

Original Research Article

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## Effect of North - South Facing Housing System on the Haematological Indices of Growing Foals in Semi-Arid Regions of Rajasthan

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### ABSTRACT

#### Keywords

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Haematological studies are usually conducted to study the normal and pathological aspects of blood and its elements. This study was conducted to quantify the effect of north and south facing housing system on the haematological indices of growing foals (n=12), during the summer (May-July 2017), taking ambient temperature, relative humidity and temperature-humidity index as factors in the semi-arid areas of Rajasthan. The foals were divided into two groups and were placed in the north (n=6) and south (n=6) facing house. Ambient temperature (°C) and relative humidity were recorded daily at 08:00h and 14:00h, and were used to obtain Temperature-Humidity index (THI). Blood samples were collected and analyzed fortnightly for a complete blood cell and differential count. Haematological indices like lymphocyte, monocyte, neutrophil, eosinophil and Red Blood Cells (RBC) values increased significantly ( $P<0.05$ ) in the north facing house, with ambient temperature, relative humidity and THI as factors. Whereas, only monocyte and basophil differed significantly ( $P<0.05$ ) in the south facing house. So from the present study it can be concluded that exposure of sun is more in the north facing house than the south facing house. With this it is evident that south facing house has a better effect on the performance of the growing foals than the north facing house and all three factors, i.e. ambient temperature, relative humidity and Temperature-humidity index, influence the blood profile of growing foals.

### Introduction

Haematology is a branch of medicine involving study of blood. Generally, blood parameters are the first to analyzed for any physiological changes that is happening within the animal body. Hence they provide significant information about the health status of animal. In horses among several factor influencing the blood parameter, housing is

often given meager importance. Studies have demonstrated that horse hen exposed to high temperature show thermoregulatory and stress responses, including neutrophil to lymphocyte ratio, serum cortisol concentration and haematological percentages (Marlin *et al.*, 1995; Friend, 2000; Stull and Rodiek, 2000). Studies also report an increased leukocyte count during spring, and an increased neutrophil, MCH, MCHC levels in summer

(Dmoch *et al.*, 2008). The housing also possess a biological challenge to the normal mechanism of health regulation in the horse. (Jackson *et al.*, 2000; Holcombe *et al.*, 1998) have suggested that even in an apparently healthy animal, a greater level of upper and lower airway inflammation is seen when housed and this subsidized, when animals are turned out. The housing may both psychologically and physically stress the horse.

Location and direction of an animal house are the main factors which determine the internal environment of the house. Orientation, layout and location of a house will influence the amount of sunlight the building receives and therefore its year-round temperature and comfort. Climatic factors are the other parameters that influence the orientation of an animal house. Temperature is the most important single bioclimatic factor known to influence the air and immediate surroundings. The direction of animal house also plays a major role in determining the amount sunlight entering the animal house, which on the other hand influences above mentioned physiological and haematological parameter. Heat stress is known to affect the physiological indices in animals, including goats, lamb and equines (Karim and Patnayak, 1999; Yousef,1990).

Thermal stress is one of the most important stressors in the hot regions of the world and it is one of the important factors which will affect the working capacity of all animals including equines (David 1980; Altan *et al.*, 2003). Heat stress is known to affect the physiological indices in animals, including goats, lamb and equines (Karim and Patnayak, 1999; Yousef, 1990). Despite the fact that nowadays there is a growing interest in recreational and therapeutic use of horses, only a few studies presenting blood parameters in those groups of animals have

been performed so far (Bis-Wencel *et al.*, 2009; Cieśla *et al.*, 2013). Thus, the aim of the present study was to determine and compare the values of selected haematological parameters in growing foals.

## **Materials and Methods**

### **Study animals**

Twelve growing foals, of age group 1-1½ years were included in the study conducted at the Equine Production Campus, NRCE, Bikaner. The twelve foals were divided into two groups; six foals were placed in the North facing house and six in the South facing house respectively. The study took place during the summer (May-July 2017) when there is an expected rise in the ambient temperature and relative humidity.

### **Study design**

Blood samples were taken from foals placed in the north and south facing house, fortnightly at 11:00h, 2ml EDTA tubes were used to collect blood, the analysis was done on the same day of sampling using Blood cell counter MS-4. Prior to analysis of the samples, the analyser was calibrated by ascertaining the accuracy of analysis through manual haematology of representative equine samples as per standard haematological methods. (Jain,1975) .

Blood samples (2ml) were collected from jugular vein, with all aseptic precautions and with minimal pain and discomfort to the animal using EDTA tubes The analysis for Total leukocyte counts (TLC, Units x 1000/cu.mm), total erythrocyte counts (TEC, Units x millions/cu.mm), packed cell volume percent and haemoglobin percent was estimated on the same day of sampling using five parts Blood cell counter MS-4, France. Prior to analysis of the samples, the analyser

was calibrated by ascertaining the accuracy of analysis through manual haematology of representative equine samples as per standard haematological methods (Jain,1975) .

### **Data management and analysis**

Uni-variate general linear models (GLM) were used to explore the effect of ambient temperature and relative humidity (RH) on each physiological parameter of foals with ambient temperature, relative humidity and temperature-humidity index as fixed factors. The significance of mean difference was tested by Waller-Duncan multiple range test. The analysis was carried out using SPSS software version 24 as described by Snedecor and Cochran (1994).

### **Results and Discussion**

The various haematological parameters were studied to quantify the effect of North and South facing housing system on the performance of growing foals under the hot semi-arid conditions characterized by high temperature and humidity are presented in the following section.

The haematological indices were studied in growing foals during summer (May-July 2017). Animals were placed in north and south facing house which was well ventilated and was given free access to water and feed. To study their performance under north and south faced housing system, haematological parameters were recorded fortnightly taking ambient temperature, relative humidity and THI as factors.

Orientation, layout and location of a house are known to influence the amount of sunlight the building receives and therefore its year-round temperature and comfort. For maximum solar gain, a building shall be located, oriented and designed to maximize the area facing North.

