Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2016; 4(5): 249-254

Received: 06-07-2016
Accepted: 07-08-2016

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Comparative effects of dominant forest tree species on soil characteristics and nesting behaviour of wasp (Hymenoptera: Vespidae) of Buner, Pakistan

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Abstract
The aim of the present study was to find out the comparative effects of dominant forest tree species and their role in improving, enhancing the soil profile with perceiving the Vespid fauna in the visited area (District Buner). For this purpose, seven samples were collected through composite method and then mixed with resulting one sample. Two way factor ANOVA were used to analyse the soil pH, K, EC, P, SOC. The results showed that forest tree species cover the different effects on soil characteristics. The pH value were noted highest (7.174) at depth of 0-15 cm whereas lowest (6.618) at depth of 16-30 cm in mixed forest, the Bulk Density were recorded 1.8768 g/cm^3 at 31-45 cm whereas lowest 1.085 g/cm^3 at 0-15 cm depth. The soil organic matter were found highest (1.008%) in Chir pine forest at depth of 0-15 cm whereas lowest (0.66%) at 31-45 cm in the same forest. Soil phosphorus were found to be maximum (8.76%), at middle 16-30 cm and lowest (6.52%) at the top soil 0-15 cm, Potassium were maximum (148 mg/kg) at top soil 0-15 and noticed (128 mg/kg) at 16-30 cm. SOM and N showed nearly close significant relation, while BD and EC have non-significant. Tree species can also be effected by different ecosystem components i.e pollution, topography, altitude and atmosphere. It was also observed that insects of the order hymenoptera: family vespidae prepare their nest in these trees with the reference to soil composition. More study will be required for the effect of tree species selection for long term conservation purposes, understand the mechanism and importance of such interaction that will be ultimately beneficial productivity for healthy and sound environment.

Keywords: Potassium, forest, Soil characteristics, vespidae

1. Introduction

Chemical composition of plants and soil community are known to influence the ecosystem services, having different effects on ecosystem components i.e soil, which is one of the dominant factor in the forest ecosystem. Trees effect the forest ecosystem by manipulating its constituents prominent to changing future forest vegetation [1] and influence them both physically and chemically [2]. Soil stability also spawns a strong reaction on existing vegetation and affects the understory vegetation and tree species development [3]. At diverse spatial time scales, forest cover helps in shielding the soil from severe climatic conditions, basically soil disintegration. The vicinity of thick vegetation bears the soil satisfactory cover, in this manner decreasing the misfortune in full scale and smaller scale nutrients that are vital for vegetation development and vitality changes [4]. Variation in the chemical composition of soil properties. The estimation of soil available nutrient contents in a complex heterogeneous system, is of a great pedological as well as ecological importance [5]. Undoubtedly, the effect of a forest canopy species on soil richness could vary generously on distinctive bedrocks. Forest grows on acidic soils which developing from crystalline rocks, poor in Ca and Mg [e.g. Sandstone, sand or rock rich in Si) could decrease because of nutrient insufficiencies. In such soils, planting a forest tree species which have a negative nutrient supplement balance. Unexpectedly, planting an acidifying tree species in shallow soils that have grown on compacted limestones, this improves soil fertility. Such phenomenon has been seen with the cultivation of *Pinus nigra*. As the relationship between soil fruitfulness and tree species is not clear, our point is to give exhortation instead of general standards for forest management [6]. The tree species impact on soil characteristics (properties) has stayed hard to measure in different forests [7]. Trees expand soil porosity, penetrability, natural carbon, nitrogen and additionally lessen erosion.

An additional to its faunal members (soil microbes) of the soil are the ultimate actors that not only accelerating the decomposition and mineralization of litter and SOC but also magnifying the effects of litter, chemical composition and enhancing the low and high quality of litter [8]. Nest construction behaviour were also studied of three species of the vespid fauna with special reference to parental care in these types of tress [9] whereas few species were found collecting nectors from the leaves of the trees [18]. The dominant forest tree species impacts on soil physical and chemical properties also identified. The objectives of the study was to measure effects of forest tree species on soil characteristics, to derive the connection between tree species influences and soil physical and chemical properties and Nesting behavior of wasp species.

