CHAPTER FIVE

DISCUSSION

As stated earlier, this study was undertaken with the view to understand the effect of seasonal changes and exogenous promoters in vegetative propagation of *Bambusa vulgaris* and *B. bambos* bamboo cuttings. Hence, the important findings related to these objectives have been discussed in the light of facts already documented on the subject and are as under.

5.1 Studies on Growth and Proliferation Rates.

5.1.1 Study of Annual Cycle of Growth.

The results of experiment (4.3) show that cuttings of *Bambusa Vulgaris* and *B. bambos* exhibit marked seasonal variations in their growth, and that these variations in growth response vary with the species and, within a species, with the growth parameters under consideration. Seasonal changes in growth behaviour and growth periodicity in bamboos have been stated earlier also by several investigators (Kondas 1981, Nath 1986, Serajuddoula 1988, Banik 1995, Azzini 1995,) studies on thirteen species of bamboo in Bangladesh. Azzini (1995) concluded that each species had a characteristic growth periodicity.

The roots of these species initiated within fifteen days of the planting of culm cutting on the research site. The overall condition required was good temperature, moist soil, with right quantity of manures and fertilizers. In *B. vulgaris* cuttings, the emergence of new root began in January. The period of rapid increase in the number of roots was mid July to end of August then declining gradually. In *B. bambos*, the periods of new root emergence were from March to mid-May and from the start of October to end of November. The period of rapid increase in root elongation was from end of June to the end of November.
The observations during the entire study revealed that plants grow well if the concentration of growth hormones are increased. To conduct this research, initially various concentrations of growth hormones were tested on these two species. Starting from 10mg/litre to 1000mg/litre of concentration was tested. Thus, it was found that the concentration of 1000mg/litre proved to be the best for the plants. So, two different concentrations i.e. 500mg/litre and 1000mg/litre were taken for the study. The results of these concentrations have been discussed in detail in the previous chapters.

The findings of the present study show that culm growth commenced in *B. vulgaris* and *B. bambos* cutting in mid April and the end of June respectively. In *B. vulgaris* culm number increased very rapidly from mid-July onwards, peaked off by the end of August, and then gradually declined. The increase in number of culms in *B. bambos* was more gradual, reaching the peak value by the middle of August, and then stabilising. The elongation of culms followed more or less the same trend as culm number in *B. bambos*, but length of culm in *B. vulgaris* began to increase rapidly towards the end of June, reached its maximum by mid-October, and showed only minor fluctuations thereafter. While new culm production and culm elongation is gradual over the entire culm growth period i.e. from the last week of June to the middle of August, and culm elongation continued from the end of June to mid-October in *B. vulgaris*.

Kondas (1981) has reported that the period of new culm production in young plants of *B. vulgaris* was rather irregular, extending from May to October. Mature clumps of *B. bambos* and *B. vulgaris* sent up new culms in June-July in northern India, but in September-October in southern India, the periods coinciding with the onset of the monsoon rains in both localities. Nath (1986) has described that new culms in bamboos were produced mainly in the rainy season, and that the culm elongation period was from two to four months. He also observed that the number of culms produced varied greatly with the species and the size and vigour of the clump. Xu and Xu (1984) have reported that, in pseudosasa
amabilis in Huaiji, shoot differentiation commenced in late December, and ended in mid-April, and shoot emergence occurred from late March to mid-April, Azzini (1995) found that, in general, culm production in bamboos started in May or June, and continued until October-November, the period of high rainfall, high soil and air temperatures, and high relative humidity. The pattern of culm production and culm elongation observed in the present study is, more or less, in conformity with these earlier reports.

The period of increase in fresh and dry weight of culms extends from the end of June to the end of August in B. vulgaris, the increase in weight increasing steeply from mid-July onwards. The period of increase in fresh and dry weight in B. bambos is from mid July to the end of September respectively. The basal diameter of the culm increases gradually throughout the year in B. vulgaris, but basal diameter growth of culms occurs during mid-July to the end of September in B. bambos. Serrajudoula (1988) had concluded that the sprout completed its growth in about 35-70 days in monopodial type of bamboos, and in 85-115 dyas in the sympodial type. Shammughavell (1998) reported the weight of seedling and full grown culms declined from the wet to the dry season. The decline of culm weight as observed in B. vulgaris and B. bambos, in the present study, is probably due to change in climate from wet to dry, and also due to mortality in culms, which appeared towards the end of the growing season.

