# the 5th ICTROPS

International Conference
for Tropical Studies and Its Applications

## "The Bridging of Multidisciplin
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# Geographical Risk Factors of Strongyloides stercoralis infection in East Kalimantan Province, Indonesia

[1.2*]Blego Sedionoto, [2]Sueptrakool Wasessombat, [3]Chuchard Punsawad, [2,4]Witthaya Anamnart, [2]Jitbanjong Tangpong

[1]*Department of Environmental Health, Faculty of Public Health Mulawarman University, Samarinda, 75123, Indonesia*
[2]*Doctoral Program in Biomedical Sciences, School of Allied Health Sciences, Walailak University, Thasala. 80160, Thailand.*
[3]*Department of Parasitology, School of Medicine, Walailak University, Thasala 80160, Thailand.*
[4]*Department of Environmental Health, School of Public Health, Walailak University, Thasala, 80160, Thailand*
*Corresponding Author*: blego_kesling@yahoo.com*

## Abstract

*Strongyloides stercoralis/ S. stercoralis* infection is still challenge in public health problem especially in developing countries where have geographical risk factors especially geographical factors that are potential for transmitting of *S. stercoralis* infection. A cross-sectional study was performed among 213 participants from rural community of Muarakaman district and Marangkayu districts, East Kalimantan province, Indonesia. In this study used two diagnostic methods: Kato Katz and Koga agar plate

culture/KAP culture for diagnosing of *S. stercoralis* infection. Pearson chi-square and odd ratio analysis were used for study correlation and level of geographical risk factors and *S. stercoralis* infection. We found S stercoralis infection in East Kalimantan Province was 17 (8%). Geographical risk factors While pH of soil, clay content of soil, vegetation, and villages area have not correlated significant with *S. stercoralis* infection (p value > 0.05). Elevation from above sea (≥41.6m) was highest odd of *S. stercoralis* infection OR: 2.72 (95%CI: (1.30-5.66). Geographical factors might support survival ability of *S. stercoralis* larvae for migrating and transmission. Essential geographical risk factors of the infections should be used for preventing program of reduction prevalence *S. stercoralis* infection.

Keywords: S. stercoralis, Geographical factors, East Kalimantan Province, Indonesia.

## Introduction

The prevalence of *S. stercoralis* infection is of serious public health concern globally. *S.*

*stercoralis* infection are prevalent in poor rural community in tropical and subtropical areas in many developing country (Wardell R et al 2017). They are transmitted through in protected contact with soil are endemic in tropical and temperate regions. The prevalence of *S. stercoralis* infection was estimated in 2010 that 100 people were infected million with strongyloides. Almost 70% of these infections occur in Asia. (Pullan et al, 2014, WHO, 2011 (Bethony et al. 2006).

*S. stercoralis* infection is transmitted through in protected contact with soil is endemic in tropical and temperate regions. Human acquire the *S. stercoralis* infection through direct skin contact with infective third stage larvae where the soil was contaminated by human feces penetrate the intact human skin and eventually reach small intestine (Forrer et al. 2016).

Generally, *S. stercoralis* infection is found among poor people with poor environmental sanitation and where the climate is warm and humid (Bannon et al., 1995; Hall et al., 1994). Factors affecting difference in distribution of *S. stercoralis* infection may include good hygiene practices among population, availability of sewerage system and the length of rainy season. Environmental factors have contributed for transmission of

diseases as well as growth and development of the worms (Anamnart et al, 2013; Prasit et al, 2016).

Environmental factors especially long rainy season may affect the decrease in prevalence of *S. stercoralis* infection. Prevalence of strongyloidiasis in south Thailand is lower than other parts of the country, in contrast, prevalence of hookworm infection is still high in the south. It is possibly because the failure in the control of hookworm infection due to 10 months long rainy season in southern Thailand contrasted with 4 months long rainy season in other parts (Anamnart et al., 2015). The study in Cambodia reported the lower prevalence of strongyloidiasis in area with heavy rainfall than in low rainfall area. Moreover, high amount of soil organic carbon content affect to the lower prevalence of strongyloidiasis (Khieu et al., 2014). Epidemiology study of hookworm infection and strongyloidiasis in Southern Laos showed 56.1% and 41% respectively where was heavy rainfall and poor sanitation. In this study Baerman and Kato-Katz techniques were used for detecting them (Vonghachack et al, 2015).

