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Studies on the response of integrated nutrient management on leaf nutrient status of date palm under arid condition

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Abstract
The effect of organic and inorganic sources of NPK and foliar spray of micronutrient on plant leaf nutrient content was studied. Experimental findings revealed that treatment T_{18} significantly increased the plant leaves N, P, K, Fe and Zn content. Therefore, it is advocated that application of 100 kg FYM + 1.50 kg N + 1.00 kg P_2O_5 + 1.50 kg K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$ (T_{18}) build up maximum leaf nutrient status and sustainable production of date palm in Bikaner condiation.

Keywords: Organic, Inorganic, Micronutrient, FYM

Introduction
The date palm (*Phoenix dactylifera* L.) is one of the important and potential fruit crop of arid irrigated region in India. It is being grown in the state of Gujarat, Punjab and Rajasthan. It is a dioecious tree plant that produces the economically popular fruits called 'dates' that are eaten as dessert. It requires almost rain free conditions during the fruiting season particularly at the time of fruit ripening to avoid spoilage of fruit due to rains. The climatic conditions of Thar desert especially in Western districts of Rajasthan (Bikaner, Jaisalmer and Barmer) and part of Kachchh district of Gujarat are suitable for cultivation of dates. The cultivated area of this crop was 8,973 hectare with production 0.54 lakh MT during the year 2000-01 but the area increased to 16,668 hectare with annual fruit production of 1.24 lakh MT of dates during 2009-10 in Bhuj, Anjar, Khedio, Mundra, Mandvi, Gadsissa and Kachchh district of Gujarat (Muralidharan *et al*., 2011) [12]. However, in Rajasthan, the area under date cultivation is about 800 hectare which is increasing fast with the plantation of tissue cultured plants obtained from Al-Ain, UAE under Public Private Partnership (Govt. of Rajasthan and Atul Ltd.) under RKVY.

Owing to the increasing area under date palm cultivation there is an urgent need for development of nutritional package for date palm in western arid part of Rajasthan to attain long term sustainability for fruit production and quality for maintaining soil productivity. Integrated plant nutrient supply system encourages integration of different sources of nutrients such as organic, biological and inorganic fertilizers etc. Date palm crop with certain floor management aspect through integrated nutrient management would be improved nutrient content of leaves that affects both productivity and quality of produce and also contribute substantial share in cost of production (Rathore *et al*., 2013) [15]. Although micronutrients are required in minute quantities but have the some agronomic importance as macro nutrients have and play a vital role in the growth of plants. Micronutrients also increase plant productivity, leaf nutrient status and yield. Most of the micronutrients, are associated with the enzymatic system of plants. Whenever a micronutrient is deficient the abnormal growth of plant result which some time cause complete failure of crop plants. They are very efficient, and minute quantities produce optimum effects. Keeping this in view the present experiment was conducted.

Materials and Methods
The present investigation conducted at Date Palm Research Centre and Department of Horticulture, College of Agriculture of Swami Keshwanand Rajasthan Agriculture University, Beechwal, Bikaner during October 2014 to July 2016.

