Tillage and Seeding for Vegetable Crops

Tillage

Tillage is the process of preparing a suitable soil environment for seed germination and plant growth. A tillage operation must be evaluated on the basis of its ability to adequately perform one or more of the following goals:

1) Management of crop residue
2) Soil aeration
3) Weed control
4) Incorporation of fertilizers and manures
5) Insect control
6) Temperature control for germination
7) improvement of soil condition
8) Provide good seed to soil contact
9) Prepare surface for further operations

However, contrary to common belief, soil can be over-worked resulting in damage to soil structure and wasted effort. If a tillage practice does not increase yield, it should be eliminated or changed.

Primary Tillage

First of all, what is primary tillage? Primary tillage is the cultivation or working of soil to depths greater than 10 cm. The usual figure given is 15-25 cm. The two main implements used to accomplish this in growing market vegetables are the moldboard plow and the PTO powered rotary tiller.

Moldboard Plows

Good plowing is fundamental to the success of following cultivations and of the crop itself. Secondary cultivation can initially hide poor plowing but sooner or later, the truth will show. Poor plowing could result in uneven plow depth which will affect root penetration and cause inconsistent crop growth and maturity.

Since trash burial is the one thing a moldboard plow can do better than any other implement, it is important to fully utilize this advantage. If trash is not fully buried, it will not rot properly. This, along with the extra work and energy required to repair a poorly plowed field, is the reason care must be taken in primary tillage.

The objectives of plowing are:

1) to bury crop residue
2) to aerate the soil
3) to control weeds, insects and crop disease
4) to incorporate lime and fertilizer into the soil a good plowing job should sandwich organic matter between the furrow slices to form wicks which will accelerate water absorption and decomposition of residue.

Good plowing also increases soil porosity and aeration which will also increase decomposition and

release nutrients to the soil. A furrow should retain a distinct crown. This helps reduce runoff. It also reduces ponding and increases moisture infiltration resulting in speedier surface drying.

Choosing the right plow for your particular operation requires more thought than purchasing the biggest unit your tractor can handle. Plows are of four various types: Mounted, semi-mounted, trailing and reversible. Due to plow size and hp requirements we will not discuss the semi-mounted or trailing plow to any extent. The plow most commonly used in vegetable growing is the mounted or integral plow. The advantage of this unit is its maneuverability and relative cost per bottom. Also, it makes the most efficient use of tractor draft. However, it requires more operator skill and plow adjustment to perform a proper plowing job.

In order to adjust a plow, you must understand the underlying principle. The working part of any moldboard plow is the bottom. The main plow bottom parts are the moldboard, share, shin and landside which are all attached to a common structure called a frog.

The plow bottom has a wedging action through the soil which exerts pressure upward and sideways to the open furrow resulting in a turning effect. As a result of this action, soil will shear, causing granulation and/or crumbling. As plow speed is increased, so is soil pulverization.

It is important that plow bottoms run level. If bottoms are out of level, a non-uniform pressure is exerted on the turning soil resulting in poor plow performance, poor granulation, and a remarkable increase in horsepower and plow wear.

The plow coulters will also greatly affect the performance of a moldboard plow. The three most common types of coulters are the smooth or plain coulter, notched coulter and the rippled edge coulter. The plain coulter is recommended where ground penetration may cause problems. Also, these coulters are easily re-sharpened. The notched and ripple edge coulters are commonly used for plowing under heavy trash.

If a coulter is improperly adjusted, it could result in any of the following conditions:

- abnormal plow wear
- ridges and valleys in the plowed field
- rough riding during secondary tillage
- excessive passes during secondary tillage

A rough rule of thumb for coulter adjustment under average conditions is to set the coulter 5 to 10 cm ahead of the share point.

If plowing is on extremely hard ground where penetration may be difficult, the coulter should be raised and moved towards the share point. However, under extremely trashy conditions, you may have to move the coulter forward to provide more clearance. Also, if the coulter is set too deep, it may push the trash rather than cut it.

As discussed earlier, the plow bottom must run level. If the bottom runs level, so should the plow frame run level with the land. The main factor to consider in most mounted plows is tractor-hitch linkage which should be adjusted according to the tractor plow operator's manual. To level the plow from front to back, the tractor's top linkage will require adjustments. To check for a level running plow, measure the depth of the furrow behind the front and rear bottoms. Also sight along the frame of the plow to

make sure it runs level with the lay of the land.

Before the width of cut adjustments are made, the plow must level in field conditions.

Mounted plows generally lack means for significant lateral adjustments, therefore wheel width adjustment is important. The plow manuals will show proper tread setting which is normally expressed in cm from center of tractor to the inside of the rear tire.

Width of cut of the front bottom of integral plows is adjustable by rotating the offset hitch bar. Rotating the bar clockwise will turn the plow towards the land increasing the width of cut. A counter clockwise rotation will lead the plow towards the furrow. Always recheck coulter adjustment after alternating width of cut. Improper adjustments will cause excessive plow wear and side draft.

