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Private Plantation Techniques

Ömer Lütfü Çorbacı[1] and Murat Ertekin[2]
[1]*Ankara University, Faculty of Agriculture*
[2]*Bartın University, Faculty of Forestry*
Turkey

1. Introduction

The visual value of a town increases directly proportional to the density of her open and green spaces. Vertically and horizontally formed greenery is an indispensable part of urban design. However, with the advanced technology during the 20 th century, wide construction areas, highways, agricultural and industrial zones have developed in an unplanned manner, and natural resources were abused in an unsystematic way. Unfortunately, the number of natural elements in towns has decreased rapidly in recent years, and with the help of uncoordinated urbanization, the situation has turned for the worse for green areas. If we were to analyze this fact with figures, the example of Ankara, Turkey would prove to be more than enough. In physiological terms, according to oxygen exchange and leaf surface calculation, there is a theoretical need of 25–40 m² green area per person in an urban area. But in Ankara, this figure was 5.1 m² in 1950, 2.8 m² in 1965, and 1.8 m² in 1979. However, the urgency of the matter has been realized during recent years, and inner urban greenery works have been started.

Improving the environmental conditions of the indoor and outdoor places where humans live, and also to arrange them to become suitable for living, has become a foremost priority. Today, extreme urbanization has become ever fast growing, and inner urban tree planting techniques are changing and improving accordingly too. Nowadays, it is necessary to make use of all new developments in technology and find ways to meet the ever increasing demands of modern life.

The first time when large plants were uprooted and transferred to somewhere else was during the Munich Olympic games in Germany. Back then, a whole new Olympic village was created with immense greenery. At that time, this transplantation process was realized with much more labour force and time, also simpler techniques were used. However, the same could be done today with much time effort and time spent, through the use of modern techniques. A very important aspect of landscaping works is the time needed until it reaches an effective power, or in other words, the dimension of time. Trees and landscaping elements need on average 30–40 years to reach an effective power in terms of physics, visual, climactic etc. aspects. Therefore, it is very important to foresee the needs of the future, and do the landscaping planning accordingly. This is a difficult and compulsory responsibility to do. However when a planning is done, people of today believe that reaching a necessary green area needs to be done as rapidly as other advancements.

Through the transplantation works done with this purpose, the inner urban areas to be planted become green very rapidly, compared to the years spent on planting seeds.

Due to industrialization and domestic immigration during the last thirty five years, Turkey has entered a fast urbanization phase and as a result of this, modern people have lost their opportunity to live in a natural environment. Therefore, they try to fill this gap by planting within as much as possible. Tree planting in urban areas is a very new application in Turkey. As well as transplantation works with simple tools, a machine for tree planting and uprooting is also used for the last few years.

Giving a short explanation on the meaning of the term "transplantation" would be useful in preventing any confusion on the meaning. The term transplantation is used in some departments of science in such a degree that it has become a cliché. For example, the term "transplantation" in medical literature means the transplantation of any organ from a person to another person, where all physical, biological and technical conditions are suitable. When an organ transplantation is to be carried out, high importance is paid for the organ of the donor to be transplanted to match certain criteria of the receiver, such as biological structure, physical conditions etc, which is important for the receiver to maintain his life healthily. And the term "transplantation" used in landscaping architecture means the re-planting of a plant from one place to another. However, it would not be right to use the term “transplantation” for all types of plants. Just like in medical terminology, the term "transplantation" in landscaping architecture does not mean the transfers of plants at an early age, but at their more mature periods. Again similar to other branches of science, transplantation process here; is a process which is realized in line with certain steps and in consideration of some basic principles, and in line with the necessary technical conditions.

Just like in all other landscaping applications, tree transplantation works also require a controlled monitoring during all phases and meticulous and well arranged implementation principles. In generally, trees and shrubs are transplanted when purchased or planted. These plants often grown in the field, and harvested in the form of bare-root, balled and burlapped (ball of soil and roots wrapped in burlap), or containerized. In nursery, trees and shrubs are often grown using cultural practices, such as root pruning, to prepare them for harvesting and transporting to the sales area. Nursery plants may have 75% of their root system intact after they are dug, nevertheless wild plants may only have 25% or less of their root system intact. When woody plants in the landscape are transplanting, they are exposed to stress because of any of the special procedures used in nurseries before the transplanting day. The increased stress on plants can make the difference between an attractive or healthy. Nursery stock grown in containers is often much more tolerant to transplanting than field-grown or wild grown plants (Anonymous, 2012 a).

2. Historical development of the transplantation of larger plants

2.1 Transplantation of larger plants in the world

It is a known fact that the Egyptians during the ancient times have carried trees with boats from distances as far as 1500 miles. They did it in order to cool down the dry climate of the Nile River Basin, and to create some shade. Plants in Egypt are being arranged in a formal way. Fruits, vegetables and medical plants are alongside other decorative plants within the gardens. The most commonly used plants are Phoenix, Palm Tree, Lotus and Papyrus.

Ancient Greeks in particular, have worked on issues regarding tree transplantation and tree protection. In relation to this, Theophrastis has carried out a research in 300 BC, on necessary methods to wholly protect the root system during plant transplantation (Nadel, 1977).

From the 15th Century, with the start of the Renaissance wave, meaning “Re Birth”, the dark view of the medieval times were broken in the west, great changes were made to beliefs, and fast advancements were made in science and arts. With these changes, living spaces also went through improvements, and trees were once again considered to be used in living spaces. During the 17th Century, tree was considered as a sign of royalty in France, and people belonging to higher classes had planted large amounts of trees at their living spaces. That way, the transplantation techniques of larger trees have developed, and machines to lift and carry these trees have been developed. During this time, tree transplantation has become very important in England. There are also rumours that, thanks to the new methods and machines developed, hundreds of years old oaks have been transferred. Therefore, as early as the beginning of 19th Century, France and England have made great advancements in transferring of trees (Mayer, 1982). On the other hand, many written sources appeared regarding trees during the 17th Century. British author William Lawson has written in 1618 "A New Orchard and Garden" which was mainly about maintenance, repair and aesthetical values of trees. This book is important because it was the first to mention about the appropriate planting intervals. And in the book, “Sylvia", written by John Evelyn in 1664, information has been given on growth features and maintenance principles of trees. Frenchman Le Notre has implemented the tree planting details given at this book in the famous Versailles Palace. During those days, having a large number of trees inside the palace gardens was considered to be a sign of civilization (Nadel, 1977).

During the 17th and 18th Centuries, a connection was also started to be made in England, between settlement areas and the nature. Great squares or open spaces have started to appear during the 17th Century, and they were surrounded by large buildings. Another century later, these squares became the dominant element of London settlement and led to the trees being used extensively within urban areas. When squares were being built, tree transplantation was widely used. Trees started to be considered alongside with urban planning only after the 18th Century. Tree transplantation works at that time were generally used for planting trees alongside the roads within the city. With this purpose in mind, engineer Baron George Houssman was assigned by Napoleon III in 1853, and he started re planning all over the city of Paris (Nadel, 1977). For the tree planting works at that time, 82.000 trees of different types and with a height of 10-12m. were transplanted, which was a real success (Altan and Önsoy, 1982). Fredeick Law Olmstead, who was the father of Landscaping Architecture and the designer of New York Central Park, which was held in 1858, had given works about urban forestation. In these works, he talked about forestation programs, particularly at the road sides in New York and San Francisco (Nadel, 1977).

In modern cities of the 20th Century, there also have been changes and improvements of the tree transplantation principles and methods. During the first half of the century, USA in particular has shown some improvements. There have been academic works in Russia, regarding plant transplantation.

Landscape architects that attended American Fair in Moscow on 1959 have made some researches in order to carry out their transplantation works. In one of these researches, they succeeded in planting a 25.40cm (10 inches) lime tree in the middle of winter when there was frost until 1,22m (4feet) depth. As the soil was frozen, soil fescue was cut with air powered saw, no fastening or molding was needed. Tree pits were also formed by chainsaw. After preparing the pits, metal covers were placed on them and a fire was lighted in it for a few days in order to ensure the heat to stay inside the pit when the soil around it was heated, root fescue was put into the pit and the process was completed. Another interesting event was that birch was to be transplanted in the middle of July. A regular maintenance and irrigation guaranteed the continuousness of the life of tree (Zion, 1968).

The landscaping design made for Munchen Olympiads in 1972 which covered the entire village. 3 years before the Olympiads, 12-15 birches that were 30-40 years old were transplanted successfully. As a result, when 1972 Olympiad games started, it looked as if landscaping in the area had started 30-40 years ago (Ürgenç, 1998).

An island system will be built 5-7 km distanced from shores of Dubai, the capital city of the United Arab Emirates. There will be 1060 small houses on the island, 5 thousand people will reside in the houses and 12 palm trees will be planted. The complex is palm shaped which has 17 branches in the middle part; it will increase the length of Dubai shore beaches to 120 km (Anonim 2012 b). Transplantation of trees is much easier today thanks to the techniques and machines that are developed with modern technology. Bigger areas can be planted in shorter times successfully.

2.2 Transplantation of larger plants in Turkey

After the Industrial Revolution in Europe, while changes in economical and social structures affected physical appearance of cities, Ottoman society were different from the societies western regions in terms of development dynamics and city types. As Turkish society wasn't directly in mechanization process, the need for public domain and green places couldn't be realized for a time until the proclamation of republic when city plans started to be done in a more organized way (Şahin, 1989).

In order to discuss plant transplantation works in Turkey, we should first talk about the understanding of open land and green land and importance given to green lands. Turkish cities were built on the basis of three elements; streets, gardens and houses. Public buildings formed most of the physiognomy of cities in Ottoman Empire, while green lands were used as parts of house gardens. In fact there were no organizations serving for the protection of public green lands in local public institutions.

In Ottoman Empire era, there were some recreation spots such as public gardens, and coppice forests that were used by the society in big cities such as İstanbul, İzmir, Edirne and Manisa (in Turkey). Besides this, royal houses and houses of high class people were organized for special use (Caner, 1976). According to the literature about the era, there were not many special plant transplantation works during the era. But in plantation of some palace gardens, parks, and roadsides roots of trees were removed from the soil and transplanted.

In old Turkish cities, similarly there were transplanted trees in squares and lined up on roadsides. But properness and professionalism in these plantation processes is controversial.

After proclamation of republic, new buildings in cities were built and systematic greening processes started in cities. As bushes and small trees can be more easily transplanted than bigger trees, they were preferred for greening applications. Tree transplantation was especially used in central refuges. But still there weren't many works that were done for this purpose. Tree transplantation works were very few when compared to the other works and methods preferred for greening processes.

Efforts for transplanting big sized plants were successfully carried out when technology wasn't developed by taking some precautions in the eras. For instance in İstanbul Sedef Island, very old plants that were put into boxes was successfully transplanted. Similarly, in Bahçeköy garden and plantation fields, maintenance processes were carried out, lime trees and horse chestnuts were successfully transplanted. Barbaros Boulevard, Maçka, Tophane, Kabataş, Şemsi Pasha parks, Beyazıt Square and Saraçhane were greened by İstanbul Municipality. Many species and types of plants such as pines, magnolia, sycamore, horse chestnut, cedar and oak were planted with simple method and positive results were reached (Ürgenç, 1998).

Palms in Kalamış Marine in Kadıköy, İstanbul were removed from the soil without any damage with the decision of Tree Transplantation Commission and transplanted into the places of a dried Palm placed in Sarmaşık Park in Kozyatağı and an area in front of Kalamış Youth Center (Anonymous 2012 b). In our country, palms have been used in transplantation processes in many facilities built especially in Mediterranean and Aegean Regions.

Artvin Çoruh University Faculty of Forestry and Foundation for Combating Desertification and Erosion General Directorate has carried out a project called "Protection of Endemic and Non-endemic Rare Plants that will submerge Çoruh Valley Deriner Dam Water Mirror". The aim of the project was to save the species that will submerge and extinct because of the dam project. In scope of this project, with the contributions of Artvin Regional Directorate of Forestry crews, 400 pieces of 18 rare plant species were removed, potted and transferred to Artvin Çoruh University Faculty of Forestry Greenhouse (Anonymous 2012c).

