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Survey of primary nutrient status of kinnow orchard in irrigated area of Sri Ganganagar district of Rajasthan

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Abstract
The experiment was conducted on "Survey of primary nutrient status of kinnow orchard in irrigated area of Sri Ganganagar district of Rajasthan" during April, 2016 to April, 2017. The ninety soil samples with three depths *i.e.,* 0-30, 30-60 and 60-90 cm were collected from thirty kinnow orchards from different five tehsil (Suratgarh, Raisinghnagar, Sri Vijaynagar, Sri Karanpur and Sriganaganagar) of Sri Ganganagar district. The soil samples were analyzed for nutritional status of kinnow orchards being grown at farmers field. The kinnow orchard soils in this investigation were found low in organic carbon and available Nitrogen, medium in available phosphorus, medium to high in available potassium low to high in available, respectively.

Keywords: primary nutrient status, kinnow orchard, irrigated area

Introduction
India has large arid zones covering an area of 317090 sq km mainly located in the North-West parts of the country Rajasthan alone covers 62 per cent area under arid zone. Fruit cultivation in India is spread over an area of 6.8 million hectares with 92.84 MT fruit production (NHB 2016-17) [1]. In Rajasthan, fruit crops cover an area of 46.5 thousand hectares, out of which area under kinnow cultivation is 8821 hectare and production is 189483 tonnes (Rajasthan Agricultural Statistics at a glance) indicated that still there is a scope to increase the area and productivity level of kinnow fruits cultivation in the state. Kinnow mandarin is one of the introduced citrus varieties, occupies a predominant place in the citrus industry of India. Most of the kinnow growing areas are confined to north western arid zones of India. Introduction of kinnow to this area changed the landscape of arid Thar Desert. North western India is characterized by low rainfall with temperature ranging from 5^0C in winter to 48^0C in summer having soil type of old alluvium to sandy. Soils are mainly alkaline with pH ranging from 7.5 to 9.0. The production of high quality fruits of kinnow requires semi-arid and subtropical climate with less than 300 mm rainfall. It can grow successfully in almost all types of soils, but deep sandy loam soils are best suitable for kinnow orchard.

Materials and Methods
The investigation entitled "fertility status of primary nutrient in kinnow orchard in irrigated area of Sri Ganganagar district of Rajasthan" was under taken during April 2016 to April 2017. The materials used and the methods followed the course of investigation are described in this chapter.

Location
Kinnow orchards under study are located in different villages/chaks of Sri Ganganagar district comprising a part of Agro climate zone I b (Irrigated north-western plain) of Rajasthan. It is situated between $28°4^1$ to $30°6^1$ north latitude and $72°31^1$ 'to 75° east longitude. It is surrounded by Firozepur district of Punjab in north; Hanumangarh district in east; Bikaner district in south and the international border of the Pakistan in north and north-west. The details of kinnow fruit growers given in table 1 and soil.

Characteristics of soil
The soils have developed from alluvial deposit of river Gaggar in the of flood plains of Sri Ganganagar district and are yellowish brown to light grey, well drained medium soil texture which varies from sandy loam to loam. In the upper layer in some pockets is calcareous but the lower horizons are calcareous in nature with accumulation of concentrations.

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Soil sampling and analysis
Collection of soil samples
Soil sample were collected from 30 Kinnow orchards located at different locations of Sri Ganganagar district. In all one hundred twenty representative of composite soil samples from different depths *viz;* 0-30, 30-60, 60-90 cm were collected. Samples were air dried, ground and passed through 2 mm sieve and stored properly labeled polythene bags for analysis. The methods of soil analysis are given in table 2.

