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Effects of stocking rates on gastrointestinal nematode infection levels in a goat/cattle rotational stocking system

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ABSTRACT

Gastrointestinal nematodes (GIN) are increasingly resistant to anthelmintic drugs worldwide, so integrated control methods are more and more needed for the sustainability of small ruminant farming. Such methods rely on knowledge in epidemiology, physiology, and genetics. Ecological studies have highlighted the effect of host density on parasite populations, and in the humid tropics, rotational grazing systems were designed according to the survival of GIN free-living stages. This study aimed to assess the effects of mixed stocking and host stocking rate on host GIN infection level.

Four groups of 15–17 Creole male kids were raised on irrigated pasture from weaning (about 3 months) until the age of 7 months, at four partial stocking rates (pSR): 100% (control), 75% (G75), 50% (G50), and 25% (G25) of the total stocking rate of the pasture. The last three groups were associated with weaned Creole heifers to obtain the same overall stocking rate as the control. Animals grazed in a 'leader' goat and 'follower' cattle design: the G25, G50, and G75 paddocks were split into six plots; each plot was grazed by goats for 1 week and by heifers the following week. The pasture then rested for 4 weeks before the animals were returned for a new grazing sequence. Five control plots were grazed rotationally for 1 week, and rested for 4 weeks. This design was repeated three times a year for a total of 10 repetitions. Average faecal egg counts (FEC) decreased according to a power function of the pSR: $FEC = 1829\ pSR^{3.7}$. The observed death rate decreased significantly with the pSR (27.6%, 16.4%, 11.9%, and 12.2%). The kids grew faster in G25 (51 g d^{-1}) than in G50 (43 g d^{-1}) and G75 or control (32 g d^{-1}, $p < 0.05$). Heifers were not significantly infected with GIN and grew normally (about 0.48 kg d^{-1}).

Reducing the pSR by associating a non-host species in a rotational stocking system may be a very promising component of integrated GIN control, at least for the humid tropics.

1. Introduction

Since the 1950s, at least in Western countries, the development of the small ruminant industry has relied on specialisation at both the farm level and animal group level, in an attempt to transfer the methods of industrial production. Each species, and within each species each physiological stage, is reared apart, and groups of animals are further split into homogenous subgroups for nutrient or sanitation needs. These methods are pushed to the extreme in indoor poultry, pig, and dairy farming, and to a lesser extent in intensive grazing systems. The increase in productivity at pasture is at least partly obtained through an increase in forage availability (fertilisation, sometimes irrigation, rotational grazing, hay, or silage utilisation, and the use of industrial feedstuffs) and the corresponding increase in stocking rate. Unfortunately, and especially in small ruminant farming in the humid

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tropics, this increase in forage biomass may provide low ultraviolet radiation and a high-moisture environment, resulting in a higher development rate and survival of the gastrointestinal nematode parasite (GIN) free-living stages (Aumont and Gruner, 1989; van Dijk et al., 2009), which could then lead to a large increase in GIN infection. During the second half of the 20th century, cheap anthelmintic compounds allowed easy control of most GINs at the farm level, using 'preventive' or 'suppressive' treatment policies. However, by the end of this period, it became evident that many parasite populations had adapted and become resistant to these drugs (Cezar et al., 2010; Kaplan, 2004; Sutherland et al., 2008; Van Wyk, 2006). In some countries, small ruminant production is now only possible if integrated methods of GIN control are implemented (Van Wyk et al., 1997). One of the first of these methods, implemented for the humid tropics, relies on the design of rotational stocking systems based on knowledge of the infective larval development and survival dynamics (Aumont and Gruner, 1989; Aumont et al., 1991; Barger et al., 1994). The practical rotational stocking design is, thus, a compromise between parasite infection risk and forage production and quality (Archimède et al., 2000; Cruz and Boval, 2000). Grazing by different species, either at the same time (mixed stocking) or alternately, has also been reported as a possible way of reducing GIN infection in small ruminants (Jordan et al., 1988; Mahieu et al., 1997; Marley et al., 2006). Some authors (Achi et al., 2003; Amarante et al., 1997; Borgsteede, 1981; Giudici et al., 1999; Jacquiet et al., 1998; Riggs, 2001) reported limited cross infection between hosts for some GIN species (*Haemonchus contortus*, *Cooperia* spp.) but, generally, positive effects on animal production are reported. In given pasture conditions, the density of infective larvae is dependent on the host stocking rate (Aumont et al., 1991). The dilution of infective larvae (Etter et al., 2000) has been hailed as a way to ensure lower infection levels in mixed grazing systems.

