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POULTRY MANURE for VEGETABLE CROPS — Effects and Value

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POULTRY MANURE for VEGETABLE CROPS – Effects and Value

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THERE IS MUCH disagreement over the value of animal manures in crop production *(2,5)*. Albrecht *(1)* states that organic matter content of the soil offers the best index of the productivity and value of agricultural land. Others have questioned whether manure is worth hauling.

In an Alabama study measuring the separate and combined effects of irrigation, organic material, and fertilizer rates, irrigation increased the average yield of 11 vegetable crops by 2,752 pounds per acre, organic material by 4,987 pounds, and higher fertilizer rates by 3,127 pounds when each was used in combination with the other 2 treatments *(7,8)*.

A study to determine by experiments the actual effects of specific materials on specific crops on sandy soils was undertaken at the Auburn University Agricultural Experiment Station.

STUDY OUTLINE

The study was started in 1962 and continued through 1966. Initial and residual effects were measured. Two series of studies, Series 5 and Series 6, were undertaken. In Series 5, different rates of poultry manure were applied in 1962 and 1963, and residual effects were studied in 1964, 1965, and 1966, Appendix Table 1. In Series 6, different methods and times of application were studied in 1962 and 1963. In 1964, the outline was changed; three treatments continued unaltered, and three treatments were altered to permit comparison of initial and residual effects of manure and commercial fertilizer, Appendix Tables 5 and 6.

Studies were conducted in field plots bordered by concrete walls on three sides and opening into a walkway and drainage alley on the fourth side. Plots were 1/640 acre in size. The soil was limed at the beginning and gypsum added each year after the first year. A mixture of magnesium and micronutrients was added each year. The summer crop was tomatoes, and the fall crops were collards, turnips, and lettuce.

RESULTS

For those interested in responses by years and by seasons, data are given in Appendix Tables 1 to 17.

Initial and Residual Effects of Rates and Kinds of Poultry Manure on Tomatoes, Series 5

Yield and Grade. Broiler manure gave substantial increases in yield at all rates during the initial period and during the first 2 years of the residual period, Appendix Table 1.

Increases in total and marketable yields from the application of broiler manure were recorded each year. Average increases for the broiler manure exceeded 220 cwt. per acre total and 170 cwt. marketable yield for all rates. There were no differences in total or marketable yields among different rates of broiler manure for the 2-year average or for 1963. Yields from hen manure were lower than from broiler manure, but 2-brood broiler manure was as effective as 5-brood.

Residual effects of manure continued for 2 years after the last application of manure at the 9-ton rate. Increases in marketable tomatoes from residual effects of the 9-ton rate over the no-manure plots were 79 cwt. in 1964 and 134 cwt. in 1965. Only in 1965 was there a difference in marketable yields among rates of manure and this was between the 3- and the 9-ton rates.

Except for the first year at the lowest rate, manure did not reduce the percentage of tomatoes in the marketable grade. The percentage of marketable tomatoes from the 6- and 9-ton manure rates in 1963 and from the 9-ton rate in 1965 was higher than from the no-manure treatment.

Earliness. The effect of manure on earliness was not consistent. In 1962, the percentage of early tomatoes was higher from treatments receiving broiler manure than from the no-manure treatment, Appendix Table 2. There was no difference in percentage

of early tomatoes from any manure treatment any year of the residual period.

Cracks and Culls. Manure did not increase cracking or the percentage of culls, Appendix Table 3. In no year was there a significant difference in cull tomatoes. In 1965, there was a significant difference in cracked tomatoes. In that year, the percentage of cracked tomatoes was lower from the 9-ton than from the 3-ton rate.

Size of Fruit. In 1962, size of fruit was 0.02 to 0.04 pounds smaller on the 6-ton and 9-ton broiler manure treatments than on other treatments, Appendix Table 4. In other years, there was no difference in fruit size.

Initial and Residual Effects of Time and Method of Application of Poultry Manure on Tomatoes, Series 6

Yield and Grade. Yield and grade data for Series 6 are given in Appendix Table 5 for the first 2 years and in Appendix Table 6 for the last 3 years. The most obvious effect of method of application was reduction in yield from row application as compared to broadcast applications, Appendix Table 5.

With minor exceptions, manure without commercial fertilizer gave higher yields than fertilizer without manure. Differences amounted to 156 cwt. of marketable tomatoes per acre for the 1962-63 average and to 105 cwt. for 1964-66 average. Only in 1964, when 18 inches of rain fell during April, did the fertilizer without manure produce higher yields than the manure without fertilizer.

Treatments receiving both manure and commercial fertilizer did not give higher yields than those receiving manure alone either of the first 2 years. However, during 2 of the 3 years of the residual period and for the 3-year average, the fertilizer and manure treatment produced considerably higher yields than the manure alone. These differences were 248 cwt. in 1964, 151 cwt. in 1965, and 143 cwt. for the 3-year average.

Yields from both fertilizer and the standard application of manure exceeded yields from fertilizer alone each year of both periods and for the average of each period. The differences in favor of both materials over the fertilizer alone were 196 cwt. per acre for the 1962-63 period and 248 cwt. for the 1964-66 period.

