

# **PAEONIES-A LITERATURE REVIEW**

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1. Introduction

According to Stern (1946) the first reference to Paeonies is back to 370 b.c. where Theophrastus, who was a friend and disciple of Plato and Aristotle, mentions the paeony in his books on the *Enquiry into Plants*. It was not however until the seventh century, in China, during the reign of the Emperor Yang (605-617) of the Sui dynasty, that peonies were thought to have been grown as ornamental plants. (Stern, 1946).

Paeonies are perennial ornamental plants of the genus *Paeonia*. Species are divided into tree and herbaceous peonies. In the Chinese calendar it is known as “moon peony” and in Japan is a symbol of prosperity. Most cultivars are derivatives from *Paeonia lactiflora*, which originated in China (Rogers, 1996).

## 2. Origin, Varieties and form of flowers

### *Taxonomy*

Paeonies have a history of centuries of breeding and selection through which the number of chromosomes has doubled from diploid ( $2n = 10$ ) to tetraploid ( $4n = 20$ ). This increase in the chromosomes tends to produce plants better adapted to changes in their environment and therefore they have colonized new territories such as the European species *P. masculata* and *P. officinalis* and Asian species *P. lactiflora* and *P. anomala*, while the diploids *P. rhodia* and *P. clusii*, have not been able to compete and have remained confined to the Mediterranean islands. Curiously most paeonies shrub are diploid (Sang, 2004).

### *Geographic distribution*

The family Paeoniaceae is restrictive to the northern hemisphere. Its species have been collected in areas ranging from north western North America to North Africa, West and Central Europe and Midwest Russia, China, Pakistan and northern India.

The geographical area of origin is directly related to their taxonomic classification. According to Stern (1946) herbaceous paeonies are grouped into two sections: Section *Onaepia* that only includes two species whose origin is the northern United States and Section *Paeon* which subsections are subdivided into groups according to their origin, so there are for example, species from the mountains of the Caucasus, the Mediterranean and southern Europe and Asia, among others.

#### *Varieties and genetic material*

There are at least 1300 commercial varieties of herbaceous paeonies, coming from breeding programs in the United States, Holland, England, France, New Zealand and Japan (Hao, 2008). Because the Paeony bloom is very short (about 15 days), breeding programs have had to incorporate different colours and shapes, varieties that cover a wider range harvesting, obtaining very early, early, mid season, late, and too late varieties with which the offer period can be extended by 45 to 60 days.

The availability of Paeonies varies from country to country. They are very popular in the United States where there are several nurseries that can supply plants.

The situation in Europe is different because Paeonies were at the top of their popularity during the late 19th century, from which time public interest has decreased causing many varieties to disappear (The World of the Paeony year?). Fortunately this situation is being reversed and gradually the range of varieties available in Holland, England and France is increasing, mainly from material imported from USA.

U.S. and New Zealand breeders have introduced herbaceous paeonies to the market. These have pink-coral colour flowers obtained from crossbreeding of *P. lactiflora* and *P. Pilgrim* with other species. At present these varieties as Coral Charm, Coral Sunset or Coral Supreme is being marketed in the U.S. market for New Zealand producers with much success.

#### *Types or forms of flowers*

With regard to the types of flowers of peonies, care must be taken in their classification as they change considerably through the process of opening up. The shape and typical colour affected by plant age and soil where the paeonies are established. According to the Canadian Paeony Society, in the development process from the original simple type, the herbaceous peonies have acquired certain forms or types, which are described below.

Simple: usually they have between 5 and 10 large and curved petals arranged in cup shape of two rows, called guard petals; they have a centre of functional stamens and carpels. Example: var. President Lincoln.

Japanese Type: they are known as "Imperial" in the British Isles. They have "guard petals" which are large and external. The filaments of the stamens and anthers have widened, which must be present, have become extremely large and yellow. Example: var. Bowl of Beauty.

Anemone form: They have one or two rows of outer broad and curved petals. Its central part is usually is fully occupied with numerous petals arranged close together, which are derived from the stamens. They can be recognized by the complete

absence of functional anthers. They are the next step towards double flowers.  
Example: var. Gay Paree.

Semi-doubles: They tend to have a mass of stamens with petals spread across the flower. In most cases petals are a result of the duplication of the floral structure, forming a flower inside another, which is usually manifested by concentric rings of stamens alternated with petals. The carpels are very developed and the guard petals may or may not be clearly differentiated. Example: var. Buck-eye Belle.

