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Explaining variability in first grazing season heifer growth combining individually measured parasitological and clinical indicators with exposure to gastrointestinal nematode infection based on grazing management practice

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ABSTRACT

The objective of our study was to explain the variability of average daily weight gain (ADWG) due to gastrointestinal nematode (GIN) infection for 291 non treated first grazing season (FGS) heifers, from 12 independent groups in the western part of France, by combining parasitological and clinical indicators at individual level and grazing management indicators at group level. Parasitological indicators were faecal egg count (FEC), anti *Ostertagia ostertagi* antibody level (*Ostertagia* ODR), and pepsinogen level. Clinical indicators were diarrhea score (DISCO) and breech soiling score (BSS). At group level, grazing management practice (GMP), based on three variables (supplementation, month of turnout, grazing season duration), was clustered into three categories reflecting low, medium or high exposure (EXP) to GIN. Depending on the groups, turnout was from mid-March to early July and housing was from mid-October to late November, with a FGS duration ranging from 4 to 8.4 months. At turnout, the mean age of heifers was 8 months (range: 6–16 months) and they weighed between 175 and 268 kg.

In each GMP category, FEC significantly decreased between the mid-season and the housing, while *Ostertagia* ODR and pepsinogen level increased gradually throughout the grazing season. In contrast, clinical indicators did not show any seasonal variation. In a multivariate linear model, 22% of the ADWG variability was significantly explained by two individual indicators (*Ostertagia* ODR: 12.6%, DISCO: 4.8%) and by the group indicator (GMP category: 4.8%). ADWG losses due to GIN exposure (*Ostertagia* ODR) were estimated up to 39 kg per heifer for the overall grazing season. For groups within the low EXP category the difference between animals with low (<697 g/day) or high (>697 g/day) ADWG was explained by the clinical indicator DISCO. In contrast, for groups within the medium and high EXP categories this difference was explained by a parasitological indicator (*Ostertagia* ODR).

This study highlighted the value of combining both grazing management (group level) and parasitological (individual level) indicators to assess the impact of GIN on ADWG of FGS heifers. As a result, this combination might allow a better discrimination of animals or groups that may be in need of treatment in a targeting selective treatment approach.

1. Introduction

Gastrointestinal nematode (GIN) infections are very common and represent an important cause of production losses in grazing cattle in temperate regions. First grazing season (FGS) cattle are the most susceptible to infection by the 2 main nematode species, *Cooperia oncophora* and *Ostertagia ostertagi*, the latter being the most pathogenic species (Michel, 1969). The production losses for

Abbreviations: ADWG, average daily weight gain; BSS, breech soiling score; DISCO, diarrhea scoring; FEC, faecal egg count; FGS, first grazing season; GIN, gastrointestinal nematodes; GMP, grazing management practices.

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FGS cattle are related to clinical signs such as diarrhea and to subclinical reduced weight gains (Ploeger and Kloosterman, 1993).

To limit this impact, the use of anthelmintics has been and still is the cornerstone of preventive/control measures and it mainly concerns whole groups of heifers because of the relatively low costs of generic products (Ploeger et al., 2000), the ease of use of pour-on products and the lack of implementation of alternative options.

It has been widely demonstrated that growth performance of heifers in FGS could be related to the level of infection occurring in FGS animals (Ploeger et al., 1990a, 1996; Ploeger and Kloosterman, 1993). Level of infection between groups is highly variable due to grazing management practices (GMP), such as rotation and stocking rate (Ploeger et al., 1990b; Charlier et al., 2010). Variations of GIN infection may also be expected within a group, as the distribution of the number of parasites in individual cattle is overdispersed (Gasbarre et al., 2001) suggesting a genetic variability in resistance.

Using more anthelmintic treatments than necessary to prevent reduced weight gains presents several drawbacks (Vercruysse and Claerebout, 2001): (i) it could exercise a heavy selection pressure on nematode populations leading to possible emergence of anthelminthic resistance (Sutherland and Leathwick, 2011; Geurden et al., 2015; Rose et al., 2015); (ii) it could generate detrimental effects on non-target fauna in the environment (Lumaret et al., 2012); (iii) it could reduce the contact between GIN and heifers and thus diminish the level of acquired immunity at the end of the grazing season (Ploeger et al., 1994).

Targeted (herd) and targeted selective (individual) treatment are proposed as means to limit the selection pressure on nematode populations by selecting herd/group or animals to be treated that will benefit the most from treatment (Kenyon et al., 2009). Targeted Selective Treatment (TST) requires identifying the most susceptible animals to parasitism in a given group and is based on the development of reliable indicators of resistance or resilience to nematode infection (Charlier et al., 2014). In grazing cattle, previous studies showed that growth performances were negatively correlated with pepsinogen values in mid-season (Ploeger et al., 1990a, 1990b) or at housing (Dorny et al., 1999) and that higher faecal egg counts (FEC) were associated with lower weight gain (Shaw et al., 1998). Recent studies focused on individual indicators as weight gain, pepsinogen or FEC to realize TST in FGS calves (Höglund et al., 2009, 2013; O'shaughnessy et al., 2014, 2015).

