Chapter 3

The Organic Amendment Improve the Yield and Quality of Vegetable

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Additional information is available at the end of the chapter

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Abstract

Using biotechnology, we can change agricultural wastes into high-quality organic fertilizers, which leads us in the direction of the development in modern agriculture and act as substitute to the chemical fertilizers. In this chapter, five types of technologies of organic amendment are elaborated. Each method can be selected based on the specific circumstance. The effects of the technology in the production are introduced and the principles of the technologies are explained in a simple manner.

Keywords: organic amendment technology, vegetable yield, biological bacterium, organic fertilizers, vegetable quality

1. Introduction

1.1. The significance of organic amendment in vegetable production

The extensive use of fertilizers and pesticides leads to problems of environmental quality and product quality and safety. A decline in productivity, soil salinization, and groundwater pollution problems are paid more and more attention [1]. The primary care taken by customers is pesticide residue or food safety problems [2]. A large number of discarded agricultural wastes such as manure, crop straw, and product residues lead to a lot of spoilage of microorganisms and bacteria. Burned crop straw pollutes the air. Using biotechnology, we can change agricultural wastes into high-quality organic fertilizer, which leads us in the direction of development in modern agriculture.

2. The ways of organic amendment

2.1. Returning straw into field

Due to the development of mechanization, returning straw into field (straw returning) is promoted throughout the world. Straw returning technology has been accepted by farmers. Straw crushing, *in situ* and returning to field, can not only improve the soil fertility and soil structure, increase soil organic matter, and income, but also reduce air pollution caused by burning straw.

Annual production of agricultural straw in China is more than 600 million ton, which is a large amount of wealth. In recent years, with the development of high horsepower tractors and harvesting machinery, the straw crushing and deep plowing and returning are developing. Straw *in situ* crushing and returning to field is more convenient and labor saving, and popular. However, the technology must be used properly. The corresponding technical measures and fermentation strains must be set [3].

Some understanding and experience for straw return to field are explained.

2.1.1. The time when corn straw returning to the field should be as early as possible

The moisture content of green corn straw is higher than the dry straw, so the straw crushed and buried into soil is easier to decompose. The best time to return corn straw to the field is just after harvest.

2.1.2. The appropriate amount of straw returned

Although the straw returned into field can improve fertility, the amount of straw returned to the field is important, the lesser, the better. The proper standard is to cover the ground with straw if there are no appropriate measures accelerating the fermentation. In general, for maize straw one half of an acre of straw is returning amount for an acre of soil. When the ground is not covered entirely by the straw, the effects of water conservation and weed suppression are not obvious, whereas with excessive amount, the straw does not decompose and there will be some difficulties in deep plowing.

2.1.3. Crushing length of straw returned

Because the withered corn subtending leaf is not easy to be crushed, the leaf must be taken out of the field. Poor crushing effect means poor decomposition. To ensure the crushing effect, a tractor with large horsepower matching with straw returning machine should be chosen. Straw length of less than 4 cm is appropriate. When the straw is tilled deeply, the soil can be mixed evenly. The depth of plowing must not be less than 23 cm.

2.1.4. A sufficient amount of base fertilizer

Straw composting process will consume nitrogen and other available nutrients in the soil, it is appropriate to use some nitrogen fertilizer that decreases the straw carbon and nitrogen ratio. The right carbon and nitrogen ratio is conducive to microbial activity and organic matter decomposition, so that the contradiction between microbes and crop competing nitrogen are addressed. Therefore, when the straw is returned into the field, it is necessary to keep sufficient nutrients in the soil, such as ammonium bicarbonate and calcium superphosphate fertilizer. If conditions permit, planter can substitute human excrement or poultry manure fertilizer for chemical fertilizer.

