International Journal of Research in Agronomy 2024; 7(8): 190-194

E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(8): 190-194
Received: 30-05-2024
Accepted: 10-07-2024

K Madhulatha
M.Sc. Research Scholar, Agricultural College, Polasa, Jagtial, Telangana, India

G Venugopal
Assistant Professor, Department of Soil Science and Agricultural Chemistry, Agricultural College, Polasa, Jagtial, Telangana, India

R Sai Kumar
Assistant Professor, Department of Soil Science and Agricultural Chemistry, Agricultural College, Polasa, Jagtial, Telangana, India

N Mahesh
Assistant Professor, Department of Agronomy, Agricultural College, Polasa, Jagtial, Telangana, India

Corresponding Author:
K Madhulatha
M.Sc. Research Scholar, Agricultural College, Polasa, Jagtial, Telangana, India

Assessment of macronutrients and sulpur in soils under predominant cropping systems of Northern Telangana zone

K Madhulatha, G Venugopal, R Sai Kumar and N Mahesh

DOI: https://doi.org/10.33545/2618060X.2024.v7.i8c.1215

Abstract
The study was conducted during *rabi* season, 2023-24 at different locations of farmer's fields in the Northern Telangana Zone. The main aim of the study was to assess the macronutrients and sulphur status in soils of the Northern Telangana Zone. A total of 75 samples were collected from the predominant cropping systems of NTZ. *viz.*, cotton-bengal gram (CS_1), soybean-bengal gram (CS_2), turmeric-sesame (CS_3), paddy-paddy (CS_4) and Paddy-maize (CS_5) at different depths (0-15, 15-30 and 30-45 cm). The available nutrient status significantly varied with cropping systems and depth of soils. Among the cropping systems, the higher available N was recorded in CS_2 (soybean-bengal gram). Whereas, the higher available phosphorous and potassium were observed in CS_3 (Turmeric-Sesame). The higher sulphur was registered in CS_2 (Soybean-Bengal gram). With regards to depth, all macronutrients and sulphur were decreased with increasing the soil depths. The maximum N, P, K and S were observed at 0-15 cm of soil (228.06, 40.34, 258.85 and 25.95 kg ha^{-1}, respectively). The interaction effect of the cropping system and soil depth was found to be non-significant.

Keywords: Cropping systems, depths, available macronutrients, sulphur

1. Introduction

India has always been an agricultural society from time immemorial (Abhilash *et al*. 2022) [1] which, has been blessed to have a wide range of climatic conditions and ensures to grow a wide range of crops. In Northern Telangana Zone, paddy, maize, turmeric, soybean and cotton are predominant crops, which have been cultivating during the *kharif* season. Others like sesame and Bengal gram are major *rabi* crops. paddy, maize, cotton, turmeric and soybean are cultivating in an area of 20.5 lakh acres, 1.7 lakh acres, 12.5 lakh acres, 0.34 lakh areas and 3.8 lakh acres, respectively. Receiving annual rainfall ranges from 900 to 1150 mm mostly during southwest monsoon season. Minimum and maximum temperatures during winter and summer seasons range between 15 °C to 25 °C and 32 °C to 40 °C, respectively with 76-95% humidity. Red soils are predominant soils in this zone, which include chalks, red sands and deep red loams along with very deep black cotton soils (Weather and Climatology of Telangana, Directorate of Economics and Statistics (DES) Planning Department, Government of Telangana, 2024) [18]. Global demand of food depends on soil fertility especially N, P and K status of the soil. Due to several factors like excess or less usage of fertilizers, addition of inorganic fertilizers without organics, intensive cultivation and improper management practices lead to decline in the crop yields as well as deteriorate the soil health.

Adopting crop diversification system is one of the promising approach as it is, a sensible strategy for attaining the objectives of food security, employment, increased revenue, and sustainable agricultural development (Anamika *et al*. 2022) [2].

However, deterioration in the soil fertility under continuous cultivation of same cropping systems led to a reduction in the crop yields. Therefore, studying the effect of exhaustive cropping systems like paddy, maize and cotton on availability of macronutrients is essential. This could aid in understanding the soil status. Furthermore, improving the productivity of the crops by managing the soil fertility.

