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A review of the orchard management in organic fruit production

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Summary: The elements of orchard management have a determining role in the success of organic fruit production, therefore, it is essential that they are applied properly. The present review gives describes some aspects of the orchard management such as site selection, orchard soil, rootstocks and cultivars, planting materials and plant density, crown shape. Then, one of the most important elements, pruning is discussed with special emphasis on winter pruning, condition and apical dominance, degree and method of pruning, summer pruning. After pruning, an overview of fruit thinning, irrigation, soil cultivation, soil protection (cover plants and mulching) and fertilization is given.

Key words: phytotechniques, orchard management, tree condition, fruit growing

Introduction

Numerous attempts have been made to determine the condition of trees. Many identified it with the vegetative performance of trees, that is with tree sizes, while others with the amount and quality of yield. One of the most expressive definitions was given by *Zatykó* (1979). According to him, optimum condition is described as a harmony between vegetative activity and assimilate supply. If the balance is shifted toward one or the other, the condition of trees is rendered.

In organic fruit production, the functions of both the subsurface and above ground plant parts deteriorates due to the limited efficacy of crop protection. The reduction in the surface and function of canopy diminishes the amount of assimilates. The assimilate supply of roots is therefore weaker, which further deteriorates the root function (water and nutrient uptake).

The withdrawal of assimilates due to the regenerative growth aimed to make up for the reduced canopy can be regarded as an indirect weakening of the condition until these new parts become self-supplying and producing.

In achieving a better condition in organic production, measures applied from the soil are of higher efficacy than those applied to plant parts above the ground. Soil quality, location and exposition of the area have a great importance in reducing and balancing the factors weakening tree condition.

Site selection and soil

The quality of the orchard area has a much greater importance in organic production than in conventional production. Southern, south-western location, a higher elevation than that of the surrounding area with runoff are crucial. Slope should not be steeper than 5% and it should have a possibility for runoff. If possible, it should not be "overprotected" from wind, a mildly (not extremely, strongly) windy area is more favourable because it can reduce the length of unfavourable (humid) microclimatic status forming within the trees after rain events (*Soltész*, 1997b).

"Virgin" areas, where no fruit orchards have been established before, are obviously more favourable, since the soil is not exhausted. If it is not possible and the area was utilized for fruit production earlier, a soil testing should be done in order to identify or exclude allelopathy. If allelopathy is verified for the given fruit species, then the area should not be used for organic production.

Soil is one of the most important factors of organic growing. If possible, a homogenous area should be selected without unfavourable spots. The higher the nutrient stock and the higher nutrient-supplying capacity the soil has, the better chances it has for balancing weaker condition. A deep fertile layer and favourable water management are essential. Soils with 30–40 plasticity index according to Arany and 1.5–3% humus content are regarded as optimal.

Too acidic or too alkaline soils (pH values under 5.5 and above 7.5) should be excluded from orchard planting due to the potential problems in nutrient uptake. The uncertainty of the efficacy of soil amelioration materials and their costs further reduce the the originally lower profitability of organic production.

Rootstocks and cultivars

In contrast to traditional fruit production where medium-strong, dwarf and semi-dwarf rootstocks are all used

depending upon the fruit species and the cultivar, the use of medium-strong and strong rootstocks is more favourable in organic fruit production. The roots of the latter go deeper and cover a larger soil volume, therefore, the nutrient uptake and the amount of available nutrients are better in spite of the lower nutrient supply and nutrient stock (*Hrotkó*, 1997).

In parallel with this, the growth of the above-ground parts are also stronger. The stronger and longer shoot growth helps the regenerative growth processes induced by the loss of canopy.

The weakening of tree conditions happens earlier and with greater losses at rootstock-cultivar combinations with moderate growth than at trees with strong growth.

Proper selection of cultivars has great importance in organic farming. One should select such cultivars which have great fertility but are not prone to yield alternation. The high yielding capacity from year to year is an important characteristic of cultivars in organic production.