Semi-rose: All petals have a uniform width, differing from the double type by the presence of a few stamens. Example: var. Asa Gray.

Doubles (rose type): flowers usually rounded and composed of 1 or 2 rows of large outer petals, slightly wrinkled, and internal petals arranged more compacted which gradually are tapering towards the center of the flower, as stamens and carpels have led to metalloids . Example: var. Red Charm.

Crown Type: The crown is characterized by petals that differ by origin, stamens or carpels. Example: var. Monsieur Jules Elies.

Pump type: Its name is related to its appearance. In the centre it has a raised mass of metalloids, very thick, developed from stamens and carpels. The external guard petals are highly differentiated. Example: var. Raspberry Sundae.

In general the types of varieties used as cut flowers are semi-rosa, crown, pump and double, since they have more compact buttons, more petals and greater resistance to dehydration and, therefore, better life post harvest.

3.. Cultivation and management for cut flowers

### *Growing conditions*

Paeony is resistant to cold and prefers a sunny position. They can tolerate a certain degree of shade if they are planted in rich, well-drained soil.

All species are multiplied by seeds, requiring up to 3 years to germinate. However, herbaceous species are rhizomatous, i.e. it can be multiplied through root cuttings divided in autumn or early spring. Once the Paeonies are removed, they suffer from disturbance and once transplanted they will take two or more seasons to be productive again.

The easiest and most successful propagation method is by rhizome division, during the dormant period of the plants (Barzilay *et al*, 2002). The cuts are made on the callus of fleshy roots, obtaining rhizomes which when planted produce new fibrous roots before winter. Development in spring is much more satisfactory when the division is made in early autumn.

Only robust and healthy roots should be selected for division as commercial rhizomes should have at least 3-5 buds. Rhizomes with less than 3 buds or without them resulting from the division, can lie dormant for an entire season before development occurs above ground (Rogers, 1996).

Plants can also be obtained from seeds, but this is a slow process and it currently only used when trying to form new varieties. Years are needed for germination and three more years of development are required before obtaining good flowering.

Herbaceous paeonies can be propagated in late summer by grafting, a method often used to increase the stock of new varieties (Barzilay *et al*, 2002). One or more eyes of the desired variety can be grafted onto the tuber of a vigorous, well developed variety.

It is important to propagate young rhizomes, between 3-5 years old, since the material obtained from older plants needs more seasons to go into commercial production.

To balance production on a year-to –year basis it is important to plant rotationally.. After dividing the rhizomes and planting, it will take 2-3 seasons to reach a desired level of production.

#### *Growth cycle*

The life cycle of Paeonies start by planting the roots, (also called rhizomes which have adventitious buds). These must develop a large mass of small roots before the soil cools or freezes if they are being planted in autumn (Barzilay *et al*, 2002 ). Once the winter is over, growth starts again in spring when thaw begins or the soil temperature slowly begins to rise.

Although this activity is below ground, hence unnoticed, the buds and roots continue growing under ground, until the first leaves appear on the surface and development is evident. The function of the Paeony rhizome is analogous to a bulb, as growth in spring until the appearance of functional leaves, is a consequence of the nutrients stored during the previous season.

Various growers (Barzilay *et al*, 2002 and Halevy *et al*, 2002), report that Paeonies show the following phenological stages: *Bud* in early spring; *First stage*, when buds pass to stem, characterised by its high growth rate and a red colour; *Extended leaf*,

when the foliage changes from red to green and extends the leaves; *Button*, flower buds appear, main and laterals, and growth stabilizes. The foliage mass remains in vegetative, creating reserves that will be stored and will give origin to flower buds the following year; *Anthesis*, which for cut flowers must be “skipped” as the buttons that are harvested must be decapitated to encourage nutrients moving to the rhizome and not supporting seed forming; and *Vegetative break*: foliage changes from green to red, leathery, withers and should be pruned in early autumn to prevent pest and diseases attacks.

### *Dormancy*

A cold winter is essential to obtain a good Paeony harvest, since a dormancy requirement is satisfied when the soil temperature is kept relatively low for a long period (winter months). After this cold period, the crown (central part of the plant located between the stems and roots), receives the signal to start to grow when the soil begins to warm up in spring (Rogers, 1996).