2. Materials and Methodology

2.1. Study area

District Buner having total area 1865 Sq.km. 34-9^0 and 34-43^0 N Latitude and 72-10^0 and 72-47^0 E Longitude in Khyber Pakhtunkhwa province of Pakistan with total population of 0.506 million. The study was conducted in tehsil Gagra, District Buner, during 2014-15. At the North, Buner District is bounded by Swat District, West by Malakand Agency, south by Mardan District, East by River Indus and Hazara Division whereas to the North-East through District Swabi [10]. The nature of the soil range were clay whereas, the mountains are barren (infertile) and deforested. Normally the soil uncovered and unprotected to water erosion with quickly disintegrated by storms. Terracing is practiced at regular and soil is significant and rich in which improvement of wheat and maize are less. Main tree species of the region include Chir (*Pinus roxburghii*), Kail (*Pinus wallichiana*), Bakain (*Melia azedarach*), Mulberry (*Morus alba*) and Kahu (*Olea ferruginea*), These forests are heavily depleted due to illegal logging, firewood collection, uncontrolled grazing, encroachments and mismanagement. The other tree species of the found in the area are Phulai (*Acacia modesta*), Sanatha (*Dodonaea viscosa*), Thagha (*Celtis australis*), Shandii (*Ailanthus altissima*), Chinar (*Platanus orientalis*), Poplar (*Populus euromericana*), Sufaida (*Eucalyptus camaldulensis*), Gurgura (*Monotheca buxifolia*) and Robinia (*Robinia psuedocaccia*) etc. This study is useful to make enhance soil attributes, physical and compound properties furthermore to recommend suitable species for study zone.

2.2. Sampling Design

The study area dominated with Blue Pine (*Pinus wallichiana*), Chir Pine *(Pinus roxburghi*) and mixed forests. Samples were collected from five different sites including Chagharzai, Budal, Badam and Ambela. Then the collected samples were mixed to single sample representing the site. Furthermore every sites were divided into three sub site: Blue pine forests, Chir pine forests and mixed forest cover.

2.3 Soil Sampling

Samples from the study area were gathered through composite sampling technique. The samples were taken from distinctive areas from the same plot and mixed with one another. Composite specimens were made so as to get the representation of aggregate soil of the plot. The soil samples tested from a depth of 0-15cm, 16-30cm and from 31-45cm were taken. These examples were sent to the soil testing laboratory, these specimens were dried then grounded in mortar and processor, sifted through two crucial stainless steel sieve and spare in plastic container. These specimens were tested and investigated in Soil Fertility and Water Quality Lab, Rawalpindi.

2.4 Soil Characteristics

The physical characteristics of different forest trees, soil for i.e. Bulk density, chemical properties, pH, accessible Potassium (K) and Phosphorus were studied and examined under forest tree cover in the study area using the procedures used by Cremers *et al.,* [11].

2.5 Sampling of Wasp Nest

During the present study wasp bilding nesting behevaour and nest were collected and shifted into National Insect Museum, National Agriculture Research Centre Islamabad for further study.

2.6 Statistical Analysis

Gathered information was tested to evaluate the statistical significance of the effects of diverse species on the soil, applying two ways ANOVA with replication with showing the results that the impact of distinctive forest cover elements has numerous perceptions for every parameter. All tests were connected in exceed expectations form 2013 at 95% significance level. Lapse bars were utilized to analyze outwardly two amounts that either two blunders has covered or not. Difference between means was statistically non-significant when error bar did not overlap while significant it overlapped.

