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An Assessment of the Effect of Design and Efficiency of Babura and Doko Shelterbelts on Wind Speed And Moving Sand

Kamal Adamu M.Sc
Department of Biological Sciences, AlQalam University Katsina, Nigeria

Corresponding Author: Kamal Adamu. M.Sc

Abstract
Shelterbelts are usual approaches employ for the control and management of degradation by wind erosive action in many places particularly, arid and semi-arid areas. Babura and Doko are prone areas located in Jigawa state Nigeria. The shelterbelts in this area were established in 1983. After almost 30 years, this study assessed the efficiency of the shelterbelts. Wind measurements using (AM 4812) for horizontal and vertical wind speeds were carried out during two periods. The result showed that the maximum horizontal and vertical wind speed at Baburawas 20.5ms^{-1} and 10.4ms^{-1} respectively, while the minimum of both two were 1.1ms^{-1}. At Doko the maximum wind speed were 4.1ms^{-1} for the horizontal direction and 2.3ms^{-1} for the vertical direction. While the minimum reading were 1.6ms^{-1} and 0.6ms^{-1} respectively. The differences in the wind speeds results between Babura and Doko is due to a number of factors.Babura is at extreme end and shares border Niger Republic where the wind effect is very strong. Doko is relatively far away from this active wind area. The extremely lower value of the vertical wind at Babura was as a result of gaps in the rows of plant trees stands in the shelterbelts. The trees were mostly removed while some were destroy by pest and diseases

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I. Introduction

Shelterbelts are strip of trees and /or shrubs planted and maintained to break the impacts of prevailing wind (Westaneys and Woodley, 1996), butalso regulate microclimate of on area (Bruce and Kimberly, 2002). Shelterbelts are called by different names (windbreaks, hedgerows or fence row), depending upon their use, region, or preference of the individual (Brandle *et al.*, 2008), has emphasized that shelterbelts do not need to be strictly linear shape (Breckwoldt, 1983). Shelterbelts are established in areassubjected to long period of drought and desiccation (Brandle *et al.*, 1988).Windbreaks have their origins in the mid-1400s when the Scottish Parliament urged the planting of tree belts to protect agricultural production (Droze, 1977). Since then, shelterbelts have been used extensively around the world (Cleugh *et al.*, 2002). African farmers use windbreaks to protect crops, water sources, soils, and settlements on plains and gently slopping farmlands. In Chad and Niger, multispecies shelterbelts protect wide expanses of cropland from desertification (Ramachandran, 1993). Afforestation is currently being carried out, not only to meet diverse environmental objectives that includes reversing land degradation but also to enhance wildlife habitat and protect water quality (Stanturf *et al*., 2000).
Jigawa state is situated within the semi- arid zone of Nigeria with widespread land degradation mainly attributed to deforestation. Increased agricultural activities and intense over-grazing, combined with increasing demands for fuel wood energy has led to a remarkably high rate of deforestation estimated at 3.5%, annually and reported as one of the highest in the world in the 80'sby Westaneys and Woodley, (1996). The situation prompted the establishment of Afforestation, plantation and shelterbelts by government of Nigeria across the affected areas as protection measures. The activities were funded by (FGN) federal government of Nigeria and World Bank (Westaneys and Woodley, 1996).After almost three decades it is important to assess the efficiency of these windbreaks, identify problems and challenges affecting the capacity of the belts to offer adequate protection.

