**Contribution to a numerical characterization of the date palm (*Phoenix dactylifera* L.) cultivar “Deglet nour” grown in the commune of Ain naga (Ziban region, south-east Algeria).**

Linda RETIMA1\*, Abdelaziz BENAZIZA1, Bilal BENAMOR2, Adel CHALA3

1 University of Biskra, Department of agronomy, Faculty of exacts sciences and life and nature sciences, BP 145 RP, 07000 Biskra, Algeria;

2 University of Mohamed Khider, Laboratory of Genetic, Biotechnology and Valorisation of Bio-resources (LGBVB.), BP 145 RP, 07000 Biskra, Algeria;

3University of Mohammed Khider, Laboratory of applied mathematics, Department of mathematics, Faculty of exacts sciences and life and nature sciences, BP 145 RP, 07000 Biskra, Algeria;

**\*For correspondence** **lindaretimaagro@gmail.com**

**Abstract**

The experiment was carried out on a private farm located in the Ziban East region on the "Deglet nour" cultivar of the date palm (*Phoenix dactylifera* L.) to study a new numerical characterization technique based on the evaluation of the absorption rate red and blue rays from the leaflets of this cultivar

The leaflets of the middle crown were taken at three positions of the palm (apical, median and basal) and according to the four cardinal points: North, South, East and west and according to the faces of the leaflet (ventral and dorsal) during two seasons (autumn and spring)

The results obtained show that the absorption of blue rays is greater than that of red rays for both sides of the leaflet (ventral and dorsal), according to the four cardinal points north, east, south and west and at different positions of the leaflets. On the palm of the middle crown of the date palm during two seasons (autumn and spring).

The light absorption of blue and red rays is greater on the ventral side (78.24%, 69.28% respectively) than on the dorsal side (76.17%, 67.75% respectively), on the orientation south (78.57%, 71.30% respectively),

The apical leaflets of the Deglet nour cultivar strongly absorb blue rays (78.53%), on the other hand, the absorption of red rays is greater in the basal and middle leaflets with (68.72%, 68,76% respectively).

**Keywords:** date palm; characterization; leaflets; absorption of blue and red light rays; Biskra

 **Introduction**

Nowadays, the preservation of species becomes one of the major activities of human beings, thanks to its importance for their continuity. For this reason, it realizes and develops methods and techniques that allow the study of the varieties to protect them and guarantee their existence in the future.

The date palm (Phoenix dactylifera L.) is one of the oldest trees in the Sahara

(Peyron, 2000; Espiard, 2002); it is a monocotyledonous and dioeciously plant, belonging to the Arecaceae family, (Munier, 1973)

Genetic diversity by sexual multiplication (seeds) results from The dioecious character of the species, Phœnix dactylifera L, this variability has allowed the selection of a large number of clones with different morphological and physiological characteristics (Belguedj, 2002b) which makes it very difficult to count the existing varieties (Aberlenc-Bertossi et al., 2008)

The Phoeniciculture is one of the strategic fields in the research of which several studies and works have been carried out, or are being carried out in several disciplines on these natural resources in Algeria and in the Biskra region.

Today, new techniques are more modern and more efficient to preserve the Phoeniciculture heritage and develop the national economy.

Our work allows us to propose a new technique of characterization of the plant, numerical and simple to estimate the concentration of chlorophyll in leaflets based on the estimation of the rate of absorbance of blue and red light rays. In addition, this study makes it possible to determine the best position for the plantation of palm trees and to assess their production.

Chlorophyll, the main leaf pigment, is used as an indicator to evaluate the potential yield of a crop, its biomass, and its physiological state to detect nutritional deficiencies or various types of pollution (Féret, 2009).

Indeed, chlorophyll absorbs light rays with low intensity wavelengths (blue rays from 445 to 500 nm) and high intensities (Red rays from 620 to 700 nm) (Devineau, 1990; Bousquet, 2007; Abidi, 2013).

Red and blue light rays are known to influence many physiological processes in green plants during growth and development, especially photosynthesis (Liet al., 2020).

