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Physical and Chemical Characteristics of Morels (Morchella Species) Habitat in Mankial Valley, District Swat, Khyber Pakhtunkhwa, Pakistan

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Abstract:
Ecological information on micro fungi is adequately but ecology of macro fungi in over-all has got minimum concentration from mycologists. The morels (Morchella species) are usually well-known as spongy mushroom belongs to genus Morchella and phylum Ascomycota. They are widely recognized as wild edible fungi. The information on ecology of morels in the study area may be data deficient or few studies may have been conducted. Therefore, this study was carried out to assess physical and chemical characteristics of morels habitat. Soil samples were collected from 10plotslaid down in various habitats of Morchella species. Five species of Morchella species include Morchella esculenta Fr., MorchelladeliciosaFr., MorchellaconicaPers., MorchellasemiliberaDC.,Morchella rotunda (Pers) Bound., grow naturally and plentifully, and their physical properties (Soil cover and texture, soil temperature, air temperature, % Relative humidity, altitude, Soil PH, water holding capacity, organic matter, Lime, Electrical Conductivity (EC), Total Soluble Salt) and chemical properties (Nitrogen, Phosphorus. Potassium) were determined.It was found that Morchellaspecies growth needed a soil that was slightly or moderatelyalkaline (pH 4.7 to 6.9) having soil temperature4 ^{0}C to 5.5 ^{0}C, air temperature 15.8 ^{o}C to 17.3 ^{o}C, % relative humidity 70% to 70.62%, altitude 2054 to 2835 meter, water holding capacity 23.4% to 29.2%,organic matter 1.79% to 2.41% , electric conductivity 0.04 to 0.2, total soluble salt 0.013 to 0.064, Nitrogen 0.09% to 0.12%, Phosphorus 4.2% to 14.6%, Potassium 1.36% to 8.28% and Calcium 3.25 % to 4.0%. The soil of the study area is rich in nutrients, elements and climatic conditions, are favorable for the growth morels thus support these five species of morels.

Keywords: *Morchella species, Physical and chemical characteristics, Mankial valley, District Swat, Pakistan*

1. Introduction

Ecological information on micro fungi is satisfactorily but ecology of macro fungi has got widely minimum attention from mycologists (Lakhanpal et al., 2010). The morels (Morchella species) are usually recognized as spongy mushroom or true morels belongs to genus Morchella and phylum Ascomycota. They are widely recognized as wild edible fungi (Kuo, 2005), morels are easily distinguished from other Mushrooms (Dahlstrom et al., 2000) and are used as an attractive, functional food and medicines. It is an additional source of income for people. (Bhardwaj and Ghakar, 2005; Lakhanpal et al., 2010, Bunyard and Nicholson 1994).

Morphologically, morels have cylindrical structure and can be divided into three parts, the hymenium or pileus, stipe or stalk and mycelium (Kanwal et al., 2011 and Lakhanpal et al., 2010). The upper most part of morels is called hymenium or pileus. The edible part is the fruiting body or ascocarp, the second part on the body is called stalk or stipe. The third part tiny roots called the mycelium. The Systematic position of morels include the Class is Ascomycetes, Sub-class Discomycetes, Family is Helvellaceae and Genus Morchella (Lakhanpal et al., 2010).

The information on ecology of morels in Mankial valley may be data deficient or few studies may have been conducted. The purpose of this study was to ascertain the characteristics morels habitat include the physical and chemical of five Morchella species growing in Mankial valley the province of Khyber Pakhtunkhwa in Pakistan, and to examine which soil and characteristics of habitat affect these Morchella species and its distribution. The morels habitat may be as vast as a forest, or as lesser as a decaying log. Abiotic factors include pH, water, climate, heat, sunlight, soil and minerals are of countless significance for the growth of morels. Of specific importance for the diversity and distribution of morels are characteristics of soil and climate. Mushrooms mostly select cool and moist environments. Additionally, soil characteristics as to hold air, salinity, water, pHand osmotic ability may influence fungal mycelia growth (Noble et al. 1999). Amid the vital nutrient needs of fungi are oxygen and water. Moreover, macro elements include magnesium, carbon, nitrogen, potassium and phosphorus, are essential in great amounts, whereas basic microelements include copper, zinc, manganese iron and molybdenum (Sümer, 2006). Soil is a constituent of a healthful ecosystem (Schoenholtzet al. 2000). The key physical and chemical features can add as indicators in altering soil characteristic under particular environmental conditions (Arshad and Coin 2009)

