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BIBLIOGRAPHIC REVIEW OF MINERAL NUTRITION AND OIL PALM FERTILIZATION (ElaeisguineensisJacq.) AT THE YOUNG CROP STAGE

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ABSTRACT

The importance of oil palm in the production of vegetable fats has increased over the last decade. This is due to the considerable increase in the area planted and the development of agronomic research. It has been demonstrated that mineral fertilization remains an exceptional practice because the use of fertilizer is profitable on any plant material. It is in the context of the current major orchard renewal projects that fertilization can play a significant role in enabling the expression of the potential of new plant materials , which are more productive and more exporters of mineral elements. Foliar diagnosis is used to study the mineral nutrition of oil palm. At a young age, nitrogen fertilization is the most used to ensure good development. However, phosphorus, potassium, chlorine, magnesium and sulfur can also occur during this immature stage whose ranges range from the poorest sandy soils to the richest volcanic soils. As for the pre-nursery and nursery stages, the contributions of mineral elements must be balanced and also depend on the substrate used. It can be limited to nitrogen, phosphorus, potassium and magnesium. The effect of good fertilization practice during this phase of young cultivation plays an important role in the precocity and productivity of the future palm grove.

Keywords: Mineral nutrition, mineral fertilization, growth, oil palm, young culture

INTRODUCTION

The extraordinary development of the place of palm oil in the world fat market at the end of the 20th century, and during the first decade of the 21st century resulted in the planting of more than 12 million hectares of palm groves (FAO, 2013). This development was more often based on an extension of areas than on an increase in oil yields per hectare. The success of the oil palm sector has, therefore, been the subject of intense criticism of its impact on the environment, deforestation and local populations.

The oil palm is the oiliest oilseed. Under the best agro-climatic conditions of its cultivation, the yield is on average 18 tons of bunches/ha/year, equivalent to 4.5 tons of palm oil and approximately 2 tons of palm kernel oil (FAO, 2013).

Due to its geographical distribution, covering the whole intertropical humid zone of the globe, the oil palm interests a large part of the world population for which it represents the main source of fat (Eric le Bihan, 2008).

Due to rapid population growth and subsequent food requirements, agricultural production, especially palm oil, must increase significantly in order to feed the world's population. Fallows and organic matter additions no longer allow the necessary increase of this production. It can, however, be increased either by improving yields or by increasing the area of land developed for agriculture. However, in the current context of desertification, deforestation and urbanization, few regions of the world are able to support a significant increase in areas devoted to agriculture (Pieri, 1989). This not only predisposes the soil to erosion, but also causes rapid depletion of nutrients, including nitrogen and phosphorus (Mulaji, 2010). The need to improve crop yields and productivity on existing farmland becomes a primary and obvious objective. Only the improvement of farming techniques (including the supply of organic and chemical fertilizers) and the selection of more productive varieties open perspectives in this direction. But in this context of perennial crops, the maintenance of soil fertility, through the supply of fertilizers, will be the keystone (Gigou, 1992; FAO, 2005;Roose*et al*., 2008).

Since the crisis of mineral raw materials, which are available in limited quantities, there has been a problem of fertilizer use and savings (Ollagnier and Ochs, 1981). It has also materialized by an increase in fertilizer prices. With regard to the oil palm, the scarcity of arable land makes it often grown on poor soils and under marginal rainfall conditions, it is unable to express its full production potential without fertilizer. It is currently estimated that less than 1% of the world's palm grove is fertilized regularly. This is paradoxical since, in most plantations, the supply of mineral fertilizers has proved economically profitable (Ng, 1977;Gurmit, 1985; Lubis and Peoleongan, 1995;Caliman*et al.*, 2003; Foster, 2003).

In many parts of the world, underutilization of fertilizers results in uncompensated extraction of nutrients by crops, depletion of already poor soils, resulting in reduced yield and severe soil degradation.. The low intensity of use of fertilizers and other external inputs in all oil palm farming systems keeps average yields well below the potential level, given the low purchasing power of the farmer. their poor application due to the poor purchasing power of the farmer, their poor application and an unorganization of the fertilizer distribution system (Sanchez *et al*., 1997).

A broad popularization of hybrids, with high yield, can revolutionize the oil palm cultivation in the world. However, the absence of mineral fertilization can prevent the expression of its potentialities, especially since these high yields are accompanied by an increase in exports of mineral elements from the soil (Ng, 1977).

