CHARACTERISTICS OF SOIL TENSION AT DIFFERENT AGES OF ACACIA PLANTATION FOREST IN A LUONG SON HEADWATER OF HOA BINH, VIETNAM

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SUMMARY
To determine the characteristics of soil tension at different ages of Acacia plantation forest, plots were established at different vegetation cover conditions such as bare land after cutting, 1 years-old Acacia trees, 3-years-old Acacia trees, and 5-years-old Acacia plantation in Truong Son Commune, Luong Son district, Hoa Binh province. Soil tension was measured by tensionmeter at 36 points of 3 depths such as 30 cm, 60 cm, 90 cm from 10th to 30th August 2020. Affecting factors on soil tension were also determined, including forest structure, soil physical characteristics of Acacia plantation. The main findings included: (1) Canopy cover, litter and understory vegetation cover tend to be increased following to age of Acacia plantation while tree density decrease. Soil moisture recorded an increase ranged from 19.1% to 22% and decrease with increasing of ages. Soil texture of silt higher than clay and sand; (2) Soil tension tend to be decreased from 36.2 kPa in 1-years-old to 9.17 kPa in 5-years-old and increase when the soil depth become deeper. Soil tension has a strong relationship with vegetation factors, soil moisture, sand, clay and weak relationship with porosity, silt. This results suggest decreasing of available water capacity of soil following to ages and lowest at bare soil after cutting, 1 year-old Acacia. Thus, proposing some solutions to control available water capacity of soil at different ages of Acacia plantation forest in headwater is necessary.
Key words: Acacia plantation, headwater, forest structure, soil physical characteristics, soil tension.

1. INTRODUCTION

Soil tension is a negative pressure that accounts for moisture held in the soil by capillary forces as well as the attraction of the water molecules to itself which is the force necessary for plant roots to extract water from the soil (Kramer et al., 1995). Small soil tension mean water is not bound tightly and Large soil tension mean water is bound tightly. Knowing soil tension in real time, allows a grower to anticipate plant stress and take action before future production and growth is compromised (White et al., 2008). The need for water in the above ground plant parts results in tension being transmitted to the roots to extract more water from the soil.

There are various factors affect to soil tension such as soil moisture, soil type and vegetation factors (Blume et al., 2009; Corradini, 2014; Feng et al., 2012; Rodriguez-Iturbe and Porporato, 2004). For example, Eunhyung et al. (2018) indicated that soil moisture and soil water tension which have relationship, characterized spatial and temporal changes in hillslope area. Heinz-Christian Fründ et al. (2016) conducted the research about soil water tension in forest skidding trails from natural regeneration which received its first thinning and shown that in undriven control soil, soil water tension in 6 cm soil depth was increasing in summer in 2013 at 457 hPa and higher than in the skid trail at 240 hPa. This result was explained that water tension in skid trail indicated a more water filled porosity than in the undisturbed soil and reflected the transpiration water extraction by trees. Moreover, according to Feltrin et al. (2013) recorded that the greatest variations of tension in the pasture and forest in Sothern Brazil happened at depths of 0.10 and 0.30 m. The tension value changed in different season especially great variation in summer which tension of native forest was higher than pasture. To prove for these finding, Yu Liu et al. (2018) stated that the root systems of forests are determined to distribution of deeply in the soil profile, and that soil moisture variations are greater in deeper layers than in shallow layers. Therefore, the soil tension characteristics play an important role in forest management especially plantation forest which bring beneficial for local people.

Acacia plantations have emerged and developed as an important resource for supporting livelihood of many thousands of rural families especially in the northern of Vietnam (Sadanandan et al., 2014). The area of Acacia plantation have increased from 66.000 ha in 1992 (corresponding to 7.2% of all plantation) (Jong et al, 2006) to 1 million ha (corresponding to 51%) in 2013 (Kien et al., 2014) and 1.5 million ha in 2019 (Ngoan et al., 2019). Location for planting Acacia tended to be increased in mountain headwater where is source of water with high elevation and slope due to shortage of low land (Chin et al., 2019). Increasing of Acacia plantation in headwater for economic objective can negative impact on available water capacity of soil due to management activities. Therefore, the research on characteristic of soil tension at different ages of Acacia plantation forest in a Luong Son headwater of Hoa Binh, Vietnam is very essential for building a sustainable plantation forest model, which can minimize negative impact from human interventions as well as hydrological process impact and threaten to natural resources.

2. STUDY SITE AND METHOD

2.1. Study site

Luong Son has geographic coordinate: N20°52.31478', E105°30.19962'° belong to Hoa Binh city (Fig. 1). This study was conducted in three small plots in a hillslope (top-hill, mid-hill, down-hill) covered by Acacia plantation located in Truong Son commune, Luong Son district (Fig. 1). The study catchment is deeply incised with dominant slope gradients ranging from 26^o to 27^o. The low mountainous terrain is approximately 200-400 m above sea level, formed by magma, limestone and terrigenous sediments, with a dense network of rivers and streams. The soils are red-yellow ferralit with thickness layer of A horizon and mud volume about 6-7% with high soil moisture. Luong Son climate is tropical monsoon, with cold winters - less rainfall; hot summer - heavy rain. The unevenly distribution mainly occurs on in some months during the rainy season, it can generate huge amount of runoff, causing flood and seriously landslide and erosion. Mean annual precipitation and air temperature are approximately from 1,500 mm to 2,200 mm and 23^{o}C, respectively. Each year, there are at least two typhoons that affect the area, the wind velocity is about 30 m/s. Most Acacia plantation was managed by households so the stand densities vary by the year and aging.

