International Letters of Natural Sciences Vol. 46 (2015) pp 76-83 Online: 2015-09-11
© (2015) SciPress Ltd., Switzerland
doi:10.18052/www.scipress.com/ILNS.46.76

Identification of Critical Periods Environmentally Sensitive to Normal Performance of Vanaraja Poultry Breed in Climatically Different Locations

Doni Jini[1], Kaushik Bhagawati[1*], Rupankar Bhagawati[1], Deep Jyoti Rajkhowa[2]

[1]ICAR Research Complex for NEH Region, Arunachal Pradesh Centre, Basar, India
[2]ICAR Research Complex for NEH Region, Umiam, Meghalaya, India
*Corresponding Author: kaushik.iasri@gmail.com

Keywords: Ambient temperature, humidity, Climate Change, Vanaraja, Poultry

ABSTRACT

Ambient temperature and relative humidity are two crucial climatic factors that heavily influence poultry production and management. Knowledge of the period during which the environmental conditions remains detrimental is crucial for successful and economic poultry production and resource management. The objective of the study is to identify and comparatively assess the most crucial months/periods during which the climatic condition hinder normal performance of dual purpose Vanaraja poultry in topographically and agro-climatically distinct locations. The average monthly temperatures and humidity of each location were compared with established critical limits of ambient temperature and relative humidity that influence poultry for the location. Results reveal that there are wide inter-location variations in sensitive period during the year and affect the performance of the introduced poultry with varied intensity. Also the cultural & management practices should be location-specific with incorporation of need-based seasonal modification leading to optimum resource use. With critical periods in mind farmers can adopt/frame appropriate and well-timed management practices to alleviate impact of adverse environmental conditions.

1. INTRODUCTION

Climate is the basic input in livestock sector and understanding livestock-climate interrelationship is vital for their production and management. Climate significantly affects the livestock sector especially poultry through direct impacts on their physiological processes and behavioral changes. Temperature and humidity are two most significant environmental factors that determine performance of poultry birds [1]. The detrimental effects of a heat stress on the performance of poultry have been well documented [2]. Poultry birds can only tolerate narrow temperature ranges to sustain the peak of their production, for any deviation from the range they need to triggers their thermoregulatory mechanisms for survival which have negative consequence on their performance [3]. The temperature range and its effect on performance of poultry are shown in Table 1. High temperature results in reduction of poultry live weight [4], growth rate and high mortality in addition to a decrease on productivity, hatchability and quality of eggs [5].

Chronic (prolonged period of high ambient temperature) heat stress is more detrimental [6. During the heat stress period the increase in body temperature has a negative effect on the fertilization process [7]. Also, when the temperature falls below the thermoneutral zone of below 12.8^{0}C, the egg production and efficiency of laying hens are affected [8].

The higher humidities favor better growth and feed conversion but induced outbreak of disease through creation of favorable environment for breeding of pathogens. Humidity aggravates the effect of temperature. The optimum humidity range was found to be between 50-75%, which may vary with breeds. Also, relative humidity level above 75% causes reduction in egg laying [1].

Table 1. Established ambient temperature range and their impact on performance of the poultry.

Temperature Range*	Effects
12.8°C -23.9°C (55°F-75°F)	Thermal neutral Zone. The temperature range in which the birds does not need to alter its basic metabolic rate or behavior to maintain body temperature.
18.3°C-23.9°C (65°F-75°F)	Ideal temperature range for poultry production. At this range the performance is optimum.
23.9°C-29.4°C (75^{0}F-85^{0}F)	Slight reduction in feed consumption and increase in water intake. The birds cope with it with adequate nutrient intake. Minor reduction in egg size and quality may be observed
26°C-28^{0}C (79°F-82°F)	Laying hen perform best at this temperature range
29.4°C-32.2°C (85°F-90°F)	Weight gains are lowered. Egg production usually suffers. Cultural measures may be induced to lower temperature inside housing. If condition remains for prolonged period, there may be loss in body weight.
32.2°C-35°C (90°F-95°F)	Heat stress is prominent. Food intake drastically lowers. Body weight gain reduces significantly. Water intake increases. Body weight drops and egg production decreases by continuous exposure to the condition.
35°C-37.8°C (95°F-100°F)	Heat prostration is probable. Emergency measures may be needed. Egg production and feed consumption are severely reduced. Water consumption is very high
>37.8°C (above 100°F)	Survival is the concern at these temperatures. Emergency measures for cooling is must.
<12.8°C (below 55°F)	Body weight gain reduces which can be attributed from the fact that energy is required to keep body warm. Mortality may occur at very low temperature. Egg production is affected.

