81a	2.92abc
120 480 120	3.15	2.36ab	0.21 c	0.29	2.91a	3.05ab
240 480 240	3.03	2.44ab	0.24 bc	0.28	2.94a	3.22a
120 480 120 ¹	3.21	2.42ab	0.22 c	0.27	3.01a	3.06ab
240 480 240 ¹	3.58	2.87a	0.24 bc	0.29	2.28 b	2.81 bc
130 500 120 ^{1,2}	3.26	2.73a	0.29a	0.27	2.64ab	2.83 bc
250 500 240 ^{1,2}	3.43	2.44ab	0.27ab	0.25	2.95a	3.08ab

¹Broadcast with an omitted six inch center band.²Included 10 pounds of N and 20 pounds of P₂O₅ banded.³Values followed by a common letter or no letter are not statistically different at the .05 level of significance.

TABLE VIII
EFFECT OF TREATMENT ON Ca AND Mg CONTENT OF SNAP BEAN PLANTS AT HARVEST

Treatment Pounds per acre		Ca		Mg	
		1968	1969	1968	1969
N	P ₂ O ₅ K ₂ O				Mean
40	80 40	2.45 cd ³	4.37a	0.51ab	0.23a
120	240 120	2.61 bc	3.85abc	0.52ab	0.18 b
120	480 120	2.28 d	3.43 bc	0.50ab	0.17 b
240	480 240	2.40 cd	3.27 c	0.48abc	0.15 b
120	480 120 ¹	2.88ab	3.76abc	0.55a	0.19ab
240	480 240 ¹	2.26 d	3.23 c	0.40 c	0.15 b
130	500 120 ^{1,2}	3.01a	4.03ab	0.56a	0.19ab
250	500 240 ^{1,2}	2.34 cd	3.77abc	0.45 bc	0.17 b

¹Broadcast with an omitted six inch center band.

²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

³Values followed by a common letter or no letter are not statistically different at the .05 level of significance.

Fe, Zn and Mn

Fe or Zn content of snap bean plants at harvest did not differ significantly as a result of treatment (Table IX).

The Mn content at this stage of growth was significantly higher in plants receiving the 130-500-120 broadcast treatment with an omitted center band.

V. YIELD

The effect of treatment on the yield of snap beans is reported in Table X.

The highest yield was recorded in 1968 with the 120-480-120 broadcast treatment. In 1969 the highest yield was recorded for the 130-500-120 broadcast treatment with an omitted center band. The mean yield of both years indicate these two treatments to be significantly higher than all other treatments.

In 1969 the 120-480-120 broadcast treatment with an omitted center band also resulted in significantly higher yields.

A significant reduction in yield resulted in 1969 from the 240-480-240 broadcast treatment.

VI. QUALITY FACTORS

Sieve Size Distribution

Data in Table XI indicate the pod sieve size distribution did not vary significantly due to treatment. These data indicate the snap beans from each treatment were harvested at approximately the same stage of maturity.

TABLE IX

EFFECT OF TREATMENT ON Fe, Zn AND Mn CONTENT OF SNAP BEAN PLANTS AT HARVEST

Treatment			Fe		Zn		Mn	
Pounds per acre			ppm		ppm		ppm	
N	P ₂ O ₅	K ₂ O	1968	Mean	1968	Mean	1968	Mean
40	80	40	162	136	95	130	32 ³	41 c
120	240	120	188	144	155	130	32 c	44abc
120	480	120	208	149	100	130	50 b	60abc
240	480	240	192	141	92	130	32 c	51abc
120	480	120 ¹	180	135	80	130	52 b	52ab
240	480	240 ¹	162	131	95	130	40 c	62ab
130	500	120 ^{1,2}	220	155	102	130	62a	63a
250	500	240 ^{1,2}	200	145	117	130	32 c	54abc

¹Broadcast with an omitted six inch center band.²Included 10 pounds of N and 20 pounds of P₂O₅ banded.³Values followed by a common letter or no letter are not statistically different at the .05 level of significance.

