DOI : 10.5958/0974-0112.2020.00064.X

Indian J. Hort. 77(3), September 2020: 450-455

Integrated nutrients management in Khadrawy date palm under hot arid region

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ABSTRACT

A field experiment was conducted to see the effect of organic (FYM) and inorganic (NPK) sources as well as foliar spray of micronutrients on fruit yield and quality of date palm fruits. Total eighteen treatments were taken, and allocated in randomized block design with three replications on uniform 35 years old date palm trees. The treatments were applied during last week of October in soil application, and foliar applications of micronutrients were applied twice in November and March. The results revealed that the combined application of T_{15} (100 kg FYM + 1.00 kg N + 0.500 kg P_2O_5 + 1.00 kg K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$) and T14 (100 kg FYM + 1.00 kg N + 0.50 kg P_2O_5 + 1.00 kg K_2O + 0.50% $FeSO_4$ + 0.25% $ZnSO_4$) significantly improved the fruit yield, total soluble solids, total sugars, reducing sugars, ascorbic acid, N, P, K, Fe and Zn content in fruit, and reduced the acidity and tannin content with higher returns over rest of the treatments. Thus, this manure, fertilizers and micro-nutrients dose helped in sustainable optimum production of quality and nutritional fruits of date palm cv. Khadrawy in Bikaner conditions.

Key words: *Phoenix dactylifera*, IPNM, organic, inorganic, micronutrient, fruit yield.

INTRODUCTION

The date palm is one of potential fruit crops of arid irrigated region of India. It is being grown in the state of Gujarat, Punjab and Rajasthan. It is a dioecious plant that produce delicious and nutritious fruits which are widely popular as 'dates' and are often consumed as a table fruit. 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*., 12). However, in Rajasthan, the area under date cultivation is about 800 hectare, which is increasing rapidly with the plantation of tissue cultured plants obtained from Al-Ain, UAE under Public Private Partnership (Govt. of Rajasthan and Atul Ltd.) under RKVY.

Date palm fruit, are eaten as raw dates (fresh fruit), dry dates (*chhuhara*) and soft dates (*pind khajoor*). Different products *viz*. sugar, starch, vinegar, juice, toffees, wine, chutney, jam, pickles *etc*. are prepared from dates fruits. Date fruit provide abundant quantities of iron, potassium, calcium, nicotinic acid and small amounts of protein, copper, magnesium, chlorine, sulphur, vitamin A, B and B_2. Date palm contain sugar (60-65%), fiber (2-6%), protein (1-3%), and less than 0.52-3.25% fat, mineral matter and pectic substances (Shafiei *et al*.,15). It's fresh fruit can supplement the dietary need of the desert people and provide about 3550 calories per kg. Dates are high in quality due to their high sugar to acid ratio; self preserved fruit, good energy and mineral supplement, low moisture content, excellent skin integrity, natural dessert with minimum acidity and pleasant taste.

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*. Nutrient management improves both productivity and quality of produce, and also contribute substantial share in cost of production. Apart from this, micronutrients are required in minute quantities, but have some agronomic importance like macro-nutrients, playing a vital role in tree growth and productivity. Most of the micro-nutrients are associated with the enzymic activities in plants. Whenever, a micro-nutrient is

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deficient, the tree expresses the abnormal growth and fruiting, and sometime causes complete failure of crop. Foliar application of micro-nutrient in plants after fruits setting gave not only higher yield of fruits, but also improve physico-chemical quality of produce . Keeping this in view, the present experiment was conducted to improve the yield and fruit quality of date palm cv. Khadrawy under hot arid region of Rajasthan through integrated plant nutrient management.

MATERIALS AND METHODS

The present investigation was 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 and replicated thrice, with eighteen integrated nutrient treatments combinations (Table 1) of manure (FYM), fertilizers ($N+P_2O_5+K_2O$) and micro-nutrients ($FeSO_4$ + $ZnSO_4$).

The treatments were applied during last week of October. Nitrogen was applied in two split doses *i.e.* 50 per cent in October + 50 per cent in March. Micro-nutrients were applied as foliar spray. First application in month of November and second application at the pea size fruit stage in the month of March.