In B. vulgaris the period of new rhizome formation, and volume increase of rhizome, is from mid-April to mid-September, mid-June to end of December and mid-April to mid December respectively. The rapid increase in dry weight occurs during April-July in this species. In B. bambos, the period of new rhizome formation, rhizome elongation, and volume increase of rhizome, is from end of April to December, mid-February to mid-March and mid-May to the end of the experiments (December) respectively. Active period for increase of rhizome weight was from April-July, Azzini (1995) reported that the rhizome buds, as a rule were initiated during summer months, were apparent by the month of June
and developed during rainy season. Shammughavel (1998) has reported that the growing period for the rhizome generally started from the middle or to the end of June, after the period of culm elongation had culminated, become more vigorous from August to September, and growth stopped by mid-November. Leaf dry weight in *B. vulgaris* and *B. bambos*, increased from end of April to end of July. Shammughavel (1998) has reported that roots in bamboo continued to grow gradually, and completed their growth within a year. However, there are very few reports on the periodicity of leaf growth and root growth in bamboos.

5.1.2 In different climatic conditions, growth and proliferation ability of cuttings:

The findings of these study (4.4) shows that the season of cutting separation and planting has significant effect on the growth and proliferation behaviour of propagules, and that the effect is manifested through seasonal variation in the various growth attributes of the bamboo seedlings. Seasonal variations in the various growth parameters of several bamboos have been reported earlier also (Kondas 1981, Nath 1998, Serajudoula 1988, Jousen 1991, Azzini 1995, Banik 1995, Shammugavel 1998). It is evident from the results of this experiment that, in both the two species studies viz. *B. vulgaris* and *B. bambos*, the number of propagules produced in the April-July trial was significantly higher than those produced in August-November and October-March trials. Similarly, almost all the growth attributes viz number, length, basal diameter, fresh weight and dry weight of culms; the number, length, volume, fresh weight and dry weight of rhizome sub-units and the fresh weight and dry weight of roots, exhibited higher values in the April-July trial, followed in decreasing order by October-March and August trials. Higher production of propagules, as also higher value of a number of growth attributeds, in April to July vis August-a-vis August March trial in *B. vulgaris* has been reported by Jousen (1991) and April-August vis-a-vis August-April trials in *B. tulca* by Jousen & Jhon (1994).

The findings of the present study confirm the observations of these previous
studies. The higher value of various growth parameters and the proliferation rates are perhaps due to the fast rate of growth of most of these parameters during the period from April to August, as has been shown by the findings of this study. April and August, therefore, may be considered the best period for propagation of bamboos through macroproliferation. The proliferation rates are comparatively lower in the other trials yet the propagules maintain the capability of proliferation during the other season also. By suitable silvicultural or physiological Manipulations, it should be possible to enhance the proliferation rates in these seasons also, so that cutting separation operations can be performed more frequently per year, and a greater number of propagules obtained.

5.1.3 Analysis of growth correlations in cuttings.

After the analysis of the present study (4.5) it was been observed that the number of culms was significantly related to the number of propagules produced in *Bambusa vulgaris* and *Bambusa bambos*. This would indicate that an increase in the number of culms in cuttings will also increase the number of propagules produced. In other words, any type of silvicultural treatment applied to bamboo cuttings that produced a higher number of culms, should produce more propagules also. There is no other report available in the literature on the relationship between the number of bamboo propagules produced through macroproliferation and the number of culms per cutting. However, the relationship of various parameters with the number of culms per cuttings, and the number of propagules is not similar in all the species on which the present study has been carried out.