3. Results and Discussion

3.1 Comparative effects of dominant forest tree species on soil characteristics

3.1.1 Soil pH

The mean values of soil pH at 0-15 cm, 16-30 cm and 31-45 cm on different vegetation sites of the study area (figure 1). The highest soil value (7.174) was found at depth of 0-15 cm in Chir pine forest, whereas the lowest (6.618) at depth of 16-30 cm in mixed forest cover. Soil pH in Blue pine forest found highest at a depth of 16-30 cm and lowest in 31-45 cm. In Chir pine forest soil pH was found basic (7.174) among all the soil depths, but the value decreases as it go down to the depth of 31-45 cm. In mixed forest cover the soil pH value was highest at a depth of 31-45 cm and lowest at depth of 16-30 cm. Soil of Blue Pine cover have medium pH (6.97), while the soil of mixed forest have lower pH of (6.75). This showed that Chir Pine forest cover and mix forest cover shows basic qualities and Blue Pine forest cover shows acidic characteristics. The statistical analysis of dominant forest trees showed on soil pH were found significant (p= 0.02). These results showed that different forest cover have significant pH value depending on various forest trees species. The soil pH (p =.684) was statistically non-significant laterally through depth showed by two way ANOVA. Leonard and Field, [12] studied pH beneath Acacia species, soil transformed from 3.55 in A horizon to 4.5 in the B to 5.5 in the BC. While under the Eucalyptus the soil pH increased. Acidity diminished in mixed forest cover because it contained broad leave tree species like Poplar and Eucalyptus and other little wooded vegetation. Our conducted results agreed with work of Vanguelova *et al.,* [13]. In his study it was accounted for their analysis that conifer forests & their litter acidifying force was more when contrasted with few of the broad leaved trees. It was concluded that an increase in soil acidity was corresponded with changes on other soil process and carbon fluxes additionally, for example, C and N cycling and pools.

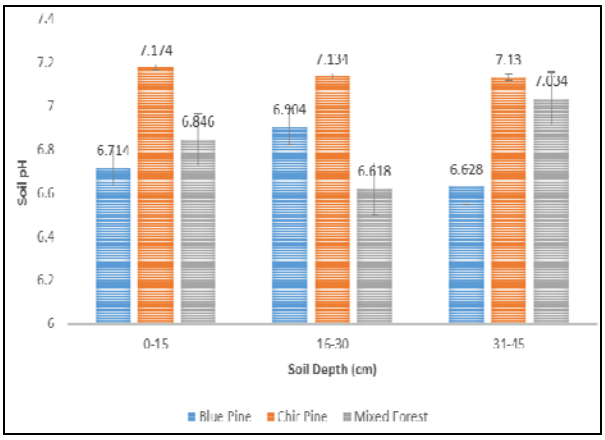


Fig 1: Comparative effects of forest trees on Soil pH at several depths on three vegetation sites in District Buner.

3.1.2 Soil Bulk Density

Figure 2 showed highest Bulk Density (1.8768 g/cm^3) among all the three forest covers at a depth of 31-45 cm and recoded lowest (1.085 g/cm^3) at 0-15 cm depth. Soil bulk density was found high (1.8768 g/cm^3) as the soil depth increased from 0-15 cm to 31-45 cm. In mixed forest cover the soil bulk density was found high in depth of 1630 cm depth same it was happened for Chir pine forest in which the soil bulk density found maximum (1.3043 g/cm^3) at depth of 61-30 cm. The ANOVA showed that among various soil depths the forest trees have non-significant (p=0.583) effect while it was found significant (p=0.008) among the different forest covers given in table 2. Our study expands the study of Dutta and Agrawal, [14]. They carried out study on soil properties and microbial movement of vegetated lands, focused on five distinctive plant species. Their results showed that Bulk Density was high in *Casuaria equisetifolia* and least in *Gravellia pteridifolia* forests.