Observations on fruit yield per plant was recorded by weighing of harvested fruit bunches on successive pickings, and expressed as per tree and per ha basis. Fruit samples were analyzed as per standard methodology *viz*., total soluble solids (TSS) by digital refractometer Atago, PAL II, Japan (AOAC,1), titratable acidity by Alkali titration method (AOAC, 1), ascorbic acid by metaphosphoric acid (AOAC, 1), total sugars by Anthrone reagent method (Hedge,6), reducing sugars by Nelson's modification of "Somogyi's method (Somogyi, 18), tannin by colorimetric method using Folins-Denis reagent (Schanderl, 14). The standard procedures were opted for the estimation of fruit nitrogen (Snell and Snell, 17), phosphorous (Jackson, 8) and potash (Bhargava and Raghupati, 3). The micronutrients (iron and zinc) were estimated digested in a tri-acid digestion mixure having perchloric acid: nitric acid: sulfuric acid ($HClO_4$: HNO_3: H_2SO_4) and estimated with atomic absorption spectrophotometer (Lindsay and Norwell, 10). In order to evaluate the economic feasibility of the treatments, the net return (Rs. ha^{-1}) and B : C ratio were worked out on the basis of prevailing market prices so that most remunerative treatment could be recommended.

RESULTS AND DISCUSSION

The results obtained in the present investigation reveal that application of inorganic fertilizer and organic manure with foliar application of micronutrient significantly improved the fruit yield, quality (TSS, sugars, acidity, ascprbic acid and tannin content) nutritient contents (N, Fe and Zn) and economic return (net returns & B:C) of date palm fruit as compared to control (Table 2-3). The highest fruit yield (56.41 Kg/ tree and 152.58 q/ ha) with T_{18} treatment (100 kg FYM + 1.50 kg N + 1.00 kg P_2O_5 + 1.50 kg K_2O + 1.0% $FeSO_4$ + 0.5% $ZnSO_4$), however it was found statistically at par with $T_{14,}$ T_{15}, T_{16} and T_{17} treatments (Table 1 and Fig. 1). The lowest yield (26.86 kg) was recorded under treatment T_1 (control). Present study strongly supported by the findings of Dialami and Mohebbi (4) who recommended application of 2/3 dose of recommended dose RD of NPK (1533 g N, 800 g P and 933 g K $tree^{-1}$) fertilizers under dry land condition for maximizing the quality of date palm cv. Nabbut Ahmar. The probable explanation might be due to balance dose of nutrients favoured the optimum fruit set and reduced the fruit drop. This work in the close agreement with the findings of Omar *et al*. (13) and Khayyat *et al*.(9) on date palm.

The various fruit quality parameters were significantly influenced by the treatments as presented in Table 2. The highest contents of TSS (45.93°B), total sugars (41.07%), reducing sugars (37.20%) and ascorbic acid (6.42 mg/ 100g) with lowest titratable acidity (0.210%) and tannin content(0.35%) with T_{15} treatment (100 kg FYM + 1.00 kg N + 0.50 kg P_2O_5 + 1.00 kg K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$), although it was similar statistically with $T_{14,}$ T_{16}, T_{17} and T_{18}. The control treatment yielded the poorest quality fruits of date cv. Khadrawy. The improvement in the quality of fruits by an increase in TSS, total sugars, reducing sugar and ascorbic acid content of fruits and decreased acidity and tannin content might be due to beneficial role of nutrients which may lead to enzymatic changes and catalytic activity of several enzymes, participate in the biosynthesis of TSS, total sugars, reducing sugar and ascorbic acid content and their precursor during growth, development and ripening of the fruits. Marzouk and Kassem (11) reported that an enhancement in fruit quality characteristics especially fruit size, TSS and total sugars contents with the application of organic manures or its supplementation with mineral NPK compared to mineral fertilization alone. Similar findings were reported by Shahein *et al*. (16) working on Samany date. Also, Al-Kharusi *et al*. (2) obtained the highest dry matter content of Khalas and

