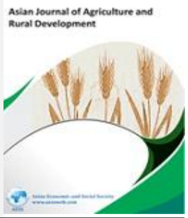
Asian Journal of Agriculture and Rural Development

journal homepage: http://aessweb.com/journal-detail.php?id=5005



Comparing the Local Climate Change and its Effects on Physiological Aspects and Yield of Ramie Cultivated in Different Biophysical Environments

M. Subandi

Lecturer; Agrotechnology Department of the State Islamic University of Bandung, Indonesia

Abstract

Three experiments in three different biophysical environments were conducted in Jatinangor, Sumedang District, Jatitujuh. Majalengka District and Bandung District of West Java Province, Indonesia. The experiment were conducted to evaluate the environments, seasons, manure, nitrogen and potassium effect on the physiological aspects and yield of ramie plant (Boehmerianivea L. Gaud).The locations diverse at different elevation, rainfall type and soil type and atmospheric regimes. The experiments passed the years 2000-2001. The experiment in Sumedang regency was continued with two other experiments in 2007, and experiment in Bandung district was conducted in 2014.The field experiments design used in all the locations were randomized block design arranged in factorial pattern with two factors and two replications. Climatic analysis is done by comparing the atmospheric data of 2000-2001 and the data of 2002-2007 and the data of 2014. Assumed that all the local atmospheric data are atmospheric data under influence of climatic global change. Results of the experiments were: Jatitujuh region is not suitable for ramie cultivation. Dosage of waterw3=35%-40% of Field Capacity affecting sufficient growth on plant.The minimum dosage at which plant survive to produce yield is representing the most efficient input of production.Water supply for ramie plant could be designed to the most efficient volume to maintain the need of metabolism.

Keywords: Change, local climate, physiological aspects, ramie

Introduction

Despite having slight disagreement on the magnitude, timing and spatial distribution of climate change, scientists agree that the climate change has been much faster than in the past (EPA a). NASA (2013) reported that certain facts about earth's climate are not in dispute; they also show that in the past, large changes in climate have happened very quickly, geological-speaking: in tens of years, not in millions or even thousands.

Agriculture and fisheries are highly dependent on specific climate conditions. Trying to understand the overall effect of climate change can be difficult (EPA b, 2013). Global climatic change has been influencing all aspect of agricultural activities. Farmers in Indonesia (tropical region) are difficult to make their cultivation plan. There is no more distinctive change of environmental and agroclimatic conditions throughout the months of the year. Chengjian *et al.* (2013) reported that it might be due to rainfall pattern shift as a result of global climate change, causing worse drought coming along with high temperature in Yangtze River basin. This climate phenomenon cannot be easily detected or explained by the average data of annual precipitation.

EPA a (2013) defined climate change refers to any significant change in the measures of climate lasting for an extended period of time. Climate change includes major change

Corresponding author's
Email address: ms24454@yahoo.com

in temperature, precipitation, or wind pattern, among other effects, that occur over several decades or longer. NASA (2013) reported earth has warmed since 1880. Most of this warming has occurred since 1981 and with warmest years occurring in the past 12 years. Even though the 2000s witnessed a solar output decline resulting in an unusually deep solar minimum in 2007-2009.

Adams *et al.* (1998) and Zhang and McCarl (2013) said changes in climate and the atmosphere is inevitable for the coming decades, raises concerns regarding the adaptive ability and the likely responses of the agricultural sector. Iqbal *et al.* (2009) and EPA a (2013) said there is a growing research interest on transdisciplinary measurement of vulnerability to climatic hazard of climatic change.

Albert and Uche (2014) said that there was climate change awareness among farmers in rural community, and they were of the view that it was human induced and saw it was a threat into their farming business.

This global and local knowledge sand special local condition encourages agronomist and local agricultural policy makers to share their analyses and assessment to formulate appropriate and likely agronomy action to avoid climatic hazards.

Traditionally, in Indonesia rainy season came in September, and the month of March was the beginning of the dry season. That regularity enabled farmer to make definitive plan for his land. And now the regularity has been extinct due to the regional climatic change. Some of environmental sensitive plants are considerably affected. Ramie is sensitive to water supply. Ramie grows and is harvested every 60 days. Ramie needs humid soil but not saturated for well growth, but ramie is cultivated in un-irrigated land. Unlike the dry-land sugarcane cultivation practice which is supplied with additional irrigation water in time of rainfall is lack within certain period. And scheduled the harvest of ramie less than 60 day after the previous harvest.