North-South faced housing system is also preferred in dairy buildings to receive maximum exposure to the sun in the north and minimum exposure to the sun in the south and for their protection from prevailing strong wind currents whether hot or cold. However, a shelter orientated east-west may intercept more solar radiation and so provide a cooler environment in which the ground temperature will also be lower (Starr, 1983).

### **Effect of North and South faced housing on the haematological indices of growing foals. Effect of ambient temperature on the haematological indices of foals placed in the North and South faced house**

White blood cell count (WBC x 1000/cu mm) (Mean  $\pm$ S.E), Lymphocyte count (Mean  $\pm$ S.E), Neutrophil count (Mean  $\pm$ S.E), Eosinophil count (Mean  $\pm$ S.E), Basophil count (Mean  $\pm$ S.E), Red blood cell count (RBC, x millions/cu mm) (Mean  $\pm$ S.E), Mean corpuscular volume (MCV) (Mean  $\pm$ S.E), Haematocrit value (Mean  $\pm$ S.E), Mean corpuscular haemoglobin (MCH) (Mean  $\pm$ S.E), Mean corpuscular haemoglobin concentration (MCHC) (Mean  $\pm$ S.E), Haemoglobin value (Mean  $\pm$ S.E) recorded in foals during the study is presented in table (1 and 1a) and Fig (1). Above mentioned haematological indices are studied in all the foals at the fortnightly period from May-July 2017 at 11:00h a day in both north and south facing house.

All the haematological indices except monocyte did not show any significant changes in foals placed in both the north and south facing house when they are exposed to a temperature 25°-38°C. Monocyte value foals increased significantly (P<0.01) in both the north (8.53 $\pm$ .27) and south (8.21  $\pm$ .35) facing house, along with basophil (0.420 $\pm$ .03) (P<0.01) only in the south facing house when they are exposed to a temperature ranging from 25°-38°C.

**Table.1** Least square means  $\pm$  SE values of the effect of ambient temperature on the haematological parameters of foals in North faced house

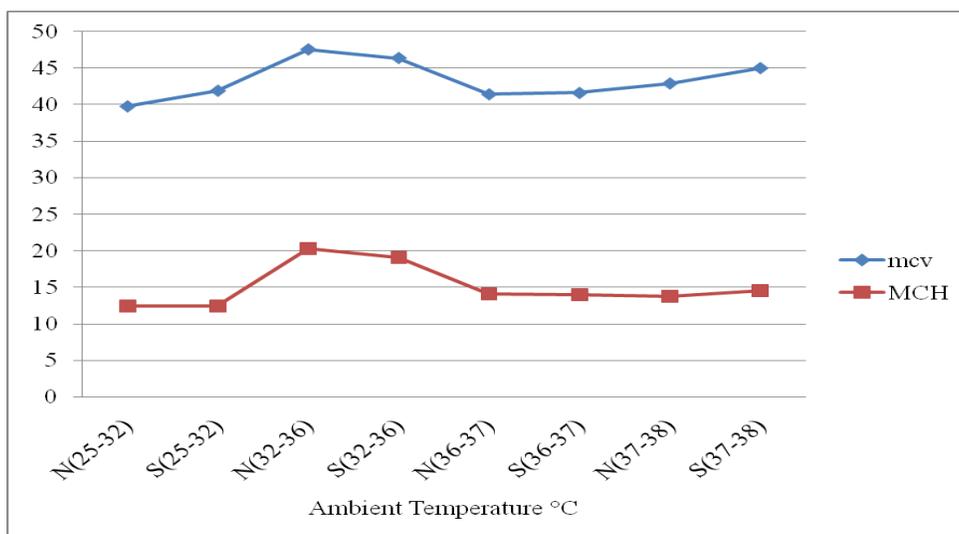
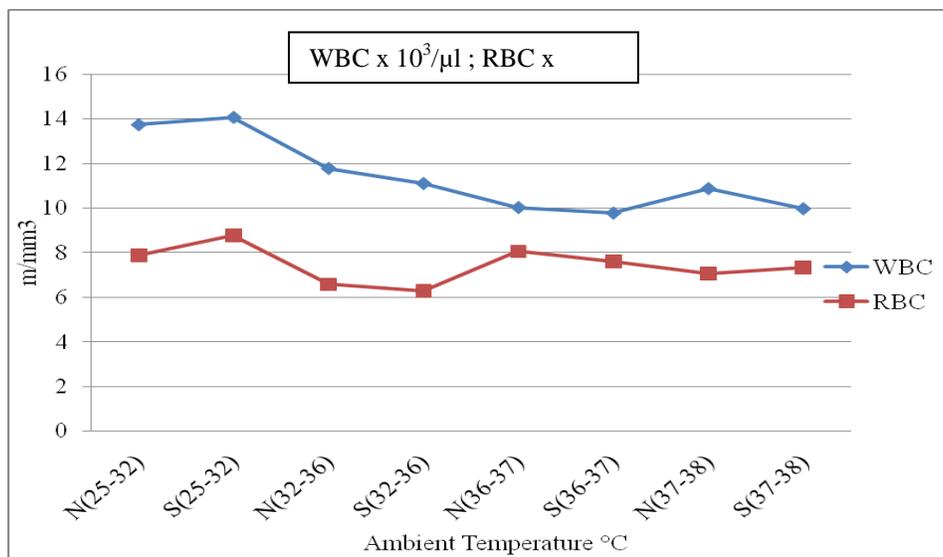
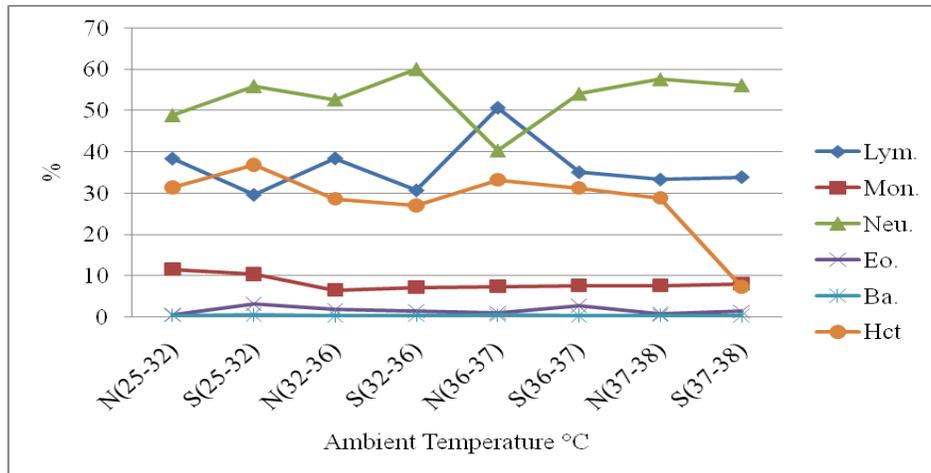
Ambient Temperature	n	WBC	LYM	MON	NEU	EOS	BAS	RBC	MCV	Hct	MCH	MCHC	Hb
Overall mean ( $\mu \pm$ S.E)		11.68 $\pm$ .50	40.29 $\pm$ 2.10	8.53 $\pm$ .27	49.78 $\pm$ 2.17	.96 $\pm$ .12	.42 $\pm$ .04	7.4 $\pm$ .34	42.66 $\pm$ 1.43	39.93 $\pm$ 10.43	14.91 $\pm$ 1.42	34.01 $\pm$ 1.24	10.29 $\pm$ .34
( $^{\circ}$ C)		NS	NS	**	NS	NS	NS	NS	NS	NS	NS	NS	NS
T1 (25-32)	8	13.98 $\pm$ 1.1 2	38.11 $\pm$ 4.67	12.61 $\pm$ .60	48.36 $\pm$ 4.81	.46 $\pm$ .27	.43 $\pm$ .10	7.7 $\pm$ .75	39.33 $\pm$ 3.17	30.23 $\pm$ 23.16	12.10 $\pm$ 3.16	30.90 $\pm$ 2.75	9.38 $\pm$ .76
T2 (32-36)	8	10.32 $\pm$ .97	46.53 $\pm$ 4.04	6.56 <sup>a</sup> $\pm$ .52	45.08 $\pm$ 4.17	1.4 $\pm$ .23	.38 $\pm$ .08	7.5 $\pm$ .65	42.73 $\pm$ 2.74	31.95 $\pm$ 20.05	14.63 $\pm$ 2.73	34.26 $\pm$ 2.38	11.46 $\pm$ .66
T3 (36-37)	7	11.54 $\pm$ .97	43.08 $\pm$ 4.04	7.27 <sup>a</sup> $\pm$ .52	48.05 $\pm$ 4.17	1.1 $\pm$ .23	.43 $\pm$ .08	7.4 $\pm$ .65	45.65 $\pm$ 2.74	31.03 $\pm$ 20.05	19.11 $\pm$ 2.73	38.70 $\pm$ 2.38	10.98 $\pm$ .66
T4 (37-38)	7	10.88 $\pm$ .97	33.43 $\pm$ 4.04	7.67 <sup>a</sup> $\pm$ .52	57.63 $\pm$ 4.17	.80 $\pm$ .23	.45 $\pm$ .08	7.07 $\pm$ .6 5	42.92 $\pm$ 2.74	66.51 $\pm$ 20.05	13.80 $\pm$ 2.73	32.18 $\pm$ 2.38	9.36 $\pm$ .66