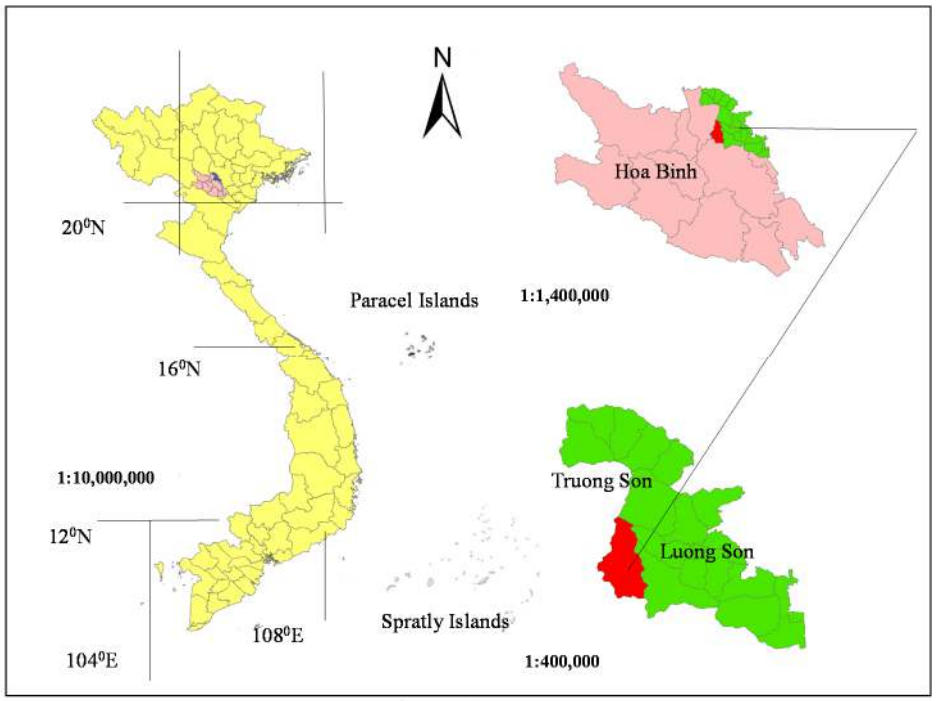

Figure 1. The location of study site

2.2. Method

Determining the characteristics of Acacia plantation structure

The entire of research area is investigated to get overview about research subject, topography, terrain, forest resource characteristics and then plots is set up that provide directions for meticulous investigation (Fig. 2). Investigated time was from 9th to 30th August. With each different ages, three plots per age are installed with 500 m^2 (length 25 m x width 20 m) at 1, 3, and 5 years old. Plot 1 is located in the top-hill, plot 2 in middle hill and plot 3 in downhill. The total number of plot at three different aged is 9 plots. The characteristics structure of Acacia plantation was investigated such as DBH, Height, canopy cover, density, litter, understory vegetation cover.

Determining soil properties of Acacia plantation

Representative soil samples were dug and taken for different ages. Soil samples were taken at depths: 30 cm, 60 cm, 90 cm equivalent to the depth of soil tension measurement. At each study plot (top hill, middle hill and downhill), three soil samples for analysis was taken in 3 depths. Samples soil was putted into plastic bags with sample symbols to be clearly identified.

Soil samples after collecting was analyzed to determine soil moisture (%), soil porosity (%), dry bulk density (g/cm^3), particle density (g/cm^3) and soil texture.

Evaluating the characteristics of soil tension

Soil water tension was determined by tensionmeter. During installation it is important to bore a straight hole to the desired depth in recently soil. As good soil contact is essential, the last 5 cm of the installation hole can be of slightly smaller diameter than the tip of the tensiometer. If the tensiometer are to be installed in a larger hole, back filling must be carried out in such a way as to provide good soil contact and also to prevent excess irrigation water running into the hole (Fig. 2b). Hilling up soil around the tensiometer will help prevent ponding around the tensiometer and preferential flow down the backfilled hole. Usually a tensiometer installed in moist soil can be measured 24 hours later. However, soil tension value is read when the value is not change.

Soil tension is measured at 3 points per plot (distance between two points is 5 m) at each different age and bare land plot to compare characteristics. Time of monitoring started from 9th August to 30th August. The total number of measure points is 36 points (9 points per one age).

