Agriculture Association of Textile Chemical and Critical Reviews Journal (2024) 656-660

AATCC Review

07 October 2024: Received
10 November 2024: Revised
25 November 2024: Accepted
12 December 2024: Available Online

https://aatcc.peerjournals.net/

Original Research Article | Open Access

Evaluation of multinutrient extractant - AB-DTPA with olsen in varying Pstatus soils

J. Pranavi[1], T. Srijaya[2], A. Madhavi[3], K. Bhanu Rekha[4]

[1]Department of Soil Science and Agricultural Chemistry, College of Agriculture, PJTAU, Rajendranagar, Hyderabad, Telangana, India
[2]Principal Scientist , Agricultural Reasearch Station, Tornala, Siddipet, Telangana, India
[3]Principal Scientist & Head, ISHM, ARI, Rajendranagar, Hyderabad, Telangana, India
[4]Professor, Agricultural College, Adilabad, Telangana, India

ABSTRACT

*An experiment was conducted at AICRP on STCR, ARI, Rajendranagar, Hyderabad to evaluate the performance of multinutrient extractant AB-DTPA in comparison with the standard method (Olsen's method) during 2019-20. Geo-referenced surface soil samples were collected through a random sampling technique from in and around Ranga Reddy district of Telangana. These soils were screened for available phosphorus status and thirty soil samples were collected with ten samples from each category viz., low, medium and high phosphorus fertility levels. The amount of available phosphorus extracted by Olsen's extractant (112 kg ha^{-1}) was found to be numerically more compared to AB-DTPA extractant (82 kg ha^{-1}). The correlation coefficient between Olsen's and AB-DTPA extractant during estimation of available P in varying native phosphorus status soils was found to be 0.84** in low P soils, medium P soils (r = 0.86**) and high P soils was (r = 0.87**) while in case of overall soils it was found to be (r = 0.94**). It can be concluded that Olsen's and AB-DTPA extractable phosphorus were equally good indices for estimating available phosphorus. Hence, AB-DTPA can be used as an extractant for the estimation of available P in neutral and alkaline soils.*

Keywords: *AB-DTPA, Low P soils, Medium P soils, High P soils, Olsen, Multinutrent Extractant, Phosphorus.*

INTRODUCTION

Soil testing is defined as rapid, chemical analysis to assess the available nutrient status, salinity and elemental toxicity of soil [13]. It is a sound scientific tool used for assessing the nutrient-supplying capacity of soil. In soil analysis, different extractants are used for the determination of various soil nutrients because use of extractants depends on various soil physico- chemical properties. Traditional methods of analysis are tedious analytical protocols which fail to provide results in time. Most of these methods/extractants are specific for few or one of the plant nutrients. For analysing a soil sample for all available nutrients, separate extractions with different extractants are required and the preparation of them is not only tedious but also costly. Assessment of available nutrients in soils depends up on the efficacy of the extractant. No single extractant can be universally recommended for soils of diversified nature. As soil testing is becoming costlier, use of cost-effective and time-saving multi nutrient extractants for estimation of macro and micronutrients in soils needs careful consideration. Multinutrient extractant that allows the simultaneous extraction of plant-available macro, secondary and micronutrients in soils will be highly useful and is apt for soil testing laboratories (1). Single multi-nutrient extractant / Universal extraction reagents will increase laboratory productivity and decrease the cost of analysis.

Corresponding Author: **J. Pranavi*

DOI: https://doi.org/10.21276/AATCCReview.2024.12.04.656
© 2024 by the authors. The license of AATCC Review. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).

AB-DTPA solution was developed for the simultaneous extraction of P, K, Zn, Cu, Fe and Mn from soils [21]. Among the major nutrients, phosphorus plays an important role in root development apart from improving crop growth and yield. In Telangana state, most of the soils are in the range of neutral to alkaline, hence there is the possibility to assess the suitability of AB-DTPA extractant for extraction of various nutrients in soils.

MATERIALS AND METHODS

A Survey was conducted in and around Ranga Reddy district of Telangana and collected nearly 140 surface soil samples. These soils were screened for available phosphorus status. Based on the available phosphorus status soils were classified into low, medium and high. Ten soils from each category of low, medium and high phosphorus fertility were selected *i.e.,* a total 30 soils were selected. pH was determined in 1: 2.5 soil water suspension and electrical conductivity of the soil in 1: 2.5 soil water extract Jackson, 1973, organic carbon was estimated by Walkey and Black method [23]. Available nitrogen in the soil was determined by the alkaline potassium permanganate method [22], available phosphorous was determined by Olsen's method [11] and available potassium was determined by the neutral normal ammonium acetate method [4]. Statistical analysis was carried out as per the standard procedures [12].

