RESEARCH ARTICLE

# Flowering and vegetative growth of olive tree submitted to pruning and paclobutrazol application

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## ABSTRACT

This work focuses on the evaluation of flowering and vegetative growth of olive tree submitted to pruning and paclobutrazol application under field conditions with low temperatures during the winter. Two-years-old olive plant variety Grappolo 575, were submitted to light pruning, removing apical dominance, before treatments application. The treatments were organized in a 4×2 factorial scheme, respective to four PBZ concentrations tested: 0, 200, 400 and 800 mg L-1 of PBZ and two plants groups, with and without pruning, in randomized block with four replications. Paclobutrazol concentrations tested did not affect the olive tree flowering. The plant vegetative growth was reduced until 60 days after paclobutrazol application. Pruning resulted in stimulation of emission of vegetative shoots and reduction of flowering.

**Key words:** Floral induction, growth regulators, management, *Olea europaea* L.

## RESUMO

Com o objetivo de avaliar o florescimento e o crescimento vegetativo da oliveira em plantas submetidas à poda e a aplicação do paclobutrazol foi conduzido um experimento em condições de campo com ocorrência de baixas temperaturas durante inverno. Plantas da variedade Grappolo 575, com dois anos de idade, foram submetidas a uma poda leve, retirando-se a dominância apical, antes da aplicação dos tratamentos, no mês de abril de 2009. Para a distribuição dos tratamentos, adotou-se o esquema fatorial 4×2, referente às quatro concentrações de paclobutrazol testadas e dois grupos de plantas, com e sem poda, em blocos casualizados com quatro repetições. As concentrações de paclobutrazol testadas não influenciaram no florescimento da oliveira. O crescimento vegetativo foi retardado até 60 dias após a aplicação do paclobutrazol. A poda estimulou a emissão de brotações vegetativas e reduziu o florescimento.

**Palavras-chave:** Indução floral, reguladores de crescimento, manejo, *Olea europaea* L.

## INTRODUCTION

One alternative to olive flowering encourage in Brazilian conditions may be achieved through the vegetative growth control and thus provide higher yields. This practice can be accomplished with the growth regulators application from group of growth retardants. Among the existing phytoregulators is the paclobutrazol (PBZ) which reduces the plants growth by inhibiting the synthesis of the gibberellins (Rademacher, 2000).

The gibberellins are involved in regulation of many physiological processes, including floral induction and growth regulation.

The gibberellins produced in roots appear to influence flowering by inhibiting the reproductive buds development (Goldschimidt et al., 1998). Thus, if the gibberellins are responsible for the flowering inhibition, then growth retardants that act by inhibiting the endogenous gibberellins synthesis may promote flowering (Davenport, 1990).

However, the PBZ response in flowering induction under non inductive conditions, such as the occurrence of drought stress or cold in period before flowering, can be variable due to factors pertaining to concentrations used, the absorption and the plant developmental stage at time of product application (Goldschimidt et al., 1998). In 'Tahiti' acid lime tree, the PBZ application increased the plants flowering submitted to low temperatures conditions of 16 ºC, but was not effective in flowering induction under conditions of 25 ºC day / night 20 °C (Cruz et al., 2008).

There are many works with the regulators growth application in other fruit species, however, the information about the effects resulting from growth regulators application in olive trees is still incipient. Floral initiation of olive tree requires the modification of buds latency conditions after floral induction. Buds located in leaves axils may have different fates, some remain dormant throughout life or until they receive an external stimulus, others have a vegetative or reproductive fate and others may simply fall (Rallo and Cuevas, 2008).

Among the management practices that may favor the buds dormancy breaking, pruning can be used; however for the olive tree, in production phase, the recommendations have been made only for specific situations. In general, light pruning can be made to remove branches poorly located close to the soil and shaded and those excessive, keeping the largest possible leaves number to prevent the sun direct action on branches and trunk of trees (García-Ortiz et al., 2008). A light pruning can promote the light entry in the crown and increase flowering. Tombesi (1984) observed the influence of light on flowers formation in olive and according to Muñoz-Cobo & Guillén (1989), intense flowering occurs in branches that are well lit.

