IMPACT AND RELATION BETWEEN PROXIMITY OF TWO INDIVIDUAL TREES AND THEIR GENERAL DEVELOPMENT

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Date – April 27th 2021

CAUTION TO THE READER

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1 ABSTRACT

The intend of the following study is to understand and analyse a trend which marks the relationship between proximity of two trees and their general development. In this study we will examine two types of regeneration techniques, Artificially and Naturally regenerated even age stands. For recording the data in regard to the artificially regenerated stand, Ekant Park was chosen as a location and Manav Sangrahalay was chosen for the naturally regenerated stand. At both locations several plots of 5 *5 squared meter plots were marked and the data pertaining to the preferred tree species was recorded. This included soil texture, average DBH, canopy cover, tree mortality ratio and temperature. Putranjiva (*Putranjiva roxburghii),* Gulmohar *(Delonix regia)* and Beeja tree *(Pterocarpus marsupium)* were the preferred species in Ekant park. Nilgiri (*Eucalyptus)* and Babool tree (*Vachellia nilotica)* were the preferred species in Manav Sangrahalay. A considerable amount of change in growth and development can be seen when comparing the stands with higher tree density to the stands with lower tree density. In other words, a trend where increasing distance between the trees resulted in an increase in the tree heights and DBH`s can be seen.

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Finally, I would like to thank Lakehead University, which provided me with this opportunity to explore much further into the topic thus expanding my knowledge and applying this knowledge into my silvicultural practices.

5 INTRODUCTION

Tree development is a complex process, with numerous factors playing their role simultaneously resulting in the development of a tree. Factors such as topography, soil type and temperatures are important factors. Other factors such as macro and micronutrients, water, light, nitrogen and many more are limited in nature. These limitations cause the imbalance in tree development. The imbalance in tree growth depends on the competition it faces with respect to its ecological surroundings to access the nutrients and other resources. One such factor that may or may not affect tree growth is the proximity of an individual tree to neighboring trees.

Tree development is an important topic in the case of commercial softwoods and hardwoods due to their importance in Silvicultural operations. Silviculture and operations being carried out in the woodlands of Canada, constitutes a significant portion of the GDP. Lumber production being the major operation going under the silvicultural practices, the quality of lumber produced is an important factor determining the economic wellbeing of the industry. Following the harvesting operations, the silvicultural firms or the First nation communities managing the forests are responsible for regeneration of the harvested woodlands. In the process of regeneration, it is important to plant trees in a way to maximize the economic value of the block and also preserve the ecological balance at the time.

In order to get further information, examining regeneration patterns following both artificial and natural regeneration is required. Several patches with the dimensions 5*5

squared meters of both the artificial and natural regeneration patterns were examined in order to get a clear understanding of the development of trees in both the regeneration patterns. Same species of the trees were examined under the same dimensions of the patch area in order to check the development with the ability to make direct comparisons.

While examining the trees under different regeneration patterns in the woodlands data was recorded pertaining to the development in terms of tree canopy cover from the centre of the patch, average diameter at the breast height, height, tree mortality ratio, soil type, the range of temperatures while recording took place, and slope.

Apart from the methods being followed in the field in order to understand the relation between the proximity of two individual trees in an ecosystem and general tree development, any previously published information on the above-mentioned topic will be reviewed. Journal articles, statistical analysis and literature available on the data which can prove the legitimacy of the mentioned techniques used will also be reviewed and cited in order to understand and prove all aspects of this study.

To summarize in the following study, we will investigate the resources, literature and use certain methods and techniques in order to determine the impact or basic relation between the proximity of two individual trees and their general development.

6 LITERATURE REVIEW

Several studies have shown that the stress that trees undergo during developmental stages affect that development which is shown in the final form of the tree, the amount of biomass produced, crown structure, tree diameter and height, among several other factors.

6.1 Deficiencies – Deficiencies of various macro and micronutrients in plants result in several deformities.

6.1.1 Nitrogen Deficiencies – In a study conducted by Will (1978) in New Zealand, it came to light that nitrogen deficiencies affect a tree from the seedling level. Reduction in growth rate infused with yellow appearance of the foliage is common. Reduced branching and diameter of the stem can often be seen. In a case of an adult tree, premature shedding can be seen in an extreme case of nitrogen deficiency, in other not extreme cases, uniformly yellow needles, reduced stem diameter and reduced branching can be seen. In another study by Boussadia et al. (2010) it was stated the nitrogen deficiencies are also directly related to the decrease in photosynthetic capabilities of the plant.

6.1.2 Phosphorus Deficiency – In the studies conducted by Reid and Bieliski (1970), it was clearly shown that the deficiency of phosphorus resulted in decrease in growth rate. In this study it can be seen immediately that the growth rate was decreased within the first 6 hours of transferring the plant to a phosphorus deficient medium. Lack of phosphorus further leads to accumulation of starch which in turn leads to reduction in

growth rate. This was also supported by Will (1978) earlier, who also noted that a phosphorus deficiency leads to shortening of needles in the case of softwoods.

