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Agriculture and Agricultural Science Procedia 9 (2016) 181 – 190

Agriculture and Agricultural Science
Procedia

International Conference on Food, Agriculture and Natural Resources, IC-FANRes 2015

Soil Chemical Properties Index of Tobacco Plantation Land in Jember District

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Abstract

Soil chemical properties have important roles for supporting tobacco growth and productivity. The study was conducted in 2014 to identify location-specific critical soil characteristics (i.e., soil-chemically-fertility indicators), build soil chemical properties index (SCPI), and understand the correlation between the SCPI with tobacco productivity in Jember district. The SCPI was constructed by applying principal component analysis procedures. Cation Exchange Capacity, total N content, soil pH, and available-P were identified as key indicators of soil fertility in the study area. Four sub districts namely Ambulu, Kalisat, Wuluhan and Sumberjambe were categorized as high level of SCPI, while others were classified as low to medium categories. It had positive correlation between SCPI and tobacco productivity, meaning the higher the SCPI the better the tobacco productivity.

Peer-review under responsibility of the organizing committee of IC-FANRes 2015

Keywords: Soil Chemical Properties Index; Tobacco Plantation; Tobacco Productivity

1. Introduction

Tobacco is a prime agricultural commodity in Jember region. Huge contribution of tobacco on economic side is undoubtedly. In 2015, the amount of profit sharing funds of tobacco product customs (DBHCHT) for Jember amounted to 63.45 billion rupiah (Menteri Keuangan RI, 2015), which is 2.19% of the total budget of Jember reaching 2.9 trillion rupiah. In addition, the importance of tobacco can be seen from the many tobacco enterprises, from upstream to downstream, that stand in Jember, which employ thousands of workers.

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Peer-review under responsibility of the organizing committee of IC-FANRes 2015
doi:10.1016/j.aaspro.2016.02.118

In Jember, “Kasturi” tobacco is tobacco Voor-Oogst most widely cultivated by farmers. Kasturi tobacco processing is done by chopping the leaves and then dried in the sun or better known as the sun curring. Because processed in the form of chopped, then productivity or quantity is a major goal in the cultivation of tobacco Kasturi.

Kasturi tobacco productivity is influenced by two factors of genetic and environmental factors. Environmental factors are composed of two things: the climate and soil conditions in the area of cultivation. Soil conditions or soil fertility is one of the most important factors in supporting the growth of tobacco plants (Siswanto, 2004).

One of the determinants of soil fertility is soil chemical properties. Including in soil chemical properties involve pH, CEC, Base Saturation, C-organic, and the levels of macro nutrients (N, S, P, K, Ca, Mg) and micronutrients (Cu, Co, Mn, Zn, Fe, B, Mo) in the soil. In general, the chemical properties of the soil are closely related to the availability of essential nutrients that play an important role in the growth and development of tobacco plants. When nutrients are met then the metabolism in plants are going well and it leads to good tobacco productivity.

Ideally, before determining the chemical treatment to improve soil fertility, farmers should perform soil tests that aim to measure all the parameters of the chemical properties of the soil. However, efforts to measure all the soil chemical properties are very expensive, especially for farmers. In addition to agricultural stakeholders in determining the chemical soil fertility levels at each location is also not easy, because the various parameters of the soil chemistry with each other can be mutually contradictory or are not always parallel. Therefore, to reduce the cost of analysis and to facilitate the determination of the level of fertility of soil chemistry, techniques are required to decide minimum data sets (MDS), which shows just some of the soil chemical properties as a determinant of specific location soil fertility. The MDS then can be used to build soil chemical properties index (SCPI).

Based on these ideas we conducted this study with the aim to identify location-specific critical soil characteristics (ie, soil-chemically-fertility indicators), build soil chemical properties index (SCPI), and understand the correlation between the SCPI with tobacco productivity in Jember. Hopefully, the results of this research can be used as a guideline to make recommendations for improvement of soil chemical properties to increase the productivity of tobacco Kasturi in Jember region; as well as a reference for selecting the best location for the cultivation of tobacco Kasturi.

2. Materials and methods

The experiment was conducted in March through December 2014 in tobacco Kasturi growing land spread over seventeen Districts in Jember. Materials used in this study include support material for analysis in a laboratory, administration map of Jember, visual map of the earth, and land use maps. The tools used in this study include computer hardware, software Quantum GIS 1.8, SPSS 17.0, field blade, compass, GPS, rool meter, and laboratory equipment.

