Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/16144
DOI URL: http://dx.doi.org/10.21474/IJAR01/16144

RESEARCH ARTICLE

NUTRIENT COMPOSITION OF YELLOW MALAY DWARF COCONUT TREE (Cocos nucifera L.) LEAF USING GREEN MANURES

Edgar Enrique Sosa Rubio[1], Matilde Cortazar Ríos[1], Gilbert José Herrera Cool[1], Jorge Humberto Ramírez Silva[2], María Del Carmen Zavaleta Cordoba[1] and Francisco Montoya Reyes[1]

1. Campo Experimental Chetumal, km 25 carreteraChetumal -Cancún s/n. Xul-ha, Quintana Roo.
2. Centro de Investigación Regional Sureste (CIRSE) del INIFAP. Calle 6 Núm. 398 x 13, Avenida Correa Rachó. Col. DíazOrdaz, C.P. 97130. Mérida Yucatán, México.

Manuscript Info

Manuscript History
Received: 30 November 2022
Final Accepted: 31 December 2022
Published: January 2023

Key words:-
Fertilizers, Legumes, Nitrogen, Fertilization

Abstract

The objective of the study was to evaluate the effect of different green manures on the concentration of macro and micronutrients present in the leaves of the Dwarf Malaysian Yellow coconut palm. The experiment was carried out from April 2018 to December 2020, at the INIFAP Chetumal Experimental Field. A randomized block experimental design was used, with four replications for eight treatments: T1 without fertilization, T2 chemical fertilization, T3 partial chemical fertilization, T4 *Tithoniadiversifolia* (Td), T5 *Clitoriaternatea* (Ct), T6 *Leucaenaleucocephala*(Ll), T7 *Canavaliaensiformis* (Ce) and T8 *Gliricidiasepium* (Gs). The sowing of the green manures was carried out between the rows of coconut palms, in two separate rows one meter apart and one meter between plants. The concentration of macro (N, P, K, Ca, and Mg) and micronutrients (Cl, Na) in leaf number 9 was evaluated. The results indicate that macro and micronutrients were not influenced by the treatments fertilized with N, P and K. It was observed that treatments T6 Coco+ *C. ensiformis*, T7 Coco+ *T. diversifolia* and T8 Coco+ *C. ternatea* influenced the evaluation obtained in leaves due to values obtained were considered optimal. Concentrations of N, P, Ca and Mg in the leaf decreased, Cu and Cl were higher than the critical levels, after two years of starting the work.

Introduction:-

Coconut culture in Mexico is highly important because of the feed resource that generates to the small farmers (Yang et al., 2018), furthermore the products and by-products obtained are abundant, healthy and friendly to the environment (Kamaniet al., 2019). However, the productivity can be seen affected due to soil use continuously what inducing the formation of new chemical combinations of nutrients (Brown et al., 2022). This combination can made unavailable nutrients that are important for this crop. One of the solutions to resolve this problem is the continuous application of organic nutrients. Another solution is the establishment of good agroecological practices that could increase the productivity (Telekaloet al., 2019). Soil fertilization should be carried out at least once a year to replenish the nutrients removed by the coconut harvest (Ramírez-Silva et al., 2022), nevertheless, the amount removed should not be used as the only recommendation criterion. Recommendations should be based on foliar

Corresponding Author:- Edgar Enrique Sosa Rubio
Address:- Campo Experimental Chetumal, km 25 carreteraChetumal -Cancún s/n. Xul-ha, Quintana Roo.

