Field Selection, Tillage, and Fertilization

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Field Site Selection

Ideally, sites for tobacco production should be chosen 2 to 3 years in advance of planting. This allows you to observe the site and take note of any problem areas such as poor drainage, low fertility, and specific types of weeds common in that field. Several factors need to be considered when selecting sites for tobacco including soil properties, rotational requirements, and proximity to curing facilities or irrigation.

The roots of a tobacco plant are very sensitive to the aeration conditions in the soil. In saturated soils tobacco roots begin to die within 6 to 8 hours with significant root loss occurring in as little as 12 to 24 hours. This is why tobacco plants "flop" after heavy rainfall events. Tobacco grows best in soils with good internal drainage that helps to keep excess water away from the roots. Of course tobacco also needs some water to grow and a soil with a good water holding capacity is an advantage during the short term dry spells that are common during summer in Kentucky. The best soils for tobacco production in Kentucky tend to be well structured silt loam or silty clay loam soils.

Tobacco can be produced successfully on heavier soils and somewhat poorly drained soils, but extra precautions are needed to avoid compaction. Such soils generally warm up and dry out much more slowly in the spring, so planting often must be delayed. Such soils should not be tilled when wet to avoid creating compaction and further reductions in drainage.

A good rotation scheme is a key element to maintaining the long term productivity of fields used for tobacco production. Continuous tillage and production of tobacco can result in losses of soil organic matter, weakened soil structure, and severe soil erosion, all leading to declining productivity over time. Rotation planning includes cover crops between tobacco crops, and other crops grown in place of tobacco in some years.

The benefits of using winter cover crops are well documented. Winter cover crops protect the soil from erosion losses, scavenge left over nutrients from the soil, and add organic matter to soil when they are plowed under or killed in the spring. Winter cereal grains such as wheat and rye are the most commonly used cover crops in tobacco production. These grains when planted in September or October make good growth by early winter to help reduce soil erosion, and grow very rapidly in spring as the weather warms. Winter grains should be plowed under or killed in early spring no later than when they are heading. Waiting too long can result in nutrients being tied up by the cover crop, significant reductions in soil moisture during dry springs, and in some cases organic matter toxicity to the tobacco crop. Organic matter toxicity can occur when a heavy cover crop is plowed under just before transplanting. The breakdown of the cover crops reduces oxygen in the root zone and may result in the production of organic compounds that are toxic to roots. Affected tobacco plants are yellowed and stunted, but usually recover in two to three weeks.

Winter legumes such as vetch or crimson clover may also be used as cover crops either alone or in combination with a winter cereal. They do not produce as much growth in the fall but have the potential to supply additional nitrogen. In practice the amount of nitrogen contributed by legume cover crops has been found to be relatively small due to the fact that they typically scavenge remaining N from the tobacco crop rather than fixing N from the atmosphere.

The benefits of crop rotation for reducing certain diseases is well known (see pest management section), however rotation also has significant agronomic benefits. The ideal rotation for tobacco in Kentucky would be one in which tobacco is grown on a specific site for no more than two years in a row, after which a sod or sod/legume crop is planted and maintained for at least four years before returning to tobacco production. The advantage of this rotation is that the sod crop helps to restore the organic matter and soil structure lost during tobacco production. Unfortunately, many tobacco growers do not have sufficient land resources to maintain a rotation of this length. Shorter rotations away from tobacco are very beneficial from a disease standpoint and at least slow the degradation of soil structure compared to continuous tobacco production. Some rotation even if it is short is better than no rotation.

Rotation to other row crops such as corn or soybean can also be beneficial to tobacco, but less so than a rotation which includes sod crops. In row crop rotations precautions should be observed to minimize the potential carry over of herbicides and to follow rotational guidelines on pesticide labels. A reduction in corn yields following tobacco has been reported by some growers.

The proximity of the site to curing facilities is an obvious, but often overlooked selection criterion. A large amount of time and money can be wasted transporting tobacco, and often crews, between the field and the curing barn. Consider placing new barns in an area that can be accessed from several tobacco production fields so that a good plan of rotation can be established.