Ditjenbun (1997) stated that ramie is best grown in area of A or B rainfall type regions where the crop can be 5 to 6 harvests. Ramie is still commercially feasible in C rainfall type region with addition water supply in months of the end of rainy season, and region of D rainfall type is not suitable for ramie cultivation (RIFT, 1997) noted annual rainfall of 1500 to 3000 mm and evenly distributed through the year considered good Ramie is one of the major foreign exchange earning crops in china due to the high quality textile of its fine fiber. However, seasonal drought has been becoming a major limiting factor for fiber yield, especially under global climate change (Chengjian *et al.*, 2013) Budi (1996) said ramie plant susceptible to water supply, it will stagnant in the peak or end of dry-season in tropical climate.

Ramie is easy plant to grow, once it grew, its rhizomes established in the soil. It will grow for years as it belongs to perennial plant. Established root system of ramie can completely suppress the weed growth. and ramie needs low cost of cultivation. This economical agronomy characteristic give beneficial prospective for relieving the burden national budget in import spending for cotton fiber as the case of Indonesia or other non-cotton producing countries).

In the period prior to economic crises happened in Indonesia since the mid of 1997, Indonesian textile industry developed and gained the most foreign revenue among non-gas and oil industries, and in1993 noted a revenue of \$.3.5 billion. Unfortunately, the development of textile industry was not based on domestic raw material. Cotton fiber must be imported mainly from the United States or other cotton producing countries. Indonesia produces only 4 % natural fiber of the total fiber requirement annually (RIFT, 1997) Ramie plant grows well in humid and warm tropical region, subtropical and temperate zones and in the winter temperature does not drop below frozen level (Ditjenbun, 1997), and

Dempsey (1963) said the optimum temperature for ramie plant in subtropic region ranged between 20 ^{0}C and 24^{0}C, and in tropical region 24^{0}C and 28 ^{0}C. CaiTiangchan and Luo (1989) said the optimum temperature for rami between 23.0 ^{0}C and 29.7 ^{0}C, and minimum temperature 9.0^{0}C. Petruszka (1977) stated ramie plant resist well the winter low temperature-such as the minimum temperature below 9. 0^{0}C thanks to the protection offered to rootstocks by a layer of dead leaves. And it is said in the tropical regions, a good yield harvested in plantation at the elevation 1300 m above sea level, and rainfall ranging from140 mm to 360 per month with even distribution through the months and the year.

Biophysical environmental condition includes elevation, climatic regime especially the rainfall; physiographical, soil condition and drainage affect the pattern of physiological growth. Ramie plant harvested within 2 or 3 months, considerable biomass are harvested and removed out of the land. This causes the enormous removal of nutrients. Budi (1996) stated sheep dung beside as nutrition it function to stabilize the soil structure. Zhou *et al.* 1989 said phosphorus is not so important for ramie, while potassium affects quality and quantity of fiber. Potassium is considered as the second most important nutrients for ramie plant. Wan *et al.* (1989) said potash gives good effect on yield quality; it can counter the negative effect of nitrogen.

Sites, material and methods

Experiments were conducted in three different locations; Jatinangor, Sumedang Dictrict and Jatitujuh, Majalengka district, and Bandung district. The experiments took place in 2000-2001 in Majalengka, and in Sumedang were repeated in the year 2002 and 2007. And in Bandung district in 2014. Data compared was data of plant in the months of June, July and August of each experiment.

-Jatinangor, Sumedang district lies on the elevation of 750 m above sea level (ASL), belongs to C rainfall type, 5 to 6 wet-months and 2 to 4 dry months (slightly wet) based on Schmidt and Ferguson (1951). Soil ordoInceptisol, subordotropeptl and subgroup Fluventik, Eutropepts, isohipertermik.