Another important aspect is that the applied cultivars should fertilize each other mutually. The arrangement of cultivars should ensure an appropriate pollen density in all parts of the orchard, which is crucial under less favoruable conditions.

According to foreign experience, preliminary domestic information and customer's opinion, world cultivars with high biological performance are much more attractive than local, traditional cultivars. Therefore, primarily the traditional cultivars should be used in organic production too. According to surveys, it is more favourable, at least from the aspect of marketability, to sell cultivars that are also used in conventional production as organic fruit. Consequently, the selection of cultivars should be made by taking into consideration the market trends and demands.

Of course, the best solution is if a cultivar is resistant or tolerant or at least less susceptible to pests or part of the pests (*Soltész*, 1997a; *Holb*, 2000; *Holb et al.*, 2001).

Unfortunately, many of the cultivars used in Hungarian fruit production that are resistant to certain diseases are not competitive with the world cultivars regarding their consumption value (*Holb*, 2000). However, resistance to animal pests is an even more difficult problem. Of course, cultivars with lower susceptibility, rougher and thicker leaf tissue or with peculiar growth characteristics should be preferred.

In organic production, cultivars with shorter vegetation period are more favourable. This shortens ecological damage and the periods of stress. A related feature is that the susceptibility period of cultivars with shorter vegetation period and/or earlier closing of terminal bud is shorter, therefore the chance for damage and the degree of damage are lower (*Soltész*, 1997a). This is a favourable characteristic for reducing or excluding that the plant parts grow fast from the cover of the contact chemicals allowed in organic production.

This latter trait partly contradicts to the use of the rootstock with stronger growth ensuring slower tree growth, but there can be great differences among the cultivars in growth even if the same rootstock is used.

Regarding the branching quality, cultivars with medium branching are the most favoruable. These have more growth points than cultivars with less branchings, which is manifested in a more harmonic, well-distributed growth finishing relatively earlier.

On the other hand, cultivars with too many growth points, shorter internodes and many broom-like branchings are not favourable either, such as cultivars Braeburn, Elstar, Florina and some spur-type cultivars in apple production. These cultivars are more prone to forming a dense canopy which can be reduced only by strong pruning.

Cultivars with a less dense, more airy canopy with more fertile habitat and a more easy crown shaping and maintaining are more favourable than too dense, upward canopies that are closed to sunlight and spray applications.

Planting material and plant density

In organic production, the use of plant material that is virus-free or virus-tested is even more important than in conventional production (*V. Németh*, 1961; *Soltész*, 1997a).

The stronger preliminary growth of virus-free plants, the possibility of uniform handling of the homogenous plant material are important features to balance the uncertainty of crop protection after planting. At the same time, virus-free material results in a higher vegetative production and a higher generative performance, that is trees start to yield earlier. That is why fruit thinning of the first years, the early removal of excess fruit, is of greater importance in organic farming, since its growth-reducing effects are more harmful than in conventional farming.

Plant density, that is the selection of the distances between and within rows is a critically important task in all production systems. Too high plant density results in losses in yield quality and quantity and a meaningless use of extra labour due to causing a fight to keep the trees in space. Too low plant density means that the available area is not exploited and by spraying the "holes" between the trees we pollute the environment and waste chemicals.

According to logical considerations, which are confirmed by production experience, it is obvious, that the same rootstock-cultivar combinations should be provided a relatively greater space under the same environmental conditions in organic production than in conventional production. Tree spacing should be selected in such a way that the neighbouring trees do not contact each other and no hedge-like status forms that is required in intensive production.

Sunlight and wind should reach the trees from all sides and the last rows should not from a wind-protecting zone. Better light conditions and airing shortens the unfavourable microclimatic conditions within the tree canopy.

Crown shape

In organic production, the crown shapes to be applied are of greater size due to the use of rootstock ensuring larger growth. At the same time, in spite of the rootstock and the environmental factors ensuring stronger growth, an increase in intensity should

be targeted, that is we try to form and maintain an intensive crown shape. This means that in addition to forming and maintaining the dominance of the central axis, the implementation of Zahn's rules is also very important (*Zahn*, 1986, 1994).