Conventional Tillage

The typical tillage scenario for tobacco production usually involves moldboard plowing in late winter often followed by smoothing with a heavy drag and 2 to 4 diskings prior to transplanting. Some growers may use a power tiller in place of the disk to break-up clods and produce a smooth seed bed. Compared to most other crops currently grown in Kentucky, the level of tillage used for tobacco is intense. Tillage in tobacco production is useful to help with weed control, incorporate cover crops, reduce compaction, improve aeration, and incorporate fertilizers and chemicals. However, excessive tillage or tillage under the wrong conditions can create compaction and lead to soil loss due to erosion.

All soils consist of the solid particles that make up the soil and the gaps or spaces, called pores, between the solids. In an uncompacted soil the pores make up about 50% of the soil volume and are well distributed between small pores and large pores. Smaller pores are generally filled with water, while the large pores may fill with water during a rain event, but quickly drain and are usually filled with air. This balance of air and water is beneficial for root growth. When a soil becomes compacted there is a significant reduction in volume and a loss of pore space with the large size pores being lost more readily than the small pores. Compacted soils tend to waterlog more easily resulting in less favorable conditions for root growth and compaction also presents a physical barrier that limits root growth.

Tillage contributes to soil compaction in at least two ways. Tillage destroys soil organic matter and weakens soil structure making the soil less able to resist the physical forces of compaction. The more intense the tillage or the longer tillage has been practiced the weaker the soil will become. Tillage implements such as plows and disks exert tremendous pressures on the soil at points of contact. So even though tillage may seem to fluff up the soil at the surface, often compaction is taking place at the bottom of the tillage implement. Power tillers can exert tremendous pressure at the point were tines contact the soil resulting in compaction. The use of these implements to increase drying of wet soils for transplanting, compounds the problems and may lead to poor season long plant performance. Power tillers may do more damage to soil structure in one pass than several diskings. Tillage induced compaction generally occurs from 4 to 8 inches below the surface depending upon the tillage implement used. Silt loam soils are most susceptible to tillage induced compaction when tilled at soil moisture contents of about 14%.

Naturally occurring compacted zones are also found in some soils, more commonly in Western Kentucky. These compacted areas are typically found deeper than tillage compaction and may range in depth from 12 to 30 inches or more. The degree to which they adversely affect tobacco production depends upon the depth and severity of compaction.

The above ground signs of a soil compaction problem are difficult to recognize and are often mistaken for other problems. These signs can include stunted growth, multiple nutrient deficiencies, and reduced drought tolerance due to limited root growth. If soil compaction is suspected the best way to identify it is by digging up and examining roots. The root system of a normal tobacco plant should be roughly bowl shaped with a horizontal spread approximately 2 to 3 inches wider than the leaf spread. The presence of flat spots or areas with little or no roots suggests that compaction may be a problem.

Compaction in fields may also be characterized with the use of a soil probe or a device specifically designed to measure compaction called a penetrometer. The penetrometer is a pointed rod with a tee-handle attached and a gauge for reading the pressure required to push the rod into the soil. It is important to note the depth at which the compacted layer begins and the overall thickness of the compacted layer so that appropriate remediation procedures can be planned.

Table 1. Effect of in-row subsoiling on the yield of burley and dark tobacco.

Soil type	Compaction	Conventional	Subsoiled
Loring	Moderate	2626	3333
Vicksburg	Moderate	1924	2448
Grenada	Moderate	1473	1691
Loring	Severe	2463	3450
Grenada	Slight	2755	2799
Tilsit	Slight-Mod	2012	2158
Loring	Moderate	2365	2679
Avg.		2200 A	2605 B

Data from Lloyd Murdock and others, 1986.

The best management for dealing with tillage induced compaction is to avoid it. This means not working ground that is too wet and avoiding overworking. The potential for compaction can be lessened by practicing rotation which adds organic matter to the soil and strengthens soil structure. Using less intensive tillage implements like chisel plows and field cultivators can also help. Deep tillage to break-up compaction should only be used when the compacted layer has been confirmed and should only be used to the depth of that layer. Deeper tillage does little to improve growth and results in excessive fuel use.

