6.1 INTRODUCTION

Bamboo grows well in warm climate, abundant moisture and productive soil (Wang and Shen 1987). Rainfall is one of the important factors for the survival and distribution of plants including bamboos (Mauseth 2006). In most cases bamboo prefers high rainfall, however some species may adapt to dry deciduous forests with poor precipitation ranging from 760 mm to 1000 mm (Banik 1989, Bedell 1997). It grows luxuriantly on deep loamy soils, sandy loam and fertile clayey loam soils as well as some species are distributed to depleted soils in the hill tops and plateaus (Tewari 1992, Bedell 1997, Banik 2000). Distribution of global vegetation is determined by the variables of the conducive microclimate by providing significant influence on their distribution, structure and roles in functioning of ecosystems (Kirschbaum et al. 1996). It is a known fact that environmental factors influence the growth of plants, and their development including flowering and fruit production. Influence of microclimate on triggering mass flowering in bamboos remained a mystery (Ramanayake 2006). Therefore environmental conditions are crucial in defining the function and distribution of plants and animals, in combination with other factors (Sahney et al. 2010). Temperature even acts as one of the important environmental factors in transforming the activity and determining the abundance and the composition of the soil microbial community (Pettersson and Baath 2003). Seasonal course of solar radiation, temperature and precipitation mainly determines the predominant type of terrestrial vegetation and the biogeochemical properties of the land surface (Brovkin 2002). There are reports on the role of environment variables in determining the timing of phenological events such as flowering in plants and altering the periods in life cycle events (Parmesan and Yohe 2003). Change in micro-climatic variables such as temperature and precipitation also affect the level of tolerance in plants resulting to species migration (Lynch and
Lande 1993, Walther et al. 2002, Parmesan and Yohe 2003). On the other hand, variation in the distribution, phenology and abundance of species may lead to inevitable changes in the relative abundance of species and their interactions, and affect the structure and function of ecosystems (Walther et al. 2002). Landscapes consisting of spatial variation of vegetation cover, topography and surface hydrology have a strong influence on regional climate (Pielke and Avissar 1990, Pielke et al. 1991). Therefore climate functions as the dominant control of the spatial distribution of the major vegetation types on a global scale, however the contribution of secondary factors such as soil parameters and topography are also important in plant distribution (Whittaker 1975, Woodward 1987). Synchronized flowering in bamboos involve a large fraction of the population, although some non-flowered patches remain (Marchesini et al. 2009). Therefore such flowering in plant populations could be brought by the alteration in the photoperiod, temperature, light quality, vernalization, nutrient deprivation, release from stress, etc. (Ramanayake 2006), and such environmental variables could trigger flowering in plants (Garner and Allard 1920, Thomas and Vince-Prue 1997). Death in large populations in bamboo after gregarious flowering is a cause of concern due to ecological, social and economic crises that set forth (John and Nadgauda 2002).

6.2 MATERIALS AND METHODS

Climatic variables such as rainfall and temperature data of the study sites were collected from Directorate of Agriculture of respective states where study sites are identified. Mean value of the soil parameters such as soil pH, moisture content, total N, P and K content along with the climatic variables were statistically analysed for generating Pearson correlation matrix. Mean values of the variables such as pH, moisture content, organic carbon and total N, P and K pools of surface and sub-surface layers of all the soils samples collected from the habitats of D. hamiltonii in Arunachal Pradesh and M. baccifera in Mizoram were analysed for determining correlation coefficient among the variables. Correlation analysis was also carried out between the soils total N, P, K and plant N, P and K content. Pearson
correlation matrices for all the variables were generated using Statistica software package.

6.3 RESULTS

6.3.1 CORRELATION BETWEEN SELECTIVE CLIMATIC VARIABLES AND SOIL PHYSICAL AND CHEMICAL PARAMETERS OF RESPECTIVE STUDY SITES

Data on correlation between climatic variables i.e. rainfall and air temperature with soil physical (soil moisture and pH) and chemical (N, P and K) parameters during pre-flowering, flowering and post-flowering phases of D. hamiltonii and M. baccifera forests were presented in Table 6.1 and 6.2.