Table 1. Details of the treatments with their symbols

T_0 ($F_0N_0P_0K_0Fe_0Zn_0$)	0 kg FYM + 0 kg N + 0 kg P_2O_5 + 0 kg K_2O + Water sprays (Control)
T_1($F_0N_0P_0K_0Fe_{0.50}Zn_{0.25}$)	0 kg FYM + 0 kg N + 0 kg P_2O_5 + 0 kg K_2O +0.50% $FeSO_4$ + 0.25% $ZnSO_4$
T_3($F_0N_0P_0K_0Fe_{1.00}Zn_{0.50}$)	0 kg FYM + 0 kg N + 0 kg P_2O_5 + 0 kg K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$
T_4($F_{25}N_{0.50}P_{0.25}K_{0.50}Fe_0Zn_0$)	25kg FYM + 0.50 kg N + 0.25 kg P_2O_5 + 0.50 kg K_2O + Water sprays
T_5 ($F_{25}N_{0.50}P_{0.25}K_{0.50}Fe_{0.50}Zn_{0.25}$)	25kg FYM + 0.50 kg N + 0.25 kg P_2O_5 + 0.50 kg K_2O + 0.50% $FeSO_4$ + 0.25% $ZnSO_4$
T_6($F_{25}N_{0.50}P_{0.25}K_{0.50}Fe_{1.00}Zn_{0.50}$)	25kg FYM + 0.50 kg N + 0.25 kg P_2O_5 + 0.50 kg K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$
T_7($F_{50}N_{1.00}P_{0.50}K_{1.00}Fe_0Zn_0$)	50 kg FYM + 1.00 kg N + 0.50 kg P_2O_5 + 1.00 kg K_2O + Water sprays
T_8($F_{50}N_{1.00}P_{0.50}K_{1.00}Fe_{0.50}Zn_{0.25}$)	50 kg FYM + 1.00 kg N + 0.50 kg P_2O_5 + 1.00 kg K_2O +0.50% $FeSO_4$ + 0.25% $ZnSO_4$
T_9($F_{50}N_{1.00}P_{0.50}K_{1.00}Fe_{1.00}Zn_{0.50}$)	50 kg FYM + 1.00 kg N + 0.50 kg P_2O_5 + 1.00 kg K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$
T_{10}($F_{100}N_{0.50}P_{0.25}K_{0.50}Fe_0Zn_0$)	100 kg FYM + 0.50 kg N + 0.25 kg P_2O_5 + 0.50 kg K_2O + Water sprays
T_{11}($F_{100}N_{0.50}P_{0.25}K_{0.50}Fe_{0.50}Zn_{0.25}$)	100 kg FYM + 0.50 kg N + 0.25 kg P_2O_5 + 0.50 kg K_2O + 0.50% $FeSO_4$ + 0.25% $ZnSO_4$
T_{12}($F_{100}N_{0.50}P_{0.25}K_{0.50}Fe_{1.00}Zn_{0.50}$)	100 kg FYM + 0.50 kg N + 0.25 kg P_2O_5 + 0.50 kg K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$
T_{13}($F_{100}N_{1.00}P_{0.50}K_{1.00}Fe_0Zn_0$)	100 kg FYM + 1.00 kg N + 0.50 kg P_2O_5 + 1.00 kg K_2O + Water spays
T_{14}($F_{100}N_{1.00}P_{0.50}K_{1.00}Fe_{0.50}Zn_{0.25}$)	100 kg FYM + 1.00 kg N + 0.50 kg P_2O_5 + 1.00 kg K_2O + 0.50% $FeSO_4$ + 0.25% $ZnSO_4$
T_{15}($F_{100}N_{1.00}P_{0.50}K_{1.00}Fe_{1.00}Zn_{0.50}$)	100 kg FYM + 1.00 kg N + 0.50 kg P_2O_5 + 1.00 kg K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$
T_{16}($F_{100}N_{1.50}P_{1.00}K_{1.50}Fe_0Zn_0$)	100 kg FYM + 1.50 kg N + 1.00 kg P_2O_5 + 1.50 kg K_2O + Water sprays
T_{17}($F_{100}N_{1.50}P_{1.00}K_{1.50}Fe_{0.50}Zn_{0.25}$)	100 kg FYM + 1.50 kg N + 1.00 kg P_2O_5 + 1.50 kg K_2O + 0.50% $FeSO_4$ + 0.25% $ZnSO_4$
T_{18}($F_{100}N_{1.50}P_{1.00}K_{1.50}Fe_{1.00}Zn_{0.50}$)	100 kg FYM + 1.50 kg N + 1.00 kg P_2O_5 + 1.50 kg K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$

Table 2. Effect of integrated plant nutrients on fruit yield and quality of Khadrawy date palm.