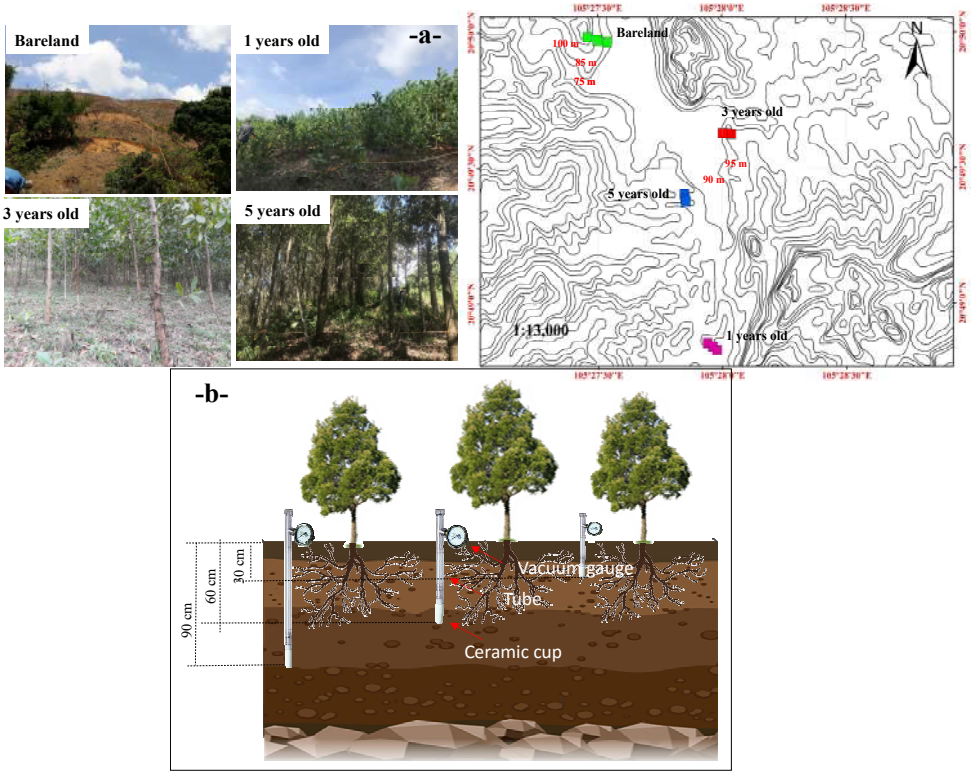

Figure 2. a - Location of different Acacia plantation and b - soil tension measurement at 3 depths

Data analysis

Data which collected in the field, was analyzed by some software including excel to draw figure, R-studio illustrate the relationship between soil tension and affecting factors. SPSS shown descriptives statistics for soil tension such as: mean, max, min, median, t-test.

3. RESULTS AND DISSCUSSION

3.1. The characteristics structure of Acacia plantation at different ages

Table 1. Results of Acacia plantation structure

Age	Plot	Coordinate	No of tree	Density (tree/ha)	Canopy cover %	Understory vegetation cover %	Litter (%)	Height (m)	DBH (cm)	Slope (o)	Elevation (m)	Aspect
Bare land	1	N20°49.98', E105°27.45'	-	-	-	45	11	-	-	20	100	South West
	2	N20°49.97', E105°27.49'	-	-	-	44	14	-	-		85	
	3	N20°49.96', E105°27.53'	-	-	-	46	15	-	-		78	
1	1	N20°48.85',E105°27.93'	80	1600	0	75	18	1.83	10.02	29	210	South East
	2	N20°48.83', E105°27.96'	75	1500	0	69	19	1.76	9.27		180	
	3	N20°48.82', E105°27.97'	70	1400	0	68	21	1.78	9.89		110	
3	1	N20°49.62', E105°28.03'	53	1060	75.5	78	66	8.72	26.50	23	110	North West
	2	N20°49.62', E105°28.02'	59	1180	77.8	75	64	8.62	24.50		98	
	3	N20°49.62', E105°28.00'	45	900	65.3	79	70	8.75	25.89		92	
5	1	N20°49.40', E105°27.84'	46	920	83.5	85	89	15.65	44.50	27	180	South East
	2	N20°49.38', E105°27.84'	37	740	89.5	82	88	15.92	39.80		155	
	3	N20°49.37', E105°27.85'	41	820	87.0	84	83	15.83	41.50		130	

The density of trees in the study area was different between ages. The aged 4-5 years old had the lowest density of about 740 trees/ha because it is the development stage after thinning and 1 years old is large (1500 trees/ha) (Table 1). Canopy cover of Acacia plantation increases when age increase, especially aged 3 and 5 is the highest average at 73% and 87%, respectively (Table 1). Understory vegetation cover increases over time with the highest rate in the 5-years-old at 84%. Litter has great difference among 3 age levels. In 1-years-old Acacia, litter only accounts 19.6%, 3 years old increased to 66.5%, and 5 years old reach the highest with 86.7%, and bare land is 13.3%. The average height of aged 1, 3 and 5 reach 1.8 m, 8.7 m, 15.8 m, respectively. Average growth in height recorded 3.4 m/year. The diameter in the 1, 3, 5 years old forests reach: 9.7 cm, 25.5 m, 41.9 cm (Table 1). Average diameter increased 7.9 cm/year. The sharp increase of height and diameter between ages indicate that the tree was grown and developed very well. In addition, the number of trees on a plot decreases by ages because 1 year old is an un-thinned stage and this process takes place from the 3rd year onwards.

3.2. Soil properties of Acacia plantation at different ages

Soil moisture in the study area fluctuated between 13% and 24%, and tend to be increased with ages and decreased with depths. At aged 1, soil moisture reached the lowest value with 17.4% at 60 cm depth, aged 3 reached to 17% at 90 cm and aged 5 had the highest moisture value at 24.3% at 30 cm (Fig. 3).

The porosity of the soil in the study area ranged from 39.2 % to 58.5 %. The difference of soil porosity under Acacia plantation forest at all ages level was not large, the lowest average in 1-years-old Acacia forest at a depth of 90 cm with 46.1%, the highest mean was bare land with 57.4% at 90 cm. At a depth of 30 cm, soil porosity increased gradually from 51% at 1 years old to 56.6 % at 5 years old. At a depth of 90 cm, the average soil porosity increased lightly from 45% to 52% of Acacia plantation (Fig. 3).

Dry bulk density in the study area ranged from 1.20 to 1.50 g/cm^3 on average. The dry bulk density in 5-years-old Acacia was higher than that in 1 and 3 years-old by 0.16 g/cm^3. The figure for bare land was 1.23 g/cm^3. The value of dry bulk density increased when age increase and vice versa. Dry bulk density of Acacia plantation forest also increased in 30 cm and 90 cm in 3-years-old and 5-years-old

Acacia. By contrast, bare land decreased because this area is affected by human, so the 30 cm depth had dry bulk density is compressed than 90 cm (Dry bulk density in 30 cm was 1.23 g/cm^3 and decreased to 1.15 g/cm^3 in 90 cm) (Fig. 3).