TABLE X
EFFECT OF NUTRIENT TREATMENT ON YIELD OF SNAP BEANS

Treatment Pounds per acre			Yield Bushels per acre		
N	P ₂ O ₅	K ₂ O	1968	1969	Mean
40	80	40	164 b ³	97 b	131 cd
120	240	120	160 b	109ab	135 c
120	480	120	224a	104ab	164a
240	480	240	172 b	36 c	104 e
120	480	120 ¹	176 b	125ab	151 b
240	480	240 ¹	170 b	88 b	129 d
130	500	120 ^{1,2}	182 b	148a	165a
250	500	240 ^{1,2}	189ab	107ab	148 b

¹Broadcast with an omitted six inch center band.

²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

³Values followed by a common letter or no letter are not statistically different at the .05 level of significance.

TABLE XI
EFFECT OF TREATMENT ON POD SIEVE SIZE DISTRIBUTION
OF SNAP BEANS

Treatment Pounds per acre			Sum of sieve sizes number 3, 4 and 5 (percent)		
N	P ₂ O ₅	K ₂ O	1968	1969	Mean
40	80	40	91.82	88.82	90.32
120	240	120	93.70	87.37	90.53
120	480	120	92.60	87.07	89.83
240	480	240	94.57	79.50	87.03
120	480	120 ¹	90.92	87.02	88.97
240	480	240 ¹	90.45	83.85	87.15
130	500	120 ^{1,2}	94.02	92.40	93.21
250	500	240 ^{1,2}	93.10	87.30	90.20

¹Broadcast with an omitted six inch center band.

²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

Percentage Seed and Pod Length

Treatment effect on the percentage seed and length of pods (Table XII) was not consistent for the two years.

Significantly greater percentage seed was noted in 1969 from the 240-480-240 broadcast, and 130-500-120 broadcast and omitted center band treatments. However, the latter treatment resulted in significantly greater percentage seed values only when compared to the 240-480-240 treatment with an omitted center band.

Treatment influenced pod length in both years but the effect of treatment was not consistent. In 1968 plants from all treatments, with the exception of the 120-480-120 broadcast treatment with an omitted center band, had significantly longer pods than those from the standard treatment.

Results in 1969 indicate pods from the standard treatment plants not to be significantly different from those of the longest pods obtained from other treatments.

Color of Pods

No significant difference in color of pods, as determined by the Hunter Color and Color Difference meter was noted (Table XIII).

Fiber Content of Pods

The fiber content of pods is reported in Table XIV. No significant differences in the fiber content of pods were noted in either year as a result of treatment. There was however a difference in fiber content between the two years. The fiber content of pods in 1969 was consistently higher than in those in 1968.

TABLE XII
EFFECT OF TREATMENT ON PERCENT SEED AND POD LENGTH

Treatment Pounds per acre		Percent Seed		Pod length centimeters	
		1968	1969	1968	1969
N	P ₂ O ₅ K ₂ O	Mean		Mean	
40	80 40	7.5	5.0 bc ³	12.2 c	12.9ab
120	240 120	6.3	5.2 bc	13.5ab	12.3 bc
120	480 120	5.7	5.1 bc	13.9a	12.1 c
240	480 240	6.1	6.1ab	13.8a	12.4 bc
120	480 120 ¹	6.3	5.1 bc	13.1 bc	13.4a
240	480 240 ¹	5.8	4.5 c	13.8a	12.9ab
130	500 120 ^{1,2}	6.7	7.2a	13.4ab	12.7abc
250	500 240 ^{1,2}	5.9	5.5 bc	13.9a	12.6 bc

¹Broadcast with an omitted six inch center band.

²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

³Values followed by a common letter or no letter are not statistically different at the .05 level of significance.

