

## **Diatomite: A New Substrate for Hydroponics**

**Nesrin Yıldız**

Department of Soil Science, Faculty of Agriculture  
Ataturk University, 25240 Erzurum, Turkey. E-mail: nildiz@atauni.edu.tr

### **ABSTRACT**

Many different substrates are used for plant support in hydroponic culture, but one of the unique requirements for research is that the media be easily separated from the roots. Peat, perlite, and vermiculite are good substrates but roots and root hairs grow into these substrates, so they are unsuitable for studies of root size and morphology. Sand can easily be removed from roots, but roots grown in sand are shorter and thicker than hydroponic roots because the sand particles are so dense. Diatomite particules was the medium of choice for research hydroponics for many years because it can easily be removed from roots. Diatomite is a sedimentary rock primarily composed of the fossilized remains of unicellular fresh water plants known as Diatoms. This organic, natural product contains the fossilized skeletons of trillions of microscopic, single cell aquatic plants of fresh water origin. This lightweight, porous, non-toxic, non-hazardous mineral is a cost effective, highly efficient, horticultural growth promoting media. Diatomit is pH stable and the pH can be adjusted to suit various crops. Diatomite will absorb up to 150% of its own weight in fluids and slowly release the fluids as required by the plant. Diatomite is available in particle sizes from 1 to 10-mm diameter. Our tests indicate that Diatomite is chemically inert and has good water holding characteristics. The plant roots muffled with the media particles during the harvest were easily separated from each other by submerging roots in to filled cup and rinsing it in a few minutes time Its disadvantage is cost 3 TL/ 7 liter in Turkey. There are a lot of Natural Diatomite sources in Turkey.

**Key words:** Diatomite, soilless culture, hydroponic, plant, root, substrate

### **INTRODUCTION**

Diatomite is a biochemical sedimentary rock composed mainly of the skeletons of a very common type of marine plankton - diatoms. Diatoms are tiny plants that float near the ocean surface. Their skeletons are composed of silica (silicon dioxide), a very durable substance. Since diatom skeletons are highly porous, diatomite is extremely light in weight, and pure samples make excellent water filters.

Biochemical sedimentary rocks form from sediment derived by biological processes. This typically occurs in the ocean where a variety of atoms float among the water molecules. Ions, such as calcium, magnesium, and potassium, along with trace elements like silicon, fluorine, iron and phosphorous, are used by marine organisms to form their hard and soft tissues. Once the marine plant or animal dies, it may settle to the ocean floor as biochemical sediment, then become compacted and cemented together into solid rock. Typically only the hard, skeletal parts of an organism are preserved as sediment (Anonymous, 2008a ).

All Diatomite is not created equal. You may be familiar with diatomaceous earth that is used in filters and as an insect and slug repellent. These types of products are not suitable for horticulture because the diatoms are of salt-water origin, leaving them with a high salinity level that is not suitable for plants. Axis ( AgroTech 2000, Plainsboro, N. J.) is a kiln – fired diatomaceous earth produced earth aggregate from diatomite deposits. It is inert and has a pH of 7. Its porous nature reportedly absorbs more than 100 % of its own weight in water, then releases the water to the surrounding soil as the soil's water content drops below field capacity.

A diatomaceous earth layer is a limnic layer that: 1. Has a matrix color value of 3 through 5 if not previously irreversibly on shrinkage of organic matter coatings on diatoms, which can be identified by microscopic ( 440x) examination of dry samples: and 2. Yields a color higher value and lower in chroma than 10YR7/3 on white filter paper that is inserted in to a paste made of the material in a saturated sodium pyrophosphate solution or the cation – exchange capacity is < 240 meq per 100 gr of organic matter ( by loss on ignition ) or both . Diatomaceous earth layers normally are more nearly mineral than organic in composition

Diatomite is High in Silica, Absorbent, Porous, Long Lasting, Environmentally Friendly, pH Neutral, Sterilized, Natural and Reusable, all factors necessary for health plants, while still being cost effective for the grower (Anonymous, 2008a )