Preparation of AB-DTPA extractant

A 0.005 M DTPA solution was obtained by adding 1.97g DTPA to 800 ml of distilled water. Approximately 2 ml 1:1 ammonium hydroxide (NH_4OH) was added to facilitate dissolution and to prevent effervescence when bicarbonate was added. When most of the DTPA is dissolved, 79.06 g ammonium bicarbonate (NH_4HCO_3) was added and stirred gently until it was dissolved.

 © *2024 AATCC Review.* All Rights Reserved.

The pH of the AB-DTPA solution was adjusted to 7.6 with ammonium hydroxide and dil. Hydrochloric acid. The solution was diluted to 1 litre volume with distilled water and used immediately.

AB-DTPA Extraction method

Accurately 10 g soil + 20 ml AB-DTPA reagent was taken in 100 ml conical flask and shaken for 15 minutes, filtered through Whatman No.42 filter paper and estimated colorimetrically**.**

RESULTS AND DISCUSSIONS

The physico chemical and chemical properties of selected 30 soil samples was presented in table 1. The soils selected for the present investigation have pH ranging from neutral to moderately alkaline (7.26 to 8.18) irrespective of the category of soil. The EC of 1: 2.5 soil water extract ranged between 0.106 dSm^{-1} to 0.582 dSm^{-1} with a mean value of 0.230 dSm^{-1}. The selected soils for the present investigation were non-saline and suitable for crop cultivation concerning electrical conductivity of soils.

The organic carbon content in the soils was ranged from 1.2 to 3.5 g kg^{-1} with a mean of 2.3 g kg^{-1} indicating that most of the soils used in the study were low in organic carbon. Available nitrogen in selected soils were low in status *i.e.,* 100 per cent of samples were low in available nitrogen. The available nitrogen content of the soils ranged from 100 kg ha^{-1} to 188 kg ha^{-1} with a mean value of 142 kg ha^{-1}. The available phosphorus content of soils ranged from 8 kg P_2O_5 ha^{-1} to 178 kg P_2O_5 ha^{-1} with a mean value of 59 kg ha^{-1} indicating that soils under present investigation were low to high in available phosphorus status. The soils under low phosphorus status ranged from 8 kg P_2O_5 ha^{-1} to 24 kg P_2O_5 ha^{-1} with an average value of 18 kg P_2O_5 ha^{-1}. Medium phosphorus status soils were in the range of 30 kg P_2O_5 ha^{-1} to 59 kg P_2O_5 ha^{-1} with a mean value of 47 kg P_2O_5 ha^{-1} while soils of high phosphorus status ranged from 60 to 178 kg P_2O_5 ha^{-1} with mean value of 112 kg P_2O_5 ha^{-1}. The available potassium content of the soils varied from 269 kg K_2O ha^{-1} to 523 kg K_2O ha^{-1} with mean value of 378 kg K_2O ha^{-1} indicating that the soils samples selected for the study were medium to high and no samples were deficient in available potassium.