2. Materials and Methods

2.1. Study Area

Mankial valley is situated at 80 km in the north east of Swat on the main Mingora Kalam road on the left bank of river Swat. Mankial valley is spread over an area of 1300 hectares between 35o 15/ 18// to 35o 25/ 17// N latitudes and 72o 36/ 11// to 72o 47/ 5// E longitudes (fig 1). It has boundaries with Kalam valley in the north, Bahrain valley in the south, Kohistan district in the east, Balakot and Swat River in the west. (Ullah and Rashid, 2014).The area is mountainous in nature and presents intact forest, glaciated peaks, streams, rivers, glaciers falls, perennial snowfields and pastures with altitudinal range from 1430 m at Mankial to 5726 m at Koohe Shaheen (Ullah and Rashid, 2014). The climate of the area is cold. The sources of perception are rain fall and snow, rain fall occurs from December to May depending upon altitude. The average annual rain fall is 492 mm whereas the average annual snow fall is 180 inches. The average minimum temperature is 2.4 ˚C and the average maximum temperature is 36.32 ˚C. The area can be divided in to the temperate, sub alpine and alpine type of vegetation. Oak forest can be observed on the southern, southeastern slopes and on the left bank of Mankial River. The upper limits oak forest bear deodar and kail, blue pine forest associated with Fir and rarely with Spruce. These forests provide habitat to cash plants like Morchella, species, Viola, Fragaria, Atropa, phytolacca species (Khan, 1995).

2.2. Methods

The study was conducted during March to May 2015. Morels species were identified with the help of authentic literature i.e., Ali and Nasir, 1989-1991; Nasir and Ali, 1970-1989 and 1980-2005; Ali and Qaiser, 1993-2018.The soil layer, cover, depth, water holding capacity texture, pH, total organic matter, total soluble salt (TSS) and electric conductivity (EC), % Calcium carbonate ($CaCO_3$), % nitrogen (%N), phosphorus (%P), potassium (%K), were determined in the soil of selected area through recommended analytical procedures (Arshad andCoen, 2009; Schoenholtz and Miegroet, 2000, Sharma et al. 2010, Sumeet et al. 2010).

2.3. Collection of Soil Samples

Soil samples were collected by the usual procedure from the selected plots of the study area i.e., from 0-90 cm depth. The soil samples were obtained from plots 1-10.As used by Sharma et al. (2010).

3. Results and Discussion

3.1. Occurrence of Morchella Species

As evident from the table-1 that five Morchella species include Morchella esculenta Fr., Morchella deliciosaFr., Morchellaconica Pers., MorchellasemiliberaDC., Morchella rotunda (Pers) Bound., were found in Mankial valley at different locations of the 10 plots laid down in morels habitat.

3.2. Physical Characteristics

<u>3.2.1. Soil Cover and Texture</u>

The soil has four major profiles called horizons including top soil, sub soil, weathered parent rocks, and deed rocks. The soil texture is determined by the % age of sand, silt and clay in the top layer of 30 cm (Kononova, 1963; Fenner, 2000). The top soil contains maximum organic matter and maximum biological activity, resulting considerable effect on plant growth especially for the growth of morels. The top soil of the study area contains nutrients composing sandy, humus peat, clay and loam created, due to the dead decay needles of conifer trees (Table-2). A study was also conducted by Guggenberger et al., (1994) regarding fungi, microorganism, and earthworms that are making base soluble fractions known as humic and fulvic acid and insoluble fraction called humin. These substances increase the fertility of soil, especially for the morel's growth (Kononova, 1963). Other researchers include Rodríguez et al. (2009)., Moncada et al. (2014)., Bach, et al. (2010) also conducted studies on soil texture and mega fungi or plant relations. Mani, (2013), Osono, (2015), Hustad et al. (2011) studies soil cover.