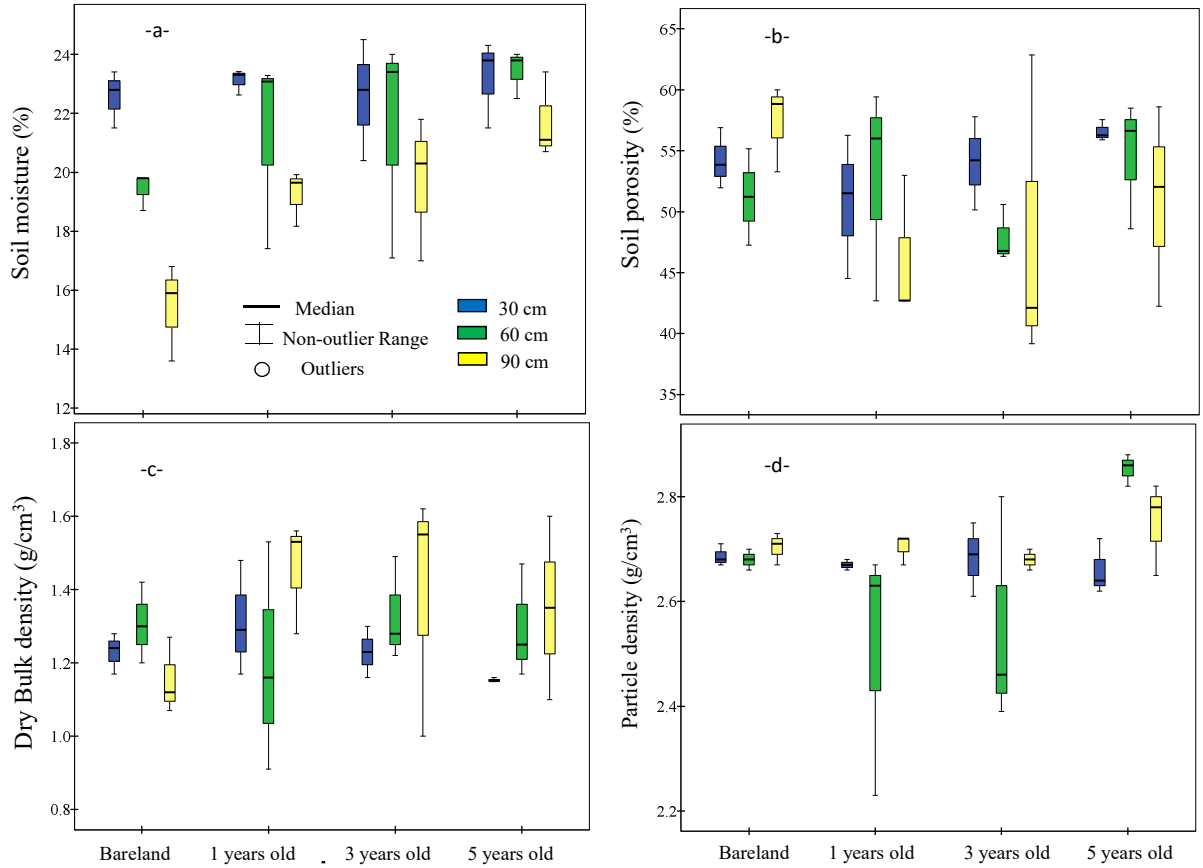

Figure 3. (a) Soil moisture (%), (b) Soil porosity (%), (c) Dry bulk density (g/cm^3) and (d) Particle density (g/cm^3) at different ages and bare land

Particle density tended to increase slightly in the period from 1-years-old to 5-years-old Acacia from 2.20 g/cm^3 to 2.90 g/cm^3. The particle density of soil under 1-years-old Acacia varied from 2.22 to 2.71 g/cm^3, the average is 2.63 g/cm^3. Acacia forest of 5 years old had particle density varied 2.64 to 2.90 g/cm^3, the average is 2.80 g/cm^3. The figure for bare land ranged from 2.66 g/cm^3 to 2.71 g/cm^3, reached 2.42 g/cm^3 on average. According to the depth, the mean of particle density at 30 cm and 90 cm of 3 ages level and bare land were nearly the same about 2.7 g/cm^3 while 60 cm depth fluctuated significantly with the lowest average in 1 and 3 years-old at 2.51 g/cm^3 and highest at 5 years-old at 2.90 g/cm^3 on average. (Fig. 3).

The percentage of sand distribution declined when age was high. In 1-years-old Acacia, the average of sand was 14.30%, decreased to 13.30% at aged 3 and lightly gone down to 11.50% at aged 5. On the contrary, the proportion of clay particles had an upwards trend from 1 years old to 5 years old. At 1 years old, the mean of clay was lowest at 38.60%, at 3 years old, it rise to 39.28% and at 5 years old was the highest clay at 40.81%. The percentage of silt particle was not follow in particular rules, ranged from 46.75% in bare land to 47.71% in 5-years-old Acacia on average (Fig. 4). The mean of sand in bare land was the highest while that of silt and clay recorded the lowest rate compared to Acacia forest.

At different depths, the proportions of soil texture differed. The proportion of sand increased gradually by depth from 12.80% to 15.90% at aged 1, from 12.90% to 13.1% at aged 3 with the exception of 5-years-old Acacia (clay in 60 cm was higher than 90 cm). The percentage of sand in 60 cm of bare land was lower than that of 30 cm. The proportion of clay particles decreased by depths whereas

silt particles varied with depth with 49.54 % in 30 cm, 46.58 % in 60 cm and 47 % in 90 cm at 5-years-old Acacia (Fig. 4).