analysis (Aliyuet al., 2021). Sobral (2015) mentions that soil and foliar analysis of the crop should be carried out in order to know the nutrients uptake. It is very important to make producers aware so that they do everything possible to fertilize their crops, permanently, from the early stages of the crop and at the same time, emphasize the importance of knowing: how much, when, where and how to fertilize. The evaluation of the nutritional status in plant species has been extensively studied (Barbedo, 2019) as well as practices that allow an adequate supply of nutrients based on the quantitative variation of nutrients in tissues (Silva, 2009). Fertilization is the practice that has the greatest impact on coconut productivity (Wang et al., 2019), since the amount of nutrients extracted by the coconut plant is high (Karthikaet al., 2018). This high nutrient intake, occurs because the plant presents a rapid and continuous development, with flowering, fruiting and ripening of the fruits simultaneously, therefore requiring constant application of fertilizers to achieve high production (Omar and Fatah, 2021). N and K are the most nutrients extracted from the soil, followed by chlorine, phosphorus, magnesium, sulfur and calcium (Kathpalia and Bhatla, 2018). According to Sobral and Nogueira (2008), the lack of N causes a yellowing of the older leaves and a decrease the number of female flowers. K has a positive influence on the number and production of inflorescences (Ramírez-Silva et al., 2021). K deficiency is characterized by the presence of rust-colored spots on both sides of the leaf and by a small etiolation (Kumi-Arhin, 2021). This nutrient is exported in great quantity for the production of fruits, thus, in low-productivity coconut palms it is possible to detect an accumulation of K in the leaves. On the other hand, it is important to consider not only nutrients applied or available in soil, but also the nutritional status of the crop, based on foliar analysis and the critical levels below which, with greater probability, a response would be obtained (Kueklanget al., 2021). The use of green manure is a practice used to reduce the high costs of inorganic fertilization and can improve soil characteristics (Iderawumi and Kamal, 2022; Vermaet al., 2020; Qaswaret al., 2019; Meenaet al., 2018). One such practice is the establishment of perennial legumes within a plantation (Rani et al., 2021). The agronomic advantages of cover legumes, used as green manures, are diverse and varied (Kinyuaet al., 2019). Perennial legumes, in addition to providing nitrogen to the coconut palm, increase the content of organic matter and protect the soil against erosion (Mukhametovet al., 2021). The use of species such as *Leucaenaleucocephala* (Gulati et al., 2022), *Gliricidiasepium* (Kabaet al., 2019), *Clitoriaternatea* (Hamza, 2021) and *Mucunapruriens* (Rugareet al., 2020) var. utilis, are good alternatives as green manures in regions with dry periods since, due to their pivoting root system, they exert less competition with the coconut palm. Additionally, those species produce a large amount of biomass (70 t/ha of green material), and in rotations with sorghum, corn, rice, cotton and sugar cane they can increase the yields of these crops by 40% (Gutiérrez, 1988). These effects are the result of the contributions of 300-360 kg total N/ha, their high tolerance to drought, their nematicidal activity and, additionally, they can be hosts of beneficial insects (Prager et al., 2012). Given then the importance of green manures, in this study their effect on the concentration of macro and micronutrients in the leaf of the Yellow Malay Dwarf coconut was evaluated, comparing it with chemical fertilization.

Materials and Methods:-

Area of study

The present study was carried out in the Chetumal Experimental Field, Quintana Roo during 2018 to 2020 in a Yellow Malayan Dwarf coconut plantation under rainfed conditions, in quincunx system at 8 m, with a density of 142 palms/ha.

In the sowing of Gs and Td, vegetative material with an average age of 18 to 24 months, 30 cm long and 2.5 cm in diameter was used. The cuttings were planted at a depth of 20 cm at the beginning of the rains, after applying hormones (rooting). The planting arrangement was eight plants between coconut and coconut, distributed in two rows of four plants each, starting 2.5 m from the stem of the coconut palm. The first cut was made at three months for Td and at 5 months for Gs, a period in which it was considered already established, at a height of 50 cm from the ground, the following cuts were every three months.