II. MaterialsAndMethod

Two situs were selected for the study. Babura shelterbelts were located at lat. 12°-77°N and log. 09°-01°E while Doko plantation was at lat 12°-20°N and 09°-06°E respectively,

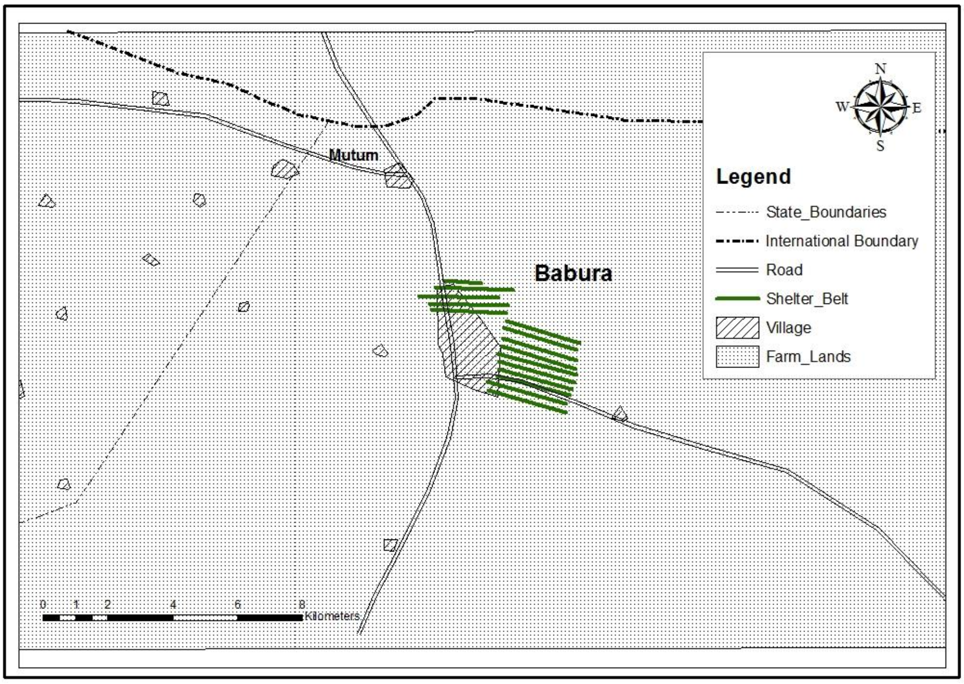

Figure 2: Map of Babura Shelterbelt

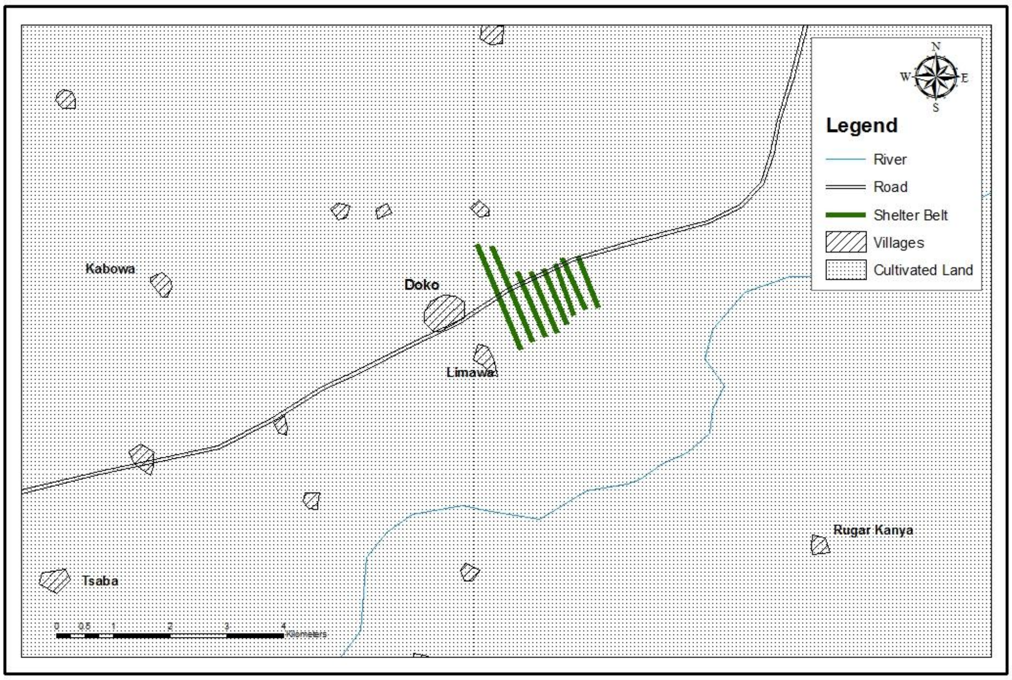

Figure 3: Map of Doko Plantation

WindSpeedMeasurement

Method of Dafa-Alla and Nawal (2011) were adapted. Wind speeds were measured using digital anemometer (AM-4812) and mobile compass for the directions. The measurements were taken at vertical and horizontal sides, the vertical measurements were made at point A and B. Horizontal measurements were taken at points ABC. Mobile compass was attached to the digital anemometer and elevated to 1m, ten minutes average wind speeds and direction were recorded at different times during the day for each position for the duration of two hours. The procedure for the estimation of wind protection efficiency was given as follows;

$F = 2(1 - \frac{-Us}{Uc}) when Us > Uc$ Where,

$$Us = shelterbeltswindspeed Uc = criticalwindspeed$$
$$f = 2(^{uc + us}/_{uc})$$

III. Results

Figure 1:Showed wind movement in a lee ward horizontal direction across belts with the height of 20.5ms^{-1} obtained in April and 1.1ms^{-1} as the lowest obtained June.