6.1.3 Potassium deficiency – Potassium being an important macronutrient, its deficiency can result in stressful growth and a decrease in the productivity of the plant. Hafsi et al. (2014), in their studies proved potassium is an important component in processes like photosynthesis, osmoregulation, protein synthesis and maintenance of the plasma membrane. Will (1978) also added to the subject in his study that in the case of softwoods, chlorosis of the tips of the needles can be seen however in older plants the chlorosis is limited to the lower crown, and in newer plants the whole crown may be affected.

6.1.4 Calcium deficiencies –
Shortle and Smith (1988) also proposed in their study that calcium is one of the top 5 necessary elements required by a tree. In red spruce loss of crown is triggered by reduced cambial growth, which is a result of calcium deficiencies as calcium is required at a constant pace during the development of the sapwood. Reduction in the width of an annual ring and suppressed cambial growth, will also lead to suppressed sapwood functioning (Shortle and Smith 1988).

6.1.5 Magnesium deficiencies- Magnesium deficiencies in spruce as studied by Mehne and Jakobs (1995) showed yellowing of the needle tips, and in some extreme cases it may also lead to development of severe chlorosis for a limited period. The newer crown may still remain green. The upper portion of the crown, with significantly more sun exposure are seen to have more yellowing of the needles. Wills (1978)) in his study

found the same results when testing softwoods for magnesium deficiencies. Mehne and Jacobs (1995) also pointed out the increased tree mortality in trees due to the deficiency in magnesium.

6.1.6 Boron deficiencies- Lambert and Turner (1977) showed that boron deficiency leads to dieback if not directly, then indirectly by weakening the immunity. The ineffectiveness of vascular system is a direct result of boron deficiency. The boron deficiency is also associated with accumulation of amino acids which helps in the growth of fungus causing dieback.

6.2 Reasons of deficiencies in trees – Several reasons have been identified and acknowledged which eventually leads to the deficiency in trees. These can be related to soil, topography, weather and the densities at which the planting occurs.

Fox et al. (2007), in their study in the southern United States suggested that the growth of softwoods in the region are limited to growth by nutrient availability in the soil. Limitations of soil nutrients determines and limits the leaf area, the leaf area is one of the key features that determines the growth rate of the stand. In their study they determined when the leaf area index reaches less than 3.5, it negatively affects the growth rate as lesser light is captured by the leaves.

Management practices are also responsible for the nutrient availability, intensive harvesting and silvicultural practices can have adverse effects on the soil nutrient availability as stated by Cole (1995). In another study conducted by Cheesmen et al.

(2018), showed a trend where plots with average or steeper slopes have lesser tree heights.

In another study conducted by Littell et al. (2008) on the growth of Douglas fir in the mountainous regions, the limiting factor determined was the climate prevailing in the area. Another reason mentioned was the competition between the trees. This directly related to the densities at which the trees are planted. This can be seen in the study conducted by Hebert et al. (2016). In their study with the increased spacings between the jack pines, increased radial growth can be seen on the lower part of the stem. It was also seen that the diameter of the longest branch increased considerably as the spacings increased, which resulted in increased crown growth.

In another study conducted by Jiang et al. (2007) in China on an important poplar species, it showed that the stands with lower density resulted trees with higher radial growth and higher stem taper. Significant difference was also found in mechanical properties of the wood. However no significant difference was seen in the wood fibre or the wood densities in general. In a study conducted by Debell et al. (1996) stem taper and slenderness of the stem varied with spacing densities, however no difference was seen in the crown closure with respect to the spacings.

Several different studies have been conducted over the years in different ecosystems with a varied range of answers. This led to this thesis question and procedures to determine if there is in fact a relation between the tree spacings and its general growth.

6.3 Water as a limiting factor -

Healthy roots are a necessity for a plant to grow in a healthy manner, in which amount of water available plays an important role. Water is responsible for carrying necessary nutrients throughout the plant. At the same time water also carries dissolved sugars. Disbalance in the water availability directly leads underdeveloped shoots, which are prone to drooping and can't support their own weight. In a study performed by Kleiner et al. (1992) on chestnut and oak, the water and nutrient deficiency on the oak provided relatively similar results. In this study the seedlings showed the signs of greater impact when a draught like situation was created. Lesser shoot weights were recorded as a result of water deficiencies. Competition for the resources especially water is generally harsh during the Thinning phase of the forest succession, when the closed canopy has formed by the initially established trees (Peet R K 1987).

7 MATERIALS AND METHODS

7.1 Materials –

To carry out the survey successfully several articles were used. These included a measuring tape, a notepad and a pen, some chalk powder. Measuring tape as used to determine the exact circumference of the trees that were being sampled, we also used the measuring tape in order to determine the 5 squared meter blocks, which were later marked and distinguished with the help of the chalk powder. At last, the notepad was used to record the measurements and the species encountered.

7.2 Area Used –

Two locations were used and taken into consideration for the process of surveying and sampling which represented both the regeneration patterns natural and artificial regeneration.