There were no significant differences in the percentage of marketable tomatoes from manure and no-manure plots any single

year of the first or second period, although the difference between the 1964-66 averages for the manure without fertilizer and the fertilizer without manure plots was significant. For the second period, the percentage of marketable tomatoes was 77.7 for the manure with fertilizer and 68.9 for the fertilizer without manure.

Results obtained during the second period, Appendix Table 6, indicated: (1) although manure was added during the second period, omission of fertilizer during the second period resulted in a considerable reduction in yields; (2) addition of manure greatly increased yields where fertilizer was not added during the second period; and (3) application of manure during the first period but not during the second period to plots receiving fertilizer both periods increased yields considerably during the second period. The difference amounted to 172 cwt. of marketable tomatoes per acre in 1964, 173 cwt. in 1965, 83 cwt. in 1966, and 143 cwt. for the 3-year average. These results confirm the relative need for and residual effects of both manure and commercial fertilizer.

Earliness. Data on earliness are given in Appendix Table 7 for the first 2 years and in Appendix Table 8 for the last 3 years. In general, any treatment that resulted in low total yields of marketable tomatoes also resulted in a low actual yield and percentage of early marketable tomatoes. In 1962 and 1963, and for the 1962-63 average, the row application of manure gave lower yields and percentage of early marketable tomatoes than broadcast application.

There was no significant difference in percentage of early tomatoes recorded between treatments receiving manure and not receiving manure for the 1962-63 average. In 1962, tomatoes receiving manure but no fertilizer gave higher percentage of early fruit than tomatoes receiving fertilizer but no manure. The results were reversed in 1963.

Cracks and Culls. Data in Series 6 confirm the Series 5 results indicating that manure does not increase the percentage of cracks or culls, Appendix Table 9. In 1964, a year of abnormally high rainfall, the percentage of cracked tomatoes was 2.6 on plots receiving manure but no fertilizer and 13.3 on plots receiving fertilizer but no manure. This difference was significant at the 0.05 level.

Size of Fruit. Series 6 results showed no significant effect of manure on size of fruit for the first period, except for the row

treatment, Appendix Table 10. Only in 1964 was there a significant difference in fruit size between no-manure plots and those receiving 6 tons broadcast. The fruit receiving manure was larger in 1964 and for the 1964-66 average, Appendix Table 11.

Initial and Residual Effects of Kinds and Rates of Poultry Manure on Yield of Fall Crops, Series 5

Any effect of manure on fall crops in Series 5 during the 5 years of the study was residual. In 1962 and 1963, the residual effect was from application to the earlier tomato crop the same year. In 1964, 1965, and 1966, it was from applications made in 1962 and 1963.

Differences were significant for collards in 1964 only. There was, however, an increase in yield of turnips from the 9-ton rate of manure for 1962, the 1962-63 average, and for 1964, Appendix Table 12.

Initial and Residual Effects of Time and Method of Application of Poultry Manure on Yield of Fall Crops, Series 6

The same rate of manure that was applied to the tomato crop was applied to the 1962 fall crop in Series 6, but none was added in 1963. This permits a comparison in Series 6 of the effects of applying and not applying manure to the fall crop.

Yields in 1962, the only year manure was applied to fall crops, were considerably higher than in any other year of the experiment. Treatments receiving these applications gave yields almost as high as treatments receiving both fertilizer and manure, whereas in all other years plots receiving only manure yielded much less than did plots receiving both fertilizer and manure, Appendix Tables 13 and 14.

Commercial fertilizer applications were the limiting factors on yields during the second period, Appendix Table 14.

While manure did not exert the major influence on fall crops, the 3-year average yields were significantly higher on plots that had received manure, provided commercial fertilizer was also used.

Value of Manure

The value of manure is ultimately measured in dollars. In Series 5, 6 tons of manure per acre gave yield increases valued at $2,687 per acre or $448 per ton of manure. Values per acre increased from $2,687 to $6,419 and values per ton decreased

from $448 to $357 as the annual rates of manure applied increased from 3 to 9 tons per acre, Appendix Table 15. Values in Series 6 were still quite high although shown for only the 2 years manure was applied, Appendix Table 16.

Effect of Poultry Manure on Soil Acidity

Soil samples for soil acidity were taken in November or December.

Acidity of soils in plots receiving manure but no fertilizer remained essentially constant throughout the first and second periods, Appendix Table 17. Acidity of soils receiving commercial fertilizer either with or without manure continued to increase over the years.

Effects of Seasonal Conditions on Effectiveness of Manure

Weather, especially rainfall, exerted a marked influence on the effects of manure. Variation in rainfall from year to year at times caused a complete reversal in relative yields from manure and commercial fertilizer.

The effect of rainfall on relative value of manure and commercial fertilizer is illustrated by yield data in Appendix Tables 5 and 6. Yields of marketable tomatoes from manure without commercial fertilizer exceeded yields from commercial fertilizer without manure by 77 cwt. per acre in 1962, by 235 cwt. in 1963, by 206 cwt. in 1965, and by 172 cwt. in 1966. In 1964, however, the order was reversed and the yield from the commercial fertilizer without manure exceeded that from the manure without fertilizer by 65 cwt. In April 1964, rainfall was 18.10 inches, exceeding 3 inches on 3 different dates. Rainfall in May was 3.01 inches, in June 3.98 inches, and in July 6.01 inches. The first fertilizer application in 1964 was made on April 16 and the second on May 13.