*The range vary for poultry breeds and with relative humidity

Thus the growth of the sector presents both enormous opportunities and challenges to the farmers, especially those residing in Himalayan regions like Arunachal Pradesh where poultry is emerging as an important economic factor for livelihood improvement and nutritional security. Around 85 percent of rural house-hold in Arunachal Pradesh keeps poultry (mostly local breed) generally in their backyard. Though the local breeds are tolerant to their environmental conditions; their size, body weight gain and egg production are very low. Keeping in view the local preferences, systems, limitations and climate, dual purpose poultry variety Vanaraja was introduced to promote poultry as an economic enterprise. Their multi-location trials reveal comparatively better performance than local breeds [9]. But, the performance is not uniform because of wide variation in topography and agro-climatic conditions within the state (five different agro-climatic zones). Inter-location variation in seasonal effect of respective environmental condition is vital. Knowledge of the period during which the environmental conditions remains detrimental is crucial for successful and economic poultry production and resource management. The purpose of this paper is to identify and comparatively assess the most crucial months/periods during which the climatic condition hinder normal performance of dual purpose Vanaraja poultry in topographically and agro-climatically distinct locations for focused and economic management and decision making. The idea was to find the thermal comfort zone of the bird for each location.

2. MATERIALS AND METHODS

Study Site

The study was conducted during 2011-2014 in West Siang District of Arunachal Pradesh in Eastern Himalayan region of India between 93°57´-95°23´E latitude and 27°69´-29°27´E longitudes. Three sites were purposefully selected within the district to represent geographically and agro-climatically distinct locations (Table 2). Seasons were broadly classified as Hot Season (June to September) and Cold Season (November to March).

Table 2. Three geographically and agro-climatically different selected study sites

Sl	Location	Hill Type	Altitude Range (meters-msl)	Agro-Climatic Zone *	Yearly temperature range
1	Mechukha	High Hills	2000-6000	Temperate to Alpine Zone	-0.5^{o}C – 24.0^{o}C
2	Basar	Mid-Hills	600-1000	Subtropical-Hill Zone	2.0^{o}C – 36.0^{o}C
3	Likabali	Foot-Hills	150-400	Tropical Zone	10.0^{o}C – 39.0^{o}C

*Agro-climatic zone division as per NARP, ICAR, New Delhi

Methods

Dual purpose poultry breed Vanaraja was introduced to each selected farmers at the age of 3-4 weeks in the month of March in the selected sites. The daily temperature (minimum and maximum) and relative humidity of the locations were recorded. The major performance indicators selected were: body weight gain, seasonal disease mortality and egg production. Therefore, following three main comparative studies were done:

a) Identification of periods during which the ambient temperature affects poultry performance (based on reference level of Table 1). Three years monthly average maximum temperature during hot season and minimum temperature during cold season were compared with critical ambient temperature. Lower Critical Temperature (LCT) (12.8^{o}C) is the effective ambient temperature below which the livestock must increase heat-production rage to achieve heat balance. While Upper Critical Temperature (UCT) (32.2^{o}C) is the ambient temperature above which the livestock must increase heat loss rage to achieve heat balance. It is obvious that minimum temperature during hot season and maximum temperature during cold season does not cause any heat or cold stress.
b) Monthly average relative humidity of three locations was compared with safe limit (50-75%).
c) Identification of periods during which the ambient temperature affects laying hens and egg production. The three years monthly average maximum temperature during hot season and minimum temperature during cold season were compared with recommended temperature range.

