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Hairy Vetch and Austrian Winter Peas for Soil Improvement

A PROGRESS REPORT

A GOOD CROP OF VETCH (12,950 POUNDS PER ACRE) WAS TURNED UNDER FOR THIS CORN. IT PRODUCED 66.1 BUSHELS PER ACRE, WHEREAS CORN WITHOUT VETCH OR COMMERCIAL NITROGEN PRODUCED 7.9 BUSHELS. (PHOTOGRAPHED AUG. 24, 1933, SAND MOUNTAIN SUBSTATION.)

AGRICULTURAL EXPERIMENT STATION
OF THE
ALABAMA POLYTECHNIC INSTITUTE

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Hairy Vetch and Austrian Winter Peas for Soil Improvement[1]

A PROGRESS REPORT

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THE MOST important problem of any farmer is to obtain the largest possible net return from his farm operation. Greater net returns may be obtained by either increasing the gross return or by reducing the cost of production or by the operation of both of these factors. The farmer can obtain greater gross returns per acre by increasing the yields. Lower production costs per unit of product can be most effectively obtained by the employment of those practices which give the highest yields at the least cost. High yields at a low production cost per unit is therefore the most important concern of the farmer.

In Alabama, the average yield of lint cotton is approximately 200 pounds and of corn approximately 13 bushels per acre. The desirability of profitably increasing the crop yields per acre is evident. These yields may be increased by applications of the right kinds and amounts of commercial fertilizers or by "turning under" certain legumes which were properly fertilized. It is the purpose of this circular to report typical results of experiments concerning the value of vetch and Austrian winter peas in the cropping system and to point out some of the problems in the production of these crops.

It is intended to place the emphasis in this circular on vetch rather than Austrian winter peas since vetch was used as the soil improving crop in most of the instances cited. Austrian winter peas grow more rapidly in the winter than hairy vetch and are thus ready to turn under earlier. They usually make an excellent crop the first year they are planted on an area, but since they are attacked by disease more than is vetch they should not be grown continuously on the same area. After growing a crop of Austrian winter peas it is preferable to skip several years before they are again planted on the same area; in the meantime vetch may be grown if desired.

THE EFFECT OF VETCH OR AUSTRIAN WINTER PEAS IN CROPPING SYSTEMS

During the past six years experiments have been conducted at the Sand Mountain, Tennessee Valley, and Wiregrass Substations which show the value of vetch and Austrian winter peas

[1]The experiments herein reported were initiated by Director M. J. Funchess and conducted by R. C. Christopher, Fred Stewart, J. P. Wilson, J. T. Williamson, and E. L. Mayton. The manuscript was prepared by J. W. Tidmore and D. G. Sturkie.

for cotton and corn grown without rotation and for these crops grown in a two-year rotation. In each instance, each area received during the year a 0-10-4 fertilizer at the rate of 600 pounds per acre. The experiments were designed so that the value of the winter legumes might be compared with that of commercial nitrogen.

Vetch for Cotton or Corn Without Rotation.—Experiments were conducted in which cotton and corn were grown each year on respective areas. The basic fertilizer treatment for all plots was 600 pounds per acre of a 0-10-4 fertilizer. On certain plots no nitrogen was added, on other plots the cotton and corn received commercial nitrogen (225 pounds per acre of nitrate of soda or its equivalent), and on other plots vetch or Austrian winter peas were planted in the cotton and corn middles each fall and turned under in the spring. Where vetch or Austrian winter peas were grown for cotton, two thirds of the phosphate and potash (mentioned above) were applied in the fall for the legume and one third in the spring for the cotton; on the other cotton plots all of the fertilizer was applied in the spring. Where vetch or Austrian winter peas were grown for corn, all of the phosphate and potash was applied in the fall for the legume; on the other corn plots all of the fertilizer was applied in the spring for the corn. The results are shown in Table 1.

It will be seen that commercial nitrogen (225 pounds of nitrate of soda or its equivalent) increased the yield of seed cotton by an average of 564 pounds per acre. This amount of cotton was worth approximately $22 and the nitrogen cost was $3.72. The plots where vetch or Austrian winter peas were turned under produced an average of 628 pounds of seed cotton per acre more than those which received neither legumes

TABLE 1.—Average Annual Yields of Seed Cotton and Corn Produced Without Nitrogen, With Commercial Nitrogen, and With Vetch at the Substations Indicated, 1930-1935.