7.2.1 Natural Regeneration – Stands of Manav Sangrahalay –

In order to survey and sample the trees in a controlled environment and being naturally regenerated we sampled few plots in the area of Manav Sangrahalay tribal museum. Stretched out over the vast area of around 200 acres and located in the capital city of Bhopal, Madhya Pradesh, Manav Sangrahalay hosts several exhibitions and workshops which entails the story of evolution of the man in real time and space. The whole museum is developed under a natural regeneration setting, yet some parts of the area is controlled. Manav Sangrahalay due to being stretched over a vast area gave us a

significant amount of space to mark the plots and sample the trees. The soil to be found here in abundance is the black soil, rich in clayey component. Due to the naturally regenerated even stands the Eucalyptus species covers majority of the area with some small patches of *Vachellia nilotica,* The babool tree (Figure 1). Eucalyptus was initially introduced in the area with vision of maintaining a systematically managed plantation. The operation was cancelled due to the government regulations on using heritage land. This resulted in free unmanaged growth of Eucalyptus in the area.

Figure 1. Stands of Manav Sangrahalay. SOURCE - Self

7.2.2 Artificial Regeneration – Ekant Park

To sample the trees and survey the area under artificial regeneration we took into consideration and marked our plots in parks maintained by the provincial government of Madhya Pradesh (Figure 2). The park is home to several trails and is open to public. Ekant park is rigorously maintained by the government and the trees and plants that are used for regeneration and nurtured in the adjoining nursery which is also a provincial government initiative. Ekant park constitutes of the black clayey soil.

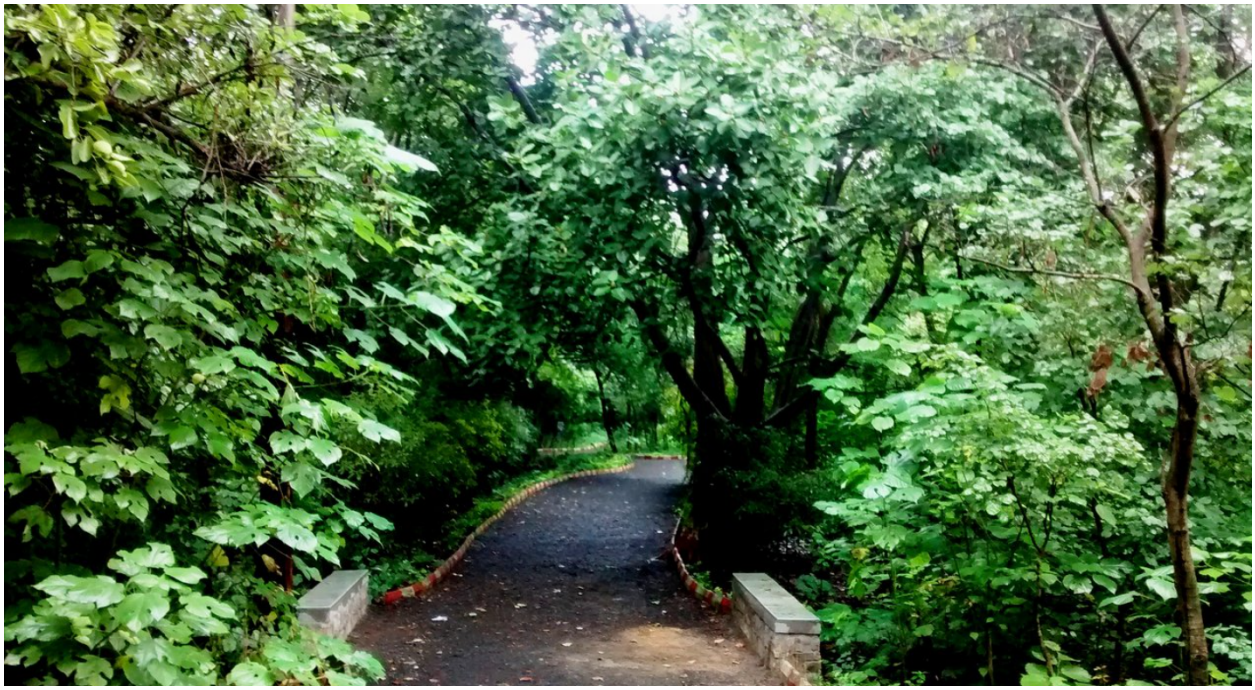

Figure 2. Ekant park trails. SOURCE – tripadvisor.com

7.3 Methods –

To understand the trend between spacing and tree development in both artificial and natural regenerated stands, several plots of 5 squared meters depending on the site and the vegetation were made in both the natural and artificial stands in order to record the tree mortality ratio and canopy cover. The species of Putranjiva (*Putranjiva roxburghii*), Gulmohar (*Delonix regia*) and Beeja tree (*Pterocarpus marsupium*) were recorded in stands following the pattern of artificial regeneration in the Ekant Park. On the other hand, the species of Nilgiri tree (Eucalyptus, Figure 3) and babool tree (*Vachellia nilotica*) were recorded in the naturally regenerated areas of Manav Sangrahalay.

In order to determine accurate canopy cover (Figure 4) and tree mortality ratio the recordings were made from the point of intersection of the diagonals of the marked plots. The distance between two trees of the same species in a stand was recorded in accordance with the diameter at the breast height. Due to high temperatures of the tropical environment, making the soil extremely dry not much understory vegetation was recorded.