TABLE XIII
EFFECT OF TREATMENT ON THE COLOR OF PODS

Treatment Pounds per acre			Hunter a/b ratio		Mean
N	P ₂ O ₅	K ₂ O	1968	1969	
40	80	40	0.74	0.81	0.77
120	240	120	0.73	0.80	0.77
120	480	120	0.72	0.88	0.80
240	480	240	0.70	0.77	0.74
120	480	120 ¹	0.73	0.78	0.75
240	480	240 ¹	0.72	0.81	0.77
130	500	120 ^{1,2}	0.70	0.79	0.75
250	500	240 ^{1,2}	0.68	0.77	0.73

¹Broadcast with an omitted six inch center band.

²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

TABLE XIV
EFFECT OF TREATMENT ON FIBER CONTENT OF PODS

Treatment Pounds per acre			Fiber content Grams per 100 grams fresh weight		
N	P ₂ O ₅	K ₂ O	1968	1969	Mean
40	80	40	0.651	1.180	0.916
120	240	120	0.617	1.166	0.891
120	480	120	0.681	1.135	0.908
240	480	240	0.726	1.162	0.944
120	480	120 ¹	0.599	1.026	0.813
240	480	240 ¹	0.612	1.143	0.878
130	500	120 ^{1,2}	0.463	1.123	0.793
250	500	240 ^{1,2}	0.843	1.064	0.953

¹Broadcast with an omitted six inch center band.

²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

N, P and K Contents of Pods

The content of the primary nutrients in the pods is reported in Table XV.

Significant differences were noted in the pod content of N in both years. No significant differences were noted in the P content of the pods in 1969 or in the K content in either year.

The standard band treatment generally resulted in N, P and K contents of the pods, comparable to other treatments.

Pods from beans receiving the 240-480-240 broadcast treatment had generally lower levels of P and K but had higher levels of N in 1969.

Ca and Mg Content of Pods

The Ca and Mg content of pods is shown in Table XVI. Significant differences occurred only in 1968. Calcium in pods from the standard band treatment was significantly higher than those from any other treatment. In the same year the Mg content of the pods from 250-500-240 broadcast with an omitted center band treatment was significantly higher than all other treatments except the standard band treatment.

Fe, Zn and Mn Content of Pods

The content of Fe, Zn and Mn of pods is reported in Table XVII.

No significant differences in Fe or Zn content of pods were noted from treatment in either year. The content of these elements in the pods in 1969, however, was considerably higher than in 1968.

Significant differences in the Mn content of the pods were noted

EFFECT OF TREATMENT ON N, P AND K CONTENT OF PODS

¹Broadcast with an omitted six inch center band.

²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

³Values followed by a common letter or no letter are not statistically different at the .05 level of significance.

TABLE XVI
EFFECT OF TREATMENT ON Ca AND Mg CONTENT OF PODS

Treatment Pounds per acre		Ca %		Mg %	
N	P ₂ O ₅	1968	1969	1968	1969
		Mean		Mean	
40	80	2.61a ³	2.03	0.34ab	0.51
120	240	2.02 d	1.59	0.27 bc	0.43
120	480	2.47 b	1.74	0.27 bc	0.43
240	480	1.80 e	1.89	0.29 bc	0.60
120	480	2.45 b	1.85	0.25 c	0.47
240	480	2.35 b	1.54	0.28 bc	0.45
130	500	1.67	f 1.54	0.29 bc	0.47
250	500	2.21 c	1.69	0.40a	0.59

¹Broadcast with an omitted six inch center band.

²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

³Values followed by a common letter or no letter are not statistically different at the .05 level of significance.

EFFECT OF TREATMENT ON Fe, Zn AND Mn CONTENT OF PODS

¹Broadcast with an omitted six inch center band.

²Included 10 pounds of N and 20 pounds of P₂O₅ banded.

³ values followed by a common letter or no letter are not statistically different at the 0.05 level of significance.

only in 1969. In general higher Mn levels resulted from the 240-480-240 treatments.

Lower levels of Mn were associated with the 120-480-120 treatments.



