Parceling of *Penaeus vannamei* production ponds: a management strategy to improve survival against white spot disease.

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ABSTRACT

A commercial pond was divided in small plots in order to estimate the effect of size enclosure on the survival of cultured *Penaeus vannamei* shrimp with white spot disease (WSD). The strategy was to produce a homogeneization of the cohabitation by dividing the pond population into smaller populations, in order to increase shrimp survival as a consequence of the decrease of effective contacts (by cannibalism) and therefore a lower horizontal viral transmission. For this purpose, a pond was divided into three small and three big parcels. In a first experiment (92 days, warm/wet season), the parcels were stocked at the same density, and the final survival was significantly higher in the small parcels (80.2 ± 0.07 %) than in the big ones (12.0 ± 9.9 %). In a second experiment (111 days, cold/dry season), controls of shrimp WSSV prevalence (polymerase chain reaction analysis) and survival during an experimental culture were carried out in all six parcels stocked at the same density. In Exp 2, a first WSSV infection started at the same time in two parcels for each treatment on day 39 after stocking. A higher survival was observed in the small parcels compared to the big ones during the first WSD outbreak (from day 43 to 47) until day 93, although differences of WSSV prevalence were not observed. A second WSD outbreak started on day 75 after stocking in the big parcels and could have started between day 93 and 106 in the small parcels. The results suggest that a high initial number of stocked animals could be a trigger for disease transmission, while in small populations, the disease impact should decrease.

INTRODUCTION

White spot (WSD) is a mortal disease that affects all kind of crustaceans and with special virulence to shrimp. The disease is caused by the white spot syndrome virus (WSSV), an DNA virus. WSSV transmission is horizontal through waterborne contact but can be more effective through oral ingestion of infected animals or cannibalism (Chou *et al.*, 1998). The purpose of this study was to determine in the field, the influence of the production unit size and therefore the initial population size, on shrimp survival and WSSV prevalence.

MATERIAL AND METHODS

A 1-ha earth pond on a shrimp farm located in the Golf of Guayaquil, Ecuador, was divided into three large (2794 ± 123 m^2) and three small parcels (431 ± 0 m^2) using nylon nets, which allowed water circulation without exchange of shrimp between parcels. Two experiments were carried out. In the first experiment (92 days during the wet/warm Ecuadorian season), the effect of parcel size or initial population size on final survival of *Penaeus vannamei* was evaluated. In the second experiment (111 days during the dry/cold Ecuadorian season), WSSV prevalence and survival of *P.*

vannamei shrimp were studied. WSSV prevalence was evaluated through polymerase chain reaction analysis (PCR) of 67 shrimp and the percentage of infected shrimp in the sample, reported with an error less than 12 % and a confidence of 95 % Differences in survival and weight were analysed using a two-factor ANOVA model, with repeated measurements in time and with parcel size and time being fixed factors. The Duncan multiple pairwise comparison method was used to compare means when significant main effects or interaction terms occurred. In each experiment, parcels were stocked at the same density [mean ± SD = 16.62 ± 0.81 (Exp 1) and 25.75 ± 0.75 (Exp 2) shrimp m^{-2}]. All values showed are expressed as means ± SEM, except in the case of stocking density and areas. In all cases, differences were considered significant when $p < 0.05$.

RESULTS

Final survival in the first experiment was significantly higher ($p = 0.004$) in the small parcels (80.25 ± 3.99 %) than in the large ones (12.05 ± 5.73 %). In the second experiment, a first WSD outbreak took place in all six parcels between day 43 and 47, when prevalence was close to 100 % (Fig. 1). A second WSD outbreak was evident in two of the three big parcels on day 75 while we assume that the second outbreak in the small parcels started after day 93 that coincided with observed decrease in survival (Fig. 2). Time and parcel size had a significant effect on survival and a significant interaction ($p = 0.026$) between both factors was observed, mainly due to the higher change in survival for the small parcels between day 57 and day 64, when the first epidemic was ending, and between day 93 and day 106 (Fig. 2). Although there were no significant differences in the final survival, the estimated partial survivals in the small parcels were significantly higher than in the large ones until day 93 (Fig. 2). Shrimp did not grow significantly from day 93 to 106 and from day 93 to 111, in the large and small parcels respectively (data not shown). On day 93, shrimp weights were 13.73 ± 0.50 g (large parcels) and 13.00 ± 0.36 g (small parcels).