2.1.5. Application of fermentation bacteria

The fermentation bacteria include CM and BM bacteria. CM bacteria, from Biological Technology Co., Ltd. of Shanxi Yuncheng, are liquid biological bacteria, and BM bacteria are from Hebi Biological Technology Co., Ltd. The dosage is 5 kg CM bacteria and 5 kg BM bacteria for 5 tons of organic straw. Twenty-four hours before the application of biological agents, intermediate culture must be taken. Water, brown sugar, and biological agents (CM:BM = 1:1) with a ratio of 100:5:1 should be mixed. The sugar must be dissolved before the static culture for 24 hours. If necessary, the culture can be further expanded using brown sugar and water. The biological agents with intermediate culture, wheat bran, and water must be mixed with a ratio of 1:5:9, covering them with film for 5–7 hours, and should be evenly spread in the crushed straw.

2.1.6. Appropriate amount of lime

Because various organic acids produced during the composting process of fresh straw injure crop root, appropriate amount of lime in the vent and acidic soil should be applied, preferably in 400 kg/ha.

2.1.7. The straw with diseases and insect pest

In the plots with serious plant diseases and insect pests, the straw will not be suitable for direct returning because of infectious diseases, turning a large number of eggs of the pest and pathogen into the soil. Such straw can be used in composting with high temperature to kill bacteria, and also be used as feed and fuel.

2.2. Fermentation bioorganic fertilizers (organic fertilizer formula, technology application)

Poultry manure and crop straw are two kinds of organic wastes in China. China's annual livestock and poultry manure is about two billion tons, far more than the industrial solid waste. The chemical oxygen demand (COD) of poultry manure is far greater than that of the industrial wastewater and domestic wastewater. It is one of the main causes of pollution in rural areas. As a result of the disappearance of firewood, a large number of crop straws are burned, which cause air pollution and at the same time increase carbon emissions, resulting in the waste of large amount of organic carbon resource. On the other hand, the long-term application of chemical fertilizer has a bad influence on the soil ecology and the quality of the products. Good organic fertilizer is the urgent need of the hour.

In the existing technologies for fermentation of poultry manure and straw for production of organic fertilizer, there are the following shortcomings: complete fermentation needs a long time at low temperatures, which in return pollutes the air; manurial efficiency is low and cannot fully meet the needs of crop growth, still a quantitative amount of chemical fertilizer needs to be added.

2.2.1. Preparation materials

The fermentation bacteria include CM bacteria and BM bacteria. CM bacteria are liquid biological bacteria and are from Biological Technology Co., Ltd. of Shanxi Yuncheng, whereas BM bacteria are from Hebi Biological Technology Co., Ltd. The dosage is 5 kg CM bacteria and 5 kg BM bacteria for 10 tons organic fertilizers. Twenty-four hours before the application of biological agents, intermediate culture must be taken. Water, brown sugar, and biological agents (CM:BM = 1:1) must be mixed with a ratio of 100:5:1. The sugar is dissolved before the static culture for 24 hours. If necessary, the culture can be further expanded using brown sugar and water. The biological agents with intermediate culture, wheat bran, and water must be mixed with a ratio of 1:5:9, covering them with film for 5–7 hours, and evenly spread in the crushed straw [4].

The cow dung is fresh, whose water content is 50–60%.

The asparagus bean, sesame, and corn stalk are crushed into 1–3 cm filament.

Wheat bran is from the ordinary market sales.

2.2.2. The method of making the biological organic fertilizer

The cow dung and cowpea, sesame, and corn straw mentioned above are mixed by pile turning, and then spread out layer by layer, each layer is about 10–15 cm high; a layer of the wheat bran mixed with biological agents is sprinkled on each layer of the mixture. The layer of wheat bran is 0.5–1 cm thick. The completed compost is about 0.8–1.2 m high, and to facilitate the operation it is covered tightly with membrane for anaerobic fermentation for 3–5 days.

Three to five days after the fermentation, the compost is turned and piled up about 1.3–1.7 m high and 1.8–2.2 m wide. The compost is not covered, but it is protected from the rain. A spade handle ramp is used into the compost to form 2–3 vents per square meters. Note that 10–15 days after composting, fermentation is completed when white mycelium appears in the compost.