Nevertheless, greater importance has been given to soil fertility and fertilization than to the development of its physical characteristics (Peralta *et al*., 1985). Mineral fertilization of oil palm therefore appears to be an essential factor for improving its growth and development.

Cultivated on tropical soils that are generally very weathered, the oil palm needs large amounts of fertilizer to reach good yields. Despite the small amount of mineral elements in the oil produced, significant amounts of nutrients are mobilized by the plant for its vegetative growth and production.

Adequate mineral fertilization at different stages of development (pre-nursery, nursery and young-crop stage) of the oil palm is a prerequisite for the success of the future palm grove and ensuring its productivity.

The nursery's soils are also steadily depleted in nutrients by the export of plant matter and organic matter by mineralization of the humus. It therefore seems logical to make various contributions intended to compensate for this impoverishment. The nursery phase is a crucial step before the establishment of oil palm plantations. Indeed, the care provided to plants in pre-nursery and nursery impact on future plantation performance (Bekker*et al*., 2004;Bayala*et al*., 2009).

In all areas where oil palm is grown, nitrogen is the element of greatest need in the juvenile stage (Belder*et al*., 2005;Bellido*et al*., 2005; Edwin *et al*., 2005; Vos*et al*., 2005) until the start of production.

A good supply of nitrogen during the growth phase is one of the main cultural measures. In addition, an excessively high or poorly targeted nitrogen supply can reduce the quality of the plants and / or cause significant losses of nitrogen in the environment, mainly in the form of nitrate (NO_3) or nitrous oxide (N_2O), negatively affecting the environment (Feil, 1998).

Although potassium chloride is essential in the process of oil palm productivity, its contribution to the juvenile stage is important for growth through chlorine. This element plays an indispensable role in the correct functioning of the photosynthetic activities of the oil palm (Eschbach, 1980). In 1972, Martin and Prioux showed the importance of phosphate fertilization on early growth of the oil palm. Since 1970, Ollagnier*et al*. therefore stressed the need to achieve a balance of mineral elements in oil palm nutrition, especially in the nursery and young crop stages. In fact, the goal of a nursery is to produce tall, vigorous plants, and start well after planting. Height growth and neck circumference are often used as criteria for selecting seedlings for transfer to the field.

The present work was initiated to make the state of the knowledge on the diversities of the methods of study of the mineral nutrition and the multiplicity of the formulas of mineral fertilizer applied to the different stages of development of the oil palm in the big regions producing. This document presents various information allowing a global comprehension of the problematic which concerns us, namely: (i) the plurality of the methods of study of the mineral nutrition of the oil palm, (ii) the multiplicity of the formulas of mineral fertilizer used at different stages of development (juvenile phase) of the oil palm.

METHODS OF STUDYING THE MINERAL NUTRITION OF OIL PALM

The studies, dealing with the mineral nutrition of the oil palm, concluded that there are three types of approach possible for nutritional monitoring of this oilseed.

- The first concerns the analytical evaluation of the nutritional power of the soil. This study is largely based on soil chemical analyzes. The diagnosis makes it possible to identify constraints, to orient the experiments to a certain extent, but rarely to go as far as the precise technical proposal, that is to say up to the manure programs (Jadin and Snoeck, 1985). This method is hampered by the difficulty of correctly reproducing, by a chemical extractive agent, the activity of a radicular system in situ. In tropical soils, which are often very deep, it is not always easy to define the limit of the horizons used by the root system and the degree of exploration of each layer of soil. More generally, even if the soil analysis is of obvious interest, the disadvantage of this approach is to be interested only in the availability of plants for their food but not the state of this diet. It is also confronted with a micro-heterogeneity of the soil. Fertilizer requirements are difficult to calculate with this method in order to obtain in the surface horizon of soils, mineral equilibriums proving experimentally the most favorable for the growth and production of plants (Jadin, 1975).

- The second is to make the weight balance of the mineral elements, by comparing the needs of the plant (export of a culture fed) to the availability of the medium (soil and symbiotic contributions). This method has the advantage of being synthetic but the balance sheet items are so difficult to estimate that it is still too vague to serve as a basis for a mineral fertilization policy.

