

## The relation between temperature and salinity with WSSV occurrence in shrimp farms in Iran: An article review

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### Abstract

Many shrimp farmers were suffering from White Spot Disease (WSD) onset in last decades. Oscillation of environmental factors could lead mortality in susceptible hosts. The results showed mortality started earlier (36h post inoculation) at 25OC in comparison to the temperature more than 29 OC as well as the salinity of 50 ppt in comparison to the lower degrees of salinities. It is concluded that the higher and the lower salinity, lesser or greater than the normal condition in exposed to WSV could lead to severe mortality of WSD. It is suggested that in site selection, in primary stage of farm designing, water temperature at more than 29OC, should be considered as key environmental factor. This finding can lead us that why the White Spot Disease occurred with high mortality in some area when the days of shrimp culture were prolonged until mid autumn.

**Keywords:** WSSV, Temperature, Salinity, Iran

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## Introduction

Shrimp culture has been a familiar industry and well extended throughout the world especially in south-east of Asia since 1990 (Sánchez-Martínez *et al.*, 2007). Among the more invasive shrimp diseases, the white spot syndrome virus (WSSV) disease is the most prevalent and widespread. It causes a sever mortality and involves entire shrimp of each farm within 7-10 days (Lightner, 1996; Hasson *et al.*, 2006). White spot syndrome (WSS) is a viral infection of penaeid shrimp and the OIE listed all crustacean as potential carriers for WSSV (OIE, 2009). A detailed review with more scientific literatures was presented to support susceptibility of 67 species (Stentiford *et al.*, 2009). The outbreak of WSD-like disease was first reported from *Marsupenaeus japonicus* in Shimonozeiki farms in Japan in 1992-1993 (Kondo, 2003; Kakoolaki, 2004). Causative agents of WSD were consequently dispersed to elsewhere in Asia and other continents where pandemics of the disease occurred (Huang *et al.*, 1995). Estimated losses due to WSSV only in Asia have been approximately 6\$ billion (Soltani *et al.*, 2009; Lightner, 2011). No statistically significant differences for weight were observed between WSSV positive and negative infected shrimp (Peinado-Guevara and Lopez-Meyer, 2006). Recent studies implied on that living organisms such as penaeid shrimp are suffering from many kinds of environmental changes specially

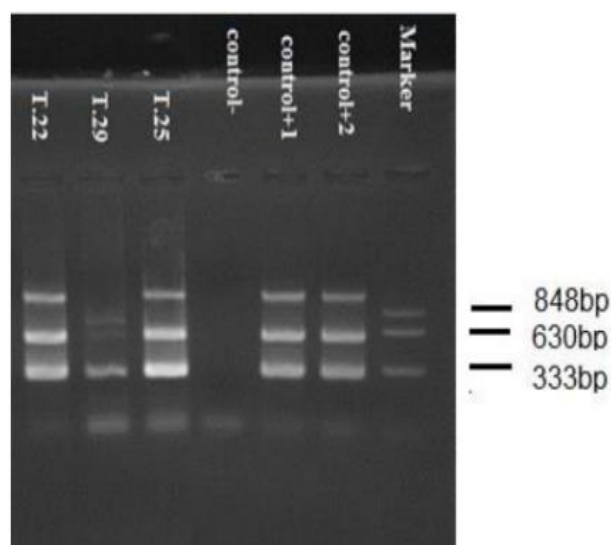
when confront acute changes (Chen *et al.*, 2014).

## Temperature

Optimum water temperature degrees are different for each phase of shrimp growth. This degree could be greater than 30°C for shrimp fewer than 5 g and be approximately 27°C for weight of 16 g and more (Wyban *et al.*, 1995). The results presented that WSSV prevalence decrease in hot months in tropical countries such as Thailand and Ecuador (Rodriguez *et al.*, 2003; Withyachumnarnkul *et al.*, 2003). The probable mechanism of warm water responsible for lowering percent of WSSV prevalence is prohibition of virus replication (Granja *et al.*, 2006) or increase of immune response level of exposed shrimp specially in function of apoptosis (Vidal *et al.*, 2001). Higher degree of water temperature ceases gene expression of VP28 which is pathogenic envelope protein (Rahman *et al.*, 2006; Reyes *et al.*, 2007). Feder (1999) confirmed that 92.5 percent of shrimp of treatment 31°C survive 40 days after exposure with WSSV whereas entire shrimp of treatment, 25°C were died 12 days post inoculation. Similar result implied on the role of 30°C of water temperature on prophylaxis of WSSV replication in shrimp, *L. vannamei* (Kakoolaki *et al.*, 2014c). Rahman *et al.* (2007) claimed hot water help to immune system in acute phase without clinical signs but in chronic phase with clinical signs could not collaborate the immune system. Iran

