Characteristics of the local distribution of the Y139C resistance gene in Norway rats (*Rattus norvegicus*) in a focus of resistance in Westphalia, Germany

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Abstract

The Westphalian resistant Norway rat strain is characterised by the possession of the Y139C variant of the *vkorc1* gene, and practical resistance occurs in rat infestations at different frequencies to the anticoagulants warfarin, coumatetralyl, bromadiolone and difenacoum. Within the present study we investigated whether there was an obvious pattern in the distribution of resistance in relation to the distance to an identified hot spot of resistance from the site of sampling and whether the frequency of the resistance gene was connected with local conditions, such as rodent control history.

Rats were trapped at a single infested site in each of 12 1km x 1km squares in a line including a resistance hot spot. Tissue samples were taken from all trapped rats, and genotyped for the Y139C variant of the *vkorc1* gene. The frequency of the resistance gene was determined for each site sampled. Data were also collected about rodent control measures applied in the past and other relevant local conditions.

The frequency of the resistance gene varied considerably between < 20% and > 80%. There was no obvious correlation of the frequency of the resistance gene and the distance to the hot spot, and there was no increase or decrease of the gene frequency in west-east direction. Permanent baiting and poor rodent control practice seemed to increase the incidence of resistance in the respective site. The implementation of good rodent control practice is recommended to prevent an increase in the frequency of resistance.

The study was funded by the Rodenticide Resistance Action Committee (RRAC) of CropLife International.

Keywords: anticoagulant resistance, Norway rat, *Rattus norvegicus*, rodent control, rodenticide treatment

Introduction

The Muensterland/Westphalia focus of anticoagulant resistance has been well investigated in terms of the extent of the area, where resistant Norway rats may appear, the genetics of the resistance gene, and the impact of resistance on the practical outcome of treatments using bromadiolone and difenacoum (Pelz et al., 1995; Rost et al., 2004; Endepols et al., 2011). The Westphalian resistant rat strain is marked by the Y139C variant of the *vkorc1* gene, and practical resistance occurs at different frequencies to the anticoagulants warfarin, coumatetralyl, bromadiolone and difenacoum. Studies investigating the nature of resistance were performed only on farms, which were peculiar for their rat control problems, obviously being hot spots of resistance. Such hot spots might be centers from where resistant rats disperse. In the present study, it was investigated whether there was an obvious pattern of the distribution of resistance correlating with the distance to such a hot spot. Further, it was investigated whether the frequency of the resistance gene was connected with local conditions such as geography and rodent control history in the respective site. The study was funded by the Rodenticide Resistance Action Committee (RRAC) of CropLife International.

Materials and Methods

A livestock farm known to be a hot spot of resistance was selected and situated at the centre of 12 squares, each measuring 1km x 1km, distributed in a west-east line near a small town in the eastern part of the Muensterland resistance area. In every square, a site was located with a rat infestation which permitted the trapping of at least 10 rats. We tried to avoid the selection of sites with extensive rat problems, but to find sites with less conspicuous rat infestations.

Tissue samples were taken from all trapped rats, and genotyped for the Y139C variant of the *vkorc*1 gene by the amplification refractory mutation system (ARMS)-PCR test. The frequency of the resistance gene was determined for each site. Data were collected about rodent control measures applied in the past, local geographical conditions, characteristics of livestock keeping and other relevant criteria.

Results

The Y139C *vkorc1* gene was found at all of the sites investigated. The frequency of the resistance gene varied considerably between < 20% and > 80%. There was no obvious correlation between the frequency of the resistance gene and the distance from the site of sampling to the central hot spot, and there was no increase or decrease of the gene frequency in either a westward or eastward direction from the hot spot.

Of all parameters noted for each site, those of rat control practice appeared to be most connected with the frequency of resistance. On one livestock farm, permanent baiting was performed, and all rats there carried the resistance gene. Those sites with good rodent control practice employed showed the lowest frequency of resistance.

Conclusions

The frequency of Y139C anticoagulant resistance varies much within short distances between infested sites within the Muensterland/Westphalia focus of anticoagulant resistance, e.g. less than one kilometer, which is less than the distance a rat may move in one night (Taylor and Quy, 1978). It is therefore difficult to make any conclusion about the incidence of resistance at one site based on resistance tests conducted on a site nearby. Most of the sites sampled in this study were livestock farms. Permanent baiting and poor rodent control practice seemed to increase the incidence of resistance at the respective site. The implementation of good rodent control practice is recommended to prevent an increase in the frequency of resistance. It is recommended that, if an anticoagulant is applied and found to be not fully effective due to resistance, surviving rats at treated sites should be removed entirely using one of the more potent and effective anticoagulants.

References

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