Pearson’s correlation matrix between the selected climatic variables such as rainfall and soil temperature and soil physical and chemical parameters such as soil moisture, pH, organic carbon, nitrogen, phosphorus and potassium during the three phases of D. hamiltonii and M. baccifera forests are presented in Table 6.1 and 6.2, respectively. There was a negative correlation between the rainfall and soil pH of all the three phases, but significant correlation values were recorded only during pre-flowering phase in D. hamiltonii forests (R= -0.71, P<0.01), whereas in case of M. baccifera forests, it was significant during flowering phase (R= -0.71, P<0.05). A similar trend of negative correlation was recorded between air temperature and soil pH in both bamboo species, but significant negative correlation was recorded only during post-flowering phase of D. hamiltonii (R= -0.78, P<0.01).

Result show significant positive correlations to rainfall and soil moisture content of D. hamiltonii forests during pre-flowering and flowering phases (R= 0.86, 0.71, P<0.01), whereas there was positive relation but no significant correlation between the rainfall and soil moisture content during post-flowering phase of D. hamiltonii. In case of M. baccifera forests, there was a positive correlation to the two parameters but without any acceptable significant levels (Table 6.1 and Table 6.2).

In case of D. hamiltonii forests, other soil parameters such as soil organic carbon (SOC), soil nitrogen and soil potassium show negative correlation and soil phosphorus show positive correlation to rainfall during all
the three phases, but their correlation coefficients were insignificant. In this bamboo forest, air temperatures also show insignificant negative correlation to SOC, and nitrogen during all the three phases, but negative correlation to potassium during pre-flowering and flowering phases.

In case of *M. baccifera* forests, correlation coefficients of rainfall show insignificant negative correlation to SOC during all the three phases, but insignificant positive correlations were recorded for nitrogen, phosphorus and potassium during all the three phases except N content during pre-flowering phase. There was no significant correlations between air temperature and rest soil parameters such as SOC, nitrogen, phosphorus and potassium during all the three phases, except K content during pre-flowering phase, where a significant positive relation was recorded (R= 0.87, P<0.001) (Table 6.2).

**6.3.2 CORRELATION AMONG SELECTIVE SOIL PHYSICO-CHEMICAL PARAMETERS OF THE THREE PHASES IN *D. hamiltonii* AND *M. baccifera* FORESTS**

Table 6.3 presents the Pearsons’ correlation matrix among the soil variables during pre-flowering flowering and post-flowering phases in *D. hamiltonii* forests of Arunachal Pradesh. Analyses of the Pearson’s correlation matrix among the selected variables revealed that, there was a significant positive correlation to the soil pH of pre-flowering phase and the flowering and post-flowering phases (R= 0.67 and 0.56, respectively P<0.01). Soil pH of pre-flowering phase also show significant positive correlation to soil organic carbon, nitrogen, and potassium during pre-flowering phase (R= 0.47, 0.48 and 0.52, respectively P<0.01), whereas there was insignificant negative correlation to phosphorus during this phase. Soil pH during pre-flowering phase had positive correlation to potassium during post-flowering phase of this bamboo species (R= 0.47, P<0.05). Moreover, there was no significant relation between pH of pre-flowering phase and soil phosphorus during all the three phases. Soil pH during flowering and post-flowering phases also show significant negative correlations to soil moisture content during all the three phases (Table 6.3). A similar trend of significant relation was recorded between soil pH of flowering and post-flowering phases and
other soil parameters during all the three phases. Soil moisture content during pre-flowering phase had significant negative correlation to nitrogen and potassium of pre-flowering phase (R = -0.41 and -0.49 respectively, P<0.05); whereas soil moisture content during flowering phase had significant negative correlation to phosphorus and potassium content during the same phase (R = -0.45 and -0.52, respectively, P<0.05). Soil organic carbon during post flowering phase showed significant negative correlation to phosphorus content during pre-flowering phase (R = -0.41, P<0.05), whereas there was a significant positive correlation to potassium during pre-flowering phase (R = 0.44, P<0.05). Soil nitrogen content during pre-flowering phase showed significant positive correlation to N content during flowering phase (R = 0.59, P<0.01), whereas, N during flowering phase showed significant positive correlation to phosphorus content during flowering phase (R = 0.48, P<0.05), and N content during post-flowering phase showed significant positive correlation to potassium during flowering phase (R = 0.42, P<0.05). Phosphorus content during pre-flowering phase had significant negative correlations to P during flowering phase and K during pre-flowering phase (R = -0.48 and -0.58, respectively, P< 0.05), whereas P during flowering phase showed significant positive correlation to K during flowering phase (R = 0.42, P< 0.05). There was a significant positive correlation between soil K content during pre-flowering phase with K content during flowering phase (R = 0.50, P< 0.05).

