INTRODUCTION

Soil is an important source of nutrients, house for microorganisms, plant growth and support for all living things. Soils are formed from different rocks and minerals, and it takes millions of years to develop. Each soil has its own characteristics and its property, which affects on crop production. Soil taxonomy plays an important role in classifying soil and advocating its fertility and capability. Madurai is one of the historical city in Tamil Nadu, India, and blessed with different soil type-based cropping systems and the Vaigai River to prop up the water supply (Karpagam et al., 2020). Detailed knowledge on morphological characteristics and site characteristics viz., landscape positions, slope percentage, slope length, erosion status, erosion type, groundwater depth, physiography, presence of stoniness, gravel content, rock out crops are very important in arriving soil series under soil taxonomy procedure and derive interpretive groupings for land use planning (Pinki et al., 2017). Hence the present study was undertaken in Melur block, Madurai District using a cadastral map to study the pedogenic characteristics of soils.

MATERIALS AND METHODS

Study area

The study area of Melur block, Madurai District of Tamil Nadu, India is having an area of 3057 ha is located between 10° 03′ 36″ N latitude and 78° 33′ 58″ E longi- tude (Fig. 1). The average elevation of the Madurai District, Melur block is 101 m above MSL. The length of the growing period (LGP) is > 120 days (Ramamurthy et al., 2009). The climate is semi-arid, the mean annual summer temperature ranges from 40 ° C to 26.3 °C and the mean annual winter temperature ranges from 29.6 °C to 18 °C, with a mean annual maximum rainfall of 926.56 mm and minimum rainfall of 723.6 mm.

Research Article
Methodology
A detailed soil survey was taken in the Melur block using a cadastral map with a 1:5000 scale. Soil pedon sampling was done based on the traverse, grid sampling, road cuts, mini pits and profiles were excavated with the dimension of 2mX2m X2m dimension from the benchmark sites. The site characteristics and morphological characteristics were taken from the profile excavated with the standard procedure at Chunampoor, Thuvaramgulam, Poonjuthi and Veppapadupu by used standard procedure by Soil Survey Staff (2014).

RESULTS AND DISCUSSION
The results on the morphological characteristics of four soil pedons are presented in Table 1 and Plate 1. The pedons of 1,3,4 come under the red soil area and the pedon 2 comes under the black soil. Landscape slope 0-1% comes under nearly level to gently undulating (1-3% slope) and slight to severe erosion and moderately well-drained conditions.

Horizon differentiation
The pedons 1, 3 and 4 were classified as red soil and pedon 2 classified under black soil. The pedon 1 had Ap, B11t, B12t and C horizons. The pedons 2,3 and 4 were Ap, B1t, B2t, B3t, and C; Ap, AB, B1t, B2t and C; Ap, B11t, B12t and C, respectively. Both red soil series and black soil had illuvial horizon represented as clay skins. A similar observation was made by Bhattacharjee et al. (1977) in the black soils of the Deccan plateau in India.

Horizon boundary
The horizon of the pedon in the red soil had unique topography of smooth throughout the profile, with the exception that wavy in Pedon4. In contrast to the above, black soil (pedon 2) had gradual and smooth boundaries with wavy in nature. The pedon had a heterogeneous transition of abrupt, clear, gradual with smooth and wavy topography. Abrupt, Smooth boundary formation might be due to ploughed soil nature and the gradual diffuse boundary was due to the absence of anthropogenic activities. A similar trend of results were observed in Alfisols in the Bako area of Ethiopia (Negassa and Gebrekidan, 2003).

Soil depth
The depth of the soils of the study area was moderately deep to very deep. Pedons 1 was moderately deep (45cm); 2, 4 are deep (<100 cm) and pedon 3 was categorised as very deep (>100 cm) in nature are presented in Table 1. The Solum depth reflected the balance between soil formation and soil loss by erosion in any area, governed by topography and slope. Soil depth varied from 48 cm to more than 155 cm across 4 pedons, indicating lesser erosion intensities. A similar type of the result of solum development has been reported in lower and mid plain contrast to upper pediment based on its landscape position of Rajasthan in Aravalli Range (Sharma et al., 2020).