For graphs and analysis, Minitab 17 software was used.

3. RESULTS AND DISCUSSION

Effect of ambient temperature on growth performance

The comparison of average monthly temperature with critical ambient temperature range for poultry is depicted in Fig.1. Season-wise significant findings were as follows:

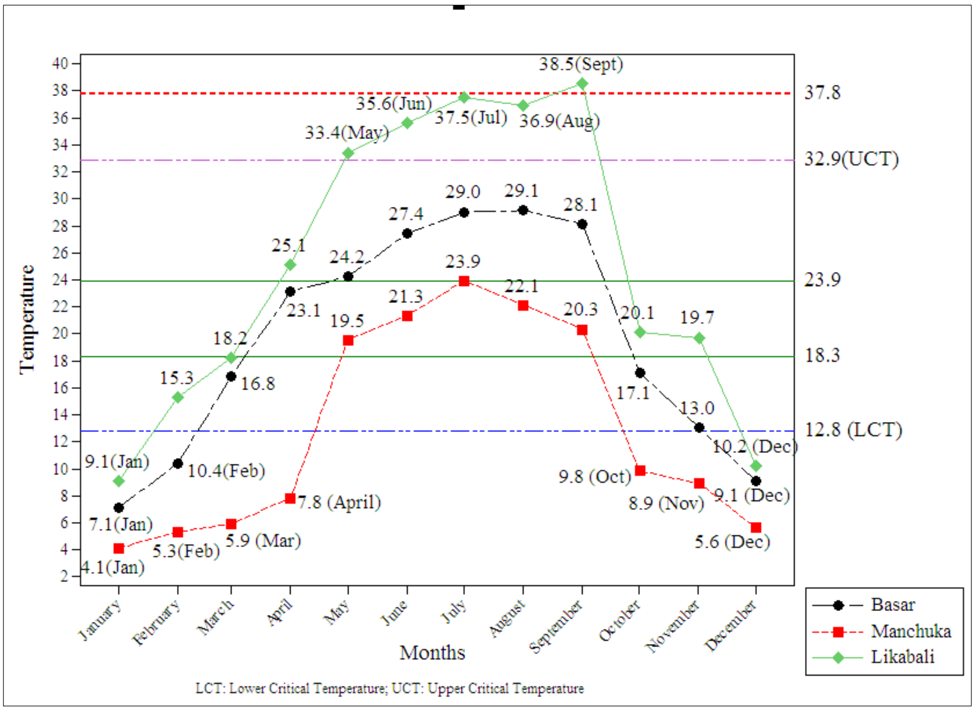

Figure 1. Comparision of three years average monthly temperature with critical ambient temperature limits influencing poultry performance. UCT denote the upper critical temperature and LTC denotes lower critical temperature. Temperatures below LCT and above UTC affect the normal performance of the poultry bird.

a) **Hot Season:** The ambient temperature in Basar and Mechukha remain below UCT (32.9°C). There was some isolated case of acute heat stress in Basar during the months of August-September, but no chronic stress was observed. The temperature during June-July in Basar remains low due to continuous rain. While in Mechukha the night temperature sometime (in the months of May) falls below LCT (12.8°C) that lowers body weight gain because of the fact that some energy gets lost to keep body warm. The ambient temperatures in Likabali during hot season exceed UCT during the months of May to September. There were both incidence of acute and chronic heat stress during these months. Chronic stress, mainly during months of July to September, have deleterious effects and sometime lasts for 20-28 days during the month of July and August negatively affecting the growth rates, feed efficiency and carcass quality in poultry reared for meat purpose. Studies found that chronic heat stress negatively affect fat deposition and meat quality in all birds [10]. The very high ambient temperature (>37.8°C) generally during the month of September is very disastrous resulting mortality and call for emergency measures. The mortality due to heat stress was significantly high in heavy meat type chickens (8.4%) due to rise in ambient temperature above 34°C [11]. Peak mortality during summer month was recorded in the earlier studies [12].