CHAPTER V

DISCUSSION

I. LEVELS OF SOIL NITROGEN, PHOSPHATE, POTASH AND SOLUBLE SALTS

It seems evident that in addition to treatment the results of these studies were influenced by both soil and climatic factors in both 1968 and 1969. The extent to which the added fertilizer interacted with the soil and climatic factors evidently determined the availability of nutrients to snap bean plants.

With the exception of N in 1968, the level of N, P_2O_5 and K_2O in the soil was increased due to increased rates of broadcast fertilizer treatments. These data (Table II) indicate the increased rates of broadcast fertilization should also be considered in light of the associated increase in soluble salts. (See Table II, page 23.)

A fertilizer-free or omitted center band in conjunction with high rates of fertilization is apparently effective in decreasing the nutrient levels and associated soluble salts in proximity to the plant row.

Omitted center band treatments, which included a supplemental band of N and P_2O_5 (10-20-0), reflected the effects of additional fertilization both in increased levels of nutrients and soluble salts.

These data indicate that rate and placement of fertilizer influences the nutrient levels and their position in the soil with respect to plant roots.

II. PLANT STANDS

The influence of high levels of fertilization and methods of placement on plant stands is quite evident in Table III, page 25.

The standard 40-80-40 band treatment apparently did not concentrate as high amounts of fertilizer, in the area surrounding the seed as did some of the other treatments. This is indicated both in terms of plant stands and soluble salt levels (Table II, page 23).

Increasing the amount of P_2O_5 from 240 to 480 pounds per acre in the broadcast treatments did not result in significant increases in plant stands. On the other hand increasing the nitrogen and K_2O from 120 to 240 pounds each per acre resulted in a 12 percent decrease in plant stand in 1968 and a 45 percent decrease in 1969. These data are in general agreement with other reports concerning the injurious effects of N and K_2O (35) and the beneficial effects of applying P_2O_5 close to seeds (8).

Applying higher amounts of fertilizer in conjunction with an omitted center band was effective in maintaining plant stands. When the 240-480-240 rate was applied with an omitted center band the stands were 32 percent higher in 1968 and 84 percent higher in 1969 as compared with stands on the broadcast plots.

The addition of supplemental bands of N and P_2O_5 in small amounts to treatments with omitted center bands did not significantly reduce plant stands in 1968 or 1969.

It has been noted that applying fertilizer to snap beans at distances of two to three inches from the seed was less injurious

than other methods of application (11,35,38,39,45), however, these studies were in terms of much lower quantities applied primarily by banding.

The data from this study indicate the injurious effects on snap beans of high rates of fertilization can be reduced by placement methods. This is indicated by the higher plant stands which resulted from treatments with fertilizer placed at a distance from the seed.

III. NUTRIENT CONTENT OF SNAP BEAN PLANTS

TWO WEEKS AFTER GERMINATION

The nutrient content of snap bean plants two weeks after germination gives an indication of the effectiveness of fertilizer treatments in supplying early nutrient needs.

N, P and K

The standard 40-80-40 band treatment was apparently as effective in supplying N, P and K at this stage of growth as were many other treatments studied.

These data indicate the N content of the standard treated plants were significantly higher than for other treatments in 1968. In 1969 the plant content of this element was at a comparable level in the standard treated plants to those of most other treatments.

The P content of plants at two weeks after germination was not significantly different due to treatment in 1968. However, in 1969 plants from most treatments were higher in P content than those from the standard treatment.

The lower P content in plants and nonsignificant difference of P between treatments at this stage, in 1968 are possibly related to the initial pH of the soil. The initial pH of the experimental area in 1968 was 5.2. At this pH level phosphorus fixation in the soil might have resulted in a general lower level of available P. The initial soil test also shows only about half as much P_2O_5 available in 1968 as compared to 1969.

Added P_2O_5 in 1969, when the initial pH of the soil was 5.9, resulted in an increased P content of plants which received higher than the standard amount of P_2O_5 .