We have four sizes available for all of your growing needs

Fine 0.5mm to 2mm

Small 2mm to 7mm

Medium 7mm to 15 mm

Large 15mm to 25 mm (Anonymous,2008a )

The benefits to using " Diatomite" for all growing applications are:

1. High-Silica Content " Diatomite" will slowly release 'plant-available' silica to your plants, which is extremely important to the development of plant cell growth.
2. Absorption 150% of Solution " Diatomite" will absorb up to 150% of its own weight in fluids and slowly release the fluids as required by the plant.
3. Capillary Action The capillary action of " Diatomite" can be tested in a water vessel. Water can be drawn 200 mm from the bottom of the vessel to the top within a short time.
4. Lateral Movement " Diatomite" provides effective lateral movement of water and nutrients.
5. pH " Diatomite" is pH stable and the pH can be adjusted to suit various crops.
6. Assists Aeration, Air penetration of " Diatomite" is excellent owing to the fact that the granules are multi-faceted and do not compact.

## 7. Insulation Qualities

The microscopic porous structure of each granule provides effective thermal insulation to plants and root zones.

8. Sterilized "Diatomite" is sterilized when Heat-treated to approximately 650 degrees Celsius.
9. Longevity "Diatomite" diatoms are fossilized exoskeletons and are approximately ten million years old prior to production of calcined diatomite. It will not break down.
10. Environmentally Safe "Diatomite" contains no Cristobalite, Tridymite or Quarts, making this product user friendly ( Anonymous, 2007a).

**High Silica Content** Silica is essential for healthy plants and roots. Because diatomite is 90% silica, your plants will receive a slow release of silica resulting in healthier more robust plants. **Absorbency and Porosity** Diatomite is naturally very porous, and can hold 150% of its weight in water. The Silica Content, natural Absorbency, and Porous qualities result in a slow release of water and nutrients to your plants, contributing to higher yields and less watering. **Capillary Action and Lateral Movement** The porosity of the Diatomite contributes to its ability to draw water, while moving water and nutrients laterally throughout the medium, making Diatomite ideal for Hydroponics ( Anonymous, 2007a).

**Air Penetration** Diatomite is multifaceted and varies in size. Because each rock is unique in shape it does not compact while in the pot. This leaves pockets, allowing air to penetrate and circulate to the root zone. **Sterilized, Non-Toxic, pH Neutral** When Diatomite is mined it is heat treated to over 600 degrees Celsius, making it completely sterile and safe for all of your planting needs. Whether you are using 100% diatomite or you are adding it to a mix of your soil it will not contribute to changes in pH. Diatomite is inert and will not break down or decompose like other growing mediums. It is Natural and completely reusable. When dry, diatomite is extremely lightweight, making it ideal for plant shipping purposes. Due to the variability of hydroponics systems and growing conditions, some trial and error will have to be used to determine your ideal nutrient levels and watering schedule. We suggest that you reduce your watering frequency and nutrient level because of the liquid retention of Diatomite (Anonymous, 2008b ).

Frequently asked questions about Diatomite:

Q.1 What is Diatomite?

A.1 Diatomite is a mined product, a unique form of diatomite consisting of amorphous (not crystalline) silica.

Q.2 Is it a fertilizer?

A.2 No. Diatomite is not a fertilizer, it provides plant available silica which will enhance the uptake of water soluble fertilizers. The silica strengthens the plants'

cuticular cell wall, and imparts a stronger physical resistance to disease and stimulates the plants' "immune system."

Q.3 Can I use it for seedlings?

A.3 Yes. Several leading commercial seedling producers use Maidenwell 0.5mm-2mm product for seedling raising. To name a few: Leppington Speedy Seedlings in N.S.W., Berwick Speedy Seedlings in Victoria and Highsun Express Plugs in Queensland.

Q.4 Do I use it by itself or mix it with other materials?