The total length of culm is significantly and positively related to the number of culms in cuttings of *B. vulgaris* and *B. bambos*. The total culm length is positively related to the number of propagules only on *B. vulgaris* and it was found that the number of culm was positively related with the number of rhizome sub-units, and negatively with the culm height, basal diameter of culm, and number of leaves
produced per seedling and not in *B. vulgaris*. Singh et. al., (2001) have also reported a positive, but statistically significant, relationship of height (culm length) with the number of culms in seedlings and cuttings of *B. vulgaris*, Nagarajaiah (1994) has reported the average number of roots and the rhizome sub-units is positively related to the number of culms in *B. vulgaris* and *B. bambos*. All the other growth parameters studied did not show any significant positive or negative correlation with either the number of culms or the number of propagules produced in seedlings of these two bamboo species. Singh et. al., (2001) have also reported that there was no significant correlation between number of culms and several other growth parameters viz culm length, dry weight of plant, in the seedlings of *B. vulgaris*. Huang and Huang (1993) have reported that in seedlings of *Bambusa bambos* the number of shoots, culms was positively correlated with only the rhizome biomass and the number of roots. Deogun (1937) has reported that within a locality, the number of culms had a positive correlation with culm weight, in mature clumps of *B. vulgaris*.

It is evident from the foregoing references and studies that conditions/treatments which favours dry weight production in general, and promotes rhizome sub-unit number but inhibiting individual culm growth may lead to an increase the number of culm per seedling, and thereby to increased proliferation rates in the propagules. It is also observed that a relationship in bamboo plants exists between the number of culms and the number of propagules produced, as well as with other growth parameters, but the growth correlations vary with species to species and, even within the species under study, they vary age of the plant and the site.


The result of the experiment shows that cuttings planted in nursery beds produced significantly higher number of propagules as compared to those planted in polybags. The increase production of propagules is a reflection of the
overall superiority of growth of the bed-raised *B. vulgaris* seedlings and *B. bambos* cuttings over the ones planted in polybags. The higher root weight in the case of cuttings raised in polybags is perhaps due to loss of a lot of fine roots while digging out the cuttings from the nursery beds, while the entire root system of polybag-raised cuttings could be recovered for taking measurements. The root system of the cutting raised in beds could explore more soil volume, and faced lesser limitations of space for growth, and had a better availability of nutrients as compared to the polybag raised seedlings. Chacko and Jayaraman (1988) have also reported that planting seedlings of *Bambusa arundinacea* in larger bags resulted in significantly higher root biomass, shoot biomass and root length, as compared to those planted in smaller bags.

### 5.1.5 Effect of growth regulators.

Gibberellic acid (GA$_3$); Auxin (NAA) and (IBA) are known promoters of plant growth which promotes the rate of elongation of numerous plant species. In the present study, Coumarin significantly increased fresh weight of rhizome and culm, dry weight of leaf and root, and total dry weight of seedlings of *B. vulgaris* and *B. bambos*. It was followed by Gibberellic acid and Indole Butyric acid. NAA came out as a normal and general inhibitor.

The reports of Bahadur (1979), Banik (1988), castillo (1990), Chen (1999), Support the finding of present study, as they have reported that Coumarin increase height, number of leaves, roots weights etc of the species of bamboos. Similarly Bennet (1990) has reported that at 100 and 500 ppm concentrations resulted in increased growth and yield of bamboo.

In the present study none of the chemical treatments produced any statistically significant effect of on the proliferation rate of the seedlings as judged by their ineffectiveness on the number of culms or rhizome sub-units of the seedlings. Perhaps studies using other concentrations/ higher frequency of spray and increased number of replicates may yield statistically significant findings. In the
present study many different chemical solutions were been tried and finally those solutions with the combinations or else alone were found effective whose experiments were not yet proved or done. Surprisingly Coumarin along with Gibberellic acid emerged as one of the important growth hormone as compared to NAA and IBAs. The overall growth of bamboo species were affected by the treatment of these two growth hormones as compared to slow growth of the other two growth hormones, provided the volume of concentration should be increased to 500 and 1000 ppm.