Substations	Cotton—Pounds per acre			Corn—Bushels per acre		
	Fertilizer—600 lbs. per acre[1]			Fertilizer—600 lbs. per acre[2]		
	0-10-4	6-10-4	Vetch[3] 0-10-4	0-10-4	6-10-4	Vetch[4] 0-10-4
Sand Mountain	500	1,394	1,730	12.0	41.3	37.4
Tennessee Valley	919	1,154	1,140	23.2	29.9	31.0
Wiregrass	670	1,232	1,102[5]	15.5	29.9	29.1
Average	696	1,260	1,324	16.9	33.7	32.5

[1]Where vetch was grown for cotton, two thirds of the phosphate and potash were applied in the fall for the legume and one third in the spring for the cotton.

[2]Where vetch was grown for corn, all of the phosphate and potash was applied in the fall for the legume.

[3]Green weight, pounds per acre, of vetch or Austrian winter peas turned under for cotton: Sand Mountain, 9,471; Tennessee Valley, 8,628; Wiregrass, 4,728. Average of 7,609 pounds.

[4]Green weight, pounds per acre, of vetch or Austrian winter peas turned under for corn: Sand Mountain, 4,898; Tennessee Valley, 7,511; Wiregrass, 5,824. Average of 6,111 pounds.

[5]Austrian winter peas used in this experiment first four years and hairy vetch last two years.

nor commercial nitrogen. This amount of cotton was worth about $25 and the cost of legume seed and planting was approximately $2.50. For cotton grown without rotation, these results would indicate that the winter legume was more profitable than the commercial nitrogen by about $3.78 per acre.

In Table 1 is shown the effect of commercial nitrogen and vetch or Austrian winter peas on corn yields where corn was grown on the same land each year. On the average, commercial nitrogen (225 pounds of nitrate of soda or its equivalent) increased the yield of corn by 16.8 bushels per acre. This increase (at 75 cents per bushel) was worth $12.60 and the nitrogen cost was $3.72; this means that the increased yield was produced at a cost of 22 cents per bushel. When vetch or Austrian winter peas were plowed under and followed by corn, the corn yield was increased an average of 15.6 bushels per acre. If a cost of $2.50 per acre is allowed for the winter legume, the increased corn yield was produced at a cost of about 16 cents per bushel.

Vetch for Cotton and Corn in a Two-Year Rotation.—Experiments have been conducted during the past six years at the Sand Mountain, Tennessee Valley, and Wiregrass Substations which afford a comparison of the value of commercial nitrogen and that of vetch for cotton and corn in a two-year rotation. The cropping systems are shown in Table 2. It may be seen that in

TABLE 2.—Average Annual Yields of Seed Cotton and Corn Produced in Various Cropping Systems at the Sand Mountain, Tennessee Valley, and Wiregrass Substations, the Value of the Increased Yields from Commercial Nitrogen and Vetch, and the Production Cost of the Increases, 1930-1935.

Cropping Systems[1]	One acre of cotton and one acre of corn					
	Yields per acre		Value of crops less cost of fertilizer and legume[2]	Increase over cotton-corn. No nitrogen	Cost of increase	
	Cotton	Corn			Cotton per pound lint	Corn per bushel
	Lbs.	Bus.	$	$	¢	¢
Cotton—Corn. No nitrogen	795	16.3	36.36	---- ----	----	----
Cotton—Corn. 36 lbs. nitrogen to each	1,325	31.9	61.82	25.46	2.1	24
Cotton—Vetch—Corn. No commercial nitrogen	1,008	34.4[3]	55.96	19.60	----	14
Cotton—Vetch—Corn. 36 lbs. nitrogen to cotton	1.468	39.7[4]	74.61	38.25	1.7	11

[1]600 pounds of 0-10-4 was applied annually to each plot; where vetch was grown this fertilizer was applied in the fall for vetch.

[2]The seed cotton was valued at 4 cents per pound, the corn at 75 cents per bushel, superphosphate at $16 per ton, muriate of potash at $33, nitrate of soda at $33, and vetch at $2.50 per acre.