<u>3.2.2. Soil Temperature</u>

The soil temperature depends upon three factors including, the heat energy required to bring about a given change in the temperature of soil, the net amount of heat absorbs by the soil and the energy required for changes such as evaporation which are responsible for the soil chemistry and affect the growth of plants comprising morels (Kononova, 1963; Fenner, 2000 and Singh et al., 2004). The effect of temperature on plant growth is not always constant. In cold soils the chemical and biological rates are slow (Davidson et al., 1998). The soil temperature of plots 1 to 10 is almost lower and ranges from 4 0C to 5.5 0C (Tabl-1). This lower temperature originates essential micro and macro nutrients, which affect the growth of morels. Pinna et al. (2010) also studied soil temperature in habitat of mushrooms. Mani, (2013), Hustad et al. (2011) also studied Soil temperature. Gharabawy et al. (2019) reported soil average temperature 10-20 °Cof sandy loam soil bearing natural morels in Egypt.

3.2.3. Air Temperature

The climate of the study area the Mankial valley is pleasant with greenery and humid condition. The temperature of the area remains high in June the hottest month of the year, reaches to above 20 oC While drop below freezing point in January the coldest of the year and remain low throughout the year in the remaining months of the year. It is evident from the table-2 that the highest mean temperature of 17.3 oC was recorded at plot No. 7. The mean temperature of the remaining plots ranging from 15.8 oc-16.3 OC with some up and down. A reverse effect between temperature and elevation was found, the plots showing high elevation shows low temperature whereas as the plots with low elevation was found in high temperature. Plants hardy to winter due to their chemical and structural modification are adoptable to survive in periods of low temperatures but they are unable to renew growth until feasible temperatures are again established. Temperature is also responsible for crop production, the limits of the growing seasons, chilling of leaves and freezing of plants (Kononova, 1963, Fenner, 2000, Singh et al., 2004).Pinna et al. (2010) studied air temperature in habitat of mushrooms.Mani, (2013), Jang et al. (2014), Hustad et al. (2011)assessed air temperature.

3.2.4. % Relative Humidity

It is evident from the table-2 that the % relative humidity was found higher at Plot No. 1 Kafar Banda (70.62) and minimum at plot No.7 Chukail-1 (69) while in the remaining plots the % relative humidity remained in the range of 70 to 70.3.Venturella & Zervakis (2000); Zervakis & al. (2002), (2002a) studied effects of soil humidity on growth of macro fungi,Vasillkov(1955)also examined relative humidity of soil.

3.2.5. Altitude

Altitude is one of the significant factors determining the local climate in mountainous regions. Altitude effect both moisture conditions and temperature. It is evident from the table-2that a total of 10 plots have been taken for the observation of Morchella specie. In which plot No.1 located at highest altitude of 2835 meter and plot No. 7 at a lowest altitude of 2020 meter. The elevation range of the remaining eight plots varies from 2054 meter to 2703 meter with gradual ups and downs. It is evident from the study that the temperature of the valley increases with decrease in the elevation and represents an inverse proportion, whereas the elevation of the Mankial is directly proportion to the relative humidity of the area. Whiteman (2000) studied the direct proportion of altitude and humidity and inverse proportion of humidity to temperature and temperature to altitude. Komer (2007) also studied effects of altitude on temperature. Li et al., 2011 also studied relationship of elevation with temperature. Mani, (2013) also studied altitude. Andrew et al. (2013), Ke and Yang (2003) assessed ecological distribution of macro fungi at different altitudes.