Shallow in-row tillage has been shown to be an effective means of reducing the negative effects of compaction on tobacco in some Western Kentucky soils (Table 1). In these studies the compacted layer was measured using a penetrometer and the depth and thickness of the layer determined. The degree of compaction was characterized as slight, moderate or severe. In all cases where moderate or severe compaction existed there was a positive benefit from in-row "sub-soiling". Where compaction was only slight, no benefit from sub-soiling was observed. In-row sub-soiling is a relatively easy and inexpensive way to deal with shallow compaction in tobacco as long as the tillage is done when the soil is relatively dry. In-row sub-soiling under wet soil conditions can lead to the development of an air cavity under the roots of young transplants.

Most tobacco production in Kentucky is on fields with at least some slope, and much of it on slopes of 6% or more. When these fields are tilled they are extremely vulnerable to erosion losses for at least 2 to 3 months during the spring and early summer when strong storms with heavy rainfall are common. Gullies to the depth of plowing are a common site in tobacco fields (Figure 1). Losses can be minimized by waiting until just before transplanting to do secondary tillage operations and by planting rows of tobacco across the slope rather than up and down the slope. Leaving the tractor tracks in place until the first cultivation can increase surface roughness, thus lessening the velocity of water runoff water and soil erosion. Alternatively some growers may want to consider some form of conservation tillage.

Figure 1. Severe gully erosion in conventionally prepared tobacco field.

Conservation Tillage

Despite the fact Kentucky is known nationally as a leader in the development of conservation tillage for row crop production the adoption of such methods for tobacco has be relatively slow. Traditionally, tobacco growers have used intensive tillage to care for this high value crop and many still believe that tobacco must be cultivated for good growth. There are other reasons that tobacco growers have been slow to adopt conservation tillage including: 1) a lack of appropriate transplanters, 2) limited weed control options and 3) uncertainty over the future levels of tobacco production. Some of these issues have been partially addressed such that some growers now consider conservation tillage to be a feasible option for tobacco production.

The principal advantage of conservation tillage is a reduction in soil erosion losses, however there are other advantages for the grower as well. The mulch layer on the soil holds in moisture and may help reduce stress during periods of short term drought. Additionally, the mulch layer may help to keep the leaf cleaner by reducing mud splash on cut tobacco during late season rain storms. Fewer heavy tillage trips means less time and less fuel use than for conventional tobacco production. Conservation tillage includes: no-till in which the soil is not worked prior to transplanting, minimum-till in which the soil is worked in such a way to leave 30 to 50% of the residue on the surface, and strip-till where a 10 to 12 inch wide band is tilled before transplanting. Each system has its advantages and disadvantages which the tobacco grower must consider.

No-till tobacco is really a form of strip-tillage in which the tillage and transplanting functions both occur in one operation. Considerable modifications must be made to the transplanter for successful no-till planting. Figure 2 shows an example of the modifications required. At a minimum a no-till transplanter needs a wavy coulter in front to cut residue, a sub-surface tillage shank to till the root zone and pull the unit into the ground, and modified press wheels to close the planting trench. Some growers have added row cleaners to assist in moving residue away from the row allowing easier planting. Costs for modifying transplanters range from $300 to $600 per row depending on how much fabrication the grower is able to do themselves.

No-till tobacco works best on medium textured soil (silt loam to sandy loams). Tobacco can be grown no-till in clay ground, but you must be patient and wait for the soil to dry sufficiently before transplanting. One of the persistent myths about no-till tobacco is that you can set it when you would not be able to get on conventional ground. In fact, experience has shown you may need to wait two or three days longer before setting no-till. Even though the ground may be firm enough to support equipment, the mulch layer slows the drying rate at the surface. Transplanting in ground that is too wet can lead to compaction of the trench sidewall which restricts root growth and may suppress growth and yield potential.

Figure 2. Modifications to a transplanter for no-till transplanting of tobacco.