A.4 Diatomite can be used alone as a growing medium for hydroponics, or may be combined with normal seedling or potting mixes (generally between 20 to 50%)

Q.5 How do I use it in potted plants?

A.5 We recommend Maidenwell be used at around a 50% blend with normal potting medium and a standard fertilizing program. (usually 0.5mm-2mm or 2mm-7mm) produce the best results for normal potted plants.

Q.6 How does Diatomite work in potted plants?

A.6 Diatomite is an insulator, it's sterilized and pH is stable, has a water absorption capacity of around 150%, it provides capillary action and lateral movement of both water and nutrient to the plant as it's required and it aerates the soil or potting medium. When all these features are combined together with the plant available silica, it creates the perfect growing environment for the plants' root system.

Q.7 Why are there different sizes of Diatomite?

A.7 We produce Diatomite in different sizes to suit varying growing applications. A wide variety of plants with different root structures and individual growing characteristics will require different size medium for their growing environment .

Q.8 Which sizes are recommended for what type of plants?

A.8 The seedling and plug industry require a small size product (0.5mm-2mm) to prevent bridging of potting media within the root cell space. The medium sizes (2mm-7mm and 7mm-15mm) are more appropriate where increased drainage is required. eg. Orchids etc. (7mm-15mm and 15mm-25mm) are mostly for orchids,hydroponic medium, decorative ground cover and insulated garden mulch.

Q.9 How often do I need to water compared to ordinary soil?

A.9 Diatomite improves the physical structure of soils, allowing water to penetrate the soil profile around the root zone more thoroughly. Watering can usually be reduced to twice weekly.

Q.10 How many days do I need to wait before I need to water the plants again?

A.10 This depends on the climate, soil type / growing medium and the type of plants.

In summer, pots may require watering daily, where as one watering every two weeks may be sufficient throughout winter.

Q.11 Is Diatomite safe to use?

A.11 Yes, Diatomite is safe to use. It is of freshwater origin (not saltwater), it consists of amorphous silica (not crystalline) as per the Amdel Report 6A05424 present and on our website [www.maidenwell.com](http://www.maidenwell.com) We recommend users to wet the product before use to settle any of the dust that may have been generated transit etc.

Q.12 How do I know for sure that Maidenwell will provide my plants with both a better and faster growth?

A.12 We suggest initially, that you pot at least one plant in your traditional potting mix alongside plants potted in Maidenwell, employ the exact watering and fertilizing treatment to all pots and you can judge for yourself the benefits of Maidenwell. After a short time you will no longer be sceptical about better and faster growth.

Q.13 Is this growing medium made from any chemical or harmful substances?

A.13 No. Maidenwell Diatomite is a naturally occurring, fossilized, mined mineral processed and heat treated to 650<sup>0</sup>C, no other materials are added during any process.

Q.14 I am already using a fertilizer and growing medium, do I still need to add something like Diatomite to my plants?

A.14 Diatomite will enhance any growing medium and with its plant available silica, will provide improved quality together with, faster and more prolific growth to your plants and flowers.

Q.15 How do I apply Diatomite to my plants? Do I need to put 100% Maidenwell or only 10% and the remaining 90% made up of potting mix etc.?

A.15 The application rates for Diatomite should be around 50% blended with normal potting mix. Diatomite can be used at 100% if you so desire. One of the significant features of Maidenwell is that you can't overdose with it. You can never use too much of it.

Q.16 How often must I replace?

A.16 Diatomite is fossilized and hence will never break down. You only need apply it once to growing media, however, other organic matter which makes up the remainder of the growing media, will probably need to be replaced at some stage.

Q.17 Do I need to wet it before using it?

A.17 It's not really necessary, however, we recommend users to wet the product down before use, just to settle any of the dust that may have been generated

in transit etc. Normally, water is added to Diatomite in the mixing process with other media.

Q.18 What is the recommended mix for growing in the ground.

A.18 This will vary from crop to crop. For roses, we recommend 3 litres of Diatomite per bush, dug into the soil and a further 3 litres around each bush. If it were incorporated at 5 litres per sq. metre, the results would be very noticeable in a short period of time.