In this study, land surveys were conducted in the districts of the centers of Kasturi tobacco plantation in Jember. Land unit was determined based on the sub-district boundaries in accordance with administration map of Jember district. Soil samplings were performed on each land unit (sub-district) with three sampling points (as replication). The sampling points were determined by purposive approach (purposive sampling) on the Kasturi tobacco crop land. Chemical properties of the soil were determined through analysis of the soil from each sampling point in each district. In addition, the survey was also conducted by interview to the land owner to obtain information about land management system in terms of both the choice of plants and the treatments those are usually done by the land owner, such as fertilization and irrigation.

Analysis of the soil samples were carried out in the Soil Fertility Laboratory, Faculty of Agriculture, Jember University. The chemical properties analyzed and evaluated from the soil were: pH, related to soil-water 1:5 (w/v) by the electrometrical methods; cation exchange capacity (CEC), with ammonium acetate (NH4OAc, pH 7.0); organic matter (OM), through the methods of organic carbon by Kurmies; total nitrogen (N) by Kjeldahl method; available phosphorus (P), by Bray I; and exchangeable potassium (K) with ammonium acetate (NH4OAc, pH 7.0) (Balai Penelitian Tanah, 2005)

Stages in determination of the soil chemical properties index were: (1) analysis of variance (ANOVA) on all parameters measured; if there are significantly differences between the land units, then it will be forwarded to the Duncan test and the process can continue; (2) correlation analysis, used to determine the relationship between the parameters at all study sites were subsequently used in the process of determining the Minimum Data Set (MDS);

(3) performing the procedure of Principal Component Analysis (PCA); (4) determine indicators (soil chemical properties) that represents the soil function, especially soil fertility and quality as the MDS; (5) scoring and weighting of the chemical properties of the soil that were included in MDS; and (6) Indexing, an determining of soil chemical properties index (Hermiyanto et al., 2003). Scorings on indicators of MDS were performed using two equations proposed by Andrews et al. (2002). The equations are:

$$y = \frac{(x-s)}{(1.1t-s)} \text{ for "more is better" } \ldots\ldots [1]$$

$$y = 1 - \{\frac{(x-s)}{(1.1t-s)}\} \text{ for "less is better" } \ldots\ldots [2]$$

where, y was the score of the soil data; x was the value of the soil chemical properties those were converted into a value scale of 0 to 1; s was the lowest value that may occur from soil characteristics (s = 0); and t is the highest value of the properties of the soil. Equation [1], the function of scoring "more is better" was used for parameters levels of available P, exchangeable K, C-organic, soil N-total, cation exchange capacity (CEC), and the soil pH when the pH value of <7.5, while equation [2] was used for parameter of soil pH when the value >7.5; it was assumed that soil with pH 6.6 – 7.5 were categorized neutral (Hardjowigeno, 1995).

Integration indicator scores into an index of soil chemical fertility was done using the formula described by Andrews et al. (2002):

$$SQI = \sum_{i=1}^{n} \text{Wi x Si} \ldots\ldots [3]$$

where SQI was Soil Quality Index, in this research it was represented by Soil Chemistry Properties Index (SCPI); W was the weighting factor of the principal component, taken from the value of % of variance in the PCA and S is the score indicator (y in equation [1] and [2]). SCPI produced has a range of values between 0-0.91. The value of SCPI close to 0.91 or 1 meant the value was the better (Partoyo, 2005; Hermiyanto et al., 2003).

Data of Kasturi tobacco productivity per sub-district were secondary data obtained from Jember Plantation Office during 2009 upto 2013. The values of SCPI built against the tobacco Kasturi productivity collected were then statistically analyzed by using regression and correlation in every research site.

3. Results

Jember district was geographically located at the position of 6º27'29 " to 7º14’35” east longitudes and 7º59'6 " to 8º33'56" south latitude with an area of 3293.34 km2 and with a height between 0-3330 meters above sea level. Jember had tropical climate with a temperature range between 23-32oC. Within a year, the average rainfall reaches ± 2350 mm. Jember is a Canyon-shaped region of fertile plains in the central and southern parts, surrounded by mountains Hyang in the north with the peak of Mount Argopuro (3,088 m asl.) and in the East was part of the Ijen Plateau which is a complex of mountains where Mount Raung exists.

Administrative boundaries of Jember district, in the North is the Bondowoso regency and a small portion of Probolinggo regency, in the East is Regency of Banyuwangi, the southern border with Indonesian Ocean and the west border was Lumajang. Jember has several rivers such as river Bedadung sourced from Hyang Mountains in the northern part, river Mayang which was sourced from Raung Mountains in the East, and river Bondoyudo sourced from Mount Semeru in the West.