Seasonal effects were shown in percentage of early tomatoes between the years 1962 and 1963, Appendix Table 7.

DISCUSSION

Salter and Schollinberger *(6)* used $3.00 per ton to compute the value of manure on the basis of its nutritive value. In data released by Cottier and Rouse *(3)*, it was reported that a ton of broiler manure had nutrients ranging in value from $8.00 to $13.50 per ton and that the average bird produced 2.6 pounds of

manure. In 1966, Alabama produced 324,120,000 birds. The potential value of poultry manure in Alabama, therefore, ranged from $3,370,848 to $5,688,306 on the basis of nutrient value.

The true value of manure can only be measured by determining its value when used on a particular crop. From data obtained in this study, gross returns from tomatoes grown as an early summer crop followed by turnips or collards grown as a fall crop ranged from $357 to $448 per ton of manure applied, Appendix Table 15. The gross value of poultry in 1966 was $161,100,000. Theoretically the potential value for Alabama poultry manure might then range from $136,097,988 to $195,509,184, figures roughly equivalent to the gross returns from poultry meat. It would be an error, however, to assume that all crops would respond the same as tomatoes and turnips, that the price received for the crops would be similar, and that acreage of such crops would be sufficient to utilize the full amount of the manure produced.

Profitable disposal of manure poses a problem to the poultry producers. There must be a sufficient acreage in crops with potential value per acre high enough to justify use of manure, and there must be a practical method of delivering the manure to users.

The poultry producer is not primarily interested in or equipped for delivering and distributing the product. Other parties should, however, be interested in delivery and there should be a good business in this occupation.

A major problem confronting the party delivering the manure concerns a fair price for the product. Certainly the user cannot pay more than a fraction of its potential value. On a national basis, for each dollar spent for fertilizer approximately three dollars is expected in return. Furthermore, there is a considerable risk on the part of the user in realizing the full potential value from the manure. However, the user and the producer or the one delivering should be able to arrive at a price offering a good return to each.

Certainly the potential value of the manure produced by the poultry industry of Alabama is too high to allow this product to go to waste or to constitute a disposal problem, although the returns may be far less than those reported in this study. Cooperatively owned mechanical equipment for efficient handling or contract handling might be suggested as a means of disposing of

manure at a profit to the poultry producer, the handler of the manure, and the farmer.

SUMMARY

Studies were conducted with poultry manure over a period of 5 years to determine initial and residual effects and comparative effects of poultry manure and commercial fertilizer.

Broiler manure gave substantial increases in yields of tomatoes at all rates during the initial period and for 2 years of the residual period at the 9-ton rate. Manure did not reduce the percentage of tomatoes in the marketable grade or increase percentage of cracks.

The effects of manure applications on earliness were not consistent. In general, they tended to delay maturity under conditions of high rainfall and to hasten maturity under conditions of low rainfall. Manure had little effect on size of fruit.

There was usually not a significant yield increase from tomatoes receiving both manure and commercial fertilizer above that obtained from manure alone during the first 2 years, 1962-63. However, during the residual period the yields from the 2 materials were higher 2 of the 3 years than from manure alone. Row application of manure reduced yields, stands, and vigor of plant.

Weather had a marked effect on the efficient use of manure, often resulting in a reversal in relative effects of manure and commercial fertilizers. In years of normal rainfall, manure gave higher yields than fertilizer. In seasons of high or excessive rainfall, commercial fertilizer gave higher yields than manure.

Residual effects on fall crops from applications of manure in the spring of the same year were less marked than on the spring crop of tomatoes the following year. Without commercial fertilizer, manure failed to produce satisfactory fall crops without reapplication to the fall crops. For the 1964-66 period, manure treatments gave significant increases in yield of fall crops over no manure treatments where commercial fertilizer was also used. Satisfactory increases in yields of fall crops were produced when manure was applied to both spring and fall crops. In the only year manure was reapplied to the fall crop, yields from manure were essentially as high as from commercial fertilizer and manure.

Repeated applications of manure did not appreciably affect soil acidity. Repeated applications of commercial fertilizer increased soil acidity considerably.

Gross returns from tomatoes and turnips at the prices used ranged from $357 to $448 per ton of manure used when it was applied for 2 years to tomatoes and values were determined for 5 years from both crops. Increases in per acre yield and value continued as rates of manure were increased from 3 to 6 to 9 tons per acre. Increases in yield and value from each ton of manure applied decreased as rate of application increased.

