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Effect of Method of Planting and Application of Acidified Press Mud on Growth of Citrus Limon Plants, Soil Properties and Nutrients Availability in Impeded Alluvial Soil.

Karamvir Singh
Department of Agricultural chemistry, Kisan (P.G.) College, Simbhaoli, Hapur, (U.P.)
Email: drnehra21@gmail.com

***ABSTRACT**:*
The effect of application of Acidified Press Mud (pH: 4.0) on soil properties, nutrients availability and growth of Citrus limon (Lemon) plants by using different methods of planting in impeded alluvial soil was studied on the farmers field of Chand Ram at village Kharkbura in Jind district of Haryana (India) using three methods of planting in Aug 2001. The effect of three methods of planting (auger, pit and flat) and application of three doses of Acidified Press Mud i.e. To-Control (No Amendment), T_1=8kg APM plant and T_2=16kg APM plant was studied on growth of lemon plants where the soil had Kankar layer at 55cm depth. A total of 84 lemon plants were planted on 0.8 ha cropped land. During establishment stage 63 percent lemon plants were survived and 37 percent mortality was found which were replaced with new plants. Growth observations with regard to height of plants were recorded and final observations were taken in November, 2004. The results revealed that the Auger hole method of planting resulted in better growth in terms of both height and root depth of lemon plants. Average height of lemon plants during November, 2004 in Auger hole treatment was 190 90 cm in comparison to the average height of 169.10 em. and 157.20 cm in pit and flat methods of planting respectively. Root studies revealed that lemon roots grew to deeper depths (150cm) in the auger hole treatment in comparison to lesser depths in pit and flat methods of planting. Effect of APM application revealed that this amendment significantly increased the nutrient availability in the soil mainly by decreasing the soil pH levels and increasing the O.C. N. P. Zn. Fe and Mn. Results further showed that uptake of N. P. K. Ca, Mg, Zn, Fe and Mn by lemon plants significantly increased with the increasing doses of APM.

***Key words:** calcareous, impeded, Auger hole, acidified press mud, Lemon, saline)*

I. INTRODUCTION:

In the semi arid areas of Jind district, the irrigation is mostly through tube wells and in some areas tube well irrigation is supported through anal system Ground water is mostly saline and the depth of water table is more than 10 meter. Due to excessive withdrawal of ground waters, the depth of water table is increasing year after year. Generally, the water quality deteriorated with increasing depth. The limited rainfall of about 550mm per annum in these areas has further aggravated the problems as it has caused the development of Kankar layer in the root zone (Singh, et al 1985), which is hindrance to the root development especially of trees. The main crop rotation in these areas is Cotton-Wheat. Although cotton tolerates high salinity waters but this crop is most uncertain as it is attacked by many pests and diseases also. Many times, the attack of pests is so acute that whole crop is totally destroyed and the yields are very less to recover even the cost of cultivation. When some farmers incur heavy losses, they commit suicides. So. to reduce the heavy risk of total failure of cotton crop, there was need for diversification by introducing other crops preferably some useful fruit trees, which required less amount of water. Growing of suitable fruit trees could be helpful to avoid the risk of total loss of economic returns if the main crop of cotton fails due to drought and/or attack of insects and pests. If fruit trees are planted in between the growing cotton-wheat crops, there will be additional income from fruit trees after a growth period of about four years. In addition to the expected increased economic returns, planting of fruit trees will increase the organic carbon content in the deeper soil layers. There is need to develop technologies for the establishment and care of fruit trees during the initial few years of growth. New techniques such as Auger hole method of planting fruit trees have been developed for different soils such as Alkali soils but no studies have been reported for soils of Jind district where cotton-wheat crop rotation is followed and there is presence of impeded Kankar layer in the soil profile. The presence of calcium carbonate further complicates the problem as it adversely affects the status of available nutrients. There is increasing feeling that scientists should come forward to conduct research on farmer's fields to solve some of the problems being faced by the farmers on such calcic soils under irrigated conditions (Tyagi and Minhas, 1998)