Soil tests (Table II, page 23) reveal a higher initial K_2O level in the soil in 1969 than in 1968. This could explain the higher levels of K in plants in 1969. The absence of significant differences in K content of plants due to treatment in either year is in agreement with the work of Mackay and Leefe (33).

These data indicate the standard 40-80-40 band treatment to be as effective in supplying N and K at this stage of growth as most other treatments. P content of the plants apparently can be increased by above standard amounts at this stage of growth. Generally no significant increases in nutrient content of plants occurred above the 120-480-120 treatment level.

Ca and Mg

Calcium and Mg were not intentionally added as part of the fertilizer treatments. These data (Table V, page 28) seem to indicate the probable presence of these elements in the fertilizer.

The significant effect of treatment on Mg content of plants in 1969 was apparent at the 120-480-120 rate since no significant increase occurred above this level. This seems to indicate the plants accumulated this element to a certain level and additional applications of fertilizer did not further increase the plant content of Mg.

Mn

The data relating to Mn content (Table VI, page 29) of plants two weeks after germination also seem to indicate the probable presence of elements such as Mn in the added fertilizer. The difference in Mn content of the plants may be a result of variations in soil pattern in the experimental area, which resulted in higher Mn levels in certain areas,

A significantly higher content of Mn resulted only from the 240-480-240 broadcast treatment compared to the standard treatment.

IV. NUTRIENT CONTENT OF SNAP BEAN PLANTS AT HARVEST

The nutrient content of snap bean plants at harvest indicate the effectiveness of treatments in supplying nutrients to the plants at the latter stages of growth.

N, P and K

The standard 40-80-40 band treatment was apparently as effective in supplying N to the plants at this stage as were other treatments.

Banding small amounts of N and P_2O_5 (10-20-0) in conjunction with omitted center band treatments was effective in increasing the P but not the N content of snap bean plants at harvest.

It seems apparent that the K content of snap bean plants at harvest was increased by above standard amounts of application.

These data indicate the levels of N, P and K in the plants at harvest time were not significantly different due to treatments above the 120-480-120 rate, with the exception of the noted increase in P from supplemental band application.

The level of P and K in the standard treated plants indicate these elements to be lower than in plants from other treatments. It is possible that at these lower levels P and K may be limiting the growth and development of the snap bean plants.

Ca and Mg

As was noted in the Ca and Mg content of plants two weeks after germination, the data for plants at harvest also appear to reflect the probable presence of these elements in the added fertilizers. These data also indicate the level of accumulation of these elements in the plants as not significantly influenced above the 120-480-120 rate.

Mn

The Mn content of harvest plants does not appear to be consistently related to treatment. However the mean value of the two years does indicate the same general relationships to treatment as was noted for the plants two weeks after germination.

V. YIELD

The data relating to yield (Table X, page 35) seem to indicate the basic rate of 120 pounds of N, 480 pounds of P_2O_5 and 120 pounds

of K_2O per acre applied broadcast to be effective in increasing yields. These data also generally indicate significant reductions in yields associated with the 240-480-240 broadcast treatment.

The reduction in yield with the high amounts of fertilizer applied broadcast can be related to a significantly lower plant stand (Table III, page 25).

Although plant stands were reduced by the basic 120-480-120 treatment, the yield data indicate the surviving plants were able to utilize the relatively high levels of nutrients to advantage.

It also has been noted in the earlier discussion that in general the nutrient content of the plants did not significantly increase when higher than the 120-480-120 rates of application were used.

VI. QUALITY FACTORS

Sieve Size Distribution

It seems apparent that fertilizer treatments in the amounts and by the methods used in these studies did not significantly influence the percentage of snap bean pods in the various sieve sizes.

Percentage Seed and Pod Length

The percentage seed indicate there was little difference in seed development as a result of treatment. Although in 1969 a significantly higher percentage seed resulted from the 130-500-120 broadcast and omitted center treatment, it was not significant in both years. The mean data of both years also indicate the standard band treatment resulted in a percentage seed that was not significantly different from most other treatments.