Chemical properties of the soil are closely related to the status of plant nutrients in the soil. Chemical properties measured in this study included pH, total N, exchangeable K, available P, C-organic and CEC of soils. Data from the analysis of all parameters of soil chemistry in the tobacco Kasturi crop land in Jember were presented in Table 1.

4. Discussion

4.1. Soil pH

Based on the analysis of the soil in the tobacco Kasturi planting area in Jember (Table 1) it was known that the average pH value of the soil generally in the range of 5.45 (acidic) to 6.81 (neutral). Soil with a neutral pH of the region were Ajung, Arjasa and Mumbulsari, while soil with a pH acidic was the Wuluhan District (pH <5.5). The others (thirteen regions) had soil pH which was catagorized in slightly acid (pH ranged from 5.5 to 6.5). Regions with the highest pH found in Mumbulsari with a value of 6.81, and the lowest soil pH localized in Sub District Wuluhan with a mean pH of 5.45 that were considered acidic soil. The results showed that in the majority of districts, it was necessary to increase efforts in order to achieve a neutral soil pH (pH> 6.5), for example through the addition of limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$).

Table 1. Some Soil Chemical Properties (pH, total N, available P, exchangeable K, C-organic, and CEC) in Tobacco Kasturi Crop Land

No	Sub Distric	pH	Total N	Available P	Exchangeable K	C-Organic	CEC
1	Ajung	6.67 ± 0.60 de	0.21± 0.02 abc	1.87 ± 1.25 a	0.46 ± 0.01 abcd	1.89 ± 0.10 abc	18.40 ± 2.42 bcde
2	Ambulu	6.11 ± 0.06 bc	0.38 ± 0.10 e	2.65 ± 1.14 abc	0.52 ± 0.10 cde	2.13 ± 0.32 bc	27.52 ± 1.21 f
3	Arjasa	6.63 ± 0.08 de	0.28 ± 0.04 cd	2.68 ± 0.17 abc	0.55 ± 0.07 de	1.64 ± 0.15 a	20.64 ± 3.00 cde
4	Jelbuk	6.42 ± 0.17 bcde	0.19 ± 0.02 ab	1.96 ± 0.08 abc	0.34 ± 0.04 abcd	1.62 ± 0.03 a	11.84 ± 1.47 a
5	Jenggawa	6.17 ± 0.42 bcde	0.28 ± 0.03 cd	2.34 ± 0.91 abc	0.57 ± 0.05 def	1.85 ± 0.30 abc	18.40 ± 1.82 bcde
6	Kalisat	6.18 ± 0.15 bcde	0.38 ± 0.03 e	3.02 ± 0.15 bc	0.57 ± 0.04 def	2.18 ± 0.05 c	21.28 ± 3.20 de
7	Ledokombo	5.97 ± 0.25 bc	0.26 ± 0.03 bcd	2.52 ± 0.93 abc	0.69 ± 0.08 f	1.75 ± 0.10 ab	20.32 ± 1.69 cde
8	Mayang	6.41 ± 0.33 bcde	0.30 ± 0.06 de	2.85 ± 0.24 abc	0.48 ± 0.11 bcd	1.73 ± 0.16 ab	12.48 ± 1.27 a
9	Mumbulsari	6.81 ± 0.05 e	0.28 ± 0.04 cd	2.90 ± 0.08 abc	0.47 ± 0.02 abcd	1.63 ± 0.54 a	16.64 ± 1.69 bc
10	Pakusari	5.93 ± 0.20 b	0.19 ± 0.02 ab	2.96 ± 0.05 abc	0.38 ± 0.06 abcd	1.75 ± 0.36 ab	19.68 ± 3.00 bcde
11	Patrang	6.47 ± 0.09 cde	0.22 ± 0.02 abcd	2.62 ± 0.65 abc	0.37 ± 0.03 abcd	1.77 ± 0.09 ab	20.16 ± 1.27 acde
12	Silo	6.40 ± 0.28 bcde	0.19 ± 0.02 ab	2.61 ± 0.56 abc	0.57 ± 0.02 def	1.69 ± 0.25 a	16.80 ± 1.44 bcd
13	Sukowono	6.28 ± 0.19 bcde	0.21 ± 0.07 abc	3.11 ± 0.19 bc	0.49 ± 0.15 bcde	1.81 ± 0.03 abc	15.68 ± 1.94 ab
14	Sumberjambe	6.43 ± 0.12 bcde	0.37 ± 0.05 e	2.95 ± 0.22 abc	0.54 ± 0.05 de	1.74 ± 0.05 abc	19.36 ± 2.73 bcde
15	Sumbersari	5.98 ± 0.28 bc	0.17 ± 0.04 a	2.63 ± 0.26 abc	0.48 ± 0.14 bcde	1.67 ± 0.08 a	18.72 ± 0.96 bcde
16	Tempurejo	6.10 ± 0.36 bc	0.26 ± 0.05 bcd	2.93 ± 0.07 abc	0.45 ± 0.05 abcd	1.74 ± 0.07 ab	17.92 ± 2.89 bcd
17	Wuluhan	5.45 ± 0.15 a	0.38 ± 0.04 e	3.15 ± 0.36 c	0.62 ± 0.05 ef	1.72 ± 0.05 ab	22.56 ± 4.40 e
	Average	6.26	0.27	2.69	0.50	1.78	18.73