The compost could be used directly. Granular products can also be formed through milling and granulating, in which the final moisture content is 20–30%.

The compost should be covered with plastic membrane and sheltered from rain, so that the organic fertilizer can be saved for more than 2–3 years.

Compared with the prior art, the invention has the following advantages and effects:

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1. Formula is reasonable, there are a variety of biological bacteria, and the fermentation can be completed at low temperature within 10–15 days.
2. The compost can improve the soil temperature and the CO_2 concentration in the greenhouse, thus improving the seedling growth at low temperature.
3. With high manorial efficiency, the organic fertilizer can fully meet the normal growth of plant, without adding chemical fertilizer.
4. The compost containing a variety of small molecular nutrients can maintain normal growth of crops in the weather with low temperature and weak light.
5. The compost or organic fertilizer can improve the yield by 20–120% and have earlier listing by 5–7 days compared with the chemical fertilizer under the conditions of greenhouse in early spring.

3. Straw reactor technologies

3.1. Six major roles of straw biological reactor

3.1.1. Effects of carbon dioxide

The reactor can generally increase carbon dioxide concentration by 4–6 times in plastic greenhouse, improve photosynthetic efficiency by more than 50%, accelerate growth, and improve rates of flowering and fruit setting. Standardized operation increases yields of cucumber and tomato by 30–80% [5].

3.1.2. Heat effect

In the greenhouse in cold winter, the temperature increases by 4–6°C 20 cm underground and air temperature increases by 2–3°C, thus improving plant growth environments and the ability of the crop to resist low temperature, effectively protecting the normal growth of crops and advancing the growth period by 10–15 days.

3.1.3. Biological control effect

Strains produced a large number of resistant spores in the conversion process of straw producing strong antagonistic, suppression, and lethal effect on plant diseases and insect pests. Plant disease rate is reduced by more than 90%, and the dosage of pesticide reduced by more than 90%. The standardized operation can be basically without pesticides.

3.1.4. Modifying the soil

In straw bioreactor planting layer of 20 cm underground, soil porosity increased 1 times, and also the beneficial microbial groups. The conditions of water, fertilizer, gas, and heat is medium, various mineral elements are directionally released, and organic matter content increased more than 10 times, which creates a good environment for root growth.

3.1.5. Decreasing pesticide residues

In the reaction process, the flora metabolism produced a large number of high activity of the enzyme, which reacted with chemical fertilizer and pesticide, so invalid fertilizer becomes effective, the harmful substances becomes beneficial, and eventually make pesticide residue into carbon dioxide which plants need. It was determined that the pesticide residues in the soil around the plant roots were decreased by more than 95% in 1 year, and eliminated in 2 years.

3.1.6. Improving the comprehensive utilization of natural resources

Straw bioreactor technology speeds up the use of straw, while improving the comprehensive utilization of natural resources such as the microbial, light, water, air, and other natural resources. According to the measurement, the carbon dioxide concentration increased four times, the light utilization rate increased by 2.5 times, water use efficiency increased by 3.3 times, and legume nitrogen fixation activity increased by 1.9 times.

3.2. Application methods and key points of four straw bioreactor technology

There are three main ways to operate the technology: internal, external, and internal-external bioreactors. Selection of application methods mainly depended on the production of crop varieties, planting time, ecological climate characteristics, and production conditions.

The choice and condition of the internal straw biological reactor:

1. For internal straw biological reactor under row: in autumn, winter, and spring season it can be used, and in high altitude, high latitude, drought, cold, and short frost-free areas it should be used, especially.

2. The internal straw biological reactor between rows: in high temperature season and in the area where there are no straw it should be used before planting.

3. The internal type for topdressing: the whole process of crop growth can be used, and the method is more flexible. Straw should be crushed and applied in holes.