- The third approach, based on the analysis of the plant, allows to define the level of deficiency, deficiency or excess of mineral elements. This method, called foliar diagnosis, is only analytical but much more precise than the previous ones. It is therefore the only one to be used more currently for a good fertilization policy. The foliar diagnosis, made from leaf analysis (determination of the generally total elements of a leaf sample), is a good way of knowing if the mineral diet of a stand is satisfactory. It relies on the existence of a fairly precise relationship between the concentration (or rate, or content) of a given element in the leaf and growth (Prévôt and Ollagnier, 1956; IRHO, 1956; Martin-Prevel*et al*., 1984).

Export of nutrients

The mineral elements taken from the soil are used on the one hand for the development of the tree and on the other hand for the genesis of the regimes that are definitively exported. To know the needs of the tree, it is enough to evaluate the quantities of elements thus put in play (Ollagnier and Ochs, 1971).

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In a study undertaken in Ivory Coast, Ollagnier*et al.* (1970) were able to determine the total amount of plant material produced each year by the oil palm which reaches 300 to 500 kg including 80 to 230 kg of diets, 150 kg of leaves and about 20 kg of male inflorescences which are added stem and root growth. The oil palm therefore has significant nutrient requirements in mineral elements to compensate for losses.

The studies carried out to determine the quantities of immobilized mineral elements per hectare of oil palms aged over 20 years for the trunk, leaves and roots are numerous.

Ferwerda (1955), in a study in Congo, found 800 kg for nitrogen (N), 134 kg for phosphorus (P), 390 kg for potassium (K), 178 kg for magnesium (Mg) and 298 kg for calcium (Ca).

In Nigeria, Tinker and Smilde (1963) found 460, 160, 340, 260 and 234 kg, respectively in N, P, K, Mg and Ca.

Siew*et al*. (1967 and 1968), in Malaysia, found 960, 80, 1300, 290 and 40 kg, respectively for N, P, K, Mg and Ca.

These fixed values are more important for the N and the K regardless of the continent (Africa and Asia). These elements are most essential for the development and production of oil palm (Martin-Prevel, 1978; Achuthman and Sreedharan, 1983; Ochs *et al*., 1991). The enormous differences between Nigeria (West Africa) and Malaysia (South-East Asia) for phosphorus and potassium can be explained by the fact that tertiary sands (Nigeria) are rich in phosphorus and alluvial soils (Malaysia) are richer in potassium.

With regard to production requirements, the evaluation of annual exports for a production of 15 tons per hectare, several authors have produced various results depending on the locality.

Siew and Thamboo (1967), in Malaysia, found 44 kg for N, 6 kg for P, 56 kg for K and 12 kg for Mg. In Ivory Coast, IRHO (1968) found 66; 5; 68 and 12 kg, respectively for the N; P; K and Mg.

The quantities evaluated are variable because they have been obtained in different countries and types of plant material. In all situations, the elements fundamentally necessary for production are represented by N and K.

The quantities of elements exported by one hectare of palm grove due to the vegetative development of the tree, after deduction of the return to the ground of the elements contained in the deciduous organs (leaves, roots, male inflorescences) generally reach: 30 kg of N, 7 kg of P, 18 kg of K, 13 kg of Ca and 10 kg of Mg (Ollagnier*et al*., 1970). The main building blocks of the plant are N and K.

By summing these two export sources, the order of magnitude of the annual needs of one hectare of palm trees producing 15 tons of diets per year (Ollagnier*et al*., 1970) gives 90 kg/ha/year for the N, 90 kg/ha/year for K, 25 kg/ha/year for Ca, 20 kg/ha/year for Mg and 15 kg/ha/year for P.

These needs must be met by sampling from the soil. If some elements fail, the mineral nutrition of the tree is insufficient or unbalanced, growth is poorly assured and production decreases.

Diagnostics of mineral deficiencies

For Ollagnier*et al*. (1970), the method of foliar diagnosis proves the easiest and the most accurate for the study of the mineral nutrition of the oil palm.

But the search for mineral deficiencies can be done by many methods. The interpretation of soil analyzes sometimes makes it possible to predict the nature of a deficiency, but this prediction remains imprecise and limited. Soil analysis is hampered by a microheterogeneity of this environment and a difficulty in assessing assimilability. And in addition, tropical soils are not as rich as those in temperate regions and the crops grown in the tropics are unproductive. It is not possible to promote the fertilization of tropical crops without a simple method of analysis that can produce results whose interpretation can lead to generalization (Manciot*et al*., 1979). Visual symptoms of deficiency often serve very well. They make it possible to guide research and reach the solution more quickly, but they are far too vague to be used alone in the development of a manure program (Ollagnier*et al*., 1970).