Treatments	Yield (Kg/ tree)	TSS (ºB)	Total sugars (%)	Reducing sugars (%)	Titratable acidity (%)	Ascorbic acid (mg/100g)	Tannin (%)
T_1	26.86	36.21	28.69	24.29	0.357	4.16	0.67
T_2	28.50	36.35	29.13	24.48	0.352	4.25	0.66
T_3	29.34	36.41	29.44	24.69	0.344	4.33	0.66
T_4	34.70	38.74	30.80	26.46	0.333	4.58	0.62
T_5	35.20	39.01	31.30	26.88	0.328	4.70	0.60
T_6	36.39	39.13	31.55	27.49	0.320	4.79	0.60
T_7	40.86	41.76	35.66	31.27	0.285	5.60	0.49
T_8	42.33	42.15	36.15	31.78	0.275	5.74	0.47
T_9	42.76	42.36	36.38	31.94	0.267	5.90	0.46
T_{10}	37.89	39.83	33.05	29.10	0.312	5.09	0.55
T_{11}	38.71	40.11	33.49	29.70	0.307	5.27	0.54
T_{12}	39.27	40.22	33.80	30.00	0.296	5.35	0.53
T_{13}	43.53	43.08	37.00	33.59	0.251	6.02	0.44
T_{14}	54.89	45.72	40.98	37.18	0.214	6.39	0.36
T_{15}	54.98	45.93	41.07	37.20	0.210	6.42	0.35
T_{16}	46.94	43.63	39.43	37.10	0.227	6.12	0.39
T_{17}	55.16	45.07	40.75	37.16	0.220	6.32	0.37
T_{18}	56.41	45.37	40.84	37.18	0.217	6.37	0.36
S Em±	1.70	0.41	0.92	0.78	0.006	0.05	0.02
C D $_{(0.05)}$	4.81	1.17	2.59	2.21	0.016	0.14	0.05

Table 3. Effect of integrated plant nutrients on fruit nutrient contents of Khadrawy date palm.

Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Iron (ppm)	Zinc (ppm)
T_1	1.02	0.015	0.891	4.32	1.18
T_2	1.02	0.015	0.891	4.33	1.19
T_3	1.02	0.015	0.891	4.34	1.20
T_4	1.10	0.016	0.892	4.34	1.20
T_5	1.11	0.016	0.892	4.35	1.22
T_6	1.12	0.016	0.892	4.37	1.23
T_7	1.25	0.017	0.893	4.39	1.25
T_8	1.27	0.017	0.893	4.41	1.26
T_9	1.27	0.017	0.894	4.42	1.27
T_{10}	1.18	0.016	0.893	4.37	1.23
T_{11}	1.19	0.016	0.893	4.38	1.24
T_{12}	1.19	0.016	0.893	4.39	1.25
T_{13}	1.35	0.018	0.894	4.43	1.27
T_{14}	1.38	0.018	0.894	4.46	1.31
T_{15}	1.40	0.018	0.894	4.47	1.31
T_{16}	1.38	0.018	0.894	4.43	1.27
T_{17}	1.41	0.018	0.894	4.48	1.32
T_{18}	1.42	0.018	0.894	4.48	1.32
S Em±	0.02	0.0001	0.0001	0.01	0.01
C D $_{(0.05)}$	0.06	NS	NS	0.02	0.02