farmers were firstly involved with WSSV in Abadan in 2002 when the days of culture were reached autumn with 3-10°C daily water temperature fluctuations. The epidemic extended to Bushehr province in 2005 with tremendous commercial losses. Iranian Fisheries Research Org. then made a research to substitute a new WSSV-resistant species, *Litopenaeus vannamei*. Nowadays, it applied throughout Iran and approximately 98 percent of the farmers utilized this species (Afsharnasab, 2012). Small size of the ponds (Kakoolaki *et al.*, 2014a) abrupt alteration in physico-chemical criteria specially higher degrees of water salinity and lower water temperature (Kakoolaki *et al.*, 2011; Kakoolaki *et al.*, 2014d) and

persisting on the days of culture in the shrimp farms until colder days (Tokhmafshan *et al.*, 2004) resulted in few epizootic of White Spot Diseases (WSD) (Afsharnasab *et al.*, 2005). In Iran and according to the figure 1, it seems that the load of the virus for the temperature of 29-30°C was lower than that of the 22 and 25°C. In addition, the cumulative mortality for the temperature of 29-30°C showed (Fig. 2) a lower slight slope with the postponed occurrence in contrary to those of 22 and 25°C. (Kakoolaki *et al.*, 2014d). This result was accordant with findings of Granja *et al.* (2006) and Rahman *et al.* (2006) that showed the load of White Spot Virus (WSV) is reduced when the shrimp maintain in higher temperature.



**Figure 1: The positive result of PCR for the WSV of the pooled samples from each treatment (IQ2000, WSV commercial kit).**

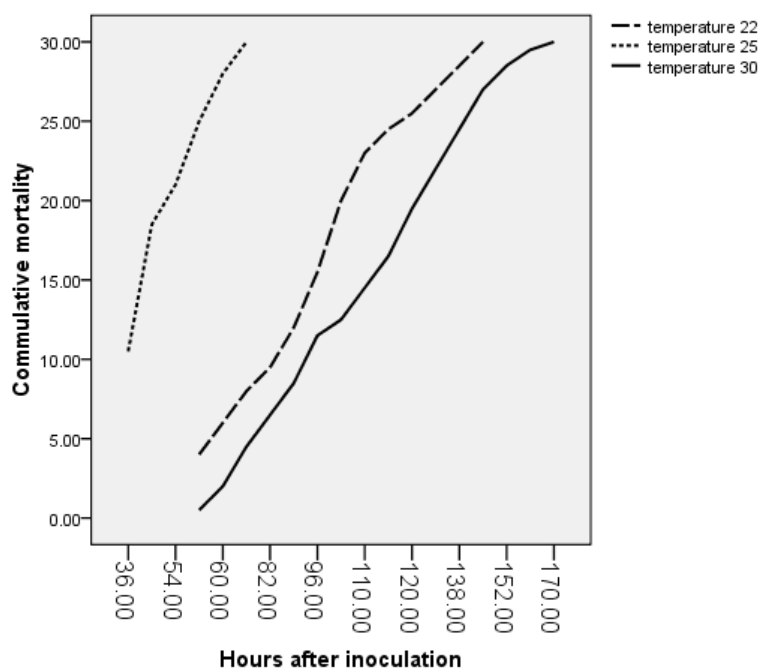


Figure 2: Cumulative mortality in different temperature (22, 25, 29-30 °C).