Thus there is need to apply organic manure from other sources like Press Mud which is a by-product from Sugar mills in this area. This press mud has been converted into useful amendment named as Acidified Press Mud (Mehta1995-96) by treating press mud with low cost sulphuric acid and was used in 1996 in the field experiments on reclamation of alkali soils at CSSRI, research farm Shivery near Lucknow (Mehta, 1998). For the present studies, Press mud having p^H of 4.00 was prepared. In our country, there are more than 579 sugar mills producing more than 3 million tones of press mud every year. A part of this huge quantity of press-mud can be converted in to APM which can be used for improving problematic soils.

II. MATERIALS AND METHODS:

A field experiment was conducted on the fields of Sh. Chand Ram at Village Kharkbhura in Jind district of Haryana, India cotton-wheat crop rotation was followed. Eighty four lemon plants were planted by using three methods of planting i.e. (Auger hole 15cm diameter up to 150cm depth, Pit 60x60x60cm and Flat/control method. On 0.8 ha in the standing cotton crop during the rainy season i.e. August, 2001 by keeping the distance of 10 meters from row to row and plant to plant. Survival/mortality was noted from time to time and dead plants were replaced. A space of 1x1 meter was left for lemon plants for proper sun light and aeration. Cotton was sown in the month of May and wheat in the month of November each year. Farm yard manure was applied uniformly to Lemon plants in Feb.2003 for better establishment of lemon plants and required doses of NPK and pesticides were applied to both main crops and fruit plants. Acidified Press Mud was applied only to select 27 lemon plants, which had same age and almost same height. Nine lemon plants which represented each method of planting were given the treatment of APM doses @ 0,5,10 kg per lemon plant during July, 2003, second dose of APM @ 0, 3, 6 kg per lemon plants in July, 2004. Each treatment was replicated three times in completely randomized block design. Results are discussed based upon the final observation taken in November 2004. For doing the chemical analysis of leaves, samples were oven dried at 70 °C, ground and passed through 16-meshsieve. The die-acid (HNO_3 –$HCIO_4$, at a ratio of 3:1) was used to digest samples for Na & K using flame photometer. Calcium, magnesium and micronutrients were determined using Atomic Absorption Spectrophotometer. Nitrogen and phosphorus were determined by Auto kjeldahl and vanado-molybdo-phosphroric-yellow color method respectively. Soil samples were taken from the 30cm distance of plant and 0-15cm depths around the lemon plants where APM was applied. Samples were air dried, ground in wooden pestle and mortar, passed through 16mm sieve and stored for analysis. The soil pH, electric conductivity, organic carbon, available N, Olsen's P, K, Ca +Mg, Na in soil saturation extracts and DTPA extractable Zn, Mn, Fe and Cu were determined by standard procedures (Jackson 1973).

CHEMICAL COMPOSITION OF ACIDIFIED PRESS MUD (APM):

Press mud (pH 6.8) was brought from Karnal Co-operative sugar mills in laboratory and Acidified Press Mud was prepared by treating with low cost commercial grade sulphuric acid. The Acidified Press Mud had composition pH (1:4) 4:0, EC (1:4) 9:0 dSm^{-1} and Organic carbon, Organic matter, total nitrogen 24.23, 41.67, 1.55 and available nitrogen, phosphorous, potassium 0.07, 0.74, 0.4% respectively. Acidified Press Mud had also micronutrients such as Fe, Zn, Mn and Cu 1021, 54, 124, 37 parts per million respectively. The moisture content of prepared acidified press mud was 12 percent.

III. RESULTS AND DISCUSSION:

Effect of application of APM on Growth (Shoot) of Lemon plants:

The results revealed that auger method of planting was better than the flat and pit methods as the mean height attained by lemon plants was 190.90 cm. in case of auger method in comparison to 157.22 cm. of flat and 169.10 cm. of pit method (Table-1). Dagar, (2001) and Tomar, et. al (2004) also reported that the heights of plants were comparatively more when planted by Auger hole method than in the Pit method.