In this context, this study evaluates the flowering and vegetative growth of olive trees according to pruning management and paclobutrazol application as an alternative to improve olive yield and quality in tropical conditions through its vegetative growth control.

## MATERIAL AND METHODS

The plants growth and treatments were conducted in experimental farm of Maria da Fé, located in southern Minas Gerais State, Brazil, Latitude 22° 18'50" (S) and Longitude 45° 22' 23" (W), at 1276 meters of altitude. The soil is classified as Typic, typical of region (EMBRAPA, 2006). The climate is mesothermal, with an average temperature of 17 °C. During the experimental period, from January to September, the variations of maximum (12 °C to 20 °C) and minimum (10.8 °C to 18.8 °C) temperatures were recorded, with the occurrence of 1015 hours at temperatures below 10 °C and precipitation of 1,296.6 mm well distributed. The wo-years-old olive Olea euro*paea L. plant*s, variety Grappolo, were planted using a spacing of 6×4 m. The plants were cultivated in accordance with the culture recommendations in relation to cultural practices, fertilization and pest control.

The treatments were organized in a 4×2 factorial scheme, respective to four PBZ concentrations tested: 0, 200, 400 and 800 mg $L^{-1}$ of PBZ and two plants groups, with and without pruning, in randomized block with four replications. The plants were sprayed with the Cultar® commercial product, soluble concentrate containing 250 g $L^{-1}$ of PBZ. The volume applied was determined by a test blank, with the water application carried in crown full extent (internal and external). Approximately 500 mL of solution per plant were used. PBZ was applied on leaves only once, in May 2009. Before the treatments application, half of plants were submitted to light pruning, removing the poorly located branches, close to soil and removal of branches at crown apex.

The plants response to PBZ was evaluated by determination of the leaf water potential, height growth, stem diameter, internode length, vegetative shoots number and flowers before treatment application and at 60 and 120 days after the PBZ application. Plant height was determined cervix to highest branch apex, the diameter measured at 20 cm of soil and leaf water potential was evaluated in mature leaves taken from the plant middle part in period between 5: 30 to 6:30 a.m. Measurements were carried out in abscission zone of leaf blade petiole, immediately after the leaves removal using a Scholander bomb 'Soilmoisture 3000' model, and readings expressed in MPa.

At 120 days after the PBZ application, the internodes length in shoots issued after the treatments application, from the length and nodes number these shoots, the vegetative shoots number and flowers issued were analyzed. The results were expressed as shoots and flowers number per 100 nodes. In order to monitore the soil moisture, analog tensiometers were installed at depth of 25 cm, region of most roots localization, with readings expressed in KPa (Figure 1).

The number of flowering and fruiting plants was also evaluated. Evaluations related to fruit set were not quantified due to the lack of uniformity in plants, which commonly occurs in perennial fruit species in its production first year.

The data were submitted to variance and regression analysis. The models choice was based on parameters significance tests and regression coefficient, using the t test at 5% probability. The qualitative treatments were compared by mean test.

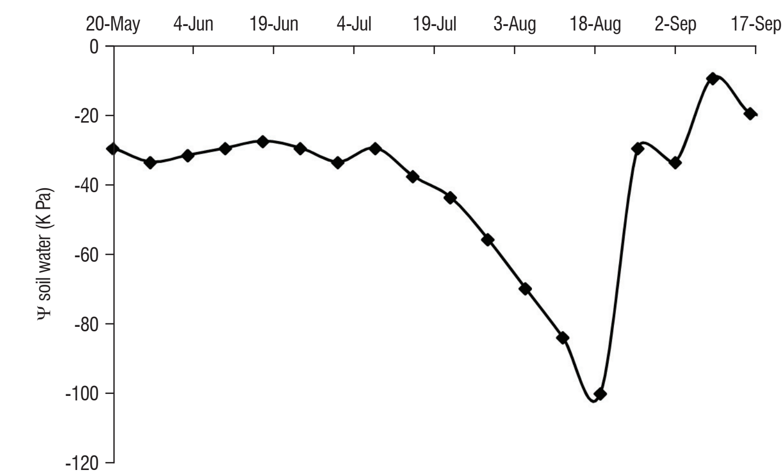


**Figure 1.** Soil water potential measured at 25 cm depth, in area planted with olive tree (*Olea europaea* L.) during the evaluation period.