Figure 3. The Nilgiri trees (Eucalyptus) spaced 12 feet apart in a naturally regenerated stand. SOURCE – self.

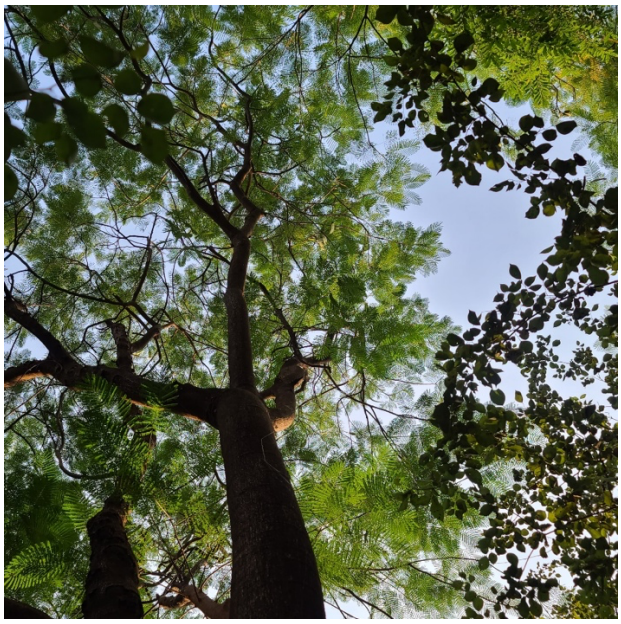

Figure 4. Canopy cover determination at an artificially regenerated stand. SOURCE - self

8 RESULTS

8.1 Artificial Regeneration Stands in Ekant Park

While sampling plots in an artificial regeneration stand, several species of tree were recorded specifying their height and diameter at breast height as compared to the distance at which they are planted. Canopy cover was also recorded in order to understand the foliar development (Table 1).

Table 1. presents the DBH, tree heights canopy cover and distance between the preferred species in the Ekant park.

Species	Common name	distance	DBH	cm	Height	meters	Canopy cover
		meters	Tree 1	Tree 2	Tree 1	Tree 2	%
Gulmohar	*Delonix regia*	9.14	74	60	10.68	9.75	80
		2.13	19	21	7.92	8.53	60
Beeja	*Pterocarpus marsupium*	4.57	48	40	19.81	18.28	60
		10.66	82	97	23.77	24.38	95
Putranjiva	*Putranjiva roxburghii*	7.04	72	70	13.41	14.93	90
		3.65	60	48	10.97	9.14	80

Species of Gulmohar, also known as Royal Poinciana (*Delonix regia*), was recorded on two sites being planted 9.14 meters and 2.13 meters apart. The DBH recorded for the trees planted 9.14 m apart was 74 cm and 60 cm for the two trees, also the height recorded were 10.68 m and 9.75 m, respectively. On the other hand, the trees had 19 cm and 21 cm DBH and 7.92 m and 8.53 m, respectively, for heights of the trees planted at 2.13 m apart as shown in Table 1.

A Similar trend was seen for the species of Beeja tree (*Pterocarpus marsupium*), the trees were recorded at being 4.57 m and 10.66 m apart. A considerable difference can be

seen in the DBH, as the trees planted at 4.57 m showed the two trees to be 48 cm and 40 cm. The height for these trees were 19.81 m and 18.28 m, respectively, where a DBH of 82 cm and 97 cm were recorded for the trees planted 10.66 m apart, with the height being 23.77 m and 24.38 m, respectively, as shown in Table 1.

Another species Putranjiva (*Putranjiva roxburghii*) was encountered to be planted at the distances of 7.04 m and 3.65 m. However, in this species no considerable difference was visible in accordance with the DBH, however a little difference was visible in case of the height of the trees. The first set of trees were recorded to have a DBH of 72 cm and 70 cm, when planted at 7.04 m apart. These trees were recorded to attain a height of 13.41 m and 14.93 m, respectively. In the second set 60 cm and 48 cm DBH was recorded when planted at 3.65 m apart. These trees had recorded heights of 10.97 m and 9.14 m, respectively. The results for these measurements are presented in Table 1.

Canopy cover was also recorded for the above-mentioned species. The percentage of canopy cover ranged from 80% to 60% for 9.14 m and 2.13 m distance of planted trees of Gulmohar, respectively (Table 1). Similarly, a range of 60% to 95% was recorded for Beeja tree planted at 4.57 m and 10.66 m apart, respectively (Table 1). In the case of Putranjiva as well it ranged from 90% to 80% for the trees planted at 7.04 and 3.65 apart, respectively (Table 1). Figure 5 displays the values for the measurements graphically for Ekant Park.

Another important factor which was recorded was the soil quality and texture. The soil found in Ekant park was black cotton soil which is highly clayey in nature. This soil is

also known by the name of Regur soil and is found in multiple parts of the province. Not an exact but similar soil type found in Canada is the vertosols. Due to lower amounts of rainfall and dryness the soil was found to be extremely dry and cracked (Figures 6 - 9).