In case of *M. baccifera* forests, soil pH of pre-flowering phase showed significant negative correlation to soil moisture of post-flowering phase (R = -0.42, P< 0.05) and positive correlation to K during flowering phase (R = 0.53, P<0.01) (Table no. 6.4). Soil pH of flowering phase showed significant negative correlations to soil moisture of pre-flowering and flowering phase (R = -0.41, P<0.05). Soil pH during flowering phase had significant negative correlation to P during post-flowering phase and K during flowering phase (R = -0.49 and -0.69, respectively, P< 0.05). Soil pH during post-flowering phase showed significant positive correlation to soil organic carbon during the same phase (R = 0.43, P< 0.05). Soil moisture content during pre-flowering phase showed significant positive correlation to moisture content during flowering phase (R=
0.45, P< 0.05) and negatively correlated to P during pre-flowering phase (R= -0.57, P< 0.05). Soil moisture content during flowering phase had significant positive correlation to soil moisture during post-flowering phase and negatively correlated to organic carbon during pre-flowering phase (R= 0.44 and -0.77, respectively P< 0.05). Soil moisture content during post-flowering phase had significant negative correlation to organic carbon during post-flowering phase, whereas, it was positively correlated to N during pre-flowering and flowering phases (R= -0.45, 0.46 and 0.48, respectively P< 0.05). It was also positively correlated to K during pre-flowering phase (R= 0.58, P<0.01). Soil organic carbon during post-flowering phase show significant correlation to P during pre-flowering phase (R= 0.49, P< 0.01). Soil N during pre-flowering phase show significant positive correlation to N during post-flowering phase and K content during pre-flowering phase (R= 0.71, 0.56, P< 0.01). Soil N during flowering and post-flowering phases show significant positive correlations to K during pre-flowering phase (R= 0.53 and 0.55, P< 0.01). Soil K content during pre-flowering phase show significant positive correlation to K content during post-flowering phase (R= 0.64, P< 0.01).

6.3.3 CORRELATIONS AMONG THE CULM N, P AND K CONTENT DURING THE THREE PHASES OF D. hamiltonii AND M. baccifera FORESTS

Data on correlation analyses among the culm N, P and K content during the three phases of D. hamiltonii and M. baccifera were presented in Table 6.5 and 6.6. In D. hamiltonii forest, culm nitrogen content during flowering phase had significant positive correlation to culm N during post-flowering phase, P content during flowering phase (R= 0.62 and 0.79, respectively P< 0.001). It was also positively correlated to potassium during flowering and post-flowering phases (R= 0.43 and 0.53, P< 0.01), whereas culm N content during post-flowering phase had significant positive correlation to P content during post-flowering phase and negatively correlated to K content during pre-flowering phase (R= 0.58 and -0.47, respectively P< 0.05) (Table 6.5). Culm P content in D. hamiltonii during pre-flowering phase show significant negative correlation to K content during the same phase(R= -0.42, P< 0.05),
whereas during flowering, it was significantly correlated to P during post-flowering phase (R= 0.65, P< 0.001) and K content of flowering and post-flowering phases (R= 0.48, P< 0.05 and 0.47, P< 0.001). Culm P content during post-flowering phase show positive significant correlation to K content during flowering and post-flowering phases (R= 0.47, P< 0.05 and R= 0.78, P< 0.001). Culm potassium content during flowering phase show significant positive correlation to K content during post-flowering phase (R= 0.80, P<0.001).

In case of *M. baccifera*, culm N content during pre-flowering phase show significant positive correlation to culm P content during the same phase (R= 0.46, P< 0.05). N content during flowering phase show significant positive correlation to N content during post-flowering phase, P content during flowering and post-flowering phases, K content during flowering and post-flowering phases, whereas negatively correlated to K content during pre-flowering phase (Figure 6.6). N content during post-flowering phase show significant positive correlations to P content (R= 0.87 and 0.70, respectively P< 0.001) and K content (R= 0.80 and 0.71, respectively P< 0.001) during flowering and post-flowering phases. And whereas during flowering phase, culm P content show significant positive correlations to P content during post-flowering phase and K content during flowering and post-flowering phases (R= 0.52, 0.70 and 0.85, respectively P< 0.01), whereas it was negatively correlated to culm K content during pre-flowering phase (R= -0.49, P< 0.05). P content during post-flowering phase also show significant positive correlation during K content during flowering phase. Culm K content during pre-flowering phase show significant negative correlation to K content during post-flowering phase, whereas K content during flowering phase show significant positive correlation to K content during post-flowering phase (Table 6.6).
6.3.4 CORRELATION ANALYSES BETWEEN SOIL N, P, K CONTENT OF *D. hamiltonii* AND *M. baccifera* FORESTS AND THEIR CULM N, P, K CONTENT DURING PRE-FLOWER, FLOWER AND POST-FLOWER PHASES