Temperature levels and long dormancy levels can be different for each species and variety. However, in general, a range of 480 to 900 hours of natural or controlled cold between  $-7^{\circ}\text{C}$  and  $7^{\circ}\text{C}$ , respectively, breaks the dormancy of most herbaceous paeonies (Halevy, 2002). For most herbaceous paeonies, producers should take into consideration its native habitat, which determines the climate and soil type they are best adapted to and their cold requirements. For example, varieties of *Paeonia lactiflora*, a native of Siberia and northern China, require a long dormancy (often more than 900 hrs of cold) to grow properly. However, native species from temperate climates like *Paeonia mascula subsp. rusii* are native from Sicily and require shorter dormancy periods.



Herbaceous paeonies establish better if they are planted in autumn, thus ensuring the good establishment of the absorbent roots. They can also be planted in spring, but in this case it is very important to provide abundant and frequent irrigation.

#### *Soil requirements*

Paeonies, like most crops, thrive better in loamy, deep, fertile, and mainly well drained soil. However, there is a wide range of soil reaction and adaptation and peonies that grow in sandy soils tend to produce more foliage than flowers, while those planted in clay soils take longer to settle but their flower production is higher. Even a clayey subsoil, if it is well drained, is very suitable when the plants are grown for cut flowers.

According to Chahin *et al*, (2003), the optimum pH to grow Paeonies is near neutral, with a range between pH 5.5 and 7.5. If the pH is higher leaves suffer chlorosis and plants will not grow at a pH lower than 6.

Most paeonies require a sunny position, as cut flowers need at least six hours of sunlight per day, however, some species whose natural habitat are forests can grow in the shade, making them suitable for mixed gardens (for example Stevens, 1993).

#### *Framework plantation*

In some countries it is recommended that frameworks of double rows of 30, 50 or 75cm on the row and 50cm between rows (44,444; 26,666 and 17,777 plants/ha respectively) are established in cut flower plantations, always leaving a corridor of 1m to facilitate harvesting on both sides (Chahin *et al*, 2003). The choice will depend on prevailing weather conditions, since a high planting density will favour the incidence of pests and diseases.

### *Planting depth*

Several authors (Stevens, 1993; Smith, 1995; and Barzilay *et al*, 2002) suggest that most Paeonies do not bloom if the buds are buried under 5cm, so it very important not to bury them too deep. However, fleshy storage roots should be sufficiently buried to allow the production of plants of fibrous roots. The ideal is to plant and then irrigate well to help the plant produce roots.

### *Fertilisation*

Paeonies, have a large biomass, grow vigorously and are large consumers of nutrients, so they need a proper and balanced nutrition plan for good production (Barzilay *et al*, 2002; Saez, 1999).

To maintain adequate nutritional levels it is recommended to have a soil analysis carried out for the assessment of nutrient availability to deliver the critical levels of both macro and micronutrients for proper nutrition of bulbs, corms, fleshy and tuber roots, and rhizomes.

Like all crops, Paeonies need most, macro and micro nutrients, but according to the soil characteristics of each plantation they require primarily N, P and K, which must be logarithmically increased in application in the second and third year (Stevens 1993; Saez, 1999). The same authors state that excessive levels of N, P and Bo, as well as deficit of K, Ca and Bo affect the quality of cut flowers.

In a general, after planting, the crop does not need further fertilization until its second autumn and subsequently, Paeonies (both herbaceous and shrubs) need two annual

fertilizations. Organic nutrition of soils with under 8% of organic matter should also be considered on an annual basis if possible, at doses of 10 tonnes/ha. Dutch experts have recommended cow manure, but by manure from sheep, pigs or rabbits is also suitable. The important thing is that it is well rotted before application.

### *Irrigation*

Although Paeonies can tolerate drought conditions, they need a supply of water, especially while blooming, so that they can achieve a good development of the plant. In general, drip irrigation is recommended as overhead watering could cause physical damage to flowers, petals and foliage and also promote diseases.

### *Pruning*

Autumn pruning of herbaceous Paeonies for cut flower production is very important as the plant starts to increase its production during the following season. This is done by cutting all the stalks or stems at the base of the crown left after harvest.

According to Pflieger, (1998) and Annon, (2009), early pruning in the autumn, when the translocation of nutrients into the rhizomes has started, also ensures protection against Botrytis which attacks the aerial tissue once the temperatures drop and through them is installed in the root may cause the death of the plant.