**Materials and methods**

**Presentation of the study area**

The experiment was conducted in a date palm exploitation located in the commune of Ain Naga in the Ziban region. This commune covers an area of 508 km². Its latitude is between 34°41′ 18″ North, and its longitude is between 6°5′ 19″ East with an altitude of 247 m at the level of the sea (Figure 1).

We chose a private exploitation grove conducted in polyculture as a study site, with an area of 25 hectares. This palm grove has 3000 palm trees in full production aged 24 years of various cultivars, the most dominant of which are Deglet nour, Mech dagla, and Ghars, the spacing is 9 m between trees, and the geographical coordinate of the palm grove is 34°41' 20.5″ North latitude and 6°07' 01.8″East longitude.



**Figure 1. Sketch map of the study sample collection sites (Ain Naga).**

**Plant material**

The material that is used in this study is the leaflets of the middle crown of the cultivar Deglet nour. It is an excellent date; its shape is tapered to ovoid. At the Bser stage, the date is the light reddish color with yellowish slivers and at the Tamr stage, it is amber in color. The epicarp is smooth, shiny and wrinkled. The mesocarp is thin, semi-soft consistency, and fibrous in texture (Dakhia et al, 2016).

These leaflets are very long and not very wide, flexible and bent downwards. They form groups of 2 to 3 well-spaced all along the rachis. Their dimensions were measured from the base to the top of the palm, which are 80 cm long and 1.8 cm wide at the base, 68 cm long and 2.7 cm wide in the middle and 35 cm long and 2.3 cm wide at the extremity (Belguedj, 2002).

The choice of the leaflet is the representative organ of the species or variety and is considered the keyword of this technique newly employed in perennial species and used for other species, including cereals, and ornamental crops (Belhadj, 2016).

The middle crown is composed of oblique palms, having completed their growth. These palms are the seat of intense photosynthetic activity (Girard, 1962) in (Elhoumaizi, 2002).

**Study method**

**Sampling**

To carry out this study, we selected leaflets from five plants of the Deglet nour cultivar, free of diseases, having undergone the same agricultural practices (Tillage, irrigation rate, manure-based amendments, weeding and cleaning of planting basins); The leaflets of the middle crown are taken at three positions of the palm (apical, median and basal) and according to the four cardinal points: north, south, east and west and according to the faces (ventral and dorsal) in two seasons (autumn and spring).

**Numerical study for the absorption rate of light rays**

The samples are then photographed with a high-resolution digital camera and the images obtained are processed by the software measure-pro-8, which allows evaluating the absorbance of light rays. Indeed, this measure is determined in the percentage of absorption of light rays based mainly on blue and red rays along the length of the leaflets and expressed in pixels. These two parameters are calculated on a standard band, chosen at the level of the digitized leaflet.

**Mesurim**: is a software intended to do different types of work on digitized images: image capture, annotation, diagram, counting, measurement, and video animation (Figure 2). Indeed, this method is based on correlations between reflectance and chlorophyll pigment concentration. Leaf reflectance and transmittance depend on the absorption of radiation by chemical constituents (Chlorophyll) and by their diffusion within the leaf tissue.



 **Figure 2:** Screenshot of the Mesurim software interface, showing an image of a palm leaf and a table with some parameters.

**Statistical analysis.**

We used SPSS 22 software to perform the following statistical treatments (Dagnelie, 1998):

The analysis of variance (ANOVA) with one controlled factor: to know if there is a significant difference (The degree according to the significance level α) between individuals for the studied variables.

Analysis of the differences between the modalities and comparison of the means using Tukey's test to determine the best representative group.

**Results and discussion**

Solar radiation is the main source of energy, which plant organisms are able to transform into organic matter with a small fraction of this radiation (Devineau, 1990).

According to Abidi (2013), under natural conditions, plants are subject to very large variations in the spectral composition of their light environment. Several factors may be responsible for these variations such as geographical location, season, daily period and crop density.