The experiment was laid out in Randomized Block Design with three repalcation and eighteen integrated nutrient management treatments combinations *viz*., T_1 (Control), T_2 (0 FYM+0 N+0 P_2O_5+0 K_2O+0.50% $FeSO_4$+0.25 % $ZnSO_4$),T_3 (0 FYM+0 N+0 P_2O_5+0 K_2O+1.00% $FeSO_4$ + 0.50 % $ZnSO_4$), T_4 (25 FYM+0.50 N+0.25 P_2O_5+0.50 K_2O+0% $FeSO_4$+0% $ZnSO_4$), T_5 (25 FYM+0.50 N+0.25 P_2O_5+0.50 K_2O+0.50% $FeSO_4$+0.25% $ZnSO_4$), T_6 (25 FYM+0.50 N+0.25 P_2O_5+0.50 K_2O+1.00% $FeSO_4$+0.50% $ZnSO_4$) T_7 (50 FYM+1.00 N+0.50 P_2O_5+1.00 K_2O+0% $FeSO_4$+0% $ZnSO_4$), T_8 (50 FYM+1.00 N+0.50 P_2O_5+1.00 K_2O+0.50% $FeSO_4$+0.25% $ZnSO_4$), T_9 (50 FYM+1.00 N+0.50 P_2O_5+1.00 K_2O+1.00% $FeSO_4$+0.50% $ZnSO_4$), T_{10} (100 FYM+0.50 N+0.25 P_2O_5+0.50 K_2O+0% $FeSO_4$+0% $ZnSO_4$), T_{11} (100 FYM+0.50 N+0.25 P_2O_5+0.50 K_2O+0.50% $FeSO_4$+0.25% $ZnSO_4$), T_{12} (100 FYM+0.50 N+0.25 P_2O_5+0.50 K_2O+1.00% $FeSO_4$+0.50% $ZnSO_4$), T_{13} (100 FYM+1.00 N+0.50 P_2O_5+1.00 K_2O+0% $FeSO_4$+0% $ZnSO_4$), T_{14} (100 FYM+1.00 N+0.50 P_2O_5+1.00 K_2O+0.50% $FeSO_4$+0.25% $ZnSO_4$), T_{15} (100 FYM+1.00 N+0.50 P_2O_5+1.00 K_2O+1.00% $FeSO_4$+0.50% $ZnSO_4$), T_{16} (100 FYM+1.50 N+1.00 P_2O_5+1.50 K_2O+0% $FeSO_4$+0% $ZnSO_4$), T_{17} (100 FYM+1.50 N+1.00 P_2O_5+1.50 K_2O+0.50% $FeSO_4$+0.25% $ZnSO_4$) and T_{18} (100 FYM+1.50 N+1.00 P_2O_5+1.50 K_2O+1.00% $FeSO_4$+0.50% $ZnSO_4$). The treatments were applied on last week of October. Nitrogen was applied in two split doses *i.e*., ½ in October + ½ in March. Iron and zinc were applied as foliar spray twice, first in month of November and second at the pea size fruit stage in month of March, in control plants water was used for spray. Inorganic fertilizers (nitrogen, phosphorus and potassium) were applied through urea containing 46 per cent nitrogen, diammonium phosphate containing 46 and 18 per cent phosphorus and nitrogen and muriate of potash containing 60 per cent potassium, respectively. Organic manures as farm yard manure (FYM) containing 0.50 per cent nitrogen, 0.25 per cent phosphorus and 0.50 per cent potash was used in the present investigation alone or with a set of inorganic fertilizers.

Leaf samples were analyzed as per standard methodology viz., Nitrogen by Snell and Snell (1949) [20], phosphorous by Jackson (1967) [7], Potash by Bhargava and Raghupati (1993) [2] and micronutrient (Iron, and zinc) in a tri-acid digest perchloric acid: nitric acid: sulfuric acid ($HClO_4$: HNO_3: $H2SO_4$) of the leaves were determined with atomic absorption spectrophotometer as suggested by Lindsay and Norwell (1978) [11].

Result and Discussion

The nutrient concentrations are important parameters for judging the capacity of soil to supply available nutrients. The data exhibited in table 1 and 2 maximum content of N, P, K, Fe and Zn in leaves was recorded under treatment T_{18} (100 FYM + 1.50 N + 1.00 P_2O_5 + 1.50 K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$) closely followed by T_{17} and T_{16}. It might be due to improved inherent nutrient supply capacity of nutrients, complexing of nutrients, flush of available nutrients on autolysis of microbial cells and play an important role in cyclically transformation of insoluble micronutrient by exchange, surface adsorption, chelation, coagulation and precipitation (Shuman and Hargrover, 1985) [18] besides, improvement in biochemical parameters.

Present study is strongly supported by the findings of Ezz *et al.* (2010) [4] who reported that leaf N, K, Fe and Zn contents tended to increase with increasing the rate of K fertilization. Whereas, K fertilization did not greatly affect leaf P content. According to Isyaku *et al*. (2010) [6] the NP fertilizer had statistically significant effect on N and P content of date palm leaves. The highest rate of N and P application (100 g N + 50g P) produced significantly higher N and P in leaves tissue compared to other rates (Hussein, 1983) [5].

The consistent and positive effect of NPK fertilizers and FYM application on NPK content could be due to better root proliferation and vegetative growth and increased availability of NPK in the soil of the experimental field resulted in greater absorption of nutrients by plants (Rao *et al.*, 1977) [14]. Further FYM addition maintain ideal soil pH leading to correct nutrient deficiencies and more solubilization of native phosphate into available form from the soil due to action of various organic acid liberated during decomposition. Further beneficial effect of organic manure on improving soil physical properties in terms of better root penetration might have also helped in increasing biomass and uptake as observed by Kaminwar and Rajagopal (1993) [8].