In rural East Kalimantan province Indonesia has environmental risk factors of prevalence of *S. stercoralis* infection that important to exploration association both of them. We perform a cross-sectional study in rural community in Muarakiaman

and Marangkayu district to analysis of geography, texture of soil, humidity, hookworm and strongyloides in pet, vegetation, elevation, volume rain, amount days of rain yearly, temperature and quality of soil as clay content, organic carbon of soil and pH of soil then was correlated with prevalence of *S. stercoralis* infection.

## Methodology

### Ethical consideration

Official permission and ethical clearance for collection human fecal samples was obtained from head master and teacher. The study protocol was approved by the Ethical Clearance committee on human right related to research involving human subjects, Walailak University HE: number WUEc-18-034-01.

### Study setting and population

The study was carried out in rural area of Muarakaman district and Marangkayu district East Kalimantan province, Indonesia. This research is a

community based, was conducted during July 2018 to September 2019. Total of number participant is 213 participants who were joined and sent stool samples.

**Field Procedures**

We collected third stool sample of participant, for collecting stool samples, the first day were requested to head of house hold and member of house hold for requesting stool sample, second day in the morning would start to collect stool samples, were brought to biomedical laboratory, school of Public Health Mulawarman University for diagnosis samples. Others day was done observation environmental condition houses surrounding village.

**Laboratory procedures**

**Agar plate culture and Kato Katz technique**

Agar plate culture was done as described by Koga et al., 1991. Briefly, a few grams of stool was placed at the center of nutrient agar and kept at room temperature for five days. Tracks from larva crawling and larvae or adult worms were observed. If positive, 10 ml of 10% formalin was added to agar

surface for 5-10 minutes and transferred to centrifuged tube. Centrifugation at 2,500 rpm for 5 minutes and supernatant was discarded. The sediment will be examined for S. stercoralis larvae or adult worm.

For Kato-katz thick smear, 50 mg of stool was placed on slide and covered with a cellophane paper soaked in glycerin solution for 24 hours. The stool was spread out using rubber stick. After 30 minutes was examined and counted for eggs

**Risk factors data**

Demographic data and personal hygiene of participants were collected by questionnaire, and sanitation facilities each house hold of participants were collected by observation, while geographical data was collected consist such as vegetation, elevation of soil, kind of pets, kind of soil around houses, length of rainy season, humidity and temperature per year. Quality of soil as organic carbon content, clay content and pH were diagnosed by soil laboratory Mulawarman University. Vegetation and kind of soil around houses were collected by observation form, kind of pet will be collected by questioner and observation, and length of rainy season, humidity and temperature per year

will collected from Central Bureau of Statistics (https://www.bps.go.id) and Central Bureau of meteorology, climatology and Geophysical of Indonesia (https://www.bmkg.go.id).

**Data analysis**

The prevalence of S. stercoralis infection was stratified according to demographic data, sanitation facilities and personal hygiene, environmental data, and reported by descriptive statistic. Statistical analysis was performed by Chi-square using SPSS verse 22. The correlation analysis chi-square to evaluate association of *S. stercoralis* infection with demographic data, sanitation facilities, personal hygiene, and environmental risk factors and the level of significance was considered as $P<0.05$ and the analysis of risk estimate by odds ratio Chi-Square with confidence interval 95%.

## Results and Discussion

### Results

### Study sample

A total of 213 individuals participated in this study. The age ranged between 2 and 70 years from 28 villages, with detail 12 villages from Muarakaman district and 16 villages from Marangkayu district, East Kalimantan province Indonesia. Among 28 villages collected each village 10-15 household with 2 to 3 participant each household, in enrolled we would collect 168 household and 296 participants. In this study collected 148 household and 213 participants. Males (60%) were dominant in the sample study. The age distribution of sample was 2 to 12(53.5%) and 13 and above (46.5%) Main occupation of the sample consist as farmer (32.9%), at home (25.8%), at school (38.0%) and others (3.3%).

**Parasitological findings**

Prevalence S. stercoralis infection was diagnosed by Kato Katz technique and APC method showed of 426 tested samples from Muarakaman district and Marangkayu district with cases positive S. stercoralis infection 6 (3.2%) and 28 (11.9%). Overall the prevalence of S. stercoralis infection in East Kalimantan Province is 8%. Detail data of prevalence of *S.stercoralis* was explained in table 1

**Association Geographical and *S. stercoralis* infection in East Kalimantan**

The results statistical analysis between environmental risk factors with S. stercoralis infection showed several of environmental factors have correlated significant with S. stercoralis ($p<0.05$) such as district, organic carbon content in soil, texture of soil, humidity, temperature, elevation, number day of rainfall, rainfall volume, and S. stercoralis infection in dog. While pH of soil, clay content in soil, and dry or wet soil surrounding house vegetation, village areas, and having cat and dog and strongyloides infection in cat. have not significant correlated with prevalence of S. stercoralis infection in East Kalimantan Province.