Explanation: The numbers followed by the same letter in the same column showed non Significantly Different on Duncan test at confidence level of 5%.

4.2. Total Nitrogen in the Soil

Nitrogen is a macro nutrient needed by the tobacco plants in the synthesis of amino acids and proteins to support the plants growth. Results of the analysis of soil total N in seventeen districts in Jember were presented in Table 1. Table 1 showed that the average value of total N of the soil in the center of tobacco Kasturi cultivation was in the range between 0.17 to 0.38%, which was categorized as low to moderate levels. According to the Soil Research Institute (2005) total N content of the soil was assumed to be low if the value is in the range 0.10 - 0.20% and was assumed to be moderate if it stands at 0.21 - 0.50%. The results showed that, District Kalisat, Ambulu, and Wuluhan had values of highest total N (0.38%), while the District Sumbersari had the lowest value (0.17%). Subdistrict Sumberjambe, Mayang, Ajung, Jenggawah, Mumbulsari, Ledokombo, Tempurejo, Patrang, Arjasa and Sukowono were grouped in middle category because they had values of soil total N > 0.21%, while Pakusari, Silo, and Jelbuk had the same values of soil total N of 0.19%, that was categorized at low level.

The average value of the soil total N of the entire district was 0.27%, which was still considered moderate. However, the value was approaching the lower limit of the medium category, ie 0.21%. Thus, in general, the research areas still need improvements in soil total N content, for examples through nitrogen fertilizer applications and/or crop rotation practices using legume crops on those lands.

4.3. Available P in the Soil

Analysis results of soil available P in the tobacco Kasturi planting area (Table 1) showed that the levels of the parameter were included in the category of very low, because all data of the available P were < 4 ppm. Region with the highest value of available P was the District Wuluhan with a value of 3.15 ppm and which was significantly different from the other districts, while the region with the smallest value of available P was the District Arjasa with a value of 1.87 ppm. The medium category was achieved when in the soil containing available P as much as 8-10 ppm. Tobacco Kasturi requires level of available P at least in the medium category. Therefore, in the tobacco Kasturi crop land in Jember, nutrient applications of phosphate (P) through appropriate fertilization were required.

4.4. Exchangeable K in the Soil

Potassium (K) is needed by the plant because of its role as a catalyst in a variety of metabolic processes such as photosynthesis, production of ATP, translocation of sugars, and protein synthesis, thus greatly affect the quality of the products. Results of soil analysis of exchangeable K contained in Table 1 showed that the values of exchangeable K in tobacco Kasturi planting area were among the category of medium to high. Exchangeable K value of soils were grouped to be high if it is between the values of 0.6 - 1.0 cmol.kg-1. Districts that had a high value of exchangeable K was Ledokombo (0.69 cmol.kg-1) and Wuluhan (0.62 cmol.kg-1). While the exchangeable K levels were categorized medium if the value was between 0.21 to 0.5 cmol.kg-1. All the Districts were categorized as moderate, except Ledokombo and Wuluhan. The lowest level of exchangeable K was possessed by Jelbuk area with a value of 0.34 cmol.kg-1. It showed that all the tobacco Kasturi crop land in Jember had a land suitability level S1 class (very appropriate) which requires level of exchangeable K in the soil from medium to high category (Puslittanak, 1993).