Table 1. Physico-chemical and chemical properties of initial soils

S. No.	Soil No.	pH	EC (ds/m)	OC (g kg^{-1})	N (kg ha^{-1})	Olsen P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
LOW P SOILS							
1	L_1	7.26	0.197	1.5	100	8	304
2	L_2	8.00	0.122	1.9	103	12	269
3	L_3	7.78	0.255	2.4	113	14	347
4	L_4	8.10	0.234	2.9	138	16	354
5	L_5	8.14	0.243	2.2	125	18	390
6	L_6	7.66	0.214	1.9	100	19	365
7	L_7	7.82	0.198	1.7	188	20	271
8	L_8	8.06	0.182	3.2	176	22	366
9	L_9	8.18	0.196	2.1	188	23	336
10	L_{10}	8.14	0.106	2.6	175	24	348
	Mean	**7.91**	**0.194**	**2.2**	**140**	**18**	**335**
MEDIUM P SOILS							
11	M_1	7.92	0.244	2.4	113	30	342
12	M_2	8.06	0.221	2.8	138	35	337
13	M_3	8.09	0.366	1.7	188	38	469
14	M_4	7.84	0.239	1.2	150	42	414
15	M_5	7.68	0.172	2.2	125	49	283
16	M_6	8.05	0.309	1.6	188	50	452
17	M_7	7.66	0.112	2.3	100	52	276
18	M_8	7.92	0.582	2.1	151	56	339
19	M_9	7.45	0.191	2.7	163	57	432
20	M_{10}	7.57	0.278	2.5	100	59	366
	Mean	**7.82**	**0.271**	**2.1**	**141**	**47**	**371**
HIGH P SOILS							
21	H_1	7.78	0.122	0.16	100	60	476
22	H_2	8.05	0.183	0.27	151	65	413
23	H_3	7.93	0.359	0.28	125	77	444
24	H_4	8.04	0.346	0.23	176	84	523
25	H_5	7.76	0.169	0.21	125	90	350
26	H_6	7.52	0.112	0.18	113	114	376
27	H_7	7.65	0.346	0.26	188	135	425
28	H_8	7.94	0.191	0.24	176	152	418
29	H_9	7.69	0.206	0.35	188	166	401
30	H_{10}	7.80	0.191	0.27	125	178	478
	Mean	**7.84**	**0.229**	**0.24**	**146**	**112**	**430**
Overall Mean		**7.84**	**0.229**	**0.22**	**142**	**59**	**378**
Minimum		**7.26**	**0.106**	**0.12**	**100**	**8**	**269**
Maximum		**8.18**	**0.582**	**0.35**	**188**	**188**	**523**

© *2024 AATCC Review.* All Rights Reserved.

Evaluation AB-DTPA extractant for soil phosphorus estimation in comparison to Olsen extractant ((kg ha^{-1})

The amount of available phosphorus extracted by sodium bicarbonate (Olsen's) extractant was varied between 8 to 178 kg ha^{-1} with an average value of about 59 kg ha^{-1} (Table-2). In low phosphorus status soils, the Olsen's P was ranged from 8 to 24 kg ha^{-1} with a mean of 18 kg ha^{-1} while medium phosphorus status soils were extended from 30 to 59 kg ha^{-1} with an average value 47 kg ha^{-1}. The highest mean 112 kg ha^{-1} was noticed in the high phosphorus status soils with values oscillating from 60 to 178 kg ha^{-1}. A perusal of data revealed that the amount of phosphorus extracted by the AB- DTPA extractant was ranged from 7 to 112 kg ha^{-1} with a mean of 46 kg ha^{-1}. The low phosphorus status soils have AB-DTPA extracted phosphorus was extended from 7 to 22 kg ha^{-1} with a mean 15 kg ha^{-1}. In the high-status soil, it was noticed from 62 to 112 kg ha^{-1} the average was 82 kg ha^{-1} while medium phosphorus status soils have available phosphorus varied from 23 to 60 kg ha^{-1}.

The above results expressed that the amount of phosphorus extracted by AB-DTPA extractant was lower compared to standard Olsen extractant irrespective of soil phosphorus status. Similar findings were observed during their studies [17]. Phosphorus extracted through Olsen extractant has recorded higher values over ABDTPA estimated phosphorus which might be due to three reasons [6]. First reason may due to the high pH of $NaHCO_3$ extractant (pH of 8.5) as compared to AB-DTPA (pH of 7.6) which resulted in quick $CaCO_3$ precipitation and release of a greater amount of phosphorus from soil calcium phosphates. The difference in shaking time (duration of the reaction) could be another reason as soil was shaken for 30 minutes in $NaHCO_3$ and only for 15 minutes in the case of AB-DTPA. Furthermore, the ratio between soil and extractant could also affect the quantity of phosphorus extracted. In $NaHCO_3$ extraction, the ratio of soil to extractant is 1:10 while in the AB-DTPA method it is 1:2, which means that more quantity of the extractant remained in contact with the soil for a longer time, resulting in greater quantities of phosphorus extracted from soil in the case of the Olsen method [11, 20]. Based on the soil and extractant ratio, the no. of soil samples that can be analysed with one litre of AB-DTPA extractant (50 Nos) was found to be that more than double the Olsen's extractant (20 Nos).