5.1.6. Effect of weeding:- The findings on the effect of weeding on growth and proliferation behaviour of B. vulgaris and B. bambos cuttings shows that weeding resulted in a significant increase of the number of propagules, as compared to control. The weight of culms, number of rhizome sub-units and rhizome weight was also significantly higher in the weeded Polybag, as compared to the control. Weeding improved, over controls, the other growth attributes also viz. number of culms, length and basal diameter of culms, length of rhizome sub-units, and the root weight, although the difference were statistically not significant. Weeding is a normal practice in nurseries, undertaken to remove competition from aggressive weeds and to improve soil conditions., Shammughavel and Francis (1995) Suggested that weeding and thinning were helpful in the growth and survival of B. vulgaris and B. bambos seedlings, They reported that weeding and thinning operations enhance the emergence of new culms and their growth. Kondas (1981) observed that the growth of young seedlings was slow, and weeding was necessary to improve their survival and growth. Kondas (1981) reported that weeding increased the total number of culms per clump, culm height and culm diameter in cuttings of B. tilda, B. bambos and B. vulgaris. Therefore, it is quite evident that weeding improve the growth performance, proliferation rates and propagules production; hence it is very useful practice for the propagation of bamboo by macroproliferation.
5.1.7. Effect of number of culms in cuttings by growth regulators.

The results of this experiment shows the presence of the variable number of culms in cuttings did not have any statistically significant effect on proliferation rates of propagules. However the propagules derived from cuttings that had fewer culms exhibited superior growth over those derived from seedlings with higher number of culms as is reflected in higher values of fresh and dry weight of rhizome and total fresh and dry weights of the seedling in the former. It shows that the smaller number of culms in cuttings can provide growth benefit to propagules whereas larger number of culm in cuttings does not give any benefit in proliferation rates. No report is available in literature on the effect of number of culms in cuttings on the growth or proliferation behaviour of propagules. Growth regulators did not influence significantly the growth and proliferation of propagules in terms of number of culms and total biomass of plants. This is due to the sufficient availability of mineral nutrients in the potting mixture. On the other hand it was observed that if the mineral nutrients were absent then these growth regulators played a vital and prominent roll in the overall growth of the seedlings of bamboo.

5.1.8. Effect of trimming of propagules.

The results of this experiment show that trimming of propagules suppressed their growth significantly. There was a reduction in culm number, hence in the rate of proliferation due to trimming, but the differences were statistically significant.

Dharia et. al., (1990) has reported that trimming followed growth regulators application resulted in lateral shoot production only, whereas the findings of Gamage (1995) support the results of the present study, as he found the negative effect of repeated prunings on the rhizome weight in *B. vulgaris* and *B. bambos*. The retention of shoot at the time of cutting separation for vegetative multiplication of planting stock generally provided more vigorous propagules in the study, although intact shoot tops dried up with in 5-7 days of cutting.
separation. The translocation of the nutrients from intact shoot tops to growing rhizome and shoot system apparently resulted in growth superiority of these propagules.

5.1.9. Effect of Age of cuttings.

Result of experiment shows that proliferation rates were comparatively higher in propagules derived from younger (6-month old) cuttings than that of propagules derived from older (one-year old) cuttings, but the differences were not statistically significant. However, values of culm height and leaf number were significantly higher in propagules derived from one year old cutting than those of six month old cuttings, indicating superior growth of the former. Reports on similar studies on bamboo are lacking. The findings indicate that proliferation rates may decrease while overall growth increases as the age of mother stock, which is used, for further multiplication increases. Hence, the findings have bearing on maintenance of the rhizome bank and planting stock production in bamboo nurseries.

5.1.10 Effect of position of Rhizome sub-unit.

Result of this experiment clearly shows that the position of rhizome sub-units on cuttings has a strong effect on growth and proliferation behaviour of the propagules. The propagules obtained from rhizome sub-unit at position one (primary rhizome unit) exhibited highest rates of proliferation and multiplication, while the reserve was true in case of those obtained from the rhizome sub-unit at position three (the tertiary unit). As cuttings of *B. vulgaris* and *B. bambos* grow, they produce successively larger rhizome sub-units. Hence, the propagules with larger rhizome sub-units within a cutting produce larger propagule that proliferates at a slower rate. No such published work is available on a single species of bamboo, but in other rhizomatous crops like turmeric (Govind and Gupta, 1989; shashidhar and Silkeri, 1997) and ginger (Randhava et al. 1972 son gupta et al, 1986) an increase in the size of rhizome of the propagules led to
increased growth and yield of the crop. The findings are significant because these provide a basis for screening of the propagules in the bamboo nurseries. Propagules with larger rhizomes may be released for field planting because these will result in faster growth of the plantation. But the propagules with smaller (primary) rhizome units, which have higher proliferation rates, should be retained in rhizome bank and used for further multiplication work.