Treatment evaluated

To evaluate the effect of the treatments on the contents of macro and micronutrients in the plant, samples of leaf 9 counted basipetally were collected. It is considered that these leaves represent very well the nutritional status of the coconut palm and were collected at the beginning and end of the experiment, in all the useful plants of the 32 plots. The treatments were T1: Without chemical fertilization (00-00-00), T2: Chemical fertilization 90-34-180 (N-P-K), T3: Partial fertilization 00-34-180 (N-P-K), T4: *Tithoniadiversifolia* (Td), T5: *Clitoriaternatea* (Ct), T6: *Leucaenaleucocephala* (Ll), T7: *Canavaliaensiformis* (Ce) and T8: *Gliricidiasepium* (Gs). Legumes and Asteraceae were planted on the row of coconut trees, to have them available at the time of use. The plot was prepared in a conventional way with a harrow, fallow and furrow pass.

Sowing of species as green manures
For the sowing of Ct, Ll and Ce, botanical seed was used that was previously scarified with hot water at a temperature of 100 °C for a period of three to four minutes. The planting was carried out between the coconut palms, using a planting arrangement equal to that of Gs and Td, the seed planting depth was 2 to 4 cm. Three months after these legumes were established, the first cut was made. The experimental unit consisted of six coconut palms; the distribution of the treatments was carried out by means of a completely randomized block design, with four repetitions.

Collect and analysis of green manures species samples
The leaves were collected from two plants per plot or repetition, removing three leaflets from each side of the central part of each leaf (Sobral and Nogueira, 2008). The leaflets were cleaned and washed with distilled water. Then, dried in an oven with forced air circulation, at a temperature between 70 and 75^{o} C for 48 hrs. They were then ground in a Willey mill, passed through 0.841 mm mesh sieves before analysis. The samples were sent for foliar analysis to the laboratory for the determination of nutrient content.

Results and Discussion:-

Based on the foliar analysis and considering critical nutritional levels, it was observed that total nitrogen and magnesium were optimal when applying T6:*C. ensiformis,* T7:*T. diversifolia* and T8:*C. ternatea*. For the case of the remaining treatments with green manures: T4:*G. sepium* and T5:*L. leucocephala*, the optimal values were observed for magnesium (Table 1).For the treatments with chemical fertilization, it was observed that T2: Chemical fertilization and T3: Partial recommendation (50%) did have not response. This lack of response to N doses may be due to a competition between Cl and NO_3 ions for the sites of absorption and transport by the roots and leaves.High concentrations of Cl decrease the absorption of nutrients, such as N, due to a competitive inhibition between Cl- and NO_3(Hessiniet al., 2019; Fernández, 2006).

On the other hand, the decrease in the concentration of N in the leaves may indicate the occurrence of excessive leaching and the low capacity of the soil to retain this nutrient. N is also very mobile within the plant.Translocation of the element may have occurred in one year from the analyzed leaves to newer leaves or to other plant organs. However, for T1: without fertilization, optimal ranges of potassium and magnesium nutrients were observed in coconut leaves. The contents of B, Cu and Cl in coconut leaves were higher than the critical level in all cases. According to Nair (2021), the coconut palm is quite demanding in Cl. Heckman (2016) mentioned that Cl is fundamental for coconut development. The Cl content in the leaves tends to decrease, due to the increasing demand for it, which is concentrated in the fruit shell and consequently is exported (Magat, 1991).

These data are agree with studies carried out on *Robiniapseudoacacia*by Wang et al., (2018), who reported higher foliar levels of nitrogen established with legumes. After 20 months of evaluation, Han & Chew (1984) found foliar nitrogen contents of 2.84% in leaf 17 of established palms covered with *Puerariaphaseolides* compared with established palms covered with grasses where values were 2.56%.

Furthermore, Tan & Ng (1981) observed 2.84% nitrogen in leaf 9, compared to palms established with native covers, where values of 2.61% were found. Barreto (2005) found that application of approximately 30 kg of green material from legumes used around each coconut palm could replace nitrogen requirement and 20% of phosphorus and potassium.

