



Review

CULTIVATION OF THE DAHLIA

Revisión bibliográfica

El cultivo de la Dalia

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ABSTRACT. The production and marketing of flowers and ornamental plants has been booming in recent years. In Cuba, the cultivation of the dahlia is characterized by variety of color, beauty and easy propagation. The aim of this work was to present the characteristics and qualities as a cut flower. Addressed in the parameters related to their origin, economic importance, botanical description, cultural practices, propagation and potting. We conclude that the dahlia is a crop with great potential in Cuban floriculture as it presents perennial and bushy growth habit, with petals intense lilac and easily spreadable by cuttings.

RESUMEN. La producción y comercialización de flores y plantas ornamentales ha tenido gran auge en los últimos años. En Cuba, el cultivo de la dalia se caracteriza por variedad de color, belleza y fácil propagación. El objetivo de este trabajo fue dar a conocer las características y cualidades como flor de corte. En el se abordan parámetros relacionados a su origen, importancia económica, descripción botánica, labores culturales, propagación y cultivo en maceta. Se concluye que la dalia es un cultivo con gran potencial en la floricultura cubana ya que presenta hábitos perennes y crecimiento arbustivo, con capítulos lila intenso y fácilmente propagable por esquejes.

Key words: biotechnology methods,
botanical description

Palabras clave: métodos biotecnológicos,
descripción botánica

INTRODUCTION

Cut flowers are about half the market for horticultural products, where developed countries consume more than 90 %. Many consumer countries do not have ideal climatic conditions for producing cut flowers, so that flowers grow under protected environments, thus production prices increase (1).

In Cuba, production levels of cut flowers still remain very low, supply does not match demand and climatic conditions allow to obtain flowers all the year round with low production

costs; however, those possibilities are not exploited, so there are no flowers with higher quality. Production volume and quality has improved; thus, today there are great prospects for achieving quality and volume, ensuring a solid production to appropriately supply the international market of fresh flowers as well as to guide the steps towards developing their seed production so far depending on imports (2).

The cultivation of dahlia (*Dahlia* spp.) is limited to Nivea variety, which has become the basic species together with the rose (*Rosa* sp.), gladiolus (*Gladiolus grandiflorus*) and gerbera (*Gerbera jamesonii* Bolus L.), to match marketing requirements every season. Dahlia (*Dahlia* spp.) is hardly known by consumers and its production levels of cut flowers are low.

The expansion of a number of types, colors and sizes provides a strong possibility to increase this production, which also allows offering superior qualities for certain periods.

In Cuba, it is of great interest to initiate the formation of a collection of dahlias that allows studying and selecting types and forms adapted to the ecological conditions, consumption habits and production needs; this work must be done considering the existing form in the country, with perennial habits and bushy growth, intense lilac chapters and easily spreadable by cuttings.

Consequently, the objective of this paper is to present the characteristics and qualities of this crop as a cut flower.

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ORIGIN AND SIGNIFICANCE OF DAHLIA

Dahlia genus is made up by 35 wild species that are endemic from Mexico; only four of them have constituted the genetic basis for the development of its cultivation. With the Spanish conquest, dahlia was successfully introduced to Europe, starting in 1818 the breeding studies that led to create inflorescences with diverse shapes and colors. Since that time up to now, four species have controlled floral horticulture: *D. coccinea*, *D. pinnata*, *D. merckii* and *D. imperialis*. The most widely known is *D. pinnata*, which is derived from a fertile hybrid between *D. coccinea* and *D. sorensenii* likely produced in Mexico about 500 years ago (1).

Dahlia is native from the clay-siliceous highlands of Mexico, although many species have been found in South America and Central America (3).

Different species of dahlia comprise several ranges of variation, from those geographically very restricted up to the ones that appear in a wide range of variation, between 200 m and more than 500 m over sea level; and other cases, such as *D. australis*, which is distributed into geographically isolated regions, comprising a height range of 1500-2500 m over sea level (4).

The name "Dahlia" was given by the botanist Andreas Dahl. In Belgium, the first ornamental plants obtained had large, double flowers, which quickly spread throughout the continent and were preferred by the court of Queen Victoria (1).

Conversely, for two centuries of cultivation, selection and hybridization have made it an ornamental species that offers greater diversity of sizes, shapes and colorful flowers (5).