4. The internal type under tree: in fruit trees, economic forest, green belt, and nursery planting areas it should be adopted

The straw, stain, and excipients of the internal straw biological reactor:

1. For internal straw biological reactor under row: every 667 m^2 the amount of straw 3000–4000 kg, strain 8–10 kg, wheat bran 160–200 kg, cake fertilizer 80–100 kg

2. The internal straw biological reactor between rows: every 667 $m^2$the amount of straw to be used is 2500–3000 kg, strain 7–8 kg, wheat bran 140–160 kg, and cake fertilizer 70–80 kg.

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3. The internal straw biological reactor for topdressing: every 667 m^2 each straw powder (or edible fungus waste) dosage is 900–1200 kg, strain 3–4 kg, wheat bran 60–80 kg, and cake fertilizer 80–100 kg.

4. The internal straw biological reactor under the tree: every 667 m^2 the amount of straw to be used is 2000–3000 kg, strain 4–6 kg, wheat bran 80–120 kg, and cake fertilizer 60–90 kg.

3.2.1. The processing method of strain

Prior to the day when using or on the day, the strain must be pretreated. Methods: 1 kg strain blending 20 kg of wheat bran, 10 kg of cake, adding 35–40 kg of water, and after 4–24 hours of fermentation it can be used. If it is not over, the mixture should be spread in the room or shade, keeping a thickness of about 8–10 cm, and continue to use on the next day.

3.2.2. Attention

Razing animals' (cattle, horses, sheep, etc.) feces can be used for growing vegetables, fruits, and legumes: in the use of fertilizer technology grazing animal manure should not be used. Research confirmed that the use of chicken, pig, human, ducks, and other nonherbivoros animal manure will accelerate the nematode reproduction and dissemination, causing plant diseases; use of fertilizers will influence the activity of bacteria, also can make soil compaction and accelerate the disease spread.

3.2.3. The operation of the internal straw biological reactors

Ditching and laying straw, sprinkling strain, vibration, covering soil, watering, plotting, drilling, and planting.

1. Ditch: double line should be used for planting size. Big lines (sidewalk) are 100–120 cm wide, little lines are 60–80 cm wide; ditching furrow under the little lines. They are 60 or 80 cm wide, 20–25 cm deep, as long as the planting line. The soli dig up is put on each side of the furrow.

2. After ditching, paving straw in the trench (corn straw, wheat straw, and rice straw, etc.). At the bottom of the general shop put the whole straw (corn straw, sorghum straw, firewood, etc.), at the top with broken soft straw (e.g., rice straw, wheat straw, corn bran, weeds, leaves, and edible mushroom leftover). The straw put down and compacted is 25–30 cm thick, at both ends of the ditch straw stubble exposed 10 cm in order to enter the oxygen.

3. Sprinkling strains: in each furrow 6 kg of treated strains are evenly sprinkled on the straw, and patted again by a shovel, so the strains and straw are closely contacted.

4. Covering soil: putting the soil on both sides of ditch back into ditch. Soil is 20–25 cm thick, planting ridge is formed, and the ridge is leveled.

5. Watering: watering to split the straw, 3–4 days later, leveling the ridge surface and the soil is kept about 20 cm thick.

6. Drilling: on the ridges with reinforcement 12# (generally 80–100 cm), and in the top welding a T type to drilling three rows of holes, line spacing 25–30 cm, and hole spacing 20 cm, to penetrate the straw layer, letting oxygen in, and promoting the straw fermentation, standing by for planting.

7. Planting: generally pouring water, a bowl of a tree. Watering 3 days after planting under high temperature, and 5–6 days under low temperature.

3.2.4. The internal straw biological reactor between rows:

1. Ditch: double line should be used for planting size. Big lines (sidewalk) are 100–120 cm wide, little lines are 60–80 cm wide; ditching furrow under the little lines. They are 60 or 80 cm wide, 15–20 cm deep, as long as the planting line. The soli dig up is put on each side of the furrow.