2. Materials and Methods

The study was carried out in Northern Telangana Zone covering districts of Adilabad, Nizamabad, Jagtial, Karimnagar and Peddapally. In Adilabad, Tamsi, Adilabad rural and Tallamadugu mandals were identified for cotton-bengal gram as predominant cropping system and covering the area of 2,128 ha. In Nizamabad, Bodhan, Pothangal, Kotagiri, Morthad and Dammanapet mandals were identified for cotton-bengal cropping system and covering the area of 4288 ha. In Jagtial, turmeric-sesame cropping systems was considered as major cropping system in Kathlapur and Metpally mandals with an area of 2419 ha. In Peddapally and Karimnagar, paddy-paddy cropping systems was considered as major cropping system in Peddapally Kamanpur, Gangadhara, Ramadugu mandals with an area of 22920 ha. In Karimnagar, paddy-maize cropping system were identified from Veleru, Bheemadevarpally, Chigurmamidi, Koheda and Ramchandrapuram with an area of 25120 ha.

All necessary precautions were taken while collecting the samples and GPS coordinates were noted. Samples were collected in a zig-zag pattern and 2 cm-thick slice of soil was removed from the top layer. These samples were combined to make a composite sample and extra soil was removed using the quartering method. Finally, half kg composite samples from each sampling field were obtained. After collection, soil samples were brought to the laboratory and allowed to air dry under shade. Stones, pebbles, roots, etc. were removed and the soils were pounded in a wooden mortar and pestle and sieved through a 2 mm sieve. The samples were stored in air-tight plastic boxes, labeled properly and the soil samples were analyzed to find physical, physicochemical, macronutrients and sulphur status in the cropping system

Soil pH was measured using a digital pH meter in a 1:2.5 soil and water solution after 30 minutes of intermittent stirring with a glass rod (Jackson, 1973) [8]. The electrical conductivity was measured with a digital EC meter after continuously stirring the soil in a 1:2.5 ratio in soil water suspension and allowing it to settle (Jackson, 1973) [8]. The study was carried out using a core sampler measuring 5.0 cm in length and 5.0 cm in diameter. A core sampler was used to collect soil samples from the surface and sub-surfaces, then the bulk density was determined by the mass-volume relationship (Blake and Hartge, 1986) [5]. Available nitrogen was assessed by using alkaline potassium permanganate method given by Subbiah and Asija (1956) [16]. Available phosphorus in soil was analyzed using olsen's extraction method. (Olsen *et al*. 1954) [11]. The available potassium of soil was assessed using Jackson,1973 [8]. Available sulphur in soil was analyzed by turbidimetric method by using Rayleigh UV Visible Spectrophotometer given by William and Steinberg, 1959. The standard protocols were used. The ANOVA was calculated by using a two-factorial analysis.

3. Results and Discussion

3.1 Soil reaction (pH)

The data related to soil pH presented in Table 1. The average pH ranged from 7.13 to 8.18. With regards to cropping systems, significantly the lowest pH was observed with paddy-maize (CS_5) (7.39) followed by soybean-bengal gram (7.50) system (CS_2). The turmeric-sesame system (CS_3) has recorded (7.57) and was on par with CS_2 system. Significantly the higher pH was recorded with paddy-paddy system. (CS_4) (8.01). With regards to soil depth, the minimum pH was observed at 0-15 cm (7.45), corresponding lower depths (15-30 and 30-45 cm) recorded the higher pH values (7.62 and 7.79, respectively). There was no significant difference observed for pH among the combinations of cropping systems and soil depth.

3.2 Electrical conductivity (d Sm^{-1})

Scrutinized data regarding to EC is presented in Table 1. The EC varied from 0.16 to 0.34. With regards to cropping systems, the highest EC was recorded with CS_4 system. Other cropping systems were on par with each other. The minimum EC was recorded in CS_2 (0.24). Data regards to soil depth, the surface layer recorded the highest EC (0.34) and with increasing soil depth, the EC was decreased gradually (0.24 and 0.19) at 15-30 and 30-45 cm, respectively. The treatment combinations of cropping systems and soil depth were found to be non-significant.

The soil pH at the selected sites ranged from neutral to alkaline. A close perusal of the data on soil pH and EC, indicates that CS_2 and CS_3 cropping systems are showing lower pH and EC, it may be due to leaf fall additions and root biomass in pulse-based cropping systems. Whereas, paddy, maize and cotton systems increase in total soluble salt content by the addition of large quantities of inorganic fertilizers. Similar results were obtained with Barros *et al*. (2014) [4] and Shah *et al*. (2013) [14].