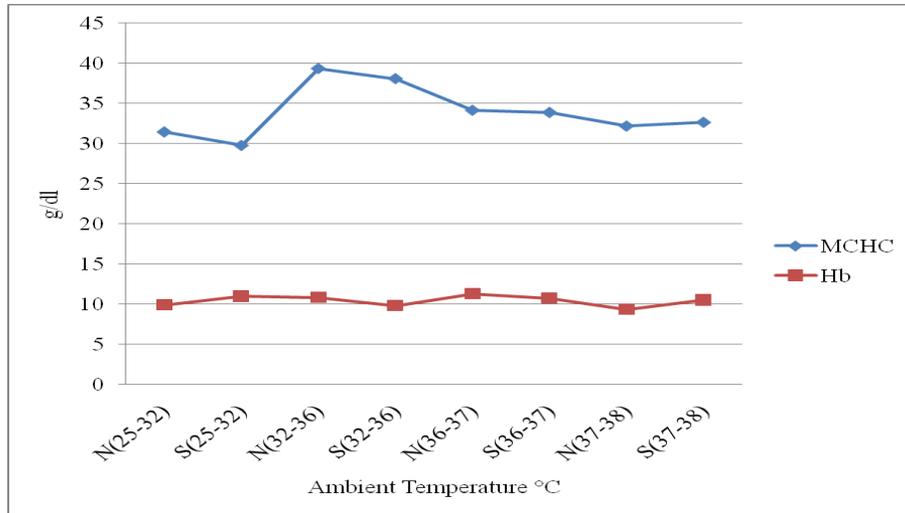
n – Number of observations; \*– Significant (P<0.05)  
 \*\* – Highly significant (P<0.01); NS – Not significant  
 Means with at least one common superscript within classes differ significantly with each other

**Table.1 (a)** Least square means  $\pm$  SE values of the effect of ambient temperature on the haematological parameters of foals in South faced house