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APPENDIX

APPENDIX TABLE 1. MARKETABLE YIELDS AND PERCENTAGE OF MARKETABLE TOMATOES FROM DIFFERENT KINDS AND RATES OF MANURE, SERIES 5

Kinds	Manure applied[1] Broods	Per acre	Marketable yields and percentage[2]					
			Initial effects					
			1962		1963		1962-63 Av.	
	No.	*Tons*	*Cwt.*	*Pct.*	*Cwt.*	*Pct.*	*Cwt.*	*Pct.*
Check	0	0	444c	79.2a	295b	55.2b	369c	67.5bc
Broiler	5	3	556b	74.9b	522a	65.4ab	539ab	70.0b
Broiler	5	6	642a	82.4a	534a	68.7a	590a	75.6a
Broiler	5	9	585ab	81.2a	585a	68.9a	585a	74.6a
Broiler	2	6	564b	77.7a	515a	62.0ab	539ab	69.3bc
Hen		3	538b	78.9a	349b	64.1ab	444bc	72.3ab
			Residual effects					
			1964		1965		1966	
Check	0	0	255b	65.4a	331b	69.2b	213a	69.4a
Broiler	5	3	303ab	69.4a	375b	72.8ab	212a	65.9a
Broiler	5	6	308ab	67.3a	410ab	75.5ab	251a	70.1a
Broiler	5	9	334a	65.4a	465a	79.4a	256a	69.2a
Broiler	2	6	295ab	63.6a	395ab	73.5ab	219a	66.3a
Hen		3	258b	62.2a	400ab	75.1ab	224a	68.1a

[1] Manure applied 3 weeks prior to the tomato crop. Tomatoes were followed by a fall crop of leafy vegetables that did not receive additional manure. No manure applied in 1964, 1965, and 1966. All treatments were fertilized with 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

APPENDIX TABLE 2. MARKETABLE YIELD PERCENTAGE OF EARLY AND MEDIUM TOMATOES FROM DIFFERENT KINDS AND RATES OF POULTRY MANURE, SERIES 5

Manure applied[1]			Maturity distribution of marketable tomatoes[2]					
			Initial effects					
Kind	Broods	Per acre	1962		1963		1962-63 Av.	
			Early	Med.	Early	Med.	Early	Med.
	No.	*Tons*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Check	0	0	9.7c	44.3a	38.6a	40.2ab	21.2b	42.6a
Broiler	5	3	13.7b	39.2a	39.1a	32.3c	26.0a	35.9bc
Broiler	5	6	17.1a	37.7a	30.1a	33.9c	23.0ab	36.0c
Broiler	5	9	14.4b	38.7a	24.8a	34.4c	19.6c	36.5bc
Broiler	2	6	14.4ab	41.5a	28.8a	35.4bc	21.3b	38.6bc
Hen		3	11.9bc	37.7a	33.8a	45.0a	20.6b	40.6ab
			Residual effects					
			1964		1965		1966	
Check	0	0	23.9a	43.1a	23.6a	55.0bc	15.3a	44.4a
Broiler	5	3	21.8a	49.5a	23.6a	61.2a	12.4a	45.7a
Broiler	5	6	21.8a	44.1a	19.4a	54.4bc	7.3a	43.6a
Broiler	5	9	19.5a	50.0a	22.0a	52.8c	11.4a	47.7a
Broiler	2	6	22.7a	49.7a	23.4a	59.5ab	13.6a	41.2a
Hen		3	22.0a	47.2a	17.0a	64.0a	8.4a	36.0a

[1] Manure applied 3 weeks prior to the tomato crop. Tomatoes were followed by a fall crop of leafy vegetables that did not receive additional manure. No manure applied in 1964, 1965, and 1966. All treatments were fertilized with 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

APPENDIX TABLE 3. TOTAL YIELDS AND PERCENTAGE OF CRACKED AND CULL TOMATOES FROM DIFFERENT KINDS AND RATES OF POULTRY MANURE, SERIES 5

Manure applied[1]			Total yields per acre and percentage cracks and culls[2]											
			Initial effects			Residual effects								
Kind	Broods	Per acre	1963			1964			1965			1966		
			Yield	Cracks	Culls	Yield	Cracks	Culls	Yield	Cracks	Culls	Yield	Cracks	Culls
	No.	*Tons*	*Cwt.*	*Pct.*	*Pct.*	*Cwt.*	*Pct.*	*Pct.*	*Cwt.*	*Pct.*	*Pct.*	*Cwt.*	*Pct.*	*Pct.*
Check	0	0	534b	22.8a	22.0a	374c	11.2a	20.7a	478b	12.4ab	18.4a	307a	11.7a	18.8a
Broiler	5	3	798a	18.1a	16.5a	437abc	10.9a	19.7a	516ab	14.0a	13.2a	321a	12.9a	21.2a
Broiler	5	6	784a	14.0a	17.2a	459ab	12.0a	20.7a	543ab	9.7ab	14.8a	358a	14.0a	16.0a
Broiler	5	9	849a	17.0a	14.0a	511a	15.6a	18.8a	586a	9.0b	11.6a	370a	11.3a	19.5a
Broiler	2	6	830a	18.8a	19.1a	464ab	14.0a	22.4a	537ab	10.9ab	15.6a	331a	11.7a	22.0a
Hen		3	544b	13.9a	22.0a	415bc	14.7a	23.1a	533ab	9.7ab	15.2a	329a	13.0a	18.9a

[1] Manure applied 3 weeks prior to the tomato crop. Tomatoes were followed by a fall crop of leafy vegetables that did not receive additional manure. No manure applied in 1964, 1965, and 1966. All treatments were fertilized with 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