Table 1: Methods of soil analysis

S. No.	Properties	Procedure	Reference
		Soil available nutrients	
1	Nitrogen (kg ha^{-1})	Alkaline permanganate method	Subbiah and Asija (1956) [2]
2	Phosphorus (kg P_2O_5 ha^{-1})	Extract by 0.5 M $NaHCO_3$ at pH 8.5 and development of colour for colorimetric measurement	Olsen *et al.* (1956) [3]
3	Potassium (kg K_2O ha^{-1})	Extract with neutral normal ammonium acetate and estimation by flame photometer	Metson (1956) [4]

Table 2: Details of the kinnow fruit orchards surveyed in Sriganganagr district of Rajasthan

S. No.	Farmer's Name	Symbol	Village/Chack	Tehsil
1.	Sh. Hajur Baba Deva Singh	L_1	9GB	Suratgarh
2.	Sh. Meghraj Singh	L_2	9GB	Suratgarh
3.	Sh. Sudesh Choudhary	L_3	9GB	Suratgarh
4.	Sh. Ashok Kumar	L_4	9GB	Suratgarh
5.	Sh. Hanuman Bishnoi	L_5	9GB	Suratgarh
6.	Sh. Pritrhvi Singh	L_6	9GB	Suratgarh
7.	Sh. Shinghara Singh	L_7	3BLM	Raisinghnagar
8.	Sh. Mangilal	L_8	3BLM	Raisinghnagar
9.	Sh. Vishnudutt	L_9	3BLM	Raisinghnagar
10	Sh. Indra Godara	L_{10}	3BLM	Raisinghnagar
11.	Sh. Baldev Singh	L_{11}	3BLM	Raisinghnagar
12.	Sh. Kartar Singh	L_{12}	3BLM	Raisinghnagar
13.	Sh. Budharam	L_{13}	1BGM	Sri Vijaynagar
14.	Sh. Om Prakash	L_{14}	1BGM	Sri Vijaynagar
15.	Sh. Ram Goplal	L_{15}	1BGM	Sri Vijaynagar
16.	Sh. Parmendra Singh	L_{16}	1BGM	Sri Vijaynagar
17.	Sh. Ram Singh Saharan	L_{17}	1BGM	Sri Vijaynagar
18.	Sh. Jugal Kishore Sharma	L_{18}	1BGM	Sri Vijaynagar
19.	Sh. Dhudhaar Singh	L_{19}	6OB	Sri Karanpur
20.	Sh. Lakhvindra Singh	L_{20}	6OB	Sri Karanpur
21.	Sh. Sadul Singh	L_{21}	6OB	Sri Karanpur
22.	Sh. Balvindra Singh	L_{22}	6OB	Sri Karanpur
23.	Sh. Balihaar Singh	L_{23}	6OB	Sri Karanpur
24.	Sh. Natha Singh	L_{24}	6OB	Sri Karanpur
25.	Sh. Dwarka Prasad	L_{25}	2M (Pussewala)	Sri Ganganagar
26.	Sh. Kishan Lal	L_{26}	2M (Pussewala)	Sri Ganganagar
27.	Sh. Mohan Lal	L_{27}	2M (Pussewala)	Sri Ganganagar
28.	Sh. Tara Chand	L_{28}	2M (Pussewala)	Sri Ganganagar
29.	Sh. Dileep Kumar	L_{29}	2M (Pussewala)	Sri Ganganagar
30.	Sh. Ram Kumar	L_{30}	2M (Pussewala)	Sri Ganganagar

Results and Discussion
Fertility status
In all, 90 soil samples were collected from 30 different orchards from the area under study at various depths and analyzed for soil fertility parameters *viz.,* organic carbon, nitrogen, phosphorus, and potassium. These parameters contribute to great deal both directly and indirectly to the growth and development of the plants of kinnow. Data regarding these essential nutrients are presented in Table 3 to 5.