b) **Cold Season:**The effect of cold season is most significant in Mechukha with almost all months (October to April) experiencing minimum temperature below LCT. The performance of breed was severely affected leading to lower body weight gain and mortality due to extreme cold. This is accordance with the earlier study that lower temperature greater portion of the food intake are utilized to generate heat which adversely affect body weight gain in poultry birds [13]. While in Basar and Likabali the ambient temperatures were below LCT only during the months of November to January and December-January respectively without any significant influence.

Effect of humidity on performance

Comparison of the average monthly relative humidity of each location with the critical limit is depicted in Fig 2. The main findings were:

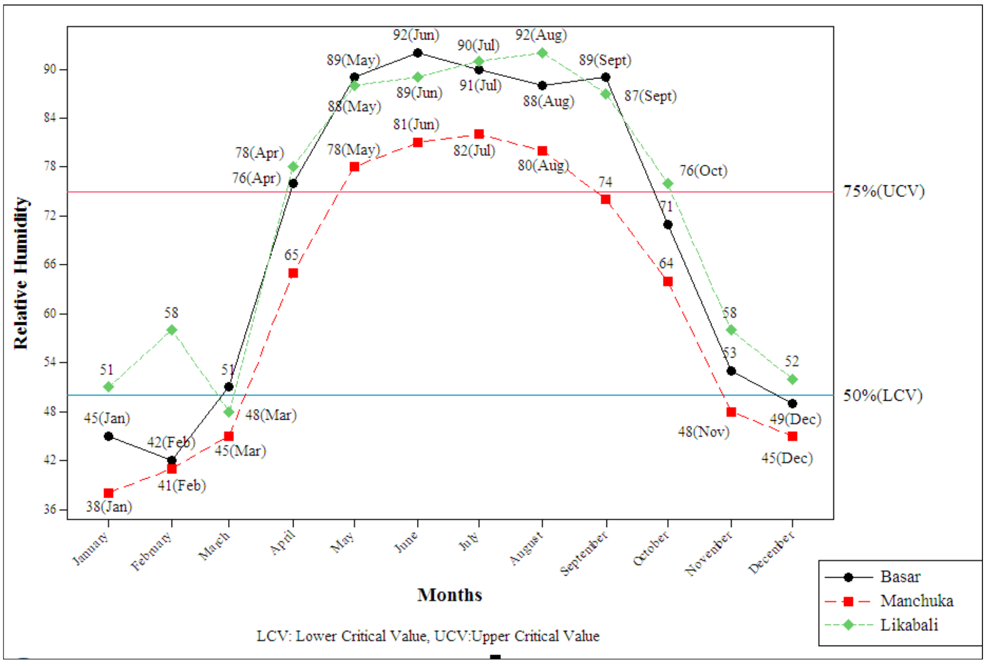

Figure 2: Comparision of monthly average humidity with critical range of humidity for poultry performance. UCV and LCV refers to Upper Critical Vlaue and Lower Critical Value respectively. The value above UCV and below LCV affect the normal performance.

a) **Hot Season:** The humidity level remains above the Upper Critical Value (UCV) of 75% during April to October in Basar and Likabali, while from May to August in Mechukha. High temperature and humidity during May to September in Basar and Likabali favor outbreak of infectious diseases in the birds. The effect was more prominent in Likabali. During the hot season the most prevailing diseases were *Ranikhet* and *Coccidiosis* in these locations. Also during the period, the humidity lowers egg laying in Basar and Likabali. High relative humidity and rainfall reported to have increases disease incidence [14]. Due to moderate temperature in Mechukha during May-August, incidence of disease and influence on egg production were not reported. Studies indicated that high temperature when coupled with high relative humidity severely affect the performance of poultry [15]. The effect of higher temperature was found to be more detrimental at relatively high relative humidity [16].

b) **Cold Season:** During December to March relative humidity remains below the Lower Critical Value (LCV) of 50% in almost all the locations. But the effect was significant in Mechukha where low humidity coupled with low temperature during November to February was very detrimental causing mortality due to extreme cold. Due to low humidity the effect of cold is high, so needs more heating materials.