Light is not only an energy source for photosynthesis, but also a source of plant environmental information. This isbecause leaves strongly absorb red and blue light (Kalaitzoglou et al., 2021).

**Variation of the absorption rate of light rays (blue and red) in the leaflets of the cultivar Deglet nour according to the four directions (north, south, east and west):**

The figure below summarizes the global analysis of the variation of the absorption rate of light rays (Blue and red) in the leaflets of the cultivar Deglet nour according to the cardinal points (North, West, east and South).

**Figure 3:** Variation of light absorption rate (blue and red) in leaflets of the cultivar Deglet nour according to cardinal points (north, west, east and south).

*Tukey's tests at p ≤ 0.05. Indicated that the different capital and small letters denoted significant differences +the standard error of the mean for each parameter*

According to Figure 3, the light absorption of blue light rays by leaflets is higher than that of red light rays whatever their orientation (North, West, East and South).

Several researchers have studied the effect of the quality of red and blue light on the anatomy, morphology and, especially the photosynthesis activity of plants. As Murchie and Horton (1997) and Bailey et al. (2001) indicated that the light intensity produces thickening of the leaf blade and the number of chloroplasts allowing a variation in the overall chlorophyll content and, Li et al. (2020) confirmed that the blue and red-light rays, which plants absorb, have the greatest effect on plant growth and development, particularly photosynthesis.

Li et al. (2020); Rehman et al.(2017) also indicated that the chloroplast function, stem and petiole growth, and the reproductive system (flowering and seed formation) are controlled by the red light

As also Seif et al (2021), found that red light improved the stomatal capacity to regulate water loss during drought.

On the other hand, some studies have shown that leaf thickness, epidermal cell number, stomata density, mesophyll, chloroplast number, and especially chlorophyll content increase with increased absorption of blue light by plants, (Zheng & Van Labeke, 2017; Izzo et al., 2021). Similarly, Research by Meidner (1968) showed that the opening of the stomata of two different species (Xanthium pennsylvanicum and Onion) is very efficient by blue light than that by red light, These results are confirmed by several previous works (Roelfsema & Hedrich, 2005; Shimazaki et al., 2007; Doi et al., 2015; Inoue & Kinoshita, 2017; Matthews et al., 2019).

The analysis of variance shows a significant difference in the absorption rate of blue and red rays, with p = 0.000 at the 5% threshold, Tukey’s test at the same threshold revealed the presence of four distinct homogeneousgroups among the four cardinal points for the absorption rate of red and blue rays. The highest absorption rate of light rays corresponds to the southern orientation (78.57%, represents group A) for blue light rays and (71.30%, represents group a) for red light rays**.**

**Variation of the absorption rate of light rays (Blue and red) in leaflets of the cultivar DegletNour according to the positioning of the leaflets (Basal, median and apical)**

The analysis of variance revealed a significant difference in the absorption rate of blue and red rays, with p= 0.000 at the 5% threshold, Tukey’s test at the same threshold revealed the presence of two homogeneous groups for the absorption rate of red and blue rays. The analysis of the above figure shows that the absorption rate of blue rays is more important than that of red rays with an average of around 78.53% (Represents group A) for apical leaflets and the absorption rate of red rays is (68.72% and 68.76%) (Represents group a) for basal and median leaflets respectively.

In contrast, Paradiso et al. (2020) reported that there was no significant difference in light absorption between different leaf positions (Upper, middle and lower) of the rose (Rosa hybrida L.) cultivar Akito.

**Figure 4.** Variation in the rate of absorption of light rays (blue and red) in the leaflets of the Deglet nour cultivar according to the positioning of the leaflets (basal, median and apical).

 *Tukey's tests at p ≤ 0.05. Indicated that the different capital and small letters denoted significant differences +the standard error of the mean for each parameter*

**Variation in the rate of absorption of light rays (Blue and red) in the leaflets of the DegletNour cultivar according to the face of the leaflet (Ventral and dorsal)**

In most plant species, the Development and functioning of the ventral and dorsal leaf surfaces in the environment are related to the intensity and quality (wavelength) of the light.