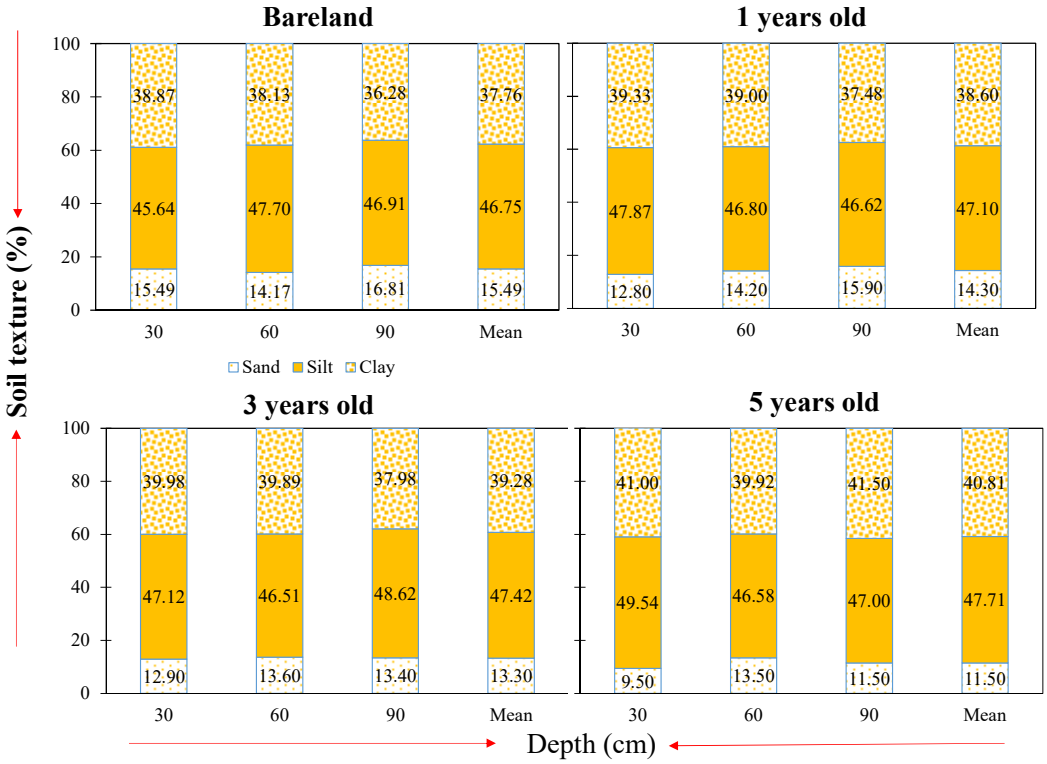

Figure 4. Soil texture of 3 different ages Acacia plantation and bareland

3.3. Soil tension characteristics of Acacia plantation

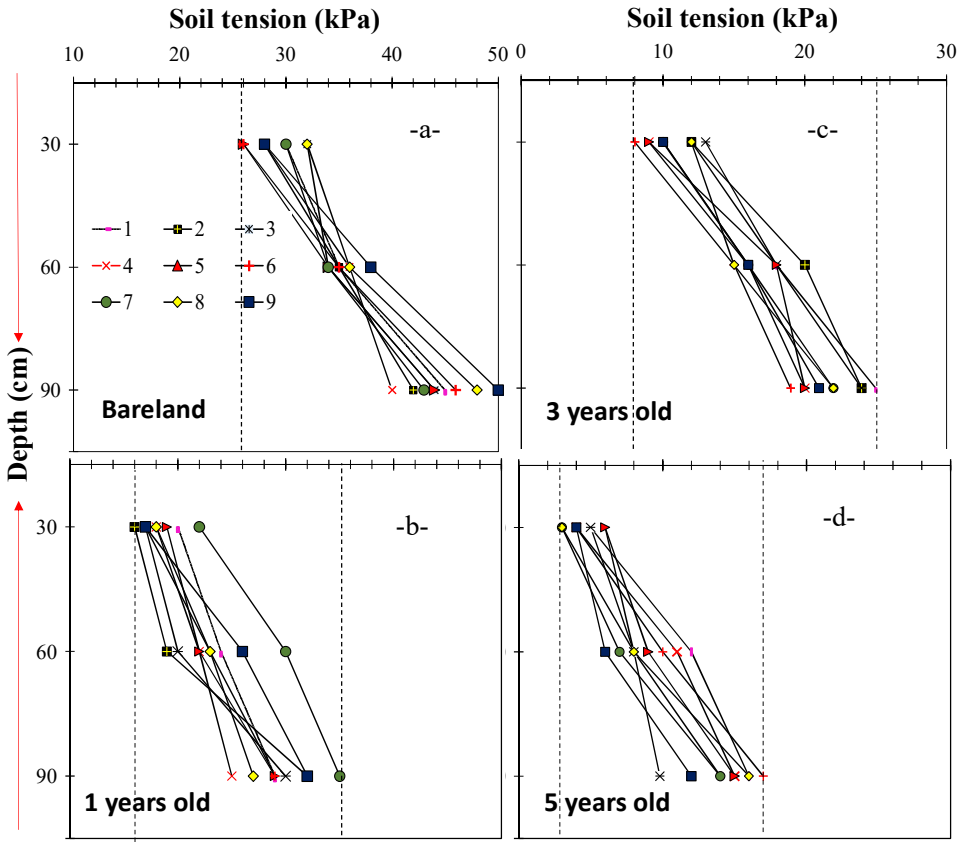

Figure 5. Soil tension at 9 points of a - bareland; b - 1-years-old Acacia; c - 3-years-old Acacia and d - 5-years-old Acacia