Accordingly, the total diameter of the lateral branches on the trunk and central axis can never be larger than half of diameter of the trunk or central axis measured directly under.

a., $\frac{\textit{Lateral branch diameter (cm)}}{\textit{Trunk diameter (cm)}} \leq 0.5$

b., $\frac{\textit{Axis diameter above the lateral branch (cm)}}{\textit{Trunk diameter below the lateral branch (cm)}} = 0.85$

If the above ratio is larger than 0.85, then the exaggerated strengthening of the axis can result in a "non-controlled" upper tree part and the weakening of lateral branches.

However, if the ratio is smaller, than the lateral branches are strengthened for the damage of the axis and it becomes harder to keep the crown within the required space.

The next proportion is derived from the former two:

c., $\frac{\textit{Axis diameter above the lateral branch (cm)}}{\textit{Lateral branch diameter (cm)}} = 1.75$

The above ratios were worked out by Zahn for the final lateral branches playing a determining role in the spindle shape and for the trunk. For the slender spindle crown shape, which is characterized by lateral branched of decreasing width from the bottom to the top, these optimal ratios should be applied for practically all parts of the central axis.

Therefore, it is important to form a larger slender spindle crown shape, because shadowed, inner inactive branches and twigs, that use of a lot of assimilates and thereby reduce the originally lower assimilate stock, should not form even in spite of the larger tree size. We should create trees with "semi-intensive" or even extensive size, even if we know that the phytotechnical operations that are extremely important in organic farming can be performed only to a limited extent or with extra input.

The stronger growth of MM-106, MM-111 and M-26 rootstocks, that are used for apple production where trees are wider and taller, can be harmonized by targeting the 1:2 width-height ratio. For example at 2 m within-row distance, if not even 4 m, but a height of 3.5 m should be aimed, but the between-row distance should also be increased for this purpose to a minimum of 6 m. In this way the plant density will be around 800 trees/hectare

In an intensive apple orchard with 4 x 1 m spacing, the number of trees per hectare is 2500. If we suppose that the shape is a perfect cone and the height is 2.5 m, then the volume of yielding parts is 3125 m^3.

In the case of an orchard with 2 m within-row distance, 3.5 m tree height and 6 m between-row distance and with similar tree shape, the volume of yielding parts is 2800 m^3, which is just 10% lower than that of intensive orchards.

However, at such spacing, the productive part of the canopy which is reached by sunlight is reduced by 20% as compared to trees with 1 m diameter. In spite of this reduction, it still represents a very productive crown shape and high level of intensity.

At higher within-row distances than above (2–2.5 m), the optimum 1:2 ratio of tree width and height cannot be maintained. Because in this case, trees would be so high, that the harvesting and handling operations would be very hard to perform. On the other hand, the plant density would shift toward the extensive direction due to the necessarily increasing between-row distance.

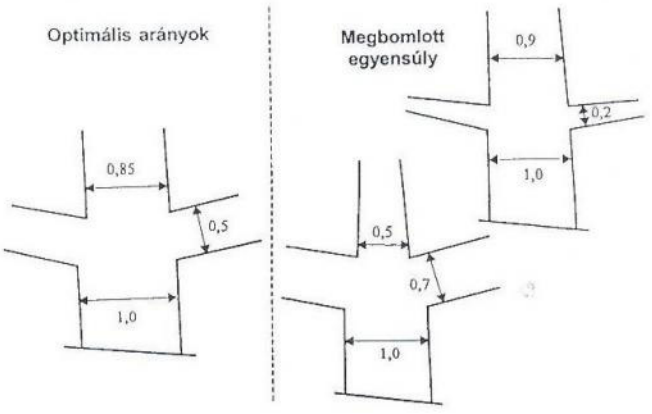
For apple, pear and some of the stone fruits (sour cherry, plum and sweet cherry) a within-row distance of 2–2.5 m is advisable, because in this way the stronger growth vigor generated by the rootstock and the growing site can be harmonized by increasing tree height. This crown shape enables the best utilization of sunlight, thereby ensures the largest productive volume of yielding parts.