### *Ridging*

This consists of lifting the earth on the row so that the plants are buried in soil and protected. Ridging is performed after pruning in autumn to prepare plants to cope with low temperatures in winter and after emergence in spring to protect the buds

from late frosts. To replace autumn ridging, many authors recommend a re-covering of the row with a mulch of straw, peat or conifer branches. On the other hand, spring ridging helps to control weeds.

### *Disbudding*

Irrespective of the strength and length of the stem during the first year, all Paeony stems should be cut off to help the optimal establishment of the rhizome (Auer *et al*, 2008). In the second year, depending on climatic zone and the strength and length of the stem, it is recommended to leave one to three flower buds per plant. Ideally production starts by the third season.

As it is a factor that directly affects the harvest, it is best not to harvest flowers during the first two seasons after division or planting to allow foliage growth at the expense of flowering Rogers (1996),

In any cases, it is necessary to leave at least two thirds of the foliage on the plant to ensure the nutrition of the rhizome. It is recommended the stems are disbudded without an optimum quality of marketing.??

As the market for commercial peonies flowers require one flower per stem, it is necessary to eliminate the side buttons as they appear. This practice tends to increase the size of the main flower and stem diameter.

### *Weed control*

According to Smith (1995) one of the major limitations in the production of ornamental bulbous plants, it is the interference caused by weeds. Paeony plantations are not exempt and therefore they must be kept weed free.

To achieve this effect is strongly recommended leave the land fallow before planting and control weeds with herbicides. To avoid increasing labour costs and not to damage the buds with manual labour the use of herbicides is recommended for annual and perennial weeds.

#### *Cultural, Pests and diseases problems*

Frost damage, water logging, lack of light and wind damage are some the cultural problems that have been reported Although Paeonies are very robust plants, they require good modern management practices to prevent these problems.

Botrytis is the main problem disease for Paeonies (Annon, 2009). Its prevalence is worst in environmental conditions of high humidity and low temperatures. Its causal agents are *Botrytis paeoniae* and *Botrytis cinnerea*. Paeony crops can also be attacked by other fungi such as *Septoria paeoniae*, *Cladosporium paeoniae*, *Alternaria sp.*, *Phytophthora sp.*, *Fusarium sp.*, *Verticilium sp.* and *Rhizoctonia sp.* as well as by insects such as aphids and thrips.

To reduce the risk of damage, application of fungicides and insecticides is recommended as a routine every 10 to 15 days from the appearance of the buttons until the harvest. However the best control is prevention, starting with a field free of

diseases, healthy plants, disinfected rhizomes from previous planting, early pruning and removing plant debris in autumn (Smith, 1995).

Paeony plants can also be affected by viruses. In these cases, infected plants must be destroyed.

### *Floral abortion*

Kamenetsky, (2003) states that almost 100% of cut flower production by herbaceous paeonies in the first growing season suffers from floral abortion. This is attributed to a low development of rootlets, which prevents inadequate nutrition of the newly transplanted rhizomes and this problem may persist until the formation and full functionality of the new tuberous roots (Halevy, 2002). Others (Fulton *et al*, 2001), report a similar level ( 98%) of a floral abortion in the second season with a maximum performance of 0.2 flowers per plant.

For these reasons Stevens, (1993), recommends disbudding during the first two seasons of cultivation, in order to induce the maximum vegetative growth and best development of new tuberous roots and rootlets systems.

Water stress is, mainly in floral induction periods (autumn) and early spring combined with low humidity, low temperatures in the emergence and appearance of buttons and a sudden change in spring temperatures to low temperatures (20°C) can create problems (Kamenetsky, 2003)

### *Harvest*

Harvesting Paeony stems, of sufficient quality for the cut flower market depends on an optimal crop. The subsequent quality and vase-life of the Paeonies depends on the

conditions they experienced over the whole process of growth , harvest and post-harvest.. According to Auer, (2008), between 30 and 70% of the longevity of the cut flower is determined by condition at harvest.

Dutch producers start harvesting by the third season, hoping to commercialise 30% of flower stems, so by the fourth year, each plant could produce 10 or more stems, depending on the variety (Stevens, 1993). Care must be taken to cut one third of the stems or cut over the third leaf so as to leave important plant foliage. The removal of all foliage reduces the force or vigour in the following years.