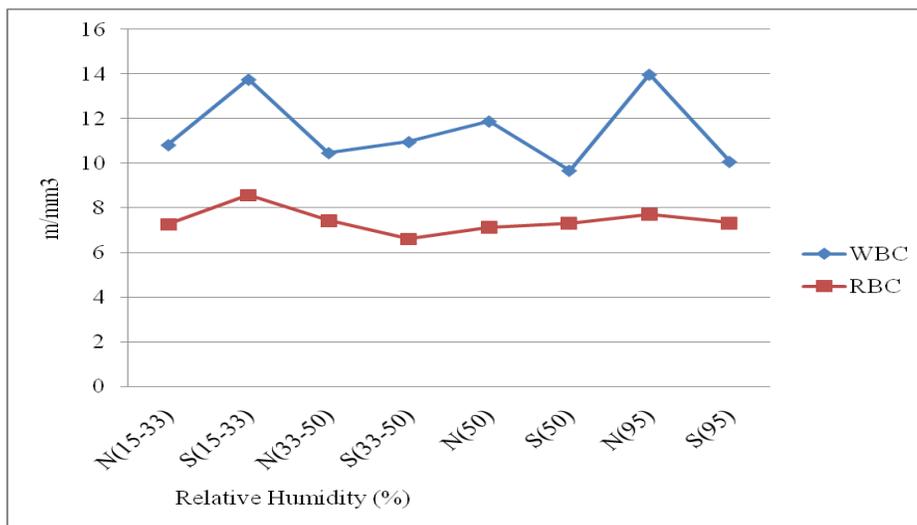
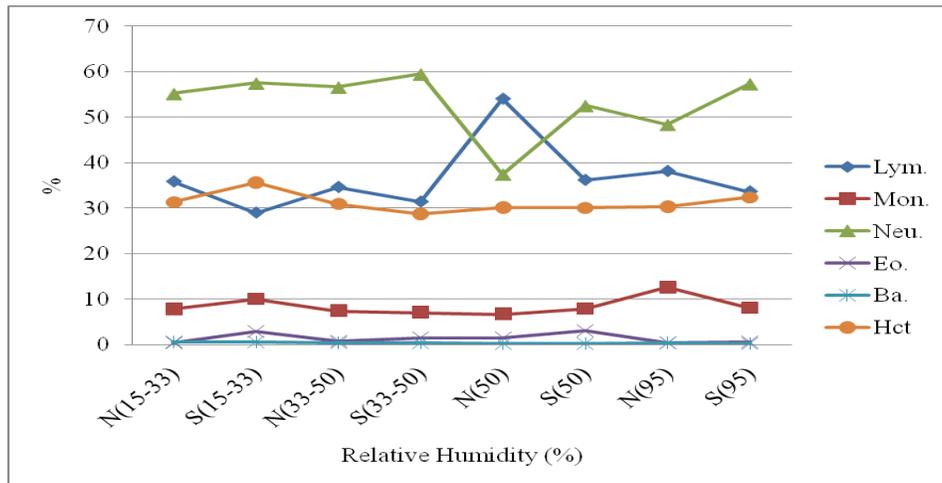
Ambient Temperature	n	WBC	LYM	MON	NEU	EOS	BAS	RBC	MCV	Hct	MCH	MCHC	Hb
Overall mean ( $\mu \pm$ S.E)		11.12 $\pm$ .68	32.43 $\pm$ .47	8.21 $\pm$ .35	56.80 $\pm$ 1.66	2.12 $\pm$ .67	.420 $\pm$ .03	7.45 $\pm$ .32	43.72 $\pm$ 1.54	31.56 $\pm$ 1.22	15.10 $\pm$ 1.46	33.73 $\pm$ 1.35	10.48 $\pm$ .30
( $^{\circ}$ C)		NS	NS	**	NS	NS	**	NS	NS	NS	NS	NS	NS
T1 (25-32)	8	13.98 $\pm$ 1.12	30.11 $\pm$ 2.84	9.98 <sup>b</sup> $\pm$ .68	56.15 $\pm$ 3.21	3.17 $\pm$ 1.30	.575 <sup>b</sup> $\pm$ 0.72	7.93 $\pm$ .63	46.71 $\pm$ 2.98	34.17 $\pm$ 2.37	17.86 $\pm$ 2.83	34.75 $\pm$ 2.62	10.97 $\pm$ .58
T2 (32-36)	8	10.70 $\pm$ 1.41	29.67 $\pm$ 3.04	6.72 <sup>a</sup> $\pm$ .73	61.68 $\pm$ 3.43	1.40 $\pm$ 1.39	.514 <sup>a</sup> $\pm$ .07	7.23 $\pm$ .67	41.15 $\pm$ 3.19	29.72 $\pm$ 2.53	13.91 $\pm$ 3.03	33.95 $\pm$ 2.80	9.85 $\pm$ .62
T3 (36-37)	7	9.54 $\pm$ 1.31	35.93 $\pm$ 2.84	8.03 <sup>ab</sup> $\pm$ .68	53.15 $\pm$ 3.21	2.61 $\pm$ 1.30	.263 <sup>a</sup> $\pm$ .07	7.32 $\pm$ .63	42.00 $\pm$ 2.98	30.28 $\pm$ 2.37	14.02 $\pm$ 2.83	33.58 $\pm$ 2.62	10.58 $\pm$ .58
T4 (37-38)	7	9.98 $\pm$ 1.41	34.0 $\pm$ 3.04	8.11 <sup>a</sup> $\pm$ .73	56.21 $\pm$ 3.43	1.32 $\pm$ 1.39	.329 <sup>ab</sup> $\pm$ .07	7.33 $\pm$ .67	45.02 $\pm$ 3.19	32.08 $\pm$ 2.53	14.60 $\pm$ 3.03	32.65 $\pm$ 2.80	10.52 $\pm$ .62