This cut flower has very particular characteristics, so that it has become into one of the most

beautiful flowers abroad; besides, it is the unique plant that has the largest number of varieties among all plant species and more than 50,000 has been registered in the Royal Horticultural Society of England (4).

The Mexican Association of Dahlia (AMD) has reported that the main growing states are Mexico City, Puebla and Mexico State. Since 2007, the National Day of Dahlia is celebrated in Mexico each August 4th (6).

WORLD PRODUCTION SITUATION OF DAHLIA

The international trade of cut flowers is worth about 11,000 million Euros, which gives an idea of the economic importance of this activity^A.

Concerning its bulb production, Holland takes the lead with 400 ha, followed by France and Chile with 40 ha and 7.3 ha respectively^B.

Taking into account its beauty, dahlia is such a flower that has acquired a similar ornamental importance to the Dutch tulip in Europe. However, few people know it is from Mexico and it is not really a flower but an inflorescence (composed by two types of small flowers), also its ancestors are still admired in Mexico City (1).

In the decade of 1820-1830, dahlias were in fashion and their prices rose considerably. Specialists cataloged them as a "decorative flower". Everyone wanted dahlias in their garden. So much successful it was (3) that it began to overshadow the chrysanthemum (a favorite flower); thus, a series of exhibitions was organized in parallel with the latter.

^A Claps, L. Perfil del mercado mundial de bulbos para flor. [Informe preliminar]. UEM INTA, Santa Cruz, 2001.

^B Traub Ramos, Alfonso y Vicuña Herrera, Bárbara. Flores de cortes: nuevas oportunidades. Oficinas de estudios y políticas agrarias- Odepa. Ministerio de la Agricultura. Chile. 2012. 13 pp.

The flower is essentially used in floral arrangements for the gift market. At present, there are 41 international associations concerned with the cultivation and spreading of dahlia; among them are the National Dahlia Society in the UK, the American Dahlia Society (ADS), other groups of New Zealand in European countries, France and Germany (6).

In Venezuela, this plant has been cultivated for more than 60 years, mainly in the Center-West region and its culture was basically used as cut flowers for commemorative wreaths; however, at present, the demand for dahlias (types: casual decorative, round and semi-cactus) has increased to decorate gardens and parks (7).

In Cuba, the development of floriculture is related to the rise of sugar industry, as a result of introducing species and varieties by settlers, ranchers and owners of mills, with the aim to brighten the environment surrounded by cane sugar. By the middle of the nineteenth century arose in Havana the first commercial gardens, mainly devoted to grow roses and ornamental plants. In 1914, the first dahlia tubers were introduced from the United States. At present, the consumption of flowers and ornamental plants has increased; however, this rate is still low, as only small areas are devoted to this crop, mainly by small growers^C.

Regarding the cultivation of dahlia (*Dahlia* spp.), so far, most studies has been related to the dynamics of biomass accumulation and extraction of nitrogen, phosphorus and potassium; assessment of postharvest flower conservation and behavior of postharvest flowers during shelf life.

^C Fernández, Alicia ; Marrero Virginia; Salgado, Julia; Cruz, Mercedes; Igarza, A; Hernández, María I; Calzada, V y Rajme, Yamir. Recomendaciones técnicas para la producción y comercialización de flores de corte. [Informe final de proyecto]. Instituto de Investigaciones Hortícolas "Liliana Dimitrova", La Habana. 2008. 21 pp.

On the other hand, recommendations have been made on N doses, N/K relationships and its division, besides defining maximum growth and macro nutrient (N, P, K) consumption times.

These results constitute the first reports on the studies related to growing technologies of cut flowers in Cuba, particularly those referring to the methodologies for obtaining seeds as well as production under protected conditions (8).

BOTANICAL DESCRIPTION

Dahlia belongs to Asteraceae family and its two main species are *Dahlia pinnata* Cav. and *D. coccinea* Cav (1). Among the 27 species comprising the genus, the best known are *D. coccinea*, *D. merckii*, *D. pinnata*, *D. imperialis* and *D. variabilis* (3).