Rotary Tillers are sometimes used in vegetable production. Among the reasons for their use are:

- minimal seedbed preparation
- reduced draft
- reduction in soil compaction

In many cases, rotary tillers will provide a negative draft. That is, they will assist the tractor in its forward motion. Care must be taken in operating tillage equipment in wet conditions, especially rotary tillers. This could result in serious damage to the soil by causing the formation of large clods and soil smearing.

To estimate power requirements for a rotary tiller, the following formula could be used:

$$\text{Drawbar hp} = \frac{\text{Draft (inch lbs.)x speed (mph)}}{375}$$

For example, in medium soil a rotary tiller 54"wide would have a draft equivalent of 30 psi. Therefore, rotary tilling 5" deep would give a draft of

5” X 30 psi X width 54” = 8100

$$\text{hp} = \frac{8100 \text{ x } 2 \text{ mph}}{375} = 43 \text{ hp}$$

PTO hp = approximately 125% of drawbar power

43 X 1.25 = 54 hp

Thus, it is apparent that heavy soil, faster forward speed and depth of tillage greatly affect hp requirements.

Other advantages of the rotary tiller are that they do a good job of chopping and mixing trash with the soil. However, the moldboard plow still does a better job of completely covering the trash. Many rotary tillers are equipped with removable and/or adjustable blades enabling them to work as a cultivator. Some units can be equipped with a toolbar to enable the attachment of an auxiliary unit such as a seeder or fertilizer spreader.

Operation of a Rotary Tiller.

Rotary tillers must be properly adjusted and operated if they are to do a good job.

The degree of soil pulverization is mostly affected by the size of the bite and the angle of the soil shield. Other factors such as soil type, moisture and amount of crop residue present are also important.

The size of the cut or bite is determined by tractor speed, rotor speed and number of blades. By increasing tractor forward speed, the tiller blades will increase the size of bite. However, this will also require more horsepower. Rotor speed can be changed on most tillers by a gear box or reinstalling or alternating easily accessible gears. With proper matching of rotor and forward speeds, a good tilth can be obtained. As operating depth increases, size of bite decreases, therefore requiring alteration to forward and/or rotor speed.

Warning - adequate horsepower is needed to maintain forward travel speed. If there is insufficient hp, one tends to over pulverize the soil. Average speed is between 3 and 8 km/h.

Hood or shield adjustments are important in the performance of a rotary tiller. When the shield is lowered, soil from the blades is thrown out against it, resulting in the clods being broken up. If the shield is raised, large clods leave the rotor without being broken up. This would be recommended for any fall work which is to be reworked in the spring.

The rotary tiller blades are arranged in a spiral pattern so that no more than one blade strikes the soil at any one time. In wet sticky soil, it may be desirable to remove several blades and speed up the rotor but care should be taken that the spiral pattern is not altered. All soil cut by the blades enters the rotor and is discharged out the back. If the soil remains in the rotor, it is obvious that it will soon plug. Plugging is affected by rotor diameter, speed, blade arrangement, soil moisture and trash.

There are only a few field adjustments on a rotor tiller and these are necessary for satisfactory performance. Some of these we have discussed and others are self-explanatory.

1) Adjusting work depth with gauge shoes
2) Alter rotor speed
3) Alter forward speed
4) Raise or lower rear shield
5) Change the number of blades or their arrangements on the rotor.

Level the unit from side to side with tractor linkage bar and front to back by the top linkage.

Secondary Tillage

The primary objective of secondary tillage is to prepare a seedbed. Although mere are a great number of different machines used for seedbed preparation, me objectives all lead toward breaking soil crust, shattering clods, and smoothing and firming me soil. This will result in closing air pockets, killing weeds and helping aerate the soil.

A good seedbed requires mat soil closely surround the seed for maximum water absorption. It is important to have quick germination and rapid development of a root system.

Disc harrows

Disc harrows have several advantages in preparing a seed bed. They generally do a better job of fertilizer incorporation. Discs are least affected by rocks and stumps because of me rolling action. Discs will tend to pulverize lumps, close air spaces, mulch the surface and provide a firm, smooth, uniform seedbed.

Discs can be divided into two classes: the mounted disc and the trailing disc. Since the mounted discs are much more maneuverable in smaller fields, we will limit our discussion to these units. A mounted disc is usually limited in size to me lifting capability of me tractor hydraulics and tractor front end stability. The depth of soil penetration is usually controlled by disc angle and tractor hydraulics.

A mounted disc can be divided into three categories:

1) single action
2) double action tandem
3) offset

The single action discs were common when power was limited to small tractors and horses. In order to do a sufficient job, they must be overlapped halfway. These discs tend to leave ridges because me two gangs of discs throw soil in the opposite direction.

Tandem discs which are the most commonly used discs for seedbed preparation have two rows of opposing gangs. The front units turn the soil outward and the back row turns the soil inward. A small ridge is left between the two front gangs. This, however, can be eliminated by a springtooth placed between the two gangs.

Offset disc harrows first move the soil in one direction and me second gang moves the soil back. These harrows are usually heavier and are more suitable for primary tillage. They are designed for tough ground and heavy trash conditions.