The ventral surface is exposed to higher light intensity and a broader spectrum of solar radiation. The leaf blade shades the dorsal sides and receives only about 10% of the light incident on the ventral sides (Paradiso & Marcelis, 2012).

**Figure 5.** Figure 5: Variation in the rate of absorption of light rays (Blue and red) in the leaflets of the cultivar Deglet nour according to the face of the leaflet (ventral and dorsal).

*Tukey's tests at p ≤ 0.05. Indicated that the different capital and small letters denoted significant differences +the standard error of the mean for each parameter*

As shown in Figure 5, there is a significant difference between the two sides (ventral and dorsal) for the rate of light absorption of blue and red rays.

The analysis of Figure 5, shows that the rate of absorption of the rays by the leaflets is more always important in the blue rays than in the red rays,

 As well as, the ventral face is presented with a more rate of absorption of blue rays with 78, 24% (Represents group A) and red with 69, 28% (Represents group a) concerning the other face with 76, 17% which constantly reflects the richness of the superior face in chlorophyll.

The results of our experiment are consistent with the results of Lichtenthaler (1987) who reported that the amount of light absorbed depends on the concentration of chlorophyll and with the results of Kuncham (2021). The latter showed that the rate of absorption depends on the concentration of chlorophyll and as the latter increases, so does the absorption with distinct peaks in the blue and red light regions.

On the other hand; the results of Izzo et al. (2021), show that the increase in photosynthesis and chlorophyll content in the leaves of lettuce plants in response to blue light indicates that plants had more chloroplasts and the number of photosynthetic enzymes

Paradiso & Marcelis, 2012, Moreover, Paradiso et al. (2020) reported similar results for the rose (Rosa hybrida L.) Cultivar 'Akito'; this study showed that the leaf photosynthesis rate was higher on the ventral side than the dorsal side. This is a consequence of the rate of light absorption (89.2%) by the ventral side of the illuminated leaf compared to the dorsal side (82.6%), as observed by (Proietti & Palliotti, 1997) on the leaves of two varieties Frantoio and Meurino of the olive tree (Olea Europaea L).

**Variation in the rate of absorption of light rays (blue and red) in the leaflets of the Deglet nour cultivar according to the season (autumn and spring)**

**Figure 6:** Variation in the rate of absorption of light rays (blue and red) in the leaflets of the Deglet nour cultivar depending on the season (autumn and spring).

*Tukey's tests at p ≤ 0.05. Indicated that the different capital and small letters denoted significant differences +the standard error of the mean for each parameter*

The analysis of Figure 6 shows that the rate of absorption of the radiation by the leaflets is more always important in the blue rays than in the red ones.

According to the results of the analysis of variance, we find that there is a significant difference in the absorption rate (Blue and Red) between the two seasons, in the Autumn season, the absorption rate of light rays is 81.28% (blue) and 72.40% (red) followed by spring with 73.13% for blue rays and 64.63% for red rays.

The classification of homogeneous groups by Tukey's test at the 5% threshold confirms the results obtained by the analysis of variance, in which each season represents a specific group for the two light rays.

According to Proietti and Famiani (2002), daily and seasonal changes in photosynthetic characteristics and total leaf chlorophyll content of olive cultivars (Frantoio, Leccino and Maurino) were studied the net photosynthetic rate of leaves per unit leaf area changed during the growing season and the day. In young and one-year-old leaves, the highest values of photosynthesis were observed in October, while, the lowest values were recorded in August and December; during the day, the highest values of photosynthesis were generally found in the morning.

**Conclusions**

Our study aims to investigate a numerical characterization of the Deglet nour cultivar in the Ziban region.

This method is based on the processing of photos of the leaflets of the middle crown of two ventral and dorsal faces, according to the different orientations (North, east, south, and west) and their positions on the palm (Basal, median and apical) relative to the palm during two seasons (autumn and spring).