Table 2: Evaluation AB-DTPA extractant for soil phosphorus estimation in comparison to Olsen extractant ((kg ha^{-1})

S.No.	Soils No.	Olsen-P	ABDTPA-P
LOW P SOILS			
1	L_1	8	7
2	L_2	12	9
3	L_3	14	12
4	L_4	16	10
5	L_5	18	18
6	L_6	19	21
7	L_7	20	14
8	L_8	22	15
9	L_9	23	19
10	L_{10}	24	22
Mean		**18**	**15**
MEDIUM P SOILS			
11	M_1	30	23
12	M_2	35	30
13	M_3	38	22
14	M_4	42	36
15	M_5	49	46
16	M_6	50	34
17	M_7	52	53
18	M_8	56	59
19	M_9	57	42
20	M_{10}	59	60
Mean		**47**	**40**
HIGH P SOILS			
21	H_1	60	62
22	H_2	65	64
23	H_3	77	72
24	H_4	84	75
25	H_5	90	82
26	H_6	114	86
27	H_7	135	94
28	H_8	152	75
29	H_9	166	101
30	H_{10}	178	112
Mean		**112**	**82**
Overall Mean		59	46
Minimum		8	7
Maximum		178	112

Correlation Studies between two phosphorus extractants and soil physico – chemical properties

Phosphorus availability was influenced by several factors which in turn relate to extraction. Soil physicochemical properties such as pH, salt accumulation (EC) and organic carbon has a greater influence on phosphorus extraction in soils. A correlation coefficient was established between the available soil phosphorus extractant and soil physical chemical properties *viz.,* pH, EC and OC and given in Table 3.

Results indicated that both the extractants were negatively correlated with pH of the soils in medium and high phosphorus status soils. The overall soil has shown a negative correlation between the phosphorus extractants *viz.,* Olsen and ABDTPA and pH of the soil. The variation in the constitutional composition might alter pH of the soil medium differently and thereby the nutrient in the soil. Similar findings were observed in soils which are having pH > 7 [17]. The above findings confirm the results of [5,10 and 16].

A negative correlation was observed between the phosphorus extractants and total salt solubility of the soil. In low phosphorus status soils EC has shown a negative correlation with both the extractants while in medium status soils, it has shown a positive correlation but it is not significant. Olsen and AB DTPA phosphorus has shown non-significant with EC in overall soils. The above results were in accordance with the results found in soils which are having pH > 7 [15 and 17]. The overall soils were also non-significantly correlated with soil physico-chemical properties of soils.

The amount of phosphorus extracted by Olsen and AB-DTPA extractants are non-significantly correlated with organic carbon in various native phosphorus-status soils. Similar findings were also observed by [15, 14 and 17]. It might be due to an irreversible fixation of extractable-P by organic matter when the soil pH is high [14].

Table 3: Relationship among phosphorus extractants and soil physico-chemical properties

P Status	Parameter	pH	EC (dS m^{-1})	OC (g kg^{-1})
Low-P Soils	Olsen	0.485^{NS}	-0.204^{NS}	0.458^{NS}
Low-P Soils	ABDTPA	0.282^{NS}	-0.140^{NS}	0.179^{NS}
Medium-P Soils	Olsen	-0.692*	0.133^{NS}	0.113^{NS}
Medium-P Soils	ABDTPA	-0.642*	0.146^{NS}	0.217^{NS}
High-P Soils	Olsen	-0.413^{NS}	-0.04^{NS}	0.498^{NS}
High-P Soils	ABDTPA	-0.544^{NS}	0.036^{NS}	0.465^{NS}
Overall Soils	Olsen	-0.319^{NS}	0.038^{NS}	0.338^{NS}
Overall Soils	AB-DTPA	-0.374*	0.047^{NS}	0.290^{NS}

** Significant at 5%level NS Non-significant*

Correlation between Olsen and AB-DTPA Extractants

Phosphorus extractants (Olsen and AB-DTPA) are significantly correlated with one another irrespective of the native phosphorus status of soils and are presented in Table 4 and Fig. 1. The overall soils has shown a significant correlation coefficient (r=0.94**) between Olsen phosphorus and AB-DTPA phosphorus. The r values between ABDTA and Olsen in low, medium and high soils are 0.84**, 0.86** and 0.87** respectively.

© 2024 AATCC Review. All Rights Reserved.