## RESULTS AND DISCUSSION

The effect of PBZ on plant growth and internodes length was evaluated at 60 days after application. There was significant interaction between the PBZ concentrations and pruning for the vegetative shoots development, but no effect was observed on flowering and leaf water potential of PBZ-treated plants.

Plant height, assessed at 60 days after PBZ application, decreased by 36.8% in plants sprayed with 800 mg $L^{-1}$ PBZ compared to that of control plants. 120 days after the PBZ application no difference was observed in plant growth between the different PBZ concentrations tested (Figure 2A).

These features might have place because the PBZ exerted short term effects, likely because it was applied at leaves, or as a result of the low concentrations tested, which could not be effective in slowing the olive tree growth for a longer period required to the characteristic non-stop vegetative growth during the winter, the most effective in Brazilian conditions.

No significant differences was observed for stem diameter in plants sprayed with different PBZ concentrations, which showed average growth of 2.90 mm and 3.87 mm in stem diameter at 60 and 120 days after the PBZ application, respectively (Figure 2B). Reduction in plant growth does not occur always and should be considered taking into account the concentration applied, the product absorption and plant developmental stage at application time (Goldschmidt et al., 1998).

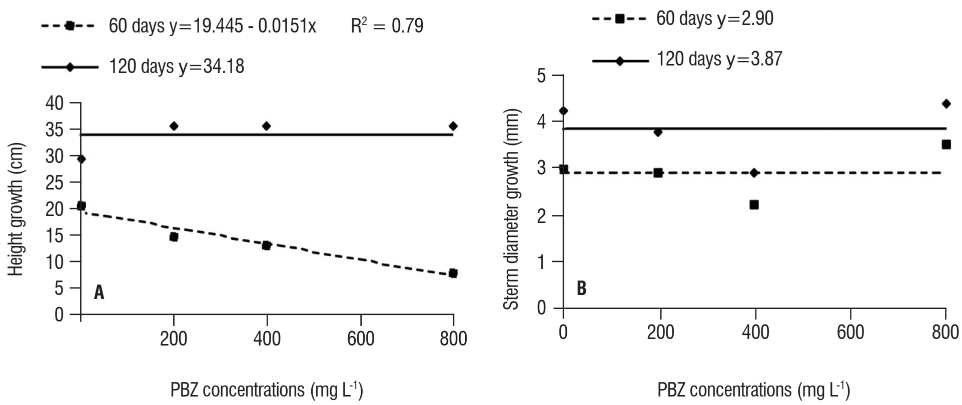


**Figure 2.** *Olea europaea* L. height (A) and stem diameter (B) growth, evaluated at 60 and 120 days after the paclobutrazol (PBZ) application.

Regarding the internodes length, plants pruning treated with PBZ concentration of 800 mg $L^{-1}$ have shoot length 37.6% lower than shoots that were not sprayed with PBZ and the plants without pruning and plants without pruning, reduction in internode length was 42.4% compared to control treatment. This difference observed in plants without pruning can be attributed to greater length found in plants which were sprayed with ethephon, which have produced higher shoot (Figure 3). The shoots development with short internodes was also observed by other researchers in citrus plants in response to PBZ application (Delgado et al., 995, Okuda et al., 1996). For the olive tree, morphological changes that increase nodes number are associated to changes that precede the production phase (Rallo and Cuevas, 2008).