2. After ditching, paving straw in the trench (corn straw, wheat straw, and rice straw, etc.). At the bottom of the furrow put the whole straw (corn straw, sorghum straw, firewood, etc.), at the top with broken soft straw (e.g., rice straw, wheat straw, corn bran, weeds, leaves, and edible mushroom leftover). The straw put down and compacted is 20–25 cm thick, at both ends of the ditch straw stubble exposed 10 cm in order to enter the oxygen.

3. Sprinkling strains: in each furrow 6 kg of treated strains are evenly sprinkled on the straw, and patted again by a shovel, so the strains and straw are closely contacted.

4. Covering soil: putting the soil on both sides of ditch back into ditch. Soil is 20–25 cm thick, planting ridge is formed, and the ridge is leveled.

5. Watering: watering the little line (plant line) to percolate into big line (sidewalk), 3–4 days later, leveling the ridge surface and the soil is kept about 20 cm thick.

6. Drilling: on the ridges with reinforcement 12# (generally 80–100 cm), and in the top welding a T type to drilling three rows of holes, line spacing 25–30 cm, and hole spacing 20 cm, to penetrate the straw layer, letting oxygen in, and promoting the straw fermentation, standing by for planting.

7. Planting: generally pouring water, a bowl of a tree. Watering 3 days after planting under high temperature, and 5–6 days under low temperature.

3.2.5. The internal straw biological reactor for topdressing

In order to maintain production of the whole growing period, the method should be used in the growth period. The new straw is crushed, adding the mixture every 667 square including 3 kg bacteria, wheat bran 60 kg, cake 30 kg, straw powder 900 kg, and water 2000 kg (the proportion of 1:20:10:300:666). The trapezoidal reactor mixture is piled up as high as 60 cm, and as wide as 100 cm to ferment. By the sticks with a diameter of 5 cm drilled the nine holes on the pile surface. Covering with membrane fermentation, when the compost is heated to 45°C to 50°C, it can be used to fertilize the caves dug in the soil. The caves are 15 cm from the plant and 30 cm from each other. A total of 0.5–1.0 kg compost per cave is fertilized; after

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covering the soil, 3–4 per holes are drilled on the cave; no watering is done for 7–10 days after topdressing, while depending on the soil moisture content during the growing period watering is done 2–3 times.

3.2.6. The internal straw biological reactor for trees

According to the different application period it is divided into full and half biological reactor, it is suitable for fruits, also green trees, antisarin, and other species of higher value may be used as reference.

The full one: The furrow is around the trunk from the surrounding soil to crown projection below, which is 10–25 cm deep. Most capillary roots may be exposed or broken. The furrow is sprinkled by a layer of vaccine, and covered with straw that is 10 cm higher than the ground, 10 cm stalks are exposed out of the pit for oxygen. The soil is filled back. Irrigate enough water, level the soil, punch, and covered film 3–4 days later. With reinforced 12#, the holes are punched with 30 × 25 cm after germination.

The half one: The method is applied in the growing season of fruit trees. Practice is to be around the trunk at six equal parts, the furrow is fan shaped and 40–60 cm deep (preventing root injury). Sprinkle a layer of vaccine, and then lay the half straw, sprinkle a layer of bacteria, lay the other straw, sprinkle another layer of bacteria, pat the soil with a shovel, and 3 days before watering and leveling the soil, punch the hole to 30 × 30 cm^2. It does not cover the plastic film, but cover plastic film in the plateau area with water shortage to protect water. Its operation method is as same as the internal straw biological reactor.

3.2.7. The external application of straw bioreactor

According to the level of investment and construction quality it can be classified into simple external and external standard. Simple external type: it only need to dig trenches, lay thick plastic sheeting on it, do isolation layer with sticks, small cement pole, bamboo billet or branches, build the base with brick, cement for airway, and switch base. It is characterized by small investment, fast construction, but the film is easily damaged.

Standard external: trenching, construct gas storage pool, airway, and the switch base with cement, brick, and sand, do isolation layer with cement poles, bamboo billet, and gauze. Although, the investment is large, the period of use is long. According to its construction site, in the low temperature season, it is built in the shed, and outside the shed in high temperature season. The one outside is convenient. The construction process should be built before sowing or planting. The feeding should be after planting or seedling.