By further increasing the within-row distance (3–4 m) primarily for economic considerations, tree height can be increased to 4 m. At trees of such size with cylindrical or rather spherical shape, the volume of yielding parts per unit area increases slightly, but the productive part reached by sunlight is dramatically reduced.

In orchards where trees are of 3 m diameter, 4 m height and the between-row distance is 7.5 m, the volume of tree canopy is 4000 m^3. If we take the highest value, 40% as productive part, it means 1600 m^3, which is much lower than that of trees mentioned above with 2 m within-row distance. In addition to the reduction in productive parts, the labour requirement of harvest and management is multiplied and the possibilities of crop protection are also worsened.

Winter pruning

Based on research and practical experience, it can be stated that winter pruning for crown shaping and maintaining which is necessitated by the weaker condition of trees in organic production should be performed strictly in the dormant period, no pruning should be done after the vessel circulation starts. Late pruning significantly reduces the originally lower nutrient stock. Late pruning has a negative effect on both shoot growth and fruit set (*Gonda*, 1977).



Source: Zahn (1986)

Figure 1 The application of Zahn's principles in crown shaping

Condition- apical dominance

It has been known for long, that tree condition, which is related also to water and nutrient supply, is closely related to apical dominance. In general, it can be stated that apical dominance is stronger in weaker trees, while the apical dominance is smaller in trees with good condition.

Practically, it means that the branching ability of the shoots and twigs in weaker trees is significantly weaker, while in trees with good condition emergence from lateral buds below the terminal bud is more frequent. In the practice, it can be harmonized by selecting the proper degree and method of pruning.

Degree and method of pruning

In trees with weak condition, a more thorough pruning should be applied, which includes frequent cutting back in addition to thinning of twigs and shoots. (*Gonda*, 1980.)

The aim of detailed pruning is to improve the conditions of fruit setting and fruit quality (size) which are worse due to the weak condition.

According to previous experience, if the yield was too high in an orchard where the ecological conditions ensure an excellent condition, then the condition is weakened in the next year. This is well indicated by less shoots that are thinner, weaker and less flowers on fruit-bearing parts etc. Another indication is that canopy formation is slower due to the lower nutrient supply.

In such cases, a detailed, thorough pruning removing the sterile, flowerless shoots near buds with a low number of flowers and a moderate cutting back of shoots would reduce the number of vegetative growth points that can be regarded competitors of flowers. This enables a better water and nutrient supply of flowers and setting fruits and results in a better final fruit setting (*Gonda*, 1979).

On stronger trees with better condition, the degree and method of pruning is different. A weaker pruning is applied, a lower volume of shoots is cut and the cutting back resulting in too dense canopy should be avoided. Unfortunately, in organic fruit production, more thorough, detailed pruning is necessitated more frequently.

In addition, the larger canopy size (width) require the formation and maintaining of a crown structure where in case of necessity, by removing the older, first- and second- etc. order branchings a more airy canopy and a better ratio of parts that can be reached by sunlight can be achieved. This type of canopy thinning can only be performed during the dormant period, in the second half of winter.

Summer pruning and phytotechnical operations of the vegetation period

In organic fruit production, the operations performed in the vegetation period are started later and are less frequent and weaker as compared to trees in conventional technology.

Damage from the previous year results in a weaker vegetation start and slower shooting in the next year. This also has an effect on the dynamics of shoot growth. Depending on the environmental and year effects, shoots are closed earlier in a terminal bud or on the contrary: the shoots have an elongated growth finishing later. In the former case, there is no extremely strong vegetative growth, therefore, there is no need for shoot selection or summer pruning or they are required only later.

In the other case, the prolongated, slow growth does not require either the above mentioned operations, since they would result in further, even later finishing shoot growth.

Crop damage in the given year (partial loss of foliage, reduction in canopy function) strictly exclude even those operations which cause only smaller foliage loss. The further reduction of the damaged foliage would cause serious problems regarding yield and the generative processes of next year.