Colour
The colour of the pedons varied with hue ranging from 2.5 YR to 7.5YR, value 3 to 4 and chroma 4-6 in red soil and hue 10 YR, values varied from 4 to 5 and chroma by 4 to 6 in black soil. 10YR hue was attributed due to the hydrated oxides of Fe formed under humid condition. Higher value and chroma observed in pedons might be due to the illuviation of Fe and Al, Low chroma indicated the aquatic condition with poor drainage and immature parent material (Samrah et al., 2019). The colour of the soil changes come under the different soil properties based viz., mineralogy of soil, texture, chemical composition, soil moisture content and landscape position. The same findings of the
study are reported by Thangasamy et al. (2005) in the Sivagiri micro-watershed of Chittoor district in Andhra Pradesh.

Soil texture
The pedons of soil textural classes were classified from sandy clay loam to sandy clay. This soil textural variation was ascribed to differences in parent material composition, topography, in-situ weathering and clay translocation by eluviation and age of soils. A similar trend of results in textural variation from sandy clay loam to clay has interpreted the enrichment of clay in lower horizon due to illuviation or vertical migration of clay in salt-affected soils of Muktsar District of Punjab (Sandhu., 2017).

Soil structure
The soil structural pattern of pedons 1, 2, 3 varied from weak to moderate in grade, medium in size and sub-angular blocky nature and pedon 4 are strong in grade, medium in size and sub-angular blocky nature. The soil structural changes in pedons were due to higher clay

| Pedon No | Depth of pedon (cm) | Texture | Colour (moist) | Structure | Consistence | Bnd | Roots | Cutans |
|----------|---------------------|---------|---------------|-----------|-------------|-----|-------|--------|
| Ap       | 0-14                | SCL     | 2.5 YR 3/4    | 1fsbk     | Sh fi ms mp | Cs  | fvf   | -      |
| B11      | 15-35               | SCL     | 2.5 YR 2.5/4  | 2msbk     | Sh fi ms mp | Cs  | fvf   | -      |
| B12t     | 35-48               | SC      | 2.5 YR 2.5/4  | 2msbk     | H fi Vs vp  | Cs  | -     | present|
| C        | 48                  | Non calcareous Gneiss with Feldspar |           |           |             |     |       |        |

| Pedon 2. Location : Thuvarangulam |
|-----------------------------------|
| Ap | 0-12 | SC | 10 YR 4/4 | 2msbk | Vh vfi Vs vp | Cs | fvf |
| B1t | 12-33 | SCL | 10 YR 5/6 | 1mgrp | H fi Ms mp | Cs | - |
| B2t | 33-44 | SC | 10 YR 5/4 | 1msbk | Vh vfi Vs vp | Cs | fvf | present |
| B3t | 44-100 | SC | 10 YR 4/4 | 2msbk | Vh vfi Vs vp | Cs | - | present |
| C | 100 | Weathered gneiss |           |           |             |     |       |        |

| Pedon 3. Location : Poonjuthi |
|--------------------------------|
| Ap | 0-21 | SCL | 7.5 YR 4/6 | 2msbk | H fi ms mp | Cs | mvf |
| AB | 22-39 | SC | 2.5 YR 4/8 | 1msbk | Vh vfi Vs vp | Cs | fvf |
| B1t | 39-72 | SC | 2.5 YR 5/6 | 1msbk | Vh vfi Vs vp | Cs | fvf | present |
| B2t | 72-155 | SC | 2.5 YR 4/6 | 1msbk | Vh vfi Vs vp | Cs | - | present |
| C | 155 | Weathered gneiss |           |           |             |     |       |        |

| Pedon 4. Location : Veppapadupu |
|----------------------------------|
| Ap | 0-35 | SCL | 2.5 YR 4/4 | 3msbk | Sh fi Ss sp | Cs | mvf |
| B11t | 35-56 | SCL | 2.5 YR 4/5 | 3scbk | Sh vfi Ss sp | Cs | mvf |
| B12t | 56-71 | SCL | 2.5 YR 4/4 | 3msbk | Sh vfi Ss sp | Cs | mvf |
| C | 71 | Weathered quartz and feldspathic gneiss |           |           |             |     |       |        |