-Jatitujuh, Majalengka district lies on the elevation 19 m ASL, belongs to D rainfall type region consisting of 3 to 4 months of wet months, and 5 to 6 months of dry months. Soil ordo is Alfisol (Mediteran). Mediteran Akuik Vertik (Tropaqualfs).

-Bandung district lies on the elevation of 715 m above sea level (ASL), belongs to C rainfall type, 4 to 5 wet-months and 3 to 4 dry months (slightly wet) based on Schmidt and Ferguson (1951). Soil ordoInceptisol, subordotropeptl and subgroup Fluventik, Eutropepts, isohipertermik

The experiments in Jatinangor and Jatitujuh were field experiment and designed in randomized block design arranged in factorial pattern with two factors and two replications. The first factors was sheep dung manure consisted of five levels (0 t ha^{-1},5 t ha^{-1}.10 t ha^{-1},15 t ha^{-1}, and 20 t ha^{-1}) and the second factor was potassium consisted of three levels ((15 kg ha^{-1}, 30 kg ha^{-1},and45 kg ha^{-1}). Each treatment was replicated twice. Experimental plots were planting beds of 5.2 m x 2.5 m, and planting space 0.5 m x 0.4 m, so the number of plants per plot was 65 plants. Rhizome cutting of Pujon 10 cultivar of 8 cm long was planted.

Climate data recorded during field experiment conducted, 2000 to 2001 were analysed to seek the conclusion of the experiment, and climatic data of the period after the field experiment 2001 to 2012 were analysed, defined their characteristic, pattern, and possible effects on ramie plant growth and yield compared to the effect of the climate in the period of field experiment.

Experiment in Bandung was polybag and in plastic house experiment. The experiment took place from June 2014-August 2014. Rhizomes cutting were of 8 cm long.

The experiment was laid out in a randomized block design with two replicates. Plot was polybags size 40 cm x 30 cm consisting of four polybags in each plot. Water supply treatments consisting of 4 levels of dosages, they are: w1= 25% -30%; w2: 45% -50%; w3: = 65% -70%; w4 = 85% -90%. Nitrogen + Potassium dosages were 3 levels: f1 = 15 kg+15 kg/ha; f2 = 30 kg+30 kg/ha, and f3 = 45 kg+45 kg/ha. There were12 treatment combination, so were36 plots.

Pujon 10 cultivar was the selected cultivar. Rhizome cutting of 8 cm length was selected based on morphological appearances and planted in polybag. Urea and ZK dosages for each plot and polybag were determined based on the dosage per ha, and applied at the first day of experiment.

The sample polybags were tested for water holding capacity by oven-drying method. Water treatments were supplied every day in the evening up to harvest time.

The parameters are 1) Leaf chlorophyll contents; 2) Leaf relative Water content), 3).Number of stem; 4) Length of stem; 5) Diameter of steam; 6) Weight of stem; 7) Crude fibre weight; 8) Fine fiber weight; 9) Fine fiber diameter). The leaf relative water content (LRWC) was measured by weighing the fresh weight (FW).the leaf samples were immersed into the distilled water as long as 12 hours for turgid weight (TW). So leaf relative water content was calculated as LRWC = (FW-DW)/(TW-DW) x100.

After spectrophotometer Optima SP-300 specification measurement the chlorophyll solution. Figures of chlorophyll content recorded in spectrophotometer then match with the Arnon (1949) calculation in Subandi (2002) formula as: Chlorophyll a = 12.7 ƛ 663 – 2.69 ƛ645; Chlorophyll b = 22.9 ƛ 645 – 4.68ƛ633; Chlorophyll total = 20.2 ƛ 645 +8.02 ƛ645 (mg/L) Determining the fineness of fiber or diameter of fine grass is by using a microscope equipped with a filter attached Optilab Upgrade edition at binocular microscope Olympus CX-21 and operated by the operating system window (7) Data obtained were analyzed with Analysis of Variance, and mean variance test was with Duncan Multiple Range Test/DMRT, significant difference at 0.05 probability level.

Descriptive comparison is made among the result of experiments in the three locations.

Result and discussion

Physiological aspects

Temperature in Jatitujuh of Majalengka was the highest, and the lowest was in Bandung. But it was still upper the $29^{0\ C}$. It means that the temperature in Bandung nearly the maximum required for good growth of ramie, CaiTiang and Luo (1989) stated that the optimum temperature is 23.0 ^{0}C – 29.7 ^{0}C and the minimum is 9.0^{0}C.