Q.19 Can I use it to absorb oil?

A.19 Yes. In fact we currently supply Diatomite to several oil and chemical companies for this very application. Diatomite, with its high absorbency rate is an excellent industrial absorbent for both oil and chemicals.

Q.20 Are there other uses for Diatomite apart from a growing medium?

A.20 Yes. There are a number of different applications for Diatomite. Snail and slug repellent, decorative ground cover (insulated garden mulch), pesticide for insects, oil & chemical absorbent, insulation for fire doors and panels etc. (or just as a thermal panel for insulation in domestic houses against heat or cold), pet litter, filler for paint, paper and plastic etc., it can also be used to produce heat resistant / heat retardant paint, cutting compound for polish and the manufacture of lighter weight, insulated bricks and concrete products (Anonymous, 2008b )

Decomposition and decay of diatoms leads to organic and inorganic (in the form of silicates) sediment, the inorganic component of which can lead to a method of analyzing past marine environments by corings of ocean floors or bay muds, since the inorganic matter is embedded in deposition of clays and silts and forms a permanent geological record of such marine strata (Anonymous. 2008c ).

Diatomite is relatively inert and has a high absorptive capacity, large surface area, and low bulk density. It consists of approximately 90 percent silica, and the remainder consists of compounds such as aluminum and iron oxides. The fine pores in the diatom frustules make diatomite an excellent filtering material for beverages (e.g., fruit juices, soft drinks, beer, and wine), chemicals (e.g., sodium hydroxide, sulfuric acid, and gold salts), industrial oils (e.g., those used as lubricants in rolling mills or for cutting), cooking oils (e.g., vegetable and animal), sugars (e.g., cane, beet, and corn), water supplies (e.g., municipal, swimming pool, waste, and boiler), varnishes, lacquers, jet fuels, and antibiotics, as well as many other products. Its relatively low abrasive properties make it suitable for use in toothpaste, sink cleansers, polishes (for silver and automobiles), and buffing compounds.

Diatomite is also widely used as a filler and extender in paint, paper, rubber, and plastic products. The gloss and sheen of “flat” paints can be controlled by the use of various additions of

diatomite. During the manufacture of plastic bags, diatomite can be added to the newly formed sheets to act as an antiblocking agent so that the plastic (polyethylene) can be rolled while it is still hot. Because it can absorb approximately 2.5 times its weight in water, it also makes an excellent anticaking carrier for powders used to dust roses or for cleansers used to clean rugs. Diatomite is also used in making welding rods, battery boxes, concrete, explosives, and animal foods (Anonymous, 2008d )

Diatomite has a growing use in agriculture. For a long time it has been used as an addition to ammonium nitrate fertilizers to prevent caking and ensure even spreading. It is important as a carrier for other agricultural products, particularly fertilizers. Our own manufactured product, Molodri is an example of the effectiveness of diatomite in this capacity. The use of diatomite in combination with other biogenic combinations is a key to its future uses as a beneficial for both plants and animals (Anonymous, 2007b). Diatomite is a sedimentary rock composed largely or wholly of the siliceous skeletal remains of microscopic, mainly aquatic plants called diatoms that are a type of algae. The skeletons (frustules) consist of amorphous (as opposed to crystalline), opaline or hydrous silica, but the rock may be contaminated by varying amounts of organic matter, alumina, iron, soluble salts, and sedimentary particles such as clay, carbonates, and sand (Anonymous, 2007b)