4.5. Soil Organic Carbon (SOC)

The existence of the organic carbon in the soil have a big impact in improving the physical, chemical and biological of the soil. The distributions of the value of soil organic carbon (SOC) in tobacco Kasturi cultivation centers were presented in Table 1. Based on the laboratory analysis, it was known that most of the SOC levels in the study area were categorized low, those were in the values of <2%. The were only two regions included in the medium category. The regions were Kalisat with SOC content of 2.18% and Ambulu with SOC content of 2.13%. Area with the lowest SOC content was achieved by the District Jelbuk (1.62%), followed by Mumbulsari (1.63%) and Arjasa (1.64%). While the other areas were in the SOC content between the range of 1.67% to 1.89% those were categorized as low. When the SOC content values were converted into soil organic matter (SOM), then the values of the level of SOM in research area were to be in the range of 2.88% to 3.76%. The results above consistent to the findings of the field study by interviewing farmers that tobacco farmers in reality rarely appliying organic fertilizer in the forms of compost and/or manure, conversely to support the nutrients requirement of the tobacco plant, the farmer only provided inorganic fertilizer on the agricultural land. In these matters the applications of organic matter to soil were very necessary, because the organic matter in the soil could improve soil properties such as soil permeability, porosity of the soil, soil structure, water holding capacity and soil cation exchange capacity (Hardjowigeno, 1989).

4.6. Cation Exchange Capacity (CEC)

In accordance with the definition, cation exchange capacity (CEC) is the total capacity of a soil to hold exchangeable cations. Soil with high CEC indicated that the soil has a high ability to provide cations nutrient such as K +, Ca2+, Mg2+, Fe2+, Mn2+, MO2+, Cu2+, and Zn2+ for plants. Soil analysis results showed that the average value of CEC of the soils in the land tobacco Kasturi plantation in Jember was > 16 cmol.kg-1, meaning that these lands provided nutrients sufficiently to tobacco plants in the forms of available cations for supporting their growths. Soil was categorized in a very suitable class (S1) if it had a CEC value of > 16 cmol.kg-1. The highest value of soil CEC was achieved in Ambulu region with the value of 27.52 cmol.kg-1. Areas with the CEC values of > 20 cmol.kg-1 were Arjasa, Ledokombo and Patrang, while Jelbuk, Mayang and Sukowono had CEC values < 16 cmol.kg-1. The lowest value of CEC was owned by Jelbuk region with a value of 11.84 cmol.kg-1. Based on the growing requirements of the tobacco plant, the CEC values throughout the districts were categorized as very suitable (S1) for tobacco Kasturi plants, unless the three areas of Jelbuk, Mayang and Sukowono. The three last areas were included in the category S2 as they had CEC values in the range of 11-15 cmol.kg-1 soil (Puslittanak, 1997). Especially for the three last-mentioned areas, improvement CEC were required through the addition of organic matter such as compost, green manure, and animal manure as well as practices those could increase soil organic matter, such as crop rotation and/or returning the remains of plants into the soil.

4.7. Soil Chemical Properties Index (SCPI)

Soil chemical properties Index was assumed as a result of the merger score of some chemical properties of soil those were determinants of soil fertility and quality, built to facilitate the assessment of the chemical properties of the soil those could be contradictory one to each other. Indicators of soil chemical properties determining of the soil quality included soil organic material (organic C), the pH of the soil, and extractable N, P, and K (Doran and Parkin, 1994). In this study, through the PCA procedure and the stages mentioned in the method above, four parameters of the soil chemical properties were selected in the minimum data sets, namely CEC, total N, pH, and available P. CEC and total N were the main component (component 1), while the pH and available P were component 2 and 3, respectively. After going through the process of scoring, weighing, and indexing, the results were obtained as presented in Figure 1.