T. diversifolia produced a positive effect in concentration of nitrogen in coconut leaves.Ikerraet al. (2006) pointed out that the corn-grain yield increased significantlywhen applying 5 t/ha of green manure.Similar effects were found in Asia with rice cultivation (Jamaet al, 2000). In both cases, the authors associated the beneficial effect of organic fertilizer with the increases produced by it in pH and exchangeable calcium, as well as with the decrease in exchangeable aluminum and the phosphorus absorption capacity in the soil.

Tithonia plants used in this study contained more than 3 % N on a dry basis, which seems to have provided a sufficient amount of N in the soil. In Cuba, Martín (2009) found a marked effect of the green fertilization of canavalia (*C. ensiformis*) on the yield of corn grains (*Zea mays*). Rivera (1999) and Baijukyaet al., (2006) also found similar result in many crops.On the other hand, the P average content found in coconut palm leaves after two years were below critical level indicated.Decrease in P concentration could be attributed to the reduction in N concentration (Peixotoet al., 2006) this is because the decrease in one of them causes the decrease in the other. The

Ca contents in leaves were above the critical interval. According toSobral and Nogueira (2008), Ca and Mg contents increase with leaf age, and according to Linset al. (2021), the coconut palm is not very demanding in these nutrients.

Table 1:- Nutrimental contain percentages of Malayan Dwarf Coconut leaves evaluated in Chetumal, Quintana Roo.

Treatments	Nutrimental contain (%)						
	N	Cl	P	Na	K	Ca	Mg
T1	1.07±0.20	0.87±0.07	0.07±0.01	0.12±0.01	1.20±0.10	1.07±0.02	0.26±0.01
T2	0.85±0.05	0.96±0.02	0.07±0.02	0.14±0.01	0.84±0.04	0.61±0.03	0.27±0.01
T3	1.07±0.02	1.05±0.01	0.07±0.02	0.13±0.01	1.08±0.01	0.50±0.20	0.70±0.2
T4	1.06±0.03	0.85±0.02	0.10±0.01	0.18±0.02	0.94±0.01	0.78±0.03	0.26±0.01
T5	0.95±0.02	0.87±0.01	0.07±0.02	0.16±0.03	0.76±0.01	0.77±0.05	0.27±0.02
T6	1.27±0.07	0.92±0.02	0.08±0.01	0.18±0.01	0.71±0.01	0.83±0.02	0.26±0.02
T7	1.20±0.10	0.82±0.0	0.09±0.01	0.25±0.04	0.91±0.01	0.52±0.02	0.28±0.02
T8	1.20±0.10	0.87±0.02	0.08±0.03	0.22±0.02	0.37±0.02	0.54±0.03	0.73±0.0

T1: Without fertilization, T2: Pack chemical fertilization, T3: Pack partial recommendation, T4: Coconut + *G. sepium*, T5: Coconut + *L. leucocephala*, T6: Coconut + *C. ensiformis*, T7: Coconut + *T. diversifolia* and T8: Coconut + *C. ternatea*.N: Total nitrogen, Cl: Chloride, P: Phosphorus, Na: Sodium, K: Potassium, Ca: Calcium, Mg: Magnesium.

Conclusions:-

Concentrations of macro and micronutrients were not influenced with partial or totalchemical fertilization of NPK excepting N, Na, and Cl. In respect with total nitrogen and magnesium, it was observed that coconut palms fertilized with *C. ensiformis*, *T. diversifolia* and *C. ternatea*green manures presented optimal values. Furthermore, the concentrations of N, P, Ca and Mg decreased, and Cu and Cl increased in leaves, according to the critical levels reported in the literature.