Table 3: Available nitrogen (kg ha^{-1}) in Kinnow orchards of Sri Ganganagar district at different soil depths

Sample No.	Depths (cm)			Mean
	0-30	30-60	60-90	
L$_1$	32.90	29.98	23.69	28.86
L$_2$	34.10	30.76	22.56	29.14
L$_3$	32.96	30.51	21.35	28.27
L$_4$	30.80	27.87	20.78	26.49
L$_5$	33.45	30.71	19.89	28.02
L$_6$	32.05	28.86	22.51	27.81
L$_7$	65.90	49.15	33.49	49.51
L$_8$	63.00	48.15	34.39	48.51
L$_9$	65.25	49.45	31.41	48.70
L$_{10}$	62.35	49.30	29.96	47.20
L$_{11}$	63.80	45.25	35.33	48.13
L$_{12}$	64.20	44.20	28.78	45.73
L$_{13}$	111.87	86.13	75.45	91.15
L$_{14}$	112.26	94.65	73.15	93.35
L$_{15}$	112.45	86.90	73.98	91.11
L$_{16}$	108.97	85.16	70.71	88.28
L$_{17}$	108.58	85.94	72.38	88.97
L$_{18}$	109.36	83.81	74.82	89.33
L$_{19}$	65.75	42.30	40.48	49.51
L$_{20}$	65.75	39.08	42.56	49.13
L$_{21}$	61.15	38.16	39.36	46.22
L$_{22}$	65.29	36.32	39.32	46.98
L$_{23}$	66.21	36.78	38.79	47.26
L$_{24}$	72.64	38.62	37.44	49.57
L$_{25}$	131.00	95.10	77.25	101.12
L$_{26}$	134.60	98.75	59.98	97.78
L$_{27}$	132.80	102.30	79.45	104.85
L$_{28}$	114.90	86.15	69.18	90.08
L$_{29}$	107.70	80.80	65.29	84.60
L$_{30}$	125.65	82.60	79.26	95.84
Minimum	30.80	27.87	19.89	-
Maximum	134.60	102.30	79.45	-
Average	79.59	58.79	47.77	-
C.V.	43.17	44.45	45.49	-

Available nitrogen
Data on available soil N, status at different depths of orchard soils are presented in Table 3. Data indicates that the available N content of surface soil (0 to 30 cm) of orchards varied between 30.80 to 134.60 kg ha^{-1} with mean value of 79.59 kg ha^{-1}, The minimum available N content (30.80 kg ha^{-1}) was obtained in soil of orchard L$_4$ and maximum value (134.60 kg ha^{-1}) in L$_{26}$. The data related to the available N content of soil depths (30 to 60 cm and 60 to 90 cm) revealed that available N varied between 27.87 to 102.30 kg ha^{-1} and 19.89 to 79.45 kg ha^{-1} with its mean value of 58.79 and 47.77 kg ha^{-1}, respectively. Distribution of available N showed a regular decreasing trend with depth. Similarly result are found Kumar (2004) [6], Gathala *et al.* (2004) [7].
Subbiah and Asija (1956) [2] suggested <250 (Low), 250-500 (Medium) and >500 (High) kg N ha^{-1} as critical limit for available N. Considering the limit given by Subbiah and Asija (1956) [2] all the soil samples were found low in available N content in all the soil depths (0-30, 30-60 and 60-90 cm soil depth).

Available phosphorus
A close study of data in Table 4 elucidates that the available P$_2$O$_5$ content in surface soils (0-30 cm depth) of kinnow orchards located in Sri Ganganagar district ranged between 27.74 to 43.85 kg ha^{-1} with mean value of 34.32 kg ha^{-1}.
The lowest amount of available P$_2$O$_5$ in surface soils was recorded in L$_5$ and highest in soils of orchard L$_{15}$. Soil samples of 30 to 60 cm depth, available P$_2$O$_5$ varied from 23.09 to 40.07 kg ha^{-1}. The minimum and maximum amount of available P$_2$O$_5$ in soils at this depth was observed in soils of orchards L$_5$ and L$_{15}$ with its mean value was 31.79 kg ha^{-1} respectively. Further, the available P$_2$O$_5$ content of soils at 60 to 90 cm depth ranged between 20.46 to 31.58 kg ha^{-1} with its mean value of 25.39 kg ha^{-1} respectively. The lowest and highest amount of available P$_2$O$_5$ was observed in soils of orchard L$_{29,}$ L$_{23}$ and L$_{12}$, respectively. The available P$_2$O$_5$ content was found to decrease with depth in most of the soils. This might be due to low mobility of P$_2$O$_5$. The same result was recorded by Dhale and Prasad (2009) [9] and Reddy *et al.* (2003) [8].
Muhr *et al.* (1965) [5] suggested <20 (Low), 20-50 (Medium) and >50 (High) kg P$_2$O$_5$ ha^{-1} as critical limit for available P$_2$O$_5$ kg ha^{-1}. Considering the limit given by Muhr *et al.* (1965) [5] all the samples found in medium in available P$_2$O$_5$ kg ha^{-1} at 0-30, 30-60 and 60-90 cm depth of soil.