Apart from the above, there are years when there is no or only slight foliage loss. In such years, there is a greater probability for the formation of a large number of peripherial and interior shoots with strong growth which makes the canopy more dense. Summer pruning should be applied also in organic fruit production in these years. With this fruit quality improving procedure performed 3-4 weeks before harvest, we remove most of the excess plant parts that should be removed by winter pruning. In this way, we open the interior of the canopy and the better lumination of the interior parts improves both the colouration of fruits and the productivity of next year (*Gonda*, 1984).

The time of pruning for mechanical crop protection (removal of shoots with powdery mildew, leaf clusters, leaves covered by aphids, shoots, twigs, fruits infectes by brown rot) should be determined as early as possible and it should be performed after detecting the damage (*Soltész*, 1997a; *Holb*, 2003a,b). Powdery mildew infection should be removed by cutting back to the healthy part during the winter pruning. After the start of the vegetative growth, it should be checked, because in many cases the separation of the healthy and diseased parts is not possible with absolute certainty.

The phytotechnical measures that can be applied in conventional and intensive orchards (breaking of shoots, trunk incision, etc.) for reducing the exaggerated vegetative growth and improving the generative performance, cannot be applied or can be used only limitedly in organic production. As it was discussed above, in organic orchards emphasis is rather laid on inducing growth processes.

Fruit thinning

In organic fruit production, thinning of the too high number of fruits has a great importance, mainly in the case of apple, pear, peach, apricot and some plum cultivars. It can be stated that fruit thinning is a crucial element of orchard management (*Soltész*, 1997c). The optimal time of thinning is necessarily earlier than in conventional production, that is the overload of trees should be reduced earlier, as a delay endangers fruit quality of the given year and yield of the forthcoming year due to the weaker condition. Thinning also

has a role in removing the infected and damaged fruit (*Holb* et al., 2001; 2003a,b).

Based on our experience, in organic trees, the same fruit size can be achieved by leaving less fruits as in conventional production.

This is logical, if we consider that in organic fruit production the foliage/fruit ratio should be larher due to the weaker foliage function and this can be influenced by the degree of thinning.

Irrigation

By now, the long-term profitability of fruit production is questionable without some kind of irrigation even in conventional production (*Ligetváry*, 1997). In organic fruit production even the short-term lower profitability is questionable. Without irrigation, organic fruit of proper quality and size cannot be produced. According to our experience, irrigation should be started earlier (10-15 days earlier) in these orchards, since in organic fruit production, the water uptake of trees is weaker, they are less able to tolerate drought. Therefore, problems in water and nutrient uptake occur earlier without irrigation.

Soil cultivation

In organic fruit production, similarly to conventional production, soil can be left bare or grass alleys can be formed between rows or the combination of the two can be applied (*Nyújtó* 1993; *Papp*, 1997). If we decide to sow cover plants between the rows, than these should be plant species that fit the ecological conditions. A frequently applied method is that the natural weed vegetation is left and regularly mown. As a result of this, in 1–2 years the monocotyledonous plants that are characteristic to the area become strengthened and they suppress the dycotyledonous weeds.

Soil protection: cover plants and mulching

In perennial crops, the protection of the between-row area can be solved in many ways such as by mechanical tools, different cover plant combinations, organic or geotextil mulches. With respect to protection against erosion, those systems are the most favourable which cover the soil completely or almost completely.

If we decide to sow cover plants between the rows, such species should be included which fit the ecological conditions and the objectives of the grower. Researchers from countries with similar climate suggest to plant e.g. cocksfoot and *Festuca* spp. because their competition with the crop for water and nutrients is minimal during the summer (*Ames & Knepper*, 2000). It cannot be neglected, that in addition to a proper nutrient management, these grasses provide mulching. The role of *Papilionaceae* as cover plants is debated. Many of them are deep-rooting plants and in this way, they compete with trees for water, therefore, they should not be growing under the canopy. However, *Papilionaceae* and mulch made from them can provide a significant amount of nitrogen for fruit trees and grapes (*Haynes*, 1980). Furthermore, in spite of their competition with the crop for water, *Papilionaceae* improve the water absorbing capacity of soils. The explanation of this is that leguminous plants increase the organic matter content of soil, which increases the water-retaining capacity of the soil too.