Minimum or strip-till may be better on heavy clay ground since some of the surface residue is incorporated allowing the soil to warm-up and dry out quicker. These methods require additional tillage passes leaving the soil more vulnerable to erosion than in no-till. Growers using strip tillage are able to transplant using their normal transplanter. However, they often have one or more modified tillage implements matched to the row spacing and number of rows of the transplanter to prepare the 10 to 12 inch wide planting band.

A good cover crop or previous crop residue is an essential part of successful conservation tillage tobacco production. The cover crop or residue helps to reduce soil erosion losses and conserve water in the soil much like a mulch in the garden. Tobacco growers have been successful planting no-till tobacco in winter grain cover crops, sod, and row crop residues.

One of the keys to success when planting no-till tobacco into a small grain is timing the kill of the cover crop. The initial burn-down of winter small grains should be made when the cover is approximately 6 to 8 inches tall. This allows a sufficient buildup of residue while limiting the production of straw that complicates transplanting. Research has shown that tobacco transplants grew better and yielded more when the cover crop was killed at least 30 days prior to transplanting. The initial burn-down should be made with a product containing glyphosate, a follow-up treatment with a paraquat containing product may be made within a few days of transplanting when residual weed control products are applied.

Sod crops should also be burned down at least 4 to 6 weeks prior to transplanting. This allows sufficient time for the root mass to break down so that the soil will crumble and fill around the plant root ball. Some growers prefer to burn down a sod in the late fall and plant a cover crop to be burned down the following spring. Elimination of a sod that includes alfalfa can be particularly difficult due to the persistence of the alfalfa crowns. To eliminate alfalfa stands to prepare for no-till tobacco may require an application of burn down in the fall and a follow-up in the spring. Even then we have seen some volunteer alfalfa in no-tobacco fields.

What to Use for Burn-down?

Because no-till tobacco is a relatively small use crop, there are very few products labeled specifically for this use. However many glyphosate containing products have a statement on the label that allows the products to be used 30 to 35 days prior to planting of crops not specifically listed on the label. Be sure to check the label of the specific product that will be used. Some products containing paraquat (Gramoxone Inteon) have been labeled specifically for use on no-till tobacco. Growers must take care to obtain a copy of the supplemental label specifically for this use as it does not appear on the label normally included with the product.

There are labeled weed control products that work well for no-till tobacco, but "rescue" options are very limited so it is best to choose sites with as low a weed potential as possible. Winter pastures, feed lot areas, and areas with sparse cover often make poor sites for no-till tobacco due to large amounts of weed seed in the soil and/or established populations of perennial weeds. Perennial weeds and vines should be controlled during the rotation prior to growing no-till tobacco.

Spartan should be a part of any weed control program for conservation-till tobacco. Research has demonstrated that this product provides more consistent control in the absence of tillage than other herbicide options. Either Prowl or Command can be tank mixed with Spartan for improved control of certain weeds and grasses. However the most consistent control has been achieved by applying Spartan 7 to 10 days prior to transplanting then making an application of Command within 7 days after transplanting. The post-transplant application of Command helps to control weeds in the strips of soil disturbed by the transplanting operation. In all cases the highest labeled rate for the soil type is recommended when used in conservation tillage.

Poast can be used over tobacco for control of annual and perennial grasses including Johnsongrass. In cases where weed control has been poor due to environmental conditions some growers have used mechanical means such as lawn mowers and cultivators to control weeds in conservation-till tobacco.

Once the in the ground the crop can be treated just like conventional tobacco. Thus far there have been no additional problems with insect or disease pests when compared with conventional tobacco

Fertilization of Tobacco

Tobacco fields should be soil tested at least 6 to 12 months before planting to allow time for the application of lime and to plan for any nutrient deficiencies that may be identified. Limestone should be applied in the fall and thoroughly mixed with the soil one to two years ahead of the crop. If applied in the spring before transplanting, or if more than 4 T limestone/A are applied, plow one-half down and disc in the other half for soils with water pH below 6.0.