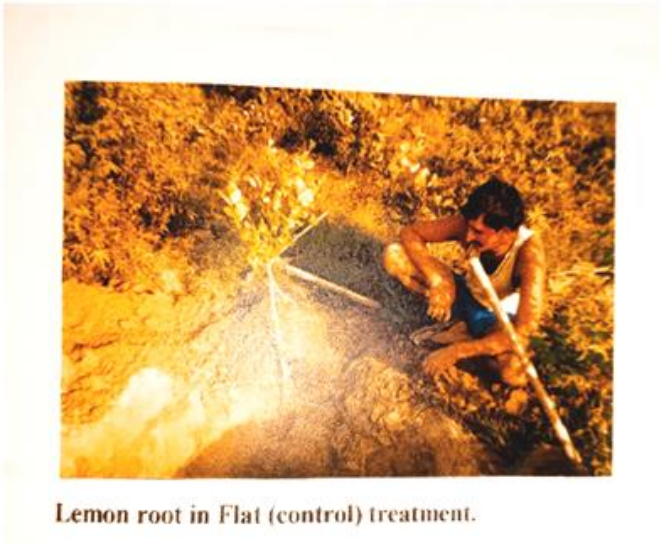
Table: 1 Effect of application of APM doses and different methods of planting on the average height (cm) of Lemon plants with time.

Methods of planting	October, 2003			November, 2004			CD. (p=0.05)
	T_o	T_1	T_2	T_o	T_1	T_2	
Flat	104.50	113.25	123.00	142.50	159.20	169.83	4.72
Pit	110.16	122.50	137.00	149.33	167.50	190.33	9.53
Auger	127.83	140.50	157.16	160.00	190.83	221.83	8.17

EFFECT OF DIFFERENT METHODS OF PLANTING ON ROOT GROWTH OF LEMON PLANTS:

Effects of three methods of plantation on growth of roots of lemon were studied the data revealed that in auger hole treatment, the roots grew up to 150 cm depth where as in pit method and flat method root growth was confined to 50 cm soil depth. This can be seen from the photographs (Fig.1) The thickness of roots of lemon plants in auger hole treatment had average thickness of 8.0 cm up to 40 cm soil depth where as mean thickness reduced to 3.0 cm at 40 to 70 cm., 1.0 cm. at 70 to 100 cm and hair type of root at 100 to 150 cm soil depth. The thickness of roots of lemon plants in pit method had mean thickness of 6.0 cm up to 18 cm soil depth where as mean thickness reduced to 3.0 cm at 18 to 50 cm and about fifteen roots hairs also continued to 50 cm. soil depth. Earlier studies of Abrol and Sandhu, (1980) reported that roots of eucalyptus grew up to 200 cm. deep to the soil where auger hole method of planting was used. These studies on shoot and root growth revealed that auger hole method was better than the surface and pit methods of plantation.

Fig: 1 Root growth study affected by different methods of planting.



Lemon root in Flat (control) treatment.

Lemon root in Auger treatment.

Lemon root in Pit treatment.

Table: 2 Effect of application of APM doses on soil properties and nutrients availability.