APPENDIX TABLE 4. SIZE OF MARKETABLE FRUIT FROM DIFFERENT KINDS AND RATES OF POULTRY MANURE, SERIES 5

Manure applied[1]			Average fruit size[2]						
			Initial effects			Residual effects			
Kind	Broods	Per acre	1962	1963	1962-63 Av.	1964	1965	1966	1964-66 Av.
	No.	*Tons*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Check	0	0	.39a	.42a	.40a	.32a	.35b	.37a	.35a
Broiler	5	3	.38a	.43a	.40a	.36a	.41ab	.37a	.38a
Broiler	5	6	.37b	.39a	.38b	.36a	.40ab	.37a	.38a
Broiler	5	9	.35c	.40a	.38b	.33a	.40ab	.37a	.37a
Broiler	2	6	.37b	.41a	.39ab	.34a	.40ab	.39a	.38a
Hen		3	.39a	.38a	.39ab	.38a	.41ab	.39a	.38a

[1] Manure applied 3 weeks prior to the tomato crop. Tomatoes were followed by a fall crop of leafy vegetables that did not receive additional manure. No manure applied in 1964, 1965, and 1966. All treatments were fertilized with 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Means followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

APPENDIX TABLE 5. MARKETABLE YIELDS PER ACRE AND PERCENTAGE OF MARKETABLE TOMATOES FROM DIFFERENT METHODS AND TIME OF APPLICATION OF POULTRY MANURE, SERIES 6

Treatments[1]		Marketable yields and percentage[2]					
Fertilizer	Manure	1962		1963		1962-63 Av.	
Lb.	*Tons*	*Cwt.*	*Pct.*	*Cwt.*	*Pct.*	*Cwt.*	*Pct.*
0	6[3] BC	535ab	74.9a	561a	67.2a	548ab	70.8a
1,500	6[3] BC	607a	78.4a	570a	64.8a	588a	71.2a
1,500	6[3] Row	387c	73.4a	449ab	65.3a	418bc	68.8a
1,500	6[4] BC	529ab	73.1a	615a	68.8a	572a	70.0a
1,500	6[5] BC	556ab	76.5a	478a	61.5a	517ab	68.8a
1,500	0	458bc	79.4a	326b	62.7a	392c	71.5a

[1] Manure applied to tomatoes and fall crops in 1962, but only to tomato crop in 1963. Fertilizer applied at the rate of 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

[3] Applied 3 weeks before planting.

[4] Applied 6 weeks before planting.

[5] Applied 1 week before planting.

APPENDIX TABLE 6. MARKETABLE YIELDS PER ACRE AND PERCENTAGE OF MARKETABLE TOMATOES FROM INITIAL AND RESIDUAL EFFECTS OF POULTRY MANURE, SERIES 6

Treatments[1]				Marketable yields and percentage[2]							
1962-63		1964-66		1964		1965		1966		1964-66 Av.	
Fertilizer	Broiler manure	Fertilizer	Broiler manure								
Lb.	*Tons*	*Lb.*	*Tons*	*Cwt.*	*Pct.*	*Cwt.*	*Pct.*	*Cwt.*	*Pct.*	*Cwt.*	*Pct.*
0	6	0	6	195c	70.3a	535b	78.8a	445a	79.9a	392b	77.7a
1,500	6	1,500	6	443a	68.7a	686a	79.6a	476a	76.1a	535a	75.3ab
1,500	6	0	6	318b	66.4a	501b	76.6a	361ab	71.9a	393b	72.2abc
1,500	6	0	0	210c	64.5a	200d	75.2a	139c	67.1a	183d	68.7c
1,500	6	1,500	0	432a	69.6a	502b	80.5a	356ab	76.7a	430b	75.5a
1,500	0	1,500	0	260b	60.0a	329c	74.2a	273bc	71.8a	287c	68.9bc

[1] Manure applied to tomatoes and fall crops in 1962, but only to tomato crop in 1963. Fertilizer applied at the rate of 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

APPENDIX TABLE 7. PERCENTAGE OF EARLY AND MEDIUM MARKETABLE TOMATOES FROM DIFFERENT METHODS AND TIME OF APPLICATION OF POULTRY MANURE, SERIES 6

Treatments[1]		Maturity distribution of marketable tomatoes[2]					
		1962		1963		1962-63 Av.	
Fertilizer	Manure	Early	Med.	Early	Med.	Early	Med.
Lb.	*Tons*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
0	6[3] BC	14.0a	35.7a	27.2c	40.6a	20.7a	38.3ab
1,500	6[3] BC	16.7a	37.2a	26.8c	42.0a	21.6a	39.5ab
1,500	6[3] Row	5.5c	18.9b	16.7d	41.6a	11.5b	31.1c
1,500	6[4] BC	13.3ab	36.9a	33.1ab	37.3a	23.9a	37.1b
1,500	6[5] BC	15.5a	36.2a	32.1bc	31.7a	23.0a	34.1b
1,500	0	7.2bc	38.6a	41.2a	45.0a	21.4a	41.3a

[1] Manure applied to tomatoes and fall crops in 1962, but only to tomato crop in 1963. Fertilizer applied at the rate of 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

[3] Applied 3 weeks before planting.

[4] Applied 6 weeks before planting.

[5] Applied 1 week before planting.