According to Barzilay, (2002), in woody species such as roses and paeonies, there are many experiences leading to consider the optimum technical harvested when the rate of carbohydrates is the highest possible, i.e. at the time of maximum net photosynthesis, which happens in the afternoon when the temperature drops without loss of light.

Harvesting all the buttons without taking into account the state of the flowers, results in, leaving the rhizomes without food, increased labour during the process of selection and classification, and the danger of increasing the respiration of the flowers inside the cold chamber.

Flower stems should be cut at approx 75cm. or following other criteria which the market may demand..

#### *Cut-off point*

The state of development of the flower at the time of cutting is a factor in the duration of vase-life. This point varies greatly between species, each has an optimal state, by

which the button does not complete its development and does not open and after which it is not possible to store the flowers.

According to Heuser *et al*, (1986), the states of maturity for harvesting Paeonies are defined as:

State 1: Hard button, with the completely closed calyx attached to the button, showing only real colour in the very external petals.

State 2: Hard button, with a closed calyx but convex to the touch, external petals closed and showing true colour.

State 3: Calyx practically separated from the button with external petals loose or fallen.

It has been reported that state 1 is very difficult to detect and has usually been harvested and flowers do not open. State 3 carries a risk of early opening before reaching the target markets.

The interface between hard and soft buds is the optimum and therefore is recommended to harvest with plants in state 2. This would ultimately be adequate to achieve the goal of distant markets, where the biggest problem is not the journey, but the actual time that elapses from they are shipped to customer purchase. This may mean between 48hrs (local markets) and 96 and 120 hrs (international markets).

Dutch producers also harvest at State 2, making sure that their flowers can be stored for a long period to increase, in their case, the marketing period.

*Post-harvest*



Flowers are live products with biological properties that make them perishable and because they are organs in active growth, they have high respiration rates which persist post-harvest producing ethylene.

Another feature of the flowers is a high surface volume ratio due to the fine structure of petals and leaves, which causes high levels of water loss and susceptibility to mechanical damage.

Cut flowers deteriorate faster than those that remain attached to plants. This is due to the water supply at root level as also that their roots are the main producers of kinetin, a hormone related to juvenility or anti-senescence (Gast, 1997).

At the same time, during their ageing they pass through a series of transformations like dehydration, weight decrease and reserve depletion. The weight decrease is mainly due to cut flowers being unable to absorb water at the same speed with which they lost it due to transpiration (Eason *et al*, 2002). This is because the roots are the organs responsible for uptake and absorption in any other form is less efficient.

*Transfer and maintenance on camera (where does the "on camera" come in??*

Once flowers are cut, it is essential to cool them as quickly as possible to reduce their respiration and ethylene production and minimize the consumption of carbohydrates. Producers aim to continue to nourish the flowers once cut, so that they last as long as possible in the vase of the purchasers (Eason *et al*, 2002).

To do this, freshly cut flowers should be moved from the field to a cold chamber between 0 and 1°C as quickly as possible in trucks, where are stored or collected "bulk" at least for 24 hours to stabilize their metabolism to low temperatures before

being packaged (Stevens, 1993). The boxes also must be cooled before packaging the flowers.

Inside the chamber temperature fluctuations should be avoided, as these lead to development of condensation on petals and leaves and is in this free water where pathogenic organisms can develop.

### *Conditioning and packing*

Flowers are selected, sorted and packed. Selection ensures only flowers of commercial value and appears healthy and fresh. They should have stiff stems with buttons of uniform size.

Once selected, the bottom leaves are removed then proceed to make bouquets made of five or ten stems (depending on the market requirements) with buttons of the same calibre using elastic bands but care must be taken avoid causing damage to the leaves (Gast, 1997).

### *Market Process*

Cut flowers are a perishable product and must reach customers quickly to ensure the highest quality product and minimize storage costs to the grower. To do this, contact with buyers should be made as early as possible.

Marketing cut flowers for domestic markets offers several selling advantages. Auer *et al*, (2008) describe three general categories for sales: direct to consumer (farmers' market), through a single intermediary (florist, grocery stores, supermarkets), and

mass markets (wholesale, packers). Each of these groups differ in requirements, quantity of flowers they can handle and price they will pay to the grower. However, whatever market is chosen, Peonies should be sold in the bud stage with instructions to the buyer on how to open the flowers for the longest vase life.

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