[3]Average green weight of vetch turned under was 7,810 pounds per acre.

[4]Average green weight of vetch turned under was 10,475 pounds per acre.

the last two rotations given, cotton was followed by vetch which was turned under in the spring for corn and this corn was followed by cotton. In all of the rotations shown in Table 2, the basic fertilizer applied annually was 600 pounds per acre of a 0-10-4 to each plot. Where vetch was used, this amount of fertilizer was applied in the fall for the vetch and no commercial fertilizer was applied in the spring for the corn. In the other cases, 600 pounds per acre of a 0-10-4 fertilizer was applied for cotton and that amount for corn except where commercial nitrogen was used, in which case a 6-10-4 fertilizer was applied to both crops. The average results from these tests are shown in Table 2.

The data show that commercial nitrogen (225 pounds of nitrate of soda per acre or its equivalent) increased the yield of seed cotton (average for the three substations) by 530 pounds and the yield of corn by 15.6 bushels per acre. The total value of the two crops on the two acres, after deducting the cost of fertilizer, was about $25 more than where no nitrogen was used. In the case of the rotation of cotton-vetch-corn, the vetch increased the corn yield 18 bushels at a cost of 14 cents per bushel. *In addition to the influence of the vetch on the corn crop, the residue the second year from this vetch increased the cotton yield by 213 pounds per acre.* This amount of cotton is worth about $8 which is usually sufficient to buy vetch seed for 4 acres.

The best cropping system, shown in Table 2, is the rotation of cotton-vetch-corn where commercial nitrogen (225 pounds of nitrate of soda or its equivalent) was applied for the cotton. This practice gave 673 pounds of seed cotton and 23.4 bushels of corn per acre more than the rotation of cotton-corn without nitrogen. These increased yields were produced at a cost of 1.7 cents per pound of lint cotton and 11 cents per bushel of corn. In addition to producing the highest yields per acre, this cropping system gave the lowest production costs per unit.

It is possible that vetch grown and turned under for cotton and for corn would give more profitable yields than the above mentioned system if a sufficient acreage of vetch could be planted and turned at the proper time. In actual practice, the farmer would be unable to turn vetch for both crops at the proper time.

THE PHOSPHATE REQUIREMENT FOR VETCH AND AUSTRIAN WINTER PEAS

In the experiments discussed above, superphosphate was applied in the fall for vetch at the rates of 250 or 375 pounds per acre. It is desirable, however, to report the results of experiments which show the value of phosphate for vetch.

The value of legumes in the cropping system and the effect of phosphorus on legumes are clearly shown in an experiment

conducted at Auburn during the past several years. In this experiment cowpeas and vetch were used as often as possible in a three-year rotation of corn, cotton, and oats. The plot treatments and results are shown in Table 3. Plots A and B were fertilized exactly alike; Plot A received a summer and winter legume (turned under) in the rotation and Plot B did not. It will be seen that the legumes produced on Plot A were sufficient to increase the yield of seed cotton by 705 pounds and the corn yield by 29.5 bushels per acre. Legumes were also planted on Plot 1 without fertilizer; the legumes made very poor growth due to a lack of fertilizer and, therefore, had very little effect on the yields of cotton and corn.

Another experiment conducted on the experiment fields near Andalusia, Hackleburg, and Sylacauga shows the importance of superphosphate for vetch. The amounts of vetch produced on each of these fields without and with superphosphate are shown in Table 4. These figures show that without phosphate a very small amount of vetch was produced; the amount of green vetch turned under was too small to produce a large corn yield. When 400 pounds of superphosphate was applied in the fall for vetch, the vetch yield was approximately four times as great as where no phosphate was used. An example of the influence of phosphate on vetch is shown in Figure 1.

FIGURE 1.—Phosphate left; no phosphate right. On the farm of J. J. Boyd, Hackleburg.

TABLE 3.—The Yields of Vetch and of Succeeding Crops of Cotton and Corn as Affected by Phosphate and Potash in a Three-Year Rotation at Auburn, Alabama, 1929-1932, Inclusive.