The results obtained are also in close conformity with that of Sen and Chauhan (1983) [17] in pomegranate, Khanduja and Garg (1984) [10] in ber, Sarkar *et al.* (1985) [16] in anola, Kavita *et al*. (2002) [9] in papaya, Athani *et al.* (2005) [1], Bhobia *et al.* (2005) [3] in guava, Ranjan and Ghosh (2005) [13] in aonla and Singh *et al.* (2007) [19] in guava.

Table 1: Effect of integrated nutrient management on nitrogen, phosphors and potassium content of date palm leaves *cv.* Khadrawy.

Treatments	Nitrogen (%)			Phosphors (%)			Potassium (%)		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
T_1 ($F_0N_0P_0K_0Fe_0Zn_0$)	1.40	1.39	1.39	0.210	0.207	0.208	1.600	1.590	1.595
T_2($F_0N_0P_0K_0Fe_{0.50}Zn_{0.25}$)	1.40	1.39	1.40	0.210	0.207	0.208	1.600	1.590	1.595
T_3($F_0N_0P_0K_0Fe_{1.00}Zn_{0.50}$)	1.40	1.40	1.40	0.213	0.210	0.212	1.610	1.597	1.603
T_4($F_{25}N_{0.50}P_{0.25}K_{0.50}Fe_0Zn_0$)	1.46	1.47	1.46	0.227	0.230	0.228	1.647	1.663	1.655
T_5 ($F_{25}N_{0.50}P_{0.25}K_{0.50}Fe_{0.50}Zn_{0.25}$)	1.47	1.48	1.47	0.230	0.233	0.232	1.650	1.670	1.660
T_6($F_{25}N_{0.50}P_{0.25}K_{0.50}Fe_{1.00}Zn_{0.50}$)	1.47	1.49	1.48	0.230	0.233	0.232	1.657	1.673	1.665
T_7($F_{50}N_{1.00}P_{0.50}K_{1.00}Fe_0Zn_0$)	1.57	1.60	1.59	0.260	0.263	0.262	1.743	1.773	1.758
T_8($F_{50}N_{1.00}P_{0.50}K_{1.00}Fe_{0.50}Zn_{0.25}$)	1.58	1.61	1.59	0.263	0.267	0.265	1.753	1.770	1.762
T_9($F_{50}N_{1.00}P_{0.50}K_{1.00}Fe_{1.00}Zn_{0.50}$)	1.59	1.62	1.60	0.263	0.270	0.267	1.760	1.783	1.772
T_{10}($F_{100}N_{0.50}P_{0.25}K_{0.50}Fe_0Zn_0$)	1.50	1.53	1.51	0.237	0.240	0.238	1.680	1.700	1.690
T_{11}($F_{100}N_{0.50}P_{0.25}K_{0.50}Fe_{0.50}Zn_{0.25}$)	1.50	1.54	1.52	0.240	0.243	0.242	1.690	1.700	1.695
T_{12}($F_{100}N_{0.50}P_{0.25}K_{0.50}Fe_{1.00}Zn_{0.50}$)	1.51	1.54	1.53	0.243	0.243	0.243	1.690	1.710	1.700
T_{13}($F_{100}N_{1.00}P_{0.50}K_{1.00}Fe_0Zn_0$)	1.63	1.66	1.65	0.270	0.277	0.273	1.783	1.810	1.797
T_{14}($F_{100}N_{1.00}P_{0.50}K_{1.00}Fe_{0.50}Zn_{0.25}$)	1.63	1.67	1.65	0.277	0.280	0.278	1.790	1.817	1.803
T_{15}($F_{100}N_{1.00}P_{0.50}K_{1.00}Fe_{1.00}Zn_{0.50}$)	1.64	1.67	1.65	0.277	0.283	0.280	1.793	1.817	1.805
T_{16}($F_{100}N_{1.50}P_{1.00}K_{1.50}Fe_0Zn_0$)	1.70	1.74	1.72	0.287	0.293	0.290	1.833	1.870	1.852
T_{17}($F_{100}N_{1.50}P_{1.00}K_{1.50}Fe_{0.50}Zn_{0.25}$)	1.71	1.75	1.73	0.290	0.297	0.293	1.837	1.870	1.853
T_{18}($F_{100}N_{1.50}P_{1.00}K_{1.50}Fe_{1.00}Zn_{0.50}$)	1.71	1.76	1.73	0.290	0.297	0.293	1.840	1.877	1.858
S Em±	0.02	0.02	0.01	0.013	0.019	0.011	0.010	0.011	0.007
C. D. at 5%	0.05	0.05	0.04	0.036	0.053	0.032	0.028	0.032	0.021

Table 2 Effect of integrated nutrient management on iron and zinc content of date palm leaves *cv.* Khadrawy.