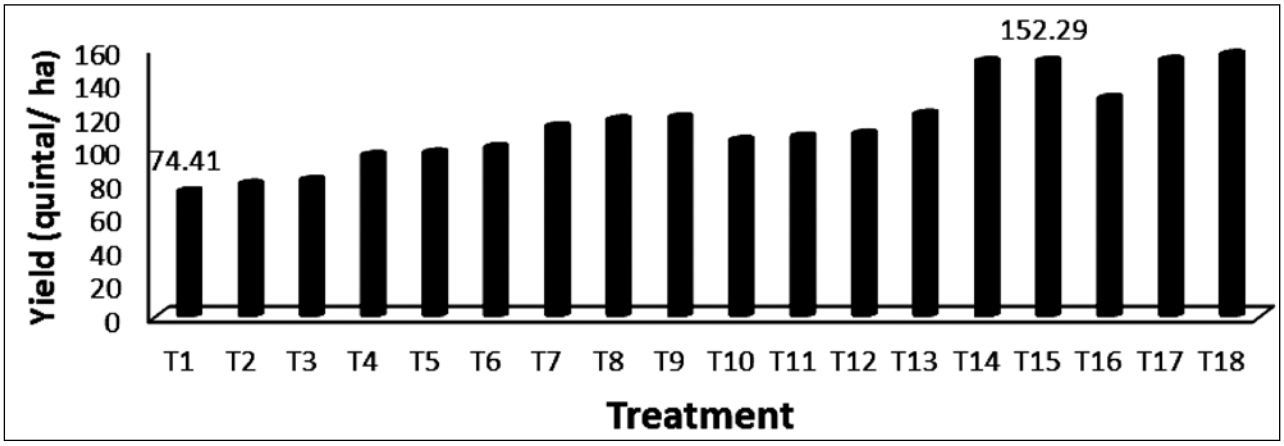

Fig. 1. Effect of integrated nutrient management on estimated fruit yield (q/ha) of Khadrawy date palm.

Khassab dates by combining NPK mineral fertilizer with organic peat.

The data relating to fruit nutrient contents (N, P, K, Fe and Zn) as influenced by various nutrient sources are presented in Table 3. The source of nutrient combination failed to exert any significant influence on fruit P and K contents. The highest fruit N (1.42%), Fe (4.48ppm) and Zn (1.32ppm) contents was registered with T_{18} (100 kg FYM + 1.50 kg N + 1.00 kg P_2O_5 + 1.50 kg K_2O + 1.00% $FeSO_4$ + 0.50% $ZnSO_4$), however, it was found statistically similar with T_{13}, T_{14}, T_{15}, T_{16} and $T_{17.}$ The lowest fruit nutrients (N, Fe and Zn) was noticed with T_1 (control) without having any significant difference with T_2 and T_3 and T_4 in respect of Fe and Zn and with T_2 and T_3 for N content. The probable reason might be due to the potential role of organic fertilization on various aspects of crop growth can be ascribed due to its

direct effect on availability of vital nutrients and indirectly *via* release of growth hormones, vitamins and augmenting microbial population *etc*. during its process of decomposition (Gaur *et al.*, 5). According to Ibrahim *et al.* (7) reported that addition of N, P and K doses cause favourable effect on total sugar content may be attributed to the response of palm trees to mineral fertilizer application and to improve fruit quality.

The economics of various treatment combinations with respect to net return and benefit: cost ratios are given in Table 4. The data revealed that the maximum net return (Rs. 1,13,879 ha^{-1}) and B:C (2.0 :1) was obtained under the treatment combination of T_{14} which was closely followed by T_{15} (with net return of Rs 1,13,817 ha^{-1} & 1.99:1, respectively) whereas, the minimum net return was gained under the treatment combination of T_1 (Rs 40,238 ha^{-1}). Thus, it is found that combined application of FYM (100 kg plant) + NPK (1.0+ 0.50 + 1.0 kg $plant^{-1}$)+ spray of $FeSO_4$ (1.0%) + $ZnSO_4$ (0.5%) during November significantly higher yield and improved the fruit quality (TSS, acidity, ascorbic acid, sugars, tannin content) and nutritional (N,P K, Fe & Zn content) value as well as better returns from date palm cultivation.

Table 4. Effect of integrated nutrient management on net return and benefits cost ratio of Khadrawy date palm.

Treatments	Net return	B:C ratio
T_1	40238	1.56
T_2	46399	1.64
T_3	49474	1.68
T_4	58655	1.69
T_5	60086	1.70
T_6	64601	1.75
T_7	70088	1.70
T_8	75556	1.75
T_9	76886	1.76
T_{10}	51107	1.48
T_{11}	53874	1.50
T_{12}	55786	1.52
T_{13}	67331	1.59
T_{14}	113879	2.00
T_{15}	113817	1.99
T_{16}	71352	1.58
T_{17}	104901	1.84
T_{18}	109651	1.88
S Em±	-	-
C D $_{(0.05)}$	-	-

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(Received : February, 2020; Revised : August, 2020; Accepted : August, 2020)