3.2.6. Soil PH

It is obvious from the table-2 that the soil pH was found in the range of 4.7 to 6.9 which shows that the soil is alkaline but a slight trend towards acidic. The highest pH value was found for plot-4, which may be due to the high lime content while the lowest pH was noted in plot-7 and may be due to the low level of phosphorous contents, lime and mineralization of organic matters. Fenner. (2000) found that the pH value of a soil is affected by the types of parent materials of the soil. The soils developed from acidic rock have generally have lower pH values then those formed from basic rocks. Other factors which affect the soil pH is rainfall, Basic nutrients. The results of the study are in conformity with Singh et al., (2004) who found soil pH from different sites morels in Himachal Pradesh India. Connell et al. (2006) found important variation in distribution patterns of species in relation to soil pH. Ferris et al. (2000) studied important correlations were noted of parasitic fungal species with soil pH in low lands of England. Gharabawy et al. (2019) reported the pH 7.04 of sandy loam soil bearing natural morels in Egypt. Manikandan et al. (2011) fond that the soil reaction as slowly alkaline (pH 7.82) in Morchella species sites in some areas of Rajasthan and Himachal Pradesh. Lakhanpal and Shad, (1986) reported suitability of neutral to alkaline soil for growth of morels in Himachal Pradesh. Munjal et al., (1977) also reported suitability of neutral to alkaline soil for growth for morels. Crabtree et al. 2010 analyzed soils and reported high pH in Karst sinks and glades in his studies in Tonka State Park, Missouri. As the climate of the study area is dry temperate with the bulk of rainfall, therefore, the pH of the study area is moderate and thus shows high potential towards the growth of morels.

3.2.7. Water Holding Capacity

The concentration of water holding capacity of morel habitat in Mankial valley District Swat was in the range of 23.4 to 29.2% (Table-2). The concentration of water holding capacity was higher in plot 10 and lower in plot 8. The rain or irrigation water enters the soil, distribute the water contents uniformly over the surface and covering the pores. The down ward movement of water in to the soil is resulted due to the continuous exposure of the soil surface to water and the soil is reached to its saturation. The mineral soil provides lesser water than humus peat soil at optimum moisture to plants (Kononova, 1963). Negase and Dunnett (2011) reported that increased organic matter in wet regime resulted in to lush growth while dry regime did not result in increased growth. Brocket et al. (2012) also reported soil organic matter, moisture, annual perception, dry sites and wet sites which favors findings of the present study. Manikandan et al. (2011) studied water holding capacity in Morchella species sites in some areas of Rajasthan and Himachal Pradesh. It was found that the soil of morels habitat in the Mankial valley is humid therefore, provides more water contents to the body of morel and keeping them fresh.

3.3. Organic Matter

Physical and chemical properties of the soil is influenced by the organic matter and is mainly responsible for the exchange of cation of soil, which in turn is affect stability of soil aggregates and works as an energy supplier for body building constituents of the microorganisms. The plant tissue is the original source of soil organic matter. Some soil fungi produce organic acid and others produce citric acid, which react with minerals of silicate and release nutrient metal ions and potassium. The availability of temperature and oxygen in the soil strongly influence the accumulation of organic matter in soil. The rate of biodegradation increases with increase in temperature and vice versa however in cooler climate organic matter does not degrade rapidly and tends to build up in soil. Where the plants grown and decay in soil is saturated the organic contents may reach to 90% in areas (Kononova, 1963; Fenner, 2000). Organic matter is an important source of nutrients and energy for the growth of morels Haktanir and Arcak (1997). Barroetaveña and Carolina (2020) examined'effects of organic matter on fruiting of edible mushroom in a study on 'diversity and ecology of edible mushroom from Patagonia Native forests, Argentina. Sharma et al. (2001) reported rich organic soil suitability for fruiting of morels. The organic matters in the soil of morels habitat of Mankial valley District Swat was find out in the range of 1.79% to 2.41% (Table-2). The highest value was found in plot 2 and the lowest in plot 4. It is evident that the concentration of organic matters in the soil of the study area for the growth of morels is enough.