Transplantation processes have been used more in landscaping processes that have been carried out in recent years. This process is accelerated especially with the increase in the number of tree drawing and planting machines. Today, landscape design works and plant transplantation are made and the areas that are planned are filled more professionally with green plants.

3. Transplantation of large plants and plantation techniques

Transplantation of large plants, especially trees, has been carried out with different methods until today. These plants have been moved as bare roots, in balloons completely leaving the roots out, within tied sacks, by wrapping the plant on a wire cage, wrapping it with a tie beam or with ratchet devices. The attention and care that we show during transplanting plants ensures the healthy continuity of its life. Pruning roots during 3 years before the transplantation, digging a wide root circle, careful wrapping and binding, carrying the plant

with big and detailed devices, giving attention to the preparation and maintenance of plantation area leads the plant's adaptation to its new place and live healthy.

It is assessed that whether or not to be a successful transplant before transplanting a tree or shrub. Stresses in transplanting of trees and shrubs may cause plants to die or to become unattractive. Plants are already in advanced stages of decline, particularly likely to succumb to transplantation stress. Generally, if a young nursery-grown plant than older growth plant will provide more long-term benefits in the new planting area so younger plants better than older plants. Also shrubs have better transplant tolerance than trees, deciduous plants better than evergreens and shallow rooted species better than deep rooted species. When deciding whether or not to transplant a plant, consider the species transplant tolerance, transplanting season, new planting site conditions, the equipment and follow-up care (Anonymous, 2012 a).

3.1 Principals to consider during application

Applied methods have both advantages and disadvantages. The success and failure of the transplantation depends on: species of the chosen plant, present conditions, and cultivation aspects of the natural place of the plant besides the aspects of the place it will be transferred. Besides the care and attention during in all these processes, the transplantation process itself is a crucial factor in success (Zion, 1968).

3.1.1 Choosing plant

Almost all kinds of plants can be transplanted. But every plant species have a different sensitivity level. Transplantation of plant species changes according to the aspects of plants during the time period necessary for plants' adaptation to the environment conditions. Transplantation of bushes is much easier than the tall trees. We can divide and analyze the criterion that should be taken into consideration while choosing plants during transplantation.

3.1.1.1 Species and age

Studies in the field showed that some plant species can be transplanted more successfully than others. Plants with roots closer to the stem, the one that are more fibrous can be generally transplanted more successfully than less fibrous and deep rooted plants. Besides, success in transplantation generally decreases from small bushes to tall trees.

The most easily transplanted plant species are: *Acer* sp. (Maple), *Alnus* sp. (Mountain Alder), *Castanea* sp. (Chesnut), *Celtis* sp. (Hackberry), *Fraxinus* sp. (Ash Tree), *Malus* sp. (Apple Tree), *Ulmus* sp. (Elm), *Paulownia* sp., *Platanus* sp. (Sycamore), *Populus* sp. (Poplar), *Robinia* sp. (Locust), *Salix* sp. (Willow), *Tilia* sp. (Lime Tree); and plants known as summer-growing plants which are: *Phoenix canariensis (Palm), Washingtonia filifera* (Desert Palm), *Washingtonia robusta* (Mexican Palm), *Chamaerops excelsa* (China Palm) *and Olea sp.* (Olive Tree). Besides these, some other easily transplanted plants are: *Gleditsia* sp. (Honey Locust), *Abies* sp. (Fir), *Juniperus* sp. (Juniper), *Picea* sp. (Spruce), *Pinus* sp. (Pine), *Betula* sp. (Birch), *Cornus* sp. (Cornelian Cherry), *Eleagnus* sp. (Elaeagnus), *Ginkgo biloba (China Gingko Biloba), Quercus palustris* (Swamp oak) *and Pyrus* sp. (Pear) (Turhan, 1994).

Juglans sp. (Walnut), *Quercus* sp. (Oak), *Carya* sp. (American Walnut) *and Fagus* sp. (Beech Tree) are the plants that are known to be difficult to transplant. While there are different opinions on the transplantation of *Aesculus* sp. (Horse Chestnut) species, there has been some successful transplantation of medium-sized *Aesculus* sp. (Horse Chestnut) species (Ürgenç, 1998).

The species whose transplantation can be easily done are: *Malus* sp. (Apple Tree), *Fraxinus* sp. (Ash Tree), *Ulmus* sp. (Elm), *Tilia* sp. (Lime Tree), *Platanus* sp. (Sycamore), *Populus* sp. (Poplar), *Salix* sp. (Willow) *and Celtis* sp. (Hackberry). Mild-climate plants are not included in this study. Some of the plants which are the most difficultly transferred are *Juglans* sp. (Walnut), and some *Pinus* sp. (Pine) species. Another important point that should be paid attention is that plants that have soft roots generally are not strong enough to be carried by frozen root skein too (Himelick, 1981).

As a general rule, no matter how big their sizes are, bushes can be much easily and successfully transplanted than trees; and deciduous trees can much easily be transplanted than evergreen trees and coniferous trees. But the success of transplantation is also related with the health of the plant (Turhan, 1994).

In order to successfully transplant the tall plants, necessary information about their root systems, root distribution depths, distribution styles, roots' activity times should be known. Plants' root systems are divided into 3 groups as taproot, heart root, shallow root (Figure 1).

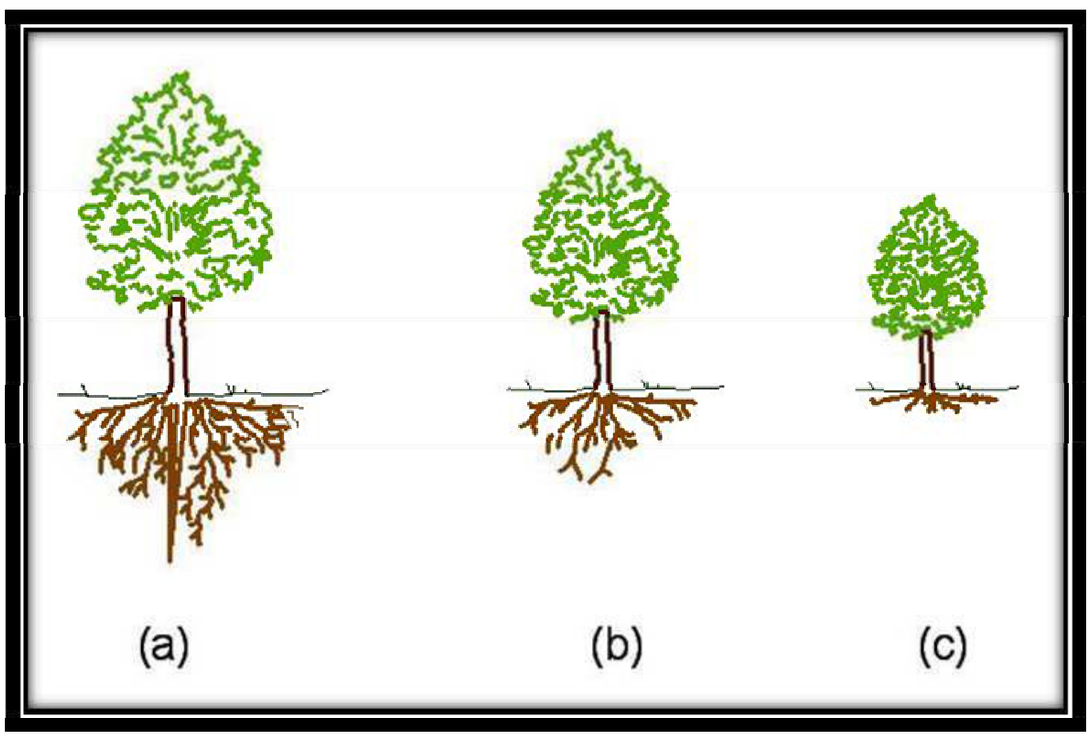

Fig. 1. Different root systems of plant species (a: taproot, b: heart root, c: shallow root).

Taproot System: *Juglans* sp. (Walnut), *Quercus* sp. (Oak), *Pinus* sp. (Mountain Pine), *Castanea* sp. (Chesnut tree) *and Cedrus* sp. (Cedar). Heart root system: *Fagus* sp. (Beech Tree), *Acer* sp.

(Maple), *Tilia* sp. (Lime Tree), *Magnolia* sp. (Magnolia), *Liriedendron* sp. (Tulip Tree), *Robinia* sp. (Locust), *Quercus coccifera* (Red Oak), *Pinus strobus* (Vermouth Pine). Shallow Root System: *Betula* sp. (Birch), *Abies* sp. (Fir), *Picea*. (Spruce), *Acer saccarinum* (Sugar Maple) *and Salix* sp. (Willow). But besides the differences between the species in the same system (for instance *Abies* sp. (Fir), species belong to shallow root system while their roots aren't as shallow as *Picea*. (Spruce) species) there are some differences in the same species. For example although natural *Quercus* sp. (Oak) species have deep and taproot system, *Quercus rubra* (Red Oak) have the heart root and *Quercus palustris* (Swamp Oak) have the shallow root system. Surely the environment they grow has a big impact on this situation. *Quercus palustris* (Swamp Oak) grows in humid climate and has shallow root in order to ease the oxygen intake. All these factors should be taken into consideration while determining the plantation field. Especially roots' growth periods should be known in order to know if the plantation time is appropriate or not. So, these growth periods should be evaluated in terms of the region's aspects and years (Ürgenç, 1998).

Almost all plants can be transplanted, but some requires more time and attention. In addition, it should be kept in mind that young plants' transplantations are more successfully made when compared to older ones.

3.1.1.2 Plant characteristics

Generally, small sized plant species can be transplanted much easier than bigger sized plant species. Besides this, plants that are not very old and whose height are 1-2 m. can generally be transplanted successfully as their root systems don't grow very much. The taller the plant is, the more difficult it becomes to carry; and it has less chance to adapt to its new place. As plants that grow in nursery are taken care more than the other ones, their roots are more fibrous and together. They have more attractive upper parts when compared to the ones that aren't grown like them. Big plants are transplanted when the soil changes, during road construction and extension and when they are too big for the place to live in. Although it is very difficult to remove the plants that are squashed because of their structures, transplanting them to better places is important for their health and life (Harris, 1983).

3.1.2 Characteristics of site condition and transplantation field

Root systems of plants in fertile and well aired soil are thicker and fibrous when compared to sandy, barren or slimy and clayey soil whose underneath is watery. Roots of the plants that grow in sandy, slimy and clayey soil have a few twigs on sideways or as have a small root close to the stem. While in sandy soils, roots have the tendency to be close to the deep, they are closer to surface and broader in clayey and slimy soil. Trees growing in soil which don't have any stone or other obstructive substances can be more easily transferred. It is very difficult to transfer trees from wet and slant soil to empty fields vertically (Harris, 1983). There may be some difficulties in removing plants from slant soils to smooth fields. In these cases, one part of the soil is higher than the other part which obstructs the adaptation of plant to smooth soil. The field of transplantation shouldn't be too slimy or dry in order to use the transplantation devices properly and make a successful transplantation. Sidewalks, cables, wires, pipes and natural gas piping systems cause difficulties in removing and planting the plants. In such cases, helicopters are used for plantation and removing processes.

Most of the planting spaces in cities are rather harmful for newly transplanted big plants. Paved roads, structuring cause increase in air temperature and radiation density. Buildings can cause wind tunnels and airflow corridors. These circumstances can make it difficult for newly transplanted plants to get enough water. Regular irrigation and proper weeding can be useful for these kinds of plants (Harris, 1983).

3.1.3 Soil characteristics

Different root characters occur according to soil structure. Root enlarges, spreads and grows with its small roots and enlarges and deepens in well aired and sandy soil. Shallow and distributed root bodies are formed in silty, clayey or drained sub soil. Roots of some plants' same species have different characteristics in different soil structure. It is difficult to transplant plants in an areas furnished with solid construction material or densely vegetated with plants (Kim, 1988).