Nitrogen fertilization rates (see Table 2) depend primarily on the field cropping history and soil drainage class. Rotation to other crops is strongly recommended after two or more years of burley tobacco production in the same field. More frequent rotation may be necessary when growing dark tobacco or burley tobacco varieties with low levels of disease resistance.

Table 2. Nitrogen recommendations for burley and dark tobacco.

	Well Drained Soil (lb N/A)	Moderately Well Drained Soil (lb N/A)
Low N levels: following tobacco or row crops	225-250	250-275
Medium N levels: first-year tobacco following a grass or grass-legume sod	200-225	225-250
High N levels: first-year tobacco following legume sod or legume cover crop	150-175	175-200

All commonly available N sources can be used satisfactorily on tobacco, particularly on well-drained soils where a good liming program is followed and soil pH is maintained in the range of 6.0 to 6.6. If soil pH is moderately to strongly acid (pH 6.0 or less) and no lime is applied, using a nonacid-forming source of N (sodium nitrate, calcium nitrate, or sodium-potassium nitrate) will lower the risk of manganese toxicity. Use these sources (or ammonium nitrate or potassium nitrate) for sidedressing, because nitrate is more mobile in soil than ammonium nitrogen. If tobacco is grown on sandy soils or soils that tend to waterlog, using ammonium sources (urea, ammonium nitrate, ammoniated phosphates, ammonium sulfate, nitrogen solutions) will lower the risk of leaching and denitrification losses.

The entire nitrogen requirement can be applied pre-plant broadcast on well drained soils. However, Kentucky often has large rainfall amounts during April and May, so applying the broadcast nitrogen as near to transplanting as possible will significantly lessen the chances for losses of applied nitrogen. Apply the nitrogen after plowing and disc into the surface soil. Because losses of fertilizer nitrogen can occur on sandy soils or soils with poor drainage, it is helpful to split nitrogen applications on these soils, applying one-third of the nitrogen before transplanting and the remaining nitrogen two or three weeks after transplanting. The use of poorly drained or somewhat poorly drained soils for tobacco production is not recommended.

Further efficiencies in nitrogen use, decreased manganese toxicity, and increased early growth can be obtained by banding most of the nitrogen (sidedress) after transplanting. These bands should be applied 10 to 12 inches to the side of the row in either one or two bands and at depths of 4 to 5 inches. All the nitrogen should be banded at 0 to 10 days after transplanting or in two applications, two-thirds at 0 to 10 days and one-third at four or five weeks after transplanting. If one third or more of the total nitrogen is applied after transplanting the rate from Table 2 should be reduced by 15 to 25 lb N per acre.

Phosphorus (P) and potassium (K) fertilizer additions should be determined by soil testing. Based on soil test results, apply the recommended amounts indicated in Table 3. Recommendations in Table 3 apply only to soil test results obtained using the Melich 3 extraction procedure as used by the University of Kentucky Regulatory Services soil testing laboratory. If you have soil tests performed at another lab please refer to their charts and tables for appropriate recommendations. Results from soil tests run at the University of Kentucky show that approximately 70% of the tobacco fields in Kentucky test very high in P and need no additional P to grow a crop. Almost 30% of tobacco fields do not need additional K for the current crop year. Growers are encouraged to take full advantage of the soil nutrients to help reduce their fertilizer expense.

Spring applications of chloride-containing fertilizers such as muriate of potash at rates greater than 50 lb of chloride per acre lead to excessive levels of chloride in the cured burley tobacco leaf. High chloride levels lead to increased curing and storage problems, decreased combustibility of the leaf, and, ultimately, greatly reduced quality and usability of the cured leaf. Consequently, sulfate of potash should be the major potassium fertilizer used on tobacco fields after January 1.

Animal manures are also known to contain chloride in concentrations high enough to reduce the quality of cured tobacco. Chloride in excess of 1% in cured tobacco leaf is considered unacceptable by the tobacco industry. Cattle and swine manure applications should be limited to no more than 10 tons per acre. Poultry manures should not be applied in the year tobacco is grown. Fall applications of poultry littler should not exceed 4 tons per acre on ground where tobacco will be planted the following spring. Fall manure applications should be made only when a living cover crop will be present to take up and recycle some of the available N. Excessive rates of manure or manure used in conjunction with chloride-containing fertilizers may result in unacceptable chloride levels in the cured leaf.