Plot	Treatment[1]	Yield per acre			
		Vetch preceding cotton	Seed cotton	Vetch preceding corn	Corn
		Lbs.	Lbs.	Lbs.	Bus.
A	240 lbs. Superphosphate 50 lbs. Muriate of potash Summer and winter legume[2]	4,276	958	5,411	37.8
B	240 lbs. Superphosphate 50 lbs. Muriate of potash No legumes	.....	253	.....	8.3
1	No fertilizer Summer and winter legume[2]	952	205	1,238	18.8

[1]The fertilizer was applied in the spring before planting the cotton and corn.
[2]Vetch preceded the cotton and corn; cowpeas were planted in corn middles and after oats which preceded corn.

TABLE 4.—The Yield of Vetch as Affected by Superphosphate.

Fertilizer (Pounds per acre)	Green weight—pounds per acre			
	Andalusia Average 7 years 1927-1933	Sylacauga Average 7 years 1929-1935	Hackleburg Average 9 years 1927-1935	Average 23 crops
None	2,734	723	964	1,473
400 lbs. Superphosphate	8.092	4,425	5,254	5,923

The results of another experiment may be reported which show that phosphate is required for a good growth of vetch. At five of the experiment fields and three of the substations tests have been conducted during the past six years for the purpose of determining the influence of various fertilizer treatments on vetch yields and the subsequent effect on corn and cotton yields. The results of only a few of the treatments are of interest here. The average results are reported in Table 5. The two-year rotation was as follows: cotton followed by vetch which was turned under the next spring for corn and this corn was followed by cotton. Two thirds of the phosphate and potash shown in Table 5 were applied in the fall for the vetch and the other one third was applied for the cotton. By referring to Table 5, it may be seen that without fertilizer 4288 pounds per acre of vetch was produced which was sufficient to produce under the conditions of these experiments 25.8 bushels of corn and leave a residue sufficient to produce only 751 pounds per acre of seed cotton the following year. When 600 pounds per acre of superphosphate was used in the rotation (400 pounds for vetch and 200 pounds for cotton), 9221 pounds of vetch was grown which produced 31.2 bushels of corn per acre and the

TABLE 5.—The Yields of Vetch and of Succeeding Crops as Affected by Phosphate and Potash in a Two-Year Rotation (Cotton-Vetch-Corn and Soybeans), 1930-1935.

Plot	Fertilizer (Pounds per acre)[1]	Yields per acre[2]		
		Seed cotton	Vetch	Corn[3]
		Lbs.	Lbs.	Bus.
Checks	None	751	4,288	25.8
2	600 Superphosphate	946	9,221	31.2
3	600 Superphosphate 75 Muriate of potash	1,047	9,959	32.3
4	600 Superphosphate 75 Muriate of potash 100 Soda to cotton and corn	1,218	10,612	33.9

[1]Two thirds of the phosphate and potash were applied to vetch in the fall and one third to cotton.

[2]Six-year average yield on Sand Mountain, Tennessee Valley, and Wiregrass Substations, and on Alexandria, Aliceville, Brewton, Monroeville, and Prattville Experiment Fields.

[3]The corn yields are low because soybeans were interplanted with corn five of the six-year period.

residue of this vetch plus 200 pounds of superphosphate per acre gave 946 pounds of seed cotton.

Plot 3 received during the two-year rotation 600 pounds of superphosphate and 75 pounds of muriate of potash. The potash did not materially influence the growth of vetch or corn, but the potash increased the cotton yield about 100 pounds of seed cotton per acre. That vetch residue did not supply sufficient nitrogen for the cotton is shown by the fact that nitrate of soda at the rate of 100 pounds per acre further increased the cotton yield by 171 pounds of seed cotton per acre. On the other hand, the corn yield following vetch was practically the same as that following vetch plus an application of 100 pounds of nitrate of soda per acre. This shows that the vetch turned under on Plots 2 and 3 was sufficient for maximum corn yields.

RELATIVE AMOUNTS OF NITROGEN IN ROOTS AND TOPS OF AUSTRIAN WINTER PEAS

The question is often raised as to the value of tops and roots of vetch and Austrian winter peas for improving the soil. In order to determine this, a test was made at Auburn in the spring of 1929. Plants of Austrian winter peas were carefully dug and the soil washed from the roots; the tops and roots were separated, dried, weighed, and analyzed for nitrogen. The nodules were left on the roots and thus the root analyses are for roots and nodules. The results are shown in Table 6.