Effect of ambient temperature on egg production and laying hens

The comparison of monthly average temperature of each location with ideal temperature range for egg production and performance of laying hens were depicted in Fig 3. and the major findings were:

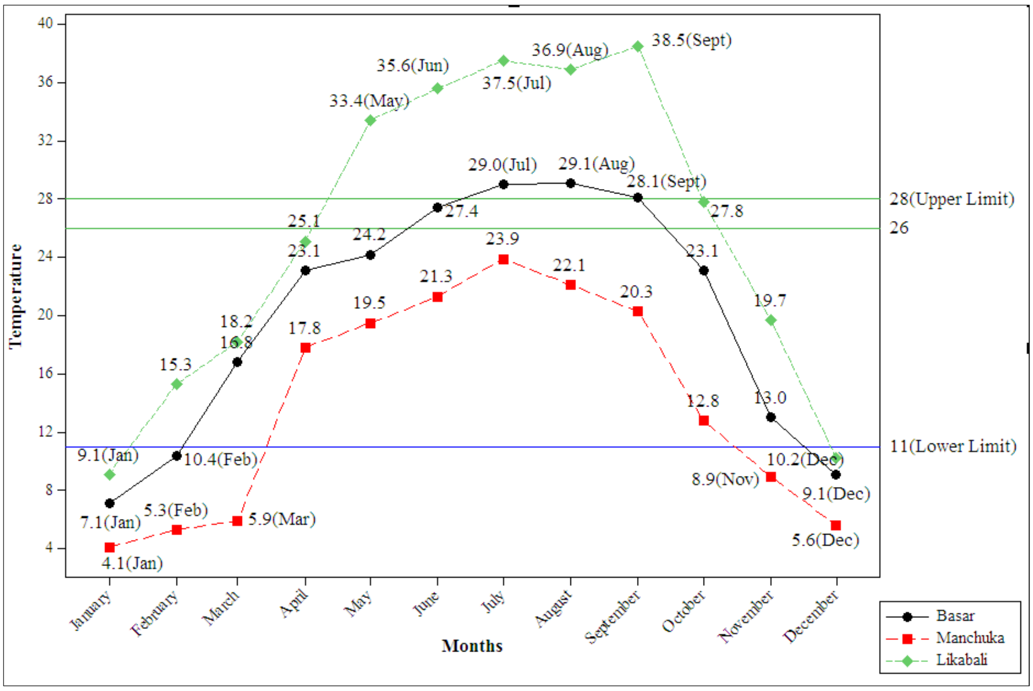

Figure 3: Comparision of three years average monthly temperature with critical ambient temperature for laying hens and egg production. Between the upper limit and lower limit the condition is optimum, while the performance drops above upper limit and below lower limit.

a) **Hot Season:** May to September was not ideal for laying hen and egg production in Likabali. The condition significantly influences quality and thickness of egg shell and lowers egg production; this is in agreement with ICAR report [11]. Also, the birds are especially sensitive to heat stress due to their feather covering and lake of sweat gland that make heat dissipation difficult [17]. Decrease in egg production and dry matter intake was also observed under thermal stress conditions with high relative humidity [18]. It was also reported that the detrimental effect of temperature on egg production and egg quality may be due to debilitating effect of high ambient temperature on ovarian function of the birds [19]. Heat stress can also disturb and disrupt the normal status and function of reproductive hormones at the hypothalamus, and at the ovary, leading to reduced systemic levels and functions [20,19,21]. In Basar the temperature range during July-August was slightly above the upper critical limit (28^0C) not significantly influencing egg production and egg quality. Hot season temperatures in Mechukha were within the safe range.

b) **Cold Season:** In the months of November to March, the thermal conditions in Mechukha were not ideal leading to drop in egg laying. Low ambient temperature was found to decrease the egg production and feed efficiency of laying hens [22,23]. While except January, the cold season does not have much influence on laying hens and egg production in Basar. Temperature was in safe zone in Likabali during cold season. Studies have shown that low temperature does not have much impact on quality and thickness of eggs [24].

