GROWING SUBSTRATES: BASICS OF SOILLESS AGRICULTURE TECHNIQUE

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With the world's population is expected to reach 9 billion by 2050, food security appears to be one of the most important themes of the new millennium and the agriculture sector's most pressing challenge. Population growth and rising human requirements are driving forces for technological innovation and modernization to meet these demands. Agricultural scientists face a difficult problem in ensuring an unbroken and sufficient supply of nutritious, healthful, and uncontaminated foodstuff to the world's rising population. In this regard, the soilless culture (hydroponic) method is unquestionably a viable option due to the ability to exploit surfaces that are no longer fertile for agricultural reasons (Fig 1). Furthermore, it should be noted that this farming strategy is a promising instrument in the context of the broader challenge of food security, as well as a positive reaction to a more environmentally friendly agriculture. Fresh vegetable availability, off-season production, excellent nutritional content, and minimal water use are just a few of the characteristics that make hydroponics essential in modern farming. It is a one-of-a-kind example of agricultural engineering that has enlisted the help of thousands of acres of land all over the world to cultivate food crops.

Plants are cultivated in several types of hydroponic medium in a soilless indoor farming system to assist nourish their roots and maintain a good water/oxygen ratio. In hydroponic cultivation, an adequate supply of oxygen to the root region is critical. Growing media have the advantage of being significantly more porous than dirt, allowing for better oxygenation. The substrate must not dry out in order for the plants to receive nutrients. In comparison to soil cultivation, the perfect supply of nutrients and oxygen to the roots is the major reason for faster and more vigorous plant growth in hydroponic systems. The typical hydroponic fertilizer solution is used to supplement plants in a soilless cultivation system. It is the only source of nutrients, which are dissolved in sterile water and travel through the roots of the plants, inundating them on a regular basis. Experts claim that under a hydroponic growing technique, the plant development rate is higher since the nutrients are rapidly absorbed by the plants. As a result, it's critical to use a well-balanced solution that contains all of the necessary plant nutrients in the proper amounts. There are inorganic and organic hydroponic-substrates with particularly advantageous features for plant growth, such as higher porosity than soil, easy rootability and access to the nutrient solution and easy drainability so that oxygen may permeate from the air.

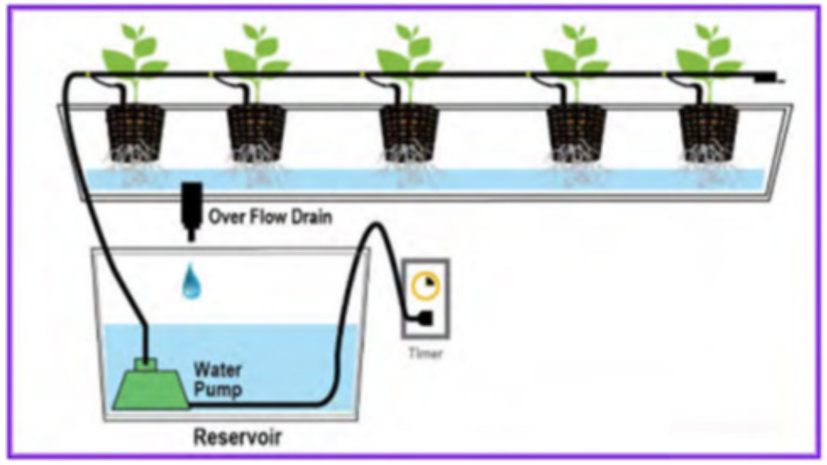

Fig. 1 Mechanism of soilless culture system

GROWING SUBSTRATE:

Everything where a plant can grow in or on is referred to as substrate. The substrate, also known as the growing media, keeps the plant in place while also providing an environment in which the root system can function. Hydroponic systems rely heavily on growing substrates. Crops and hydroponic systems require specific substrate properties. A good substrate allows you to have more control over the root environment, which can help you create a more precise irrigation plan, increase crop uniformity, and prevent root infections. There are likely hundreds of different types of growth media on the market today. The following are a few of them.

STANDARD GROWING MEDIA

Rockwool:

Many commercial gardeners consider rockwool to be the best substrate for hydroponic production. Because of its favorable structure, rockwool cubes are popular among hydroponics and conventional gardeners alike. When the fibers are spun together, they form a structure that is ideal for retaining water while also holding more oxygen than traditional soil media. When beginning seeds and rooted propagation cuttings, the enhanced water holding capacity and oxygenation inside the root zone is quite useful. Because rockwool has a slow, consistent drainage profile, the crop can be managed more accurately between vegetative and generative growth without danger of EC or pH fluctuations. A lack of cation exchange capacity (CEC) stops nutrients from being altered or tied up and unavailable for plant uptake by the growth medium. Rockwool is suitable for plants of all sizes, from seeds and cuttings to giant plants, and can be used with continuous drip or ebb and flow systems.