Treatments		pH_2	EC_2 (dSm^{-1})	O.C. %	Available N ($Kg\ h^{-1}$)	Olson's-P (ppm)
Flat Method	T_o	8.32	0.56	0.34	78.40	8.62
	T_1	7.73	0.84	0.72	106.43	25.28
	T_2	7.33	1.17	0.81	121.73	68.07
CD. (p=0.05)		0.353	0.15	0.097	16.07	4.26
Pit Method	T_o	8.30	0.51	0.29	67.0	8.74
	T_1	7.59	0.82	0.74	106.70	27.55
	T_2	7.25	1.03	0.85	140.01	69.90
C D. (p=0.05)		0.101	0.13	0.011	16.25	4.36
Auger	T_o	8.22	0.78	0.40	84.90	9.93

Method	T_1	7.56	0.97	0.76	117.30	28.92
	T_2	7.21	1.17	0.94	141.20	76.43
CD. (p=0.05)		0.214	0.09	0.092	11.87	5.25

EFFECT OF APPLICATION OF APM ON SOIL PROPERTIES AND NUTRIENTS AVAILABILITY:

The results showed that the effect of application of APM decreased the soil pH_2 significantly in all the three methods of planting was probably due to quantity of APM mixed to the soil, low pH of the added material and high carbon content and an appreciable increase in EC was observed due to probably higher concentration of dissolved salts in APM (Table-2). Similar results leading to reduction in soil pH, increase in O.C, available N & P were reported with the application of acidic materials.

Similar results were obtained with the application of H_2SO_4 and other acid forming materials Ryan, et al, and Sutaria, et al (1992). Organic carbon content, available nitrogen, available phosphorous were significantly increased with the increasing levels of APM application (Table-2). Kapur, (1995), Singh, et al (1999) and Perez, et al (2002) also reported increase in soil O.C., nitrogen, available P when treated with sulphitation cane filter cake.

EXCHANGEABLE K, Na & Ca+Mg IN SOIL SATURATION EXTRACT:

Potassium and Calcium+Megnisium in soil saturation extract significantly increased and Sodium content significantly decreased with the increasing APM doses in all the three methods of planting (Table-3). The acidic nature of APM mobilizes the native Ca^{++}, which facilitates replacement of Na^{+} ions. Similarly, Kapur, (1995) reported build up of K nutrient in SCFC treated soil. Singh, et al (1999) also reported increase in soil Ca+Mg and decrease in Na content when soil was treated with Sulphitation Cane Filter Cake.

Table: 3 Effect of application of APM doses on K, Ca Mg, and Na in soil saturation extract in different methods of planting.

Treatments		K (ppm)	Ca+Mg (meql-1)	Na (ppm)
Flat Method	T_0	11.63	19	508.99
	T_1	26.91	30.67	420.44
	T_2	34.07	40	237.36
CD. (p=0.05)		5.23	6.04	71.09
Pit Method	T_0	10.21	19.33	501.17
	T_1	29.38	30	416.30
	T_2	35.07	43	207.92
CD. (p=0.05)		6.84	9.60	57.44
Auger Method	T_o	10.65	19.33	468.74
	T_1	33.15	32.67	413.54
	T_2	43.39	43.33	200.90
C D. (p=0.05)		4.38	2.88	59.10

DTPA EXTRACTABLE Zn, Fe, Mn AND Cu:

Effect of application of APM doses on DTPA extractable micronutrients i.e. Zn, Fe and Mn were significantly increased in all the three methods of planting was probably due to quantity of APM mixed to the soil and Cu was increased non-significantly with the increasing APM levels in all the three methods of planting (Table-4).

Table: 4 Effect of application of APM doses on DTPA extractable micronutrients in different methods of planting.

Treatments		Mean value in ppm			
		Zn	Fe	Mn	Cu
Flat Method	T_0	1.13	8.97	12.81	1.57
	T_1	1.75	13.43	16.63	1.77
	T_2	2.10	15.27	19.02	1.41
CD. (p=0.05)		0.16	2.76	3.22	3.22
Pit Method	T_0	1.51	9.23	14.15	1.60
	T_1	2.01	13.80	17.87	1.83
	T_2	2.21	18.40	25.65	1.34
CD. (p=0.05)		0.19	4.51	2.95	2.95
Auger Method	T_0	1.85	11.10	16.67	1.62
	T_1	2.14	18.0	19.75	2.66
	T_2	2.50	25.46	28.37	1.35
CD. (p=0.05)		0.09	2.98	3.06	3.06