The disc blades are the work horse of the discs. A small blade of equal weight to a larger diameter blade will penetrate much better. However, larger blades are better for cutting through trash. Many discs have a heavier gauge in front to compensate for the fast wearing of these blades. Some disc blades are notched to give better penetration, and to cut crop residue more effectively. These blades are more expensive. Some disc harrows only have me front set of gangs notched.

Many discs are rated on a weight per foot or weight per disc basis. A weight per foot will give a good comparison of overall weight of the unit where a weight per disc will better explain the penetration ability of the disc. Also, size and thickness of blade should be checked and noted in a comparison.

Scrapers are essential on discs if the unit is to be used in wet sticky soil or trash conditions. A scraper should be adjusted to touch the disc lightly. If improperly adjusted, a build-up of material on the disc will result.

In the operation of a disc, it is important to check the nut on the end of a disc gang and tighten it to the owner's manual specification. A loose nut will cause excessive wear and possible damage to the disc itself.

The angle of a disc gang usually ranges from 10 to 25 degrees to a line perpendicular to me line of travel. The sharper the angle, the deeper the cut which results in better trash covering and more power requirement

Soil immediately below the disc blades will have a tendency to compact. This is even more evident in wet conditions where compaction can be severe enough to prevent root penetration.

In order to prepare a proper seed bed, it is important to leave the soil uniformly smooth and firm. Therefore, me disc must be level from side to side and from front to back. These adjustments can easily be made with the tractor linkage system.

Field cultivators and harrows do not compact soil as disc harrows do. Also, they do a much better job in controlling weeds such as couch grass especially if equipped with a sweep.

When operating in small fields and tight corners, the mounted 3 point hitch units are recommended. In a three point hitch unit, it is not desirable to use a gauge wheel for total depth control. A properly adjusted depth wheel should carry little weight when cultivators are at me desired depth.

As with the disc harrow, it is important to have the cultivator level. Also, speed greatly affects the tilth left behind by the cultivator. Speed will usually range between 5 to 8 km/h. When operating a cultivator and sharp turns must be made, the cultivator should be raised to avoid twisting, or breaking teeth.

The double curved springtine cultivator commonly referred to as the "S tine" cultivator, does an excellent job of breaking clods and pulling weeds as a result of its vibration action. These cultivators are relatively easy to pull and only require approximately 1.5 hp per tooth.

These cultivators usually have four bars on which tines are attached at 40 cm intervals, therefore giving an overall spacing of 10 cm. A 3 meter cultivator would require approximately 45 hp and can cover as much as 3 hectares per hour.

A trailing cultipacker on the "S tine" cultivator is a desirable feature. It provides additional levelling and firming of the seedbed.

The conventional springtooth harrow usually works at depths of 7 to 15 cm loosening and breaking clods. The springtooth harrow if set shallow and travelling in the direction of plowing will not drag up chunks of sod to the extent an "S tine" cultivator would in a freshly plowed field. Also the springtooth harrow is better than the disc harrow for stoney ground but will plug badly in heavy trash conditions.

On many farms, springtooth harrows have been replaced by the "S tine" cultivators because of their ability to penetrate hard ground and pull tough weeds.

High adjustment of the springtooth harrow is usually done by the angle of teeth along with the adjustment of running shoes. Most springtooth harrows have three rows for which the teeth are spaced 30 cm apart.

Power harrows utilize tractor engine power through the PTO rather than through traction. This can be an advantage in wet fields.

Precision Seeders

In selection of a precision seeder, several factors should be kept in mind. A grower with a number of crops must consider the seeder’s adaptability to these crops. On many farms, the speed of operation is also an important factor. The quality of work, ease of operation and adjustment are important factors

but most of all, there must be service and availability of parts from a reputable dealer.

A precision seeder is designed to give accurate placement of individual seeds. If these units are to give satisfactory results to the operator, they must be handled with care and respect.

Before the beginning of a season, a seeder should go through a complete maintenance overhaul in the workshop. All moving parts should be checked for wear and ease of movement.

Preliminary adjustment such as seed placement (depth and spacing), should be completed along with press wheel tension etc. Most units can be shop calibrated and then again recalibrated in the field. It is important that the operator of any seeder completely understand his unit and read his operator's manual so that small problems can be avoided. In many cases, a small problem can greatly affect the performance of the seeder.

The seeder should just be cleaned on a regular basis to ensure that the mud or soil particles are not altering performance. Also, the seed chamber should be clean of dust and other foreign particles. These seeders are precision units and require careful, accurate adjustment if satisfactory results are to be obtained. In two-row units or larger, it is necessary to have the units running level so that equal pressure on the soil is exerted by each unit. Three-point hitch tool bars will require sway bars on the tractor to ensure proper seed placement. These seeders require precision operation along with precision sized seeds.

The performance of a precision seeder is greatly affected by soil conditions. It is important to have the seed bed in optimum condition. This will also minimize the effects of soil crusting. Varying soil conditions such as moisture will require minor adjustments to the covering mechanism and depth controls.

Although this section has dealt with tractor mounted precision seeders, for the smaller operator hand pushed models are available. Plate type models have an advantage for large, irregular shaped seeds such as corn, cucumber or squash.

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