It is a vigorous, perennial and "sometimes" little woody plant, some epiphytic or climbing species (5); herbaceous with fleshy roots (tubers). The roots grow during a developing stage, so that after completing its cycle and when the vegetative organs (stems and leaves) are dying, they start a dormant period (latency) of 60 or 90 days, after which canopy buds are activated and produce new shoots (9); then, a tuberous root develops to be used for vegetative propagation (4).

The inner and outer stem structures lack of nodes and internodes, the buds are only presented at the end of the proximal stem or canopy and form fibrous roots only at the distal end of the stem or canopy. They have a reverse polarity to that of a normal tuber (5).

Dahlia has triangular leaves of denticulate margin and unifoliate nervure. Foliage is pale green and lacks a special bright. This plant can have different sizes, from 30 cm to more than 1.2 m high; also, it develops a messy branching

directed only to sunlight, but dense, with a large number of leaves (9).

Inflorescence is presented by large heterogamous heads, sometimes mid-sized, isolated or irregularly headed on long and naked stalks, with beveled, bell-shaped and hemispheric involvement (3).

The small heads are radiated and have 15 cm diameter, raised or inclined, with very variable ray flowers light purple, yellow or pink at its basis. Disc flowers are sometimes replaced by fertile or sterile ray ones (9). It has been also stated that flowers are usually peripheral, uniserial, ligular, sterile, white or purple, yellow or red, as well as fertile hermaphrodite disc, yellow or purple (6).

Inflorescence may be single with an outer ring of bright flowers surrounding a central disc of smaller and double yellow flowers predominating the colored ones (5).

The fruit is a linear oblongate or sometimes broadly spatulate achene or it consisting of two small rudimentary or sometimes conspicuous and often outdated ones (3). It has very different forms depending on the species or variety; it is constituted by a variable number of squamous head-forming bracts wrapping seeds; in chapters, very double seeds are often limited, monstrous and usually sterile (9).

The dahlia is a medium strength flower, which has a wide popularity in Cuba, mostly used in floral arrangements. However, its production on a significant scale is limited to semi-cactus white Nivea variety.

TAXONOMIC LOCATION

- ◆ Kingdom: Plantae
- ◆ Sub-kingdom: Tracheobionta
- ◆ Division: Magnoliophyta
- ◆ Class: Magnoliopsida
- ◆ Sub-class: Asteridae
- ◆ Order: Asterales

- ◆ Family: Asteraceae
- ◆ Sub-family: Asteroideae
- ◆ Tribe: Coriopsidae
- ◆ Genus: *Dahlia*
- ◆ Species: 30 species, 20 000 varieties

CLASSIFICATION

The specific name adopted, *Dahlia variabilis* (octaploid hybrid: $2n=64$) indicates its characteristic of spontaneously producing new forms, as well as its ability to interbreed and hybridize, which have led to a number of types, forms and hybrids that impede their botanical classification (6).

At present, there are about 20,000 varieties recognized by the International Registration of Dahlias (5). According to its chapter characteristics and plant habit, which determine its application to gardening or as cut flower, dahlia has been classified by the American Dahlia Society, as:

Curved cactus flower: double-flowered varieties with rolled dewlaps bent towards the chapter center.

Upright cactus flower: double-flowered varieties with upright dewlaps in the chapter.

Semi-cactus: double flowers with less rolled dewlaps than in the two previous types.

Peony flower: double large flowers of irregular and curly petals leaving the flower center visible; ray flowers are arranged to communicate to peony flower chapter.

Decorative flower: double-flowered varieties with regularly arranged dewlaps in concentric line with its acuminate end. It has every color. Examples: "Napoli" and "Cream" (dark salmon), "Peau Rouge" (red).

Irregular decorative flower: chapters have much more irregularly arranged dewlaps than the previous type.

Flower in ball: its crop is limited; very double, firm, nearly spherical chapters. Globe-shaped flowers and cylindrically rolled round

petals, upright stems reaching up to 1.50 m high and profusely blooming.

Anemone flower: its chapters resemble the flowers of that ornamental species.

Single flower: chapters are not doubled; flowers have long petals and different colors; it is used in garden borders and in groups on the grass.

Double flowers: not very stuffed double chapters that do not present defined typical shapes.

Collar flowers: chapters with a medium dewlap circle around the disc, shorter than radial dewlaps and of a different color.

Liliput flowers: very small spherical chapters with short or serrated (honeycomb) dewlaps. Ex: "Atoll" (red).