APPENDIX TABLE 8. PERCENTAGE OF EARLY AND MEDIUM MARKETABLE TOMATOES FROM INITIAL AND RESIDUAL EFFECTS OF POULTRY MANURE, SERIES 6

Treatments[1]				Maturity distribution of marketable tomatoes[2]					
1962-63		1964-66		1964		1965		1966	
Fertilizer	Broiler manure	Fertilizer	Broiler manure	Early	Med.	Early	Med.	Early	Med.
Lb.	*Tons*	*Lb.*	*Tons*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
0	6	0	6	24.8bc	52.5a	21.0bc	63.4a	6.9a	36.1a
1,500	6	1,500	6	20.8bc	48.1a	16.9c	53.9a	6.4a	36.6a
1,500	6	0	6	28.6ab	48.1a	26.4b	61.1a	8.3a	46.2a
1,500	6	0	0	20.3bc	42.1a	32.9a	49.2a	9.9a	29.6a
1,500	6	1,500	0	18.5c	53.8a	21.6bc	56.9a	8.1a	36.7a
1,500	0	1,500	0	33.1a	47.5a	31.3a	52.7a	9.6a	52.1a

[1] Manure applied to tomatoes and fall crops in 1962, but only to tomato crop in 1963. Fertilizer applied at the rate of 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

APPENDIX TABLE 9. TOTAL YIELDS AND PERCENTAGE OF CRACKED AND CULL TOMATOES FROM INITIAL AND RESIDUAL EFFECTS OF POULTRY MANURE, SERIES 6

Treatments[1]				Yields per acre and percentage cracks and culls[2]											
1962-63		1964-66		1964			1965			1966			1964-66 Av.		
Fertilizer	Broiler manure	Fertilizer	Broiler manure	Total	Cracks	Culls	Total	Cracks	Culls	Total	Cracks	Culls	Total	Cracks	Culls
Lb.	*Tons*	*Lb.*	*Tons*	*Cwt.*	*Pct.*	*Pct.*	*Cwt.*	*Pct.*	*Pct.*	*Cwt.*	*Pct.*	*Pct.*	*Cwt.*	*Pct.*	*Pct.*
0	6	0	6	277e	2.6b	27.0a	679b	11.0a	10.2a	557a	10.0a	10.0a	504b	9.2ab	13.2b
1,500	6	1,500	6	645a	10.3a	20.8a	862a	10.7a	9.7a	635a	13.2a	10.6a	711a	11.3a	13.3b
1,500	6	0	6	478b	10.9a	22.6a	654b	9.4a	14.0a	502ab	14.0a	14.2a	545b	11.2a	16.6b
1,500	6	0	0	326d	4.3b	31.2a	267d	7.2a	17.6a	207c	13.1a	19.8a	266d	7.6b	23.7a
1,500	6	1,500	0	621a	9.1a	21.3a	623b	8.1a	11.4a	465ab	10.1a	13.3a	570b	8.9ab	15.5b
1,500	0	1,500	0	428c	13.3a	25.7a	443c	10.0a	15.8a	380b	12.6a	15.7a	417c	10.7a	19.2ab

[1] Manure applied to tomatoes and fall crops in 1962, but only to tomato crop in 1963. Fertilizer applied at the rate of 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

APPENDIX TABLE 10. SIZE OF MARKETABLE FRUIT FROM METHODS AND TIME OF APPLICATION OF POULTRY MANURE, SERIES 6

Treatments[1]		Average fruit size[2]		
Fertilizer	Manure	1962	1963	1962-63 Av.
Lb.	*Tons*	*Lb.*	*Lb.*	*Lb.*
0	6[3] BC	.40ab	.43a	.41ab
1,500	6[3] BC	.39ab	.43a	.41ab
1,500	6[3] Row	.37b	.39a	.38b
1,500	6[4] BC	.39ab	.43a	.41ab
1,500	6[5] BC	.40ab	.38a	.41ab
1,500	0	.41a	.43a	.42a

[1] Manure applied to tomatoes and fall crops in 1962, but only to the tomato crop in 1963. Fertilizer applied at the rate of 60 lb. N, P_2O_5, and K_2O (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

[3] Applied 3 weeks before planting.

[4] Applied 6 weeks before planting.

[5] Applied 1 week before planting.

APPENDIX TABLE 11. SIZE OF MARKETABLE FRUIT FROM INITIAL AND RESIDUAL EFFECTS OF POULTRY MANURE, SERIES 6

Treatments[1]				Average fruit size[2]			
1962-63		1964-66		1964	1965	1966	1964-66 Av.
Fertilizer	Manure	Fertilizer	Manure				
Lb.	*Tons*	*Lb.*	*Tons*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	6	0	6	.31b	.46a	.45a	.42b
1,500	6	1,500	6	.37a	.45a	.42a	.42b
1,500	6	0	6	.37a	.45a	.48a	.45a
1,500	6	0	0	.31b	.34b	.32a	.31d
1,500	6	1,500	0	.36a	.42a	.44a	.45a
1,500	0	1,500	0	.30c	.42a	.39a	.38c

[1] Manure applied to tomatoes and fall crops in 1962, but only to tomato crop in 1963. Fertilizer applied at the rate of 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