Table 1: Mean values at several depths on three vegetation sites in Tehsil Gagra, District Buner during 2014-15

Vegetation Types	Soil Depths (cm)					
	0-15		16-30		31-45	
Blue Pine	6.714		6.904		6.628	
Chir Pine	7.174		7.134		7.13	
Mix Forest	6.846		6.618		7.034	
ANOVA Table						
Source of Variation	**SS**	**Df**	**MS**	**F**	**P-Value**	**F crit**
Soil Depth	0.015	2	0.007829	0.382656	0.02	3.259446
Forest Covers	1.319	2	0.659819	32.24802	0.6847	3.259446

Table 2: Mean values at several depths on three vegetation sites in Tehsil Gagra, District Buner during 2014-15

Vegetation Types	Soil Depths (cm)					
	0-15		**16-30**		**31-45**	
Blue Pine	1.1374		1.2926		1.8768	
Chir Pine	1.085		1.3043		1.1277	
Mix Forest	1.2485		1.4559		1.3277	
ANOVA Table						
Source of Variation	**SS**	**Df**	**MS**	**F**	**P- Value**	**F crit**
Soil Depth	0.64287758	2	0.321439	0.7461	0.583	3.259446
Forest Covers	0.53517239	2	0.267586	4.5898	0.008	3.259446

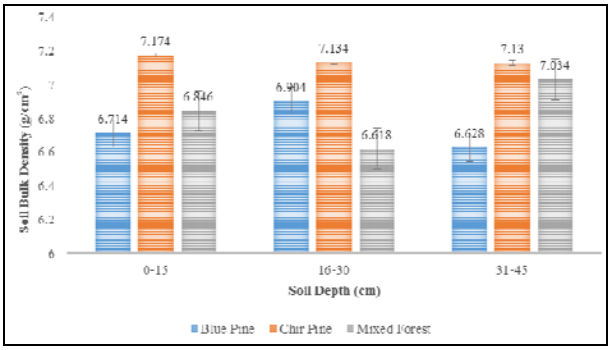


Fig 2: Comparative effects of forest trees on Soil Bulk Densityat several depths on three vegetation sites in District Buner.

3.1.3 Soil Organic Matter

The soil organic matter of distinctive forest tree cover are different and there was a huge difference at diverse depths. In figure 3, among all forest covers, the soil organic matter was found highest (1.008%) in Chir pine forest at depth of 0-15 cm and lowest (0.66%) at 31-45 cm in the same forest. In Blue pine forest the soil organic matter percent was maximum (0.912%) at depth of 0-15 cm and minimum (0.66%) at extreme depth of 31-45 cm. The soil organic matter % was highest (1.008%) among all the forest cover types. In mixed forest cover the soil organic matter % was lowest at 31-45 cm depth. At surface, the analysis showed that organic matter content was too high while towards the depth the organic matter decreases. The results show that as compared to other forest cover, the mix forest cover have lower organic matter content. In Table 3. The ANOVA showed that forest tree species have non-significant effect on both soil depths (p=0.82) and among different forest covers (p=0.86). Our study findings are in line with the study led by Laurent *et al.*, [15], in which they found the effect of wood tree species on soil richness relying on the kind of bedrock, climate and timberland organization and consequently forward species complexity have no as such effect on the soil organic matter. Yet, however, these results contrast from the investigation of Dutta & Agrawal [14] studied that organic matter was higher under the *Chinensissonn* as contrasted and soil under the species of *Magnifera indica*.

Table 3: Mean values at several depths on three vegetation sites in Tehsil Gagra, District Buner during 2014-15

Vegetation Types	Soil Depths (cm)					
	0-15cm		16-30cm		31-45 cm	
Blue Pine	0.912		0.766		0.71	
Chir Pine	1.008		0.752		0.66	
Mix Forest	0.88		0.798		0.782	
ANOVA Table						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-Value***	***F crit***
Soil Depth	0.378364	2	0.1891822	3.26766	0.82	3.259446
Forest Covers	0.004338	2	0.0021688	0.15210	0.86	3.259446