Thumbnail flowers: chapters are equal in shape and arrangement to decorative ones, but very small.

SEXUAL AND ASEXUAL PROPAGATION

The most widely used methods for its propagation are via cuttings or tuberous root division (3); however, the most commonly used is the commercial form by cuttings^D.

Seed: seed method is employed to obtain new varieties (1). When seeds are sown in the soil, germination lasts up to a month; however, when they are put in filter papers at Petri dishes, it only takes three days. Seed germination is associated to the highest levels of oxygen, because it has an internal impervious membrane to oxygen^E.

In Cuba, seedbed should be

prepared at the beginning of dry or poorly rainy season to reduce adverse factors characteristic of the rainy season, such as high temperature, low rainfall and relative humidity (9). Seeding bottom should be ready at the beginning of germination by mixing one part of plain soil and one part of river sand.

Sowing should be done in such a way that seeds are only covered by a mixture layer of 2 to 3 mm, and then a slight irrigation is applied to prevent the subsequent drying of the layer where seeds are; the container or seedbed will be protected with guano, cheese cloth or straw. If seedbed is properly managed and the seed has the required fertility, germination must start at the 8th or 10th days, although it may take up to 21 days (3).

Once small plants reach 5-7 cm high, they are transplanted to transient beds (nurseries), where they will remain until they have four leaves, then at this time they are transferred to containers or a new nursery until reaching about 20 or 22 cm high and transplanted to the definite field, where they are given the same cultural attention as plants derived from cuttings, with only one difference that they are not subjected to desuckering to get a more vigorous growth and an earlier flowering (9).

Cuttings: its production consists of placing tuberous roots in a humid substrate to rapidly induce sprouting; then sprouts are cut and placed in pots to be rooted (3).

In May, they can be definitely transplanted to plain soil leaving about 80 cm between them. They usually bloom the same year. In November, plants should be removed and tubers kept in a dry room (5).

On the other hand, to better induce branching, the central stem end should be cut in spring; later, when stems have reached 10 to 12 cm, a stem is separated and a rooting is applied to it (3).

It has been pointed out that there are some varieties with low rooting capacity whereas others with quick capacity (5). In another study it was indicated that such capacity increase may be greater when growth is inhibited, by removing all vegetative parts that are growing, also the inhibitory activity is higher in hardly rooting reproductive cuttings than in easily rooting vegetative cuttings.

Original plant sprouting should be separated from the main tubers from February to April. First, in January-February, tubers are put on hot beds at 15-20 °C using a substrate made of equal parts of peat and sand. Cuttings of 5 to 10 cm are taken out from the mother tuber with a disinfected knife. They are placed in trays or pots with a quite rich soil mixture (improved peat) at 18 °C. They are regularly watered as rain, so the soil is kept moist. Rooting takes place in two to three weeks (20-60 cuttings per tuber in two or three months). Planting takes place from June to mid-July for obtaining medium sized tubers. Cuttings are planted in the rooting medium, burying them 1/3 long in rows 7-8 cm apart and about 4 or 5 cm of others; from 240 to 300 cuttings per square meter will be planted at these distances. Rooting starts when there is a color change from pale to intense green and terminal bud growth ends (9). Once root system is developed (5), cuttings are transplanted to beds at 50 cm apart and a row spacing of 90 cm. This density and late planting date restrict tuber development or thickening (minimum standards: 40 g for decorative dahlias).

Tuber division: This is the most commonly used form or method of propagation in Cuba, due to material stability, and plants derived from tubers show an earlier blooming than those obtained by other methods (9); multiplication by tuber division is the simplest and easiest way to practice and has the advantage that plants get vigor (5).

^DSeeman, P. y Andrade, N. Cultivo y manejo de plantas bulbosas y ornamentales. Universidad Austral de Chile. Facultad de Ciencias Agrarias. Instituto de Producción y Sanidad Vegetal, 1999. 218 pp.

^EArroyo L., E. N. Tamaño, forma y vigor de germinación en semilla de dalia. [Tesis de Licenciatura]. Universidad Autónoma Popular del Estado de Puebla, Puebla, Méx. 1991. pp. 6-11.