Thus the impacts of environmental stress on performance of Vanaraja poultry bird (poultry in general) are very much location-specific that vary seasonally with variation in intensity. Precautionary and remedial strategies to combat environmental stress like cultural (especially housing) and nutritional intervention are to be studied and modified for each location based on respective critical periods. All the activities must aim at increasing the resilience of rural communities by raising their capacity to adapt and to respond to new hazards due to climatic variations. Impact due to heat stress will reduce the rate of animal feed intake and result in poor growth performance [25].

Total controls of these factors are difficult and the costs involved are not affordable by poultry farmers in developing countries. Appropriate and well-timed management practices can alleviate impact due to adverse environmental conditions with minimum resource use. With critical periods in mind the poultry farmers can make better decision regarding suitable diet, water supply, vaccinations, incubation period, housing and cultural practices. It could also help to frame better advisories and contingent planning. The result obtained from several research in this direction also suggest early acclimation of birds [26], nutritional changes and improved site specific modern houses [27].

Acknowledgement

We hereby acknowledge NICRA research project for all the necessary support and aids during the study. We are very thankful to all the scientific and technical staffs of ICAR Research Complex for NEH Region, A.P. Centre, Basar for all their help and support during the endeavor.

References

[1] Elijah, A.O. and Adedapo, A. (2006). The effect of climate on poultry productivity in Ilorin Kwara State, Nigeria. Int. J. Poult. Sci. 5(11), 1061-1068.

[2] Lin, H., Jiao, H.C., Buyse, J. and Decuypere, E. (2006). Strategies for preventing heat stress in poultry. Worlds Poult. Sci. J. 62, 71-86.

[3] Weaver Jr, W.D. (2002). Poultry housing. In: Commercial chicken meat and egg production, 5th edition. (Eds.) Donald D. Bell and William D. Weaver Jr. Kluwer Academic Publishers. Norwell, MA, pp. 102-103.

[4] Nienaber, J.A. and Hahn, G.L. (2007). Livestock production system management responses to thermal challenges. Int. J. Biometereol. 52, 149–157.

[5] Ozbey, O. and Ozcelik, M. (2004). The effect of high environmental temperature on growth performance of Japanese quails with different body weights. Int. J. Poult. Sci. 3, 468-470.

[6] Aengwanich, W. (2008). Pathological changes and the effects of ascorbic acid on lesion scores of bursa of Fabricius in broilers under chronic heat stress. Res. J. Vet. Sci. 1, 62–66.

[7] Karaca, A.G., Parker, H.M. and McDaniel, C.D. (2002). Elevated body temperature directly contributes to heat stress infertility of broiler breeder males. Poult. Sci. 81, 1892-1897.

[8] Al-Bashan, M.M. and Al-Harbi, M.S. (2010). Effect of Ambient Temperature, Flock Age and Breeding Stock on Egg Production and Hatchability of Broiler hatching Eggs. European J. of Bio. Sci. 2(3), 55-66.

[9] Islam, R., Kalita, N. and Nath, P. (2014). Comparative performance of Vanaraja and Indigenous chicken under backyard system of rearing. J Poult Sci. &Tech. 2(1), 22-25.

[10] Lu, Q., Wen, J. and Zhang, H. (2007). Effect of chronic heat exposure on fat deposition and meat quality in two genetic types of chicken. Poult. Sci. 86, 1059–1064.

[11] ICAR. (2011). DARE/ICAR annual report 2010-2011. India Council of Agricultural Research (ICAR), New Delhi, India, pp: 13.