The fertilizer experiment is the safest solution. But it has the disadvantage of being expensive, so rare, so that the problems posed by the generalization of the results obtained are sometimes difficult to solve.

According to Ollagnier*et al*. (1970), foliar diagnosis can be the solution to this problem. Developed in France by LAGATU and MAUNE on the vine since 1926, it consists in analyzing the contents in mineral elements of a leaf whose choice is standardized and to deduce the level of nutrition of the plant by reference to critical levels. According to Prevot and Ollagnier (1957), he brings a physiological interpretation to agronomic experimentation and directs the choice of mineral fertilization formulas by the detection of deficiencies. This method consists of measuring the mineral element concentrations of the leaves and comparing them to critical levels, which are defined as the levels below which the element is deficient.

The work of Chapman and Gray (1949), taken up by the IRHO (1965), made it possible to specify critical levels which proved to be valid in the vast majority of situations.

On the oil palm, Chapman and Gray (1949) analyzed the evolution of the contents (N, P, K, Ca, Mg) according to the rank of the leaf, the position of the leaflet on the leaf, the position of the fragment taken from a leaflet. This study served as a basis for the standardization of the sampling method. The standard method is to take 4 leaflets from the central zone of the 9th or 17th leaf, counted from the first open leaf. On each fragment, two marginal millimeters and the large central vein are removed (IRHO, 1965).

These critical levels were set in percent (%) for West Africa at 2.50 for N; 0.15 for P; 1.0 for K; 0.6 for Ca and 0.24 dry matter for Mg for the leaf 17 (Ollagnier*et al*., 1987, Tampubolon*et al*.,

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1990). The work of Ollagnier and Ochs (1981) set the critical levels of Southeast Asia for Sheet 17 at 2.08% for N; 0.15% for P; 0.92% for K; 0.6% for Ca and 0.11% dry matter for Mg.

These critical levels first established for the rank 17 sheet were also adapted to the 9th grade sheet by Bachy (1965), using the gradients as a function of the rank of the sheet. One can thus use the foliar diagnosis from the age of one or two years by taking the sheet 9 while the sheet 17 does not exist or is in poor condition.

Fertilization study according to stage of development

Pre-nursery stage

The pre-nursery corresponds to the culture of the young palms during the approximately 4 months which follow their germination. During this period, the young seedling goes through different successive stages. The sprouted seed is transplanted with a stem and a radicle into the bag filled with potting soil. After one month after transplanting, the first two lanceolate leaves and the first primary root are emitted. After 4 months of development, the young seedling has 3 to 4 leaves with lanceolate limb and a well-developed root system, with primary, secondary and tertiary roots. It is at this stage that, having become entirely autotrophic, it is good to transplant in a nursery (Wuildart, 197;Jacquemard and Boutin, 2005).

This stage of development that lasts 4 to 5 months is usually conducted in plastic bags or bags. The bags are made of transparent polyethylene or black with bellows, 5/100 mm thick, 8.5 cm wide, 20 cm high, 5 mm in diameter and with a hole of 20 holes at the base. The bags are filled with soil humus surface (10 cm) enriched or not with compost.

Normally, the substrates used can allow a good start of the pre-nursery. But one can bring a weekly supplement from the end of the first month, 25 g of urea in 10 l of water per 1000 seedlings with a light watering with pure water after the spreading to avoid any burn. The fertilizers used must have a rapid action and, therefore, be soluble and complete (Jacquemard and Boutin, 2005).

Ollagnier*et al*. (1970) and Jacquemard (1995) have proposed versatile formulas that can be satisfactory across large production areas.

In South-East Asia, on humus soil, fertilizers must contain 100 g of ammonium phosphate, 100 g of potassium sulphate and 100 g of magnesium sulphate which are diluted in 30 liters of water and applied weekly on 350 seedlings.

In West Africa, it is first necessary to add 5 g of super simple per plant as a basic fertilizer and the maintenance fertilizer is made monthly in solution and composed of 400 g of potassium sulphate, 200 g of urea and 200 g of kieserite diluted in 200 liters of water and applied to 2500 seedlings (Jacquemard and Boutin, 2005).