Appropriateness of soil aspects from which the plant is removed is as important as the plant species. Some soils can be as effective as the plant species in growing a root system which is compact and rich in terms of hairy root. As plants that grow in sandy soil forms deep and complicated root systems, they are more risky in transplantation when compared to the plants removed form clayey soil. But as there is not enough oxygen in clayey soil, capillary roots that are very important in new root formation don't grow enough. Because of this, ventilation of soil with different methods increases the level of success. Deep soil without any rocks, logs etc. are better in removing big plants (Ürgenç, 1998).

3.1.4 Transplantation time

Some definite periods of a year are much better for transplantation of plants. But this situation doesn't mean that plants can only be transplanted in these periods. Successful plantation can be made with a more careful digging, planting and after care processes if the transplantation isn't made in these definite periods.

It is very important to determine the weather conditions that will affect the placement stage of plant's plantation and transfer period. This important factor increases the level of success in transplantation of special plant species. In addition to this, in order to make a good development during transplantation, preparations should be completed before planting, landscaping programs and lists should be made and reviewed. Spring season is preferred more in regions that have cold climate. A plant that is transplanted in early spring regains some of its sections that it lost before the weather becomes warmer and it renews itself although partially. A plant that is transplanted in autumn has to be very strong and endure the winter season before completely recover from the shock of transplantation. August is generally preferred for planting evergreen plants in cold climate regions. Transplantation of *Betula sp.* (Birch) species is preferred to be made in early spring. As roots of *Magnolia sp.* (Magnolia Tree) are damaged during transplantation, they are exposed to fungus disease. This is why transplantation process should be carried out in spring when the plants are awake and their physiological activities are more alive; thus they are more resistant to these diseases. In such cases, the best thing to do is to take professional opinions into consideration (Harris, 1983).

Although antiperspirant sprays are used in plant transplantations that are made off-season, these transplantations shouldn't be made as much as possible especially when the plants have just started to stool. A proper digging process is one of the most important factors in the success of transplantation. Studies until now have shown that digging for the transplantation of a tree in leaf foliated should be made in two stages. Firstly, bottom roots should be dug and irrigated, then after waiting for 7-10 days; all roots should be dug and taken out.

Divaricated and in leaf foliated plants are transplanted mostly at the beginning of autumn and at the end of spring. If the winter is very mild in a region, the transplantation can be done towards winter; but soil should be prepared separately and should be prevented from becoming mud. Transplantation in winter has the advantages of cool and cold weather. But if it becomes too cold, plants may be affected and be damaged. During spring plantations, trees should absolutely be protected from cold weather and soil should be moist.

Plantations at the end of summer and in autumn have a big advantage which is related with the warmth of soil. Soil warmth lead the plant roots grow healthy and distribute. Some plantations during summer gave better results than the spring plantations in terms of longevity.

3.1.4.1 Transplantation time for non-evergreen plants

It is more appropriate for non-evergreen plants to be transplanted before the leaves start to fall and change color, before the soil is frozen in early winter or before the growth starts in spring (Kim, 1988).

3.1.4.2 Transplantation time for evergreen plants

Coniferous trees are generally transplanted during early autumn or late spring. The proper time for the plantation of Latifolius – Broad leaved evergreen plants is generally spring and autumn (Kim, 1988).

3.1.5 Effects of seasons on transplantation

When the ground is not frozen, some species may transplanting any time during the year but woody plants are generally moved in the spring but also they may moved in the fall after leaf drop and before the ground freezes. Fall planting should take place soon after leaf drop. Before the ground freezes in the fall, evergreens are especially prone to winter browning. Therefore, they should be moved late in the summer to early fall. Antitranspirants applying may help reduce the effects of winter desiccation in some species. Fall transplant success may be increased by transplanting hardy plants into sites with good soil moisture and wind protection. When shoot growth is peak, it's shown that the greatest transplant injury so woody plants are transplanted in late spring and early summer (Jakson et al., 1998).

Spring: Shoot growth in plants prevents them from being damaged from cold weather. This situation will promote root growth before Top growth starts. But as plantation during active growth period will cause various negations, if it is possible, plantations shouldn't be made during that time. Because when the plants' roots or branches are pruned, plants loose more water from these parts when compared to the other seasons. Because of these,

transplantations shouldn't be made during the middle of spring when fast growth occurs and at the beginning of summer months (Kim, 1988).

Summer: In summer, plants actively absorb water that is passing through the plants' xylem. This is why too much sap loss will occur in the cut places of roots during plant transplantations in summer. It is determined that when plants grow in spring and complete their development, some of them accommodate better to the summer transplantation. We don't need to worry about the sufficient water amount in plants as active transpiration occurs more in hot air (Kim, 1988).

Autumn: Towards the end of summer season and during autumn, there are generally warm weather conditions that prevent root growth. As the days shorten and weather becomes warmer, plant transpiration decrease. Autumn season is the best season for most of the plants' transplantation. In this season, plants don't loose too much sap. *Citrus sp*. (Lemon), *Hibiscus sp.* (Hibiscus), *Bougainvillea sp.* are the plant species which can be damaged easily without placing their roots. It is better to transplant this kind of fragile plants in spring (Kim, 1988).

Winter: As the weather is warm and cold during winter, plant activity decrease which is a big advantage for transplantation. Plants can make use of the cold weather in winter. Transplantation can be done if the freezing level of soil is about 30 cm in big trees. But special attention should be given to pores in order not to freeze, and to roots root ball in order not to be broken. Transplantation at about 3 °C weather is proper as plants can be damaged in other weather conditions. No matter what the season is, plants should be protected from freezing and drying. Planting pits should be filled with water a few times before transplantation. Transplantation area should be mulched; after the area is filled with mulch, other irrigation process can be done although the ground is still always wet. Drainage system is crucial for increasing the success of transplantation process (Kim, 1988).

3.2 Preparation of plants for transplantation

Plants that are grown in nursery are rich in terms of capillary and hairy roots as they get all the necessary elements. These plants that have compact structures are transplanted very successfully. On the other hand, transplantation of plants that grow in rural areas and forests where maintenance process aren't made is very difficult. In this scope, root of a plant that will be transplanted should be nurtured 1-3 years before the transplantation and other maintenance processes should be completed. Transplantation will be successful if these conditions are carried out.

3.2.1 Preparation of large bushes and shrubs for transplantation

Bushes higher than 3-4 meters and shrubs that can reach 8-10 meters are in this group. While root structure of a plant that grows naturally in nature varies, there are root systems that are scattered to the sideways, elongated, and moved into deeps. If nutrient is abundant in the field where these plants grow, these kinds of plants don't need dense and capillary roots. If we try to transplant these kinds of plants without any process, only a part of the root will fit into the root soil and as a result of this, root/body will become unbalanced in the new planting site. This will increase the risk of plant's drying. This is why; root pruning should

be done 1-2 years before transplantation. Root pruning should be done before the start of root activities when significant root growth occurs. Too much grown roots are cut with a sharp knife according to the size of the plant; for example, for small plants that have 4-6 thickness, 30-40 cm radius circle is drawn and roots around this circle is cut. In this way, new roots grow more strongly near the area of cut root. This increases plant's chance to adapt the new place (Figure 2).

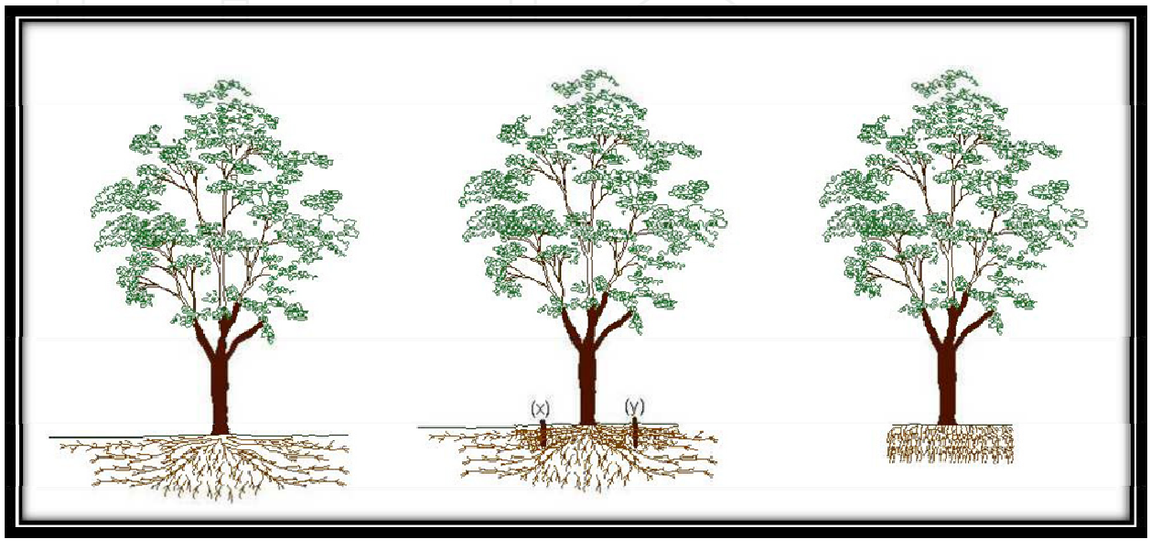

Fig. 2. Deeply spading the plant that has very long and many side roots from x and y points and forming a new, strong and more compact plant root system.

3.2.2 Preparation of middle sized plants for transplantation

Trees that are 10 - 20 m tall are in this group. A denser root nurturing is necessary in transplanting these plants, or else the chance of plants to continue life decreases. This is why; preparations should start 1-2 years before transplanting the plant. Firstly tap part of the plant is pruned strongly but according to the rules. A pit about 30-40 cm is dug around the plant by taking plant's tap corolla. Especially the depth of pit is significant; all side roots of the plant should fit in to the pit. Roots that appear in the soil that is dug are cut with a sharp device, if the thickness of root is over 1 cm, puttying should definitely be done.

Organic substances, compost, qualified and slight soil mass is filled into the pit in order to ensure the easy growth of roots and accordingly ensure plants to form a strong root system. In this way, many new thin and capillary roots develop. New roots tie soil mass stronger and minimize the risks in transplantation (Figure 3).

While forming the pit, digging part by part can increase the level of success. Digging and filling the pit is extended over 2 years. The area around the plant is divided into 6 equal parts. 3 of these parts (A) are filled as can be seen in (Figure 4), while the other 3 parts (B) are dug and filled in the second year. The aim of this is to prevent the collapse of tree because of a possible wind effect.

Mulching during this process will be helpful for strengthening the root system placed between ditch and plant body. Soil should also be aerated and substances that will enhance

development should be used. In this way, plant can be removed easier and better during transplantation. Digging process of a plant that will be removed should be done from a direction that will prevent root ball from splitting (Figure 5).

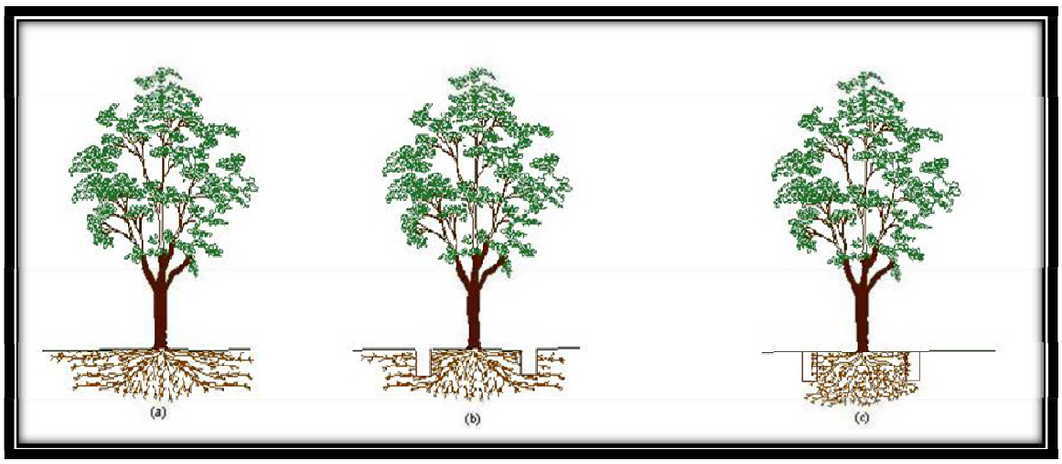

Fig. 3. Strengthening root system by digging a pit (a: Before pruning long side roots; b: Pruning and shortening long side roots in the dug pit; c: Filling the pit with materials that promote rooting and grown roots).