Hydroponics, simply defined, is the growing of plants in a water and fertilizer solution containing the necessary nutrients for plant growth. It is not a new science, with work being done by researchers as early as the 1600's. In the early 1930's, W.E Gericke, of the University of California, put laboratory experiments in plant nutrition on a commercial scale. In doing so, he termed these nutrient systems "hydroponics". The word was derived from two Greek words, hydro, meaning water, and ponos, meaning labor, or literally, water working. Gericke's application of hydroponics soon proved itself by providing food for troops stationed on non-arable islands in the Pacific in the early 1940's. In 1945 the U.S. Air Force solved its problem of providing its personnel with fresh vegetables by practicing hydroponics on a large scale on the rocky islands normally incapable of producing such crops. With the development of plastics, hydroponics took another large step forward and is now a widely accepted method of producing certain specialty crops such as tomatoes, lettuce, cucumbers, and peppers. Other crops that can be grown by this method include herbs, foliage plants, and flowers. Most of the roses exported from Holland are grown hydroponically (Anonymous, 2006)

There are various systems of soilless culture. One of them is Media culture This is a system in which crops are planted on solid substrate rather than on soil and nutrient solution is applied to the media. Both inorganic and organic media are used. Inorganic media are classified according to their shape into particles, foam, fiber and others. Particle media culture include sand culture, gravel culture, expanded clay culture and Kuntan culture. Passive hydroponics, also known as hydroculture, is one of the techniques of hydroponics. Hydroponics refers to the method of growing plants without soil. Instead of soil, hydroponics depends on a special substrate, known as a hydroponic growing

medium. Passive hydroponics does away with the need for water or air pumps, by depending on the capillary action of the plant's own roots to transport water and nutrients to it. It essentially involves growing the plant in a porous container with a reservoir containing water and hydroponic nutrients. This system allows the plant to take in only the specific amount of nutrition it needs. The most basic passive hydroponics system consists of a pot placed in a nutrient solution or a capillary mat saturated with nutrient solution. Passive hydroponics, and other hydroponic techniques, offer many advantages over traditional methods of horticulture. Firstly, since a sterile medium is used instead of soil, the plant is protected against soil-borne diseases. Secondly, plants grown using hydroponics take up much less space than those grown in soil, which makes hydroponics the perfect choice for hobby horticulturists. These are some common hydroponic growing mediums: Perlite: Perlite is an amorphous volcanic glass. It is a popular growing medium. Vermiculite: Vermiculite is a natural mineral that resembles mica rock in appearance. It retains moisture well. Vermiculite is often used along with perlite as the two materials complement each other. **Diatomite: Diatomite is a naturally occurring, soft sedimentary rock. It contains elemental minerals, required for the growth of plants, which makes it an excellent hydroponic growing medium.** Charcoal: Charcoal is a residue of impure carbon. It is often used in combination with other growing mediums. Rockwool: Rockwool is a manmade mineral fiber. Because it is chemically and biologically inert, it makes an ideal hydroponic growing medium. Information on passive hydroponics is readily available. Besides the technique requires little expense or care. Because of this, even enthusiasts who are beginners with passive hydroponics beginners often enjoy successful results with relatively little effort. Freshwater diatomite can be used as a growing medium in hydroponic gardens. It is also used as a growing medium in potted plants, particularly as bonsai soil. Bonsai enthusiasts use it as a soil additive, or pot a bonsai tree in 100% Diatomaceous earth. Like perlite, vermiculite, and expanded clay, it retains water and nutrients while draining fast and freely allowing high oxygen circulation within the growing medium (Anonymous, 2008b)

## **MATERIALS and METHODS**

Diatomite as a growth media for higher plants

### **As a Preliminary Study**

A preliminary simple experimental work is conducted with a commercially available cheap material called diatomite which is sold in supermarkets ( Bought in Migros) as a cat sand in order to look in to possibility of using as growth media for crop plants in place such materials as sand, gravel, saw – dust and others in sand culture experiments and gardening . The material is available as coarsely ground sand-like form ( particle size varied between 0-10 mm) and packed in different sized bags.

The experimental material have been filled in to pots ( 2 liter) and sawn with tomato seeds. After emergence of seedlings pots and plants are watered with (Arnon ,1938) nutrient solution weekly

in the beginning and once in a few days later on . Namely plants are irrigated with the nutrient solution less frequently towards the end as needed . The experiment has continued till the beginning of the flowering stage.