References:-

1. Aliyu, K. T., Huising, J., Jibrin, J. M., Mohammed, I. B., Nziguheba, G., Adam, A. M., &Vanlauwe, B. (2021). Understanding nutrient imbalances in maize (*Zea mays* L.) using the diagnosis and recommendation integrated system (DRIS) approach in the Maize belt of Nigeria. Scientific Reports, 11(1), 1-13.
2. Baijukya, F. P., de Ridder, N. &Giller, K. E. (2006). Nitrogen release from decomposing residues of leguminous cover crops and their effect on maize yield on depleted soils of Bukoba District, Tanzania. Plant and Siol. 279:77.
3. Barbedo, J. G. A. (2019). Detection of nutrition deficiencies in plants using proximal images and machine learning: A review. Computers and Electronics in Agriculture, 162, 482-492.
4. Barreto, A. C. (2005). Cultivo de alamedas de Gliricídia (*Gliricidiasepium*) em solos de TabuleirosCosteiros. Folders. EmbrapaTabuleirosCosteiros.
5. Brown, R. W., Chadwick, D. R., Bending, G. D., Collins, C. D., Whelton, H. L., Daulton, E.,& Jones, D. L. (2022). Nutrient (C, N and P) enrichment induces significant changes in the soil metabolite profile and microbial carbon partitioning. Soil Biology and Biochemistry, 172, 108779.
6. Fernández, M. S. (2006). Nutrição mineral de plantas. Viçosa: SociedadeBrasileira de Ciência do Solo, 1, 432.
7. Gulati, S., Chitralekha, P., Pandit, M. A., Katyal, R., Bhandari, N., Mehta, P., & Kaur, J. (2022). Diversity, Succession and Seasonal Variation of PhylloplaneMycoflora of *Leucaenaleucocephala* in Relation to Its Leaf Litter Decomposition. Journal of Fungi, 8(6), 608.
8. Gutiérrez, P.D. (1988). Efecto de la rotación de cultivos y los abonos verdes sobre la producción de arroz (Oryza sativa L.). SuelosEcuatoriales 18 (1):160-165.
9. Hamza, W. A. E. (2021). Evaluation of Growth, Yield, Nutritive Value and Antibacterial Activity of *Clitoriaternatea* Forage (Doctoral dissertation, Sudan University of Science & Technology).
10. Han, K. y Chew, P. (1984).Growth and nutrient contents of leguminous covers in oil palm plantations in Malaysia. Disponibleen: International Conference on Oil Palm in Agriculture in the eighties,2.
11. Heckman, J. R. (2016). Chlorine. In Handbook of plant nutrition (pp. 295-308). CRC Press.
12. Hessini, K., Issaoui, K., Ferchichi, S., Saif, T., Abdelly, C., Siddique, K. H., & Cruz, C. (2019). Interactive effects of salinity and nitrogen forms on plant growth, photosynthesis and osmotic adjustment in maize. Plant Physiology and Biochemistry, 139, 171-178.