Abbreviations: i). Texture: S- sand, LS- loamy sand, SL-sandy loam, L-loam, SIl-silt loam, Si-silt, ScL-sandy clay loam, CL- clay loam, ScL- silty clay loam, SC- sandy clay, ScC- silty clay clay, ,C- clay. ii). Grade: 0-structureless, 1-weak, 2-moderate, 3-strong; Size; vT- very fine, fT-fine, m-medium, c-coarse, vc-very coarse,iii). Type: gr-granular, cr-crumble, cl-columnar, pr-prismatic, pl-platy, abk-angular blocky, sbk-subangular blocky, sg- single grain, m-massive, c-cloppy, iv). Dry; l-loose, s-soft, sh-slightly hard, h-hard, vh-very hard, eh-extremely hard,. Moist: l-lose, vfr-very friable, fr-friable, f- firm, vfi-very firm, efi- extremely firm,. Stickiness: so- non sticky, ss-slightly sticky, ms- moderately sticky, vs- very sticky. Plasticity: po- non plastic, sp- slightly plastic, mp-moderately plastic, vp- very plastic; v). (Kd): Disseminated materials, Masses, Nodules, Concretions, v). Roots: Quantity: f- few (<1 per area), c- common (1-5), m- many (>5); Size: vT- very fine, fT- fine, m-medium, c-coarse; vs- very coarse; Location (Loc): between peds (p), cracks (c), throughout (l); Shape (Shp): tubular/ irregular/ vesicular/ interstitial.
content in the subsurface horizons when compared to surface horizons. A similar result of the low clay content of soil and low organic carbon content status was the reason to the weak structural formation of pedons in Alluvial Soils of Rajasthan in India (Samrah et al., 2019).

**Soil consistency**
The dry consistency ranged from slightly hard to very hard in nature and it might be due to the presence of fine-textured nature. The moist consistency had a range of firm to very firm, but the wet consistency ranged from slightly sticky to very sticky and slightly plastic to high plastic in nature. The same trend of results was also reported by Christy (2020) in the Vaigi river basin, Madurai District, Tamil Nadu in India.

**Roots and pores**
The fine, medium and tubular to irregular roots could be seen in the pedons due to the cultivation of coconut, banana, paddy and vegetables.

**Cutans**
Clay cutans with slickenside were seen in the pedons of 1 and 2, which might be due to the clay illuviation in Bt horizon. Similar results were observed on the west coast of southern Karnataka soils (Patil and Kumar, 2014).

From the above results, it was confirmed that red soils are formed from granite gneiss parent material. They are dominated by kaolinite clay minerals in this area. The soil texture is sandy clay loam to clay loam, so these soils are more water holding capacity and water retention type are also. Soil comes under subangular blocky in nature, so the soil holds more nutrient, and thus plant-available nutrients are high. Hence they are highly suitable for field crops and all vegetables.

Plate 1. Pedon 1 - 4. Each profile showing the clearly smooth wavy boundary, roots and clay cutans.
Conclusion

The present study concluded that the morphological characteristics of soils of Melur block, Madurai District, are fully developed in nature and classified as Alfisol soil order of Irugur and Vygloam benchmark soil series. The crops viz., paddy, sugarcane, banana, groundnut and vegetables like okra, brinjal, tomato, chillies, cluster bean, cucumber etc. are very suitable for this area. Thus there is a substantial and significant addition of information to the existing knowledge on the soils of Melur block Madurai District.

Conflict of interest

The authors declare that they have no conflict of interest.

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