5.2. Studies on culm cuttings.

5.2.1 Effect of age of clump.

The results of experiment (4.1.3) show that culm cuttings of very young as well as very old clumps may not be suitable for propagation purposes. In this experiment, the best performance was observed in culms cuttings taken from ten year old clumps, which exhibited higher percentage of rooting, sprouting, rhizomegenesis, and number and length of shoots per cuttings which were taken from one or twenty years old clumps of B. vulgaris and B. bambos. This is perhaps the first report on the effect of clump age on propagation of bamboo by culm cuttings. However, the effect of age of donor tree on rooting cuttings is well known for a number of woody species including dicotyledons and gymnosperms [Ahmed (1986), Azzini, (1995)] where the rooting potential of cuttings declines with the change of phase from vegetative to reproductive, as the mother tree ages. But in bamboo different mechanisms govern the age related response of culm cuttings as phase. Change from vegetative to reproductive occurs only once and that too at the terminal stage of life cycle of most of bamboos.
Fig 37 - Percent sprouting in culm cuttings as influenced by clump age and chemical treatment in *B. vulgaris*.

![Bar chart showing sprouting percentage with age and treatment](image)

**Fig 37** – Effect of clump age and treatment on percent sprouting

Fig 38 - Percent rooting of culm cuttings as influenced by clump age and chemical treatment in *B. vulgaris*.

![Bar chart showing rooting percentage with age and treatment](image)

**Fig 38** – Effect of clump age and treatment on percent rooting
Fig 39 - Percent rhizomogenesis in culm cuttings as influenced by clump age and chemical treatment in B. vulgaris.

Fig 39 – Effect of clump age and treatment on percent rhizomogenesis

Fig 40 - Mean number of shoots per cutting as influenced by clump age and chemical treatment in B. vulgaris.

Fig 40 – Effect of clump age and treatment on mean number of shoots per cutting
Fig 41- Mean length of shoots per cutting as influenced by clump age and chemical treatment in B. vulgaris.

Fig 41 – Effect of clump age and treatment on mean length of shoots per cutting

Fig 42- Percent sprouting in culm cuttings as influenced by clump age and chemical treatment in B. bambos.

Fig 42 – Effect of clump age and treatment on percent sprouting
Fig 43- Percent rooting in culm cuttings an influenced by clump age and chemical treatment in *B. bambos*.

![Bar chart showing rooting percentage by clump age.]

**Fig 43** – Effect of clump age and treatment on percent rooting

Fig 44 Percent rhizomegenesis in culm cuttings as influenced by clump age and chemical treatment in *B. bambos*.

![Bar chart showing rhizomegenesis percentage by clump age.]

**Fig 44** – Effect of clump age and treatment on percent rhizomegenesis
Fig 45- Mean number of shoots per cutting as influenced by clump age and chemical treatment in *B. bambos*.

![Bar chart showing the effect of clump age and treatment on mean number of shoots per cutting.](chart1.png)

**Fig 45** – Effect of clump age and treatment on mean number of shoots per cutting

Fig 46- Mean length of shoots per cutting as influenced by clump age and chemical treatment in *B. bambos*.

![Bar chart showing the effect of clump age and treatment on mean length of shoots per cutting.](chart2.png)

**Fig 46** – Effect of clump age and treatment on mean length of shoots per cutting
5.2.2. Effect of Age of culm.

Results of experiment (4.1.2) show that age of culm has a strong effect on sprouting, rooting and rhizomegenesis in culm cuttings of B. vulgaris and B. bambos. In general, cuttings taken from 2-3 years old culms, showed more profuse rooting, sprouting and rhizomegenesis than do the cuttings taken from one year old culms. The reports of Chen (1990) and chew (1992) support the present investigation as they have reported that cuttings taken from two year old culms showed higher percent rooting survival values than those from one or three year old culm in a number of bamboo species. However Hertmann (1983) Dumas and Hamman (1998), obtained better rooting and survival using cuttings from one year old culms of a number of bamboo species. Therefore, the optimal age of culm for taking cuttings varies with species.