[12] Warriss, P.D., Pagazaurtundua A. and Brown, S.N. (2005). Relationship between maximum daily temperature and mortality of broiler chickens during transport and lairage. Br. Poult. Sci. 46, 647–651.

[13] Bruzual, J.J., Peak, S.D., Brake, J. and Peeblest, E.D. (2000). Effect of relative humidity during the last five days of incubation and brooding temperature on performance of broiler chicks from young broiler breeders. Poult. Sci. 79, 1385-1391.

[14] Moreda, E., Singh, H., Sisaye, T. and Johansson, A.M. (2014). Phenotypic characterization of indigenous chicken population in South West and South part of Ethiopia. Br. J. Poult. Sci. 3(1), 15-19.

[15] Ajakaye, J.J., Perez-Bello, A. and Mollineda-Trujillo, A. (2011). Impact of heat stress on egg quality in layer hens supplemented with l-ascorbic acid and dl-tocopherol acetate. Vet. Archive. 81, 119-132.

[16] Romijn, C. and Lokhorst, W. (1961). Climate and poultry. Heat regulation in the fowl. Tijdschr. Diergeneeskd, 86, 153-172.

[17] Estrada-Pareja, M.M., Marquez-Giron, M.S. and Restrepo-Betancur, L.S. (2007). Effect of temperature and relative humidity on the productive behavior and heat transfer in broilers. Rev. Col. Cienc. Pec. 20, 288-303.

[18] Karaman, S., Tarhan, S.and Ergunes, G. (2007). Analysis of indoor climatic data to assess the heat stress of laying hens. IJNES, 1 (Suppl. II), 65-68.

[19] Rozenboim, I., Tako, E., Gal-Garber, O., Proudman, J.A. and Uni, Z. (2007). The effect of heat stress on ovarian function of laying hens. Poult. Sci. 86, 1760-1765.

[20] Donoghue, D.J., Krueger, B.F., Hargis, B.M., Miller, A.M. and El Halawani, M.E. (1989). Thermal stress reduces serum luteinizing hormone and bioassayable hypothalamic content of luteinizing hormone-releasing hormone in hens. Biol. Reprod. 41, 419–424.

[21] Elnagar, S.A., Scheideler, S.E. and Beck, M.M. (2010). Reproductive hormones, hepatic deiodinase messenger ribonucleic acid, and vasoactive intestinal polypeptide-immunoreactive cells in hypothalamus in the heat stress-induced or chemically induced hypothyroid laying hen. Poult. Sci. 89, 2001–2009.

[22] Ensminger M.E., Oldfield, J.E. and Heinemann, W.W. (1990). Feeds and Nutrition the Ensminger Publishing Company, USA. 593–666.

[23] Spinu M. and Degen, A.A. (1993). Effect of cold stress on performance and immune responses of Bedouin and White Leghorn hens. Brit. Poultry Sci. 34, 177–185.

[24] Sloan, D.R. and Harms, R. H. (1984). The effects of temperature on feed consumption and egg size in commercial layer houses. Poultry Sci. 63, 38.

[25] Rowlinson, P. (2008). Adapting Livestock Production Systems to Climate Change – Temperate Zones. Livestock and Global Change conference proceeding. May 2008, Tunisia.

[26] Mcdonald, K., Belay, T., Deyhim, F. and Teeter, R. (1990). Comparison of a 5-day acclimation and fasting techniques to reduce broiler heat distress mortality. Poult. Sci. 69 (Suppl. 1), 90-95.

[27] Daghir, N. J. (2009). Nutritional strategies to reduce heat stress in broilers and broiler breeders. Lohmann information, 44: 6-11.

Volume 46
10.18052/www.scipress.com/ILNS.46

Identification of Critical Periods Environmentally Sensitive to Normal Performance of Vanaraja Poultry Breed in Climatically Different Locations
10.18052/www.scipress.com/ILNS.46.76