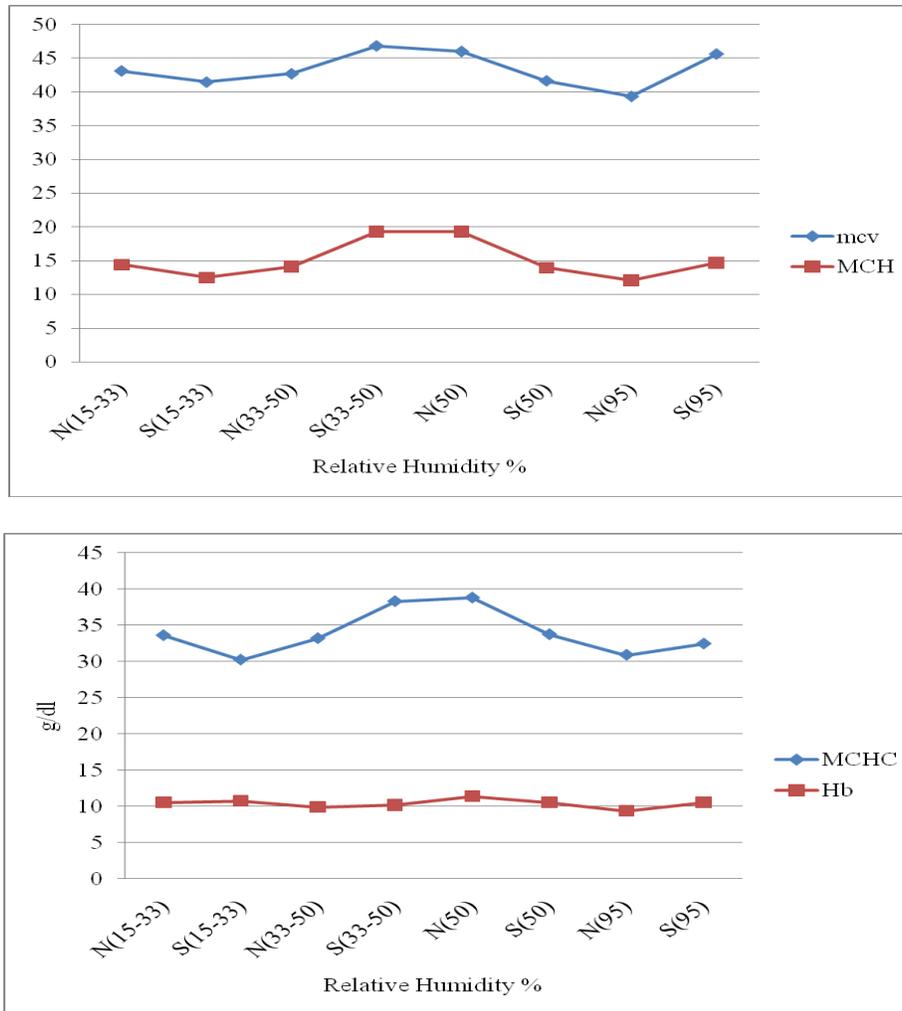
n – Number of observations; \*– Significant (P<0.05)  
 \*\* – Highly significant (P<0.01); NS – Not significant  
 Means with at least one common superscript within classes differ significantly with each other.





**Fig.1** Effect of ambient temperature on the haematological indices of foals placed in the North and South facing house





**Fig.2** Effect of relative humidity on the haematological indices of foals placed in the North and South facing house

**Effect of relative humidity on the haematological indices of foals placed in the North and South faced house**

White blood cell count (WBC x 1000/cu mm) (Mean ±S.E), Lymphocyte count (Mean ±S.E), Neutrophil count (Mean ±S.E), Eosinophil count (Mean ±S.E), Basophil count (Mean±S.E), Red blood cell count (RBC, x millions/cu mm) (Mean ±S.E), Mean corpuscular volume (MCV) (Mean ±S.E), Haematocrit value (Mean ±S.E), Mean corpuscular haemoglobin (MCH) (Mean ±S.E), Mean corpuscular haemoglobin concentration (MCHC) (Mean ±S.E), Haemoglobin value (Mean ±S.E) recorded in

foals during the study is presented in table (2 and 2a) and Fig (2). Above mentioned haematological indices with regard to relative humidity (RH) were studied in all the foals at the fortnightly period from May-July 2017 at 11:00h a day in both north and south facing the house. The hematological values of foals, lymphocyte (40.47±2.00), neutrophils (49.91±1.95), basophil (0.42±0.03), monocyte (8.17±.37) RBC (7.38±0.29) and Eosinophil (1.02±.11) increased significantly (P<0.05) in the north facing house and in the south facing house, only monocyte (8.22±.31), value increased significantly (P<0.01) when they are exposed to RH ranging from 15-95 percent.

**Effect of temperature humidity index on the haematological indices of foals placed on the North and South faced house**

White blood cell count (WBC x 1000/cu mm) (Mean  $\pm$ S.E), Lymphocyte count (Mean  $\pm$ S.E), Neutrophil count (Mean  $\pm$ S.E), Eosinophil count (Mean  $\pm$ S.E), Basophil count (Mean  $\pm$ S.E), Red blood cell count (RBC, x millions/cu mm) (Mean  $\pm$ S.E), Mean corpuscular volume (MCV) (Mean  $\pm$ S.E), Haematocrit value (Mean  $\pm$ S.E), Mean corpuscular haemoglobin (MCH) (Mean  $\pm$ S.E), Mean corpuscular haemoglobin concentration (MCHC) (Mean  $\pm$ S.E), Haemoglobin value (Mean  $\pm$ S.E) recorded in foals during the study was presented in table (3 and 3a) and Fig (3).

Above mentioned haematological indices with regard to temperature humidity index (THI) are studied in all the foals at the fortnightly period from May-July 2017 at 11:00h a day in both north and south facing the house. The hematological values of foals lymphocyte ( $40.81\pm 1.62$ ), monocyte ( $8.25\pm 0.42$ ), eosinophil ( $0.99\pm 0.12$ ), neutrophils ( $49.50\pm 1.77$ ) increased significantly ( $P<0.01$ ) in the north facing house, whereas basophil ( $0.42\pm 0.03$ ) values increased significantly ( $P<0.01$ ) in the south facing house when they were exposed to THI value of 79.82-86.35.

The haematological indices were recorded fortnightly at 11:00h between May-July 2017 in all the twelve foals, placed in the north and south facing house is presented and discussed in table (1 and 1a 2 and 2a and 3 and 3a). The haematological indices, total erythrocyte count, total leukocyte count, haemoglobin, PCV, MCV, MCHC were studied in the all the foals placed in north and south facing house. In this study, we found that only monocyte values increased significantly in both north and south facing house with

ambient temperature as influencing factor. Whereas lymphocyte, monocyte, neutrophil, eosinophil and RBC values increased significantly in the north facing house, with only monocyte showing significant changes in the south facing house with relative humidity as influencing factors.