Ekant park being an example of well managed stands, tree mortality was found to be negligible. Throughout the survey only one tree was found dead in the peripheral species which according to the managing committee of the park is due to the pollution and harm to the trees due to an urban setting.

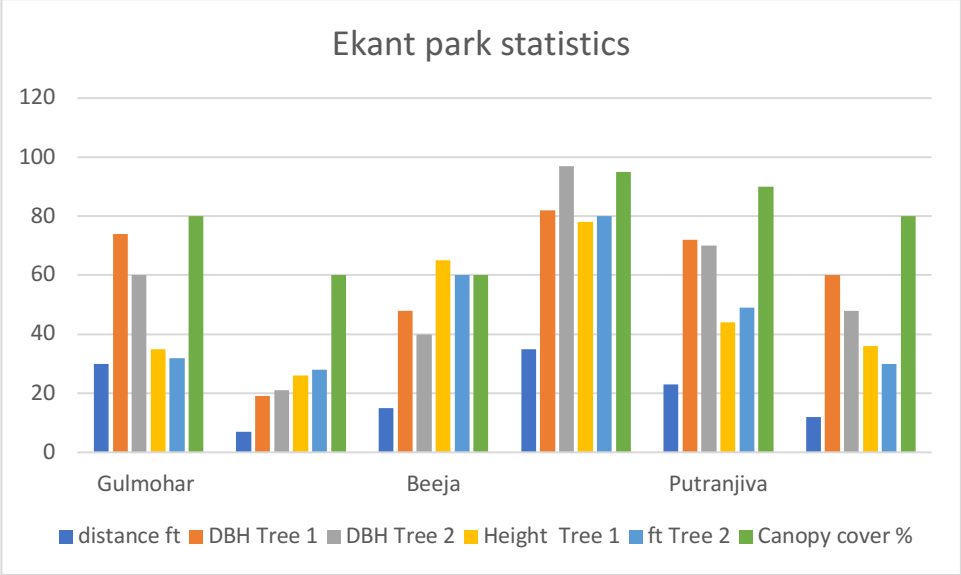

Figure 5. Shows the graph depicting the species, their DBH, height and canopy cover encountered in Ekant Park, the sight chosen for the artificial regeneration data.

8.2 Rainfall and moisture over the growing years

The figures mentioned below shows the monthly rainfall and rainy days in the city of Bhopal, where both the stands are located. Figure 6 shows the graph depicting monthly rainfall in Bhopal in the year 2017. Figure 7 shows the graph depicting monthly rainfall in Bhopal in the year 2018. Figure 8 shows the graph depicting the rainfall in Bhopal in the year 2019. And figure 9 shows the graph depicting rainfall in Bhopal in the year 2020.

Most of the rainfall over the span of mentioned years is concentrated in the months from May to October. Following these months with absence of rain and higher temperature the soil becomes extremely dry and cracked in some cases in Bhopal. This was the reason we encountered the cracked up black cotton soil (Regur) in both the stands (Figures 6 - 9).

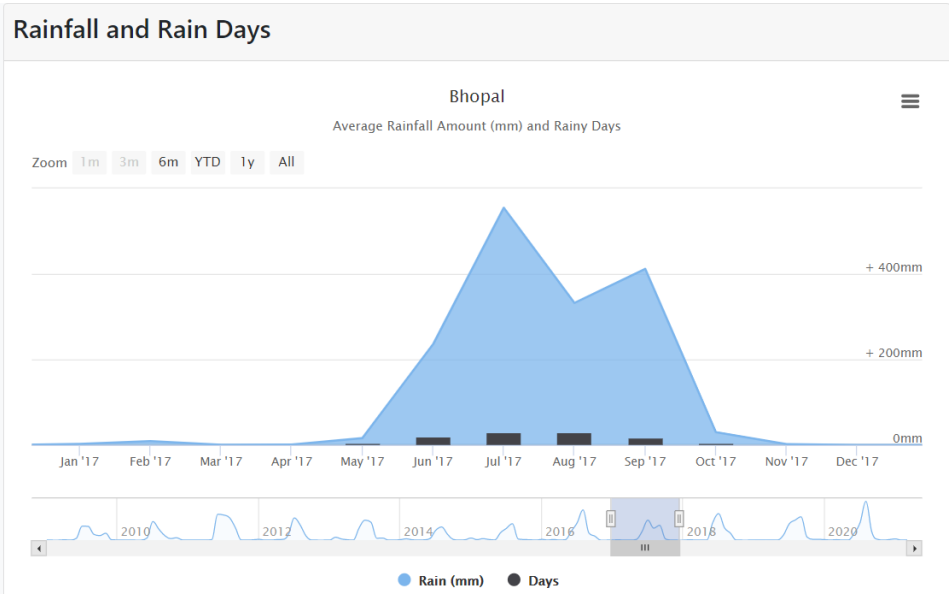

Figure 6. shows the graph depicting the monthly rainfall experienced by the area in the year 2017. (Source: https://www.worldweatheronline.com/bhopal-weather-averages/madhya-pradesh/in.aspx)