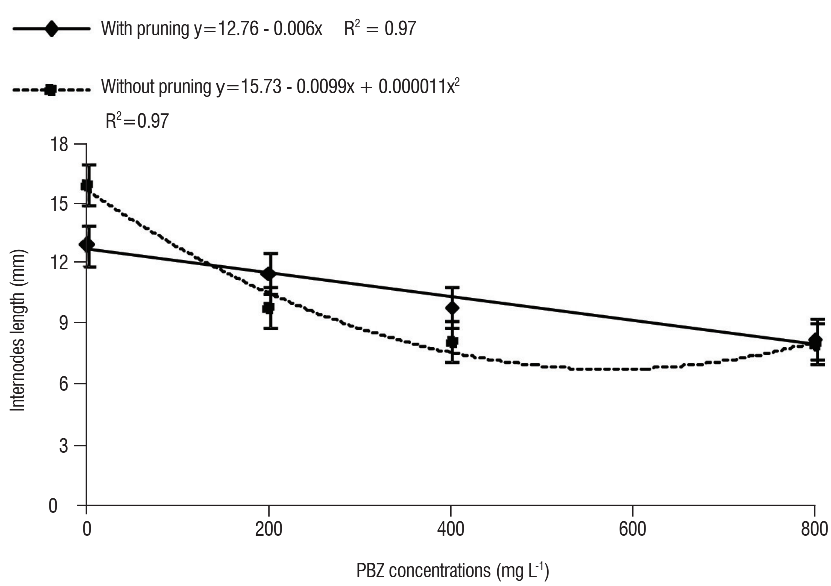


**Figure 3**. Length of internodes in the shoots of olive tree (*Olea europaea* L.) as a function of paclobutrazol (PBZ) concentration applied to leaves. Vertical bars represent standard deviation of the mean.

For the vegetative shoots proliferation, the PBZ application caused a reduction of 22.7% in plants submitted to pruning and sprayed with the concentration of 800 mg $L^{-1}$ as compared to control treatment. No decrease was observed in plants without pruning (Figure 4A). This might occur in function of anticipation in shoots issuance from plants that were submitted to pruning, before the spring starts, when probably the PBZ was active in plants. The reduction in the shoots number in citrus plants was also observed by Mataa et al. (1998). Plants submitted to pruning exhibited a greater shoot number as compared with those not pruned (Figure 4A). This feature is possibly related to the bud dormancy break.

Some buds are initiated and some of those differentiate to produce inflorescences. According to de la Rosa et al. (2000) and Rapoport (2008), although some morphological signs may be evident earlier, floral initiation can be unequivocally recognized soon after bud burst (PS53) about two months prior to flowering (PS60) in late spring. In addition to internal controls, environmental conditions following the bud burst are important determinants of floral morphology, including number of flowers per inflorescence and the proportion of staminate flowers (Rallo et al. 1981; Rapoport and Rallo 1991).

Higher number of flower buds was observed in plants that were not submitted to pruning compared to pruned ones (Figure 4B). This trait might be related to higher vegetative shoot development of these plants. Despite the pruning of plants, the branch number with buds capable of flower production, formed during last year spring, was not reduced significantly. Furthermore, in the following year, based on concept that plants flourish in previous year branches, the flowering is expected to increase.

For the flowering capacity, there was no difference between plants sprayed with PBZ regardless submitted or not to pruning (Figure 4B). However, this analysis could be negatively influenced by the absence of flowers observed in several plants (Table 1).

The percentage of plants that set fruit was equal to that of plants with flowers (Table 1). This was observed despite of the non-uniformity commonly found in perennial species during its first year of production, and of natural flowers abscission in olive tree, which according to Rallo and Cuevas (2008) can reach 96-99% in years of high flowering. The present weather conditions were also satisfactory to the flower pollination and fruit set, since the occurrence of high temperatures or other adverse factors could affect the pollination due to pollen and stigma susceptibility (Connor and Fereres, 2005).