These results show that on February 8, 82 per cent of the total nitrogen in the plant was in the tops and on March 4, 92.6 per cent of the nitrogen was in the tops. These data show that it is necessary to plow under the tops in order to furnish ample nitrogen for the succeeding crop.

TABLE 6.—Dry Matter and Nitrogen in the Tops and Roots of Austrian Winter Peas at Auburn, Alabama.[1]

Part of plant	Dry matter		Nitrogen	
	Per cent	Per cent of the total in	Per cent	Per cent of the total in
	February 8, 1929			
Tops	20.4	76.3	3.15	82
Roots	17.0	23.7	2.26	18
	March 4, 1929			
Tops	18.2	91.5	3.78	92.6
Roots	11.2	8.5	3.24	7.4

[1]Average of 6 tests on each date shown.
(These determinations were made by E. L. Mayton.)

SUGGESTIONS FOR SUCCESS WITH VETCH OR AUSTRIAN WINTER PEAS

(1) Twenty pounds per acre of hairy vetch seed or 30 pounds of Austrian winter peas should be planted; seeding should be done during September or the first half of October. Under average conditions, early planting enables the plants to form a good root system before winter.

(2) Hairy vetch and Austrian winter peas must be inoculated when they are planted on the land for the first time. This may be accomplished by using soil from a field which has grown a good crop of either vetch or Austrian winter peas or by the use of a good commercial culture. In order for the inoculated soil or commercial inoculant to stick to the seed, the seed should be moistened with thin syrup and mixed with the inoculated material before planting. There is less chance of failure in inoculation if both commercial culture and soil are used.

(3) Superphosphate should be applied at the rate of 300 to 400 pounds per acre or the equivalent of basic slag at the time of planting unless the land has received annually the equivalent of this amount of phosphate for several years. Basic slag may be mixed with the seed and inoculant at the time of planting without injury to the inoculation. Superphosphate may injure inoculation if it is mixed with the seed and inoculant.

(4) Vetch or Austrian winter peas may be planted either by broadcasting or drilling. Drilling is preferable.

(a) *Broadcast.*—After sowing the seed, they may be covered with a disk harrow, a "Gee Whiz", a "scrape", a cultivator with disk hillers or plows, a "turn plow", or a "middle buster". The operations should move the seed from the middles toward the old cotton or corn rows.

(b) *Drilling.*—Experimental results and field experience show that drilling vetch or Austrian winter pea seed is a safe method of planting. It is the most generally used method in North Alabama. It is also rapid and the most practical method of planting before harvesting a crop which may be on the land. By drilling, the depth of planting (2 inches) can be controlled. Inoculation seldom fails if well inoculated soil is put down in a small stream with the seed. The three-row drill is well adapted for planting between cotton and corn rows. The middle drill should be closed since a row of vetch or Austrian winter peas planted in the center of the cotton middle is likely to be drowned or "sanded out". In using any type of drill, some means must be provided to drag the loose soil back into the furrows so that they will be filled practically level. Failure to fill these furrows may result in soil being washed into the furrow and covering the young plants. A good "knocker" or vibrator fertilizer distributor is very satisfactory for planting vetch and Austrian winter peas. Regardless of the type of drill which may be used for planting vetch or Austrian winter peas, the seed should be placed as near the old cotton stalks as possible. This is an important point because in addition to the phosphate added the plants will have access to the residual phosphate applied for the previous crop.

(5) Vetch and Austrian winter peas should be turned under in the spring as soon as 15 to 20 pounds of green tops per 100 square feet have been produced. Figure 2 shows an area of vetch which produced 6600 pounds of green material per acre or approximately 15 pounds per 100 square feet. This growth of vetch appears to be small, yet it was sufficient to increase the yield of corn 40 bushels per acre.

Crops following vetch may be lost if turning is delayed to get an extra large growth. Turning should be done before the winter and early spring moisture is lost from the soil. Dry weather may result in the land becoming so hard that the vetch cannot be turned satisfactorily; thus, planting the following crops may be delayed so long as to greatly reduce the yield.