Higher pH in the paddy monocropping system is caused by the predominance of exchangeable bases in surface soils. Similar results were obtained with Yavanika *et al*. (2021) [20] and Kiflu and Beyene, (2013) [9]. The extended submergence, which may have promoted the reaction process, particularly of basic cations, may be the cause of the highest soil pH value under rice-rice. Similar results were obtained with Asha *et al*. 2014 [3], Ponnamperuma *et al*. 1966 [12], Dekamedhi and Datta, 1995 [7].

3.3. Bulk Density (Mg m^{-3})

Data pertaining to bulk density varied from 1.35 to 1.84 Mg m^{-3} (Table 1). Among the cropping systems, rice-rice and rice-maize cropping systems were observed for the highest bulk density (1.74 Mg m^{-3}) followed by cotton-bengal gram system (1.63 Mg m^{-3}). The turmeric-sesame cropping system has recorded the lower bulk density (1.45 Mg m^{-3}) when compared to the other systems. Furthermore, the bulk density was gradually increased with soil depth. However, the lower bulk density was observed at 0-15 cm for bulk density (1.53 Mg m^{-3}) followed by 15-30 cm (1.62 Mg m^{-3}). The highest BD was recorded at 30-45 cm (1.70 Mg m^{-3}). There was no variation observed for BD among the treatment combinations of cropping systems and soil depth.

Lower BD in pulse-based cropping systems is due to the addition of root biomass and organic matter. Higher BD was seen in paddy fields as a result of frequent ploughing and puddling thus, compacting the top soil. Similar results were obtained by Yavanika *et al*. (2021) [20] and Celik *et al*. (2004) [6].

3.4 Available N

The available nitrogen is significantly influenced by the cropping systems and soil depths. However, there is no variation observed among the treatment combinations. The available nitrogen ranged from 141.12 to 264.60 kg N ha^{-1} (Table 2). With regards to the cropping systems, the highest available nitrogen was recorded with soybean-bengal gram cropping system (228.06 kg ha^{-1}) and was on par with CS_3 (213.78 kg ha^{-1}). A 9.94% and 13.44% reduction in the availability of available nitrogen was recorded under CS_4 and $CS_{1,}$ respectively over CS_2 (228.09 kg ha^{-1}). Significantly the lowest available nitrogen was registered with CS_5 system (161.28 kg ha^{-1}). The available N was decreased with increasing the soil depth. The highest available nitrogen was noted at 0-15 cm (235.36 kg ha^{-1}) followed by at 15-30 cm (199.33 kg ha^{-1}). The least available nitrogen was registered at 30-45 cm (168.84 kg ha^{-1}).

Higher values of available N in pulse-based cropping systems could be owing to the presence of organic debris from leaf fall, roots, nodules, and plant waste degradation (Shrinivasulu *et al*. 2000) [15]. However, Similar results were obtained with Tuti *et al*. 2013 [17]. Higher values of available N were obtained in pigeonpea-lentil might be due to the utilization of the growth resources more effectively and with symbiotic nitrogen fixation.

3.5 Available Phosphorous (kg P_2O_5 ha^{-1})

The data related to available P_2O_5 is presented in Table 2. The average available P_2O_5 ranged from 17.52 to 52.60 kg ha^{-1}. Among the cropping systems, the highest available P_2O_5 was registered with CS_3 (40.34 kg ha^{-1}) and was on par with CS_4 (36.03 kg ha^{-1}). However, the CS_4 is comparable with CS_2 system (32.46 kg ha^{-1}). Relatively. The lower available P_2O_5 was recorded with CS_1 system (27.34 kg ha^{-1}). The variation observed for available P_2O_5 at different depths of soils. The maximum available P_2O_5 was recorded at 0-15 cm (45.21 kg ha^{-1}) followed by (32.45 kg ha^{-1}) at 15-30 cm. The minimum available P_2O_5 was registered at 30-45 cm (21.27 kg ha^{-1}). There is a non-significant effect observed for treatment combinations of cropping systems and soil depths.