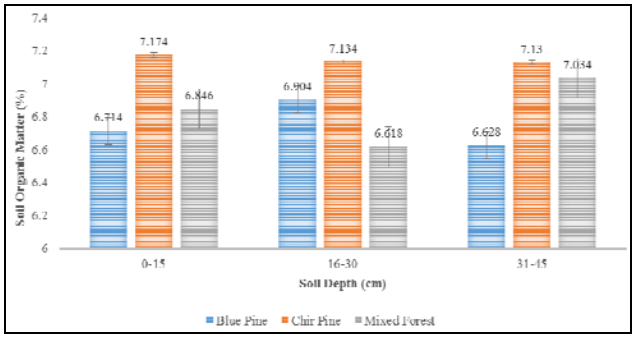


Fig 3: Comparative effects of forest trees on Soil Organic Matter at several depths on three vegetation sites in District Buner**.**

3.1.4 Soil Phosphorus

The figure 4 showed that soil phosphorus content was maximum (8.76%) at a depth of 16-30 cm in Chir pine forest and lowest in both of the surface depth 0-15 cm of Chir pine and mixed forest cover. In Blue pine forest the soil phosphorus content was maximum at a depth of 16-30 cm which was (7.6%) and lowest (7.06%) at top surface 0-15 cm. In Chir pine it was found to be maximum at middle 16-30 cm and lowest (6.52%) at the top soil 0-15 cm. In mixed forest cover the phosphorus content percent was higher as compared to the top surface depth. In table 4, statistical analysis showed that dominant forest tree species have a significant effect on soil depths (p= 0.008). Among different forest cover ANOVA showed that it had a non-significant effect (p= 0.62) on soil phosphorus. The present study agreed with the study conducted by Sabo and Ghani, [16]. As compared to the study on the effect of *Acacia polyacantha* on the supplement of soil in Galambi Forests, Nigeria and the soil chemistry demonstrated that the convergence of N, SOM, P, Ca, K, Na and cation trade breaking point were by and large under the tree shades than open regions.

Table 4: Mean values at several depths on three vegetation sites in Tehsil Gagra, District Buner during 2014-15

Vegetation Types	Soil Depths (cm)					
	0-15cm		**16-30cm**		**31-45cm**	
Blue Pine	7.06		7.6		6.96	
Chir Pine	6.52		8.76		7.64	
Mix Forest	6.52		7.6		7.3	
ANOVA Table						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-Value**	**F crit**
Soil Depth	12.43511	2	6.217556	2.693396	0.081271	3.259446
Forest Covers	2.211111	2	1.105556	0.623343	0.623343	3.259446

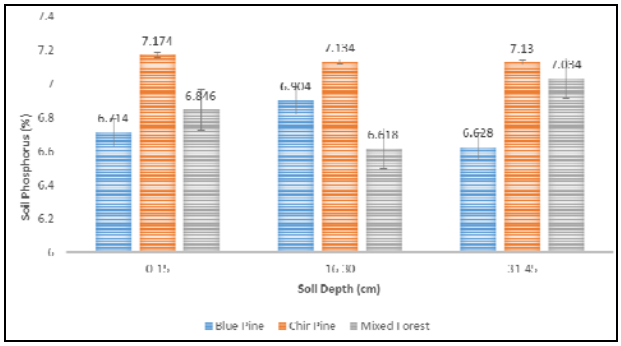


Fig 4: Comparative effects of forest trees on Soil Phophorus at several Depths on three vegetation sites in District Buner**.**

3.1.5 Soil Potassium

In figure 5, Blue pine forest and Chir pine forest have the same maximum potassium content (148 mg/kg) at top soil 0-15 cm depth. The lowest value was found in Chir pine forest which was (128 mg/kg). At 16-30 cm depth mixed forest cover showed high potassium content of (128 gm/kg). At depth of 31-45 cm the potassium content was high (138gm/kg) in a mixed forest cover. It showed that in Chir pine forest and Blue pine forest soil, the potassium content decreased with increased in depth while in mixed forest cover the content increased with the soil depth. Statistically it was found that, soil available potassium among of different forest tree cover have non-significant (p = 0.14) variation. It has been concluded that, at 95% confidence levels predominant different forest trees cover soil potassium at different soil depth, there have no huge (p = 0.67) variation in soil potassium given in (Table 5).