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After 4 months of pre-nursery, a normal seedling has 3 to 4 lanceolate leaves. The height of the plant, leaves stretched, is 20 to 25 cm. The circumference at the collar measures 4 cm.

Nursery stage

The nursery is the stage that consists of the transformation of the seedling into a well-developed plant. It loses its juvenile aspect and begins to have true palms with bifid leaves followed by pinnate leaves, the bulb begins its development with the emergence of primary roots (Surre and Ziller, 1963;Jacquemard and Boutin, 2005). Nurseries can be conducted in the ground, in plastic bags or in direct seeding and without shading.

The quality of the substrate and the possible inputs of bottom manure or compost are important for the proper start of the nursery. A maintenance manure is then regularly distributed. Fertilizers must have a rapid action, but it is possible, since this phase lasts from eight to sixteen months depending on the case (open-ground, plastic bags, direct seeding), to use slightly slower action fertilizers (Ollagnier*et al*., 1970; Turner *et al*., 1983;Jacquemard, 1995).

Full ground

The use of organic manure is frequently recommended, as well as mulching with diet residues (rounds). In this area, no rigid formula can be recommended. As for mineral manure, certain formulas are currently applied.

In Congo, Ferwerda (1955) and Ollagnier*et al*. (1970) proposed to apply three times at three-month intervals 200 kg of nitrogen, 114 kg of P_2O_5, 220 kg of K_2O, 114 kg of MgO, 372 kg of CaO and some trace elements per hectare of nursery

In West Africa, on forest, post-till fertilization comprises 200 to 300 kg of KCl / ha followed by 200 kg of ammonium sulphate and 100 kg of magnesium sulphate, and applied every month, starting from the second month after transplanting, ie about 5 g per plant as maintenance manure (Ollagnier*et al*., 1970;Quencez, 1982).

In South-East Asia, 125 kg of dicalcium phosphate are used as bottom fertilizer per hectare, followed by 250 kg of potassium chloride, 200 kg of urea, 200 kg of dicalcium phosphate and 100 kg of magnesia per hectare and per month, from the second month as maintenance manure (Ollagnier*et al*., 1970; Quencez, 1982; de Berchoux and Lacoustre, 1986).

In plastic bags

Bags of black polyethylene 15 or 20 / 100^{th} of mm in thickness measuring 40 cm x 40 cm, without bellows, of a volume of 15 liter and containing 20 to 25 kg of soil are used. They are perforated in their lower half of 3 parallel rows of holes 3 to 4 mm in diameter, distant 5 cm. The bags are arranged according to an equilateral triangle device at 70 cm (distance of 60 cm between lines). Main tracks 5 meters wide and trails made by removing a line or a column of bags allow easy movement in the nursery and delimit the boards. Their shape and size depend on the irrigation system adopted.

The substrate consists of humus soil. Generally, it is fine with slush or organic waste at a rate of 2 kg / 25 kg bag.

In bottom manuring in all production areas, 75 centilitres per bag of 4 kg of urea, 3 kg of KCl, 4 kg of dicalcium phosphate and 1 kg of kieserite diluted in 200 l of water are generally used. Maintenance manure varies by locality (Ollagnier*et al*., 1970; Jacquemard, 1995;Jacquemard and Boutin, 2005). In order to allow the practitioner to determine, typical manures, expressed in g / plant / month, are proposed in the main production areas of the oil palm.

In Ivory Coast, 5 g of compound fertilizer (N, P, K, Mg) of composition 11.6.7.2 and 5 g of urea per plant per month are used as maintenance manure for the first 4 months. . From the 5th month, the manure to be fed consists of 10 g of compound fertilizer (N, P, K, Mg) and 10 g of urea per plant and per month (Jacquemard and Boutin, 2005; CNRA, 2006).

In Malaysia, the maintenance manure consists of 10 g of compound fertilizer (N, P, Kand Mg) of composition 15.15.6.4 per plant per month, at the first 5 months. At this month, manure is composed of 30 g of compound fertilizer (N, P, Kand Mg), composition 12.12.17.2 and 15 g of kieserite per plant per month (Jacquemard and Boutin, 2005).