3.6 Available Potassium (kg K_2O ha^{-1})

The available K_2O was presented in table 3. The mean soil available K_2O ranged from 177.13 to 302.40 kg ha^{-1}. With regards to the cropping system, the CS_3 has recorded the highest available K_2O (258.85 kg ha^{-1}) and was on par with CS_4 (252.85 kg ha^{-1}). Furthermore, other cropping systems *i.e.* CS_1 (249.42 kg ha^{-1}) and CS_2 (230.00 kg ha^{-1}) were comparable with CS_4. The lower available K_2O was registered in rice-maize system CS_5 (220.68 kg ha^{-1}). At different depths, the higher available K_2O was registered at 0-15 cm (281.98 kg ha^{-1}) followed by at 15-30 cm (239.98 kg ha^{-1}). The lower available K_2O was registered at 30-45 cm (205.63 kg ha^{-1}). The variation among the different combinations of cropping system and soil depths was found to be non-significant.

Due to the higher addition of organic matter, leaf fall and increased root biomass residue retention was enhancing and nutrient availability is increasing. Thus available phosphorous and potassium content was higher in pulse-based cropping systems when, compared to other cropping systems. Similar results were obtained with Rajiv *et al*. (2019) [13].

3.7 Available Sulphur (mg kg^{-1})

The available sulphur in the soil varied from 15.42 to 33.52 mg kg^{-1}. (Table 3). There was a significant variation observed among the cropping systems for available sulphur. The CS_2 system has recorded significantly the higher available sulphur, which was 4.43% and 13.59% higher over CS_4 (24.8 mg kg^{-1}) and CS_3 (22.8 mg kg^{-1}). The CS_5 and CS_1 systems were found to be lower values for available sulphur (20.6 and 20.4 mg kg^{-1}, respectively). The surface soils were observed with more available sulfur over subsurface soil depths. A 23.07% increase in available sulphur at 0-15 cm soil depth over 15-30 cm (23.40 mg kg^{-1}). The least available sulphur observed at 30-45 cm (16.50 mg kg^{-1}). There was no significant variation observed for available sulphur among the combinations of cropping systems and soil depths.

Table 1: Effect of cropping systems with depth-wise variations on physicochemical properties of soils in Northern Telangana Zone

Factor-I Cropping system	pH	EC dS m^{-1})	BD (Mg m^{-3})
CS_1	7.62	0.25	1.63
CS_2	7.49	0.24	1.53
CS_3	7.57	0.25	1.45
CS_4	8.00	0.29	1.74
CS_5	7.39	0.26	1.74
Sem±	0.03	0.01	0.03
CD @ 5%	0.08	0.03	0.09
Factor-II Depths			
D_1 (0-15cm)	7.45	0.34	1.53
D_2 (15-30cm)	7.61	0.24	1.62
D_3 (30-45cm)	7.78	0.19	1.70
S.Em±	0.02	0.01	0.02
CD @ 5%	0.06	0.03	0.07
Interaction (CS×D)			
CS_1D_1	7.49	0.33	1.58
CS_1D_2	7.61	0.23	1.64
CS_1D_3	7.78	0.19	1.68
CS_2D_1	7.35	0.30	1.44
CS_2D_2	7.48	0.23	1.54
CS_2D_3	7.64	0.17	1.60
CS_3D_1	7.42	0.34	1.35
CS_3D_2	7.59	0.24	1.46
CS_3D_3	7.68	0.16	1.55
CS_4D_1	7.86	0.37	1.64
CS_4D_2	7.98	0.26	1.74
CS_4D_3	8.18	0.22	1.84
CS_5D_1	7.13	0.34	1.65
CS_5D_2	7.40	0.23	1.74
CS_5D_3	7.63	0.18	1.83
S.Em±	0.05	0.01	0.06
CD @ 5%=	NS	NS	NS
CV	1.54	17.44	8.33

Table 2: Effect of cropping systems with depth-wise variations on macronutrients of soil in Northern Telangana Zone