The length of pods in 1968 was significantly longer as a result of practically all treatments compared to the standard. This relationship was not repeated in 1969 and pod length due to the standard treatment was not significantly different from those receiving larger amounts of fertilizer.

Color of Pods

Color differences as determined by the Hunter Color-Difference meter were not statistically different due to fertilizer treatment.

Fiber Content of Pods

Data relating to the fiber content of pods indicate fertilizer treatment did not result in significant differences in either 1968 or 1969.

The fiber content of pods was influenced by climatic differences in the two years. Kaldy (27) indicated snap beans were more fibrous when grown under warmer rather than cooler temperatures. The results of the studies reported here indicate the fiber content of pods to be higher in 1969. The temperature (Figure 1, page 19) during the period of pod development in 1969 was higher than the comparable period in 1968.

N, P and K Content of Pods

The standard 40-80-40 band treatment resulted in levels of N, P and K in pods comparable to that of most other treatments.

These data seem to indicate the N, P and K content of pods was not greatly influenced by fertilizer treatments above the 120-480-120 rate.

Ca and Mg Content of Pods

The Ca and Mg content of pods had the same general relationship to treatment as did the content of these elements in the harvest plants. This relationship is essentially one of higher Ca and Mg contents resulting from the standard band treatment and little difference in the content of these elements due to fertilization rates above the 120-480-120 rate.

The standard band treatment appears to concentrate amounts of most nutrients in a position in the soil that is favorable for uptake by the plants.

Mn

The pod content of Mn also reflects the same general relationship to treatment as did the content of this element in the plants at two weeks after germination.

CHAPTER VI

SUMMARY

The purpose of this study was to evaluate the response of snap beans in relation to high soil levels of nitrogen, phosphorus and potassium applied by different placement methods. The factors evaluated were: plant stand, nutrient content of the plants at two weeks after germination and at harvest, yields, pod size distribution, percentage seed, pod color, pod length, pod fiber content and pod nutrient content.

The treatments included a standard band application of 40 pounds of N, 80 pounds of P_2O_5 and 40 pounds of K_2O per acre respectively. This treatment served as the control. Other treatments generally included multiples of three and six times the standard amount applied by broadcast and incorporation over the entire plot area and treatments similar except omitting fertilizer in a six inch area where the seeds were to be drilled. Supplemental narrow bands of N at 10 pounds per acre and P_2O_5 at 20 pounds per acre were also superimposed on two of the treatments with omitted center areas.

The experiments were conducted at the University of Tennessee Plant Sciences farm in Knoxville during the fall of 1968 and the spring of 1969.

Plant stands were significantly reduced both years as a result of high broadcast treatments. Reductions were not as great when high rates of fertilizer were applied in conjunction with omitted center bands.

The nutrient content of plants two weeks after germination and at harvest were generally not significantly higher when amounts of fertilization exceeded 120 pounds of N, 480 pounds of P_2O_5 , and 120 pounds of K_2O per acre. The standard band treatment resulted in a N content of plants at harvest that was comparable to other placement methods and amounts of higher fertilization.

Significant yield increases were generally associated with broadcast treatment at the 120-480-120 level. The P and K content of plants at harvest time due to the standard band treatment indicated these elements may have limited yields at this level and method of fertilization.

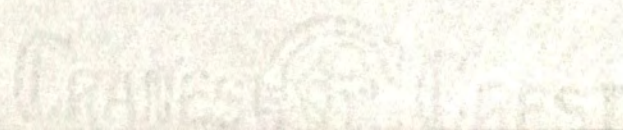
Significant differences in percentage seed and pod length were not generally evident due to treatment.

The distribution of pod sieve size was not significantly influenced by treatment.

The color or fiber content of pods was not significantly influenced due to treatment.



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He was employed as a teacher of vocational agriculture in Taylor County, Kentucky, in 1959. He was employed by Berea College, Berea, Kentucky, from 1960 to 1968 at which time he was granted a leave of absence to pursue the Doctor of Philosophy degree.

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