APPENDIX TABLE 12. YIELDS OF FALL CROPS FROM DIFFERENT RATES AND KINDS OF POULTRY MANURE, SERIES 5

Manure applied[1]			Yields per acre[2]						
			Initial effects			Residual effects			
Kind	Broods	Per acre	1962	1963	1962-63 Av.	1964	1965	1966	1964-66 Av.
	No.	*Tons*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*
						Collards			
Check	0	0	185a	149a	167a	33c	132a	61a	75a
Broiler	5	3	178a	156a	167a	47abc	136a	62a	82a
Broiler	5	6	196a	201a	198a	46abc	143a	48a	79a
Broiler	5	9	227a	209a	218a	54ab	146a	63a	87a
Broiler	2	6	195a	217a	206a	57a	146a	49a	84a
Hen		3	169a	167a	168a	40bc	137a	59a	77a
						Turnips			
Check	0	0	612b	508a	560b	194b	358a	161a	238a
Broiler	5	3	610b	472a	541b	266ab	365a	139a	257a
Broiler	5	6	706ab	494a	600ab	297ab	333a	162a	264a
Broiler	5	9	813a	549a	681a	357a	427a	144a	309a
Broiler	2	6	680b	503a	592b	282ab	450a	145a	292a
Hen		3	652b	437a	545b	232b	379a	144a	252a

[1] Manure applied 3 weeks prior to the tomato crop. Tomatoes were followed by a fall crop of leafy vegetables that did not receive additional manure. No manure applied in 1964, 1965, and 1966. All treatments were fertilized with 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

APPENDIX TABLE 13. YIELDS OF FALL CROPS FROM METHODS AND TIME OF APPLICATION OF MANURE, SERIES 6

Treatments[1]		Yields per acre[2]					
		Collards			Turnips		
Fertilizer	Manure	1962	1963	1962-63 Av.	1962	1963	1962-63 Av.
Lb.	*Tons*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*
0	6[3] BC	255ab	38b	147b	713bc	119b	416c
1,500	6[3] BC	231ab	153a	192ab	853ab	376a	614a
1,500	6[3] Row	226ab	133a	180ab	903a	359a	631a
1,500	6[4] BC	288a	172a	230a	873ab	339a	606a
1,500	6[5] BC	224ab	132a	178ab	707bc	362a	534ab
1,500	0	166b	137a	152b	629c	323a	476bc

[1] Manure applied to tomatoes and fall crops in 1962, but only to tomato crop in 1963. Fertilizer applied at the rate of 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

[3] Applied 3 weeks before planting.

[4] Applied 6 weeks before planting.

[5] Applied 1 week before planting.

APPENDIX TABLE 14. YIELDS OF FALL CROPS FROM INITIAL AND RESIDUAL EFFECTS OF POULTRY MANURE, SERIES 6

Treatments[1]				Yields per acre[2]							
1962-63		1964-66		Collards				Turnips			
Fertilizer	Manure	Fertilizer	Manure	1964	1965	1966	1964-66 Av.	1964	1965	1966	1964-66 Av.
Lb.	*Tons*	*Lb.*	*Tons*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*
0	6	0	6	10c	37b	4c	17c	85c	156c	11b	84c
1,500	6	1,500	6	76a	188a	84a	116a	422a	441ab	124a	329a
1,500	6	0	6	11c	25b	6c	14c	51c	142cd	6b	66c
1,500	6	0	0	10c	15b	2c	9c	67c	101d	3b	57c
1,500	6	1,500	0	86a	185a	61b	111a	405a	462a	96a	321a
1,500	0	1,500	0	53b	152a	45b	83b	261b	412b	108a	260b

[1] Manure applied to tomatoes and fall crops in 1962, but only to tomato crop in 1963. Fertilizer applied at the rate of 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

APPENDIX TABLE 15. MARKETABLE YIELDS, INCREASES, AND VALUE OF INCREASES FROM DIFFERENT RATES AND SOURCES OF POULTRY MANURE, SERIES 5

Manure applied[1]			Yields, increases, and value of increases[2 3]							
			Tomatoes			Turnips			Both crops	
Kind	Broods	Total per acre	Yield per acre	Increase from manure	Value of increase	Yield per acre	Increase from manure	Value of increase	Value of increase	Value each ton manure applied
	No.	*Tons*	*Cwt.*	*Cwt.*	*Dol.*	*Cwt.*	*Cwt.*	*Dol.*	*Dol.*	*Dol.*
Check	0	0	1,537	----	----	1,833	----	----	----	----
Broiler	5	6	1,969	432	2,592	1,852	19	95	2,687	448
Broiler	5	12	2,149	612	3,672	1,992	159	795	4,467	372
Broiler	5	18	2,226	689	4,134	2,290	457	2,285	6,419	357
Broiler	2	12	1,988	451	2,706	2,060	227	1,135	3,841	320
Hen		6	1,769	232	1,392	1,844	11	55	1,447	241

[1] Manure applied 3 weeks prior to the tomato crop. Tomatoes were followed by a fall crop of leafy vegetables that did not receive additional manure. No manure applied in 1964, 1965, and 1966. All treatments were fertilized with 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Yields and values measured over 5-year period, 1962-1966.

[3] Tomatoes valued at $6.00 and turnips at $5.00 per hundredweight.