Factor-I Cropping system	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})
CS_1	197.4	27.34
CS_2	228.06	32.46
CS_3	213.78	40.34
CS_4	205.38	36.03
CS_5	161.28	28.73
Sem±	5.45	1.67
CD @ 5%	15.46	4.73
Factor-II Depths		
D_1 (0-15cm)	235.36	45.21
D_2 (15-30cm)	199.33	32.45
D_3 (30-45cm)	168.84	21.27
S.Em±	4.22	1.29
CD @ 5%	11.97	3.66
Interaction (CS×D)		
CS_1D_1	216.72	35.59
CS_1D_2	199.08	28.89
CS_1D_3	176.4	17.52
CS_2D_1	257.04	51.48
CS_2D_2	230.58	28.12
CS_2D_3	196.56	17.77
CS_3D_1	264.6	52.60
CS_3D_2	207.9	38.89
CS_3D_3	168.84	29.53
CS_4D_1	253.26	48.13
CS_4D_2	201.6	36.07
CS_4D_3	161.28	23.89
CS_5D_1	185.22	38.24
CS_5D_2	157.5	30.30
CS_5D_3	141.12	17.64
S.Em±	9.45	2.89
CD @ 5%=	NS	NS
CV	10.50	19.63

Table 3. Effect of cropping systems with depth-wise variations on macronutrients of soil in Northern Telangana Zone

Factor-I Cropping system	Available K_2O (kg ha^{-1})	Available S (mg kg^{-1})
CS_1	249.44	20.43
CS_2	230.00	25.95
CS_3	258.85	22.78
CS_4	252.85	24.79
CS_5	220.68	20.65
Sem±	8.79	1.18
CD @ 5%	24.90	3.33
Factor-II Depths		
D_1 (0-15cm)	281.48	28.80
D_2 (15-30cm)	239.98	23.43
D_3 (30-45cm)	205.63	16.52
S.Em±	6.80	0.91
CD @ 5%	19.29	2.58
Interaction (CS×D)		
CS_1D_1	302.4	24.04
CS_1D_2	238.69	21.11
CS_1D_3	207.24	16.12
CS_2D_1	269.33	34.57
CS_2D_2	231.97	25.75
CS_2D_3	188.69	17.52
CS_3D_1	294.06	28.54
CS_3D_2	264.76	23.43
CS_3D_3	217.72	16.36
CS_4D_1	281.16	33.52
CS_4D_2	240.03	25.40
CS_4D_3	237.35	15.43
CS_5D_1	260.46	23.32
CS_5D_2	224.44	21.46
CS_5D_3	177.13	17.17
S.Em±	15.22	2.04
CD @ 5%=	NS	NS
CV	14.04	19.88

Table 4: Correlation between available nutrients under different cropping systems

	Available N	Available P	Available K	Available S
Available N				
Available P	0.80**			
Available K	0.73**	0.85**		
Available S	0.87**	0.88**	0.71**	

Positive correlations were observed with available N, P_2O_5, and K_2O under different cropping systems (Table 4), the available P, K, and S were significantly positive correlating with available N by 0.83, 0.73, and 0.87%, respectively. Available K was significantly positively correlating with available P and S by 0.85 and 0.88%, respectively and available S with available K by 0.71%. It indicates that the available major nutrients significantly positively correlated with each other, and similar findings were reported (Majhi, 2021) [10].

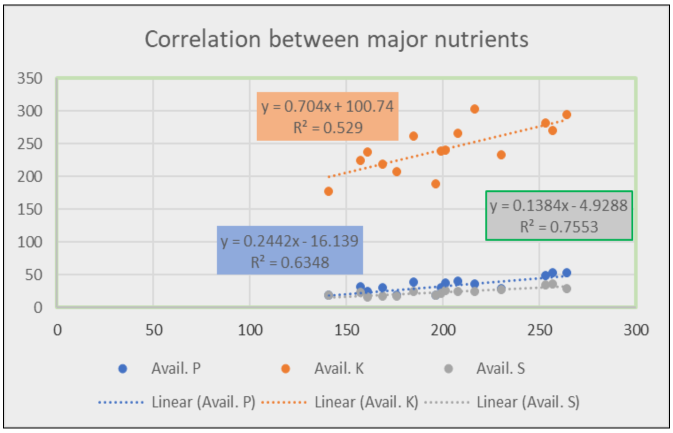

Fig. 4.1: Correlation between available N, P, K and S under different cropping systems.

