Plants' food and water supervision center: Roots

The hardest and most difficult functions regarding a plant's growth are realized by the root part beneath the soil. Therefore, the physical and chemical events that take place inside the root and the root's structure form a very special mechanism. When the root system is examined with all of its structural features, it is seen that a plant has the most perfect qualities to acquire water and food from the soil.

Extraordinary Precaution Taken by the Root While Sprouting

The root's structure begins to surface with the seed sprouting. The first root emerging when the seed first pullulates is called the "primary root". This root emerges from the growth region inside the embryo in the seed. The primary seed grows slowly in the direction of gravity, thickens and begins to grow subsidiary roots connected to it. These subsidiary roots, composed of primary roots, are called "secondary roots".

Here, the most striking point is that there is great cooperation and harmony between these two roots. When the primary root cannot do its duty for any reason, one of the secondary roots closest to this root begins to grow in the direction of the primary root, and takes over its functions. Thus, a plant emerging from the seed takes precautions against the possibility of incurring losses and carries with it a "backup" root system.

How Much Can a Root Spread Inside the Soil?

H.J. Dittmer, a botanist from the University of Iowa, has conducted experiments about the size of the root surface needed for water, and inorganic materials in water, to be absorbed by the root. The experiment, conducted on a rye plant to find this size, has given very surprising results. The rye plant was taken out of the soil some time later and after its roots were washed, it had become thinner in size. It was then calculated that the rye root has grown 13.800.000 branches, and all of these take up a root surface 235 km^2 in size. In addition, it was found that there were 14 billion root hairs and these equaled an area of 400 km^2 in size. As a result of this research, it was found that the area of the root's water and food absorption equaled an area of 635 km^2. When these findings gathered from the rye plant alone are considered, it is understood that the activities carried out by plant roots under the ground reach to amazing extent.

The Unique Structure That Enables the Root to Move in Soil

Movement of the root inside the soil is as interesting as the root being able to move towards the soil. The rootlets which have just emerged from the seed are very delicate but the soil is very tough; therefore, there is a very difficult mission waiting for the root: **To enter and move inside the soil with its relatively weak structure.**

Because the soil has an uneven and granulated structure, the rootlet has to deal with great friction forces once it begins to move ahead. **So how could the root resist against friction with its delicate structure and grow in the soil without being harmed?**

- When rootlets emerge from the seed, they emit a "special secretion" with a chemical composition that protects them from friction once they enter the soil. This special secretion makes the root's surface slippery and so the root is protected against the harm and negative effects of the friction caused as the root enters the soil and moves ahead.

- The roots, having a special geometrical "cone" shape, allows the root to decrease friction force to a minimum as it moves along the soil. The area at the very tip of the root is called the "root hat" and this part has a conical shape, as it is the part that first meets friction as the root moves ahead. This shape brings an elevation to the root to make it move easily in the soil and also allows the root to easily pierce the soil.

As it is seen, the root has all that befits it, as if it knows what it will face under the ground, before coming out of the seed. Here, there is a biological knowledge, and the owner of this knowledge is Almighty Allah Who creates everything in a flawless manner.

The Secret in the Root's Shape

At the first look, the branch-like structure of the root seems to be complicated and unordered. However, a new field of geometry that emerged in recent years, and the mathematical rules it provided, has shown that structures that cannot otherwise be explained by the complexities of classical geometry actually do have an ordered shape. This new field of science is called "fractal" geometry. The word fractal means, "broken up" or "divided".

Beneoit B. Mandelbrot proved, when he was working in the Watson Research Center, that some forms cannot be explained by known geometrical models, and even these do not have unarranged shapes, through the use of special computer programs. Truly, all shapes seen in nature cannot be explained by classical geometry. For example, the branched structure of a defoliated tree cannot be explained by a square or a circle. As stated by Beneoit B. Mandelbrot, "Neither the clouds are round, nor the mountains are conic, nor the sea shores are circular, nor tree peels are straight, nor lightning moves in the direction of straight lines. (Fractal Geometry)

The Common Result Explored in Fractal Structures

When we look at the geometric structures of objects identified with fractal geometry, we can discern a common quality. The parts or sections that make up the object looks like the whole of the object. The parts or sections of the object continuously repeat themselves in gradually smaller sizes. If we assume that this condition continues constantly in a mathematical way, the object forms parts that look like the object itself. Therefore, when a small part of the object is magnified, it looks like the object itself. This common quality observed in the fractal structures in nature is not a "repeat", but it is nonetheless a mathematical rule that lies at the basis of geometry.

Fractal Geometry in Roots

The parts that form the fractal structure of plant roots are the subsidiary rootlets that emerge from one another. This geometric quality is a necessary process for the root. Some scientific research conducted about the root clearly prove this fact. For example, research about the "branching density" of roots in soil has shown that for the plant roots to complete their functions, branching needs to have the most optimal (suitable) density. Scientists have calculated the most optimal branching density for a root under the ground through computer techniques and compared them to plant roots growing in natural habitats. The results obtained showed values very close to one another in a miraculous way.

As it is seen, the quality of self-repetition that makes plant roots seem as unordered is not an unnecessary detail, but rather a miracle of creation that makes the movement and spread of the root system easy and allows it to complete its functions. Almighty Allah, the Lord of all worlds, bestowed on everything a flawless shape and appearance and created plant roots with a perfect functionality in terms of shape.

Conclusion: The Truth Revealed by Plant Roots

It is clear that plants and living things, having many sensitive details and mechanisms like roots and acting in an intelligent and conscious manner, is something created especially for human beings to contemplate the facts of Creation. Our responsibility is to think about Creation, and to try to appreciate Allah's Might.

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