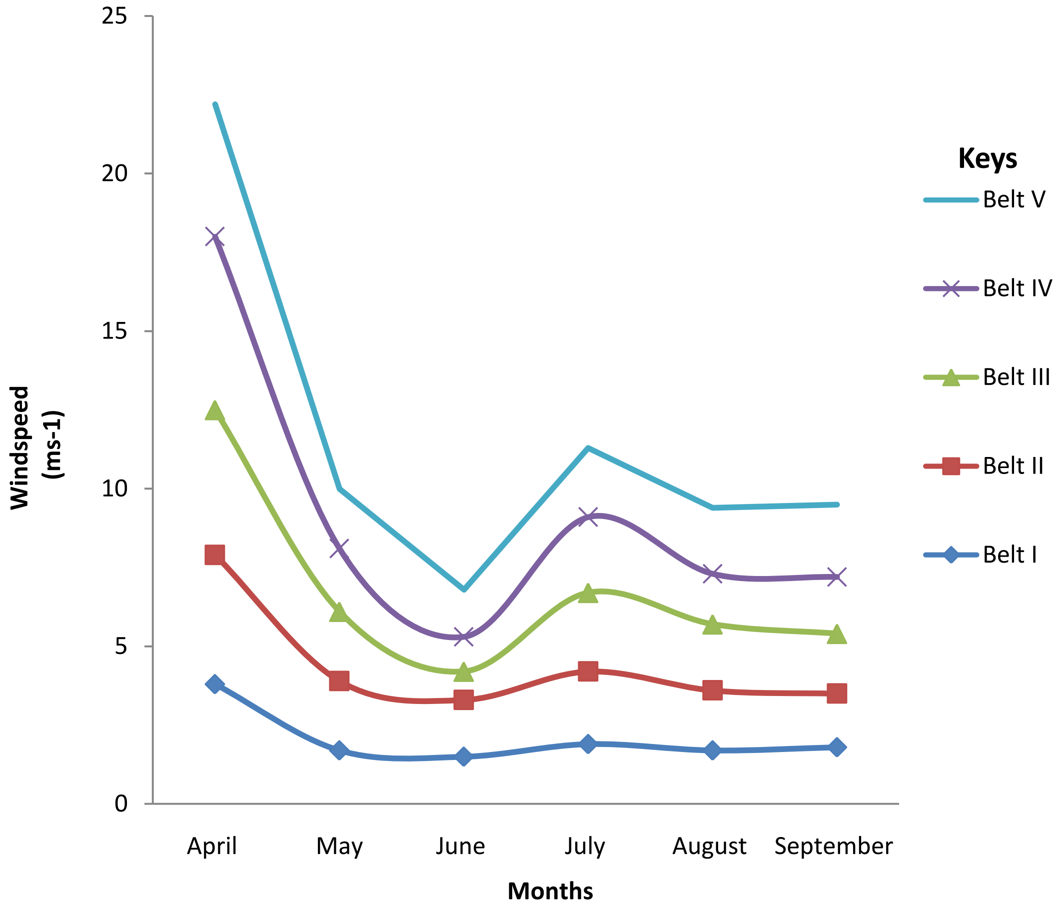

Figure 1: Monthly Average Wind Speeds (ms^{-1}) in Horizontal Directions at Babura, 2013

Figure 2:Showed wind movement in a lee ward horizontal direction across belts with the height of 4.5ms^{-1} obtained in April and 1.6ms^{-1} as the lowest obtained August.