Perlite and vermiculite:

Perlite is a soil-free growth media that have long been used to assist aerate soil mixes. It's made by air-pumping volcanic glass, which results in a light, porous substance. Because of its porousness, it possesses one of the highest oxygen retention levels of any growing medium. It's white and light in weight and it's frequently used as a soil supplement to improve aeration and drainage. Perlite is usually blended with coco coir, soil, or vermiculite and is rarely used alone. Vermiculite is a flaky, glossy material created from heat expanded mica that is utilized in the same way as perlite. It has a higher water retention rate than perlite. It has the ability to draw water and nutrients upwards. It's frequently combined with other materials to provide highly tailored media for specific hydroponic uses. Perlite and vermiculite are only recommended for beginning seeds and cuttings due to their small weight.

ALTERNATIVE GROWING MEDIA

The improvement and popularization of alternate growing media has been one of the most fascinating advances in the field of hydroponics. Because of the escalating cost of rockwool and the difficulty of disposing of it, many growers are looking into other substrates. With so many alternatives, there is nearly a substrate for every condition. The solutions listed below are only a handful of the most popular and promising.

Oasis cubes:

Oasis cubes are comparable to rockwool cubes. Oasis rooting cubes are firm, open-celled, water-absorbing foam cubes designed for optimal callus and root growth. Oasis cubes are made of phenolic foam and are commonly used as a rooting media in commercial floriculture. They also work well for beginning seeds and cuttings in hydroponic production. Oasis cubes feature a wicking motion that attracts water to the top of the foam and can store almost 40 times their weight in water. They have a neutral pH and may be transplanted into almost any hydroponic system or growing medium with ease. It is a low-cost media that can be used for seedling germination and growth.

Hydroton expanded clay pellets:

These are manufactured by inflating clay to make round balls of porous substance, as the name implies. The stones are innocuous and range in size from 1 to 18 mm. Clay pellets have a lot of tiny air spaces, so they drain well. Clay pellets are ideal for ebb and flow systems or other watering-intensive systems. The fact that they emit absolutely no nutrients into the water stream and are pH neutral is the nicest feature about them. Furthermore, their spherical shape and porousness aid to maintain a good oxygen/water balance, preventing the roots from becoming excessively dry or drowned. Grow rocks are a man-made product that works incredibly well as a growing medium. Pellets are one of the few types of media that can be easily reused, despite their high cost. Remove old roots after harvesting and sanitize with bleach, steam, heat, or hydrogen peroxide. Clay pebbles can be combined with coco coir or other substrates to improve drainage.

Sand:

Sand, one of the earliest known hydroponic substrates, is extremely inexpensive and readily available. Sand is no longer frequently used, owing to its low water-holding capacity and high weight. Because sand has a propensity to compact, limiting the quantity of air available to the roots, coarser grade sand is preferable for hydroponic application. Sand can also be blended with different media to increase the water-holding capacity and reduce the weight.

Gravel:

Gravel was one of the first commercially accessible hydroponic medium. Gravel is usually inexpensive, works well, and is quite easy to come by. Gravel provides ample air to the roots but does not absorb water, allowing them to dry out rapidly. It is difficult to handle because to its weight, but it has the virtue of not breaking down in structure and being reusable. Cleaning can also be done with heat, steam, bleach, or hydrogen peroxide.

Growstones:

It is manufactured by combining waste glass bottles with calcium carbonate. Growstones come in a variety of sizes, ranging from 1 to 2 inches in diameter. It's exceptionally light, long-lasting, and suitable for practically any purpose. Perlite has less air and water retention space than this material. Growstones appear to be a comparable option to clay aggregate that has been stretched. It cannot be reused since roots will adhere to it after harvest, causing sterility to be ruined.

Pumice:

Pumice is a low-cost hydroponic material that is easily available. The use of a combination of fine and coarse materials allows a grower to regulate the drainage capacity of the media, while the porous volcanic rock allows for efficient water retention and aeration. Pumice is a lightweight material that takes a long time to break down. Because of its light colour, it is an excellent media for summer growing because it does not absorb heat. To promote aeration and drainage, pumice can be blended with other forms of growing media, such as vermiculite or coir.