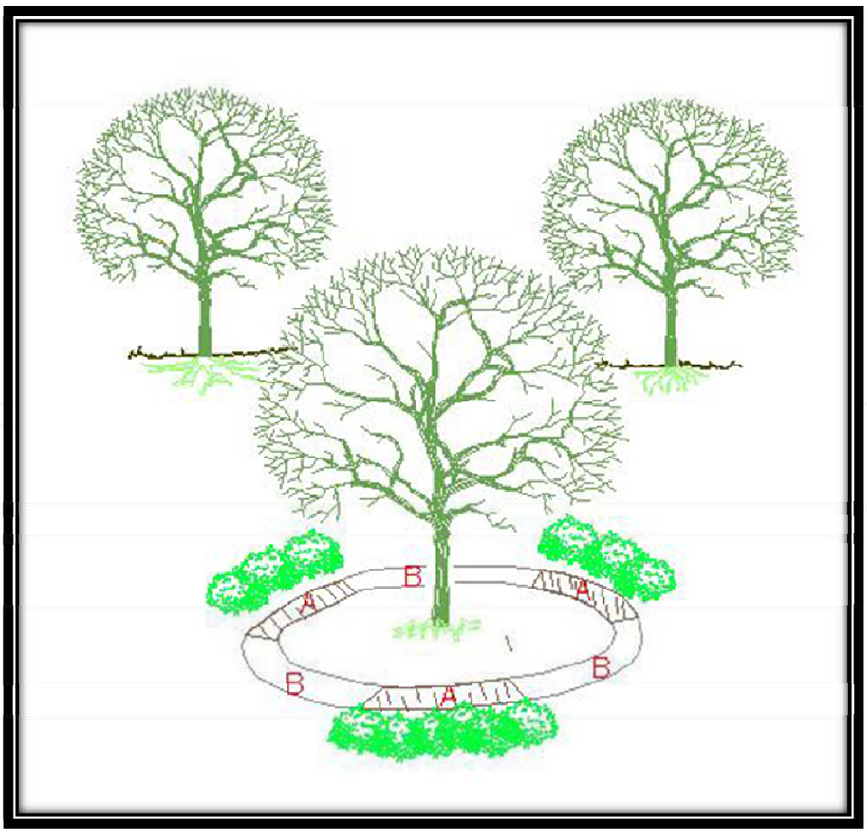

Fig. 4. Root nurturing in two phases and preparation of plant for transplantation in 3 years.

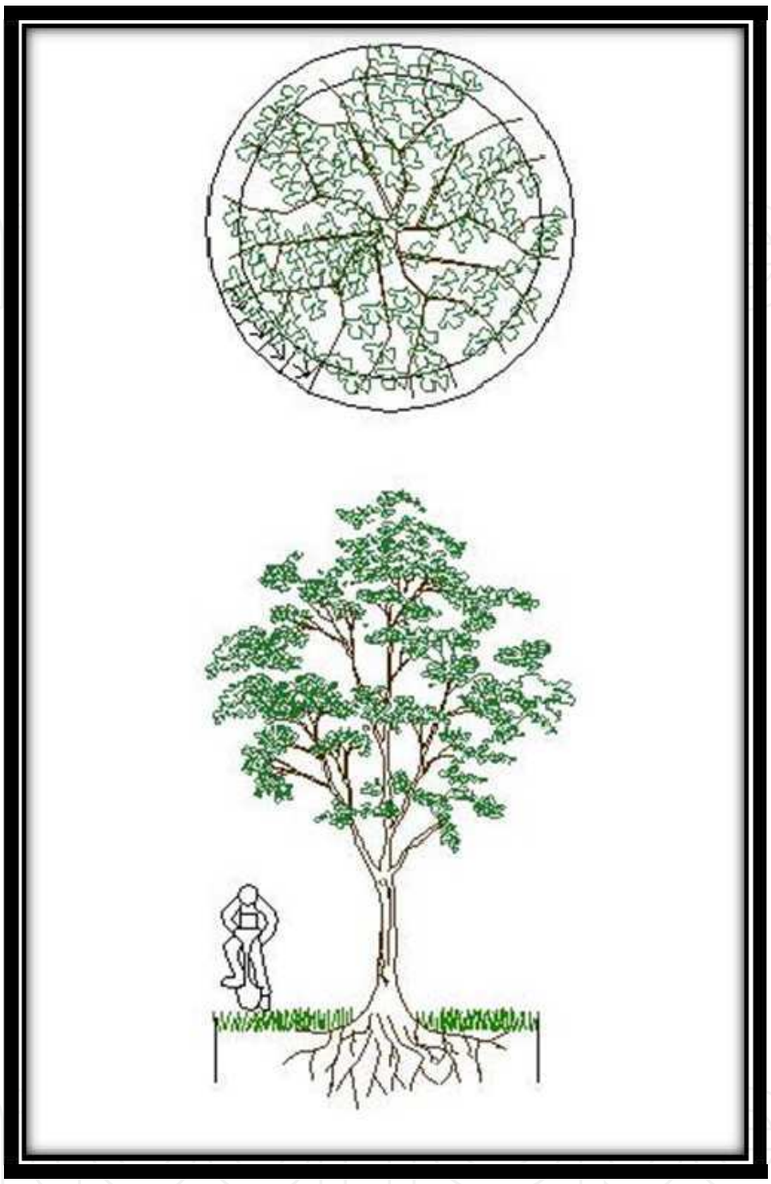

Fig. 5. Digging direction of the plant.

3.2.3 Preparation of big sized plants for transplantation

Plants that are taller than 20 m are in this group. The pit dug for developing root structure of these plants can be formed as 2 or 3 yearly periods. In 2 yearly period, during the first year, A,C,E parts are dug and filled while in the second year B, D, F parts are dug and filled. In 3 yearly period, in the first year A, D parts are dug and filled, in the second year B, E parts are dug and filled and in the last year C, F parts are dug and filled (Figure 6). When the last filling process is completed, necessary pruning is done and after 1 year, plant becomes ready for transplantation.

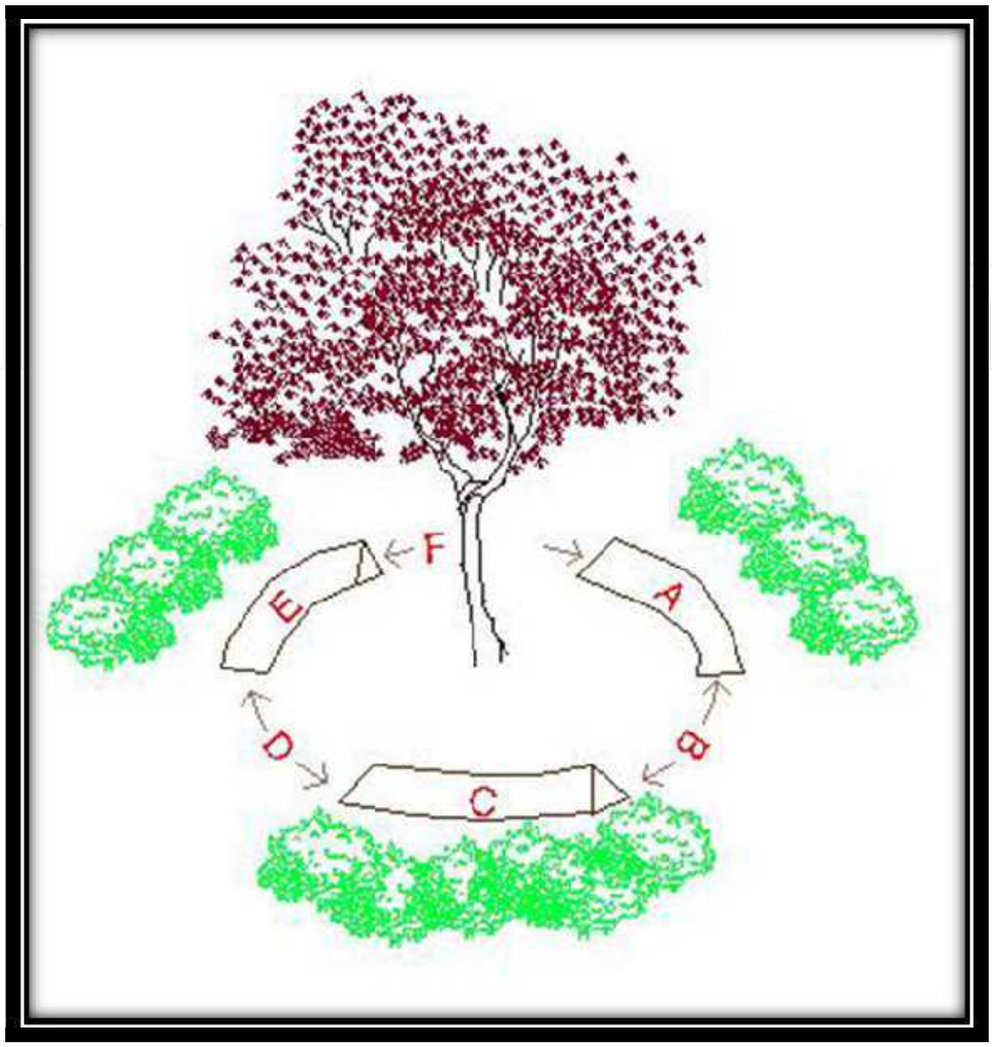

Fig. 6. Preparation of a plant for transplantation in four years with root nurturing in three phases.

3.3 Transplantation methods

While determining the transplantation methods of plants: aspects of the natural soil and transplantation area, distance between these areas, aspects of the settlements around these areas, the amount of time between removing and planting the plant, devices that will be used during the process and finance factors have significant roles. In order to make vegetal design of big areas and make successful plantations time, money, protectors and development methods are needed.

Removing the plant which will be transplanted should be made in overcast, rainy weather rather than in windy, sunny, too dry or too cold weather; nights are preferable for transplantation as microorganisms that revitalize root development are protected at night. Microorganisms are damaged and sometimes die because of direct exposure to sun and because of dryer winds. If plants are grown in nurseries, transplanted a few times, while

being replicated their roots are pruned and capillary roots are increased, their plantations will be more successful. Although plants whose roots have never been maintained before, plants that are grown in a compact area, taller plants, sensitive and precious species can be transplanted in far fields, they should be protected very carefully and more precautions should be taken as their roots can fall apart (Ürgenç, 1998). Transplantation methods of plants are divided into three categories; bare roots, root balls, sacks, boxing and mechanical plant transplantation.

3.3.1 Transplantation of bare rooted plants

These are the plants whose body diameter is under 5 cm. In removing the small bare rooted plants, firstly a pit is dug which can taken all the root system in; the distance between the body and pit should be proper, or else roots can be damaged. Beginning from the edge of the root, the ground is dug until main root system appears. In order to ensure plants' adaptation to their new environment, soil parts between roots should be protected as much as possible. If the plant has a taproot system, this part should be laterally cut with a cutter and the plant should be released. The removed plant should be wrapped loosely with a piece of cloth in order to protect it from the wind and sun and create a humid environment, and then it must be transferred (Ürgenç, 1998).

Bare Rooted transplantation method is used more for large surfaced special trees. It is more successful during winter. Transplantations during mild climate winter are more successful. Plants should be waited in sandy soil and the ground they will plant shouldn't be too far. The important point is to ensure the development of plant roots. Necessary precautions should be taken in order to protect plants from fog and smoke (Harris, 1983).