The results showed that the Deglet nour cultivar is characterized by:

* Blue and red light rays are best absorbed by date palm leaflets compared to the visible spectrum;
* Blue light rays are more strongly absorbed by leaflets than red light rays;
* The absorption rate of blue and red light rays differs according to the orientation of the leaflets, their position on the palm, the season and the face
* From the point of view, the orientation has proved that the light rays, whatever their type, are more absorbed in the southern orientations compared to the other cardinal points.
* Light absorption of red and blue rays is greater on the ventral face than the dorsal face regardless of the orientation of the leaflet on the tree and its position on the palm.

**Acknowledgments**

The author would like to offer particular thanks to the farmers of studied phoeniciculture exploitation.

**Author Contributions**

Linda RETIMA, Abdelaziz BENAZIZA, Bilal BENAMOR, Adel CHALA

**Conflicts of Interest**

All authors declare no conflict of interest

**Data Availability**

Data presented in this study will be available on a fair request to the corresponding author

**Ethics Approval**

Not applicable to this paper

**References**

Aberlenc-Bertossi, F., N. Chabrillange, Y. Duval, and J. Tregear. (2008): Contrasting globulin and cysteine proteinase gene expression patterns reveal fundamental developmental differences between zygotic and somatic embryos of oil palm. Tree Physiology, 28, 1157.

Abidi, F., (2013): Effets de la qualite de la lumiere sur l'elaboration de l'architecture du Rosier buisson. Thèse de Doctorat, Université d'Angers, France.

Bailey, S., R.G. Walters, S. Jansson, and P. Horton. (2001): Acclimation of Arabidopsis thaliana to the light environment: the existence of separate low light and high light responses. Planta, 213, 794.

Ballaré, C.L., R.A. Sánchez, A.L. Scopel, J.J. Casal, and C.M. Ghersa. (1987): Early detection of neighbour plants by phytochrome perception of spectral changes in reflected sunlight. Plant, Cell & Environment, 10, 551.

Belguedj, M., (2000): Phytogenetics ressources of Date Palm Groves in Algerian Southeast: Teste of varietal calssification. . Proceedings of the date palm, international symposium, Windhoek, Namibia. 338.

Belguedj, M., (2002): Caractéristiques des cultivars de dattes dans les palmeraies du Sud-Est. N 11, INRAA. El-Harrach, Algiers.

Belhadj, A., (2016): Contribution à une caractérisation numérique chez les espèces fruitières cas de l’abricotier «Prunus armeniaca L.». Thèse de Magister en sciences agronomiques, Université Mohamed Khider-Biskra, Algeria.

Bousquet, L., (2007): Mesure et modélisation des propriétés optiques spectrales et directionnelles des feuilles. Institut de Physique du Globe de Paris. Thèse de Doctorat, Université de Paris 7, Paris.

Dagnelie, P., (2011): Statistique théorique et appliquée. Vol.2: Inférence statistique à 1 et à 2 dimensions. De Boeck, Brussels. Belgique.

Dakhia, N., Benahmed, K., Belguedj, N. Elbar, D. . (2016). Guide de bonnes pratiques orientations pour une meilleure conservation des dattes.

Devineau, J.L., (1998): Propriétés spectrales de la végétation: Images satellite et milieux terrestres en régions arides et tropicales. ORSTOM. Paris. 43.

Doi, M., Y. Kitagawa, and K.-i. Shimazaki. (2015): Stomatal Blue Light Response Is Present in Early Vascular Plants Plant Physiology, 169, 1205.

Elhoumaizi, M., (2002): Modélisation de l’architecture du palmier dattier (Phoenix dactylifera L.) et application à la simulation du bilan radiatif en oasis. Thèse de Doctorat, Université de Cadi Ayyad, Marrakech.

Espiard, E. (2002). Introduction to the industrial transformation of fruits.

Féret, J.-B., (2009): Apport de la modélisation pour l'estimation de la teneur en pigments foliaires par télédétection. Thèse de Doctorat, L'université Pierre-et-Marie-Curie, Paris-VI, Paris.

Inoue, S.-i. and T. Kinoshita. (2017): Blue Light Regulation of Stomatal Opening and the Plasma Membrane H+-ATPase Plant Physiology, 174, 531.