Ramie planted in field was destructed by that high temperature, and all plant in Jatitujuh was died till the corm or the roots system was dried. There were no data of growth and yield in Jatitujuh experiment. While in Jatinangor the plant root still withstand un-dried and the shoot stagnant. Out of the Figures 1, 2, and 3 concluded that in the months of June, July and August are noted as critical temperatures for ramie plant especially for early generations of plant where its root system is not yet established. These high temperatures were cause by the very low precipitation.

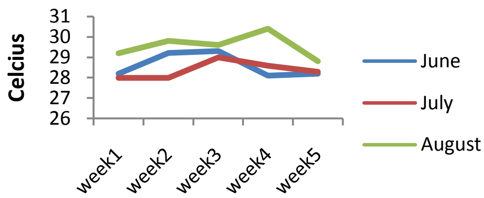


Figure 1: Temperature at Jt Nangor

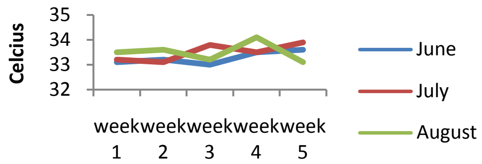


Figure 2: Temperature At Jt Tujuh

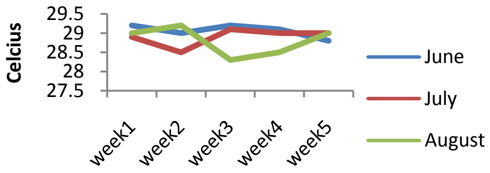


Figure 3: Temperature At Bandung

Figure 4 showing the rainfall during the experiments. In June there was recorded rainfall in all the locations. In Jatitujuh there were small rainfalls in the first week. There was 52.3 ml rainfall, but in Jatitujuh the temperature is high the week was 33.2 ^{0} C, and hot air evaporate the rainfall up. Figure 1. showed daily evaporation in this region is more than 60 ml. So that no rest of rainfall water for moister the soil.

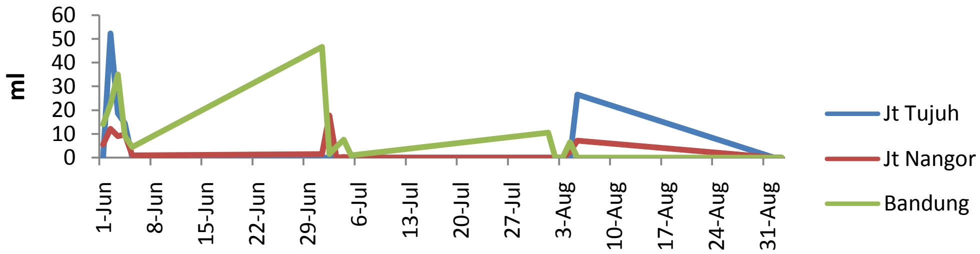


Figure 4: Rainfall

Figure 4: Rainfall in locations of Jt Tujuh, Jt Nangor, and bandung

Relative humidity (rH) at the sites of experiment were recorded in June at the average 74.29%, in July 75.77%, and in August where in this month no rainfall this region were causing the air humidity lower to be 72. %. However, these percentages were still lower than the good humidity for ramie plant growth. In all the locations the rH were lower than the favourable rH for good growth. It was moderate low for the optimum, growth of ramie plant. Budi (1996) found relative humidity for good growth is 80%, and below 21% detrimental to plant. Record during the months indicated that the global climatic change is affecting the local climate.

Experiment in Bandung showed the Leaf Relative Water Content (LRWC) of Leaf measured yielding data and then analyzed

Showed the effect of water and fertilizer treatments on relative water content of plant as differ significantly. The more water and fertilizer applied the more LRWC. Based on Subandi (2014) reporting Figure 5. Shows the effect of water dosages at levels of fertilizers as different. Plant water status as response to the water and fertilizer.