Correlation analysis between the soil N, P, K pool and plant N, P, K content in the culms during three different phases of *D. hamiltonii* and *M. baccifera* forest are presented in Table 6.7 and 6.8. This analysis revealed that, in *D. hamiltonii* forest, soil Nitrogen content during flowering phase had significant positive correlation with culm N, P and K content during post-flowering phase (R = 0.44, 0.41 and 0.55, respectively P< 0.05). It also had significant positive correlation with culm K content during post-flowering phase (Table 6.7). Phosphorus content of the soil during pre-flowering phase show significant negative correlation with P content of the culm during pre-flowering phase and culm K content during post-flowering phase (R= -0.54 and -0.45, respectively P< 0.01). During flowering phase, soil P content show significant positive correlation with culm P content during pre-flowering phase and culm K content during post-flowering phase (R= 0.42 and 0.41, P< 0.05), whereas it was negatively correlated with culm K content during pre-flowering phase (R= -0.45, P< 0.05). Soil P content during post-flowering phase show significant positive correlation with culm K content during pre-flowering phase (R= 0.42, P< 0.05). Soil K content during pre-flowering phase was positively correlated with culm N content during pre-flowering phase, culm P content during flowering phase and culm K content during post-flowering phase (R= 0.42, 0.57 and 0.47, respectively P< 0.01).

In case of *M. baccifera* forests, soil nitrogen content during pre-flowering phase show significant negative correlation to culm N content during flowering and post-flowering phase (R= -0.51 and -0.44, respectively, P< 0.05) (Table 6.8). It was also negatively correlated to culm P and K content during flowering and post-flowering phases, but positively correlated to culm K content during pre-flowering phase (R= -0.45, -0.59, -0.47 and 0.58, respectively P< 0.05). Soil N content during flowering phase show significant negative correlation to culm N and K content during flowering and post flowering phases and to culm P content during flowering phase, but positively
correlated to culm K content during pre-flowering phase (Table 6.8). Soil N content during post-flowering phase show significant negative influence on culm N content during flowering and post-flowering phases (R= -0.72 and -0.60, respectively P< 0.001). It had also significant negative influence on culm P and K content during both flowering and post-flowering phases. Soil P content during pre-flowering phase had significant negative correlation to culm N and K content during flowering and post-flowering phases, and it also had significant negative influence to culm P content during flowering and post-flowering phases. Soil P content during flowering phase show significant negative influence to culm N content during flowering and post-flowering phases, and also negatively correlated to culm K content during post-flowering phase, whereas soil P content during post-flowering phase show significant negative influence only to culm P content during flowering phase. Soil K content during pre-flowering and flowering phase show significant negative influence to culm P content during flowering phase, whereas soil k content during post-flowering phase show significant positive influence to culm P content during pre-flowering phase and negative influence to culm K content during post-flowering phase (Table 6.8).