Treatments	Iron (ppm)			Zinc (ppm)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
T_1 ($F_0N_0P_0K_0Fe_0Zn_0$)	140.00	140.00	140.00	45.33	45.00	45.17
T_2($F_0N_0P_0K_0Fe_{0.50}Zn_{0.25}$)	143.33	143.67	143.50	48.00	48.33	48.17
T_3($F_0N_0P_0K_0Fe_{1.00}Zn_{0.50}$)	145.00	145.33	145.17	50.33	50.67	50.50
T_4($F_{25}N_{0.50}P_{0.25}K_{0.50}Fe_0Zn_0$)	143.00	142.67	142.83	47.33	47.00	47.17
T_5 ($F_{25}N_{0.50}P_{0.25}K_{0.50}Fe_{0.50}Zn_{0.25}$)	147.33	147.67	147.50	52.00	51.67	51.83
T_6($F_{25}N_{0.50}P_{0.25}K_{0.50}Fe_{1.00}Zn_{0.50}$)	150.67	151.00	150.83	54.67	54.33	54.50
T_7($F_{50}N_{1.00}P_{0.50}K_{1.00}Fe_0Zn_0$)	155.00	155.00	155.00	55.33	55.33	55.33
T_8($F_{50}N_{1.00}P_{0.50}K_{1.00}Fe_{0.50}Zn_{0.25}$)	160.33	161.00	160.67	61.00	61.67	61.33
T_9($F_{50}N_{1.00}P_{0.50}K_{1.00}Fe_{1.00}Zn_{0.50}$)	164.00	164.67	164.33	64.33	65.00	64.67
T_{10}($F_{100}N_{0.50}P_{0.25}K_{0.50}Fe_0Zn_0$)	147.33	147.00	147.17	51.00	50.67	50.83
T_{11}($F_{100}N_{0.50}P_{0.25}K_{0.50}Fe_{0.50}Zn_{0.25}$)	154.00	154.67	154.33	55.67	56.00	55.83
T_{12}($F_{100}N_{0.50}P_{0.25}K_{0.50}Fe_{1.00}Zn_{0.50}$)	157.67	158.00	157.83	60.00	60.67	60.33
T_{13}($F_{100}N_{1.00}P_{0.50}K_{1.00}Fe_0Zn_0$)	158.67	158.33	158.50	62.33	62.00	62.17
T_{14}($F_{100}N_{1.00}P_{0.50}K_{1.00}Fe_{0.50}Zn_{0.25}$)	166.33	166.67	166.50	68.67	69.00	68.83
T_{15}($F_{100}N_{1.00}P_{0.50}K_{1.00}Fe_{1.00}Zn_{0.50}$)	168.00	169.00	168.50	70.33	70.67	70.50
T_{16}($F_{100}N_{1.50}P_{1.00}K_{1.50}Fe_0Zn_0$)	160.33	159.67	160.00	64.33	64.00	64.17
T_{17}($F_{100}N_{1.50}P_{1.00}K_{1.50}Fe_{0.50}Zn_{0.25}$)	167.33	168.00	167.67	70.00	70.33	70.17
T_{18}($F_{100}N_{1.50}P_{1.00}K_{1.50}Fe_{1.00}Zn_{0.50}$)	169.00	170.00	169.50	72.33	72.67	72.50
S Em±	1.73	1.52	1.15	1.70	2.13	1.36
C. D. at 5%	4.96	4.37	3.24	4.89	6.12	3.84

Conclusion

Application of 100 kg FYM + 1.50 kg N + 1.00 kg P_2O_5 + 1.50 kg K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$ (T_{18}) registered significantly higher leaf nutrient status that build higher nutrient absorption and improved in future definitely would be productively of that orchard.

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