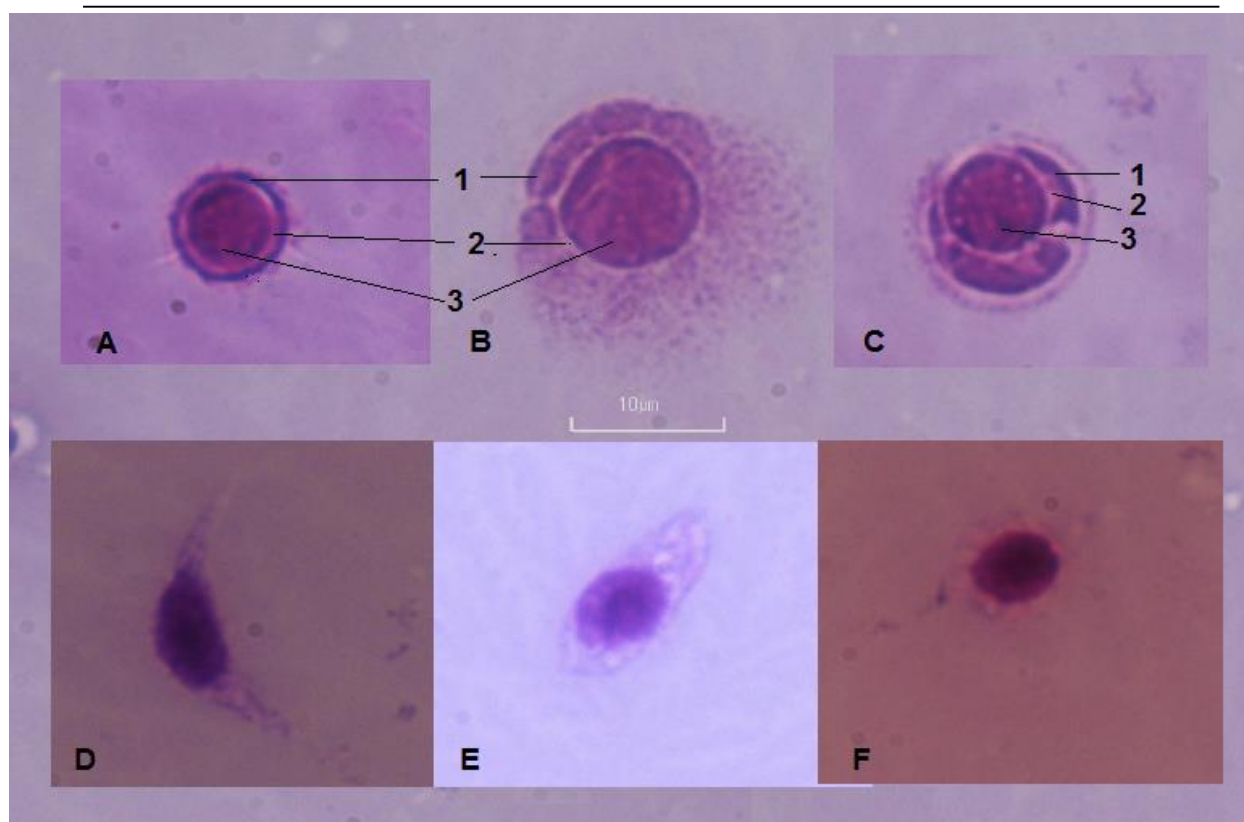
WSSV Outbreak 1 week after rainfall and consequent 3°C temperature fluctuation in range of 26-31°C in different ponds of a site in Mexico suggested a related between the two events due to abruptly changing water physicochemical parameters (Peinado-Guevara and Lopez-Meyer, 2006).

No significant water temperature fluctuation with the range of 28.5-30 °C and better preparing management of culture ponds specially such as pond bottom plowing and drying, lower ammonia (0.05 to 0.02 ppm in the first to the next months of culture, respectively) in Chabahar shrimp site of Iran (Kakoolaki *et al.*, 2014a) helped immune system of the shrimp to resist against WSSV. In the other hand and regardless the worth management site factors in Hormozgan farms in comparison to other provincial shrimp site of Iran, shrimps of Hormozgan farms did not show any sign of WSSV.