Growth of the test plant, tops and roots alike was very healthy. In this simple observatory work separation ease of plant roots from the diatomite particles were also studied and evaluated. The plant roots muffled with the media particles during the harvest were easily separated from each other by submerging roots in to filled cup and rinsing it in a few minutes time.

## RESULTS and DISCUSSION

With the above mentioned perfect physico-chemical properties ( high water holding capacity , freedom of pathogenes, to be chemically inert or inactive, ideal pH , etc..) of the test material ( diatomite), it seems to be an excellent growth media for crop plants in sand culture experiments , greenhouse propagation and gardening ( Table. 1-2) . It is particularly suitable for studies concerned with plant root physiology and plants needing much air circulation ( figure.1).

Our tests indicate that Diatomite is chemically inert and has good water holding characteristics. The plant roots muffled with the media particles during the harvest were easily separated from each other by submerging roots in to filled cup and rinsing it in a few minutes time Its disadvantage is cost 3 TL/ 14 liter in Turkey. But there are a lot of natural diatomite sources in Turkey ( Figure. 2)

Table. 1.The Physical and Typical chemical properties of diatomite (Anonymous,2008b)

Physical properties	Typical chemical properties
Color- White, cream to yellow	Silicon Dioxide (SiO <sub>2</sub> ) 82.17%
Moisture- Approximately 6%	Aluminum Oxide (Al <sub>2</sub> O <sub>3</sub> ) 6.74%
Bulk Density- Approximately 0.4	Iron Oxide (FeO <sub>3</sub> ) 3.15%
PH- 6.2 to 6.9	Calcium Oxide (CaO) 0.04%
Water absorption- 150% - 170% w/w	Magnesium Oxide (MgO) 0.37%
Oil absorption- 115% - 125% w/w	Titanium Oxide (TiO <sub>2</sub> ) 0.60%
	Sodium Oxide (Na <sub>2</sub> O) 0.30%
	Potassium Oxide (K <sub>2</sub> O) 0.04%
	Phosphate Oxide (P <sub>2</sub> O <sub>5</sub> ) 0.09%
	Manganese Oxide (MnO) 0.01%
	Strontium Oxide (SrO) 0.01%
	Sulphur Trioxide (SO <sub>3</sub> ) 0.04%
	Loss on Ignition L.O.I 5.93%

Table 2. Some physico-chemical properties of diatomite used in experiment (Jackson, 1962)

pH	CEC cmol.kg <sup>-1</sup>	Na K cmol.kg <sup>-1</sup>	P mgk g <sup>-1</sup>	O.M %	CaCO <sub>3</sub> %	W.H.C %
6.6	2.7	6.5 0.4	2.1	0.03	0.28	190
7.1	3.0	6.0 0.5	2.0	0.02	0.25	185



Figure.1. Tomato roots were separated from diatomite particules easily



Figure. 2 .Diatomite sources (44 224 029 tone good quality Diatomite) in Turkey (Bayırtepe, 2001)

## REFERENCES

- Anonymous. 2008a ( [www.diatomiteusa.com](http://www.diatomiteusa.com)) Feb.2008
- Anonymous. 2007a ( <http://www.diatomiteusa.com/moreinfo.html>) Dec. 2007
- Anonymous. 2006 (<http://www.cropking.com/intro.shtml>) sep.2006
- Anonymous. 2008b (<http://www.maidenwell.com/>) june.2008
- Anonymous. 2008c (<http://en.wikipedia.org/wiki/Diatom>) Aug. 2008
- Anonymous. 2008d (<http://www.britannica.com>) April 2008
- Anonymous. 2007b (<http://www.mtsylviadiatomite.com.au/diatomite-products/intermediary/>) Nov.2007
- Arnon. D.I. 1938. Jour.Botany, 25; 322-325
- Jackson, M.L.1962. Soil Chemical Analysis. Prentice Hall.Inc N.J.
- Bayırtepe. H. 2001. The important Diatomite Ditsen Profillit Talk Asbest sourcesmap of Turkey.  
Phy. Tezes