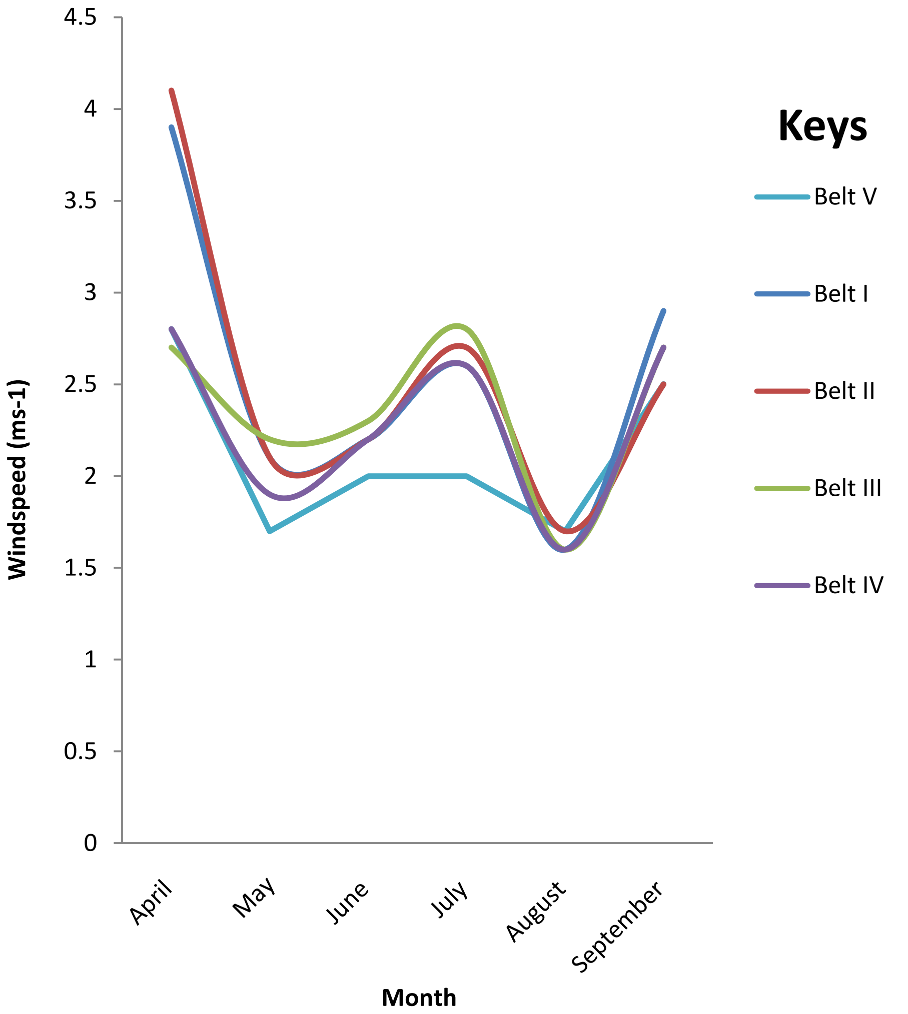

Figure 2: Monthly Average Wind Speeds (ms^{-1}) in Horizontal Direction at Doko, 2013

Figure 3:It described wind movement along vertical direction of the lee ward side across belts with the height of 2.3ms^{-1} obtained in April and 0.6ms^{-1} as the lowest obtained August.