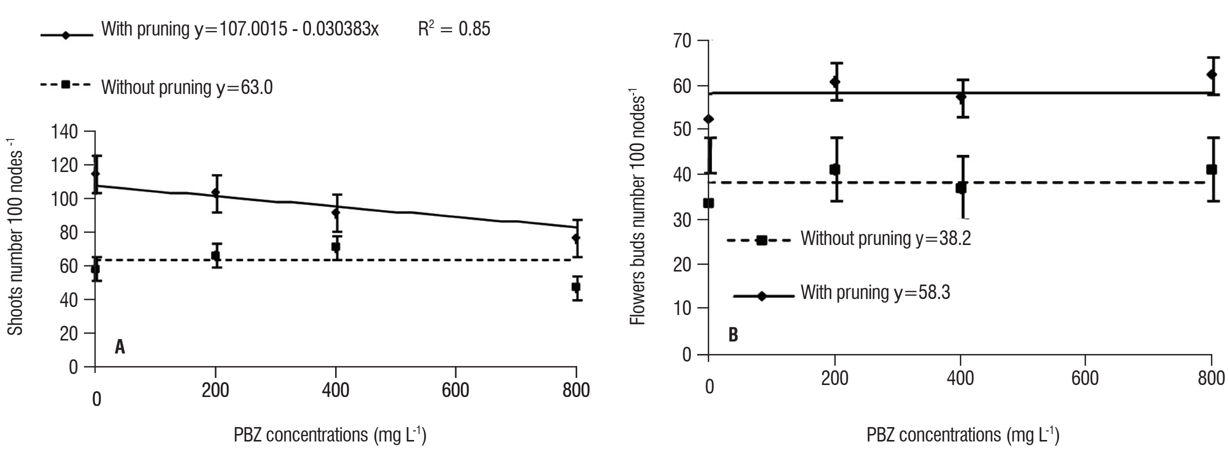


**Figure 4**. Number of vegetative shoots (A) and flowers (B) produced by olive tree (*Olea europaea* L.) as a function of paclobutrazol (PBZ) concentration applied to leaves. Vertical bars represent standard deviation of the mean.

**Table 1.** Percentage of olive tree variety Grappolo 575 treated with paclobutrazol (PBZ) that exhibited flower emission and fruit set, two years after planting.

| PBZ concentrations | Flowering (%) | | Fruit set (%) | |
|---|---|---|---|---|
| (mg $L^{-1}$) | with pruning | without pruning | with pruning | without pruning |
| 0 | 50 | 50 | 50 | 50 |
| 200 | 75 | 100 | 75 | 100 |
| 400 | 50 | 50 | 50 | 50 |
| 800 | 50 | 75 | 50 | 75 |
| C.V (%) | 44.4 | 49.9 | 44.4 | 49.9 |

Regarding to the leaf water potential, there was an increase of 70.5% at 120 days after application of PBZ, period when the plants were in full flowering, as compared to leaf water potential in plants assessed in May (Figure 5). This feature might also be influenced by the increased rainfall incidence during the period that favored the water availability in soil (Figure 1).

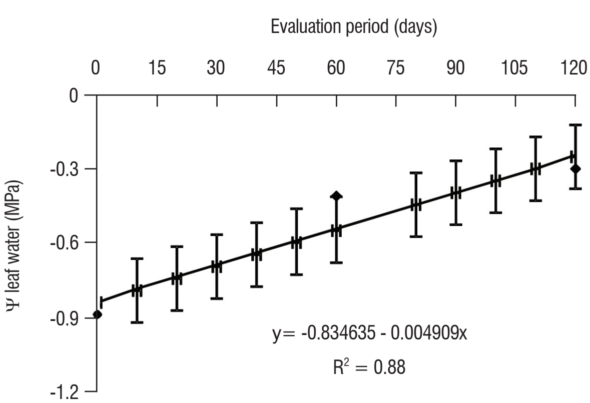


**Figure 5**. Leaf water potential in olive tree (*Olea europaea* L.) as a function of paclobutrazol (PBZ) concentrations applied to leaves. Vertical bars represent standard deviation of the mean.

## CONCLUSIONS

Paclobutrazol treatments tested did not interfere with olive tree flowering. The plant vegetative growth was slowed until 60 days after paclobutrazol application. Pruning stimulated emission of vegetative shoots and reduced flowering.

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