In Indonesia, 10 to 15 g of fertilizer composed of formula (N, P, K, Mg) and composition of 15.15.6.4, are provided as maintenance manure per plant and per month, during the first 4 months. From the 5th month, the manure consists of 25 to 30 g of composite fertilizer (N, P, K, Mg) of composition 15.15.6.4 and 10 to 20 g of urea per plant and per month.

A careful selection at the end of the nursery is the guarantee of a satisfactory productivity of the future plantation. It is necessary to practice this elimination at one time. We proceed by board of the same plant material and same date of transplanting. At 8 months of nursery, a normal plant has a height of 0.6 to 1 m, a circumference at the collar of 18 to 22 cm and carrying about 7 to 8 functional leaves in the crown.

Nurseries under direct seeding

The technique of the direct nursery tends to generalize. Its goal is to eliminate the pre-nursery stage to gain 1 to 1.5 months on the development of the plants. Sprouts are transplanted directly into large bags. For every 100 germinated seeds, 90 nursery bags and 10 pre-nursery bags are put in place. This pre-nursery will be used to replace seedlings that are dead or eliminated early in the nursery. The staking is identical to that of a normal nursery but the bags of 4 or 6 lines are grouped side by side, this to install the shading during the first 2 months to facilitate the recovery of the plants. The shading is progressive during the following month. At this stage, the replacements of the dead and stunted plants are carried out, then the bags are placed at their definitive distance. From the definitive spacing, the plants are treated as in a traditional nursery.

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Young culture stage

The main issues of the young crop phase, show that it is a question of installing a palm stand of better genetic quality and avoiding any mortality, then to lead it so that its genetic potential is expressed in term precocity and yield (Raflegeau, 2008). At the end of this immature period, two stand status variables, its vigor and the homogeneity of this vigor, are good indicators of what will be the production in the first years and later (Caliman*et al*., 1994; Jacquemard 1995; Corley and Tinker, 2003). This stage plays an important role in the productivity of the future palm grove.

The term "palm grove" according to Rafflegeau (2008) refers here to a population of palms planted according to a more or less regular device, with the main aim of producing diets. In general, the operators aim to achieve the production potential of the selected plant material under local pedoclimatic conditions. Indeed, the establishment and management of a palm plantation strongly mobilizes financial, human and land resources during the entire juvenile phase which lasts 3 years and the entire period of exploitation (Sébillotte, 1990; Cheyns and Rafflegeau, 2005;Rafflegeau, 2007). In the general case of perennial crops, the impact of the technical choices made at the time of implantation and then during the juvenile phase is only observed from the start of production (Carberry*et al*., 2002 and Michel-Dounias, 2006).

In the case of the oil palm, the effect of good fertilization practice during the young crop phase is reflected in the homogeneity of the vigor. It is defined as a state of growth at a given age compared to a reference of good development vegetative in relation to this age, and used as an indicator of precocity and the cumulative yield of the first two years of production (Dubos, 2006). Fertilization at young age therefore appears to be a determining factor in oil palm productivity (Hornus*et al*., 1987; Anon, 1992).

At a young age, regardless of the locality, nitrogen fertilizer is the mainstay of fertilization to ensure good vegetative growth of palms and early production (Rafflegeau, 2008). However, phosphate, potassic and magnesium fertilizers are generally essential for the proper development of young oil palms. Fertilizer doses must be modulated according to the previous crop, soil, climate and plant material used (Caliman*et al*., 1994; Wey *et al*., 2002).

In the elaeiculture, among the factors involved in the modulation of fertilizer doses, the physical and chemical characteristics of soils play the most important role (Olivin, 1968; Ng, 1968;Barral*et al*., 2004).

In Africa, most soils have a high proportion of sands and coarse sands in both surface and depth (Hartmann, 1991). These soil formations, developed on sediments of the tertiary era are predominantly sandy and characterized by the presence of iron or aluminum. They are called Tertiary Sands in Ivory Coast (Olivin and Ochs, 1978) or Ferralsols (Anonyme, 2008), bar Land in Benin (Taffin and Ochs, 1973), Acid Sands in Nigeria (Ollagnier*et al*., 1970), a ferritic soil in Cameroon (Bakoume*et al*., 2002). Their chemical wealth is generally low (especially in nitrogen, potash and magnesium). The responses to fertilizers, thanks to their physical and chemical structure are faster and sharper.