Summing up, some advantages and disadvantages of applying cover plants:

Advantages:

- The root excretes of cover plants enhance the microbial decomposing activity in the soil and improve the stability of soil structure.
  Cover plants sown under in the spring enrich the soil with the organic and inorganic nutrients released during their microbiological decomposition.
- If the cover plant belongs to *Papilionaceae*, it increases the nitrogen stock of the soil.
- Cover plants provide a living and hiding place for useful arthropods (insects, spiders and predatory mites).
- The nectare of flowering cover plants attracts the useful pollinating insects. The presence of cover plants reduces the number of dangerous weed species occurring in fruit orchards.
- The application of cover plants in mountaineous areas is one of the most effective methods for protection against erosion. In orchards with plant cover, machine operations can be performed directly after rain or irrigation, even on wet soil. This also reduces the destruction in soil structure caused by the use of machines.

Disadvantages:

- Plant care and harvest of cover plants cause an increase in machine and general costs.
- In many cases, extra input (nutrient and water) is needed to avoid the yield reduction arising from the competition between the crop and the cover plant.
- Cover plants attract not only useful insects but also pests.
- In orchards with cover plants, early spring frosts have a larger frequency than in orchards without cover plants.

It is important that the growers should select cover plants which adapt to the conditions of the growing site. In walnut orchards, e.g. the selection of leguminous plants is favourable, which increases the originally low N content of the soil. If we aim to increase the biomass production by sowing under, we should apply a mixture of plant species including at least one grass species. In addition, soil type, intensity of nutrient supply and irrigation should also be considered.

A good mulching system covers the soil, provides nutrients and living habitat for useful insects. Those cover plants are the best, which drop their seeds already at the beginning of summer, die in the hottest period of the vegetation season and leave a thick mulch suppressing weeds. Several relationships exist between soil protection of orchards and crop protection. Most cover plants provide a living habitat and food for useful organisms, which results in

a reduction of the number of pest species (*William*, 1981). However, some mulches and cover plants might increase pathogen and pest danger. For example, mites can survive unfavourable periods on cover plants, or it is known about dandelion and chickweed that they can be hosts of apple and pear viruses (*Skroch and Shribbs*, 1986). *Papilionaceae* attract many pests, therefore they are not used alone as cover plants in organic orchards. Other plants such as mustard, buckwheat, sorghum and some species of *Umbelliferae* and *Compositae* host many useful organisms without attracting many pests. Most of the studies, however, show that cover plants have more advantages than disadvantages in protection agains pathogens and pests (*William*, 1981).

After orchard establishment, mulching with organic materials (straw, litter or sawdust) can significantly inhibit weeds. If the mulch is thick enough and bulkinh paper also placed under it, weeds can be suppressed completely. Weed suppression can be controlled by mulching only the alleys or the rows. At strawberry for example the whole space between the rows or just the area around the plant can be covered by mulch against weeds. In grape and fruit orchards, mulch can be laid around the trees or into the whole row, e.g. in the line of the drip irrigation system (*Ames & Knepper*, 2000).

An important rule for crop protection is that mulch must not be laid directly next to the trunk, as the damage caused by voles increases. This is especially important in winter. By placing the mulch at 20-30 cm distance from the trunk, the frequency of collar diseases is also reduced e.g. in numerous apple rootstock species (*Wilcox*, 1989; *Bilderback & Patent*, 1984).

An allelopathic effect of plant mulch against weeds has been found. Allelopathy means that one plant inhibits the growth of other plants nearby via chemical compounds. An example of this is when a compound excreted by the plant (e.g.walnut) has a negative effect on neighbouring plants and seeds. Another example is the use of plant remnants (rye, sorghum, Sudan grass,wheat, barley, oat) are used as mulch and these inhibit the emergence and growth of weeds. Research has proven, that mulching with plant remnants does not have an allelopathic effect on fruit trees, moreover, the growth of trees is better in such orchards than in orchards without mulching (*Daar*, 1986).