Tuberous root division consists of crown division, so that each section carries a stalk bud. The procedure for this method begins by extracting intact tuberous roots from the soil at the beginning of dry season and drying them a few days before storing. Storage takes place at 2 to 10 °C, where roots are put on a bed of sawdust or vermiculite, preventing to be exposed, because they become wrinkle (3).

The plant is provided with a number of underground tubers, each one with its corresponding bud on the fleshy part, otherwise reproduction would be impossible. Rhizome division should be done at the same time of planting. It accepts all non-calcareous soils with pH around 7, enriched with very rotted manure and avoiding excess nitrogen that causes a very significant foliage development at the expense of tuber growth; basal dressing must be of 100 kg ha⁻¹ P₂O₅ and 200 kg ha⁻¹ K₂O whereas maintenance application of 50 kg ha⁻¹ N in June, July and August; there should be plenty regular irrigation (9).

The ethylene present in plants (3) increases within short days, marking a quick change between tuber bearing period and apex growth cessation; thus, ethylene may be involved in its tuber initiation or induction.

In vitro culture: it is the best choice, because it is a quick and reliable method (2).

Because of its wide genetic variability present in various wild species, tissue culture could guarantee asexual clonal multiplication of individuals with outstanding genetic characteristics and would allow more efficient and reliable crossing schemes^F.

Over 50 years ago, Morel and Martin reported the regeneration of free-of-virus plants by excision and meristematic dome apex culture of infected plants; then, the best result was reached by a Knop solution medium half diluted with 2 % glucose and 0.5 mg L⁻¹ Difco yeast extract, achieving 1-mm-high plants without rooting. In general, this discovery encouraged intensive cultivation (10).

However, apical meristems were also used^F on a Murashige and Skoog medium (11) at different combinations of IAA and BAP. The best combination was 1 mg L⁻¹ IAA with 1 mg L⁻¹ BAP to obtain sprouting.

Consequently, a study was performed to carry out a process for its propagation from flower buds and stem apices, growing on a Murashige and Skoog medium (11) with IAA (0, 0.05 and 0.1 mg L⁻¹) +BAP (0, 0.05, 0.1, 0.2 mg L⁻¹). Shoot rooting can be done in a medium with IAA (0.5 mg L⁻¹) or even without auxin in the culture medium; however, evidently, there is variation in shoot rooting ability. Cultured apices in presence of BAP yielded reddish pigmented shoots (12).

Some has noted that *in vitro* culture shoot rooting may be directly made in a mist chamber (13). Others studied the effects of cytokinins (BA and zeatin) as well as sampling time of primary explants. The highest regeneration rate of primary explants was observed (14) when explants were cultured on a Murashige and Skoog medium with 0.5 mg L⁻¹ zeatin. Dahlia Mosaic Virus (DMV) can be removed from infected plants by meristem culture. Meristem culture efficiency in removing DMV was 50 % whereas 9 % for the plants growing from meristem sizes 0.4-0.5 mm and 0.9-1 mm, respectively.

Cotyledon leaves and hypocotyl explants have also been used on a MS medium supplemented with combinations

of plant growth regulators. In medium A (NAA and BAP) was used whereas in medium B (IAA and BAP). Callus induction and shoot regeneration was directly proportional, while root formation was inversely proportional to the addition of different growth regulators. Top values for callus induction and shoot regeneration were recorded in a medium with 3 mg L⁻¹ NAA and BAP. Regeneration could be useful for a mass material propagation and to enhance ornamental plant diversity (15, 16).

Studies have been done on accelerated reproduction, evaluating five media, four regeneration media, four rooting media and four growing substrates and concluding the best stem and shoot inducing medium was MS+BA+NAA, the generating medium was MS+BA+NAA+B, and rooting medium was ½ MS+NAA, growth substrates being pine+sand needles (17).

A good micro-propagation protocol could be useful for plant material production. Plant regeneration has also been directly reported from explants without callus formation or indirectly through callus induction and regeneration. There are few available reports on *in vitro* propagation of *Dahlia* spp. However, in other flower cultures like carnation and gerbera, indirect regeneration was reported from explants as apical meristems (18), floral buds and hypocotyl (19) in different media and stems as well as root regeneration took place in the callus (10).

Thus, *in vitro* propagation in the world plays an important role, since it enables to obtain large quantities of plants using little material and plants will present the same characteristics as the one that gave origin to it^G (2).