The category of geographical risk factors which had percentage of positive *S. stercoralis* infection more than 8% and with significant correlation such as elevation from above sea (<41.6m), volume of rainfall (<3549mm3), number day of rainfall (<164days),humidity ( <65.4%), temperature(<28.60C), organic carbon content in soil(<2.47%), texture of soil ( sandy soil with organic material), district (Murangkayu District), the detail data in table 2.

**Geographical risk factors of *S. stercoralis* in East Kalimantan province**

Result analysis of estimating risk between environmental risk factor with *S.stercoralis* infection by chi-square odds ratio analysis had showed several environmental risk factors with OR> 1, but the odds ratio had deferent each others of infection.

Analysis OR in district explained that Marangkayu district OR: 2.66 (95%CI: 1.28-5.54) is higher risk than Muarakaman district OR: 0.64 (95%CI: 0.54-0.77) district for *S.stercoralis* infection. Marangkayu district where have temperature (<28.6 0C), humidity (<65.4), number day of rainfall (<164 days), and rainfall volume (3549-4000 mm3) is higher OR=2.66 (1.28-5.54).

Organic carbon content in soil <2.47% was higher OR than 2.47-4.04% was OR: 2.56 (95%CI: 1.38-4.71) and OR: 0.52 (95%CI: 0.45-0.65) respectively. Elevation with category 41.6-50 m, has higher OR than < 41.6m with OR: 2.72 (95%CI: 1.30-5.66) and OR: 0.63 (95%CI: 0.53-0.76) respectively, and texture of soil with category sandy soil with organic material higher OR than non-sandy soil with OR: 2.05 (95%CI: 0.98-4.29) and OR: 0.77 (95%CI: 0.66-0.92) respectively, detailed data in table 3.

**Discussion**

The results statistical analysis between geographical risk factors with *S. stercoralis* infection showed several of environmental factors have correlated significant with *S. stercoralis* ($p<0.05$) such as district, organic carbon content in soil, texture of soil, humidity, temperature, elevation, number day of rainfall, rainfall volume, and *S. stercoralis* infection in dog. While pH of soil, clay content in soil, and dry or wet soil surrounding house vegetation, village areas, and having cat and dog and *strongyloides* infection in cat have not significant correlated with prevalence of S. stercoralis infection in East Kalimantan province.

Geographical risk factors which were highest association/correlation *S. stercoralis* infection were organic carbon content in soil ($p<0.0001$) that has 14.3% positive *S. stercoralis* infection with category organic carbon content <2.47%. The category of environmental risk factors which had percentage of positive *S. stercoralis* infection more than 9% and with significant correlation such as elevation from above sea (<41.6m), volume of rainfall (<3549 mm3), number day of rainfall (<164days),humidity ( <65.4%),

temperature(<28.6 0C), organic carbon content in soil(<2.47%), texture of soil ( sandy soil with organic material), district (Marangkayu district),

District, organic carbon content in soil, texture of soil, humidity, temperature, elevation, number day of rainfall, rainfall volume, and *S. stercoralis* infection in dog have high significant with *S. stercoralis* infection due to the variables have contribution for surviving of parasitic larvae of *S. stercoralis* and potential increase for penetration the larvae to human via soil contact and pet contact. In this study had showed that quality of soil and climatology such as humidity, temperature have correlation with survive of S. stercoralis and heavy rainfall effected for reducing and increasing of distribution *S. stercoralis*. In general condition soil surrounding houses more than 80% covering with soil where close the location with plantation and forest that have high position for contamination from plantation and forest where some time the participants used open defecation on there. Warm temperature and texture of soil (sandy loam soil) could support mature of *S. stercoralis* eggs to develop filarial parasitic larvae. in addition heavy rainfall to make spreading stool with parasitic larva of *S. stercoralis* then has supported the larvae penetrated to skin surrounding at home or in

plantation. *S. stercoralis* infection is neglected tropical diseases (Anamnart et al, 2010). In poor countries with tropical climate, where have environmental condition favorable for transmission *S. stercoralis* infection the prevalence still high. (Jongwutiwes et al, 1999).

