

EFFECT OF ORGANIC FERTILIZATION, MULCH AND NATURAL PHOSPHATE BY BIOMASS PRODUCTION, FLAVONOIDS AND INSECTS ASSOCIATED IN THE *CALENDULA OFFICINALIS*.

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ABSTRACT

The present work evaluated the effect of organic fertilization, mulch and natural phosphate by biomass production, level of flavonoids and insects associated in the *Calendula officinalis* L.. A factorial experimental design was arranged in random blocks with four replicates, where four types of fertilization (substrate utilized for sun mushroom plantation 6 Kg/m²; natural phosphate 0.02Kg/m²; mixture of substrate of sun mushroom 6 Kg/m² and natural phosphate; and the control) and two levels of mulch (with mulch and without mulch). It was recommended the use of substrate of sun mushroom as organic fertilization, since that showed tendency of higher production of dry matter and flowers number of *C. officinales*. The substrate of sun mushroom with natural phosphate showed higher tendency flavonoids levels. The substrate of sun mushroom, natural phosphate and mulch did not affected the insects.

KEYWORDS: Medicinal plants, pests, organic agriculture.

EFEITO DO COMPOSTO ORGÂNICO, COBERTURA MORTA E FOSFATO NATURAL SOBRE A PRODUÇÃO DE BIOMASSA, FLAVONÓIDES E INSETOS ASSOCIADOS À *CALENDULA OFFICINALIS*

RESUMO

Este trabalho objetivou avaliar o efeito da cobertura morta, composto orgânico e fosfato natural sobre a produção de biomassa, teor de flavonóides e insetos associados à *Calendula officinalis* L.. O delineamento utilizado foi o de blocos casualizados, disposto em esquema fatorial 4x2, sendo quatro tipos de adubação (substrato utilizado para o cultivo do cogumelo do sol 6 Kg/m²; fosfato natural reativo 0,02Kg/m²; combinação de adubação orgânica 6 Kg/m² e mineral 0,02Kg/m²; e testemunha) e dois níveis de cobertura (com cobertura morta e sem cobertura morta). Recomenda-se o uso do substrato do cultivo do cogumelo do sol como adubação orgânica, já que houve uma tendência de maior produção de matéria seca e número de capítulos. Substrato do cogumelo associado ao fosfato natural apresentou uma maior tendência de produção de teores de flavonóides. Os insetos não foram afetados pela adubação orgânica, fosfato natural e cobertura morta.

PALAVRAS-CHAVE: Plantas medicinais, pragas, agricultura orgânica.

INTRODUCTION

Calendula officinalis L. (Asteraceae) is widely used in traditional medicine, as it has been scientifically proven therapeutic actions such as: against sores, antiseptic, purifying, healing, emmenagogue, sudorific, among others (LORENZI & MATOS, 2002). Its flowers have insecticidal action to pests and pollinators attraction. The main chemical constituents of *C. officinalis* are the carotenoids, essential oils, flavonoids, saponins and coumarins (MARTINS et al., 2000; SIMÕES, 2007).

In the cultivation of medicinal plants, the use of organic fertilizer is recommended, since this improves the physical and biological soil properties, and enables correction of possible deficiencies of macro and micro nutrients (MARTINS et al., 2000) being that *C. officinalis* is not very demanding on soil fertility, needing only a high content of organic matter (MONTANARI, 2000), resulting in higher production of flowers and content of flavonoids (LEITE et al., 2005). The north of Minas Gerais has produced sun mushrooms, which results in the end of cultivation, organic compound that can be reused in the cultivation of plants.

However, the savanna soils adsorb high rate of phosphorus, it unavailable to plants, especially those from sources more soluble, which affects the balance of other nutrients and, in turn, attack from insects. An alternative is the use of natural phosphate, which gradually releases phosphorus to the soil (MALAVOLTA, 2006).