Table 5: Mean values at several depths on three vegetation sites in Tehsil Gagra, District Buner during 2014-15

Vegetation Types	Soil Depths (cm)					
	0-15	16-30	31-45			
Blue Pine	148	128	128			
Chir Pine	148	132	136			
Mix Forest	130	136	138			
ANOVA Table						
Source of Variation	SS	df	MS	F	P-value	F crit
Soil Depth	840	2	420	2.065574	0.141507	3.259446
Forest Covers	160	2	80	0.393443	0.677596	3.259446

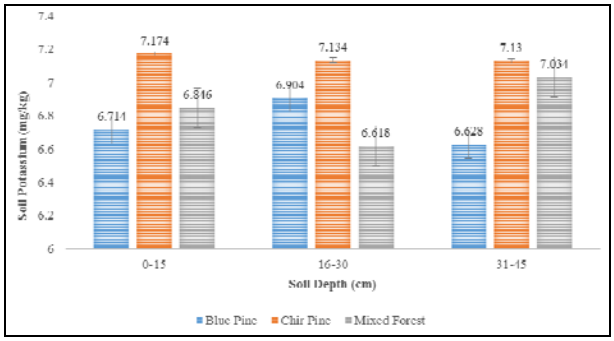


Fig 5: Comparative effects of forest trees on Soil Potassium at several depths on three vegetation sites in District Buner.

3.1.6 Soil Electric Conductivity

Figure 6 showed that as the depth increased, it had no major effect on EC. The soil EC of various forest tree cover at depth 0-15 cm was high in Chir Pine forest cover (0.790 dS/m). Blue Pine forest cover have (0.725 dS/m) and Mix forest covers soil have low EC (0.711 dS/m). Blue Pine showed high EC (0.772 dS/m) at 16-30 cm soil depth, followed by a mixed forest cover (0.7288 dS/m) and Chir Pine has a little (0.6696 dS/m) EC. At 31-45 cm soil depth, the soil electrical conductivity was high (0.7764 dS/m) in Chir pine forest followed by Blue pine forest (0.7612 dS/m) and then mixed forest cover (0.7112 dS/m). Among the various forest tree cover statistically it showed that there was no major variation in EC (p= 0.58). Along with various depths, the dominant forest trees cover indicated non-significant variation (p= 0.34). Soil Electrical Conductivity unit is (deciSiemens per meter dS/m) given in Table 6). EC was different in different forest cover. Under the Acacia more variation was recorded, while under the Eucalyptus EC declined Verstraeten *et al.,* [17].

Table 6: Mean values at several depths on three vegetation sites in Tehsil Gagra, District Buner during 2014-15

Vegetation Types	Soil Depths (cm)					
	0-15	**16-30**	**31-45**			
Blue Pine	0.725	0.772	0.7612			
Chir Pine	0.790	0.6696	0.7764			
Mix Forest	0.711	0.7288	0.7112			
ANOVA Table						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Soil Depth	0.005332	2	0.02666	0.544673	0.584736	3.259446
Forest Covers	0.010787	2	0.005393	1.101919	0.343178	3.259446