6.4 DISCUSSION

This study has revealed the relations between selective climatic parameters and soil variables, relations among the soil variables, among the selective plant nutrients and between selective soil and plant nutrients etc. In both bamboo species i.e., Melocanna baccifera and Dendrocalamus hamiltonii, there was a negative influence of rainfall on soil pH during all the three phases (pre-flowering, flowering and post-flowering phases), where soil acidity was increased with the increase in rainfall which may be explained due to the accelerated microbial activities in the soil. This finding is supported by the works of many authors, where it was stated that bamboos prefer to grow in low pH with high annual precipitation (Gaur 1985, Banik 1989, Singha et al. 2007, Alam 2008). It was also evident from the analyses of the soil data, that there was a decreasing trend in soil pH from flowering to post-flowering phase, and such change in soil acidity level is supported by the findings of Rai (2009) (Chapter IV). Rapid decrease in soil pH from pre-
flowering to flowering and post-flowering phases in both bamboo species may be explained due to rapid increase in litter fall and its accumulation on the forest floor associated with increased activities of macro and microorganisms in the forest soils. Similar findings were reported by Rai (2009), while doing comparative analyses of the soil physico-chemical parameters and microbial populations between flowering and post-flowering bamboo habitats in Mizoram. Similar findings on negative influence of soil moisture on pH have been reported by many workers (Rowell 1988, Von Uexkull and Mutert 1995, Rai 2009). Several workers also have reported such increase in acidity in the forest soils during wet seasons due to the increased rate of nitrate uptake (Poss et al. 1995, Noble et al. 1997, Tang et al. 2000, Weligama et al. 2008). Air temperature was also observed to have negative influence on soil pH, which may be explained due to increased microbial activities at high temperatures in presence of optimum soil moisture. Rise in soil moisture content with the increase in precipitation is a universally accepted statement. A similar trend of positive correlation between rainfall and soil moisture content was recorded during this study, where soil moisture content also increased with the increase in organic matter content in the soils of forests of both bamboo species during all the three phases (Chapter IV). Rainfall and air temperature show insignificant but negative influence to soil organic carbon in the forests of both bamboo species, which may be due to regular decomposition of organic matters during the wet and hot seasons associated with inputs of variable quantity of litter to the forest floor. Both climatic variables also show insignificant but negative influence to soil nitrogen and potassium during all the three phases in D. hamiltonii forest, which may be explained due to the variability in uptake of such nutrients from the soil by the active root systems during pre-flowering and flowering phase, whereas, in case of post-flowering phase such negative influence may be due to leaching loss and surface runoff (Chapter IV). Soil P content show insignificant but positive influence by rainfall and air temperature during pre-flowering and flowering phase which may be explained due to successful mineralization at optimum level with lesser
uptake by the root systems as Phosphorus is taken up in lesser quantity than Nitrogen an Potassium (Chapter IV).

Correlation analyses among the soil variables revealed that soil pH during all the three phases show significant negative influence to soil moisture, but positive influence to organic carbon, nitrogen, phosphorous, and potassium, which may be explained due to the higher rate of mineralization at low pH. Soil moisture had negative influence on soil N, P and K during all the three phases in both bamboo species, which may be explained due to greater assimilation of these nutrients during high moisture content in the soil, but with additional leaching effects in case of post-flowering phase in both bamboo species (Chapter IV). Tang et.al. (2000) reported that, upper soil layer acidification were mostly contributed by nitrification of excess ammonia-nitrogen inputs combined with nitrate leaching with base cations. Rhizosphere pH in subsoil layers is also increased through the uptake of nitrate by plants (Poss et.al. 1995, Noble et.al. 1997, Tang et.al. 2000, Weligama et.al. 2008, 2010). Removal of plant litters either by grazing or harvest also accumulates hydrogen ion resulting soils acidic in nature (Gazey 2009). However, Kemmitt et.al. (2005) addressed the restriction of increased in soil acidity by nitrification in which NH$_4^+$ becomes the major N source for plants in acidic soils. Significant negative influence of soil organic carbon on P content may be explained due to immobilization of this nutrient at high C/N ratio in those bamboo forests, whereas, positive influence of such carbon on K content may be due to the release of optimum K and lesser uptake by these bamboos during pre-flowering and flowering phases. Positive correlation of N content to N, P, and K content during the three phases in both bamboo species may be explained due to the rich N content in the litters mainly leaf litter which release organic N to inorganic N at fast pace by the soil organisms, while disintegrating and utilizing the carbon content (Chapter IV). There was a negative correlation of P content between the pre-flowering phase and flowering phase In D. hamiltonii whereas no such relation could be established in case of M. baccifera forests. Potassium during flowering phase had positive influence on phosphorus during post-flowering phase, and K during pre-flowering phase show positive influence by K during pre-
flowering phase in both bamboo species, which may be explained due to the important role played by K in nutrient transport systems. Many information on the important role of K in bamboo forests are being reported (Chapter IV).