The straw, strains, and auxiliary materials dosage: each time: straw, 1000–1500 kg, strain, 3–4 kg, wheat bran, 60–80 kg. The whole growth period:2–4 times.

Construction period: during the whole growth period the application of external type biological reactor increases yield, the sooner the reactor is used, the larger the yield is increased. Average increase of yield is more than 50%.

The construction process of external reactor:

1. Standard external: for winter and early spring crop it is built in at the inner side of the gable greenhouse imported, 60–80 cm away from the gable, from north to south to dig 120–130 cm for a catchy width and 100 cm deep, 90–100 cm for mouth wide, long, 6–7 m (a little less than greenhouse width) of ditch. The excavated soil is evenly placed along the ditch, and the shape of the outer high and low profile is spread out. The ditch is laid with plastic sheeting (can reduce the dosage of cement and sand walls), and extends 80–100 cm along the trench. And then from the middle of the ditch excavate an airway that is 65 cm wide, 50 cm deep, 100 cm long, connected with the ground round the exchange base. The base diameter is 50 cm. At the two ends of the ditch, the back airway is constructed with a length of 50 cm, width of 20 cm, and height of 20 m. Then feeding inoculation begins: sprinkle three layers of straw and bacteria (every layer: 40–50 cm thick straw, with a layer of bacteria), wet straw so that half of furrow is filled with water. Finally, the furrow is covered with plastic sheeting to cover the moisture. The covering should not be too strict, the same day pumping gas, so that gas can be circulated to accelerate the reaction.

2. The simple external construction process: ditching with external standard. Just in order to save ditch costs, cement, sand, and brick of the ditch wall is replaced with plastic sheeting.

3.2.8. The use and management of external reactor

External reactor use and management can be summarized as: “three application” and “three amendments.” Boot uninterruptedly on the day of feeding regardless of that the weather is cloudy or sunny.

Gas: to boot for 5–6 hours per day at the seedling stage, 7–8 hours at the flowering period, and 10 hours per day at the fruit period, whether it is cloudy or sunny. It is confirmed that the reactor carbon dioxide gas can increase production by 55–60%, especially at noon.

Liquid: on the second day water in the ditch should be irrigated out of the ditch, poured the leaching in the straw three times on the reactor, once a day. If the ditch is short in water, replenish it. The reason is that the activity of enzyme and spore is high, and the effect is good. The solution including 1 parts of the leaching solution and 2–3 parts of water is sprayed on the leaves or roots, 3–4 times per month. Reactor leaching solution contains a large amount of carbon dioxide, mineral elements, and disease-resistant spores, which can increase plant nutrition, and it can also play the role in prevention and control of diseases and insect pests. It is proved that the reactor liquid can increase the yield by 20–25%.

Slag: straw reactor releases a large number of mineral elements, except dissolved in leaching solution and also in slag. It is a mixture of organic and inorganic nutrients vegetables need. External reactor slag can be cleaned out and piled up to decay into powder as matrix fertilizing, it is to not only to replace chemical fertilizers for seedling growth, but also to prevent and control plant diseases and eliminate damage from pests. It is showed that the reactor slag can increase the yield by 15–20%.

The water: water is one of the important conditions of the reactor. In addition of water in building a pile, the water must be supplied every 7–8 days to fill a water reactor. Untimely replenishment will reduce the efficiency of the reactor, causing the reactor to stop.

The oxygen is a prerequisite for the reactor to produce carbon dioxide. The straw bioreactor needs a large number of oxygen. With the reaction reactor working, ventilation condition is getting worse and reaction is slow so that the covering film on the piles should not be too strict, every 20 days the film should be uncovered, and 5–6 hole per square meter should be drilled.

Amendments: when external reactors generally use for 50 days or so, the straw consumption is more than 60%. Note that 1200–1500 kg straw and strains should be added. In winter the amendments are supplied three times.