With THI as a factor, Lymphocyte, monocyte, eosinophil, neutrophil values increased significantly in the north facing house, with only basophils showing significant changes in the south facing house. Alam *et al.*, (2011) reported an increase in WBC, lymphocyte, neutrophil, lymphocyte, monocyte and RBC with increased heat stress, which is in line with our findings in this study. It is known that Neutrophil is the main defender of the body against infection and antigens.

High levels may indicate an active infection; a low count may indicate a compromised immune system. Lymphocytes are known to be involved in the protection of the body from viral infections. Elevated levels may indicate an exhausted immune system may be due to heat stress.

Eosinophil rise indicates some kind of allergy or stress due to the combined effect of temperature and humidity. Monocytes are helpful in fighting severe infections, stress and allergy through the release of cytokines and are considered the bodies' second line of defence against infection and the largest cells in the bloodstream.

Satue and Munoz (2013) reported that meteorological factors control the dynamics of haematological indices in horses, which is in accordance with results of the present study. Higher PCV, RBC, Hb was observed in the Carthusian horses during summer Satue and Munoz (2013), whereas there is a decrease in erythrocytic count of horses during winter Ruiz *et al.*, (2004).

**Table.2** Least square means ± SE values of the effect of relative humidity on haematological parameters of foals in North faced house

Relative Humidity	n	WBC	LYM	MON	NEU	EOS	BAS	RBC	MCV	Hct	MCH	MCHC	Hb
Overall mean (μ ± S.E)		11.50±.52	40.47±2.00	8.17±.37	49.91±1.95	1.02±.11	.42±.03	7.38±.29	43.00±1.33	30.42±1.24	15.21±1.38	34.32±1.25	10.36±.38
		NS	*	**	*	*	*	*	NS	NS	NS	NS	NS
H1 (15-33)	8	10.81±1.00	35.82 <sup>ab</sup> ±3.87	7.83 <sup>a</sup> ±.72	55.16 <sup>ab</sup> ±3.78	.55 <sup>a</sup> ±.21	.62 <sup>b</sup> ±.07	7.26 <sup>a</sup> ±.57	43.11±2.58	31.27±2.41	14.43±2.67	33.6±2.43	10.52±.75
H2(33-50)	8	10.08±1.07	33.51 <sup>a</sup> ±4.14	6.81 <sup>a</sup> ±.77	58.02 <sup>b</sup> ±4.04	1.34 <sup>bc</sup> ±.23	.30 <sup>a</sup> ±.08	7.88 <sup>a</sup> ±.61	41.68±2.76	31.00±2.58	13.64±2.86	32.81±2.59	10.05±.80
H3 (50)	7	12.12±1.07	48.31 <sup>b</sup> ±4.14	6.88 <sup>a</sup> ±.77	42.88 <sup>a</sup> ±4.04	1.55 <sup>c</sup> ±.23	.35 <sup>ab</sup> ±.08	6.03 <sup>a</sup> ±.61	48.11±2.76	26.72±2.58	20.34±2.86	38.91±2.59	10.67±.80
H4 (95)	7	12.98±1.00	44.22 <sup>ab</sup> ±3.87	11.15 <sup>b</sup> ±.72	43.58 <sup>a</sup> ±3.78	.63 <sup>ab</sup> ±.21	.40 <sup>ab</sup> ±.07	8.36 <sup>b</sup> ±.57	39.12±2.58	32.70±2.41	12.45±2.67	31.96±2.43	10.18±.75

n – Number of observations;

\*– Significant (P<0.05)

\*\* – Highly significant (P<0.01);

NS – Not significant

Means with at least one common superscript within classes differ significantly with each other

**Table.2 (a)** Least square means ± SE values of effect of relative humidity on haematological parameters of foals in South faced house

Relative Humidity	n	WBC	LYM	MON	NEU	EOS	BAS	RBC	MCV	Hct	MCH	MCHC	Hb
Overall mean (μ ± S.E)		11.14±.68	32.46±1.54	8.22±.31	56.77±1.71	2.11±.62	.41±.04	7.43±.29	43.92±1.47	31.52±1.14	15.29±1.38	33.89±1.24	10.49±.30
		NS	NS	**	NS	NS	NS	NS	NS	NS	NS	NS	NS
H1 (15-33)	8	9.54±1.32	0.88±2.98	7.30 <sup>a</sup> ±.60	56.71±3.31	4.68±1.20	.41±.08	7.32±.56	41.07±2.84	29.66±2.20	13.73±2.67	33.65±2.40	10.38±.58
H2 (33-50)	8	9.38±1.42	31.67±3.18	7.88 <sup>a</sup> ±.65	59.14±3.54	.92±1.29	.37±.09	7.49±.60	43.01±3.04	32.12±2.35	14.24±2.86	33.25±2.56	10.71±.62
H3 (50)	7	11.71±1.42	33.04±3.18	7.08 <sup>a</sup> ±.65	57.94±3.54	1.48±1.29	.44±.09	6.34±.60	49.58±3.04	28.37±2.35	20.45±2.86	38.34±2.56	9.97±.62
H4 (95)	7	13.87±1.32	34.26±2.98	10.61 <sup>b</sup> ±.60	53.30±3.31	1.37±1.20	.45±.08	8.56±.56	42.02±2.84	35.95±2.20	12.73±2.67	30.32±2.40	10.91±.58

n – Number of observations; \*– Significant (P<0.05)  
 \*\* – Highly significant (P<0.01); NS – Not significant  
 Means with at least one common superscript within classes differ significantly with each other