Result analysis of estimating risk between environmental risk factor with *S. stercoralis* infection by chi-square odds ratio analysis had showed several environmental risk factors with odds ratio/OR> 1, but the odds ratio had deferent each others of infection. Analysis OR in district explained that Marangkayu district OR: 2.66 (95%CI: 1.28-5.54) is higher risk than Muarakaman OR: 0.64 (95%CI: 0.54-0.77) district for *S. stercoralis* infection. Marangkayu district where have temperature (<28.6 0C), humidity (<65.4), number day of rainfall (<164 days), and rainfall volume (≥3549 mm3) is higher OR: 2.66 (95%CI: 1.28-5.54). Supporting environmental factor against survival of *S. stercoralis* infection was maximum temperature and minimum rainfall increased the odd of infection. *S. stercoralis* larvae same as with hookworm larvae that might have ability to migrate in to soil in presence of sufficient humidity (Forrer et al 2019). When communities defecated in rubber or palm plantation could be spread in village or rice field that

condition was caused elevation plantation is higher than village and rice field elevation, run of water from plantation or forest when rainfall maybe bring the eggs or larvae *S. stercoralis* from hill to village and field rice. Potential infected together via field rice and rubber and palm plantations adult communities also for children when they were playing around houses.

*S. stercoralis* infection no significant correlated with clay content, texture, vegetation and village areas although the prevalence co-infection still high in several geographical factors. Collaboration many geographical l risk factors could support the survival of larvae the worms. Geographical risk factors of *S. stercoralis* infection in East Kalimantan has similar with southern Thailand including long rainy season, temperature and several geography area, then the prevalence of hookworm infection in East Kalimantan Province (44.1%) is higher than in southern Thailand but equal for *S. stercoralis* infection, (Anamnart, et al., 2015). Epidemiology study of *S. stercoralis* infection Southern Laos showed was 41% where has heavy rainfall and poor sanitation. (Vonghachack et al, 2015).

Prevalence *S.stercoralis* infection was higher in Marangkayu district (11.9%) than Muarakaman

district (3.2%). even though the prevalence *S. stercoralis* was lower than hookworm infection in overall cases. The range prevalence *S. stercoralis* infection in East Kalimantan Province have different with study in Preah Vihear province Cambodia, where the prevalence of *S. stercoralis* infection was 48.6%, in contrast the prevalence of *S. stercoralis* infection was lower in East Kalimantan province, Indonesia (8 %). The geographical factors should effect against increasing or decreasing prevalence of S.stercoralis infection in rural area. (Forrer et al 2018).

Organic carbon content in soil <2.47% was higher OR than ≥2.47% was OR: 2.56 (95%CI: 1.38-4.71) and 0.52 (0.45-0.65) respectively. Elevation with category 41.6-50 m, has higher OR than < 41.6m with OR: 2.72 (95%CI: 1.30-5.66) and OR: 0.63 (95%CI: 0.53-0.76) respectively.and texture of soil with category sandy soil with organic material higher OR than non-sandy soil with OR: 2.05 (95%CI: 0.98-4.29) and OR: 0.77 (95%CI: 0.66-0.92) respectively. The study was similar with study in Cambodia reported the lower prevalence of *S. stercoralis* infection in area with heavy rainfall than in low rainfall area. Cambodian study also explained that high amount of soil organic carbon content affect to the lower prevalence of *S.*

*stercoralis* infection (Khieu et al., 2014), equal with study in East Kalimantan which organic carbon soil more in became have effected for reducing *S. stercoralis*, in this study showed where organic carbon content in soil <2.47% has higher *S. stercoralis* than organic carbon content ≥ 2.47.

Geographical risk factors have significant correlation with high prevalence of S. strercoralis such as district, humidity, temperature, volume and amount day of rain organic carbon of soil, texture of soil and elevation, the environmental factors make survive of infective larvae of S. strercoralis infection, had explained with Garcia (2007) that a significant increase the prevalence of *S. strercoralis* infection with environmental conditions. Changing environmental conditions, specifically deforestation and subsequent silting of locally river, have caused periodic flooding with deposition on layer of sandy loam topsoil could increase soil moisture, and supporting by low quality of sanitation facilities and hygiene personal to add the increasing of *S. strercoralis* infection. These conditions, all of which are conducive to *S. strercoralis* transmissions, have allowed S. strercoralis infection to reemerge as an important human pathogen in this area (Forrer, et al 2018).