Several studies have already addressed the positive effects of mixed grazing on individual performance (Abaye et al., 1994), and on the overall production of the pasture (Bennett et al., 1970; Dickson et al., 1981; Fraser et al., 2007; Hamilton and Bath, 1970; Mahieu et al., 1997; Nolan and Connolly, 1977, 1989). Most published works have dealt with the association between cattle and sheep, and very few have included goats (Celaya et al., 2008, 2007a,b; Squires, 1982) or other domestic or wild species. Some studies have highlighted a decrease in the competition for pasture resources, linked to a dietary overlap below 100% between associated herbivore species (Celaya et al., 2007b; Squires, 1982), and others have reported a decrease in gastrointestinal parasite infection (Mahieu et al., 1997; Marley et al., 2006; Owen, 1998)

To date, very few if any published studies addressing the effect of species ratio (expressed as the proportion of each species in the overall stocking rate of the pasture) on parasite infection are available. Here, we investigated the effect of goat stocking rate ratio on goat GIN infection in a goat 'leader' and cattle 'follower' grazing design in a humid tropical environment.

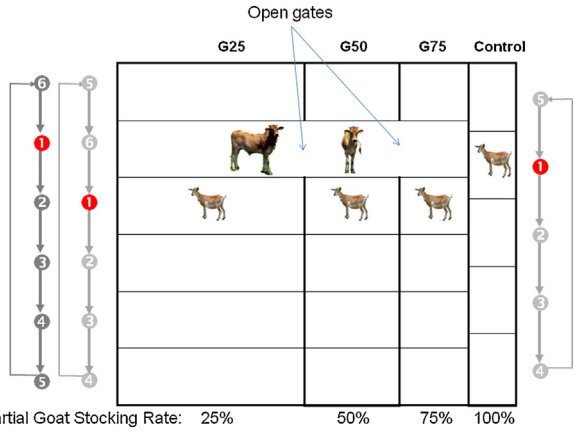

Fig. 1. 'Leader–follower' rotational grazing design. G25, G50 and G75: goat groups associated with cattle and stocked at approximately 25%, 50% and 75% of the Control stocking rate, respectively. Each group grazed a given plot for 7 days. The middle grey arrows on the left (G25, G50, and G75 groups) and right (control) indicate the goat grazing direction. The dark grey arrows on the left indicate the cattle grazing direction. The '(❶)' figure show the position of animals for the current week; the '(❷)' to '(❻)' figures show the position of animals for the subsequent weeks. Each animal group returns to the same plot after 6 weeks (G25, G50, G75, and cattle) or 5 weeks (control).

2. Materials and methods

The experiment was conducted in farm-like conditions in Guadeloupe (16°20 N, 61°20 W), at the INRA-Gardel experimental farm. The climate was oceanic-tropical: the mean monthly maximum temperature was in the range 29–31 °C, mean minimum 22–25 °C, annual rainfall 1500–2000 mm, with a dry season between January and July, and pastures were irrigated during the dry season if needed. The Creole goat of Guadeloupe is a local breed related to the West African Dwarf goat (Pepin et al., 1995), and is reared at pasture all year round, together with Creole cattle, related to West African zebu and Spanish cattle (Magee et al., 2002; Miretti et al., 2004).

Four groups of 15–17 male Creole kids were raised on irrigated pasture from weaning (about 3 months) until the age of 7 months, at four partial stocking rates (pSR): 100% (control), 75% (G75), 50% (G50), and 25% (G25) of the total stocking rate of the pasture. The goat groups were balanced according to their initial live weight and genetic index of resistance to GIN (Mandonnet et al., 2001). In order to achieve the goat pSR, the pasture area allocated for each goat group was 0.19, 0.25, 0.38, and 0.76 ha, each one split into five, six, six, and six plots grazed rotationally, respectively. The G75, G50, and G25 goat groups grazed a given set of plots for 1 week then moved to the next. The fences were then opened and 5–8 weaned Creole heifers weighing 150–300 kg live weight (kg LW) were allowed to freely graze for 1 week the remaining herbage of the three plots previously grazed by the G75, G50, and G25 groups, so we could assume that the G75, G50, and G25 overall stocking rates were automatically the same (see Fig. 1). The control group grazed rotationally its five plots, for 1 week each. Each plot rested for 4 weeks before the animals were