CHEMICAL COMPOSITION OF LEAVES OF LEMON PLANTS:

The results showed that application of APM doses and three methods of planting on Lemon plants had significant effect on nutrients uptake. Effect of treatment on mean concentration of N, P, K, Ca, and Mg of Lemon leaves are increased except Na is reported in (Table-5). These results are similar to the results obtained earlier by Balsaraf and Mohite, (1994) who reported higher uptake of nitrogen by maize plants when FYM & PMC was applied to calcareous soils. Low Na concentration in lemon leaves in treated soil was probably due to a decrease in the exchangeable sodium percentage as a result of APM application. Singh, et al (1999) also reported increased uptake of K, Ca and Mg and low concentration of Na in leaves of Pomegranate when SCFC amendment was applied to calcareous soil.

Table: 5 Effect of application of APM doses and different methods of planting on various nutrients uptake by Lemon plants leaves.

Treatments		Mean value of Nutrients in %					
		N	P	K	Ca	Mg	Na
Flat Method	T_0	1.10	0.062	0.28	1.08	0.19	0.059
	T_1	1.15	0.067	0.31	1.29	0.22	0.046
	T_2	1.32	0.073	0.40	1.37	0.28	0.034
CD. (p=0.05)		0.038	0.0008	0.021	0.121	0.020	0.0041
Pit Method	T_0	1.10	0.063	0.28	1.13	0.21	0.059
	T_1	1.35	0.082	0.36	1.25	0.23	0.041
	T_2	1.50	0.090	0.43	1.48	0.30	0.031
C D. (p=0.05)		0.030	0.0013	0.008	0.043	0.005	0.0018
Auger Method	T_0	1.16	0.080	0.30	1.19	0.19	0.054
	T_1	1.48	0.094	0.40	1.39	0.26	0.029
	T_2	1.61	0.113	0.44	1.60	0.31	0.021
C D. (p=0.05)		0.082	0.0025	0.019	0.053	0.004	0.0031

Abbaspour, (2004) reported increase in P concentration of Maize plant where acidified converter sludge was applied to calcareous soils. Similarly increase in K uptake was reported by Yadav, et al (1991) with the application of FYM and SCFC amendment.

Table: 6 Effect of application of APM doses and different methods of planting on micronutrients uptake by Lemon plants leaves.

Treatments		mean value in mg kg^{-1}			
		Zn	Fe	Mn	Cu
Flat Method	T_0	16.67	62.33	52.13	6.6
	T_1	29.17	93.33	81.97	7.3
	T_2	44.0	118.67	100.67	6.0
CD. (p=0.05)		6.47	15.77	9.23	1.03
Pit Method	T_0	17.50	71.0	54.32	7.2
	T_1	32.17	103.33	85.33	8.0
	T_2	47.17	123.0	112.67	6.8
CD. (p=0.05)		4.41	23.89	20.52	0.93
Auger Method	T_0	19.33	71.0	59.17	7.3
	T_1	38.0	116.67	97.17	8.8
	T_2	41.50	140.0	128.83	7.0
C D. (p=0.05)		5.21	14.56	9.31	1.28

The results showed that application of APM doses and three methods of planting on Lemon plants had significant effect on micronutrients nutrients uptake (Table-6). Fenn, et al (1990) investigated that the acidification of root zone increased the uptake of Zn by Pecan tree. Kaplan and Orman, (1998) reported that increased the uptake of Mn by plant due to application of elemental sulphur & sulphur containing waste to calcareous soil. Abbaspour, (2004) also reported increase in Fe and Cu concentration of Maize plant where acidified converter sludge was applied to calcareous soils.

The above studies revealed that Auger hole method of planting was better for calcareous soils having impeded layer in root zone for better growth of shoot and root of lemon plants, and application of APM increased the soil nutrients availability and uptake of both major and micro nutrients to lemon plants.

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