3.3.1. Electrical Conductivity (EC)

Electrical conductivity is one of the indirect factors for determining physical and chemical properties of the soil (Sudduth, 2005). Soil water contents play a key role in influencing soil electrical conductivity while electrical conductivity has good potential to differentiate in soils of moist nature (Brevick, 2006). The electric conductivity of the Mankial soil was investigated and it was found in the range of 0.04 to 0.2. The table-2 reveals that the electric conductivity was on higher side in plots No. 2 and 10 with no variation while lower in plots No. 8 and 9 with no variation. The higher value next to plot No. 2 and 10 was found in Plots No. 1 and 3. The electric conductivity of the Mankial shows that moisture contents are available in the soil and has good potential for the growth of morels. Singh et al., (2004) investigated electrical conductivity and the result of this study are in conformity with their study. Manikandan et al. (2011) found high electrical conductivity capacity in Morchella species sites in some areas of Rajasthan and Himachal Pradesh.

3.3.2. Total Soluble Salt (TSS)

Soils form from weathering processes including physical, chemical and geological processes resultantly the soil contains soluble salts. Rain can also cause the accumulation of slat but it is in small amount. The total soluble soil contains cations of calcium, sodium, magnesium, and the anions of chloride, sulfate and carbonate including bicarbonate (Rengasamy and Olsson, 1991). When the quantum of rain fall is not enough to leach the salts then the salt accumulates in sub soils (Rengasamy, 2002). The total soluble slat when increased from its threshold level in the soil, the soil is converted to its adverse form with properties of alkalinity and sodicity resultantly affect plants growth. Rengasamy (2010) studied process of soil that affect plant growth. Manikandan et al. (2011) found soluble salts as low (EC< 1 dS m-1) in Morchella species sites in some areas of Rajasthan and Himachal Pradesh. The Total Soluble Salt in soil of morels habitat of Mankial valley was observed in the range of 0.013 to 0.064. The highest value was recorded in plot No. 10 and 2 while the lowest value was recorded in plot No. 8 and 9. The Total Soluble value in the remaining plots was from 0.016 to 0.062 (Table-2). The findings regarding the Total Soluble Salt in Mankial valley have no adverse properties and provide a healthy soil for the growth of morels.

3.4. Chemical Characteristics

3.4.1. Nitrogen %Age

Nitrogen being a macro nutrient of the soil determines the %age of proteins and has a distinct effect on the growth of morels. Nitrogen is available in soil in three forms including organic Nitrogen, ammonium Nitrogen and soluble inorganic ammonium and nitrate compounds. The organic Nitrogen is associated with soil humus; ammonium nitrogen is determined by clay minerals. During warm growing season the rate of Nitrogen release is faster than in winter months (Kononova, 1963; Fenner, 2000 and Singh et al., 2004).Sharma et al. (2001) reported rich nitrogen suitability for fruiting of morels. The % Nitrogen status of the study area was found in the range of 0.09 to 0.12 (Table-3). The highest value was found in plot 1-3 while the lowest value was in plot No. 4. The growth of morels is faster in the summer season because of the availability of essential nutrients specially nitrogen in the soil easily.

3.4.2. Phosphorous %Age

Phosphorus is an important component of plant material but its %age is relatively low. Before the intake of plants, phosphorous is available in simple inorganic form. Generally, in acidic soil orthophosphate ions are precipitated or sorbet by species of Al^{+3} and Fe^{+3}. In alkaline soil orthophosphate, may react with calcium carbonate to form insoluble hydroxyapatite. The factors which regulate the availability of inorganic soil phosphorus are soluble iron, soil pH, manganese and Aluminum. Manikandan et al. (2011) found low phosphorus in Morchella species sites in some areas of Rajasthan and Himachal Pradesh. The phosphorus in the soil of various localities has also been reported by earlier research workers (Kononova 1963; Fenner, 2000 and Singh et al., 2004).Kaul et al. (1981) reported higher phosphorus in morel sites of Kashmir. Crabtree et al. 2010 analyzed soils and reported high phosphorus in Karst sinks and glades in his studies in Tonka State Park, Missouri. The % phosphorous status of the study area Mankial valley shows the concentration from 4.2 to 14.6(Table-3). The highest value was recorded in plot-2 and lowest value in plot-7 Chokail-1. It was found out that all plots show a sufficient quantity of phosphorus therefore the environment is healthy for morel population in the study area.