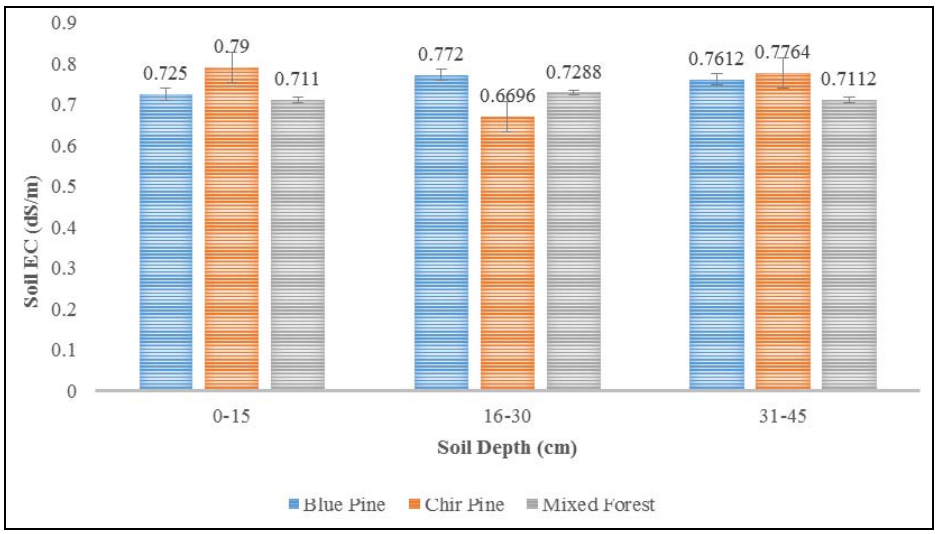
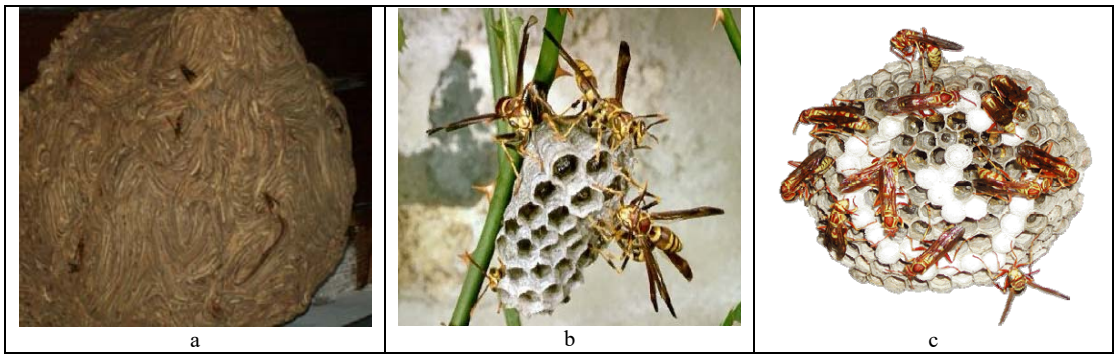


Fig 6: Comparative effects of forest trees on Soil EC at several depths on three vegetation sites in District Buner

3.2 Nesting behavior of Insects

During the present study different species of Vespidae family were found building their nest on the branches of trees. One species of the subfamily Vespinae: *Vespa velutina* whereas two species of the subfamily Polistinae *Polistes stigma* and *Polistes olivaces* were showing the habitat suitable for the nesting (Figure, 7). The same species were also reported by Shah *et al.,* [9], Parveen and Shah [18].



a b c

Fig 7: Insects built their nest on plants a: *Vespa velutina*; b: *Polistes stigma*; c: *Polistes olivaces*

4. Conclusion

The forest tree species cover have different effects on soil characteristics. Different parameters had diverse value clearly demonstrated that in forest soil there is variation among the soil organic matter, their physical and chemical properties. Soil pH, K and P at various depths (0-15cm, 16-30cm and 31-45cm) among different forests showed significant effects. SOM and N showed very nearly close significant relation, while BD and EC have non-significant. The percentage of the SOM was high among the other forest types and it was due to litter fall and plant decay. The trees can influence the present soil richness and some few factors like SOM, EC, BD and P amount. Different species of Vespidae family were found during building their nest on the branches of trees out of which one species of the subfamily Vespinae: *Vespa velutina* whereas two species of the subfamily Polistinae *Polistes stigma* and *Polistes olivaces* were showing the habitat suitable for the nesting. Tree species can also be effects by different ecosystem components like pollution, topography, altitude and atmosphere. Numerous studies are required for better understand the effect of tree species selection for long term conservation purposes and also for productivity for healthy and sound environment.

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