Another technique recommended for cultivation of medicinal plants is the use of mulch, by promoting lower water losses and soil (ALVES et al., 1995), reduce evaporation, soil temperature fluctuations (BRAGAGNOLO & MIELNICZUK, 1990), contamination of leaves by soil particles (MARTINS et al., 2000), and pest attack (GALLO et al., 2002).

This study aimed to evaluate the influence of mulch, organic compost and natural phosphate on the production of biomass, total flavonoids and pest attack in *C. officinalis*.

METHODOLOGY

The experiment was conducted at the Institute of Agrarian Sciences, Federal University of Minas Gerais (ICA/UFMG), Montes Claros municipality, Minas Gerais state, Brazil, in the period from May to September 2005. The design was a randomized block, arranged in a 4x2 factorial scheme, with four types of manure (substrate used for cultivation of sun mushroom 6 kg/m²; natural phosphate 0.02 kg/m²; combination of organic - 6 kg/m² - and mineral - 0.02 kg/m² - fertilizers, and control - soil without treatment) and two levels of soil coverage (with and without mulch).

We used leaves of *Paspalum notatum* Flugge (Gramineae) dry (without seeds) as mulch in a layer two inches thick. The plots had a total area of 5.4 m² each and 25 plants, and nine central plants/plot were used as the useful plot. The spacing between plants was 0.3 x 0.5 m. The substrate of sun mushroom and natural phosphate was added to soil 10 days before transplanting. *Calendula officinalis* was sowed in trays with 150 cells, and after 15 days after emergence of seedlings, transplanting was made. Irrigation was made by micro sprinkler when needed.

The flowers were collected from 35 days after transplanting (June) to the end of the experiment (September). The commercial dry weight was obtained after drying at 40°C for 40 hours. Total flavonoid level was determined in the end of *C. officinalis* cultivation (September) according to methodology adapted of SANTOS & BLATT (1998).

The number of insects and its damage were made by direct counting, weekly, in the morning, in the leaf surface (adaxial and abaxial) in an apical, median, and basal leaves of nine plants from 15 days after transplanting. When the plants began the process of inflorescence, was also evaluated the number of insects in flowers stalks and flowers, weekly, in nine plants/plot. All data were subjected to analysis of variance.

RESULT AND DISCUSSION

We did not observe significant differences among fertilization treatments (Table 1), probably due to *C. officinalis* is not very demanding on soil fertility (MONTANARI, 2000). However, there was a tendency of higher production of numbers of flowers and dry weight when used rest of substrate for sun mushroom cultivation as fertilizer (Table 1). In relation total flavonoids, there was a tendency of higher percentage of production in the treatments that were fertilized with the cultivation of sun mushroom substrate associated with natural phosphate (Table 1).

TABLE 1. Summary of variance analysis for the variables: number of flowers (N.F), dry weights flowers (D.W.), and flavonoid level (F.L.) of *Calendula officinalis*, grown with and without mulch and four fertilizer levels.

Sources of variation	D.F.	Mean square		
		N.F ¹	D.W.	F.L. ²
Block	3	47.179	256.474	0.0001532
Mulch	1	25.762	223.719	0.0001415
Fertilization	3	5.633	25.854	0.00005991
Mulch x Fertilization	3	4.056	7.666	0.00005150
Residue	21	4.511	35.518	0.00006229

$$1- \frac{\sqrt{N.Flor}}{100}, \quad 2- \frac{\sqrt{Flav}}{100} \text{ arc sine}$$

We observed higher dry weight for treatments without mulch, but which was not observed for flavonoid content (Table 2). The deleterious effect of mulch can be explained by allelopathic phenomena where there is the release of organic substances called allelochemicals during decomposition process of waste. Allelopathic effects by *P. notatum* have been observed in soybeans plants (POPE & THOMPSON, 1984). Thus, the *P. notatum* mulch can be released substances that interfere in the development of *C. officinalis*, indicating the need for further investigations. Also, may have occurred to immobilization of mineral nitrogen by soil microorganisms during decomposition of organic material used in mulch, resulting in the temporary depletion of this nutrient in soil (CORREIA & DURIGAN, 2006), because this mulch has high C/N, negatively affecting the growth and production of *C. officinalis*.