**Table.3** Least square means ± SE values of effect of THI on haematological parameters of foals in North faced house

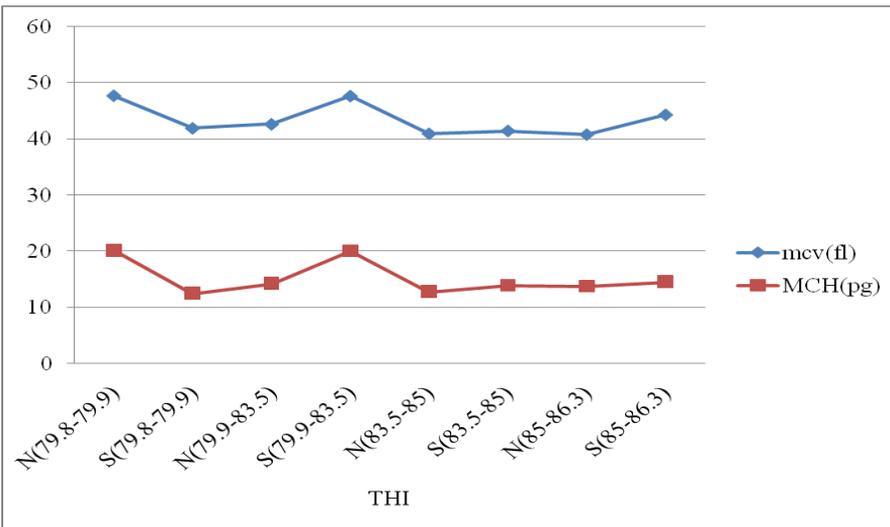
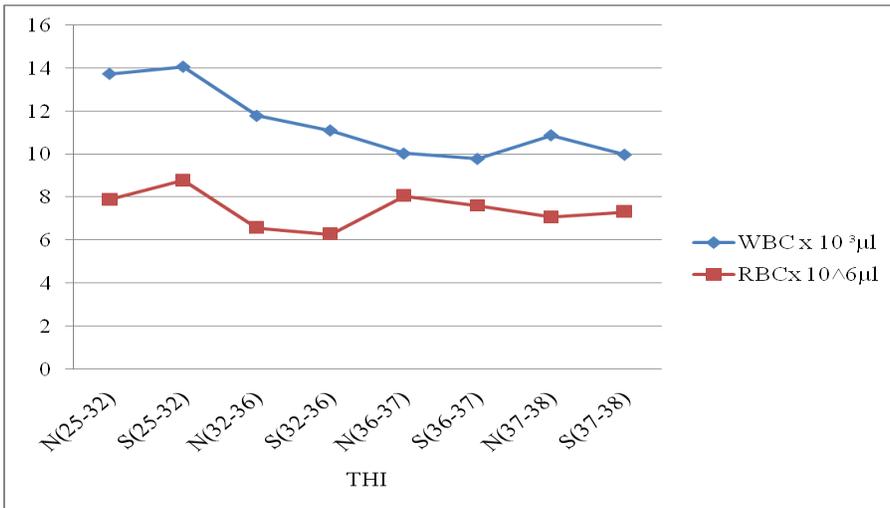
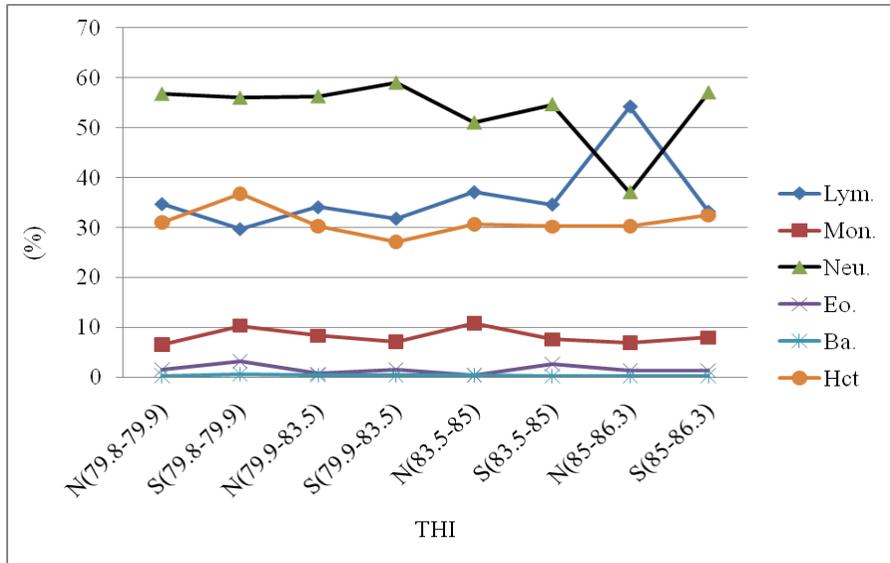
THI	WBC	LYM	MON	NEU	EOS	BAS	RBC	MCV	Hct	MCH	MCHC	Hb
Overall mean (μ ± S.E)	11.47±.52	40.81±1.62	8.25±.42	49.50±1.77	0.99±.12	.427 ±.04	7.43 ±.33	42.77±1.40	30.52±1.32	14.99±1.41	34.12±1.26	10.35 ±.37
	NS	**	*	*	*	NS	NS	NS	NS	NS	NS	NS
THI 1 (79.82-79.99)	11.89±1.02	35.46 <sup>a</sup> ±3.13	6.72 <sup>a</sup> ±.82	55.97 <sup>b</sup> ±3.43	1.41 <sup>a</sup> ±.23	.42± .08	7.14± .65	46.80±2.71	30.81±2.55	19.32±2.74	38.28±2.44	10.91 ±.72
THI 2 (79.99-83.50)	12.76±1.02	34.81 <sup>a</sup> ±3.13	9.93 <sup>b</sup> ± .82	54.21 <sup>b</sup> ±3.43	.61 <sup>a</sup> ±.23	.42± .08	7.20± .65	42.05±2.71	30.26±2.55	13.72±2.74	32.73±2.44	9.96±.72
THI 3 (83.50-85.07)	11.32±1.09	37.35 <sup>a</sup> ±3.35	9.44 <sup>ab</sup> ±.88	52.07 <sup>b</sup> ±3.66	.61 <sup>a</sup> ±.24	.51± .09	7.57± .69	41.18±2.90	30.34±2.72	13.04±2.92	31.68±2.61	9.64±.77
THI 4 (85.07-86.35)	9.90 ±1.09	55.64 <sup>b</sup> ±3.35	6.91 <sup>a</sup> ± .88	35.77 <sup>a</sup> ±3.66	1.32 <sup>a</sup> ±.24	.34± .09	7.80± .69	41.05±2.90	30.70±2.72	13.90±2.92	33.80±2.61	10.90 ±.77