3.4.3. Potassium %age

The Potassium is also a macronutrient and essential for starch formation, photosynthesis, the development of chlorophyll and translocation of sugar. However, most of the soil potassium is unavailable to plants but relatively soil growing plants use maximum quantum of Potassium. Egillaet al., (2001) also reported deficient potassium availability in plant. Thus, Potassium plays key function in the activation of some enzymes, water balance, and carbohydrate transformation in the plant body. Moreover, the mechanism that is required to the potassium fixation and released is unknown but there are some factors which effect thereof potassium comprising, wetting and drying, soil colloids and the presence of lime contents (Kononova, 1963; Fenner, 2000 and Singh et al 2004).Manikandan et al. (2011) found high potassium in Morchella species sites in some areas of Rajasthan and Himachal Pradesh. Kaul et al. (1981) reported higher potassium in morel sites of Kashmir. The morels yield depends upon potassium, the higher the potassium the greater was the morel yield and the soil deficient in potassium will result in reduce production of morels. It is evident from the table-3that the quantity of potassium in the soil of the study area was high enough ranging from 1.36 to 8.28%. The % Potassium was higher in plot-6 Serai-2 and was lower in plot-1 Kafar Banda. The Potassium quantity in the soil of the study area is enough to support healthy growth of morels.

3.4.4. Calcium % age

The activity of heterotrophic soil organism is accelerated by biological effects. This process is not only helpful in the removal of some organic transitional products that might be toxic to plants but also encourages the formation of humus (Kononova, 1963).Kaul et al. (1981) reported higher calcium in morel sites of Kashmir. Singh et al. (2004) high calcium in morel habitats in India. The lime contents in the form of calcium carbonate ($CaCO_3$) were investigated and it was found in the range of 3.25 to 4.0 in plot 1-10 (Table-2). The highest value was recorded in plot-1 at Kafar Banda, followed by plot 10 and the lowest value was found in plot 2 to 9, Therefore, the above stated physical, biological effects and chemical effects in the soil chemistry of the study area favors the great potential towards the growth of morels.

4. Conclusion

Soil samples were collected from 10 plots laid down in various habitats of Morchella species in Mankial valley district Swat Pakistan where five species of Morchella species include Morchella esculenta, Morchelladeliciosa, Morchellaconica, Morchellasemilibera, Morchella rotunda, grow naturally and plentifully, and their physical properties (Soil cover and texture, soil temperature, air temperature, % Relative humidity, altitude, Soil PH, water holding capacity, organic matter, Lime, Electrical Conductivity (EC), Total Soluble Salt(TS) and chemical properties (Nitrogen, Phosphorus. Potassium) were determined. The soil of the study area the Mankial valley is rich in nutrients, elements and climatic conditions, are favorable for the growth morels thus support these five species of morels. Additionally, the elevation vegetation and growing seasons of Morchella species were analyzed to explore impacts of habitat properties on growth of morels. it is believed that areas somewhere morels grow abundantly inthe wild will be useful in guarding or producing under farming numerous eatable morel shaving own soil conditions, representative habitat, climatic, and which are consumed as commercial, medical resources and food generally or locally. Moreover, morels might be signs of the habitat where they originate and grow in the soils.

