

Management of Social Wasp Colonies in Eucalyptus Plantations (Hymenoptera:Vespidae)

by

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ABSTRACT

Polistes paper wasps have shown potential for the biological control of agricultural plagues. Twenty post-emergent colonies of *P. versicolor* were transferred from human constructions to artificial shelters installed on a eucalyptus plantation. We obtained 85% success in colony transference, as determined by the permanence of individuals in the colony after the colony transference. Transferred colonies stayed active at the plantation for 64.05 ± 38.43 (8-123) days. We demonstrated that post-emergent colonies of *P. versicolor* can be easily transferred to areas where they can act as biological control agents.

Key words: *Polistes versicolor*, artificial shelters, colony transference.

INTRODUCTION

Social wasps are known to prey upon caterpillars (De Souza *et al.* 2008; Bichara *et al.* 2009; Da Rocha *et al.* 2009; Picanço *et al.* 2010). In fact, the presence of *Polistes* paper wasps in different cultures is associated with decreased damage from lepidopterous pests of cotton (Kirkton 1970), tobacco (Lawson *et al.* 1961), cabbage (Gould & Jeanne 1984), coffee (Gravena 1983) and maize (Prezoto & Machado 1999a). Despite these previous works demonstrating the ability of social wasps to regulate pest populations in agroecosystems, we are not able to make general rules for social wasp management in Biological Control Programs (BCPs). This is because wasps vary greatly in their life-cycles, behavior and ecology (Raveret-Richter 2000), which reflects on the specific conditions of colony management. For example, *Ropalidia marginata* accepts colony transference to artificial shelters, while a closely related spe-

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cies, *Ropalidia cyathiformys*, does not (Gadagkar 2001). Another aspect that illustrates this situation is the social wasps' homing ability, which predicts the adequate distribution of colonies in the culture. According to species, this ability varies from 20 to 650 meters from the colony (Gobbi 1978; Hibino 1981; Giannotti 1994; Santos *et al.* 2000; Prezoto & Gobbi 2005). So, the use of social wasps in BCPs requires specific protocols for each species.

During BCPs with social wasps, colonies are managed according to the culture of interest in order to increase populations of pest enemies (Raveret-Richter 2000). So, the development of social wasp colony management techniques is an essential step for their use in BCPs. For these purposes, a variety of artificial shelters composed by wood or plastic have been developed (Kirkton 1970; Gillaspay 1979; Shang-Shiu 1976; Turillazzi 1980; Prezoto & Machado 1999b). Another required step is to know how much time colonies remain active after transference. This allows inferences to be made about the necessity of colony reintroduction in the culture. Despite its relevance, there is no information about this last topic.

Colonies of *Polistes versicolor* (Olivier, 1791) can be initiated by one or a few inseminated females, who produce one or more generations of workers, followed by males and reproductive females. These reproductive forms leave the original colonies (end of colony cycle), copulate and then, females start a new colony (Gobbi 1977). In general, colonies are less than 100 individuals (West-Eberhard 1969). Nests are fixed on the substrate by a single peduncle and larger nests can reach around 11x10 cm (Marques & Carvalho 1993). These characteristics facilitate colony transference and allow the possibility of colony self-maintenance in the culture.

Previous studies have already investigated some essential aspects that will make possible the use of *P. versicolor* in BCPs, such as the finding that (I) this species is widely found in South America (Richards 1971), (II) foragers prey upon caterpillars, when foraging in monocultures (Elisei *et al.* 2010), (III) they are able to forage 200 meters around the colony (Gobbi 1978) and (IV) they are naturally found in eucalyptus monocultures (De Souza *et al.* 2011). So, in this paper, we attempt to advance on two additional aspects. First, we describe a new technique of colony management and then we verify how much time colonies remain active after the transference to a monoculture.

MATERIALS AND METHODS

Period of study and study area

Between January and June of 2007, we transferred 20 early post-emergent colonies of *P. versicolor* from human constructions to artificial shelters in a eucalyptus plantation, both of them located in the city of Juiz de Fora, Minas Gerais state, Southwestern Brazil (21° 47'S 43° 38'W, elevation 730 m). Human constructions and the eucalyptus culture was around 25 km apart from each other. The eucalyptus plantation comprised approximately three ha of early regrowth *Eucalyptus urograndis* (*Eucalyptus urophylla* x *Eucalyptus grandis*), nearly four years old following the last felling. Eucalyptus trees varied in height from 2-10 m, interspersed with other plant species. No pesticide treatments were applied in the plantation during the study period.