Table 4: Available phosphorus (kg ha^{-1}) in kinnow orchards of Sri Ganganagar district at different soil depths

Sample No.	Depths (cm)			Mean
	0-30	30-60	60-90	
L$_1$	28.56	25.86	23.56	25.99
L$_2$	28.97	25.05	23.75	25.92
L$_3$	31.78	29.83	22.56	28.06
L$_4$	33.59	29.49	21.55	28.21
L$_5$	27.74	23.09	22.88	24.57
L$_6$	28.36	24.57	21.15	24.69
L$_7$	38.10	35.88	27.76	33.91
L$_8$	36.94	34.72	27.12	32.93
L$_9$	36.81	34.59	25.63	32.34
L$_{10}$	37.07	34.85	29.14	33.69
L$_{11}$	36.94	34.72	26.52	32.73
L$_{12}$	38.10	35.88	31.58	35.19
L$_{13}$	40.77	37.82	29.35	35.98
L$_{14}$	35.38	32.50	29.38	32.42
L$_{15}$	43.85	40.07	30.58	38.17
L$_{16}$	36.92	35.85	28.76	33.84
L$_{17}$	34.62	32.11	31.14	32.62
L$_{18}$	42.31	37.85	26.57	35.58
L$_{19}$	32.90	29.63	23.44	28.66
L$_{20}$	34.10	27.49	25.21	28.93
L$_{21}$	32.96	31.42	21.45	28.61
L$_{22}$	30.80	30.78	26.22	29.27
L$_{23}$	33.45	33.36	20.46	29.09
L$_{24}$	32.05	31.82	24.65	29.51
L$_{25}$	33.00	29.63	23.44	28.69
L$_{26}$	30.00	27.49	25.21	27.57
L$_{27}$	34.00	31.42	21.45	28.96
L$_{28}$	33.50	30.78	26.22	30.17
L$_{29}$	31.50	33.36	20.46	28.44
L$_{30}$	34.50	31.82	24.65	30.32
Minimum	27.74	23.09	20.46	-
Maximum	43.85	40.07	31.58	-
Average	34.32	31.79	25.39	-
C.V.	11.60	13.03	12.87	-

Available potassium

Data pertaining to available K content of soils of kinnow orchards are presented in Table 5 Data revealed that the available K content of surface soil (0-30 cm) varied between 171.98 to 480.77 kg ha^{-1} with the mean value of 377.56 kg ha^{-1}. The minimum available K content (171.98 kg ha^{-1}) was recorded in L$_3$ while its maximum value (480.77 kg ha^{-1}) was recorded in L$_{15}$ orchard with thw mean value of 377.56 kg ha^{-1}, respectively.

Data related to the K content of soil depths (30-60 and 60-90 cm) indicate that the available K content ranged between 149.33 to 457.20 kg ha^{-1} and 158.75 to 390.24 kg ha^{-1} with the mean value in the range of 30-60 cm and 60-90 cm depth of soil was recorded 356.00 kg ha^{-1} and 301.76 kg ha^{-1}, respectively. Muhr *et al.* (1965) [5] suggested <125 (Low), 125-300 (Medium) and >300 (High) kg K$_2$O ha^{-1} as critical limit for available K$_2$O kg ha^{-1}. Considering the limit given by Muhr *et al.* (1965) [5] 20.00 and 80.00 per cent samples found in medium and high in available K$_2$O kg ha^{-1} at 0-30 cm depth of soil, respectively. While, 80.00 and 20.00 per cent samples found in low and medium in available K$_2$O kg ha^{-1} at 30-60 cm depth of soil, respectively. Further, data presented in appendix 40.00 and 60.00 per cent samples found medium and high in available K$_2$O kg ha^{-1} at 60-90 cm depth of soils. Similarly results are found by Dhale and Prasad (2009) [9] and Singh and Chanda (2012).