In addition, it should be mentioned that mulching with organic matter improves the nutrient content, structure and available water content of soils. It is known that the availability of potassium, phosphorus and nitrogen is better in mulched orchards (resulting primarily from the slow decomposition of mulch) (*Haynes*, 1980).

Mulches woven from plastic, i.e. geotextiles permeate water and air, but the inhibit the growth of weeds. Geotextile mulches will replace the traditional, non-permeating plastic foils used in fruit orchards. Research has proven that the traditional black foil cover is not favourable for tree crops because it induces root growth between the foil and the soil, which increases sensitivity to draught, the danger of winter freezing and the plant is weakly held in the soil (*Whitcomb*, 1979).

Although geotextiles does not enrich the organic matter and nutrient stock of the soil, their use is increasing in foreign fruit orchards.

Fertilization

In fertilization in organic production, manures have a major role. For the use of compost, it is regulated that it should originate from an organic farm. If they are not from an organic farm, then they cannot contain forbidden materials and the control organization should give permission for their use. No synthetic materials can be used for fertilization. In organic production, no soluble, quickly absorbed artificial fertilizers can be used and spray fertilization can be applied only in certain cases (*Anonymus*, 1997).

We have only limited possibilities for supplementing one or more deficient nutrients (resulting from the lower nutrient stock and nutrient supplying capacity of the soil or from the conditions unsuitable for nutrient uptake such as compacted soil, lack o fair, water saturation) and they cannot be supplemented in the short term.

In order to supply the trees with optimum amount of nutrients in proper time, growers should pursue a complex nutrient management program. This means that in addition to applying the necessary amounts of nutrients, soil structure and microbial activity should be maintained and improved. The manures used in organic production can fulfill their function only if the microbial activity of the soil enables the mineralization of bound nutrients and they become available for uptake by roots.

The amount of nutrients extracted by the crop yield serves as a good basis for calculating the nutrient requirement. Fertilization should be based upon soil testing and leaf analyses when deficiency symptoms appear. Of course, the physiological balance or its potential problems should also be considered. The growth of shoots, the formation of buds, the amount and quality of yield should also be taken into consideration when planning the necessary actions (*Ames & Knepper*, 2000).

In nitrogen supply of fruit trees, not the amount but the timing of the applications might be problematic. The higher nitrogen requirements occur in the spring, when the soil has not warmed up yet and the amount of nitrogen provided by the microorganisms is still low. However, trees can satisfy half of the total nitrogen requirement from their own reserves between bud burst and flowering. By cultivating the area near the trees at this time (loosening, hoeing), nitrogen supply and uptake can be improved.

If nitrogen is applied as compost or sewage, then it should be applied at the middle or end of February, after snow melting, because of the slow nitrogen release.

Rules of organic production allow the use of some liquid and solid nitrogen sources that become quickly available. These include blood meal (12% N), molasses (3.5% N), as a by-product of sugar beet processing. These materials can be useful in easing the above mentioned nitrogen deficiency in early spring. However, a lower than optimal soil fertility

cannot be and must not be cured by applying quickly available nitrogen fertilizers (*Ames & Knepper*, 2000).

Supplementary phosphorus and potassium applications can only be performed if their necessity is verified by soil testing. Only a limited number of materials can be used. In the case of phosphorus, fine-ground phosphates, ash and aluminium, calcium phosphates can be used. Allowed potassium fertilizers include raw potash salts (*Anonymus*, 1997).

In organic fruit production, balanced nutrient supply primarily via the soil and root system should be aimed. The problems in nutrient supply seriously weaken the resistance of plants to diseases and pests. Spray fertilization can only be used in emergency cases, if the control organization has been notified about the lack of one or more elements and the detection of deficiency symptoms. Under such conditions magnesium sulphate, iron-, boron, manganese-, zinc- and molibden-chelates can be used. At present, there are no sufficient experimental results for easing nitrogen-deficiency in the short run.

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