Significant positive correlation between AB-DTPA and Olsen's extractant [7]. It was also found for cereals [19], legumes and oil seeds. In Islamabad soils also the correlation between the two extractants was found as 0.97** [18].The studies of [19] and [3] had observed similar relationship in loamy sand to loam soils of Ludhiana while in Gujarat soils the correlation coefficient was found to be 0.94** [14]. Similarly, AB DTPA phosphorus was strongly correlated with Olsen's phosphorus (r=0.95**) in neutral and alkaline soils of Tamil Nadu [9].

Table 4 Correlation studies between Olsen and AB-DTPA extractants

Extractants	AB-DTPA-P				
	Status	Low Soils	Medium Soils	High Soils	Overall Soils
Olsen-P	Low Soils	0.84**			
	Medium Soils		0.86**		
	High Soils			0.87**	
	Overall soils				0.94**

***Significant at1% level*

CONCLUSIONS

The above studies concludes that, the correlation between the two extractants was found to be 0.84** in low phosphorus status soils, 0.86** in medium phosphorus status soils while in high phosphorus status soils it was 0.87**. In overall soils also the two extractants are significantly and positively correlated with each other with co-efficient value r = 0.94**. In conclusion, it may be inferred that Olsen's and AB-DTPA extractable phosphorus were equally good indices for predicting phosphorus availability. Hence, AB-DTPA can be used as an extractant for the estimation of available P in neutral and alkaline soils.

Acknowledgement

The authors acknowledge Professor Jayashankar Telangana Agricultural University formerly PJTSAU, Hyderabad, Telangana for providing financial assistance and facilities during the above study.

Future Scope of Study

Phosphorus estimated through ABDTPA extractant should be correlated with phosphorus extracted through Olsens extractant in different kinds of soils.

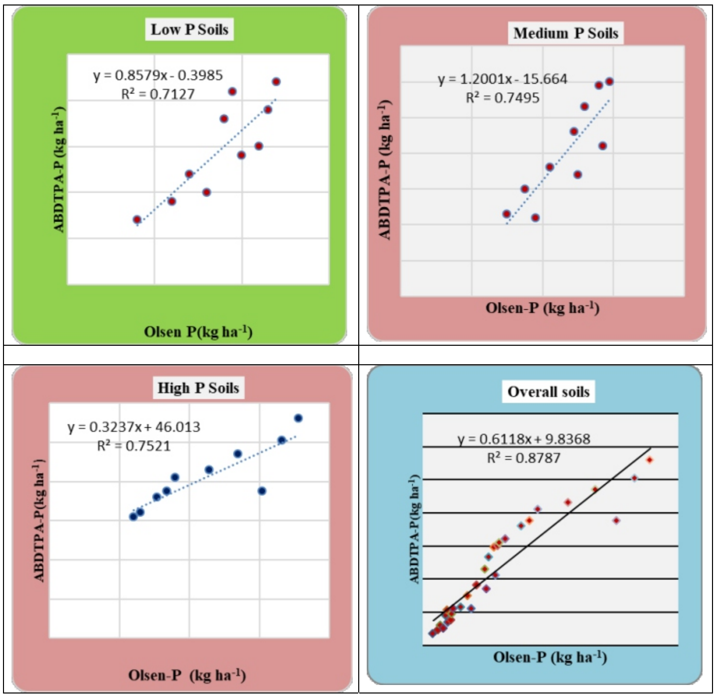

Fig 1 Correlation studies between Olsen and AB-DTPA extractants

REFERENCES

1. Alva, A.K. 1993. Comparison of Mehlich 3, Mehlich 1, ammonium bicarbonate-DTPA, 1.0 M ammonium acetate, and 0.2 M ammonium chloride for extraction of calcium, magnesium, phosphorus, and potassium for a wide range of soils. *Communications in Soil Science and Plant Analysis*. 24(7-8):603-612.

2. Bates, T.E. 1990. Prediction of phosphorus availability from 88 Ontario soils using five phosphorus soil tests. *Communications in Soil Science and Plant Analysis*. *21*(13-16):1009-1023.

3. Brar, B.S. Dhillon, N.S. and Chhina, H.S.2003. Response of wheat (*Triticum aestivum*) to applied phosphate in some flood plain soils of Punjab. *Indian Journal of Agriculture Science.* 73 (10):564-566.