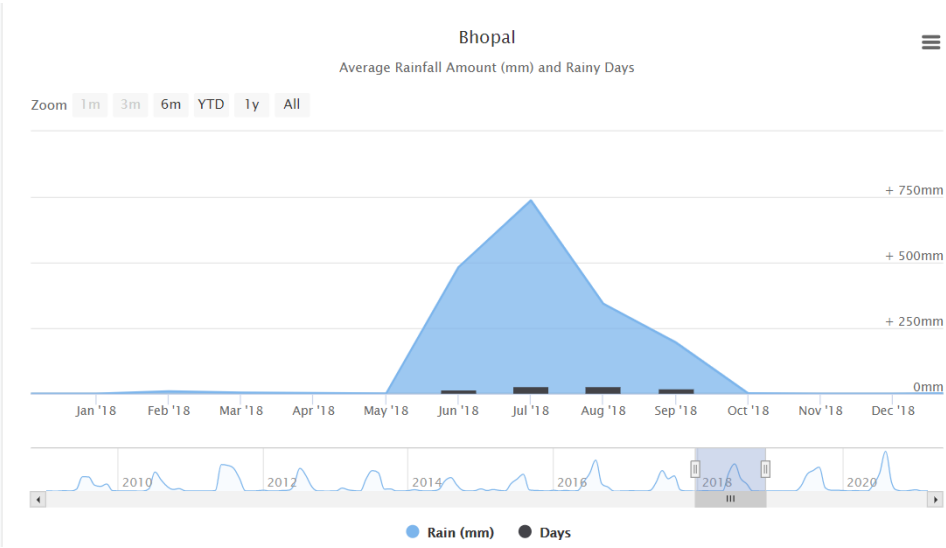

Figure 7. Shows the graph depicting the monthly rainfall experienced by the area in the year 2018. (Source: https://www.worldweatheronline.com/bhopal-weather-averages/madhya-pradesh/in.aspx)

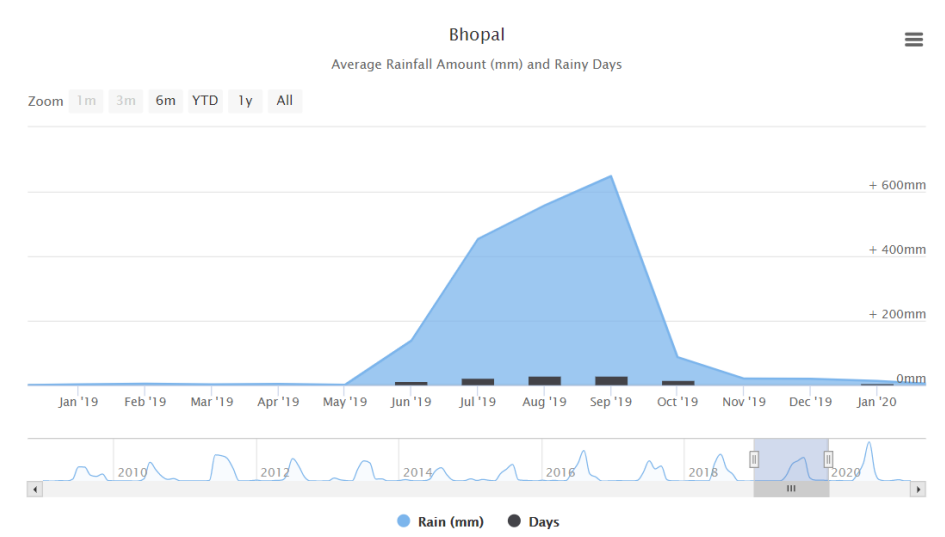

Figure 8. Shows the graph depicting the monthly rainfall experienced by the area in the year 2019. (Source: https://www.worldweatheronline.com/bhopal-weather-averages/madhya-pradesh/in.aspx)

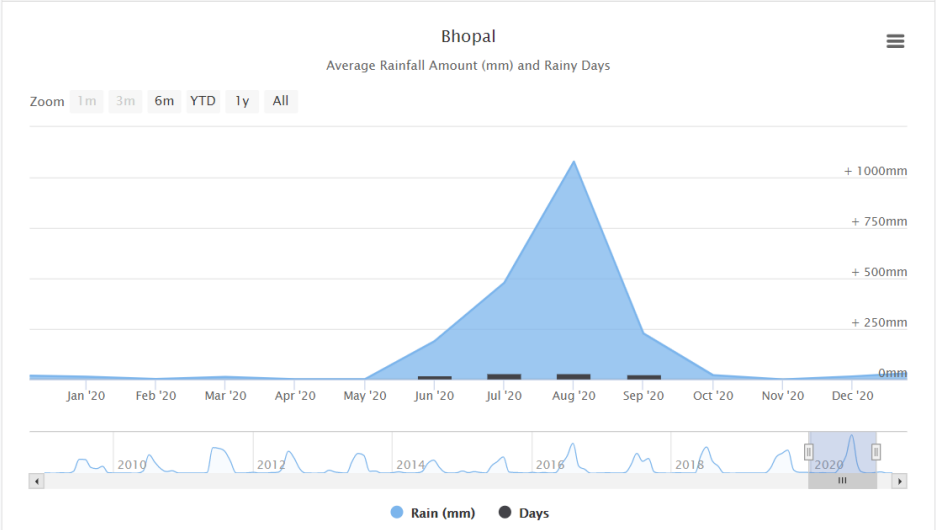

Figure 9. Shows the graph depicting the monthly rainfall experienced by the area in the year 2020. (Source: https://www.worldweatheronline.com/bhopal-weather-averages/madhya-pradesh/in.aspx)