Correlation analyses among the plant nutrients (N,P,K) revealed that there was a positive influence of plant N content during flowering phase to N content during post-flowering phase in both bamboo species, which may be explained due to the uptake and accumulation of large quantity of N in the culms of flowering bamboos but unable to utilize completely at the end of flowering phase. The positive influence of culm P content during flowering phase on K content during flowering and post flowering phase may be explained due to the mobilization of K for the developing flowers and fruits by the P as biological energy and their large-scale accumulation in the culms during both phases. There are several such reports on the importance of P on regulation in plants (Griffith 1973, Anonymous 1999). The importance and role of soil available phosphorus as limiting factor in bamboo biomass accumulation was reported by Totey and co-workers (1989) while studying with *Dendrocalamus strictus*. The trend of movement of phosphorus in soil varies according to the soil type. The problem of phosphorus nutrition is frequently linked with the mobilization of P pools in the soil due to highly acidic or alkaline conditions, where pH 5.5 to 6 may be the optimum condition for its accessibility to plants (Duchaufour 1998).

This study also revealed the relation between soil N, P, K content and plant N, P, K content during the pre-flowering, flowering and post-flowering phases in both bamboo species. There was no significant influence by the soil N, P, K to the culm N, P, K content during the respective phases in both bamboo species, whereas influence of one soil nutrient to the culm nutrient content was significant, such as soil N and K content during pre-flowering phase show significant positive influence on N, P and K content during post-flowering phase in both bamboo species, whereas soil P content show negative influence on the N and K content in the culm of both bamboo species.
Like other plants, various physiological changes were reported in bamboos during their flowering and seeding phases with a remarkable reduction in starch and nitrogen content (Ueda 1960, Kao 1972, Janzen 1976). Nitrogen is an important component of proteins that build cell material and plant tissue. In addition, it is necessary for the functioning of biochemical pathways including chlorophyll complex, enzymes and nucleic acids (Charles et al. 1999). According to Shanmughavel et al. (1997) nitrogen is required in large quantity followed by potassium and phosphorus. Takahashi and co-workers (2007) reported that soil nutrients such as total nitrogen, available nitrogen, etc. were low in the localities where bamboo flowering took place. They also reported that the post flowering localities with dead bamboos was relatively infertile compared to the localities with non-flowering alive individuals. It is also supported by the findings of Rai (2009). As per Luna (1996) bamboos require large quantity of nitrogen followed by potassium and phosphorus. Potassium plays a major role in nutrient and water uptake and their retention in plants, where adequate potassium content in plants also increase enzyme activity and resistance to fungal attack (Patterson 2011). There are also reports on improvement of annual nutrient accumulation in soil with age in D. hamiltonii, Neohouzeaua dulloa and Bambusa khasiana (Rao and Ramakrishnan 1989). Erosion of surface soil after gregarious flowering in bamboo plays a key role on the reduction and large-scale loss of soil organic carbon and other nutrients (Carson 2011, Pluske et al. 2011). The importance and role of soil available phosphorus and organic carbon as limiting factor in bamboo biomass accumulation was reported by Totey and co-workers (1989) while studying with Dendrocalamus strictus. The trend of movement of phosphorus in soil varies according to the soil type.

There are also reports on the release of immobilized K in clay particles under the influence of alternate wet and dry process (Duchaufour 1998). K travels as counter-ion together with NO$_3^-$ in the xylem from root to the shoot (Marschner et al. 1996). Potassium is also highly mobile in the phloem and can be moved to newer leaves or reproductive organs if the nutrient is in short supply (Quinlan and Wherrett 2011).
There are several schools with the thoughts and reports on the significant influence of climatic variables and soil parameters on the induction of flower in many bamboo species. On the other hand, many workers have declared the complete absence of any such role played by microclimatic variables on the induction flower in bamboos. The present study has revealed that there is significant positive or negative influence of climatic variables on soil physico-chemical parameters during pre-flowering, flowering and post-flowering phases in the forests of *Dendrocalamus hamiltonii* and *Melocanna baccifera*, in Arunachal Pradesh and Mizoram, respectively. But, as the study was carried out within the same climatic regime for all the three phases, *i.e.*, pre-flowering (vegetative) phase, flowering (reproductive) phase and post-flowering (death) phase, for both bamboo species at their respective states, decision on their influence for switching from vegetative phase to reproductive phase remains indecisive. It is also evident that most of the soil physical and chemical parameters have significant positive and negative role on the quality and or content of the other in both bamboo forests. Culm nutrients also show positive as well as negative influence among each other while proceed from pre-flowering to post-flowering phase. Soil nitrogen played key role in regulating plant P and K in both bamboo species during all the three phases, whereas, soil K regulated plant P and N content significantly.

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