Fig 47- Sprouting percentage of culm cuttings as influenced by different position of cuttings in culms of different ages in B. vulgaris after 15 days of planting.

![Sprouting percentage graph](image)

**Fig 47-** Effect of age of culm and position of cutting in culm on sprouting after 15 days.
Fig- 48. Sprouting percentage of culm cuttings as influenced by different positions of cuttings in culms of different age in *B. vulgaris* after 30 days of planting.

![Sprouting Percentage](image)

**Fig- 48** Effect of age of culm and position of cutting in culm on sprouting after 30 days.

Fig- 49. Rooting percentage of culm cuttings as influenced by different position of cuttings in culms of different age in *B. vulgaris*.

![Rooting Percentage](image)

**Fig- 49** Effect of age and position of cuttings in culm on rooting.
Fig- 50 Rhizomegenesis percentage of culm cuttings as influenced by different position of cuttings in culm of different ages of *B. vulgaris*.

![Graph showing rhizomegenesis percentage for different positions of culms.](image)

**Fig- 50**- Effect of age and position of cuttings in culm on rhizomegenesis.

Fig-51- Sprouting percentage of culm cuttings as influenced by different position of cuttings in culms of different ages in *B. bambos* after 15 days of planting.

![Graph showing sprouting percentage for different positions of culms.](image)

**Fig- 51** effect of age of culm and position of cutting in culm on sprouting after 15 days.
Fig-52- Sprouting percentage of culm cutting as influenced by different positions of cuttings in culms of different ages in *B. bambos* after 30 days of planting.

![Sprouting percentage diagram](image)

**Fig-52-** Effect of age of culm and position of cutting in culm on sprouting after 30 days.

Fig-53- Rooting percentage of culm cuttings as influenced by different positions of cuttings in culms of different age of *B. bambos*.

![Rooting percentage diagram](image)

**Fig-53-** Effect of age and position of cuttings in culm on rooting.
Fig-54- Rhizomegenesis percentage of culm cuttings as influenced by different positions of cuttings in culms of different ages in *B. bambos*.

![Diagram showing rhizomegenesis percentage](image)

**Fig-54-** Effect of age and position of cuttings in culm on rhizomegenesis.

### 5.2.3. Effect of position of cutting on the culm.

The result of experiments (4.1.1 and 4.1.2) show that in general cuttings taken from basal position of culm showed better rooting, sprouting and rhizomegenesis in *B. vulgaris* and *B. bambos*. Better performance in terms of rooting and survival of cuttings taken from basal portion of culm has also been demonstrated by Khan (1972) in Bambusa tulda; Prabhu (1980) in Dendrocalamus hamiltonii in several species of Bambusa and by Othman (1992) in Bambusa wamin, However Pathak (1997) reported that best performance was obtained if cuttings were from the middle and basal position of one year old culm in *B. nutans*. But Kumar (1998) reported that in several species of bamboo the culm segments from middle zone of young culm were the best material for propagation. Therefore position effect varies with the species and age of the culm. It was also observed in the present investigation that the effect also varies with the chemical treatment. Thus, the culm cuttings taken from basal position of two year old culms gave the best results when treated with 1000mg/l coumarin solution, whereas cuttings from
basal portion of the three year old culm rooted equally well with IBA and NAA treatment as compared to Gibberellic acid treatment. The difference in rooting response caused by culm age and position of cutting on culm may be attributed, beside other factors that may also play some role, to various growth hormones in the culms that differs with culm age and position from base of the culm to top.

**Fig-55** - The effect of chemical treatments and position of cuttings in culm on sprouting percentage of *B. vulgaris* cuttings after 15 days of planting.

**Fig-55** - Sprouting percent of culm cuttings after 15 days.
Fig-56- The effect of chemical treatments and position of cuttings in culm on sprouting percentage of *B. vulgaris* cuttings after 30 days of planting.

Fig-56- Sprouting percentage of culm cuttings after 30 days.
Fig-57- The effect of positions of cutting in culm on number of shoots per cutting under different chemical treatments after one month of planting the cuttings of *B. vulgaris*.