It could be due to the permanent higher degree of water temperature above 29-30 °C (Kakoolaki *et al.*, 2014d). In last years, shrimp farmers interested in increasing the area of shrimp ponds from 0.7 -0.8 ha to 1.4-2.4 ha and use of imported *L. vannamei* as main species instead of *F. indicus* (Kakoolaki *et al.*, 2014d; Kakoolaki *et al.*, 2014e). The result of that showed a decrease WSSV outbreak potential in Bushehr province. The farmers of Bushehr province have no any sign of WSSV outbreak for last 3 years in contrary to Khuzestan and Sistan & Baluchestan provinces where the farmers were annually suffering. Climate changes in Khuzestan and Sistan & Baluchestan were more fluctuated against Bushehr (Kakoolaki *et al.*, 2014a; Kakoolaki *et al.*, 2014e; Kakoolaki *et al.*, 2014f) specially in second half of doc (days of culture) when some stressors such as higher

stocking, extra feeding, oxygen depletion resulted in increasing the susceptibility of shrimp to WSSV infection. According to the former results, water temperature level reached 30-32°C in Bushehr in late summer against temperature fluctuated conditions in 2 other provinces. Due to lack of paddle wheels or proper electricity in the provinces, it is predicted the sever WSSV outbreak will be occurred if improper climate condition will be observed (Kakoolaki *et al.*, 2014e). Based on our results, reducing the transparency of the pond water as well as decrease early morning dissolved oxygen were more problems of the farmers throughout Iran in late of summer and first of autumn due to high levels of temperature, humidity and shrimp size. Sometimes, especially during humid nights when there was no wind or electricity, farmers apply diesel agriculture pumps to refresh the pond waters through water falling model in order to increase the exchanging gases between water layers and air but this implementation could not be enough. Lack of WSSV occurrence in the late course of our study could be due to higher water temperature more than 29-30°C (Kakoolaki *et al.*, 2014b) but any

temperature fluctuation or lower temperature degree in late of summer in future years could be resulted in severe WSSV outbreak. (Kakoolaki *et al.*, 2014a; Kakoolaki *et al.*, 2014e). The risk of WSSV outbreak is reduced when the water temperature goes up and salinity fluctuation is low (Tendencia *et al.*, 2010). They confirmed that low atmospheric temperature is a hazard indicator in the development of WSSV in cultured shrimp *Penaeus monodon*. They showed that rainfall is also a risk factor. Stressors are usually related to the physico-chemical properties of both water and pond bottom. Stress factors could make shrimp to be more susceptible to WSSV infection (Takahashi *et al.*, 1995). Esparza-Leal *et al.* (2010) showed if days of shrimp culture extend to autumn, the susceptibility to WSV among the exposure shrimps could be increased. This type of temperature effectiveness was mostly similar to the first outbreak occurred in Abadan in 2002, when the farmers intended to postpone the harvest time due to larger size demand for export (Afsharnasab *et al.*, 2004). Some WSSV infected hemocytes are shown in Fig. 3.



**Figure 3: Shows hemolymph Infection; A-C) Infected hemocytes, 1: hemocyte Marginated nucleus, 2: cowdry type A inclusion body, 3: inclusion body, D-F) Uninfected hemocytes: MGG staining, Scale bar: 10, ×100.**

### Salinity

One of the major environmental factors to develop WSSV or impact on growth is salinity (Pequeux, 1995; Kakoolaki *et al.*, 2011). Salinity alteration affect on osmo-regulation, material metabolism, oxygen consumption, growth and survival rates (Pequeux, 1995). He believed the optimum salinity For *Litopenaeus vannamei* in south of America is below 20 ppt but due to variety of ecosystem in Persian Gulf countries, 40 ppt could be optimum degree to promote growth for imported

*L. vannamei* from south of America (Ramezani Fard, 2006a). *L. vannamei* can tolerates wide range of salinity from 5 up to 45 ppt (Green, 2008).

Kakoolaki *et al.* (2011) presented the mortality at the salinity of 30 ppt began at 72 h after inoculation with WSSV as well as the salinity of 40 ppt but at 50 ppt started after 50 h. This result showed a condition with greater or lower salinity degrees than optimum (40 ppt) in expose to WSSV could be lead to sever mortality (Fig. 4).