^FFernández, C.; Hernández, P.; Becerra, L. Propagación de meristemos apicales de dalia (*Dahlia spp*) *in vitro* (ensayo). [Tesis de Licenciatura]. Universidad Popular Autónoma del Estado de Puebla, Puebla, México. 1990. 92 pp.

^GFonseca, D. Establecimiento y multiplicación *in vitro* del clavel español (*Dianthus caryophyllus*) con el empleo de algunos reguladores del crecimiento. [Tesis de Diploma]. Facultad de Ciencias Agrícolas, Universidad de Granma, Cuba. 2007, 85 pp.

EDAPHOCLIMATIC REQUIREMENTS

Referring to soils, dahlia is a rustic plant, although it prefers plain soils with perfect drainage and pH between 6 and 8, with a high content of organic matter and nutrients (9). Excessive N fertilization weakens its stems, overdevelops leaves and damages flower preservation. Phosphorus and potassium make stems rigid, emphasize flower color and activate tuber maturity. Potassium invigorates the plant and encourages tuber reserve formation. It was also found that magnesium sulphate has particular impact in bloom (3).

Dahlia prefers temperatures between 18 and 23 °C, relative humidity of 75 to 78 % (5), high rainfall from 11 to 13 hours and little wind action (9).

This plant grows in sunny areas; however, it can also be cultivated in semi-shade (5). The leaf characteristics, its wide surface as well as weak stem constitution demand to be duly cultivated in protected areas from the abrasive wind action, which can raise transpiration up to inconvenient levels and also seriously give mechanical damage to plantation (3). Other authors state that it must be watered after planting, but no more irrigation is applied until sprouts do not appear unless there is a dry period, then when leaves develop large surfaces, irrigation increases (1).

CULTURAL PRACTICES

◆◆ Staking

It may be performed at two different times: before or at planting, as explained above, or when plants have reached sufficient height (25 to 30 cm) to do the first tie (9).

◆◆ Tipping or disbudding

It should be performed when new plants reach about 25 cm high, then the apical bud is removed, which promotes the development

of lateral branches and when they reach 6 inches (15 cm), they are cut into cuttings and treated as previously explained (5). Cuttings or stakes should have two or three knots without leaves (9).

◆◆ Disbudding

Flower production of good size and quality for cutting (good size and long stem) requires flowering control and guide by removing buttons and secondary buds located in the axils of the two pairs of leaves, which are immediately under the apical button; this activity must be done before such sprouts reach 5 cm, when tissues are still tender (3). Their removal will let obtain a main flower with stalks reaching 60 to 70 cm long (5).

◆◆ Desuckering

It consists of removing a high number of shoots or sprouts in tubers, allowing only the development of two or three of the most vigorous ones, ensuring shapely and vigorous plants to yield flowers with good size, shape and stem length (9). If all shoots are allowed to grow, flower production is greater in number, but of lower quality (3).

PESTS AND DISEASES

◆◆ Pests

- Aphid (*Myzus persicae*). The nymphs and adults suck sap, causing leaf yellowing and plant weakening. Also, it produces molasses on which the black fungus stays.

Control: Treatments with systemic insecticides at the onset of attacks.

- Whitefly (*Trialeurodes vaporariorum* and *Bemisia tabaci*). Direct damages are yellowing and plant weakening caused by larvae and adults when feeding, sucking sap from leaves. Indirect damages, as in aphids, are due to black fungus proliferation on bold molasses produced by whiteflies.

Control: Treatments with systemic insecticides at the onset of attacks.

- Thrips (*Frankliniella occidentalis*). Direct damages are caused by larvae and adults when feeding, especially on leaf underneath and inside flowers. One way to detect them is by shaking any flower on the back of the hand.

Control: Treatments with systemic insecticides at the onset of attacks.

- Lepidopteran caterpillars (*Spodoptera exigua*, coastal *Spodoptera*, *Heliothis armigera*, *Autographa gamma*, etc). Damages are caused by larvae when feeding on leaves and fruits. Adults are nocturnal moths that do nothing.

Control: Treatments with systemic insecticides at the onset of attacks and removing weeds.