8.3 Natural Growth Stands in Manav Sangrahalay

The first species to be encountered was *Eucalyptus*, also know as Nilgiri trees in Indian local language. The scientific name however is *Eucalyptus*. Three 5 * 5 squared meter blocks were taken into consideration for the species where in the first block the tree density was higher with 4 trees in a block. On average the distance between two trees was 3.6 meters, with the farthest trees at the distance of 4.02 meters and shortest distance being 3.20 meters (Table 2). The average DBH recorded in this block was 13.8 cm (Table 2), with the largest being 14.9 cm and the smallest being 12.7 cm. The average height came out to be 18.58 meters, with the tallest tree being 21.33 meters in height and shortest being 15.54 meters in height (Table 2).

Table 2. DBH, height, canopy cover and distance in block 1 for Nilgiri.

Niligiri	Block 1			
Eucalyptus	Distance from next tree (m)	DBH (cm)	Height m	Canopy cover %
4 to 1	3.65			
Tree 1		14.9	21.33	80
1 to 2	4.02			
Tree 2		12.7	15.54	60
2 to 3	3.2			
Tree 3		13.6	17.67	75
3 to 4	3.6			
Tree 4		13.9	19.81	70
Average	3.6	13.8	18.5875	71.25

Table 2 shows the DBH, canopy cover, height, and distance between the trees of preferred species in block 1 of the stands in Manav Sangrahalay.

The second block which was considered had 2 trees in a block making it considerably lower tree density and a higher percentage of the canopy cover (Table 3). The trees were found 4.2 meters apart (Table 3). The DBH recorded was 16.8 cm and 17.5 cm for tree one and two, respectively (Table 3). Also, tree one attained the height of 25.9 meters and tree two attained the height of 27.43 meters (Table 3).

Table 3. DBH, height, canopy cover and distance in block 2 for Nilgiri.

Niligiri	Block 2			
Eucalyptus	Distance from next tree (m)	DBH (cm)	Height m	Canopy cover %
Tree 1		16.8	25.9	75
1 to 2	4.2			
Tree 2		17.5	27.43	75
Average	4.2	17.2	26.665	75

Table 3 shows the DBH, canopy cover, height, and distance between the trees of preferred species in block 2 of the stands in Manav Sangrahalay.

The third block which was considered contained only one preferred species tree. Some understory shrubs and weeds like worm killer and red sorrel were encountered, but only one preferred species tree. The reason was to understand the development without much competition. The DBH was counted to be 19.9 cm and attained a height of 29.87 meters. The canopy expanse was much higher as compared to the trees in both the previous blocks (Table 4).

Table 4. DBH, height, canopy cover and distance in block 3 for Nilgiri.

Niligiri	Block 3			
Eucalyptus	Distance from next tree (m)	DBH (cm)	Height m	Canopy cover %
Tree 1		19.9	29.87	90
Average		19.9	29.87	90

Table 4 shows the DBH, canopy cover, height, and distance between the trees of preferred species in block 3 of the stands in Manav Sangrahalay.

The second species to be encountered was *Vachellia nilotica* also known as the Babool tree in the native language. Two blocks of 5 * 5 squared meters were taken into consideration for this species. Manav Sangrahalay is an even aged naturally regenerated stand where not many babool trees were found in the area. The first block to be considered had 3 preferred species trees, with the average distance of about 3.6 meters (Table 5). The furthest being 3.96 meters and the closest being 3.35 meters (Table 5). The average DBH recorded was 18 cm, largest being 20.3 cm and smallest being 15.5 cm (Table 5). The average height came out to be 4.97 meters, where the tallest tree was 6.7 meters and shortest was 3.65 meters (Table 5). The canopy cover recorded was 60%.

Table 5. DBH, height, canopy cover and distance in block 1 for Babool.

Babool	Block 1			
Vachellia nilotica	Distance from next tree (m)	DBH (cm)	Height m	Canopy cover %
3 to 1	3.65			
Tree 1		20.3	6.7	80
1 to 2	3.96			
Tree 2		15.5	3.65	50
2 to 3	3.35			
Tree 3		18.2	4.57	50
Average	3.7	18.0	4.97	60

Table 5 shows the DBH, canopy cover, height, and distance between the trees of preferred species in block 1 of the stands in Manav Sangrahalay.

The second block which was considered had 2 trees of the preferred species. The trees were 3.5 meters apart. The DBH recorded was 27.5 cm and 14.3 cm with heights of 8.5 meters and 2.7 meters, respectively (Table 6). A canopy cover of 80% was recorded.

The soil found in Manav Sangrahalay was black cotton soil also known as the Regur soil in the literature for this area, which had cracked due to the dryness of the weather conditions, and absence of rain and moisture (Figures 6 - 9).