Conclusion

The present study unveiled that the physicochemical properties *viz.*, pH, EC and BD were highest under the paddy-paddy cropping system. Available nitrogen and sulphur were recorded under soybean-bengal gram cropping system. Available phosphorous and potassium were recorded under turmeric-sesame cropping system. Available major nutrients significantly positively correlated with each other, pulse-based cropping systems showing significant superior over other cropping systems in nutrient availability and fertility point of view. Based on the above findings, pulse-based cropping systems are included in crop rotation for sustainable soil health conditions.

Acknowledgement

It gives me a great pleasure to convey my highest regard and gratitude to my advisory committee. I would also like to thank Professor Jayashankar Telangana State Agricultural University (PJTSAU) for the generous funding support for the research work presented in the study.

References

1. Abhilash SM, Ram RK, Mishra A. Women in agriculture. Status, scope and opportunities. In: India and Agriculture; c2022.
2. Anamika B, Saha P, Patel S, Bera A. Crop diversification an effective strategy for sustainable agriculture development. Sustain Crop Prod; c2022. p. 102635.
3. Asha KS, Nargis K, Singh RS, Amalendu K. Physico-chemical properties of acid alfisol as influenced by different cropping systems. Int J Curr Microbiol Appl Sci. 2014;3(6):1079-1084.
4. Barros JDS, Chaves LHG. Changes in soil chemical properties under different farming systems exploration in semiarid region of Paraiba. Afr J Agric Res. 2014;9(31):2436-2442.
5. Blake GR, Hartge KH. Bulk density. In: Methods of Soil Analysis: Part 1 Physical and Mineralogical Methods. 5th ed; c1986. p. 377-382.
6. Celik I, Ortas I, Kilic S. Effects of compost, mycorrhiza, manure and fertilizer on some physical properties of a chromoxerert soil. Soil Till Res. 2004;78(1):59-67.
7. Dekamedhi B, Datta SK. Effect of green manures and prilled urea on the changes of electrochemical properties of soil under lowland rice. J Indian Soc Soil Sci. 1995;43:572.
8. Jackson ML. Soil Chemical Analysis. New Delhi: Prentice Hall of India Pvt. Ltd.; c1973. p. 498-500.
9. Kiflu A, Beyene S. Effects of different land use systems on selected soil properties in South Ethiopia. J Soil Sci Environ Manage. 2013;4(5):100-107.
10. Majhi P, Rout KK, Nanda G, Singh M. Long term effects of fertilizer and manure application on productivity, sustainability and soil properties in a rice-rice system on Inceptisols of Eastern India. Commun Soil Sci Plant Anal. 2021;52(14):1631-1644.
11. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. Circ US Dep Agric; c1954. p. 939.
12. Ponnamperuma FN, Martinez E, Loy TA. Influence of redox potential and partial pressure of carbon dioxide on pH values and the suspension effect of flooded soil. Soil Sci. 1966;101:421.
13. Rajiv N, Vikram S, Sati SS, Virender K, Kali KH, Chaitanya PN, et al. Impact of conservation tillage in rice-based cropping systems on soil aggregation, carbon pools and nutrients. Geoderma. 2019;340:104-115.
14. Shah S, Sharma DP, Pala NA, Tripathi P, Dar A. Carbon stock and density of soils under pine (Sargent) forests of Solan forest division, Himachal Pradesh. Soil Biol Biochem. 2013;41(3):279-286.
15. Shrinivasulu K, Singh RP, Madhavi K. Effect of pigeon pea based intercropping system on soil fertility status. J Environ Ecol. 2000;3:93-99.
16. Subbiah BV, Asija GL. A rapid procedure for the estimation available N in the soils. Curr Sci. 1956;25:259.
17. Tuti MD, Mahanta D, Bhattacharyya R, Pandey BM, Bisht JK, Bhatt JC. Productivity, economics and energetics of pigeonpea-based cropping systems in mid-hills of northwest Himalaya. Indian J Agron. 2013;58(3):303-308.
18. Weather & Climatology of Telangana. Directorate of Economics and Statistics (DES), Planning Department, Government of Telangana; c2024.
19. Williams CH, Steinbergs A. The evaluation of plant-available sulphur in soils. Plant Soil. 1962;17(3):279-294.
20. Yavanika P, Madhuri KVN, Krishna GT, Reddy MP. Soil physical and physicochemical properties under major cropping systems of Chittoor district, Andhra Pradesh. Pharma Innov. 2021;10(8):1645-1650.