## Conclusions

Geographical factors in East Kalimantan province, Indonesia have significant correlation and high odd ratio of *S. strercoralis* infection such as district, humidity, temperature, volume and amount day of rain organic carbon of soil, texture of soil, and elevation from above sea. Supporting geographical factor against survival of *S. stercoralis* infection was maximum temperature and minimum rainfall increased the odd of infection. *S. stercoralis* larvae might have ability to migrate in to soil in presence of sufficient humidity. Geographical factors might support survival ability of *S. stercoralis* larvae for migrating and transmission. Essential geographical risk factors of the infections should be used for preventing program of reduction prevalence *S stercoralis* infection.

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## Figures and tables

**Fig 1. Prevalence of *S. stercoralis* infection in Muarakaman district and Marangkayu district, East Kalimantan province**

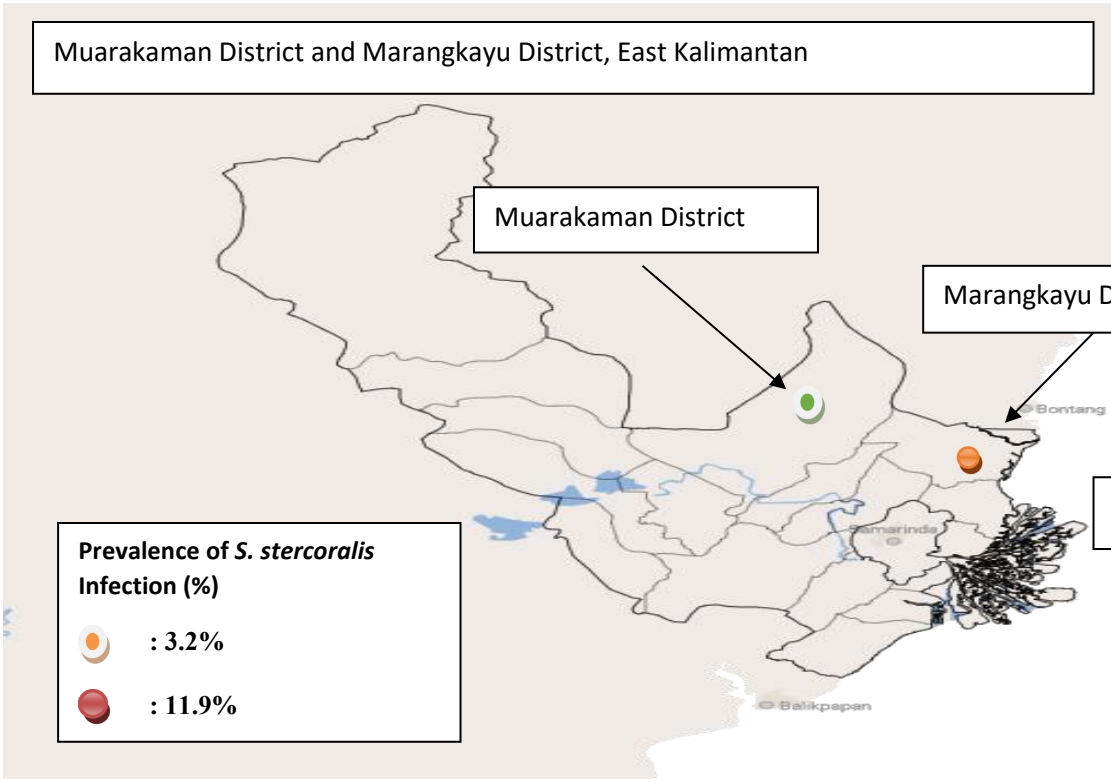
Muarakaman District and Marangkayu District, East Kalimantan
Muarakaman District
Marangkayu D
Bontang
Samarinda
Balikpapan
Prevalence of S. stercoralis Infection (%)
: 3.2%
: 11.9%

**Table 1. Prevalence of *S. stercoralis* infection among Communities in East Kalimantan Province**

| Infections | Muarakaman District | | Marangkayu District | | T |
|---|---|---|---|---|---|
| *S. stercoralis* | Positive | Negative | Positive | Negative | Positive |
| | 3 (3.2%) | 92 (96.8%) | 14 (11.9%) | 104 (88.1%) | 17(8%) |