After carrying necessary soil into the pit the plant will be planted and it the plantation is completed, it is covered up with sandy soil. In order to ensure the continuity of plants' lives, systematic irrigation and development conditions are crucial. Plants in Disneyland Amusement Center in the United States of America were planted with this method and have been very healthy through years (Harris, 1983).

3.3.2 Transplantation of plants with bare soil

Some contended plants can be transplanted without bare soil mass. Although depending on the plant species, generally many bushes and trees can be transplanted even in summer season. But the soil mass shouldn't lose its humidity in a short time. Before the plantation, a few holes should be made on soil mass in order to enable the water pass through the soil and prevent the humidity (Ürgenç, 1998).

3.3.3 Transplantation of plants by freezing soil mass

This method is used in regions with cold climate. In order to use this method, the soil should be frozen at least 30 cm and deeper. Firstly, a pit is dug and soil around the root is prepared for removal. Soil is often irrigated during frost period in order to freeze the soil. Freezing can be accelerated by using carbon dioxide. If it is -7 C° during daytime, wrapping during digging and plantation is unnecessary. In a *Pinus slyvestris* (Scots Pine) forest, a tree at the age of 40 can be successfully transplanted (Ürgenç, 1998).

3.3.4 Transplantation as root balls, sacks and boxes

Transplantation with soil is the best way to transplant the evergreen, needle-leaved, big trees and other plant species that drop leaves no matter how big they are. While transferring a plant from a green area to another, it is carried with a soil mass and wrapped in order to prevent it from falling apart. If the width and depth of the pit isn't enough, plants' chance to live is very little. Plant roots can become smaller or bigger with the effect of weather and development. In such cases, preparations should be done by taking possible difficulties into consideration. The most proper method is to dig a pit around the plant in order to leave it a little smaller than the size it will be at the end. In the first year, an area equal to the half size of the root of plant is dug and filled with organic substance and soil mixture in order to promote root rooting. In addition to these, the plant can be dug as big as tits root ball and prepared or root balls are promoted for growing together with soil (Harris, 1983). If root balls aren't pruned according to the pit, this can pose a risk in terms of getting wet. The second method is growing roots without damaging the environment very much. Studies have shown that the first method is better than the second method. On the other hand, it is known that pruning the roots before transplantation cause loss of time (Zion, 1968).

The plants that are thicker than 10 cm should be transplanted with soil. Although it is possible to plant small sized plant species that fall leaves during winter, in vegetation period without soil, it is more proper to plant them with soil. Otherwise their chance to live will decrease. These are the plants that should especially be taken care of; *Fagus sp.* (Beech), *Betula sp.* (Birch), *Cornus sp.*, *Ginkgo sp.* (China Ginko Biloba), *Liriedendron sp.* (Tulip), *Magnolia sp.* and *Quercus sp.* (Oak). The amount of digging starting from the roots is a very important point in order to ensure the health and continuity of plant life. In Kim's study in 1988, a formula is made for root ball's diameter and depth:

For big-sized plants:

R= Diameter of root ball and the height of root ball diameter (cm.)
DS= Diameter of the stem (cm.)
(8)=Constant.
R=(8 + 8) x DS
For bushes and small sized plants (generally smaller than 3 m. height)
R= (6 + 2) x DS
For instance: root ball diameter and removal depth of a plant that has 15 cm stem diameter will be as such:
R= (8 + 8) x DS
= (8 + 8) x 15 =240 cm.
For instance: root ball diameter and removal depth of a plant that has 4 cm stem diameter will be as such:
R= (6 + 2) x DS
= (6 + 2) x 4 =32 cm.

This formula can be used for pits. In order to add mulch, pits should be dug around the plant. This is the minimum diameter needed for cutting the root system from the bottom of stem. After calculating the diameter of the area that will be dug, the digging should be made clockwise. If the digging isn't made clockwise, root system can be mixed and it would be difficult to make a root ball. After cutting the widest root, root bark should be peeled by a

knife. In order to cut the peeled root from the middle, sharp devices should be used. When root systems are peeled with sharp devices, cambium cells promote root system more (Kim, 1988) (Figure 7).

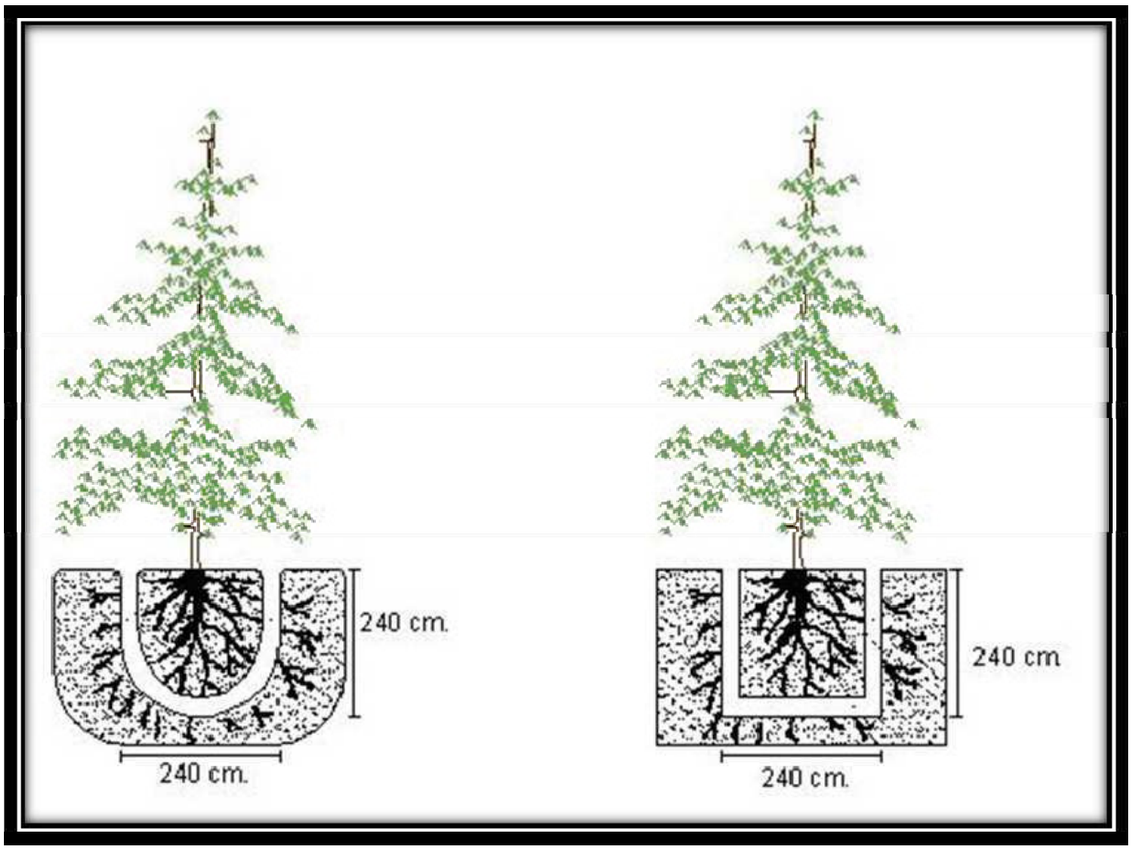

Fig. 7. Root ball diameter of a plant that have 15 cm body diameter and its removal depth.

As a general rule, the size of the soil mass around the root should be 8-12 times bigger than the diameter of the stem at the level of the chest height of the plant. While this measure can be more in smaller plants (for instance 12 times), it can be less in bigger plants (for instance 8 times). If this formula is taken into consideration, a plant with 25 cm diameter should be removed with a 100 cm soil mass. The depth of the soil mass shouldn't be less than 75 cm no matter how big is the size of the plant. In small sized plants, the mass should be %75 of the soil mass; in big sized plants, it is %40. For example, a 25 diameter plant is removed with 100 cm. radius or 200 cm. diameter soil mass, the soil mass depth should be at least 80 cm. (Ürgenç, 1998).

Digging process should start when the soil is moist. The digging start from 7.5-12.5 cm. outer and the pit is dug outwards. But some people take the roots out starting from the sides towards the inner part although their pit is wide enough; they sometimes exceed the level of soil which should be dug and come close to the stem. In this case, soil mass is smaller. As a general rule, in the soil-root mass; the soil amount should be as little as possible while root amount should be as much as possible. The sack that covers the roots should be moist. Roots that are out during planting, should be prepared in their natural positions and planting

should be completed (Ürgenç, 1998). Moist material covering the root balls should be fastened with rope and protected carefully. If steel rope will be used in this process, root surface should be dried carefully in order to protect the rope from rust. Spray is used during transplantation in order to prevent leaves from falling. Concentration that will be used in the spray should be carefully chosen and applied. Short branches of the plant should be pruned and then the plant should be carefully tied (Kim, 1989). After wrapping and fastening of the plant that will be transplanted, special attention should be given in order not to touch the plant and clean the underside of the soil after the plant slants. If there is a steel cable or another fastening material around the underside of the ball, they should be cut in order to free the big soil roots. During transplantation of plants, chains or cables shouldn't be connected to root ball or basic stem. In order to transplant big sized plants, steel ropes can be attached to plants' root balls. But steel ropes shouldn't be used in short distanced transplantations (Zion, 1968).

Roots of the leaves can sometimes get smaller or bigger than the development sizes calculated according to the effect of time and air. In such cases, roots should be pruned 1-2 years before the transplantation in order to avoid ant possible difficulties (Harris, 1983).

In his research in 1988, Kim mentions transplantation of a 10 m. height coniferous plant's transplantation in Korea only with human power to 50 m. distance. He said that he needed 5 people for this plantation and summarized the method as such:

Firstly, the soil is dug and root ball is made, the root ball is then fastened. After that, the plant is bended to one side with 15-30 angles which cause emptying of the other bottom part of the root ball. The bottom part of the root ball is filled with the soil that is dug while preparing the root ball. The plant is moved to the other side and bended to one side again. The hollow that is created with removing the root ball without using heavy devices is filled with soil. This process continues until the bottom part is filled with soil. Finally, the plant is moved out of the pit and gathered in order to protect it from any damage in case it is bended to different directions. While 2-3 people push the plant, the other two holds the stem. After that, the plant is rolled to transplantation area. The stem is hold in a bended position and special attention is given in order not to lay it n the floor. Because the plant is heavy and it is difficult to move. This is the easiest way to transplant a plant without using heavy machines or devices. On the other hand, if the plant will be moved to a long distance, it can be wrapped with sack and tied (Kim, 1988) (Figure 8).

Transplantation is made with boxes if the soil is sandy or easy to scatter. Plants that are put into boxes in the shape of tetragonal prisms, with wider tops and narrow bottoms are transplanted. The soil mass of the plant whose around is opened with pits are put into strong cases or boxes. When crating is completed, bottom board is put under the root system and the process is completed. Crating can be started even at the process of preparation. The 5.5-15 cm. space between box and soil mass is filled with fertilizer, compost and highly nutrient soil and kept waiting for one year. In this way, a rich capillary root system is produced. In order to fertilize this process, crating is prepared in 3 years firstly by preparing the 2 faces in the first, the other 2 in the second year; a safer transplantation is made in this way (Turhan, 1994).