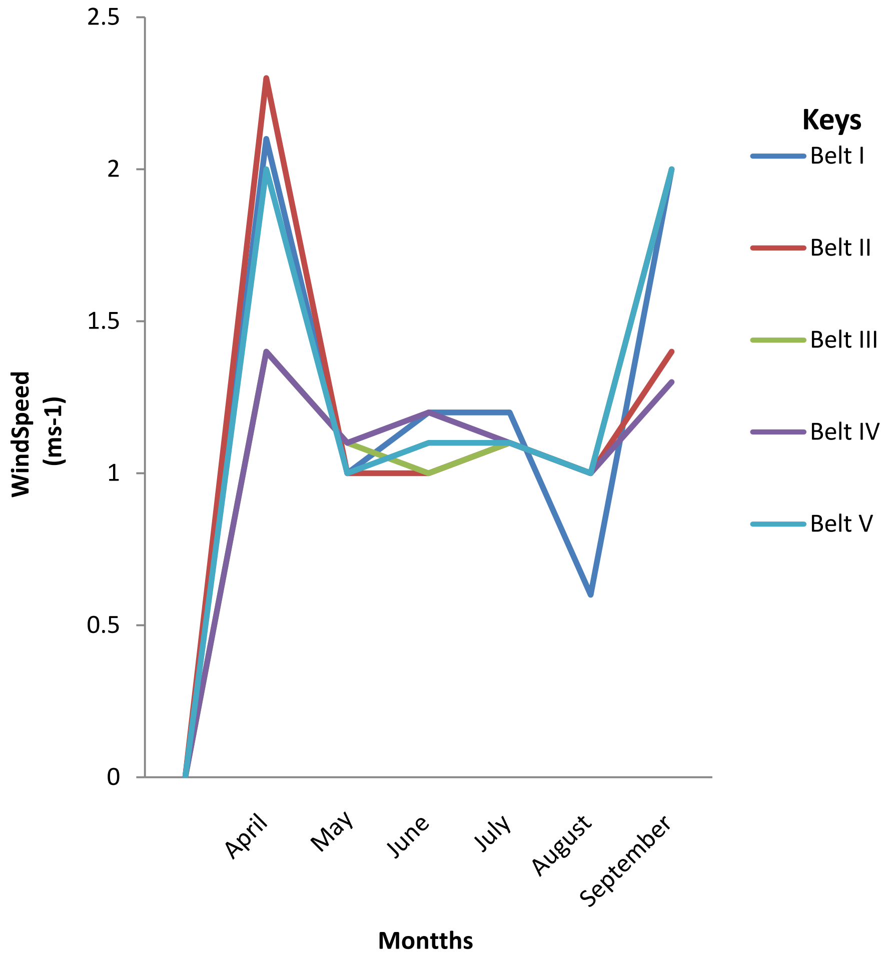

Figure 3: Monthly Average Wind Speeds (ms^{-1}) in Vertical Direction at Doko, 2013

Figure 4..It described wind movement along vertical direction of the lee ward side across belts with the height of 10.4ms^{-1} obtained in May and 1.1ms^{-1} as the lowest obtained July.