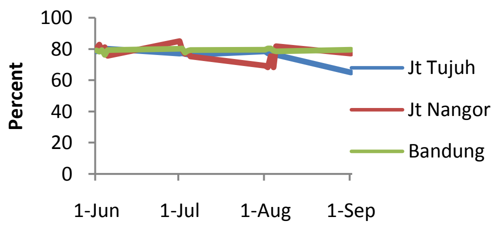


Figure 5: Air relative humidity

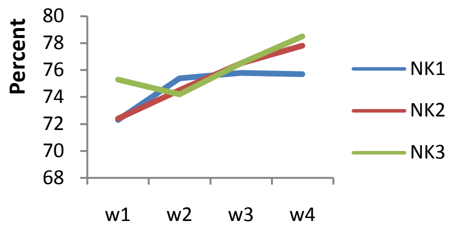


Figure 6: LRWC at Bandung

Plant absorbs nutrition (nitrogen and potassium) in the presence of water as solvent. Chengjian *et al.* (2013) stated LRWC representing the plant water status, reflecting the metabolic activity in tissue. Sartaj *et al.* (2013) said LRWC is usually used as one of the most meaningful indexes for dehydration tolerance in wide variety of plant. In the first ramie plant generation the effect of fewer water supplies is not yet causing problem in plant metabolism. The cutting as source of growing energy was still supplying sufficiently for germination and further first growth. But it apparent the trend is becoming that the different dosages of water and fertilizer will result in different response of ramie plant. It is apparent in the extrapolation of the curves in the Figure 7, there will be a arise of the effect of more water and more fertilizer. In Jatinangor ramie plant treated with potash and sheep dungs at various levels could increase and maintained at higher percentages as presented in Figure 7. It indicates that organic fertilizer (sheep dung) could enhance the absorption of water with roots or other case the water were deposited in soil rich in sheep dung.

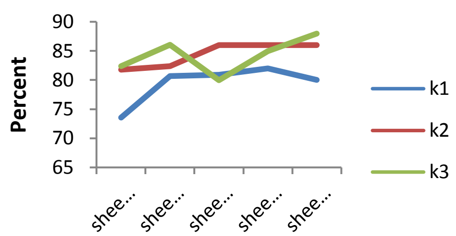


Figure 7: LRWC of Jt Nangor

As for the LRWC in Jatitujuh was unrecorded due to plant was all dried with the harsh of atmospheric condition no data of plant could be collected. Even though the plant were treated with sheep dung and potash fertilizers.

Chlorophyll Content of leaf Fig. 8 and 9) as reported by Subandi (2014) Increase of chlorophyll content is detected in the data analysis, and there was a significant effect of water supply and fertilizer application treatments. Farooq *et al.* (2009) found the increase of chlorophyll content in line with the increase of water supply and fertilizers is due to the increase of the photo oxidation pigment and development of the chlorophyll. In contras is happen in water stress (dosages of less water and less fertilizer), chlorophyll content decrease in water stress condition due to creation of photo-oxidation pigment, and consequent of the damage in chlorophyll leaves.

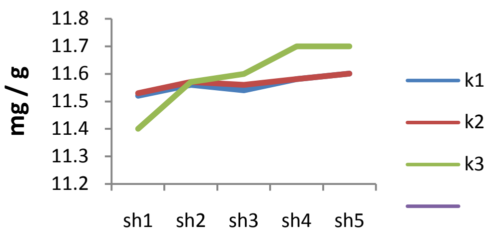


Figure 8: Chlorophyll at Jt Nangor

In stress water condition, the formation of chlorophyll must have been decreased, this will make other organ disturb and may be experiencing the degradation of chlorophyll. Cornoy *et al.* (1988) stated that decrease of chlorophyll was due to the chloroplast decomposition and deleting of tylacoid structure. The curves in Figure 8 show there will be a possible development or increase of chlorophyll in further growth (in the second generation plant). It is not so wise comparing chlorophyll content of Jatinangor and Bandung, the ramie plant were treated with different treatment and at different location and time, but there are relatively the same treatment nitrogen and potash fertilizer and water treatment. In Jatinangor ramie was treated with sheep dung, it mean organic fertilizer that serve as water deposit, while in Bandung ramie was treated with water.