Plants' root development should be measured and determined in boxing method too. The width of the pit from which the plant will be removed is determined (*which is in the shape*

square or rectangle rather than hemisphere shape in root balls with boxing method) by taking the situation and development of the root area into consideration. If the width and depth of the pit is not proper, the plant might die. Firstly, the soil is dug and the mass that will be moved is prepared. This mass is surrounded by wooden material and boxing process is started. The plant is bended 15-30 angle with the method mentioned above; the space left is filled. The same process is applied to other side and can be moved without using crane or any other technical devices. When plants are bended to a side, needed pruning is done without harming roots, the bottom part of the prepared part and boxing is done (Ürgenç, 1998)

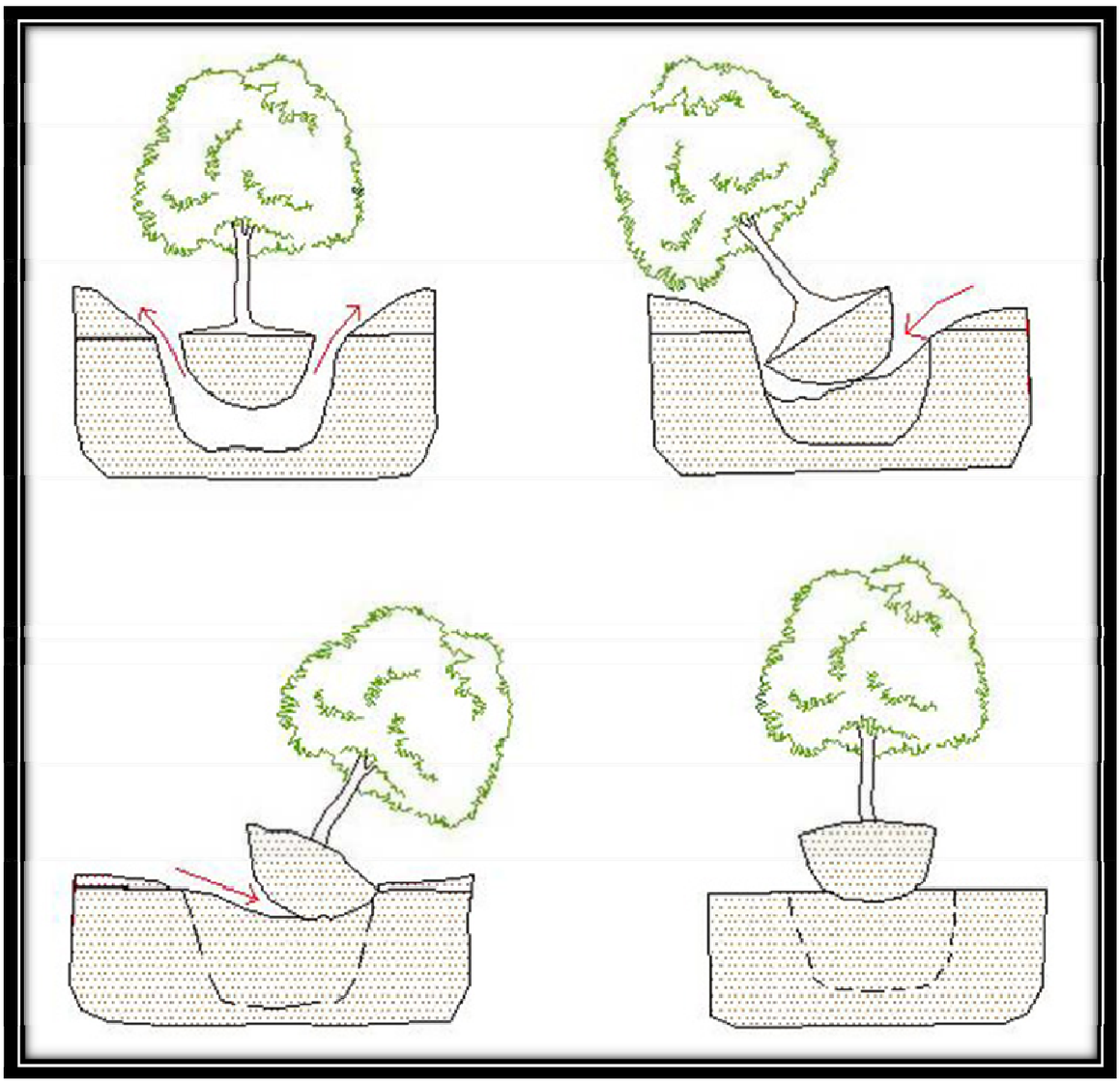

Fig. 8. Transplantation of plant without using heavy instruments and equipments.

Points that should be given importance during plant transplantation can be summarized as (Kim, 1988):

- Root balls of the plants should be measured and determined, and the number of healthy roots should be as much as possible.
- The ground should be dug when it is warm.
- Roots should be clean cut, wide root skin should be whittled with a knife and then saw should be used.
- Big scissors should be used for small roots.
- Irrigation should be well.
- Pruning reduces transpiration.
- Alginate hormone should be used for roots.
- Water should be sprayed for moist.
- Fertilization should be done with 0.225 kg for 0.08 m^3 area.

Apart from plantations made by big companies, company owners, municipalities, it is difficult for private garden owners to use heavy tools. They may not find the chance to use complicated machines. Using human power is the only choice in such situations.

3.3.5 Transplantation with mechanic methods

There are some models developed for digging, removing and transferring of plants. In a model called "Tree Nursery", carriage of plant can be done with an articulated lorry or truck. Plants are wrapped and hydro alkali booster four scoops are stuck on the ground; after shaping the root ball, the bottom of the plant is lifted with the scoops and moved out of the soil. If the weather is proper and the distance is not very long, the plant can be carried vertically or can be bended toward the front and carrying can be done. Pits in which plants will be put should be dug beforehand. Planting should be done by taking the slope and the shape of the ground into consideration (Harris, 1983).

The second method used in plant transplantation is called "Skin with Cohesive". This skin is made of a scoop and there are sharp parts on the tips. This sharp part is installed before starting to dig the plant and locked. Transplantations that are done with this method is applicable for big sized plants. Tree nursery technique is preferred for smaller sized plants (Harris, 1983).

The third method is making a hole by digging the plant roots with one scoop and removing the root balls. Scoops are clamped together and the root ball is lifted with crane. Each of the scoops are for digging soil. There are two kinds of curved scoops; 80 cm. and 200 cm. the weight of device is totally 115 kg. Compressor that works with tractor or mobile gas produces hydraulic power. Scoops are numbered according to their usage methods (Turhan, 1994).

Functions of tree lifting are (Harris, 1983):

- Digging planting pits.
- Removing the plant with its roots neatly and in a way that fits the planting pit.
- Carrying the removed plant to the planting place without harming and planting it properly.

Tree removing and planting machine is made of 2 strong lifter arms connected to truck frame, digging knife unit, hydraulic system etc. hydraulic pump is provided by the vehicle to which the machine will be connected. Rotary digging knife unit is connected to lifting arms and can be controlled while working, transferring in vertical position and horizontally. Digging knife unit is made of at least four knives which are arranged around the knife frame. The number of knives can vary according to the aspects of vehicle. The unit is openable and closable; knives can be pushed downwards and can be pulled back upwards (Harris, 1983).

3.4 Transplantation of palms

Palms are monocotyledon and they have either one body or many bodies that are not branched out. Any damages on the body leave a scar as cambium shell doesn't exist. Most of the bodies of palm species are in the shape of filaments that grow at the bottom of body. If a root is cut or broken, the plant generally dies. Although palms can be transplanted at any time of year, warm spring and summer months are generally preferred as root growth is fast in these months (Harris, 1988). Transplantation in our country should be made in summer because of climatic conditions; transplanted palms' roots die during the process and soil heat is needed in order to ensure the development of new roots. According to the research in Mediterranean Region, it was determined that transplantations should be done on April, May and June; and if there is not a chance to make transplantation in these months, then the period between September-November should be the second choice (Anonymous 2012 d).

Before carrying palm fronds (each one of pieces that constitute the crusty structure of tree body), leaving 6 or 8 per body pruning is a general rule as each body has an eye and it should be protected. Annuluses of leaves besides the eye are generally separated in order to prevent from the pressure in eye when fronds are tied. Less leaves are suggested for urgent transplantation of palms. Long sticks should be tied to body in order to support palms that have long thin bodies (*Phoenix redinata* Jacq. Fragm. and *Acoelorrhaphe wrightii* (Griseb. & H. Wendl.) (Himelick, 1981).

Plantation of palms is similar with the other trees. Planting pit is dug wider than the root ball. Crumbled stones that are removed from the pit are used for refilling. Palm should sit on the palm pit which is very important for palms as they have curved body. Palms should be put in 75-125 mm deeper than their original position in order to prevent development of new root. Many kinds of mixtures can be used in filling the planting pit such as sand and soil with vegetal mixture. These soils should be around the root and be irritated very well (Harris, 1988). Leaves on shoot should be tied around the leaf that grown the latest in a way to protect the leaf (Anonymous 2012 d).

In order to ensure immobility, palm should be tied with steel topes but nails or screws shouldn't be stuck into the body. Protector bars that are placed around the body protect them from stuck (Harris, 1988). If the bottom part of body moves, thin roots that newly develop split and the plant cannot grow. In order to prevent this, palm body thickness should be measured and metal circle should be prepared; then, this circle should be mounted onto the body and the tree should be set from 4 sides. Steel circle is made of 2 hemicycles that can be affixed on 1/3 bottom part of the tree. These hemicycles are connected to one another with two screws. Additionally, 4 ringers for setting steel rope on

the circle (Anonymous 2012 d). Single body palms are piled on Lorries and treys and carried. Palms that have wide and many stems should be laid on truck haulage and be tied with one stem in order to increase stability and the width of the load (Harris, 1988).

Newly planted palms should be irrigated very well in the first season. They should be irrigated slowly, twice in a week for 8 hours during the first two months, after that period, they should be irrigated once in a week for 12 hours. This process can be carried out in well drained soil. Fronds of newly planted palms pale especially because of alkali soil, cold weather or due to the lack of manganese or iron. This is why; necessary mineral elements and fertilizers should be added into the soil (Harris, 1988).

4. Transplantation of trees in campus of Bartın University (case study)

Transplantation processes of large trees in Campus of Bartın University were analyzed in this study. The aim of this study was to ensure a modern appearance and qualification to Campus of Bartın University in terms of plantal arrangement. A commission was formed by Deanship of Faculty of Forestry. Necessary literature review and field analysis studies were done by the commission and some alternative projects were prepared. At the end of the meeting with deanship, the most proper project in terms of practicability and cost was chosen. The chosen project was detailed and prepared for application. Mechanic tree mover was rented from Karabük Municipality. The project was applied on May 2004 and transplantation of 10 plants that were of 6 species was completed.

Material: Faculty of Forestry has been put into service on 1993-94 academic years. Campus was built at Gaffar district, Ağdacı Village, Bartın approximately 5.5 km distanced from city center on 1.14 hectare land. 900 m village road on Bartın-Kozcağız highway was used for going to the campus.

Pinus pinea L. plantation in Boğaz district situated in Bartın Central Forestry Operation Directorate was the area on which working area existed; transplantation process, removal and plantation of trees were carried out on this area. Application area, plantation, was an inclined land on the right side of campus entrance, situated at the north of library building in Faculty of Forestry. The area was approximately 450 m^2.

Campus's map section in 1/500 scaled base map was used in order to draw the project and determine the definite boundaries of application area; digital camera was used in order to view the sections of transplantation process in the area.

Method: The method used in this study can be summarized as:

- Determination of the area on which transplantation will be done in the campus,
- Determination of area's map section on 1/500 scaled base map,
- Transferring present plan from paper map sheet to computer ,
- Determination of plants which will be transplanted,
- Preparing projects of the area on which transplantation will be done,
- Renting mechanic tree mover and preparation of necessary equipment,
- Making land survey. Within this scope:
  - Digging of the pit in which plants will be placed,
  - Completing removal and transfer processes of plants,

- Planting plants,
- Maintenance of plants that were transplanted.

A study group was formed by Deanship of Faculty of Forestry in order to carry out transplantations. At the end of the meetings held in the group and with Deanship authorities, processes and necessities were determined. Application process started after determining the priority of these necessities and processes.

4.1 Transplantation process in campus of Bartın University

It was determined that the plants that had been planted during ten years history of Faculty of Forestry would be transplanted as they couldn't create a beautiful effect; especially big sized plants should be transplanted in order to increase the scenery quality of the faculty. In this context, meetings were done with Karabük Municipality and tree mover was rented for two days in order to use it in transplantation process.