13. Iderawumi, A. M., & Kamal, T. O. (2022). Green manure for agricultural sustainability and improvement of soil fertility. Farming and Management, 7(1), 1-8.
14. Ikerra, S., Semu, E. &Mrema, J. (2006). Combining *Tithoniadiversifolia* and minjingu phosphate rock for improvement of P availability and maize grain yields on a chromic acrisol in Morogoro, Tanzania. Nutrient Cycling in Agroecosystems, 76, 249.
15. Jama, B., Palm, C.A., Buresh, R. J., Niang, A., Gachengo, C., Nziguehbh, G. and Amadalo, B. (2000). *Tithoniadiversifolia*as a green manure for soil fertility improvement in western Green manuring: its effect on soil properties and crop growth under rice-wheat cropping system. European J. Agronomy, 19,225.
16. Kaba, J. S., Zerbe, S., Agnolucci, M., Scandellari, F., Abunyewa, A. A., Giovannetti, M., &Tagliavini, M. (2019). Atmospheric nitrogen fixation by gliricidia trees (*Gliricidiasepium* (Jacq.) Kunth ex Walp.) intercropped with cocoa (*Theobroma cacao* L.). Plant and Soil, 435(1), 323-336.
17. Kamani, M. H., Eş, I., Lorenzo, J. M., Remize, F., Roselló-Soto, E., Barba, F. J., &Khaneghah, A. M. (2019). Advances in plant materials, food by-products, and algae conversion into biofuels: use of environmentally friendly technologies. Green chemistry, 21(12), 3213-3231.
18. Karthika, K. S., Rashmi, I., & Parvathi, M. S. (2018). Biological functions, uptake and transport of essential nutrients in relation to plant growth. In Plant nutrients and abiotic stress tolerance (pp. 1-49). Springer, Singapore.
19. Kathpalia, R., &Bhatla, S. C. (2018). Plant mineral nutrition. In Plant physiology, development and metabolism (pp. 37-81). Springer, Singapore.
20. Kinyua, M., Cao Diogo, R. V., Sibomana, J., Bolo, P. O., Gbedjissokpa, G., Mukiri, J.,&Kihara, J. (2019). Green manure cover crops in Benin and Western Kenya-A review. CIAT Publication.
21. Kueklang, M., Krisanapook, K., Havananda, T., Phavaphutanon, L., &Luengwilai, K. (2021). Seasonal variation of fruit yield and leaf macronutrient concentrations of Thai aromatic coconut. Agriculture and Natural Resources, 55(5), 858-866.
22. Kumi-Arhin, E. (2021). “The contribution soil heavy metals pollution to the cause of destruction of the coconut palm in some selected areas of the Central Region of Ghana”:(A case study in Ajumako-EnyanEssiam to Bobikuma) (Doctoral dissertation, University of Cape Coast).
23. Lins, P. M. P., Viegas, I. D. J. M., & Ferreira, E. V. D. O. (2021). Nutrition and production of coconut palm cultivated with mineral fertilization in the state of Pará. RevistaBrasileira de Fruticultura, 43.
24. Magat, S.S. 1991. Fertilizer recommendations for coconut based on soil and leaf analyses. Philipp. J. Coconut Stud, 16,25-29.
25. Martín, G. M. (2009). Manejo de la inoculaciónmicorrizicaarbuscular, la *Canavaliaensiformis* y la fertilizaciónnitrogenadaenplantas de maiz (*Zea mays*) cultivadassobresuelosFerralíticosRojos de La Habana. Tesis Dr. Universidad Agraria de La Habana. 100 pp.
26. Meena, B. L., Fagodiya, R. K., Prajapat, K., Dotaniya, M. L., Kaledhonkar, M. J., Sharma, P. C., ... & Kumar, S. (2018). Legume green manuring: an option for soil sustainability. In Legumes for soil health and sustainable management (pp. 387-408). Springer, Singapore.
27. Mukhametov, A., Bekhorashvili, N., Avdeenko, A., &Mikhaylov, A. (2021). The impact of growing legume plants under conditions of Biologization and soil cultivation on Chernozem fertility and productivity of rotation crops. Legume Research-An International Journal, 44(10), 1219-1225.
28. Nair, K. P. (2021). The coconut palm (*Cocos nucifera* L.). In Tree Crops (pp. 79-128). Springer, Cham.
29. Omar, Z., & Fatah, F. A. (2021, May). Determinants of Technical Efficiency among Coconut Smallholder Production in Johor, Malaysia: A Cobb Douglas Stochastic Frontier Production Approach. In IOP Conference Series: Earth and Environmental Science, 757, 1,012013.
30. Prager, M. M., Sanclemente, R. O. E., Sánchez, P., M., Miller, G., J., &Sánchez, D. I. (2012). Abonos verdes: Tecnología para el manejo agroecológico de los cultivos. Agroecología, 1, 7.
31. Qaswar, M., Huang, J., Ahmed, W., Liu, S., Li, D., Zhang, L., & Zhang, H. (2019). Substitution of inorganic nitrogen fertilizer with green manure (GM) increased yield stability by improving C input and nitrogen recovery efficiency in rice based cropping system. Agronomy, 9(10), 609.
32. Ramírez-Silva, J. H., Cortazar-Rios, M., Ramírez-Jaramillo, G., Oropeza-Salín, C. M., &Rondón-Rivera, D. N. (2022). Heterogeneity and Spatial Distribution of Inorganic Nitrogen as Nitrate (N-NO3) in Two Soils Dedicated to Green Dwarf Coconut in Guerrero, Mexico. Open Access Library Journal, 9(11), 1-11.
33. Ramírez-Silva, J. H., Cortazar-Ríos, M., Ramírez-Jaramillo, G., Oropeza-Salín, C. M., &Rondón-Rivera, D. D. (2021). Soil Organic Matter and Nitrogen Content as Related to Coconut Nutrition in Guerrero, Mexico. Open Access Library Journal, 8(8), 1-16.