Izzo, L.G., M.A. Mickens, G. Aronne, and C. Gómez. (2021): Spectral effects of blue and red light on growth, anatomy, and physiology of lettuce. Physiologia Plantarum, 172, 2191.

Kalaitzoglou, P., Taylor, C., Calders, K., Hogervorst, M., van Ieperen, W., Harbinson, J., de Visser, P., Nicole, C. C. S., & Marcelis, L. F. M. (2021). Unraveling the effects of blue light in an artificial solar background light on growth of tomato plants. Environmental and Experimental Botany, 184, 104377.

Kuncham, V.S., (2021): The Impact of Light Irradiance, Chlorophyll Concentration and Solvent on Chlorophyll Absorbance Spectrum. McGill University (Canada).

Li, Y., G. Xin, C. Liu, Q. Shi, F. Yang, and M. Wei. (2020): Effects of red and blue light on leaf anatomy, CO2 assimilation and the photosynthetic electron transport capacity of sweet pepper (Capsicum annuum L.) seedlings. BMC Plant Biology, 20, 318.

Lichtenthaler, H.K., (1987): Chlorophylls and carotenoids: Pigments of photosynthetic biomembranes. Academic Press. 350.

Matthews, J.S.A., S. Vialet-Chabrand, and T. Lawson. (2019): Role of blue and red light in stomatal dynamic behaviour. Journal of Experimental Botany, 71, 2253.

Meidner, H., (1968): The Comparative Effects of Blue and Red Light on the Stomata of Allium cepa L. and Xanthium pennsylvanicum. Journal of Experimental Botany, 19, 146.

Munier, P., (1973): Le Palmier-Dattier. Techniques Agricoles et Productions Tropicales. Paris 5eme. Maisonneuve et Larousse. Paris. 209p.

Murchie, E.H. and P. Horton. (1997): Acclimation of photosynthesis to irradiance and spectral quality in British plant species: chlorophyll content, photosynthetic capacity and habitat preference. Plant, Cell & Environment, 20, 438.

Paradiso, R., P.H.B. de Visser, C. Arena, and L.F.M. Marcelis. (2020): Light response of photosynthesis and stomatal conductance of rose leaves in the canopy profile: the effect of lighting on the adaxial and the abaxial sides. Functional Plant Biology, 47, 639.

Paradiso, R. and L. Marcelis. (2012): The effect of irradiating adaxial or abaxial side on photosynthesis of rose leaves. VII International Symposium on Light in Horticultural Systems, 157.

Peyron, G., (2000): Growing date palms. Ed. C.I.R.A.D. 110 p.

Proietti, P. and F. Famiani. (2002): Diurnal and Seasonal Changes in Photosynthetic Characteristics in Different Olive (Olea europaea L.) Cultivars. Photosynthetica, 40, 171.

Rehman, M., S. Ullah, Y. Bao, B. Wang, D. Peng, and L. Liu. (2017): Light-emitting diodes: whether an efficient source of light for indoor plants? Environmental Science and Pollution Research, 24, 24743.

Roelfsema, M.R.G. and R. Hedrich. (2005): In the light of stomatal opening: new insights into ‘the Watergate’. New Phytologist, 167, 665.

Seif, M., S. Aliniaeifard, M. Arab, M.Z. Mehrjerdi, A. Shomali, D. Fanourakis, T. Li, and E. Woltering. (2021): Monochromatic red light during plant growth decreases the size and improves the functionality of stomata in chrysanthemum. Functional Plant Biology, 48, 515.

Shimazaki, K.-i., M. Doi, S.M. Assmann, and T. Kinoshita. (2007): Light Regulation of Stomatal Movement. Annu. Rev. Plant Biol., 58, 219.

Zheng, L. and M.-C. Van Labeke. (2017): Long-Term Effects of Red- and Blue-Light Emitting Diodes on Leaf Anatomy and Photosynthetic Efficiency of Three Ornamental Pot Plants. Frontiers in Plant Science, 8.