In the juvenile phase, a legume (*Pueraria*) is sown as soon as possible, because this plant enriches the soil with nitrogen from the air and increases the fertility of soils under palm in this element. This reduces the costs of buying nitrogen fertilizer. Generally speaking, in West Africa urea is supplied at a rate of 200 g / tree / year in year 1, 400 g / tree / year in year 2 and 400 g / tree / year in year 3. However, Specific formulas are used across large production areas, following pedoclimatic factors.

In Ivory Coast, on forest, the fertilizer intake at the young age must be done in April and July. And these contributions must contain, according to the CNRA (2006) for each application, from the first to the third year after planting, 100 to 200 g of urea, 50 g of kieserite only in the first year and 100 to 200 g of potassium chloride per tree and per turn.

On savannah, the inputs must contain 200 to 500 g of urea, 250 to 1000 g of potassium chloride and 50 to 100 g of kieserite per tree per year (Ollagnier*et al*., 1970;Ollagnier and Ochs, 1981).

In Nigeria, fertilizer applications at young age must contain 450 to 1500 g of urea and 200 to 900 g of potassium chloride per plant per year (Ollagnier*et al*., 1970).

In Cameroon, split intakes in 2 applications of 100 g of urea per foot in the first year and 2 times 200 g in the following two years are recommended. The occurrence of magnesium deficiency symptoms, which are common in some production areas (Dubos *et al*., 1999).

In Congo, according to Ollagnier*et al*. (1970) and Dubos *et al.* (1999), the nitrogen is supplied in the form of ammonium sulphate at a dose of 100 to 200 g per foot, then 100 to 400 g of triple superphosphate, 120 to 500 g of potassium chloride and 50 to 200 g of kieserite per foot and year.

Concerning the oil palm, nitrogen is the element whose need is essential for the juvenile stage (Belder*et al*., 2005;Bellido*et al*., 2005; Edwin *et al*., 2005; Vos*et al*., 2005) until the start of production.

Rosenquist (1962) and Tan (1973) have shown that increasing the application of nitrogen results in higher leaf emission rates and more leaves on the crown. For Achuthman and Sreedharan(1983), the application of nitrogen increases the leaf content of phosphorus (P) and potassium (K), resulting in an improvement in yield from the start of production.

The highly desaturated sandy ferrallitic soils of Africa, with abundant rainfall, are deficient in magnesium and poor in K (Ng, 1977), but they have the advantage of reacting very quickly to the slightest stress and, with the help of foliar diagnosis (DF), to manage potassium and magnesium nutrition with great precision (Ollagnier and Ochs, 1981). In order to avoid the occurrence of magnesium and potassium deficiency, all measures must be taken to ensure that the young culture program includes the application of the necessary amount of Mg and K, example, the application of potassium chloride and magnesium sulphate.

In South-East Asia, the three types of soils (alluvial soils, soils of sedimentary formations and soils of volcanic origin) (Lauzeral, 1980) are physically suitable for oil palm cultivation, mainly due to a very satisfactory rainfall. These soils are generally quite rich in organic matter but very poor in total phosphorus. The desaturated absorbent complex still contains appreciable quantities of bases exchangeable, witnesses of the initial wealth of the mother rock. The exchangeable potassium is frequently greater than 0.2 cmol / kg (Indonesia). Exchangeable magnesium, which is highly variable, may be low in some areas (Ummar*et al*., 1976). Some volcanic soils have some difficulty in providing nitrogen nutrition (due to the complexation of organic matter) and some visual symptoms of magnesium deficiency (Lauzeral, 1980).

The chemical composition of soils in Southeast Asia varies with soil type and requires less mineral fertilizer input depending on the locality (Ollagnier*et al*., 1970).

In Malaysia, mineral fertilization at a young age is essentially composed of complete fertilizer, dosed at 8.4% nitrogen; 14.4% P_2O5; 7.2% K_2O and 2.1% MgO. Inputs are at a single application of 600 to 900 g / tree / year depending on the age of the plantation (Ollagnier*et al*., 1970; Ng and Tan, 1974).

In Indonesia, the chemical fertilizer formula commonly used in immature palm groves is composed of 500 to 1000 g of ammonium sulphate, 1000 to 1500 g of rock phosphate and 500 to 1000 g of potassium chloride per foot per year. (Ollagnier*et al*., 1970; Ng, 1986).