Table 5: Available potassium (kg ha^{-1}) in kinnow orchards of Sri Ganganagar district at different soil depth

Sample No.	Depths (cm)			Mean
	0-30	30-60	60-90	
L$_1$	184.91	171.77	165.46	174.05
L$_2$	184.91	169.91	163.56	172.80
L$_3$	171.98	149.33	162.98	161.43
L$_4$	183.62	165.75	162.12	170.50
L$_5$	186.21	173.65	158.75	172.87
L$_6$	204.31	196.22	160.32	186.95
L$_7$	419.52	380.41	345.23	381.72
L$_8$	420.97	417.30	345.16	394.48
L$_9$	421.69	381.49	358.75	387.31
L$_{10}$	408.63	375.16	364.26	382.68
L$_{11}$	407.18	388.93	369.34	388.48

L12	410.08	394.82	355.65	386.85
L13	467.95	441.64	388.45	432.68
L14	448.72	421.64	356.24	408.87
L15	480.77	450.56	390.24	440.52
L 16	410.26	384.31	382.19	392.25
L17	384.62	357.38	375.68	372.56
L18	467.95	443.33	377.56	429.61
L19	339.40	323.75	269.46	310.87
L20	367.95	345.00	270.58	327.84
L21	399.50	384.45	289.30	357.75
L22	414.05	388.30	280.42	360.92
L23	400.15	384.85	267.65	350.88
L24	374.00	346.95	266.59	329.18
L25	471.00	446.40	330.50	415.97
L26	452.25	426.30	345.35	407.97
L27	472.50	456.60	329.54	419.55
L28	446.25	416.10	339.00	400.45
L29	459.75	440.40	345.26	415.14
L30	465.75	457.20	337.18	420.04
Minimum	171.98	149.33	158.75	-
Maximum	480.77	457.20	390.24	-
Average	377.56	356.00	301.76	-
C.V.	27.33	28.16	26.42	-

Conclusion
Available nitrogen
The available N content of surface soil (0 to 30 cm) of orchards varied between 30.80 (L4) to 134.60 (L26) kg ha^{-1} with mean value of 79.59 kg ha^{-1}. The data related to the available N content of soil depths (30 to 60 and 60 to 90 cm depths of soils) revealed that available N varied between 27.87 (L4) to 102.30 (L27) kg ha^{-1} and 19.89 (L5) to 79.45 (L27) kg ha^{-1} with its mean value of 58.79 and 47.77 kg ha^{-1}, respectively. The soils of the study area were found low in available nitrogen and it showed decreasing trend with increase in depth of soil.

Available phosphorus
The available P$_2$O$_5$ of study area varied from 27.74 (L5) to 43.85 (L15), 23.09 (L5) to 40.07 (L15) and 20.46 (L29, L23) to 31.58 (L12) at 0-30, 30-60 and 60-90 cm soil depths with mean values of 34.32, 31.79 and 25.39 kg ha^{-1}, respectively. The soils of study area were found medium in available phosphorus content. In most of soils, the available phosphorus showed decreasing trend with depth.

Available potassium
The available K$_2$O content of surface soil (0-30 cm) varied between 171.98 (L3) to 480.77 (L15) kg ha^{-1} with the mean value of 377.56 kg ha^{-1}. In 30-60 and 60-90 cm soil depths the available K$_2$O content ranged between 149.33 (L3) to 457.20 (L30) kg ha^{-1} and 158.75 (L5) to 390.24 (L15) kg ha^{-1} with the mean value 356.00 and 301.76 kg ha^{-1}, respectively. The available K$_2$O in soil is medium to high in different orchards. The available potassium showed decreasing trend with depth.

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