4.1.1 Determination of the transplantation area

We can classify the factors that play role in the process of choosing field:
Soil characters of species that will be brought to the field,
Enable the mechanic tree mover to enter the field and make transplantation easily,
Choosing the best places for plants in terms of aesthetical and functional aspects,

By taking these criterions into consideration, the area of the campus transplantation area was determined to be: At the north of the library building, southwest of former Forest Engineering and Forest Industrial Engineering building, northwest of Landscape Engineering and Vocational School of Higher Education and the area on the right side of campus entrance was chosen.

4.1.2 Choosing plants

Time is crucial in transplantation process. The plant that is removed should be transferred to the plantation area as soon as possible. This is why, the species that would be brought to campus were chosen in meetings held with Bartın Forestry Operation Directorate. Chosen areas were in the area that belonged to Bartın Central Forestry Operation Directorate, Boğaz district *Pinus pinea* L. plantation. Special importance was given in order to enable mechanic tree mover move freely; the chosen area was a level land as much as possible, there were no other plant species that were very close to the working area.

While choosing the species, it was very important to choose plants whose habitats were similar with the area that they will be planted; on the other hand, their colors, forms, texture and line of these plants were very important in terms of creating the desired effect in the field.

Removal and planting, namely transplantation of some species of trees are easier than the others. Tree species that have shallow roots with hairy, thin and compact root systems are more successfully transplanted than the species that have thin roots and taproots which go deep in the soil. But if the maintenance of the species which have thin root and taproot system is done carefully, they can be transplanted successfully and they can live long. By taking these criterions into consideration, at the end of researches and analysis in Boğaz district *Pinus pinea* plantation it was determined that 3 *Pinus pinea* L., 1 *Pinus nigra* Arnold., 3

Cedrus libani A. Rich., 1 *Prunus avium* L. and *Malus floribunda* Sieb. were chosen to be planted (Figure 9, 10 and 11).

The *Picea punges* Engelm. that was placed at the north of Bartın University public housing, at the south of information building in Faculty of Forestry was a decorative species, but it had lost its aesthetical aspect in the area. Because of this, in order to use the tree more aesthetically, it was determined that it should be transplanted. North side of plant was marked with oil color and it was transplanted according to these marks.

4.2 Characteristics of the species used in the transplantation

Pinus pinea L. (Stone pine or umbrella pine):

Stone pine grows in the Mediterranean countries and their picturesque shape of straight trunk and domed crown. Leaves are in pairs (Brain and Valerie Proudley, 1976). This tree grows in native to south-west Europe around the Mediterranean to Greece and Asia. The seeds are eaten raw, roasted like peanuts or added to stews a ragout, a traditional Italian dish. Remains of husks have been found in Roman camps in Britain, indicating a long history of their use. Height may reach 30 m (100 ft) but in the open it forms a much lower umbrella-shaped tree. Flowers open in June, males golden and clustered, females pale yellowish green, about 1-2 cm (1/2 in) long. Cones are large, about 2-5 cm (5 in) long and heavy. They remain closed for 3 years. Needles are dark green, thick, slightly twisted and pointed. They are in pairs and often rather sparse. Bark is reddish brown with deep dark cracks forming long plates (Roger, 1979).

Fig. 9. *Pinus pinea* L. plantation in.Boğaz district, Bartın, Turkey.

Cedrus libani A. Rich. (Lebanon cedar):

Lebanon cedar is native to Taurus (south Anatolia) and near east (Lebanon). The trees are planted as an ornamental in Europe and N.America. This is the familiar slow-growing tree of our parks and large gardens. Younger ages, it is pyramidal in shape gradually becoming flat-topped with age. The widespread branches of clear gren foliage sometimes suffer damage during heavy falls of snow and should be propped where possible (Brain and Valerie Proudley, 1976). It is height to 24-36 m (80-120 ft). Male flowers are abundant 1cm (1/2 in) and pale green through the summer expanding to 5 cm (2 in) to shed pollen in November. Females appear in November and develop in to large purplish green cones 9-15 cm (3.5-6in) which taper to the top. Foliage is made up of dark green needles up to 2cm (3/4in) long. Young twigs are almost hairless (Roger, 1979).

Lebanon cedars grow at elevations of 4,264-6,888 ft. They grow best in deep soil on slopes facing the sea. The trees require a lot of light and about 40 inches (1000 mm) of rain a year. They form open forests with a low undergrowth of grasses (Anonymous, 2012e)

Fig. 10. Transplantation of *Picea pungens* Engelm.

Pinus nigra Arnold. (Black pine):

Black pine grows in native to Austria, Italy, Yugoslavia, Greece and Anatolia. It is planted in Britain for shelter and for ornament. Height may reach over 30 m (100 ft) in the forest. Flowers open in late May, males is golden yellow, females is red, about 0.5 cm (1/4 in) long. Cones are 5-7,5 cm (2-3 in) long and the scales open to release winged seeds. They are arranged in pairs in dense clusters separated by bare lengths of twig. (Roger, 1979). The rough bark is brown to dark brown and the cones solitary or in clusters up to 8 cm (3 in.) long. It is a useful shelter belt tree for dry, chalky soil (Anthony, 1973).

İts habit is broad and vigorous and the long needles are of a delight ful, dark green colour, givig this pine a sound and luxuriant look all the year round. It tolerates wind and poor soil, and will grow most attractive in a light, sunny localitiy but needs plenty of space in order to unfold in all its glory (Eigil, 1973).

Malus floribunda Sieb. (Japanese or Shoey Crab Apple):

A Japanese tree, probably a hybrid rather than parks and streets, as it flowers profusely every year. It has height to about 6-9 m (20-30 ft). Flowers open in late April and early May, each about 2,5-3cm (1-1,25in) wide in clusters of 4-7. Fruits are about 2cm (3/4in) in diameter, ripening yellow in October (Roger, 1979).

They would look nice as specimens on the lawn or with other bushes in the front garden, where they give the entire road a festive look in the spring. The trees can be bought in the shape of ordinary bushes or standarts. In many instances a young bush specimen will grow into a handsome tree with many slightly cooked trunks of much better effect then one long, straight trunk. This should be as for ordinary apple trees, i.e. good, deep soil, rich in humus without stagnant water in winter. Pruning should consist of a suitable thinning-out of the branches at an interval of a few years, always done in such a manner as to maintain then natural shape of the top (Eigil, 1973).

Prunus avium L. (Sweet Cherry):

A very fast-growing, ornamental tree which will not produce berries owing to its double flowers (Eigil, 1973). Its fruits trend to be bitter but it is one of the parents of most European cultivated cherries. The wood is reddish-brown with a very straight grain, and used in cabinet making, and for anything requiring a straight bore such as pipes and musical instruments. To be found in hedges and woods, gardens and parks in most of Europe, also cultivated and naturalised in eastern N. America. It has height to 18 m (60 ft) or more. Flowers open in mid April, each about 2-5cm (1in) across in clusters on previous year's growth. Fruits are about 2 cm (3/4 in) across and may be light or blackish red, sweet or bitter. Leaves have stems red above and yellowish beneath with 2 or more glands or lumps near the base of the leaf blade and colour yellow and red in autumn. Bark is reddish Brown and clearly marked by lenticels in horizontal lines and broken by large cracks (Roger, 1979).

Picea punges Engelm. (Colorado spruce or Blue spruce):

Colorado spruce grows in native to the Rocky Mountains in western N. America, particularly at the south end of the range grown for ornaments and sometimes for timber in northern and central Europe. Height to about 30 m (100 ft) but may reach 45 m (150 ft) in favourable conditions. Flowers open in May, males about 2 cm (4/5 in) long, females twice that. Cones

are a distinctive pale colour, with wavy toothed scales. They are about 7,5-10 cm (3-4 in) long. Needles are 4-sided with whitish-blue buds on each face. They are spine tipped when young, becoming blunter with age. Bark is purplish-grey, breaking into coarse plates. (Roger, 1979).

They are seldom as high in cultivation where the fine glaucous foliage forms are more common. Because of their brilliant colouring these named clones are some of the most desirable of conifers suppliers being hard put to meet the demand for established specimens (Brain and Valerie Proudley, 1976).

Fig. 11. *Malus floribunda* selected in order to transplantation.

4.3 Determination of planting area of transplanted species

After choosing the species to be transplanted, the project was prepared in order to place the chosen species on the field and the project was drawn on computer (Figure 12). According to this project, in order to determine the exact places of plants, piles on which plant species were written were penetrated one by one on the ground and application work was carried out.

4.3.1 Features of mechanic tree mover

Working style and features of tree removing and planting machine can be summarized as: The machine works with a hydraulic system; hydraulic pump of the system is placed in the vehicle on which the machine is mounted. The machine is composed of 4 strong lifter arms, digging unit, hydraulic system and a trailer system by which the tree will be carried and

some other parts. Digging knife lifting arms are jointed and while it is hold vertically during working, it is hold horizontally during transfers. Digging knife unit is made of 4 knives put around the knife frame. It has an extensible and closable frame. Knives can be pushed downwards and pulled back upwards.

4.3.2 Making planting pits of the plants

Size of the planting pits in which plants will be transplanted depends on the mouth size of mechanic mover. Plant pits have to be opened again with the same device while mechanic tree mover removes and transfers plants (Figure 13). Size of the pit from which plant is removed and into which it will be planted is significant in terms of adaptation to new place, being affected form strong winds and regular root development.

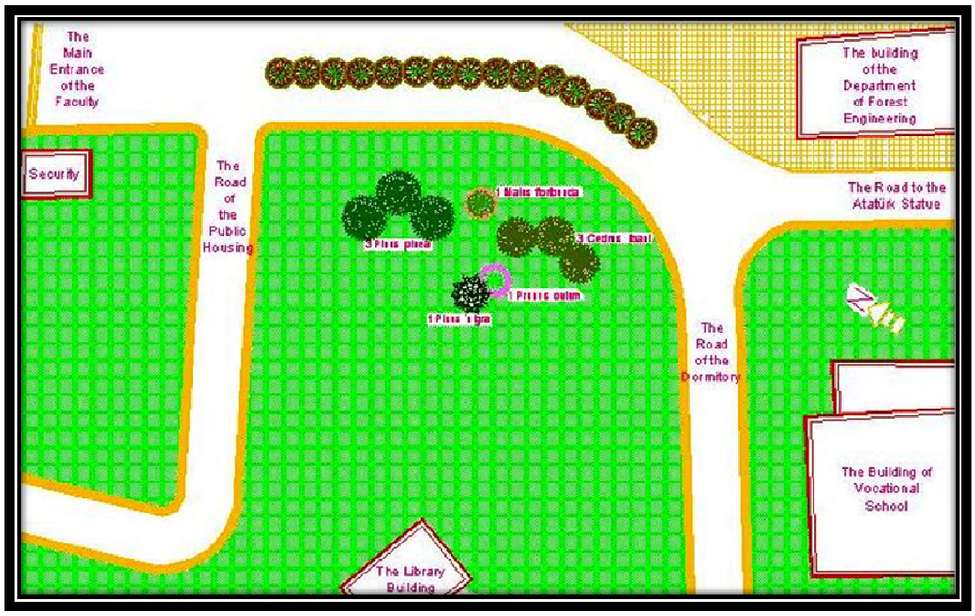

Fig. 12. The project of transplantation tree.

Fig. 13. *Picea punges* Engelm. planting pit.

In the transplantation made by mechanic tree mover, firstly planting pit is opened and irrigation must be done as a rule; because when tree mover transfers the plant, no time should be wasted and plants should be protected from damage caused by time. This is why each time mechanic tree mover comes to the campus, planting pits were opened and then the plants that would be transplanted were brought.

4.3.3 Removal and transfer of the plants

Time effect has a big importance in the success of removal and transfer of plants. As a general rule, overcast and flurry weather should be preferred. But as the tree mover rented from Karabük Municipality had to be returned maximum two days later, the process had to be carried out in sunny days.

Transplantation season is also important in order to continue a healthy life and adapt quickly to the new soil. Early spring is the most proper season for transplantation as vegetation time doesn't completely start in this season. More careful removal, transfer and maintenance are needed for plantations that are made in the seasons except transplantation seasons. Mechanic tree mover used in the project studies were required from Karabük Municipality on March, but it could be taken from the Municipality on May because of its workload. As the season wasn't very appropriate enough for transplantation, processes during transplantation were carried out very carefully.