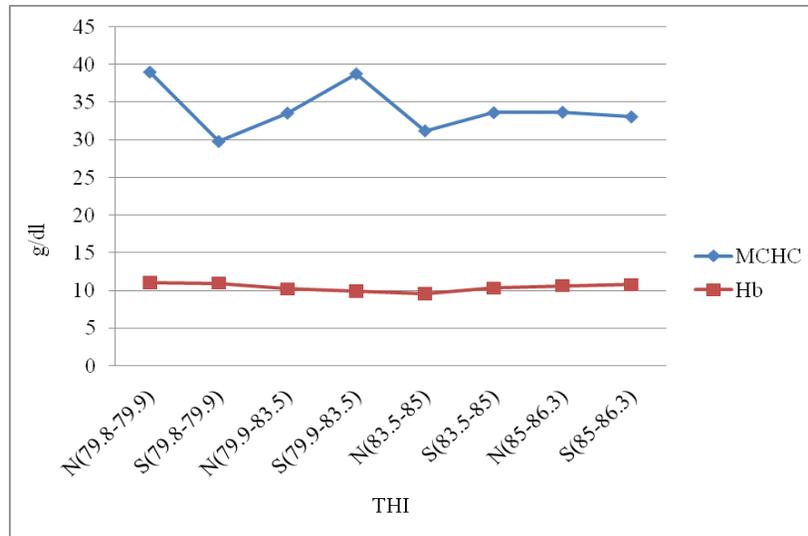
n – Number of observations; \*– Significant (P<0.05)  
 \*\* – Highly significant (P<0.01); NS – Not significant  
 Means with at least one common superscript within classes differ significantly with each other

**Table.3 (a)** Least square means  $\pm$  SE values of effect of THI on hematological parameters of foals in South faced house

THI	WBC	LYM	MON	NEU	EOS	BAS	RBC	MCV	Hct	MCH	MCHC	Hb
Overall mean ( $\mu \pm$ S.E)	11.12 $\pm$ .69	32.50 $\pm$ 1.50	8.24 $\pm$ .39	56.59 $\pm$ 1.74	2.22 $\pm$ .66	0.42 $\pm$ .03	7.44 $\pm$ .31	43.81 $\pm$ 1.54	31.52 $\pm$ 1.20	15.2 $\pm$ 1.40	33.8 $\pm$ 1.25	10.48 $\pm$ .30
	NS	NS	NS	NS	NS	**	NS	NS	NS	NS	NS	NS
THI 1 (79.8-79.9)	9.78 $\pm$ 1.34	34.75 $\pm$ 2.90	7.78 $\pm$ .77	56.37 $\pm$ 3.38	0.82 $\pm$ 1.28	.26 <sup>a</sup> $\pm$ .07	7.16 $\pm$ .59	44.16 $\pm$ 2.97	30.52 $\pm$ 2.32	14.28 $\pm$ 2.71	32.57 $\pm$ 2.41	10.37 $\pm$ .58
THI 2 (79.9-83.5)	14.10 $\pm$ 1.34	29.20 $\pm$ 2.90	9.46 $\pm$ .77	58.72 $\pm$ 3.38	2.16 $\pm$ 1.28	.45 <sup>ab</sup> $\pm$ .07	8.4 $\pm$ .59	41.97 $\pm$ 2.97	35.18 $\pm$ 2.32	13.3 $\pm$ 2.71	31.91 $\pm$ 2.41	11.12 $\pm$ .58
THI 3 (83.5-85.0)	9.88 $\pm$ 1.43	32.14 $\pm$ 3.10	8.07 $\pm$ .82	55.67 $\pm$ 3.61	3.50 $\pm$ 1.37	.61 <sup>b</sup> $\pm$ .07	7.41 $\pm$ .64	41.55 $\pm$ 3.18	30.75 $\pm$ 2.48	13.4 $\pm$ 2.90	32.25 $\pm$ 2.58	9.95 $\pm$ .62
THI 4 (85.0-86.3)	10.72 $\pm$ 1.43	33.94 $\pm$ 3.10	7.65 $\pm$ .82	55.60 $\pm$ 3.61	2.42 $\pm$ 1.37	.37 <sup>ab</sup> $\pm$ .07	6.78 $\pm$ .64	47.57 $\pm$ 3.18	29.62 $\pm$ 2.48	20.02 $\pm$ 2.90	38.75 $\pm$ 2.58	10.50 $\pm$ .62

n – Number of observations;                      \*– Significant (P<0.05)  
 \*\* – Highly significant (P<0.01);                NS – Not significant  
 Means with at least one common superscript within classes differ significantly with each other





**Fig.3** Effect of temperature humidity index on the haematological indices of foals placed on the North and South facing house

Zakari *et al.*, (2015), reported an increased MCV, MCH and PLT in adults and yearlings than in foals in rainy and cold-dry seasons. Dmoch *et al.*, (2008) also reported an increased leukocyte count in spring, with the rise in neutrophil, MCH, MCHC levels found during summer, from which we can conclude that climatic factors and season have considerable influence on the haematology of foals.

Hence, only lymphocyte differed significantly ( $P < 0.01$ ) between the two houses, with an increase in the north facing and neutrophils were found significantly different ( $P < 0.01$ ) between the two houses. The combined (mean  $\pm$  S.E) values is also in accordance with the results obtained through individual comparison of (mean  $\pm$  S.E) values, proving that between the north and south faced housing system, the north facing house tends to have maximum influence on haematology of foals.

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