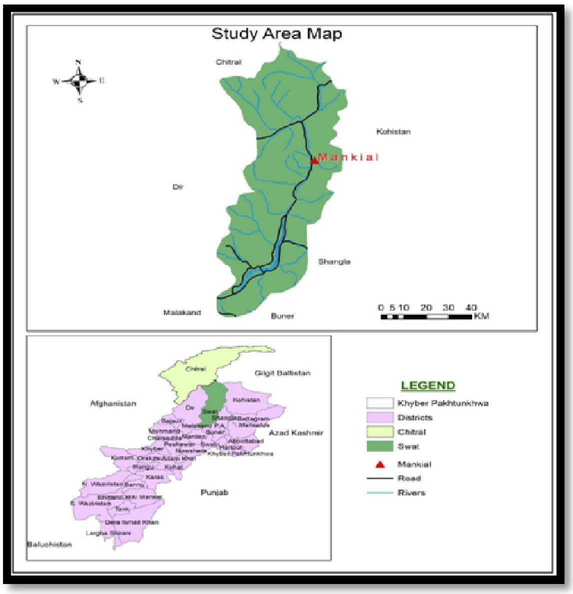

Figure 1: Location of Mankial Valley District Swat Khyber Pakhtunkhwa Pakistan

S. N	Morels (Morchella species)	Locality
1	Morchella esculenta Fr.	Mankial valley
2	MorchelladeliciosaFr.	Mankial valley
3	MorchellaconicaPers.	Mankial valley
4	MorchellasemiliberaDC.	Mankial valley
5	Morchella rotunda (Pers) Bound.	Mankial valley

Table 1: Morsels (Morchella Species) Recorded In Mankial Valley, District Swat

Plot No	Site	Soil Temp. ºC	Air Temperature in ºC	Altitude (in m)	Relative humidity %age	Soil cover	Soil pH	Electric conductivity	% Total Soluble Salt	% Organic matter	% Water holding capacity	Soil layer	Soil depth in Cms
1	Kafar Banda	4.0	15.8	2835	70.62	Dead Decay leaves	5.8	0.19	0.062	2.34	27	A_{00} A0	5
2	Badai Pattay-1	4.5	16.2	2069	70.0	-do-	6.3	0.20	0.064	2.41	28	-do-	5
3	Badai Pattay-2	4.4	16.3	2054	70.0	-do-	6.7	0.14	0.045	2.34	29	-do-	5
4	Tapra	4.4	16.2	2060	70.0	-do-	6.9	0.07	0.022	1.79	24	-do-	2
5	Serai-1	4.2	16.0	2605	70.2	-do-	6.8	0.07	0.022	2.20	23.7	-do-	3
6	Serai-2	4.2	16.0	2620	70.2	-do-	5.2	0.05	0.016	2.16	26	-do-	4
7	Chokail-1	5.5	17.3	2020	69.0	-do-	4.7	0.05	0.016	2.03	25.2	-do-	3
8	Chokail-2	4.4	16.2	2180	70.0	-do-	5.2	0.04	0.013	1.93	23.4	-do-	5
9	SeraiBaik	4.1	15.9	2703	70.3	-do-	5.3	0.04	0.013	2.01	27.7	-do-	3
10	Neem	4.2	16.0	2582	70.3	-do-	5.1	0.20	0.064	2.10	29.2	-do-	4

Table 2: Physical Parameters of Morels Habitat in Mankial Valley District Swat

Plot No.	Name of site	% Nitrogen	% Phosphorous	% Potassium	% Calcium
1	Kafar Banda	0.12	7.1	1.36	4
2	Badai Pattay-1	0.12	14.6	1.47	3.25
3	Badai Pattay-2	0.12	7.8	2.30	3.25
4	Tapra	0.09	11.8	3.68	3.25
5	Serai-1	0.11	7.8	4.14	3.25
6	Serai-2	0.12	8.2	8.28	3.25
7	Chokai 1	0.10	4.2	2.30	3.25
8	Chokai 2	0.10	6.4	5.52	3.25
9	SeraiBaik	0.10	8.9	1.86	3.5
10	Neem	0.11	4.83	2.76	3.5

Table 3: Chemical Parameters of Morels Habitat in Mankial Valley District Swat

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