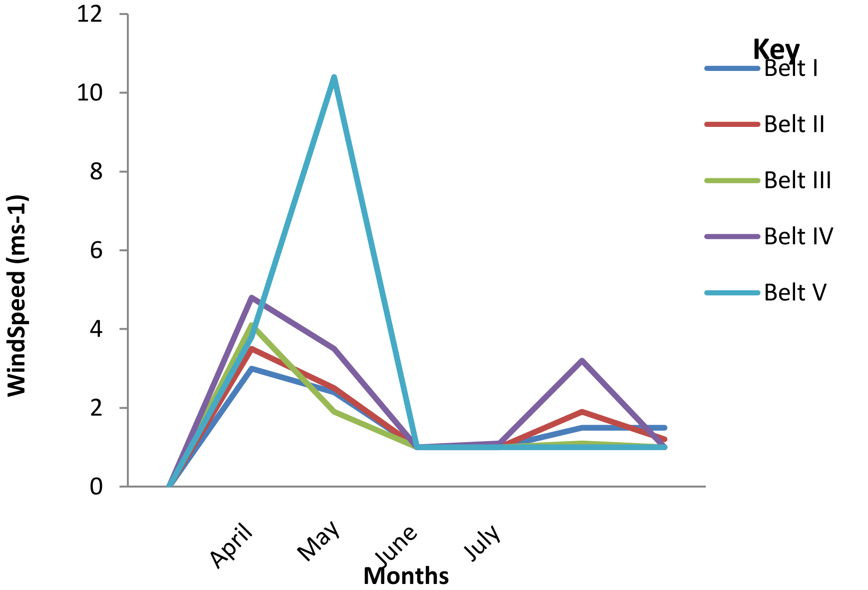

Figure 4: Monthly Average Wind Speeds (ms^{-1}) in Vertical Direction at Babura, 2013

Figure 5.It described wind movement along horizontal and vertical direction of the lee ward side across belts with the height reading obtained at belt v in May and the lowest obtained at belt 10 in September.

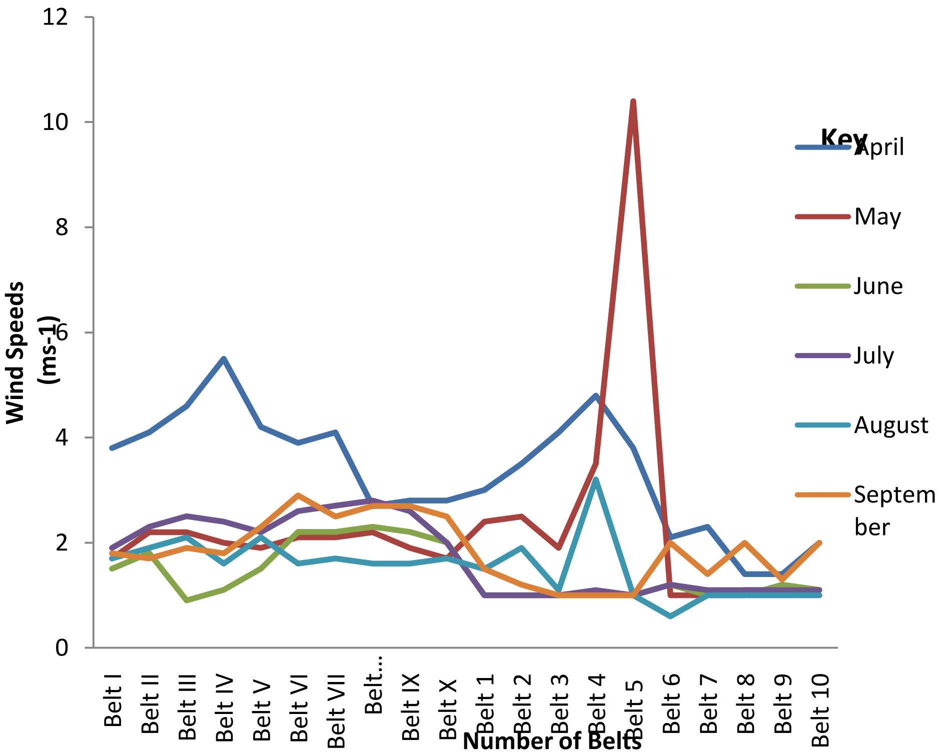

Figure 5: Monthly Average Correlation of Wind Speeds (ms^{-1}) at Horizontal and Vertical directions for Babura and Doko, 2013