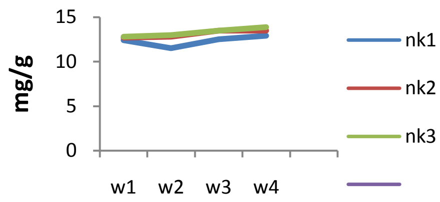


Figure 9: Chlorophyll at Bandung

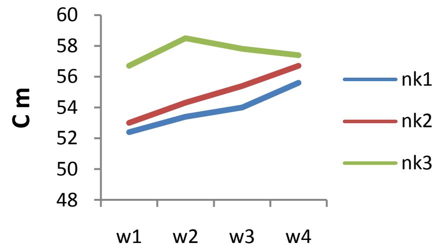


Figure 10: Stem length at Bandung

Stem Length Effect of water dosages on stem length showed differ significantly. Indeed, the most high-dose treatments are at the affected gaining the peak of the stem length. Although the conclusion, the provision of water in all levels above 75% of field capacity causing most good influence on the upwards growth or stem length. Edward (1981) said that potassium enhance root to penetrate deeper into the lower part of soil horizon enabling reach the wetter part of dryer soil. More water could be extracted. While in the poly bag plant, it means potash could initiate growth of roots, and better root will absorb more nutrients for growth and development of stem.

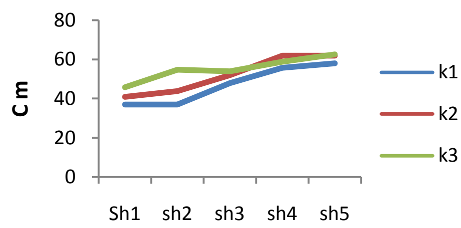


Figure 11: Stem length at Jt Nangor

Fine fibers Weight are fibers that have been cleaned through degumming process. Non fiber content is a group of compounds likes slime (gum). This gum removal process called degumming using an alkaline solution. After cleaning fiber out of gum. Thus the results of a further statistics test show the same result. It is logically proportional to the weight of the stem and the weight of crude fiber, and of fine fibers which are obtained. Plants were difficult to differentiate its tissue in the water stress condition. Fiber yield were below the standard production. Shao *et al.* (1989) said to increase the ratio of fibre to the stem weight was required the management of fertilizer and watering.

Esau (1984) said that ramie fiber is extraxiler that is fibre existing outside the xylem tissue. And Fahn (1992) said that ramie fiber develop in secondary phloem tissue. Curves of Figure 12 show the increase of fibre in line with the increase of water supply and application of fertilizer. Balittas (2014) stated that the fiber production of Ramindo 1 (formerly the Pujon 10 cultivar) per stem is 4-5 gram, while the experiment showed at the dosages w1 and w2 at all levels of fertilizer produced below the 1.5 gram. It means the stress of water made plant difficult to develop its tissue.

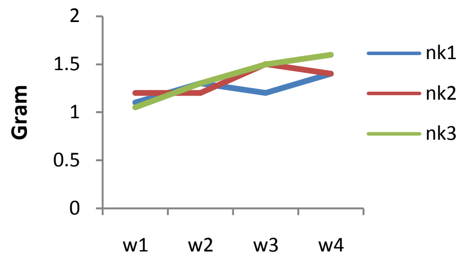


Figure 12: Fine fibre weight at Bandung

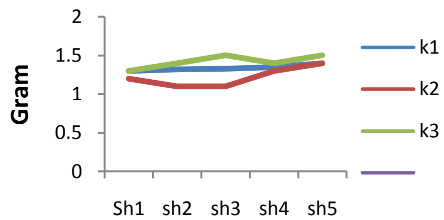


Figure 13: Fine fibre weight at Jt Nangor

Diameter of fine fibre showing the pattern of erratic increase in line with the increase of fertilizer application and water supply. The more apply of fertilizer and more water supplies the bigger diameter are. Dimension of ramie fiber may be between 13µ up to 126µ and the mostly found between 40µ to 60 µ (Ditjenbun, 1997). Diameter representing the fineness of fibre or quality, the smaller the diameter the finer the fibre is. Finer fibre is wanted by the producer of textile.