34. Rani, T. S., Umareddy, R., Ramulu, C., & Kumar, T. S. (2021). Green Manurs and Grean leaf manures for soil fertility improvement: A review. Journal of Pharmacognosy and Phytochemistry, 10(5), 190-196.
35. Rivera, R. (1999). Uso del isotopo 15N enlosestudiossuelo-planta-suministro de nutrientes. Curso de TécnicasIsotópicasen la relaciónSuelo-Planta. MaestríaenNutrición de las Plantas y Biofertilizantes. Instituto Nacional de CienciasAgrícolas, Cuba
36. Rugare, J. T., Pieterse, P. J., &Mabasa, S. (2020). Effects of green manure cover crops (*Canavaliaensiformis* L. and Mucunapruriens L.) on seed germination and seedling growth of maize and *Eleusineindica* L. and *Bidenspilosa* L. weeds. AllelopathyJournal, 50(1), 121-139.
37. Peixoto, J. F. S., Chaves, L. H. G., & Guerra, H. O. C. (2006). Leaf macro and micronutrients content of the green dwarf coconut (*Cocos nucifera* L.) after one-yearfertigated with NK. Agricultura Técnica, 66(3), 324-330.
38. Silva, R. A. (2009). Crescimento e produção do coqueiroanãoverdefertirrigadocomnitrogênio e potássio. Revista Caatinga, Mossoró, 22,1, 161 -167.
39. Sobral, L. F. (2015). Informe de Comisión a Brasil. Proyecto INIFAP-SAGARPA-EMBRAPA “Formación de técnicos especializados en agricultura, ganadería y silvicultura para el desarrollo de las zonas tropicales de México”. 33 p.
40. Sobral, L. F., &Nogueira, L. C. (2008). Influência de nitrogênio e potássio, viafertirrigação, ematributos do solo, níveiscríticosfoliares e produção do coqueiro-anão. RevistaBrasileira de Ciência do Solo, 32, 1675-1682.
41. Tan, K. y Ng. W. (1981) Preliminary results of nutrient cycling of covers in oil palm on Inland soils. Intenational Conference on Oil Palm in Agriculture in the Eighties. Kuala Lumpur:Malasia, 17-20.
42. Telekalo, N., Mordvaniuk, M., Shafar, H., &Matsera, O. (2019). Agroecological methods of improving the productivity of niche leguminous crops. Ukrainian Journal of Ecology, 9(1), 169-175.
43. Verma, B. C., Pramanik, P., &Bhaduri, D. (2020). Organic fertilizers for sustainable soil and environmental management. In Nutrient dynamics for sustainable crop production (pp. 289-313). Springer, Singapore.
44. Wang, X., Fan, J., Xing, Y., Xu, G., Wang, H., Deng, J., & Li, Z. (2019). The effects of mulch and nitrogen fertilizer on the soil environment of crop plants. Advances in agronomy, 153, 121-173.
45. Wang, X., Guo, X., Yu, Y., Cui, H., Wang, R., &Guo, W. (2018). Increased nitrogen supply promoted the growth of non-N-fixing woody legume species but not the growth of N-fixing *Robiniapseudoacacia*. Scientific Reports, 8(1), 1-9.
46. Yang, Y., Iqbal, A., &Qadri, R. (2018). Breeding of coconut (*Cocos Nucifera*L.): The tree of life. In Advances in Plant Breeding Strategies: Fruits (pp. 673-725). Springer, Cham.