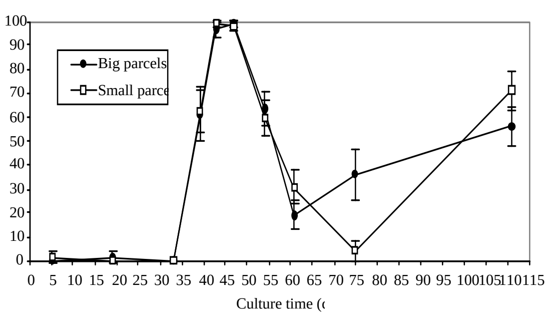

Fig. 1. WSSV prevalence (2nd Exp.).

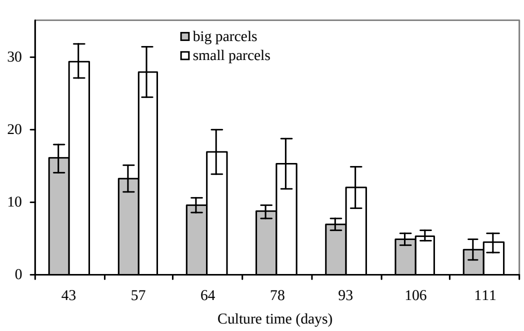

Fig.2. Shrimp survival (2nd Exp.)

DISCUSSION

The hypothesis for both experiments consisted in dividing a pond into parcels (large and small areas with the same stocking density) to decrease the risk of high shrimp density in determined zones of the pond. Big parcels, stocked with a higher number of shrimp than small parcels, should present higher WSSV prevalence and therefore higher mortality, due to the higher probability of effective contacts by cannibalism. In the first experiment (carried out under favourable climatic conditions), the final survival in the small parcels was significantly higher than in the large ones. Nevertheless, there were no significant differences in the final survival in the second experiment (carried out under non-favourable climatic conditions and with a higher density than the first experiment) The estimated partial survivals and therefore shrimp density in the small parcels were significantly higher than in the large parcels from the first WSD outbreak until 2 weeks (day 93) before harvest, when mean shrimp weight was higher than the minimum commercial weight in Ecuador (approximately 10 g), suggesting evidences in favour of the hypothesis of this study. Mortalities during the first WSD outbreak began at the same with similar prevalence in all six parcels. Therefore, it is probable that waterborne transmission should be the cause of the infection spread between the parcels, but given the cannibalistic nature of shrimp, once the outbreak began, this could be the major mechanism of viral transmission, and therefore the cause of higher mortality in the big parcels, due to a higher number of shrimp stocked than in the small parcels. After the first outbreak, as consequence of higher survival in the small parcels, the density remained higher in these parcels and could be one of the causes of the higher impact of a second WSD outbreak. The first WSD outbreak was extremely strong, since 100 % of both populations were infected. Two factors could explain the high WSSV prevalence and mortalities for both treatments: (1) the second experiment was carried out in the dry/cold season of Ecuador and, (2) shrimp were stocked at a density that further experiments carried out in Ecuador have showed to be higher than the optimum density for that season (J. Rodríguez, Fundación CENAIM-ESPOL, personal communication). Recent research has showed that the dry/cold season is an important risk factor in the occurrence of WSSV in Ecuador (Rodríguez *et al.,* 2003). In order not to interfere with the population size, the last prevalence sampling was delayed until harvest (day 111), when mortality was observed in the small parcels. However, the pond could be harvested around day 93, since shrimp of both parcels did not grow significantly between day 93 and 106. Results of both experiments are strong evidence that the parceling of a pond combined with adequate management decisions could be a potential strategy to diminish the impact of WSD.

REFERENCES

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