APPENDIX TABLE 16. MARKETABLE YIELDS, INCREASES, AND VALUE OF INCREASES FROM DIFFERENT TIME AND METHODS OF APPLICATION OF POULTRY MANURE, SERIES 6

Treatments[1]		Yields, increases, and value of increases[2]							
		Tomatoes[6]			Turnips[6]			Both crops[6]	
Fertilizer	Manure per acre	Yield	Increase from manure	Value of increase	Yield	Increase from manure	Value of increase	Total value of increase	Value each ton of manure app.
Lb.	*Tons*	*Cwt.*	*Cwt.*	*Dol.*	*Cwt.*	*Cwt.*	*Dol.*	*Dol.*	*Dol.*
1,500	18[3] BC	1,177	394	2,364	1,229	277	1,385	3,749	208
1,500	18[3] Row	836	53	318	1,262	310	1,550	1,868	104
1,500	18[4] BC	1,143	360	2,160	1,212	260	1,300	3,460	192
1,500	18[5] BC	1,034	251	1,506	1,069	117	585	2,091	116
1,500	0	783	----	----	952	----	----	----	----

[1] Manure applied 3 weeks prior to the tomato crop. Tomatoes were followed by a fall crop of leafy vegetables that did not receive additional manure. No manure applied in 1964, 1965, and 1966. All treatments were fertilized with 60 lb. N, P_2O_5, and K_2O per acre (60 lb. N, 26 lb. P, and 50 lb. K) before and again about 4 weeks after planting both the spring and fall crops.

[2] Yields, increases and values for 1962 and 1963.

[3] Applied 3 weeks before planting.

[4] Applied 6 weeks before planting.

[5] Applied 1 week before planting.

[6] Tomatoes value at $6.00 and turnips at $5.00 per hundredweight.

APPENDIX TABLE 17. SOIL ACIDITY FROM INITIAL AND RESIDUAL EFFECTS OF MANURE AND FERTILIZER APPLICATIONS, SERIES 6

Treatments				Soil acidity[1]				
1962-63		1964-66						
Fertilizer per acre[2 3]	Man.	Fertilizer per acre[2 3]	Man.	1962 11/14	1963 11/6	1964 11/13	1965 12/3	1966 11/16
Lb.	*Tons*	*Lb.*	*Tons*	*pH*	*pH*	*pH*	*pH*	*pH*
0	6	0	6	6.80a	6.68a	6.73a	6.53a	6.57a
1,500	6	1,500	6	6.25c	5.60b	5.70c	5.23d	5.10d
1,500	6	0	6	6.38bc	5.73b	6.33b	6.27b	6.40b
1,500	6	0	0	6.43bc	5.50b	6.23b	6.18b	6.33b
1,500	6	1,500	0	6.27c	5.70b	5.87c	5.27d	5.13d
1,500	0	1,500	0	6.47b	5.68b	5.85c	5.55c	5.20c

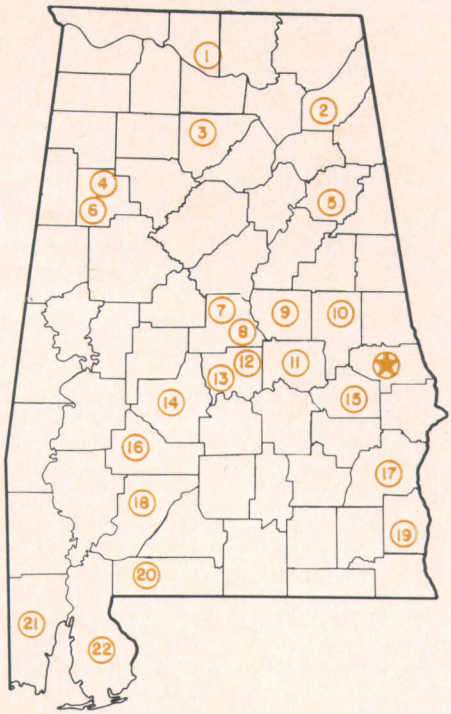
[1] Figures followed by the same letter do not differ significantly at the 0.05 level by Duncan's test.

[2] Fertilizer applied each year to both crops where treatment received fertilizer; nitrogen was derived ¾ from ammonium and ¼ from nitrate forms. The soil was limed at the beginning of the study to aproximately 7.0 pH.

[3] Manure during the 1962-64 period applied only to tomatoes except in 1962 when it was applied to tomatoes and fall crops.

AGRICULTURAL EXPERIMENT STATION SYSTEM OF ALABAMA'S LAND-GRANT UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Alexandria Experiment Field, Alexandria.
6. Forestry Unit, Fayette County.
7. Thorsby Foundation Seed Stocks Farm, Thorsby.
8. Chilton Area Horticulture Substation, Clanton.
9. Forestry Unit, Coosa County.
10. Piedmont Substation, Camp Hill.
11. Plant Breeding Unit, Tallassee.
12. Forestry Unit, Autauga County.
13. Prattville Experiment Field, Prattville.
14. Black Belt Substation, Marion Junction.
15. Tuskegee Experiment Field, Tuskegee.
16. Lower Coastal Plain Substation, Camden.
17. Forestry Unit, Barbour County.
18. Monroeville Experiment Field, Monroeville.
19. Wiregrass Substation, Headland.
20. Brewton Experiment Field, Brewton.
21. Ornamental Horticulture Field Station, Spring Hill.
22. Gulf Coast Substation, Fairhope.