On the soils of Sumatra (Indonesia), Tailliez (1982) showed that phosphate fertilization improves growth and speed of development during the first year of cultivation (+ 6% over the length of the leaf, + 3 to 4 % of the number of sheets appeared). The highest phosphorus deficiencies occur in Indonesia on volcanic soils north of Sumatra (Pacheco *et al*., 1985).

Pacheco *et al*. (1985) argue that in South-East Asia, phosphate fertilization is generally required as soon as young oil palms are planted and the frequency of passage depends on the evolution of the N / P relationship verified annually by the foliar diagnosis (DF).

Nitrogen uptake is highly correlated with that of P so the improvement in vegetative growth due to the application of phosphate fertilizers can be attributed to its indirect influence on the nitrogen content of the tissues (Manciot*et al*., 1979;Ollagnier and Ochs, 1981).

To these main minerals, the contributions of magnesium and sulfur are needed in Asian palm groves. Sulfur and magnesium have effects on growth at early age and subsequently on production in the first crop years (Ollagnier and Ochs 1972; Eschbach 1980;Manciot*et al*., 1980).

In South America, there is a wide variation in chemical composition from one soil to another. They usually have a high clay content but pose a physical problem of waterlogging and asphyxiation by nitrification stoppage. Although chemically rich (especially potassium and magnesium), nitrogen requirements are high (Pacheco *et al*., 1985).

Of all the soils of Latin America, the recent alluviums of Colombia are the richest (except in nitrogen and potassium), on the latosols and vertisols of Brazil, nitrogen and potassium are lacking and the ancient alluvium of Peru, nitrogen and magnesium tend to be absent (Ollagnier*et al*., 1970; IRHO, 1971;Lauzeral, 1980).

The mineral fertilizers usually recommended at young age vary according to the country and the type of soil.

In Brazil, for vertisols, mineral inputs in young oil palm crops should contain 250-750 grams of urea and 500-1200 grams of potassium chloride per plant per year. 600 g of kieserite can also be added to the third year (Ollagnier*et al.*, 1970; Lauzeral 1980; Pacheco *et al.*, 1985).

In Latosols from Brazil, the inputs are more complex and must contain 200 to 500 g of urea, 500 to 1000 g of super simple, 200 to 1000 g of potassium chloride and 100 to 700 g of magnesium sulphate per foot and per year (Lauzeral 1980; Pacheco *et al*., 1985).

On recent alluvial soils of Colombia, additions of 125 to 250 g of urea, 500 to 1000 g of slag, 250 to 1250 g of potassium chloride, 500 to 650 g of kieserite and 50 to 75 g of borax per foot and per year are necessary for the proper maintenance of young oil palms (Ollagnier*et al*., 1970, Lauzeral, 1980).

In ancient alluvial deposits in Peru, fertilizer intake at early age contains only urea and kieserite at doses of 100 to 200 g and 50 to 100 g per foot per year (Ollagnier*et al*., 1970; Daniel and Ochs, 1975).

The general observation is that in less than a year after oil palm plantation on all continents, 5 deficiencies can be detected, namely N, P, K, Mg and B (Tailliez, 1982). For the same author, the instability of nutrition at a young age makes it difficult to use the foliar diagnosis (DF) to program the fertilization of these very young plantations in all regions. This is the case for regions with a favorable climate and relatively poor soil in which the root system, which is barely irregularly installed, does not always catch the mineral elements necessary for a very active growth. It is necessary to resort to scales which bring all the elements in moderate quantity and with a relatively high frequency during the 1st year of vegetation.

CONCLUSION

The above study gives sufficient results to show that mineral fertilization can be a source of good growth from the pre-nursery stage to the end of the young crop stage and the future good productivity of oil palms. The progress made by the research for forty years lead to a good understanding of the agronomic problems of the palm grove.

A methodology is emerging. Prospecting by foliar diagnosis, combined with a good knowledge of the soil and the weight balance of the mineral elements, is an excellent means of investigation to take stock of the mineral nutrition of the oil palm. The foliar diagnosis and its interpretation must be followed by the setting up of an experimental support network to confirm the hypotheses, define the degree of response and specify the links between the elements. The results of the agronomic experiments show that the manures in general required for the oil palm at the young culture stage are nitrogenous and magnesian. In some less frequent cases, we must bring phosphorus and sometimes trace elements (especially boron). These acquired results must be passed on to farmers through extension services, which will at the same time liaise with the organizations responsible for credit.

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