Tree removing mechanism was put on the ground from the back of the vehicle and surrounded the tree that will be removed with the opened frame. Knives moving with the electronic system penetrated into the soil according to the points determined by the frame and they were united in a way to shape a dome. The tree and soil was picked up with tree removing device and was placed onto platform and booth vertically, and the tree was ready to be transferred (Figure 14). Distance between the campus and Boğaz district *Pinus pinea* L. plantation was approximately 20 km. Transfer process was very carefully made as the distance was long.

4.3.4 Plantation and maintenance process of the plants

Plantation: Plants were planted into the pits where piles were situated according to the project. Trees whose northern sides were marked with oil paint were brought to the planting field and they were placed in a way to face the same direction and stand straight. Pits were irrigated with plenty of water before plantation.

Refilling removal pit after plantation: Pits that were formed during plantation were filled with soil. In this way roots could be ventilated and they were protected from drying and dying. Soil that was used for filling had a pervious structure and was mixed with organic substance.

Protection of Stem: Stems were wrapped with sacks in order to protect newly grown trees from sunburn, frost cracks, damages of winds and cold.

Supporting of root fescue: Newly transplanted trees were supported in order to make them get used to their new places and protect them from environmental pressures. In the supporting works, trees were roped with rubber hoses by leaving 2-3 cm spaces from stems of trees according to the incline of the field. Rubber hoses were roped to trees from 3 sides tightly with 45° angle (Figure 15 and 16).

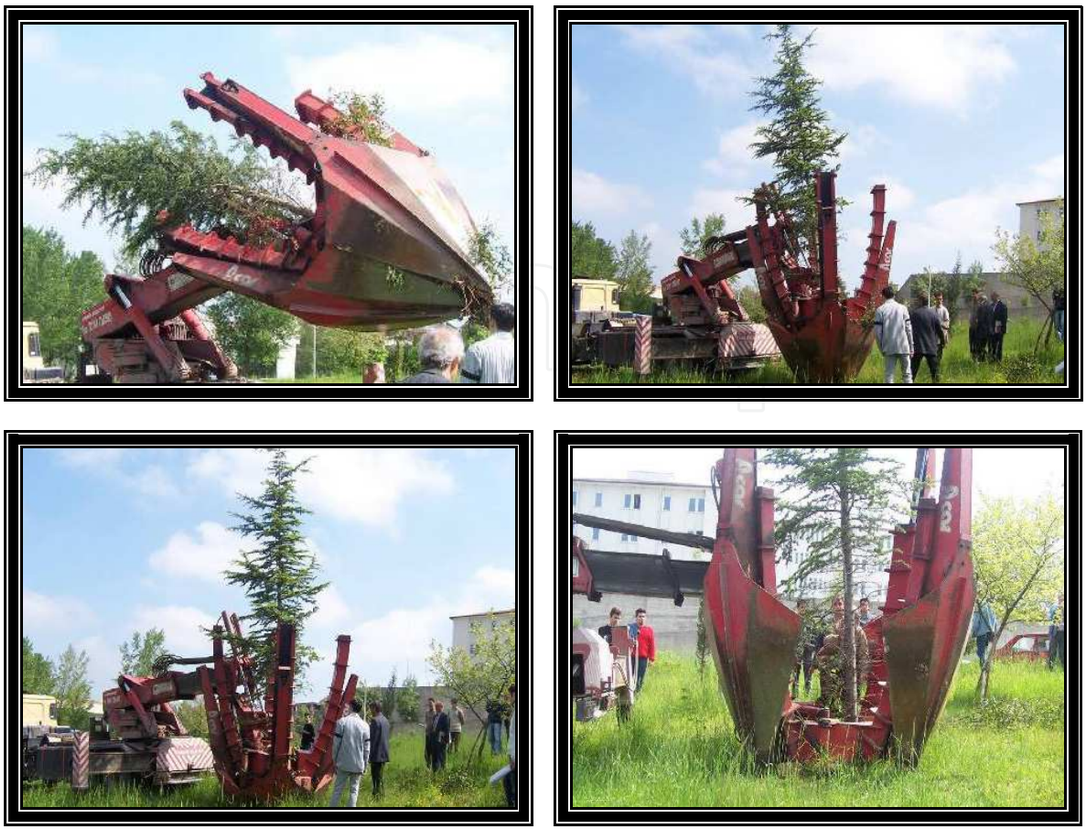

Fig. 14. *Cedrus libani* A. Rich planting processes.

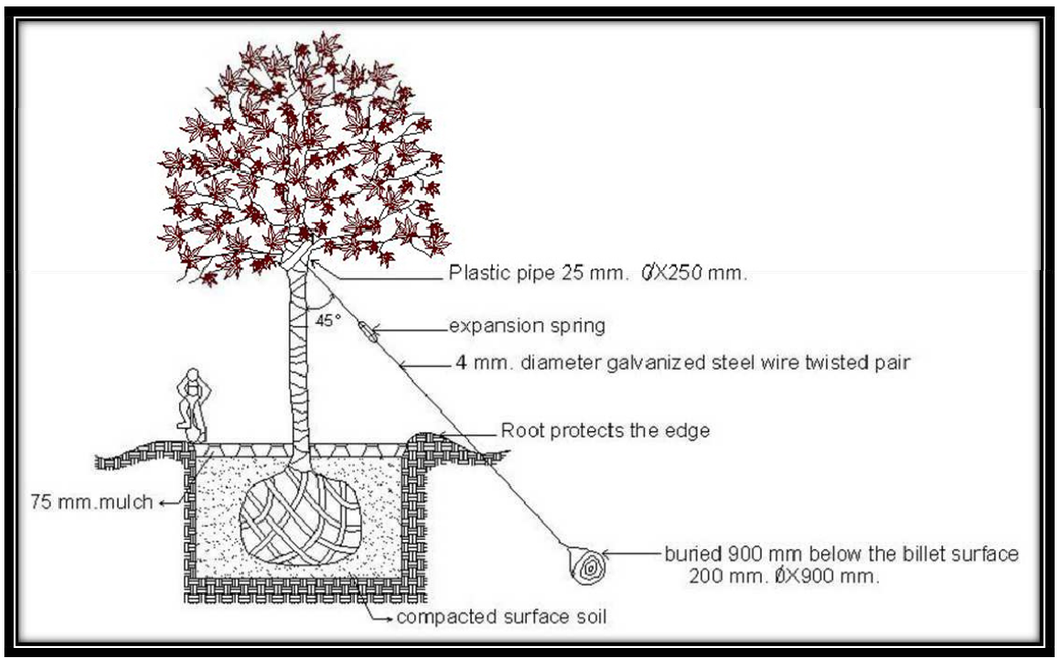

Fig. 15. Detail of supporting made with buried piles under the ground.

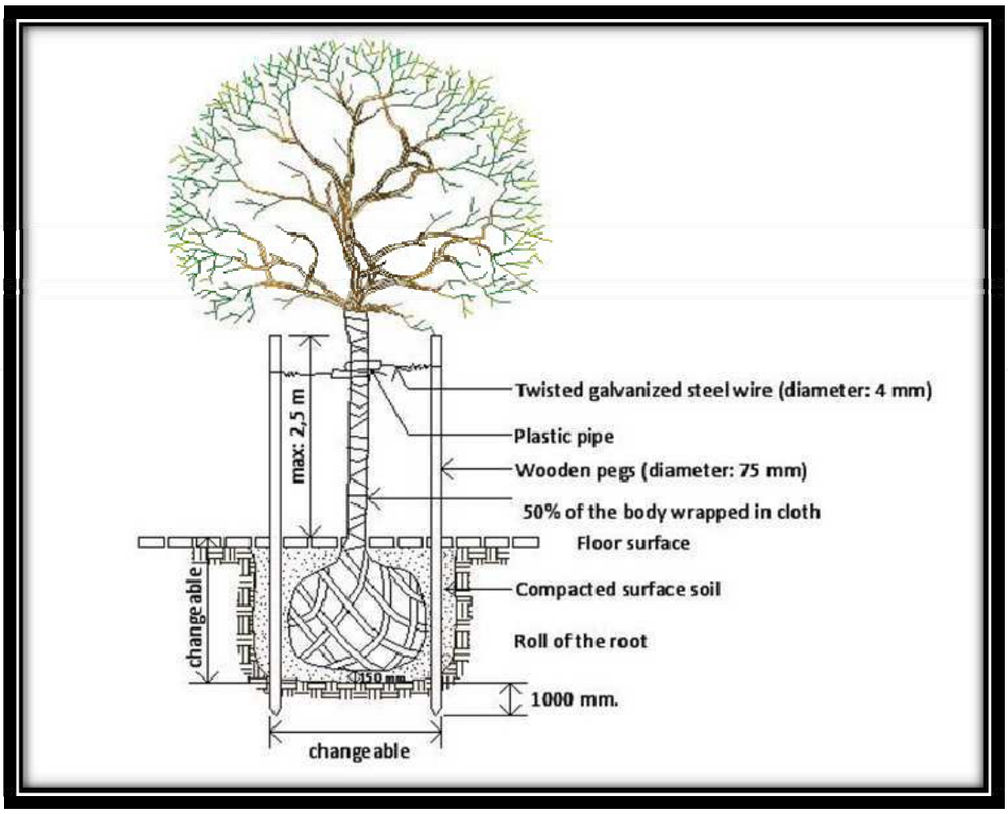

Fig. 16. Detail of supporting made with vertical piles.

Pruning: Branches of trees that were broken and dried were pruned. This had a big effect in preventing water loss. 1/3 – ¼ of unnecessary branches were pruned and growth direction was controlled.

Irrigation and Mulching: Mulching with 5-10 cm thick rotten leaves and well developed fertilizer applied on the bottom and all around the plants that were transplanted; mulching process decreased evaporation in the soil around roots thus protected the humid in soil. On the other hand, mulching balanced the heat of soil and made a positive effect on the life of the plant. Plants that were transplanted were irrigated periodically in order to develop the relation between root and soil and give necessary moisture to the soil.

5. Conclusion

Transplantation is the process of removing plants that are at a certain age and planting them to other places in order to create the desired effect. When places such as public gardens, youth centers, schools, Olympiad villages should be designed in a short time, especially trees that are at a certain height and form are preffered. Plantation of young bushes doesn't create the same effect created by the older ones. The importance of transplantation in terms of landscaping as to minimize the loss of time until small bushes grow and have enough strength in the field. Younger bushes create the desired effect in 20-30 years while planting big trees that have aesthetic, functional and climatic effects will create the desired appearance and will balance size and space in a short time.

Transfer time is very important in the process of removing and transferring plants. The most proper time for transplantation is the stable period between October and March. Mechanic tree mover rented for transplantation was requested from Karabük Municipality on March. But as the municipality had used the vehicle for its works, it was sent to the project on May. As the weather was very sunny and hot on the day of transplantation and the vehicle was rented only for two days, there was no other choice but to complete transplantation in two days. This caused plants to adapt their new places difficultly. As the proper period for transplantation, namely early spring had passed and it was very hot, a more intensive care was necessary. Not making enough maintenance caused drying of two *Cedrus libani* species. Dried cedars were removed from the field.

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Landscape architecture is the design of outdoor and public spaces to achieve environmental, socio-behavioral, and/or aesthetic outcomes. It involves the systematic investigation of existing social, ecological, and geological conditions and processes in the landscape, and the design of interventions that will produce the desired outcome. The scope of the profession includes: urban design; site planning; town or urban planning; environmental restoration; parks and recreation planning; visual resource management; green infrastructure planning and provision; and private estate and residence landscape master planning and design - all at varying scales of design, planning and management. This book contains chapters on recent developments in studies of landscape architecture. For this reason I believe the book would be useful to the relevant professional disciplines.

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
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Unit 405, Office Block, Hotel Equatorial Shanghai
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