4. Jackson, M. L.1973. Soil Chemical Analysis.Englewood Cliffs, New Jersey, USA: Prentice .

5. Kanwar, J.S.and Grewal, J.S.1960. Phosphate fixation in Punjab soils. *Journal of Indian Society of Soil Science*. 8 (1): 211-218.

6. Katy El Sitt. 2013. Comparison of the AB-DTPA method with the routine methods (Olsen, CH_3COONH_4) for extraction of P and K in soils of Crete, Greece. *M.Sc. (Ag.) Thesis*, International centre for advanced Mediterranean agronomic studies, Greece.

7. Labhsetwar, V. K and Soltanpour, P.N.1985. A comparison of NH_4HCO_3-DTPA, $CaCl_2$, and Na-EDTA soil tests for phosphorus. *Soil Science Society of Agriculture Journal.* 49: (437-1440).

8. Madurapperuma, W.S and Kumaragamage, D.2008. Evaluation of ammonium bicarbonate–diethylene triamine penta acetic acid as a multinutrient extractant for acidic lowland rice soils. *Communications in Soil Science and Plant Analysis*. 39(11-12):1773-1790.

9. Malathi, P and Stalin, P. 2018. Evaluation of AB - DTPA extractant for multinutrients extraction in soils. *International Journal of Current Microbiology and Applied Science.* 46*(2):113-119.*

10. Mehta, B.V and Patel, J.M.1963. Some aspects of phosphorus availability in Gujarat soils. *Journal of Indian Society of Soil Science.* 11(2): 151-158.

11. Olsen, S. R., Cole, C.V. Watanabe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus by extraction with sodium bicarbonate. United States: Department of Agriculture, *USDA* Cir. No-939.

12. Panse, C.G and Sukhatme, P.V.1967. Statistical methods for Agricultural Workers "2nd Edition, *Indian Council of Agricultural Research*. New Delhi.

13. Peck, T.R and Soltanpour, P.N.1990. The principles of soil testing. *Soil testing and plant analysis*. 3:1-9.

 © *2024 AATCC Review.* All Rights Reserved.

14. Rahman, G.K.M., Jahiruddin, M., Ali. Hoque, M.S and Haque, M.Q.1995. Effect of soil properties on the extraction of phosphorus and its critical limit for rice. *Journal of Indian Society of Soil Science.*43 (1): 67-71.

15. Rajesh Sharma.2004. Evaluation of soil test methods for available phosphorus and response of maize to phosphorus fertilization in different soils. *M.Sc. Thesis*, submitted to Anand Agricultural University.

16. Sharma, P.K and Kalia, A.K.1985. Factors influencing diffusion of phosphate in some soils of Himalayan Region. *Journal of Indian Society of Soil Sci*ence. 33(3): 278-285.

17. Sharma, S. K., Sharma, A., Rana, S and Kumar, N. 2018. Evaluation of multi-nutrient extractants for determination of available P, K, and micronutrient cations in soil. *Journal of plant nutrition*. 41(6): 782-792.

18. Shriniwas, Qureshi F. M. and Singh, N.1991. Relative efficiency of phosphatic fertilizers on the uptake of nutrients in wheat. *Journal of Nuclear Agriculture Biology.* 20 (3): 212-214.

19. Singh, B and Bishnoi, S.R. 1998. Evaluation of soil test methods of phosphorus in Udic *Ustochrepts*. *Journal of Indian Society of Soil Science*. 46(2):323-325.

20. Soltanpour, P. N and Workman, S.M. 1985. Modification of the NH_4HCO_3 – DTPA soil test to omit carbon black. *Communications in Soil Science and Plant Analysis.* 10: 1411 - 1420.

21. Soltanpour, P.N and Schwab, A.P.1977. A new soil test for simultaneous extraction of macro-and micro-nutrients in alkaline soils. *Communications in Soil Science and Plant Analysis. 8* (3):195-207.

22. Subbiah BV and Asija GL. 1956. A rapid procedure for the determination of available nitrogen in soils. *Current Science* 25(8): 259-260.

23. Walkley, A and Black, C.A.1934. An examination of Degt-Jreff method for determination soil organic matter and proposal for modification of the chromic acid titration method. *Soil Science.* 37: 29-38.

 © *2024 AATCC Review.* All Rights Reserved.