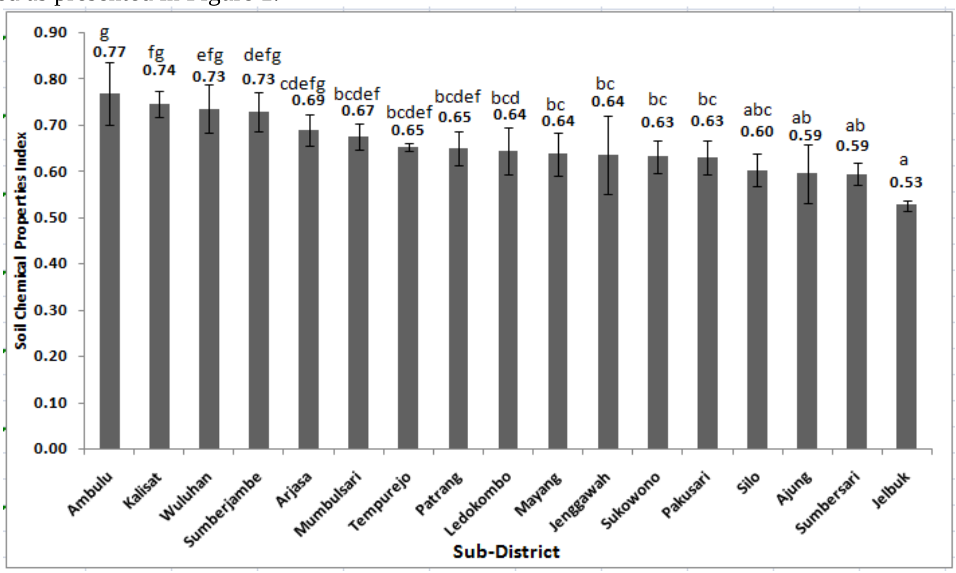

Figure 1. The Value of Soil Chemical Properties Index in Land of Tobacco Kasturi Planting. Description: The same letter in the bars showed not significantly different on Duncan test at 5% confidence level.

Based on Figure 1, it could be said that the distribution of the SCPI in tobacco Kasturi planting area, Jember, mostly in middle categories. There are only three areas grouped within the low level those were Ajung, Sumbersari, and the lowest Jelbuk with the value of SCPI from the largest at 0.59, 0.59, and 0.53, respectively. While the four other areas, Ambulu, Kalisat, Wuluhan, and Sumberjambe were included in the category of high-value of SCPI with the values of 0.77; 0.74; 0.73 and 0.73, respectively. Ambulu area had the highest value of SCPI because the area had the CEC, total N, and available P of the soil in high levels, even the value of the CEC was categorized in highest level compared to other areas. Jelbuk area had a lowest value of SCPI, because its soil CEC, total N and available P was relatively low, although the pH value included in normal category.

The high value of SCPI in the Districts of Ambulu and Wuluhan due to the two regions were located in downstream part of Jember those had alluvial soil parent material and many received sediment material from stream Mayang and Bedadung which passes through the Jember area that contained lots of dust and clay and nutrients washed and deposited in the areas. Consequently, the both areas had good chemical properties and rich in soil nutrients. While in the Kalisat and Sumberjambe areas, the high values of SCPI due to the two regions were on foot and track of lava flows of Mount Raung which is still active, so that they had soil parent materials from formation “Mandiku”, the rock formations that consisted of breccia volcano and tuff breccia, colored gray-brown to whitish-brown and blacky (Naryanto et al., 2007). The components consisted of andesite, basalt and tuff insertion rocks those were alkaline. In addition, these areas often experienced rejuvenation process by pouring of volcanic ash from Mount Raung that could affect process of soil genesis toward the formation of soil types with a high CEC. Volcanic ash originated from Mount Raung also contained alkaline cations and other nutrients those were very supportive to the local soil fertility. Moreover the high values of SCPI in the four areas above were likely due to the very good land management practices applied by local farmers, including through the intensive applications of N and P fertilization.

The proportion of SCPI components in each region was presented in Figure 2. It was seen that in all districts, there were two components of SCPI with the highest portion, CEC and pH, followed by total N and available P, respectively. The conditions showed that in general the lands of tobacco Kasturi in Jember naturally had good soil fertility. In addition, the lands also got good treatments through management of N and P fertilizers application by farmers in order to increase soil fertility and obtain growth and yield of tobacco Kasturi optimally.