IV. Discussion

As it can be observed in Figure 1, that the wind speed taken from April to September varied across the belts. Based on Beaufort scale, the wind action in April was not beneficent to the system because the Us was greater thanUc. Thus, at belt IV it was destructive. However, for belts I, II, III and V, the scale indicates that the effect was not destructive. The highest wind speed of 20.5ms^{-1} was obtained in April at belt IV while the lowest wind speed of 1.1ms^{-1} was obtained at the same belt in June. Over all, there is no statistically significant difference at 5% level (p= 0.760) among the belts in terms of wind protection efficiency. This work was corroborated with the work of Dafa-Alla and Nawal (2011) who worked on Alhudi shelterbelts in sudan a similar semi-arid areas. The wind speed measured at Doko plantation (Figure 2) showed that there was uniform wind movement or action because the wind speed was within normal range of Beaufort scale ($Us < Uc$). This indicates that there was a protection along the belts. This was in agreement with the report of Al-Amin *et al.* (2010) which said field investigations indicated the effectiveness of trees and shrubs to suppress moving sand compared to other mechanical measures. The highest wind speed of 4.5ms^{-1} was obtained in the month of April at belts II while the lowest wind speed of 1.6ms^{-1} were obtained in the month of August at belt I, III and IV. However, there was no significant differences at 5% level (p = 0.760) across the belts.

The vertical wind speed recorded as shown in figure 3 for Doko plantation indicates that there was variation across the months during of the study; the highest vertical wind speed of 2.3ms^{-1} was recorded in the month of April at belt II while the lowest of 0.6ms^{-1} was obtained in the month of August at belt I. However, there were no significant differences at 5% level of significant (p = 0.988). Also, the vertical wind speed recorded in figure 4 for Babura shelterbelts showed that highest wind speed of 10.4ms^{-1} was obtained in May at belt V which indicates an abnormal range of the Beaufort scale. Thus, there was no protection provided by the trees. The lowest speed of 1.1ms^{-1} was obtained in July. However, statistically there is no significant difference at 5% level (p = 0.927) between the belts.

The poor protection to wind effect indicated by the Beaufort scale at belt IV both vertically and horizontally in the month of April was attributed to the change in weather condition in the area due to hamattan period which is usually windy in the months of November to Jan/Feb. In addition, the month of April also signals the beginning of the rainy season. It often comes with strong wind too. This finding was similar to that of McNaughton (1988), Brandle and Wight (2000) who reported that shelterbelt structure determines the amount of wind speed reduction that occurs. As a result of changes in wind speed and turbulence created by a shelterbelt, microclimate within the sheltered area is altered. The swap rates between the atmosphere, soil and plant surfaces are reduced, and as a result, average daily temperature and humidity are increased slightly in the sheltered area.

Figure 5 indicates action of wind along lee ward of both horizontal and vertical direction and their distribution along the shelter belt. It also indicates the variation of wind across the months. It shows the changes of wind with seasons. The month of April and May showed changes and signal of rainy season while the months of June, July and August indicates fluctuation of wind action which was in agreement with Beaufort scale. The month of September signal wind action which may raise up as rainfall was reduced and hamattan sets in. This observation was in agreement with the report of Ki-pyo and Young-moon (2009) who reported that the effectiveness of a barrier depends on its porosity, although, low porosity create turbulences on lee ward side of the shelterbelts.

The shelterbelts studies are abandon for long period of time which affected the design. The activities of man and animals play an important role in reducing/destroying the protection provided by the belts. The need of reviving the lost trees and the used of correct insecticides and pesticides should be employ to revoke the challenges faced in the past and present ones.

Recommendation

I. There is need of replanting the cut and dead plant.
II. The gaps between rows should be increase to 6m to provide strong protection.
III. There is need to introduce /test new trees species.
IV. Government should increase the numbers of forestry workers.
V. Community participation should be encourage

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