Table 6. DBH, height, canopy cover and distance in block 2 for Babool.

Babool	Block 2			
Vachellia nilotica	Distance from next tree	DBH (cm)	Height m	Canopy cover %
Tree 1		27.5	8.5	90
1 to 2	3.5			
Tree 2		14.3	2.7	70
Average	3.5	20.9	5.6	80

Table 6 shows the DBH, canopy cover, height, and distance between the trees of preferred species in block 2 of the stands in Manav Sangrahalay. Figure 10 displays an example of the canopy cover of the area.

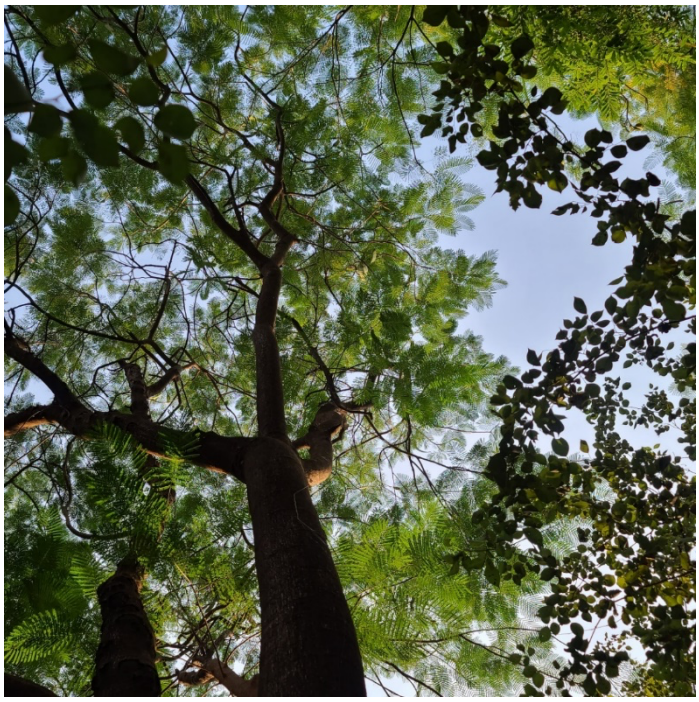

Figure 10. Estimation of canopy cover for the species of Putranjiva at the Ekant park, the site chosen for artificial regeneration sampling in the year 2020.

9 DISCUSSION

During the survey being conducted the data that was acquired showed an increase in distance between the trees, the height and DBH can also be seen increasing in a comparative manner. For instance, in the naturally regenerated stands of Manav Sangrahalay in block one for the species of Nilgiri the tree density was extremely high as compared to the tree density in block 3 of the same area. The result of this can be seen in the DBH of the trees, where the maximum DBH in block one reached 14.9 cm whereas the DBH in block 3 was 19.9 cm (Table 2). A similar trend was also seen in the species of Babool in the stands of Mana Sangrahalay, and also in Gulmohar, Beeja and Putranjiva in the stands of Ekant park. Decreased growth rate can be a result from deficiencies of a number of nutrients that are necessary for a proper growth of the trees (Wills 1978). Several studies conducted on the topic as mentioned earlier suggests that the limitations in availability of nutrients such as Nitrogen, Phosphorus, Potassium, Calcium, Magnesium and Boron have a great impact on the development of the trees as it inhibits the growth rate by either slowing down the pace or reducing the tree measurements (Will 1978; Bousidia et al. 2010; Ried and Bieliski 1970; Hafsi et al. 2014; Shortle and Smith 1988; Mehne and Jackobs 1995; Lambert and Turner 1977).

Deficiencies in the growing plants arises depending on the level of competition the tree experiences from neighbours (Hebert et al. 2016; Jiang et al. 2007). It was noted in the studies performed that trees growing in lower stand density areas have higher radial

growth (Hebert et al. 2016; Jiang et al. 2007) which was the trend also seen in the data collected in this study in both regeneration stand types.

10 CONCLUSION

In conclusion, after following the measures and the methods stated above in both artificially and naturally regenerated stands, it can be said that a trend can be seen in the growth and development of the trees with respect to the proximity with other individual trees. An extremely clear trend is seen in the artificially regenerated stands of Ekant park displayed a comparatively larger DBH, heights and more canopy cover in the species of Royal Poinciana (*Delonix regia*), Beeja tree (*Pterocarpus marsupium*) and Putranjiva (*Putranjiva roxburghii*). The soil texture was also taken into consideration, which came out to be black cotton soil rich in clay, which is also equivalent to the Vertosols category of soil in Canada.

A similar but not very clear trend was also seen in the naturally generated stands of Manav Sangrahalay. The preferred species in this area were Nilgiri (*Eucalyptus*) and Babool (*Vachellia nilotica)*. The general trend of comparatively bigger DBH induced with higher heights and canopy cover percentage was seen in the blocks when the proximity between trees decreased while surveying for *Eucalyptus.* However, in the case of *Vachellia nilotica* the trend was seen in the first block, but the case was different when surveyed the second block in regard to DBH. A similar dried up black cotton soil was recorded in the naturally regenerated stands of the Manav Sangrahalay.

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APPENDICES

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