Different studies assessed the dynamics and the interactions between growth performances and parasitological indicators at individual or group level separately (Ploeger et al., 1990a; Ploeger and Kloosterman, 1993). Grazing management as an indicator of level of exposure to GIN was also integrated in some studies (Ploeger et al., 1990b; Charlier et al., 2010), but a combination of individual growth performances, individual parasitological and clinical indicators as well as exposure to GIN at group level has not been pursued yet.

The objective of our study was to explain the variability in average daily weight gain (ADWG) due to gastrointestinal nematode (GIN) infection for FGS heifers, by combining parasitological and clinical indicators at individual level and grazing management indicators at group level.

2. Materials and methods

2.1. Experimental sites, animals and pastures

The field study was conducted during the 2013 grazing season and involved a total of 291 FGS heifers from 6 different field stations and a commercial farm located in Pays de la Loire, Brittany and Normandy regions i.e. in the western part of France. This large dairy cattle breeding area is characterized by an oceanic climate and a very limited altitude (<300 m) above sea level. In each farm one to 4 independent groups of FGS were followed, giving a total of 12 groups for the whole study. The number of animals per group varied from 12 to 42. Selected heifers were born according to group from December 29, 2011 to March 9, 2013. 76% were of Prim'holstein (PH) breed, 22% of Normande (N) breed and the remaining 2% crossbred. Depending on the groups, turnout was from mid-March to early July, and housing was from mid-October to late November, with a FGS duration ranging from 118 to 249 days. At turnout, the mean age of heifers was 8 months (range: 6–16 months) and they weighed between 175 and 268 kg.

Before the start of the study, each participant agreed not to treat with long-lasting anthelminthic treatment during the whole grazing season. In 2 groups, FGS heifers were treated once in mid-summer against *Dictyocaulus* infections with levamisole. Information on GMP was obtained from a questionnaire filled in by the field station's manager.

2.2. Sampling protocols and parasitological indicators

In each group, faecal and blood samples were collected for each heifer on 3 selected occasions: S1: 3 months (1.1–5.0) after turnout, S2: 1.5 months (1.0–2.2) after S1 and at housing (S3): 1.7 months (1.0–2.3) after S2. The two first sampling occasions were selected because S1 and S2 are indicators of a mid-grazing season exposure of the heifers to GIN (Eysker and Ploeger, 2000).

The individual faecal samples (5 g) were used for a faecal egg count (FEC) of gastrointestinal nematode eggs (expressed as eggs per gram of faeces, epg), according to the McMaster technique, with $MgSO_4$ as flotation solution, and with a sensitivity of 50 epg (Raynaud, 1970). Coprocultures were made from pooled faeces of each group of heifers on each sampling period. Pooled faeces were mixed with vermiculite and incubated at room temperature for 14 days. After incubation, third stage larvae (L3) were collected by the Baerman technique and identified according to Van Wyk and Mayhew (2013). The larval composition was obtained by counting and identifying a minimum of 50 L3.

Individual serum pepsinogen concentrations were determined according to Kerboeuf et al. (2002), and the values were expressed as unit of tyrosine (U Tyr). For ELISA testing, sera were diluted at 1/160 (Charlier, personal communication). Individual serum anti *O. ostertagi* antibody levels were determined, following the kit procedure, using the commercially available SVANOVIR® *O. ostertagi*-Ab ELISA kit (Svanova Biotech, Uppsala, Sweden). Results were expressed as the optical density ratio (ODR) calculated as follows:

$$\text{ODR} = \frac{\text{OD sample} - \text{OD negative control}}{\text{OD positive control} - \text{OD negative control}}$$

2.3. Clinical indicators

At each faecal sampling occasion, individual clinical scorings using faecal consistency and breech soiling, expressing faecal marks on the rear of calves, were used as potential indicators of low resistance/resilience to GIN comparable to diarrhea and dag scores in sheep (Larsen et al., 1994; Cabaret et al., 2006). Thus, faeces consistency was visually determined for diarrhea scoring (DISCO) on a scale from 0 (normal) to 1 (soft) or watery (2) (Pérez et al., 1998). Breech soiling score (BSS) was visually determined on a scale from 0 (no breech faecal soiling) to 1 (moderate soiled areas of faecal contamination: perineum and/or tailhead, and/or superficial gluteal region) or 2 (severe breech soiling).