The soil tension in bare land had the highest value in terms of depths compared to the remaining ages. At the soil depth of 30 cm, the highest number recorded at 32 kPa at point 3 which was equal to the point 8 while the lowest point was point 6 in the middle hill with 26 kPa. The remaining points had a similar soil tension with each other. At the depth of 60 cm, the soil tension increased from 5 kPa to 10 kPa depending on measurement location. Point 9 had maximum value of 38 kPa which is considered as usual range for irrigation (most soils). At the depth of 90 cm, the soil tension compared to other depths increased by more than 10 kPa and compared to other ages. 50 kPa was the soil tension at point 9, followed by point 8 with 48 kPa (Fig. 5a)

1-years-old Acacia plantation had soil tension ranged from 17 kPa at 30 cm to 35 kPa at 90 cm. Soil tension at point 7 was the highest at three depths with 22 kPa at 30 cm, 30 kPa at 60 cm, 35 kPa at 90 cm. Soil tension at point 9 ranked the second position with the highest tension at depth of 60 cm and 90 cm with 26 kPa and 32 kPa, respectively. Point 2 had the greatest different soil tension from 16 kPa in 30 cm increased to 32 kPa in 90 cm (Fig. 5b)

Soil tension continued a decrease in 3-years-old Acacia varied from 8 kPa to 25 kPa. The figure for soil tension was lowest at point 6 at 3 three depths at 8 kPa, 15kPa, 19 kPa and highest value at point 2 with 24 kPa at 90 cm. The difference among depth in point 1 was the highest, higher than other depth by 13 kPa, lowest at point 6 by 8 kPa in 90 cm and other points increase by from 9 kPa to 11 kPa (Fig. 5c).

In terms of 5-years-old Acacia plantation, soil tension recorded from 3 kPa to 17 kPa. At 30 cm, soil tension of point 2 and point 5 were the highest number with 6 kPa, followed by point 1, 3 and the lowest was point 7 with 3 kPa. At 60 cm, the average of soil tension doubled compared with 30 cm especially point 1 from 5 kPa to 12 kPa. At 90 cm, there was a slight rise in the soil tension by 4 kPa. Moreover, soil tension at point 6 in 90 cm witnessed the highest value with 17 kPa (Fig. 5d). The different soil tension between 9 points was not changed much, only point 3 in 60 cm and 90 cm was the same value.

Table 2. Descriptives statistics of soil tension and the paired mean comparison at different Acacia plantation

Ages	Depth (cm)	Mean (kPa)	Max (kPa)	Min (kPa)	SD	Correlation	t	df	p-value
Bare land	30	28.8	32	26	2.2	Bare land and 1-years-old	17.6	26	0.00
	60	35.5	38	34	1.3				
	90	44.7	50	40	3	Bare land and 3-years-old	30.3	26	0.00
1 years old	30	18.2	22	16	0.6				
	60	23.2	30	19	3.2	Bare land and 5-years-old	35.9	26	0.00
	90	29.7	35	25	0.9				
3 years old	30	10.5	13	8	1.7	1-years-old and 3-years-old	11.09	26	0.00
	60	16.8	20	15	1.7				
	90	21.8	25	19	2	1-years-old and 5-years-old	20.4	26	0.00
5 years old	30	4.4	6	3	1.1				
	60	8.7	12	6	1.9	3-years-old and 5-years-old	13.69	26	0.00
	90	14.3	17	10	2.2				

The average of soil tension from 30 cm to 90 cm in bare land ranged from 28.8±44.7 kPa, in 1 years old Acacia varied from 18.2±29.7 kPa, 3 years old from 10.5±21 kPa and 5 years old was 8.7±14.4 kPa. The standard deviation was quite low ranged from 0.6±3.2 (Table 2). Soil tension between different ages of Acacia plantation and bare land had statistically significant with p-value=0.00.

The reasons are interpreted that the ability of water storage and water absorption in soil profile are difference. Different depth has different soil texture and the proportion of macropore also differ. Macropores are large

soil pores, usually between aggregates, that are generally greater than 0.08 mm in diameter. Macropores drain freely by gravity and allow easy movement of water and air. They provide habitat for soil organisms and plant roots can grow into them. Suction or tension is required to remove water from micropores. Clay-rich soils have the largest pore space, hence the greatest total water holding capacity. Therefore, macropore has negative affect to soil tension. At 90 cm depth, the size of macropore is small so the ability to retain water is high. According to the study, the proportion of clay particle in soil decreased by depth from the lowest 37.98% at 90 cm to 39.98% in 30 cm at 3-years-old and from 49.54% in 30 cm to 47% in 90 cm at 5-years-old (Fig. 4). Therefore, the marcopore size decrease when soil become deeper.

Soil tension is always strong relationship with hydrology factor such as structure characteristics of forest such as soil condition, vegetation,…Each plant species grow and developed by absorbing water from soil though roots to shoots. These force is called capillary force that directly related to soil tension. Capillary water is held with the force of surface tension by the soil particles and its resistant to the forces of gravity. The root system developed and increased over time, root plunges deeper into the ground so capillary water is high, while the capillary forces have an inverse relationship with the soil tension. Moreover, soil moisture has enormous impact to soil tension in this study. Soil moisture in 5 years old Acacia was higher than other ages so the soil tension was lowest at 5 years old (Fig. 3a). In addition, the proportion of clay and silt demonstrated the great water holding capacity. From the study, the average clay particle increased from 46.75% in bare land to 47.74% in 5-years-old Acacia and silt particles rose from 37.76% in bare land and 40.81% in 5-years-old Acacia so the soil tension was low when ages increase. (Fig. 4).