(6) When vetch or Austrian winter peas will produce 15 to 20 pounds of green matter per 100 square feet, the plants may be turned under with a two-horse plow which has a 12-inch rolling coulter attached. Such a plow is shown in Figure 3.

(7) Corn and cotton should not be planted for at least two weeks after the vetch or Austrian winter peas have been turned under. Poor stands may result if this precaution is not ob-

FIGURE 2.—This vetch has made sufficient growth; it weighed 15.1 pounds per 100 square feet. Corn following this crop produced 47.3 bushels per acre on land which made 6.7 bushels without vetch or commercial nitrogen. The vetch was photographed and turned under at the Sand Mountain Substation on April 4, 1935.

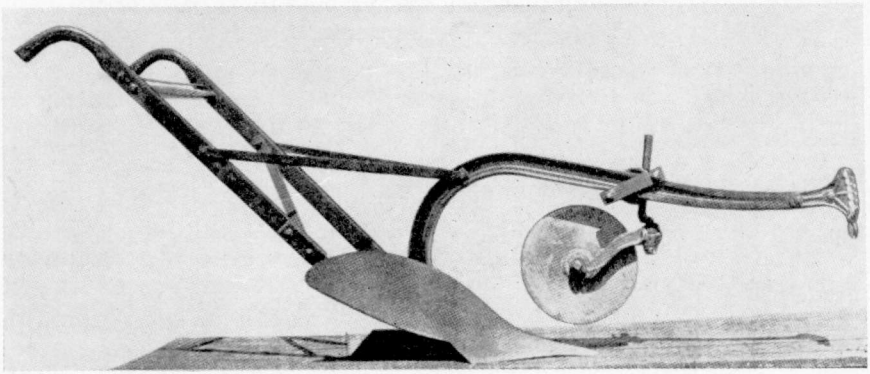

FIGURE 3.—Two-horse plow with rolling coulter properly adjusted. This plow turns winter legumes satisfactorily. The plow should be adapted to the type of soil. (Photograph was supplied by J. C. Lowery.)

served. Worm damage to corn usually follows if planting is done too soon after turning.

SUMMARY

The results of field tests to determine the value of vetch or Austrian winter peas for increasing cotton and corn yields and

suggestions for success with these crops are given and discussed. These results may be briefly summarized as follows:

(1) Where cotton and corn were grown on respective areas each year, vetch or Austrian winter peas (turned under) increased the yield of seed cotton by 628 pounds and of corn by 15.6 bushels per acre.

(2) The increase in cotton yield due to the vetch or Austrian winter peas was worth $3.78 per acre more than the increase from 225 pounds of nitrate of soda or its equivalent after considering the cost of the legume seed and the cost of the soda.

(3) Where corn was grown without rotation and was preceded by vetch or Austrian winter peas, the cost of the increased yield was 16 cents per bushel.

(4) Vetch or Austrian winter peas grown in a two-year rotation (cotton-winter legume-corn) increased the corn yield 18 bushels per acre at a cost of 14 cents per bushel. *In addition to the influence of the legumes on the corn crop, the residue the second year from these legumes increased the cotton yield by 213 pounds of seed cotton per acre.*

(5) Vetch or Austrian winter peas, when not fertilized with a sufficient amount of phosphate, usually failed to make enough growth to economically increase cotton and corn yields; whereas, with a sufficient application of phosphate they made enough growth to greatly increase the yields of subsequent crops.

(6) In order to furnish sufficient nitrogen for the succeeding crop, is it necessary to turn under the tops of vetch or Austrian winter peas since approximately 90 per cent of the total nitrogen in the legume plant is in the tops at the proper time for turning.

(7) The essentials for success with vetch and Austrian winter peas for soil improvement are:

(a) Early planting—September or first half of October.

(b) Planting as close as practical to the old cotton or corn stalks.

(c) Inoculation—if planting on a given area for the first time.

(d) Use 300 to 400 pounds of superphosphate or 600 pounds of basic slag per acre unless the land has been *well fertilized* with phosphate for several years.

(e) Turning under in the spring when the green tops harvested from 100 square feet weigh 15 to 20 pounds.

(f) Waiting at least two weeks before planting the succeeding crop.