Management technique

Colonies were collected at the end of the afternoon (5-8 p.m.), a period in which most of the wasps are in the colony (Prezoto & Machado 1999b). We collected colonies by wrapping them up with a transparent plastic sack (sack dimensions: 50x80 cm; 0.05 cm of thickness). To separate nest and substrate, we used a sharp tool. After colony collection, we separated wasps from the nest. To do this, we turned the sack's open side to the ground. Wasps show a very accurate positive phototropism (authors' personal observation), moving immediately to the higher and brightest part of the sack. As a result, they relocated close to the sack's open side. At this time, with the use of an adhesive ribbon, wasps were isolated in a particular area allowing the nest removal from the sack. Nests were attached to the internal central superior part of the shelter by taking advantage of the peduncle as a collage point (Super-bonder®). The shelter consisted of a white plastic box, opened only in the inferior part, measuring 13x17x11 cm (Fig. 1). The group shelter + nest were fixed to the eucalyptus plants with nails, around 1.80 meters from the ground. After the fixation, this group (shelter + nest) was wrapped by the plastic sack containing the wasps, allowing wasps to acclimate to the nests. This new group (shelter + nest + wasps) stayed wrapped by the plastic sack until the following morning, between 8 p.m.-6 a.m., and then, we removed the sack and individuals could forage freely.

Colony transference success and activity time of transferred colonies

We conducted a daily census for 123 days in the monoculture to check transferred colonies. The success of the transference technique was considered by the individuals' presence in the colony at least five days after transference. From this time on, we verified the time in which colonies were active, as determined by individuals' presence in the colonies on the following days after the colony success evaluation period. When no individual was found in the nest for three consecutive days, we considered this the end of the colony activity period.



Fig. 1. A colony of *Polistes versicolor* in an artificial shelter.

Data analysis

The relative frequency of active colonies after the transference to a eucalyptus plantation was submitted to a linear regression analysis with a 5% significance level and 95% confidence interval.

RESULTS

Successful *P. versicolor* colonies in eucalyptus monocultures were obtained in 17 out of 20 colonies. Three out of 20 transferred colonies didn't accept transference, being abandoned immediately after the transference processes (fewer than five days). The 17 remaining colonies stayed active for 64.05 ± 38.43 (9-123) days. During this period, three colonies were abandoned after a storm. In 10 colonies, activity lasted until the end of the colonial cycle and in four colonies activity was observed during the entire period of study, lasting more than 123 days.

We identified three periods (Fig. 2): The first (colony success evaluation period) was characterized by some failure in colony transference. In the sec-

ond period (stabilized period), colonies tended to stay active in the culture. In the last one (decline period) some colonies were abandoned after storm sor due to the end of the colony cycle.

DISCUSSION

The success of the *P. versicolor* colony management technique in this study (85%) was greater than that observed for previously utilized methodologies for the same species (Butignol 1992), which had a success rate of 60% using wooden shelters. So, our technique enables a cheaper and more practical method of *Polistes* colonies management.

Wasps are opportunistic insects who feed on abundant food resources (Raveret-Richter 2000), and are easily found in agrosystems (Aquad *et al.* 2010; De Souza *et al.* 2011) and urban areas (Lima *et al.* 2000, Alvarenga *et al.* 2010). Elisei *et al.* (2010), studying the foraging activity of *P. versicolor* in a eucalyptus plantation, verified that wasps foraged for nectar, water, vegetal fiber and prey. Thus, the colonies' survival after transfer to the culture was expected. However, we observed a decrease in the proportion of active colonies after transference. According to these dynamics of *P. versicolor* colony durability in eucalyptus culture, we can make some recommendations related to colony management. In the first period (1-5 days after transference) colonies

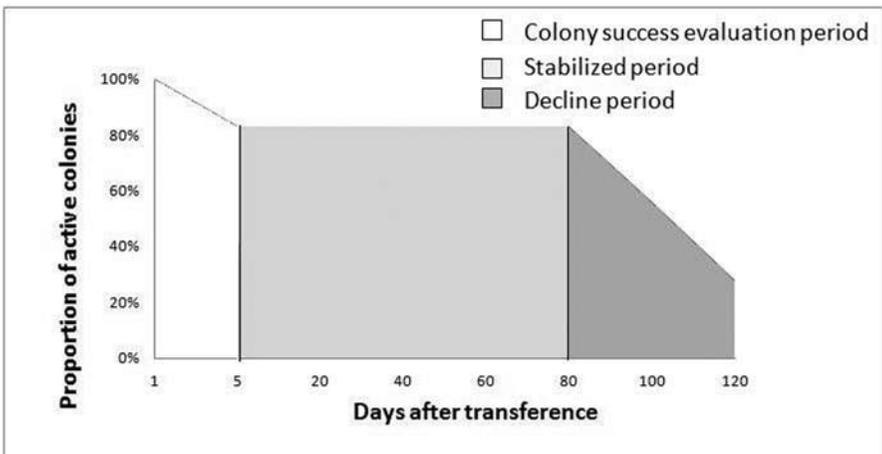


Fig. 2. Relative frequency of active colonies of the social wasp *Polistes versicolor* after transference to a eucalyptus plantation in Minas Gerais state, Brazil (linear regression: $r = 0.69$; $p = 0.04$, $n = 20$ colonies).

should be checked daily in order to detect abandonments. If so, a new colony can be established. In the second period (6-80 days after transference), visits could be less frequent because colonies are less likely to be abandoned. Since storms were found to cause colony abandonments, it seems to be reasonable to propose personal inspections in the colonies after each storm, even in the stabilized period. Visits should be intensified in the last period (after 80 days) because colonies can be abandoned due to the end of the colony cycle. These procedures could keep wasps in the culture continuously, maximizing their control of plagues and saving potential costs with pesticides.

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