Polyurethane grow slabs:

Polyurethane grow slabs are a relatively new hydroponic media that was developed expressly for this purpose. This medium is made up of about 75-80 percent air space and 15% water-holding capacity. They're inexpensive, widely available, and drain effectively. Due to their small weight, they are difficult to employ uncovered outdoors; they are commonly used in Nutrient Film Technique systems. Plants have the potential to absorb styrene, posing a contamination danger.

ORGANIC GROWING MEDIA

Rockwool and phenolic foam are two of the most common substrates used in recirculating water systems for leafy crops, such as nutrient-film technique (NFT) and deep-flow technique (DFT) systems, as well as high-wire slab or bag systems for vining, fruiting crops in hydroponic crop production. These are hydroponic producing substrates that have been thoroughly tested and confirmed in the field. Organic substrates for hydroponic production, on the other hand, are gaining popularity.

Coconut coir:

Coconut coir is quickly becoming one of the world's most popular growing mediums, if not the most popular. It's the first completely "organic" medium to deliver outstanding results in hydroponic systems. Coconut coir is a fibrous pith found in the coconut husk, which is a byproduct of the coconut industry. After being separated from the husk, the coir is processed into a variety of sizes, ranging from bigger pieces or chips to finer pulverised particles. The root zone can benefit greatly from high-quality coconut products. Coconut coir has a high capacity for aeration and water retention. It likewise has a pH range of 5.6 to 6.6. Coconut fiber's key benefits are its oxygen and water-holding properties. It can keep a higher oxygen capacity than rockwool. Coir has also been demonstrated to offer insect-repelling properties in some studies. High-quality coir (the coarser fibers in the grade frequently used for hydroponics) also has the advantage of carrying no or very low quantities of nutrients, so it won't change the nutrient solution's composition. When looking for coconut coir to use as a substrate, it's critical to look for high-quality items. Some coco products include a lot of salt, which makes controlling a hydroponic system more challenging. Coconut coir is also available in smaller block and plug forms for seedling propagation, in addition to slabs or bags for producing vine crops.

Sphagnum peat moss:

Another organic component that can be utilised as a hydroponic production substrate is sphagnum peat moss. It's a perfectly natural medium that's a key component of most soilless mixes, but it's often neglected as a hydroponics medium. It does, however, have a number of qualities that make it ideal for hydroponic cultivation and is readily available. Long strands of very absorbent, sponge-like material hold and retain enormous volumes of water while providing enough aeration. Because of this structure, it works best in bigger lattice or net-pot production, where the long strands can pour out of the openings in the pots and wick up water without dropping out. To prevent an excessive amount of particles from entering the recirculating nutrient solution, peat moss must be stabilized with a physical or chemical binder. The main disadvantage of this growing medium is that it decomposes over time and sheds microscopic particles that can clog your drip emitters or pump.

Wood fiber:

The most frequent organic component used to make micro-green substrates is wood fiber. Simply said, wood fiber is an excellent and cost-effective growing medium for hydroponic systems. Wood chips are the best alternative for those looking for totally organic growing media. Growers must guarantee that their sawdust is free of soil, diseases, and chemicals from wood-processing industries, as well as undesired tree species. Because wood fiber absorbs a lot of moisture, it's important not to overwater it. The nicest part is that it is frequently free and natural. Furthermore, wood chips have been shown in certain research to inhibit the efficacy of plant growth regulators, implying that your plants may grow slightly larger.

Rice hulls:

In most regions of the world, rice hulls are a lesser-known and underutilized substrate. Rice hulls are a natural and biodegradable substrate, making them an environmentally beneficial choice. Rice hulls are a by-product of rice production that has the potential to be a low-cost, high-impact medium in rice-growing areas. The pH of rice hulls is roughly neutral, which is ideal for plant growth. Because of the high porosity levels, which allow oxygen to enter deep into the root zone, the roots may receive enough water and oxygen. Rice hulls tend to accumulate salt and degrade after one or two crops, thus they should be replaced on a regular basis.

CONCLUSION:

This summary of the various growing substrates used in soilless cultivation systems clearly shows that they are indispensible components for assisting plant root nutrition and maintaining a good water/oxygen ratio inside the plant system. Using organic and inorganic substrate allows plants to absorb nourishment and grow properly while also maximizing water availability and maintaining an optimal oxygen level. As a result, the correct substrate for growing plants must be chosen from among these many materials in order to maximize crop yield.