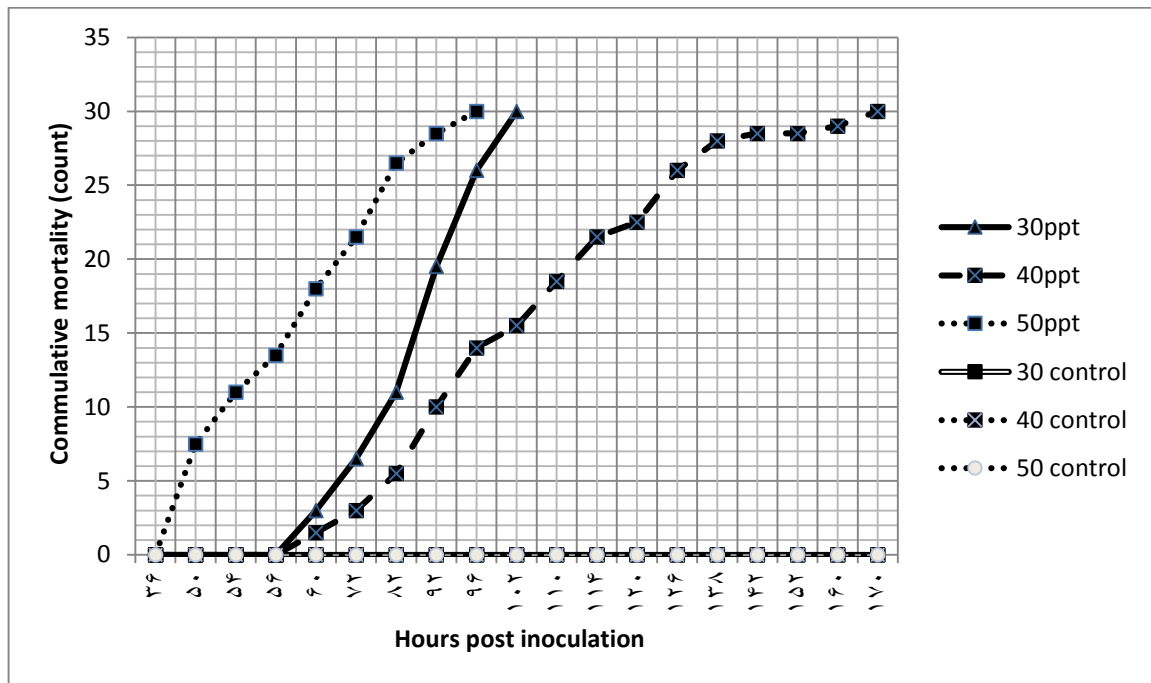


Figure 4: Cumulative mortality for different water salinities in an experimental study after expose with WSSV.

They confirmed that the salinity of 30 ppt could be better condition for multiplication of WSSV among 30, 40 and 50 ppt. This is contradicted to our non- experimental previous believes that the lower temperature than optimum is the better degrees against WSSV. They showed that this mortality continued with a faster trend resulting in shorter survival durations at 30 ppt and followed by 50 ppt but the mortality trend in 40 ppt is slower and the survival duration is longer than those of 30 & 50 ppt. It was likely that the severity of the disease in treatments of 30 and 50 ppt (lower and greater value than the normal condition) were greater than the salinity of 40 ppt and shrimp in 40 ppt have more time to retrieve the injured tissues or resist relatively against the viruses. Similar to our results, in the case of salinity of lower levels, Carbajal- Sanchez *et al.*

(2008) believed that lower salinity shows a severe trend of mortality in *L. vannamei* in comparison to the normal and greater levels normal condition. Based on our results the shrimp reared in salinity of 50 ppt (high salinity level) were died faster (less than 3 days) in comparison to 40 and 30 ppt. In the other study which was done in Iran the growth rate of the shrimp, *L. vannamei*, which reared in salinity of 40 ppt, was greater than that of 30 ppt (Ramezani Fard, 2006b).

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