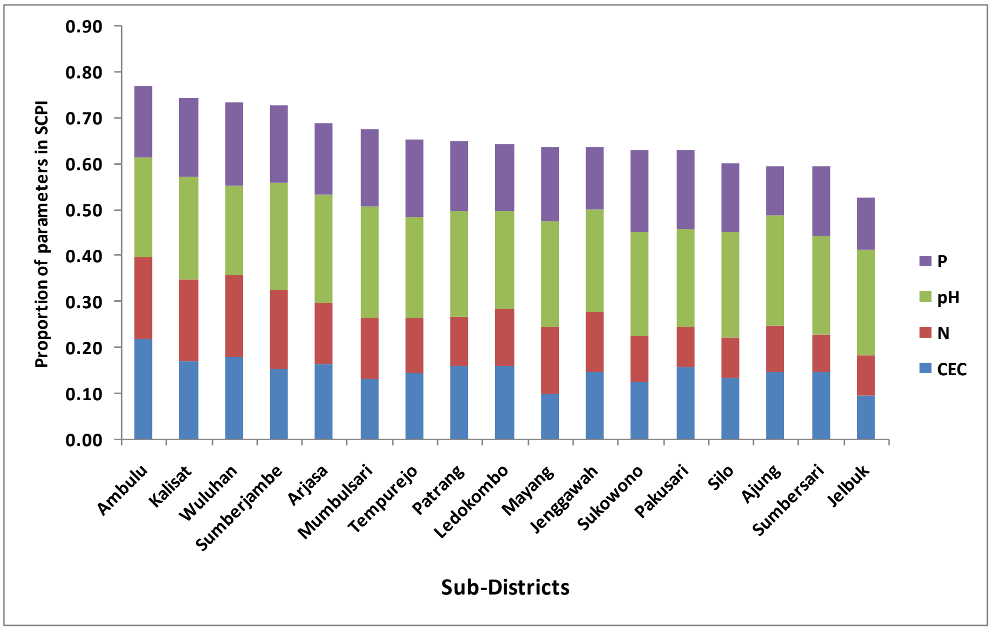

Figure 2. Proportion of SCPI Components of Soils in Tobacco Kasturi Plantation Land

4.8. Kasturi Tobacco Crop productivity in Jember Regional

In general, crop productivities were determined by soil fertility and soil management practices. Productivity data of tobacco Kasturi plant used in this research were secondary data obtained from the Plantation Office of Jember Regency. The data of tobacco Kasturi plant productivities were available within a period of four years, in 2009 upto 2013. The results of the statistical analysis of the tobacco Kasturi crop productivities in Jember were presented in Figure 3. The results showed that the average of productivity of tobacco Kasturi plants in Jember reached 11.69 kw.ha-1. The highest value of the tobacco Kasturi crop productivity was obtained in Kalisat Sub-District with the productivity value of 15.77 kw.ha-1, whereas the lowest productivity was reached by Jelbuk Sub-District with productivity values of 10.10 kwha-1.

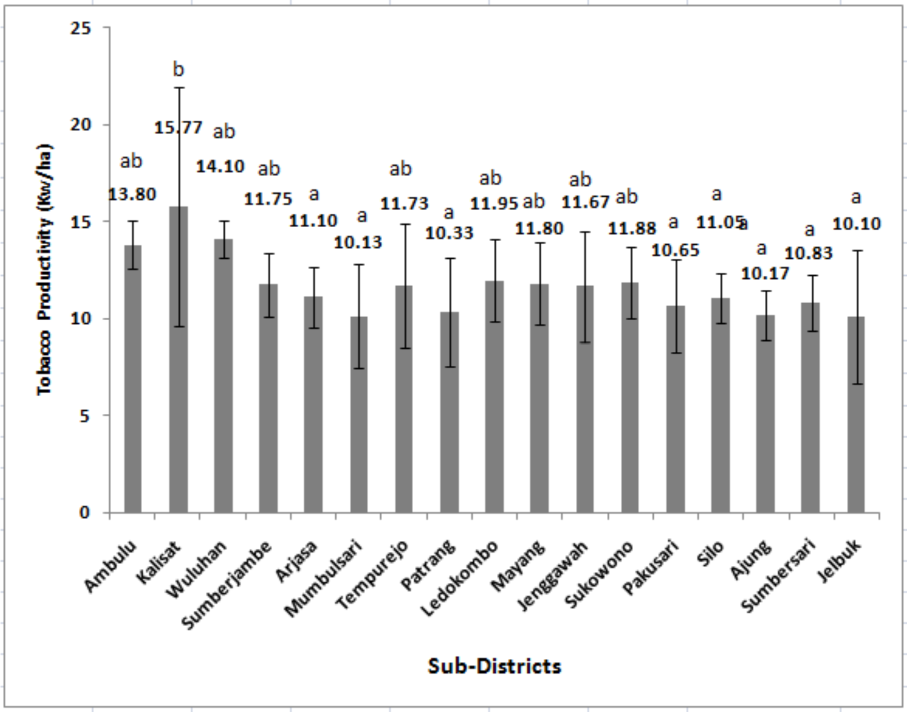

Figure 3. Productivity of Tobacco Kasturi in Each Sub-District of Jember. Description: The same letter in the bars showed not significantly different on Duncan test at 5% confidence level. Source of data: Plantation Office of Jember Regency, 2015

4.9. Relationship between SCPI and Crop Productivity of Tobacco Kasturi

Theoretically, the chemical properties of the soil affect the availability of nutrients in the soil, and subsequently also will influence the growth and productivity of crops, including tobacco Kasturi crops. In this study it was used the analysis of regression for determining how far the influence of variables of SCPI (independent variable) on the productivity of Tobacco Kasturi plants (dependent variable). While the degree of relationship between SCPI variable and Tobacco Kasturi Productivity variable could be measured through correlation analysis. Results of regression and correlation analysis between the two variables were presented in Figure 4.