We did not observe significant effect of different fertilizations and the use of mulch in the number of insects and their attack on *C. officinalis* plants. These facts were due to, probably, the planting season, in which temperatures start to decline in the region, resulting in lower densities of insects. However, LEITE et al. (2005) observed higher production of flowers and flavonoid levels as well as attack of *Uroleucon ambrosiae* (Thomas) *lizerianum* (EE Blanchard) (Hemiptera: Aphididae) in *C. officinalis* plants in the treatment that received 6 kg/m² tanned cow dung.

TABLE 2. Number of flowers (N.F.), dry weights flowers (D.W.), and flavonoid level (F.L.) of *Calendula officinalis* cultivated with and without mulch.

Source of variation	N.F.	D.W.	F.L.
Without mulch	62.52 a	11.55 a	0.68 a
With mulch	35.34 b	6.26 b	0.61 a

Means followed by same letter in column are not statistically different between them by the test f.

We noted several insects in *C. officinalis*, ranging from an insect to every 100 to 1,000 leaves, flower stalks and/or flowers, such as defoliators *Diabrotica speciosa* Germar, *Acalymma* sp., *Systema* sp., *Colaspis* sp. (Coleoptera: Chrysomelidae) and *Lagria villosa* (Fabri.) (Coleoptera: Lagriidae), resulting, in average, 2.50% of defoliation, *Frankliniella* (Thysanoptera: Thripidae), *U. ambrosiae* f. *lizerianum*, *Empoasca* sp., *Xestocephalus* sp., (Hemiptera: Cicadellidae), *Bemisa tabaci* (Genn.) (Hemiptera: Aleyrodidae), *Coccus* sp. (Hemiptera: Coccidae), *Xyonysius* sp. (Hemiptera: Lygaeidae), *Harmostes* sp. (Hemiptera: Rhopalidae), *Eurygaster* sp. (Hemiptera: Scutelleridae), *Trigona spinipes* Fabr. (Hymenoptera: Apidae), *Liriomyza* sp. mines (Diptera: Agromyzidae), Acrididae and Tettigonidae (Orthoptera), natural enemies such as *Cycloneda sanguinea* L. and *Eriops connexa* Germar (Coleoptera: Coccinellidae), *Syrphus* sp. (Diptera: Syrphidae), Dolichopodidae (Diptera), Braconidae (Hymenoptera), *Chrysoperla* sp. (Neuroptera: Chrysopidae), spiders, and *Cephalotes minutus* (Fabr.) (Hymenoptera: Formicidae).

LEITE et al. (2006) observed low density of insects, in general, in more than 80 medicinal plants, including *C. officinalis*. This fact might be due to chemicals present in their leaves (SIMÕES, 2007) and/or because the plants were grown under an organic system, which provides the nutrients more slowly, reducing the attack of pests (MARSCHNER, 2011) and/or polyculture (ALTIERI et al., 2003). In the case of *C. officinalis*, LEITE et al. (2005) reported that the most important insects were *U. ambrosiae* f. *lizerianum* and *Aphis spiraeicola* Patch (Hemiptera: Aphididae), attacking mainly the flower stalks, forming large colonies; *Sistema* sp. and *D. speciosa* as defoliators, and *Frankliniella* sp. in the flowers. LEITE et al. (2005) observed that the intense attack of aphids in the flower stalks and thrips in flowers may have reduced the production of *C. officinalis*.

CONCLUSIONS

The use of the substrate of sun mushroom cultivation as source of organic fertilizer is an alternative for production of *C. officinalis*. The use of mulch using *P. notatum* should be avoided due to reduce in the production of *C. officinalis*. The substrate used for cultivation of sun mushroom, organic and mineral fertilizations,

natural phosphate and mulch do not effect the pest attack in *C. officinalis*.

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