**Table 2. Geographical factors and S. stercoralis infection**

| Variable | Category | *S. stercoralis* | |
|---|---|---|---|
| | | **Negative n (%)** | **Positive n (%)** |
| District | Muarakaman | 92 (96.8) | 3 (3.2) |
| | Marangkayu | 104 (88.1) | 14 (11.9) |

| | | | |
|---|---|---|---|
| Organic carbon content in soil | <2.47% | 78 (85.7) | 13(14.3) |
| | ≥2.47% | 118 (96.7) | 4 (3.3) |
| pH soil | <5.85 | 95 (93.1) | 7 (6.9) |
| | ≥5.85 | 101 (91.0) | 10 (9.0) |
| Clay content in soil | <18.5% | 79 (92.7) | 7 (7.3) |
| | ≥18.5% | 107 (91.5) | 10 (8.5) |
| Temperature | <28.6 $^0$C | 104 (88.1) | 14 (11.9) |
| | ≥28.6 $^0$C | 92 (96.8) | 3 (3.2) |
| Humidity | <65.4% | 104 (88.1) | 14 (11.9) |
| | ≥65.4% | 92 (96.8) | 3 (3.2) |
| Number day of rainfall | <164 day | 92 (96.8) | 3 (3.2) |
| | ≥164 day | 104 (88.1) | 14 (11.9) |
| Rainfall volume | <3549 mm$^3$ | 92 (96.8) | 3 (3.2) |
| | ≥3549 mm$^3$ | 104 (88.1) | 14 (11.9) |
| Elevation from above of sea | <41.6m | 99 (96.9) | 3 (3.1) |
| | ≥41.6m | 102 (87.9) | 14 (12.1) |
| Texture of soil | Sandy soil with organic material | 125 (89.9) | 14 (10.1) |
| | Non-sandy soil with organic material | 71 (95.9 | 3 (4.1) |
| Vegetation | Surrounding palm plantation and/or rubber plantation | 155 (92.8) | 12 (7.2) |
| | Surrounding rice field | 41 (89.1) | 5 (10.9) |
| Village areas | Buffer river/sea | 154 (92.8) | 12 (7.2) |
| | Hill area | 42 (89.4) | 5 (10.6) |
| Dry or wet soil surrounding house | Dry soil | 154 (91.1) | 15 (8.9) |
| | Wet soil | 42 (95.5) | 2 (4.5) |

**Table 3. Geographical risk factors of *S. stercoralis* in East Kalimantan province**

| Essential risk factors | Category | *S. stercoralis* | | OR |
|---|---|---|---|---|
| | | Negative n (%) | Positive n(%) | |
| District | Muarakaman | 92 (96.8) | 3 (3.2) | 0.64 (0.54 |
| | Marangkayu | 104 (88.1) | 14 (11.9) | 2.66 (1.28 |
| Organic carbon content in soil | <2.47% | 156 (85.7) | 13 (14.3) | 2.56 (1.38 |
| | ≥2.47% | 118 (96.7) | 4 (3.3) | 0.52 (0.45 |
| Temperature | <28.6 $^0$C | 104 (88.1) | 14 (11.9) | 2.66 (1.28 |
| | ≥28.6 $^0$C | 92 (96.8) | 3 (3.2) | 0.64 (0.54 |
| Humidity | <65.4% | 104 (88.1) | 14 (11.9) | 2.66 (1.28 |
| | ≥65.4% | 92 (96.8) | 3 (3.2) | 0.64 (0.54 |
| Number day of rainfall | <164 day | 92 (96.8) | 3 (3.2) | 0.64 (0.54 |
| | <28.6 $^0$C | 104 (88.1) | 14 (11.9) | 2.66 (1.28 |
| Rainfall volume | <3549 mm$^3$ | 92 (96.8) | 3 (3.2) | 0.64 (0.54 |
| | ≥3549 mm$^3$ | 104 (88.1) | 14 (11.9) | 2.66 (1.28 |
| Elevation from above of sea | <41.6m | 94 (96.9) | 3 (3.1) | 0.63 (0.53 |
| | ≥41.6m | 102 (87.9) | 14 (12.1) | 2.72 (1.30 |
| Texture of soil | Sandy soil with organic material | 125 (89.9) | 14(10.1) | 2.05 (0.98 |
| | Non-sandy soil with organic material | 71 (95.9 | 3 (4.1) | 0.77 (0.66 |