Figure 4 appeared that the relationship between the SCPI variable with tobacco Kasturi crop productivity variable was positive linear (b>0), meaning SCPI positively affect the productivity of tobacco Kasturi plants, in other words, the higher the SCPI value, the greater the productivity of tobacco Kasturi plants. Based on the regression coefficient, each degree increase in SCPI variable would influence in improving the value of the tobacco crop productivity Kasturi by 18.38. Coefficient of correlation (r) between SCPI and tobacco Kasturi crop productivity was also high, reaching 0.74. The high and positive value of correlation coefficient indicated that there was a strong positive correlation between SCPI and tobacco Kasturi plants productivity. Furthermore, when viewed from the coefficient of determination (55%), SCPI contributed 55% (moderate) on the productivity of tobacco Kasturi plants, the remaining were influenced by other factors.

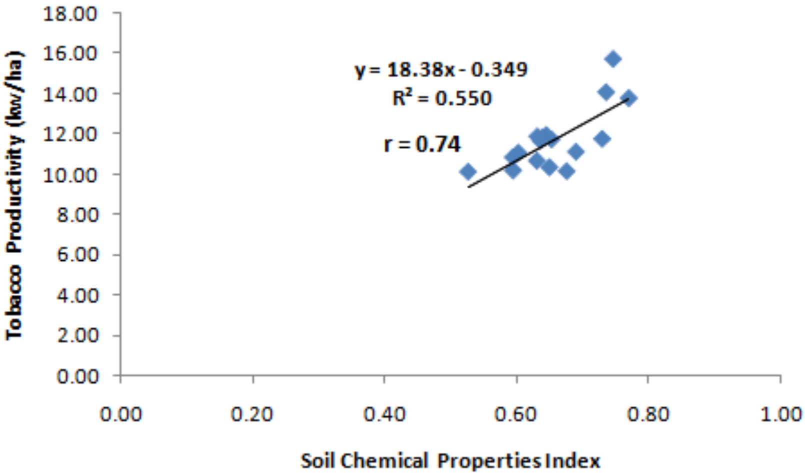

Figure 4. Results of regression and correlation analysis between SCPI and Tobacco Kasturi Plant Productivity

Results of this study recommended that for increasing crops productivity of tobacco Kasturi could be achieved by improving the soil chemical properties such as CEC, total N and available P, as well as pH, for example through the addition of organic matter, applying N and P fertilizers and adding of lime or dolomite materials. However, the most urgent to improve the productivity of tobacco crop in the study areas was by improving CEC through the addition of organic matter such as compost, green manure and animals manure.

5. Conclusion

Parameters of CEC and total N became the major components as constituents of specific locations Soil Chemical Properties Index (SCPI), followed by pH as the second component and soil available P as a third component. Subdistrict Ambulu had the best soil chemical properties as evidenced by its highest SCPI value of 0.77 with Kasturi tobacco plant productivity by 13.80 kw.ha-1. Meanwhile the District Jelbuk had the worst soil chemical properties compared to other districts, seen from the value of its lowest SCPI of 0.53 and tobacco crop productivity of 10.10 kw.ha-1. There was a strong positive correlation between the parameters of SCPI and tobacco Kasturi crop productivity, which means the higher the SCPI value the better the productivity of tobacco plants produced. The SCPI significantly influenced on productivity of tobacco Kasturi plants. In order to increase the productivities of tobacco Kasturi in Jember, particularly in the three districts with the lowest SCPI like Ajung, Sumbersari and Jelbuk, they were required improvement of the chemical properties of the soil in between CEC, total N, pH, and available P of the soil.

Acknowledgments

This work had been financially supported by UPT Pengujian Sertifikasi Mutu Barang – Lembaga Tembakau (PSMB-LT), East Java Province. Meanwhile, technical supports have been obtained from the Department of Soil Science, Faculty of Agriculture, Jember University.

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