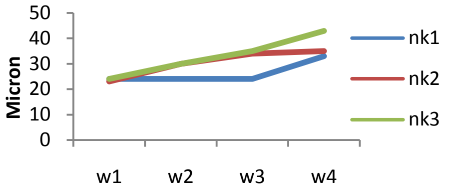
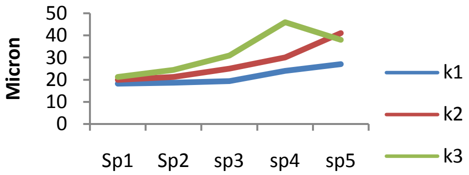


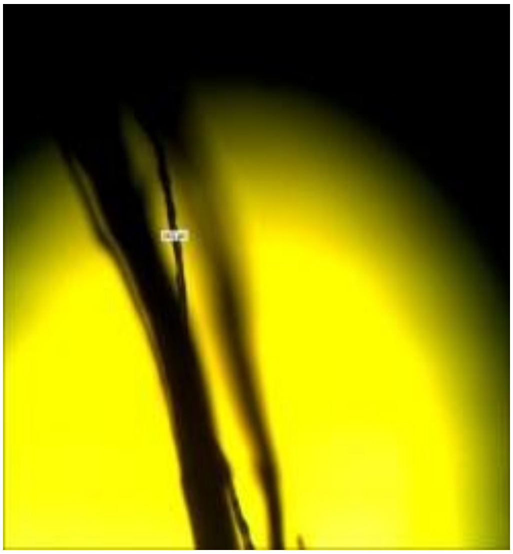
Figure 14: Fibre diameter at Bandung

Subandi (2002) found ramie planted in dryer region will have finer fiber. Plant suffered with lack of water limited in developing its tissue. Ramie grows in more fertile soil with sufficient water develop its tissues better, and the more fertile soil and the more water available affect plant to grow rigorously and develop better vegetative organs with bigger cells and tissues. Fiber is vegetative tissue, so supplying more water and fertilizer yield the worse dimension of fiber in respect of quality.



Figures 15: Fine fiber diameter at Jt nangor

Figures 16 and 17are photos of samples of diameter of fine fiber. Fine fiber measured with Optilab equipped to Binocular Microscope (Subandi, 2014). Measurement is excecuted with program of Window 7. (Sample 16 = 24 µ; 17 = 24 µ).



Figures 16:

Figures 17:

Figures 18, 19, and 20 are 15 days after planting of Ramie plantin Plastic house experiment in Bandung (Subandi, 2014).

Figure 18: Treatment A (less water)

Figure 19: Treatment A and Others.

Figure 20: Treatment G (more water)

Conclusion

Climate change and global warming have considerable effect on life, and the effect on local weather is the changing of dry and wet season periods. There is revealed in this research that the dry and rainy season is shifting. The classification of region on rainfall types has been not accurate and valid any more. Climate change was observed to have changed the regional and local climate inclusively in the experimental sites. It was recorded in the local temperature and air relative humidity. There was a very efficient dosage of water w3=35%-40% of Field Capacity affecting sufficient growth on plant. The minimum dosage at which plant survives to produce yield is representing the most efficient input of production. Water supply for ramie plant could be designed to the most efficient volume to maintain the need of metabolism Nitrogen and potassium were significantly support plant to growth in the limited volume of water supply, and potassium showed good effect on quality of fibre.

References

Adams, R. M., Brian H. H., Stephanie L., & Neil, L. (1998). Effect of global climate on agriculture. An interpretative review. *Climate Research*, 11(1), 19-30.

Albert, U. O., & Uche, N. U. (2014). Acceptance of climate change by rural farming communities in delta state Nigeria effect of science and government credibility. *Asian Journal of Agriculture and Rural Development*, 4(6), 372-380.

Balittas, (2014). *Ramindo 1. Characteristic of Ramindo 1*. Research institute for tobacco and fiber crops. Malang.

Budi, S. (1996). *Agroclimatical effect on growth and china grass production*. Dharma agrika foundation. Semarang.

CaiTianchang, & Luo, L. (1989). *A discussion for establishment of ramie commercial productive base in die southeast Sichuan.* First int sym. on ramie profession. Changsa. hunan. China. p. 8.