3.2.9. The notice for operation

1. The operating time of the internal reactor should be more than 20 days ahead of planting, otherwise the results will be postponed.
2. The first watering should be enough to foot (with wet straw); the second watering is uniform, with the interval time of 10–15 days; watering for the third time to be clever, watering for the fourth time should be careful, in winter or spring period it should not be watered, if not be dry.

The use of built-in master four should not be the principle of:

Ditching should not be too deep (not to exceed 25 cm); strain and straw quantity should not be too little (straw 3000–4000 kg, 8–10 kg bacteria per 667 m^2), covering soil should not be too thick (20–25 cm); and drilling the hole should not be too late, or too little (3 days after watering, a hole per 20 m^2).

3.3. The application effects of straw biological reactor technology

3.3.1. Growth performance

Seedling: early onset—fast growth, wide stem diameter, short internodes, large and thick leaves, early flowering, fewer pests and diseases, and resisting natural disasters. Medium—strong growing of crop, many big fruit of less deformity, and 10–15 days of listing period in advance. Late—the strong ability of continuous fruiting, longer harvest period by 30–45 days, and obstacles lead to continuous cropping are overcome.

3.3.2. Yield performance

The yield of different fruit varieties generally increase by 80–500%; the yield of different vegetable varieties increase by more than 50–200%, the yield of root, stem, and leaf crops generally increase 1–3 times, the yield of legumes (such as peanuts and soybeans) increase by 50–150%.

3.3.3. Quality performance

Fruit tidy, commodity rate, the color and luster, sugar content, flavor, and aroma quality are improved significantly; nitrite content and pesticide residues significantly decreased or disappeared.

3.3.4. The input-output ratio

Greenhouse vegetable, melons for 1:14–16; high arch shed vegetables, melons for 1:8–12; small arch shed melons, vegetables 1:5–8; open field cultivation of melon and vegetable 1:4–5; and special Chinese village is 1:20–50.

3.3.5. Reducing production costs

In greenhouse the reduction is 3500–4000 yuan per 667 m^2; in shed it is 1500–2500 yuan; in small arch shed it is 500–1000 yuan.

4. Plant vaccines and their use

Plant vaccine is a kind of biological technology that uses plant immune function to prevent plant diseases. The mechanism of preventing and controlling the disease is to activate the immune function and to realize the purpose of preventing and controlling the disease. It is an important part of the biological reactor technology system. The technology is now used in Shandong, Liaoning, Hebei, and other 10 provinces, as well as in more than 100 counties (cities, districts); fruit trees, vegetables, herbs, legumes, tea, tobacco, and other crops on large areas; also, the control effect reached 80–100%, the average cost decreased by 60%, with an average increase of more than 30%. The plant vaccine has important significance to solve the problem of pesticide pollution and pesticide residues in agricultural products, and to realize the organic cultivation and food safety of crops.

5. Production of nursery soil

5.1. How to make breeding soil with biological organic fertilizer

There are two stages in field cultivation of crops. In seedling stage it is mainly for crop root growth and seedling cultivation so that fertilizer quantity is not big, but uniform. There cannot be too high nutrients, otherwise it will produce burning phenomenon of seedling roots. The nutrients needed for the growth of seedlings were mainly supplied by the bed soil and the substrate. The bed soil or other nursery matrix requires loose, fertile, air permeability, and moisture retaining property.

Production of nursery soil: 10% organic biological fertilizer and 90% ripening fertile garden soil mixing, sieving, and joining right amount of nitrogen, phosphorus, and potassium nutrient. Available nutrient contents are controlled as nitrogen 150–300 mg/kg, 200–500 mg P_2O_5/kg, and K_2O–600 mg/kg. Nursery soil adding fertilizer can be calculated according to the effective nutrient content, generally as for 100 kg nursery soil, 0.5 kg ammonium sulfate, 1 kg superphosphate, and 1 kg potassium sulfate, which are mixed evenly to avoid inhibition of seedling growth.

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