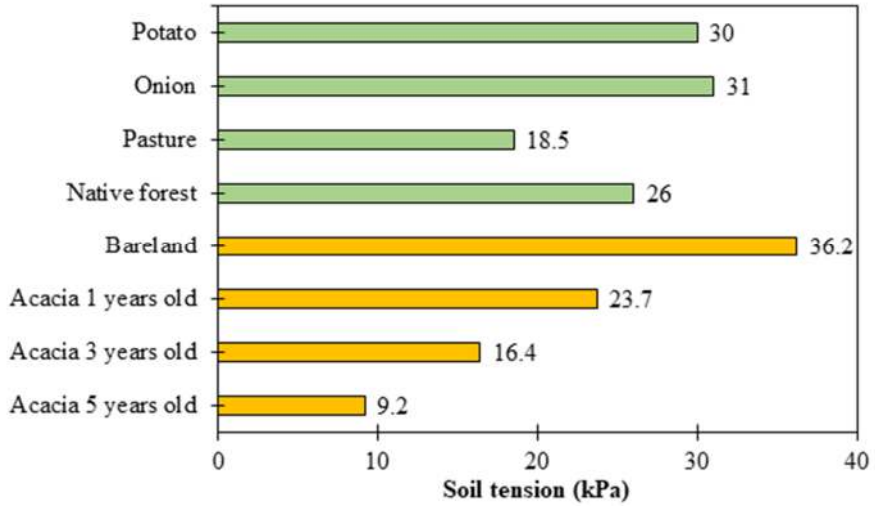

Figure 6. Soil tension in different area of other studies (Feltrin et al., 2013; Shock et al., 2007a).

Compared to the soil tension was reported by other researches at different locations, the soil tension in the Acacia ranged from 9.2 kPa to 23.7 kPa (Fig. 6), bare land was the highest at 36.3 kPa. In previous studies, the soil tension in summer was compared between native forest and pasture with the tension at 26 kPa and 18.5 kPa on average. This difference in soil water storage between the native forest and pasture is mainly due to the formation of an internal microclimate in the forest due to interception of solar radiation by the tree canopy. In the forest, the soil surface is completely covered by organic matter that prevents the growth of vegetation and protects the surface, reducing soil moisture loss while grass completely covers the soil surface, and solar radiation falls which educated the water content in this environment (Feltrin et al., 2013). Onion and Potato was planted for agriculture purposes and the soil tension in Oregon region of onion and potato was 31 kPa and 30 kPa (Fig. 6), respectively. Potato and onion is a shallow-rooted crop requiring relatively wet soil. It response to soil water tension was included in a review of vegetable

crop irrigation so it related to irrigation criteria. (Shock et al., 2007b).

3.4. Evaluating factor affecting soil tension and their relationship

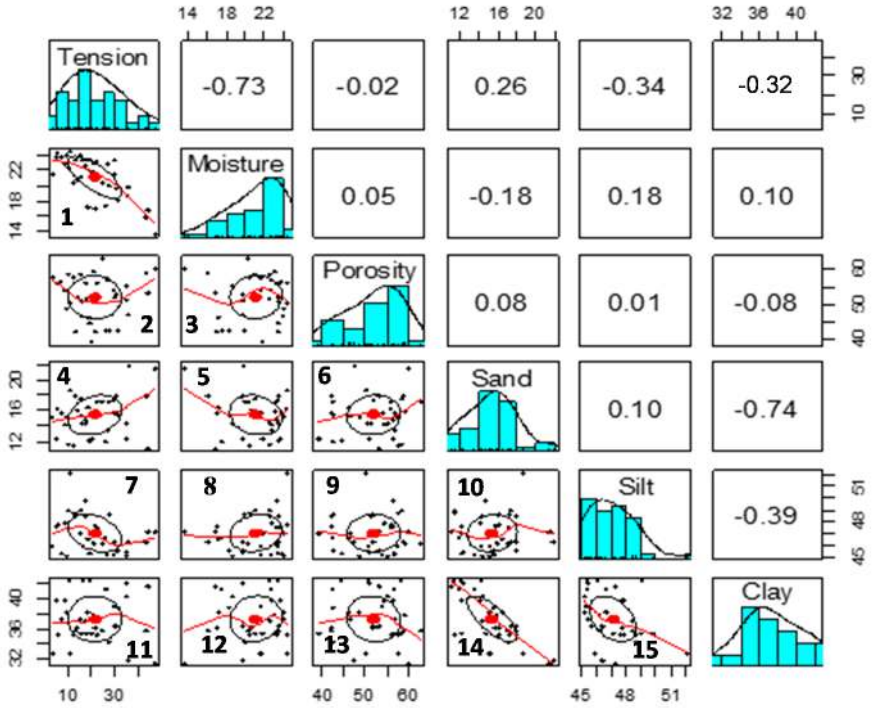

Figure 7. Correlation between soil tension and soil properties

Soil tension and soil properties have correlation though correlation coefficient (r). If r is less than 0 that mean correlation has negative relationship. Coefficient coefficient r is more than 0, correlation has positive relationship, r is equal that mean there are no correlation between variables. From figure 7, soil tension has negative correlation with soil moisture, silt, clay and positive correlation with sand and weak relationship with soil porosity with r = -0.02.

The correlation between soil tension and canopy cover, understory vegetation cover, litter had negative relationship with r is -0.88, -0.96, -0.91, respectively (Fig. 8). Moreover, the relationship between canopy cover, understory vegetation cover and litter have positive relationship.