![Bar chart showing number of shoots per cutting after one month.](chart)

Fig-57- Number of shoots per cutting after one month.
Fig-58- The effect of position of cutting in culm on number of shoots per cutting under different chemical treatments after six months of planting the cuttings of *B. vulgaris*.

![Bar chart showing number of shoots per cutting after six months.](image)

**Fig-58-** Number of shoots per cutting after six months.
Fig-59- The effect of positions of cutting in culm on length of shoots per cutting under different chemical treatments after one month of planting the cutting of *B. vulgaris*.

Fig-59- length of shoots per cutting after one month.
Fig-60- The effect of position of cutting in culm on length of shoots per cutting under different chemical treatments after six month of planting the cuttings of *B. vulgaris*.

Fig-60- Length of shoots per cutting after six months.
Fig-61- The effect of different chemical treatments and position of cuttings in culm on percent rooting in B. vulgaris.

Fig-61- Effect of chemical treatment and position of cuttings in culm on percent rooting.
Fig-62- The effect of different chemical treatments and position of cuttings in culm on percent rhizomegenesis in *B. vulgaris*.

Fig-62- Effect of chemical treatment and position of cuttings in culm on percent rhizomegenesis.
Fig-63- The effect of chemical treatment and position of cuttings in culm on sprouting percentage of *B. bambos* cuttings after 15 days of planting.

Fig-63- Sprouting percent of culm cuttings after 15 days.
Fig-64- The effect of chemical treatments and position of cuttings in culm on sprouting percentage of *B. bambos* cuttings after 30 days of planting.

![Graph showing sprouting percentage of culm cuttings after 30 days.]

*Fig-64- sprouting percent of culm cuttings after 30 days.*
Fig-65- The effect of positions of cutting in culm on number of shoots per cutting under different chemical treatments after one month of planting the cuttings of *B. bambos*.

![Bar chart showing the number of shoots per cutting after one month with different treatments.](image)

**Fig-65-** Number of shoots per cutting after one month.
Fig-66- The effect of positions of cutting in culm on number of shoots per cutting under different chemical treatments after six months of planting the cuttings of *B. bambos*.

**Fig-66- Number of shoots per cutting after six months**
Fig-67-The effect of position of cutting in culm on length of shoots per cutting under different chemical treatments after one month of planting the cuttings of *B. bambos*.

Fig-67- Length of shoots per cutting after one month.
Fig-68- The effect of positions of cutting in culm on length of shoots per cutting under different chemical treatments after six months of planting the cuttings of *B. bambos*.

![Bar chart showing length of shoots per cutting after six months under different treatments.]

Fig-68- Length of shoots per cutting after six months.
Fig-69- The effect of different chemical treatments and position of cuttings in culm on percent rooting in *Bambusa bambos*.

Fig-69- Effect of chemical treatment and position of cuttings in culm on percent rooting.
Fig-70- The effect of different chemical treatments and position of cuttings in culm on percent rhizomegenesis in *B. bambos*.

![Graph showing the effect of chemical treatments on rhizomegenesis.]

Fig-70- Effect of chemical treatment and position of cuttings in culm on percent Rhizomegenesis.

5.2.4 Effect of type of cuttings:

Results of this experiment show that the performance in terms of percent rooting, percent sprouting, percent rhizomegenesis, and mean number of shoots produced per cutting was superior in 2-nodal cuttings than in 1-nodal cuttings, although average shoot length was higher in the latter. The report of Rajapaske,
M.C. (1991) and Rodriguez et. al., (1998) who observed more success in propagation with binodal cuttings than with single-nodal cuttings of bamboo, support these findings other workers also support this finding indirectly. Banik (1988) and Sutiyono (1991) has reported that 3-nodal culm segments of Bambusa tulda, B. blumeana, Gigantochloa asper and G. levis performed better than their 2-nodal segments and Agnihotri and Ansari (2000) recommend the use of 2-nodal or 3-nodal culm cuttings of B. vulgaris and D. strictus propagation. Hence, in general longer culm segments performed better than shorter ones for vegetative propagation of bamboo. The differences may be attributed to increased nutrient pools, and the presence of higher number of buds due to higher number of nodes per segment in larger culm cuttings.