Molybdenum (Mo) is recommended for use on burley tobacco either as a broadcast soil application or as a mixture in transplant setter water when the soil pH is below 6.6. Research and field trials have shown that setter water applications are equally as effective as broadcast applications for supplying molybdenum to the crop. Molybdenum can be purchased in dry solid form or as a liquid. Either source is satisfactory when molybdenum is needed.

For broadcast field applications, apply at the rate of 1 lb of sodium molybdate (6.4 oz of molybdenum) per acre. Dissolve this amount of dry sodium molybdate (or 2 gal of 2.5% Mo liquid product) in 20 to 40 gal of water and spray uniformly over each acre. Apply before transplanting and disc into the soil. Because sodium molybdate is compatible with many herbicides used on tobacco, it can be applied with herbicides normally applied as a spray in water. Combining the two chemicals can result in savings in application costs because only one trip over the field is necessary. It is recommended that not more than 2 lb of sodium molybdate (12.8 oz of molybdenum) per acre be used during a five-year period.

For transplant applications, use 0.25 to 0.50 lb sodium molybdate (1.6 to 3.2 oz of molybdenum) per acre. If dry sodium molybdate is used, divide the total recommended amount (0.25 to 0.50 lb/A) equally among the number of barrels of water used per acre. For example, if 2 barrels of water per acre are used, add one half of the total recommended amount to each barrel, and fill the barrel with water. Adding the dry material before filling the barrel will aid in dissolving and mixing. If a 2 .5% liquid source of molybdenum is used with 2 barrels of setter water per acre, add 1 to 2 qt of the liquid product per barrel before filling the barrel with water.

The need for iron, copper, and zinc in tobacco has not been shown for Kentucky soils. Improper rates could result in toxicity to the plant so they are not generally recommended on tobacco. Some isolated cases of suspected boron deficiency have been observed in recent years; however recommendations are being made on a case by case basis.

Table 3. Phosphate and potash recommendations (Lb/A), tobacco.

Burley and Dark		**Burley**		**Dark**	
Test Result: P	**P_2O_5 Needed**	**Test Result: K**	**K_2O Needed**	**Test Result: K**	**K_2O Needed**
Very high		*Very high*		*Very high*	
> 80	0	> 450	0	> 450	0
High		*High*		*High*	
73-80	30	424-450	30	398-450	30
71-72	40	417-423	40	383-397	40
68-70	50	409-416	50	368-382	50
66-67	60	402-408	60	353-367	60
64-65	70	394-401	70	338-352	70
62-63	80	387-393	80	323-337	80
58-61	90	379-386	90	308-322	90
		372-378	100	296-307	100
		364-371	110		
		357-363	120		
		349-356	130		
		342-348	140		
		334-341	150		
		327-333	160		
		319-326	170		
		312-318	180		
		304-311	190		
Medium		*Medium*		*Medium*	
54-57	100	296-303	200	286-295	110
50-53	110	286-295	210	276-285	120
46-49	120	276-285	220	266-275	130
41-45	130	266-275	230	256-265	140
37-40	140	256-265	240	246-255	150
33-36	150	246-255	250	236-245	160
29-32	160	236-245	260	226-235	170
		226-235	270	216-225	180
		216-225	280	206-215	190
		206-215	290		
Low		*Low*		*Low*	
25-28	170	195-205	300	195-205	200
22-24	180	184-194	310	184-194	210
18-21	190	173-183	320	173-183	220
14-17	200	162-172	330	162-172	230
11-13	210	151-161	340	151-161	240
7-10	220	140-150	350	140-150	250
		129-139	360	129-139	260
		118-128	370	118-128	270
		107-117	380	107-117	280
		96-106	390	96-106	290
Very Low		*Very Low*		*Very Low*	
< 7	230	< 96	400	< 96	300