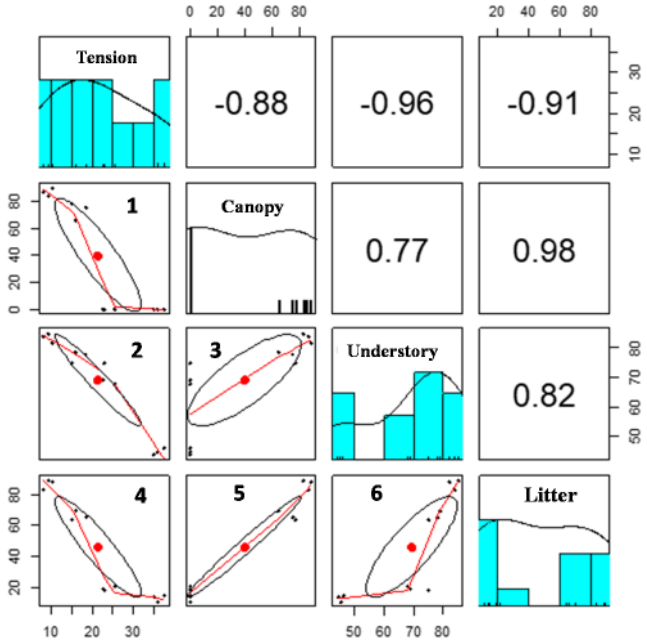

Figure 8. Correlation between soil tension and vegetation characteristics

From the above research results, the study proposes a number of measures for water storage of Acacia plantation: maintaining vegetation for Acacia plantation such as litter and understory vegetation cover, research on planting of a number of crop like legume species under the canopy of Acacia hybrid forest where erosion and leaching occur to improve soil properties, increase soil water retention. According to the study, the lower ages, the higher soil tension (the higher depth, the lower soil tension) because soil moisture increase by ages and decrease by depths. This argument prove that bare land and 1-years-old have poor water permeability and retention leading to high risk of overland flow so intercropping some crops and vegetation are very essential.

4. CONCLUSION

After doing experiments at 3 different ages of Acacia plantation and bare land in 12 different locations (36 point of soil tension measurement) at different times, the main conclusions included:

Each age of Acacia plantation has different characteristics of forest structure and soil properties. Canopy cover in 3-years-old Acacia was lowest with 73% and the highest in 5 years-old Acacia was 87% on average. Understory vegetation cover accounted only 45% in bare lad and reached 8% in 5 years old Acacia while litter cover also increase when age increase from 13.3% in bare land to 86.7% in 5 years old. Soil properties had the different condition in different location. Soil moisture tended to increased when age increased and decreased by depth, it ranged from 13% to 24%. Soil porosity varied from 39.2% to 58.5%. Dry bulk density have compaction in soil deeper in 90 cm with the highest about 1.65 g/cm^3. Particle density has not the great difference between age ranged from 2.2 g/cm^3 to 2.8 g/cm^3. Moreover, sand particle was the lowest percentage, lower than silt, clay.

Higher age of Acacia trees tends to decrease soil tension due to soil factors and plant factors. The average of soil tension at depth 30 cm of bare land, 1-year-old, 3-years-old, 5-years-old Acacia was 28.8 kPa, 18.2 kPa, 10.5 kPa, 4.4 kPa, at 60 cm was higher at 35.5 kPa, 23.2 kPa, 16.8 kPa, 8.7 kPa, respectively. In 90 cm, the soil tension was the highest value at 44.7 kPa in bare land, 29.7 kPa in 1 years old, 21.8 kPa in 3 years old, 14.3 kPa in 5-years-old Acacia. Soil tension have strong positive relationship with vegetation factor. Soil tension has a strong relationship with soil moisture, sand, silt and vegetation factors but have weak relationship with soil porosity, clay.

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ĐẶC ĐIỂM SỨC CĂNG BỀ MẶT CỦA ĐẤT Ở CÁC ĐỘ TUỔI KHÁC NHAU CỦA RỪNG TRỒNG KEO TẠI VÙNG ĐẦU NGUỒN LƯƠNG SƠN, HÒA BÌNH, VIỆT NAM

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TÓM TẮT

Để xác định đặc điểm sức căng bề mặt của đất tại rừng trồng keo ở các độ tuổi khác nhau, các ô tiêu chuẩn đã được thiết lập ở các điều kiện gồm đất trống sau chặt trắng, rừng keo 1 tuổi, 3 tuổi và 5 tuổi ở xã Trường Sơn, huyện Lương Sơn, tỉnh Hòa Bình. Sức căng bề mặt của đất được đo bởi máy đo độ căng bề mặt tại 36 điểm với 3 độ sâu: 30 cm, 60 cm, 90 cm từ ngày 10 đến 30 tháng 8 năm 2020. Nhân tố ảnh hưởng đến sức căng bề mặt được xác định bao gồm cấu trúc rừng và tính chất của đất. Kết quả chính thu được là: (1) Độ tàn che và thảm tươi cây bụi tăng theo độ tuổi trong khi mật độ cây tầng cao giảm. Độ ẩm của đất tăng từ 19,1% đến 22% theo độ sâu và giảm theo độ tuổi. Tỉ lệ phần trăm của các cấp hạt đất thịt cao hơn cả đất sét và đất cát; (2) Sức căng bề mặt của đất ở rừng keo 1 tuổi giảm từ 36,2 kPa giảm xuống còn 9,17 kPa ở rừng keo 5 tuổi và càng xuống tầng đất sâu sức căng bề mặt của đất càng tăng. Sức căng bề mặt của đất có mối quan hệ chặt chẽ với yếu tố thực vật, độ ẩm đất. Kết quả này cho thấy khả năng giữ nước của đất giảm theo độ tuổi và thấp nhất ở đất trống và rừng trồng keo 1 tuổi. Vì vậy, đề xuất một số giải pháp để kiểm soát khả năng giữ nước của đất ở các độ tuổi keo khác nhau ở vùng đầu nguồn là rất cần thiết.

Từ khóa: cấu trúc rừng, rừng trồng keo, sức căng bề mặt của đất, tính chất vật lý của đất, vùng đầu nguồn.

Received : 28/9/2020
Revised : 05/11/2020
Accepted : 13/11/2020