◆◆ Diseases

- White Coal (*Entyloma dahliae*). It causes circular spots (up to 1 cm diameter) on round, elliptical or angular leaves. Spots change color from pale to brown when ripe.

- Wilt (*Fusarium* sp.): The affected plant cannot develop very well, it losses quality and dies. Its symptoms start by changing older leaf color. Its inner tissues turn reddish coffee; this damage extends towards plant top.

Control: Use healthy plant material, remove all infected plants and reduce irrigation.

BACTERIOSIS

There is bacteriosis as *Agrobacterium tumefaciens* that swells tubers; *Corynebacterium fascias* that makes galls on leaves and *Erwinia chrysanthemi* that leads to tuber rot.

Control: Discard affected plants, disinfect work tools and hands after handling diseased plants and keep foliage dry to avoid further injuries.

POT CULTIVATION OF DAHLIA

Potted dahlias can be obtained with dwarf varieties grown from seeds or vegetatively-propagated tubers after reducing its size by means of growth retardants (5).

Research on the application of phyto regulators included three types (Agromyl V, TF Biozyme, Nettle and control). Three applications of each phyto regulators were performed, whereas the manufacturer's recommended dose was applied to commercial types, and Nettle at 20 g fresh weight per liter of water. Different doses were prepared and applied to leaves. The natural breeder based on Nettle (*Urtica dioica*) showed greater height, with a value of 6 cm over 30 days which surpassed TF Biozyme growth of 5 cm and Agromyl V growth of 4 cm. Chemical phyto regulators increased leaf area and presented a larger bud number¹.

Also, other studies have been conducted on height reduction according to forms of application (foliar and substrate), frequency (all in one application or two) and rate (three doses and a control) with Unicozole-p (Sumagic). Both foliar and substrate applications were efficient in reducing the height of dahlia (*Dahlia variabilis*). It was observed that a single application of Unicozole-p (Sumagic) is sufficient. A height reduction of 40-44 % (3 ppm to substrate or 10 ppm to foliage) was achieved compared to the control over the range studied, without affecting some characteristics, such as number of flower buds and head diameter. When increasing growth regulator dose, the accumulation of total dry matter decreased in the stem and increased root/shoot ratio (20).

Others applied concentrations of 0, 50, 100, 200 and 400 mL L⁻¹ paclobutrazol to *Dahlia pinnata* Cav plants every 14 days (21). After seven dosages, the best response was observed with 400 mL L⁻¹, obtaining 45,30 cm high plants with short internodes, higher chlorophyll content as well as increased weight and volume of tuberous roots, compared to the control.

Several studies related to the effect of different growth media on the development of Dahlia in pots have been carried out (17): sand, silt, leaf mold, silt+sand, sand+leaf mold, silt+leaf mold and sand+silt+leaf mold. The best medium was sand+silt+leaf mold for almost all parameters evaluated: plant height (42,08 cm), stem diameter (1.93 cm), number of branches per plant (4) minimum days to flowering (92), number of flowers per plant (11), number of petals per flower, flower diameter (8.8 cm) and vase life duration (5 days). The medium composed of leaf mold alone also did it well with all parameters, including a maximum of 42 leaves per plant. The sand, when used alone as a growing medium recorded the lowest response and provided unsatisfactory results for all parameters.

Concerning seed varieties, between 8 and 12 weeks are required from sowing to flowering. They are most easily grown from February to May. Crop temperature should be between 18 and 20 °C. Regarding plants derived from tuberous roots, about six weeks are needed and often using pots of 20-25 cm. Fungicide treatments are given at planting time to avoid rot. The substrate used may be a mixture of 1:1:1 of sterilized soil, peat and perlite, and it is desirable that peat is enriched in potassium, as dahlia has a high intake of this element, due to its large flowering capacity. One slowly released fertilizer can be used or fertigation applied at a rate of 100 ppm of a

balanced mixture of 2:1:2. The light should be high, between 30,000 and 50,000 lux, to prevent an excessive rise in temperature (5).

CONCLUSIONS

In Cuba, the cultivation of dahlia can be an important choice for the ornamental plant marketing, as it has been poorly studied and most growers are ignorant about it. Thus, it is evident the need to apply biotechnological methods for its rapid spread and obtain new varieties and crop technology, which allows to make up a collection of dahlias adapted to the ecological conditions, consumption habits and production demands.

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