Chengjian, H., Siji, Z., Longchang, W., Shakeel, A. A., Man, C., Hangpei, Z., & Cong, M. (2013). Alteration in chlorophyll flourescense, Lipid per oxidation, and antioxidant enzym activities in hybrid ramie under drought stress. *Australi Journal of Crop Science*, 5, 594-599.

Cornoy, J. P., Virgon, J. M., Smilie, R. M., & Barlow, E. W. (1988). Influence of drought acclimation and Co2 enrichment on osmotic adjustment and chlorophyll aflorescence of sunflower during drought. *Plant Physiol*, 186, 1108-1115.

Dempsey, J. M. (1963). *Long vegetable fibre.* Development in South Vietnam and other countries. Saigon.

Ditjenbun (1997). *Manual of ramie cultivation*. Directorate of production service of plantation crops. Ministry of agriculture R. I. Jakarta.

Edward, E. (1981). *Potash fertilizer and increased tolerance to stress agriviews*, 1, no. I. Canada.

EPA (a). (2013). *United States environment protection agency*. www.epa.gov/Climatechange/impact-adaptation/.

EPA (b). (2013). *EPA (United States environment protection agency*. www.epa.gov/Climatechange//agriculture-climate impact on agriculture and food supply.

Esau, K. (1984). *Plant anatomy.* Second edition. John wiley & Son, Inc. New York. London. Sydney.

Fahn, A. (1992). *Anatomi Tumbuhan. Edisiketiga*. Terjemahan A Sudiarto., trenggono K., Mahmud N. dan H Akmal. Gajah Mada University Press, Yogyakarta.

Farooq, M. A., Wahid, N. D., Kobayashi. F., & Basra, M. A. (2009). Responses of seven diverse rice cultivars to water deficit: accumulation of abscisic acid and proline in relation to leaf water potential and osmotic adjustment. *Field Crops Res*, 27, 105-107.

Iqbal, M., Mohsin, M., Arif, G., & Arshad, M. K. (2009). Climate-change aspersions and food security of Pakistan. *Science Vision*, 15(1), 15-23.

NASA (2013). Global climate change, vital signs of the planet. http;//climate.Nasa.gov/Scientific-consensus.

RIFT (Research Institute for Fiber Plant and Tobacco.) (1997). *Ramie.* Annual report years 1996/1997. Malang.

Petruszka, M. (1977). *Ramie fibre production and manufacting food and agricultural industries services*. Agricultural division. Rome.

Shao, K., Cui Y., Luo, Y., Liao, X., & Yin, B. (1989). *Studies on biological characteristics and the physicochemical properties of Fibre in the different growth stages of ramie*. First int. sym. on ramie prof changsa. Hunan china.

Sartaj, A. W., Subhash, C., Najar, G. R., & Teli, M. A. (2013). Organic farming: As a climate change adaptation and mitigation strategy. *Current Agriculture Research Journal*, 1(1), 45-50.

Schmidt, F. H., & Ferguson, P. J. A. (1951). *Rainfall type based on wet and dry period ratios for Indonesia with western new Guinee*. Verhandelingen No. 42. Telecomunication ministry. The Republic of Indonesia. Meteorology and geophysic service. Djakarta.

Subandi, M. (2014). *Report of Ramie Experimentin 2014 (unpublished).* Centre for experimentation and publication. Institute for research and community devotion of the state Islamic university of Bandung. 2014.

Subandi, M. (2002). *Adaptation, Growth and Yield of Ramie in C type agroclimatical Zone*. Research report of junior lecturer. Bandung.

Wan Q., Xiao Z., Wang C., & Li T. (1989). *Studies on nutritive peculiarity and fertilization of fine quality and high yield ramie*. First Int. Sym. on Ramie Profession. Changsa. Hunan. China.

Zhang, Y. B., & McCarl, W. A. (2013). US agriculture under climate change: An examination of climate change effects on ease of achieving RFS2. *Economic Research International*, 20(3), 13.

Zhou, Z., Li T., Qugang, D., Wang, C., & Li, T. (1989). *Effect of fertilizers on ramie*. First Int. Sym. on Ramie Profession. Changsa. Hunan. China.