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Nutritional requirement of oil palm in Konkan region

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Abstract

A field investigation was undertaken under All India Coordinated Research Project on Palms at Agricultural Research Station, Mulde in Sindhudurg district of Maharashtra since 1989 to assess the feasibility of growing oil palm in Konkan region and to assess the fertilizer and irrigation requirement. Five years pooled data from 12th to 16th year after planting revealed that oil palm showed high degree of response to fertilizer and irrigation. Irrigation by drip system with a discharge of 70 l of water per day during post monsoon season and by giving NPK fertilizer @ 1200:600:2700 g per palm par year secured the total returns of Rs. 75,775 (with the FFB rate of Rs. 3,500/ t) with a benefit cost ratio of 1.86 over rain fed condition. In the present study, cultivation of oil palm with basin irrigation at 560 l of water at an interval of four days from cessation of monsoon along with NPK at 1200:600:2700 g per palm par year recorded total returns of Rs. 69,615 with benefit cost ratio of 1.74 over rainfed crop. Cultivation of oil palm under rainfed condition along with same fertilizer level earned total returns of Rs. 44,450 with benefit cost ratio of 1.0 and cultivation of oil palm as rainfed crop without fertilizer was not a profitable proposition. Based on the study, it is recommended that cultivation of oil palm under irrigation (either by drip or through basin) along with a fertilizer dose of 1200:600:2700 g per palm per year is beneficial under Konkan conditions.

Keywords: Benefit cost ratio, fresh fruit bunches, oil palm, yield

Introduction

Edible oil economy of India has not been stable for quite a long time and huge import of edible oil is a regular feature requiring large foreign exchange expense every year. Oil palm is known for its exceptionally high oil yield as compared to the traditional oilseed crops and has wide adaptability to different climate and soil conditions only if irrigation is assured under Indian conditions. Oil palm is rated as the crop of maximum oil yield potential. Therefore, it could be considered as one of the most important sources to meet the challenges of edible oil demand arising due to ever increasing population as well as per capita consumption of edible oils in near future.

According to Rankine and Fairhurst (1999), the crop has a heavy nutrient demand and has a high degree of sensitivity to nutrients like N, P and K and Mg. Similarly, irrigation is a very critical input in the cultivation of oil palm crop. Hence, for achieving the potential level of yield, it is necessary to standardize the levels of critical inputs like irrigation and fertilizers for oil palm crop.

The present investigation is aimed at deciding an economically feasible level of fertilizers and the amount and kind of irrigation which can promote the yield and its components of oil palm favorably under Konkan conditions of Maharashtra.

Materials and Methods

Konkan is the coastal region of Maharashtra characterized by high annual rainfall, which ranges from 3,000 to 3,500 mm restricted between the months from June to September and with a warm humid climate, high humidity and modest climate with the temperature ranging from 15^0 C to 35^0C. The average relative humidity is 80 %. It has a hilly topography and soils are lateritic as well as alluvial coarse shallow type.

Under the All India Co-ordinated Research Project on Palms (ICAR), a trial on irrigation and fertilizer requirements for oil palm was initiated in the year 1989 at Agricultural Research Station, Mulde in Sindhudurg district of Maharashtra State to assess the feasibility of growing oil palm under different agro climatic conditions

of India. The planting material was procured from the Scientist - in-Charge, Central Plantation Crops Research Institute, Research Center, Palode, Kerala. The experimental station is located at 16°2' latitude, 73°42' longitude and at 17 m above msl in Konkan region of Maharashtra. Oil palm planting was done at 9 x 9 m spacing on contour in coarse shallow soils having a slope of about 4 to 5 %. The experiment was conducted in a Strip Plot Design with three replications. The treatments comprised of four levels of fertilizers viz. F_0 - No Fertilizer, F_1 - 400, 200, 900 g NPK/palm/year, F_2 - 800, 400,1800 g NPK/palm/year and F_3 - 1200,600,2700 g NPK/palm/year in the form of urea, single super phosphate and muriate of potash were allocated to vertical strips whereas, three irrigation treatments viz. Io - No Irrigation, I_1 – Conventional Irrigation (through Basin 560 l/ 4 days at 5 mm P.E. of previous week) and I_2 - Drip Irrigation.(70 l/day through 4 drippers) were given to horizontal strips covering a unit of six palms per treatment. Common dose of 250 g of Borax and 500 g of $MgSO_4$ per plant was applied to all experimental palms. Irrigation treatments were given from cessation of south-west monsoon season i.e., from October onwards.

The plantation attained the age of 17 years in 2006. The pooled yield data over five years regarding Fresh Fruit Bunch (FFB) i.e. from 2002 to 2006 were subjected for statistical analysis following the method given by Gomez and Gomez (1985). Water Use Efficiency (kg/ ha. mm) was calculated by using the formula given by Michael(2008).

Water Use Efficiency (kg/ha. mm) =

$$\frac{The\ marketable\ yield\ (kg/ha)}{Total\ water\ requirement\ (mm)\ or\ used}$$

Soil analysis was done after concluding the experiment i.e. during 2006. Data on various items of expenditure on cultivation under three different methods of irrigation were recorded for estimating the cost of cultivation over a period of 17 years under consideration. The total returns were obtained from multiplication of the pooled FFB yield (t /ha) with the selling price @. Rs. 3,500/t prevailed during 2006.

Results and Discussion

Oil palm is an efficient source of vegetable oil and can produce on an average 4 to 5 tonnes of edible oil per hectare (Abdul Halim *et al.*,1988). Corley (1982) postulated that the physiological potential of oil palm crop is around 12 to 14 t of oil per hectare per year which can be achieved with proper management practices, breeding and physiological manipulation. The crop has a heavy nutrient demand and several experiments on nutritional requirements have been conducted in different parts of the world. However, no general conclusion could be drawn regarding specific nutrient management package for oil palm crop (Heartley, 1988). Recent studies conducted by Gawankar *et al*. (2003) indicated that oil palm can also be successfully grown in this region as an irrigated crop

I) Effect of irrigation and fertilizer on yield of Fresh Fruit Bunches (FFB)

Data regarding the effect of different levels of NPK fertilizers under rainfed and irrigated (basin and drip irrigation) situation during the year 2006 and pooled yield data over the years from 2002 to 2006 are given in Table 1.

Table 1. Effect of fertilizer levels under different methods of irrigation on yield of FFB

Treatment	Yield during 2006			
	No. of bunches/palm year	Weight of bunch (kg)	Yield of FFB (t/ha)	Pooled yield (2002-2006) t/ha
Irrigation				
I_0	3.7	21.80	11.18	10.39
I_1	4.0	24.90	13.90	15.36
I_2	3.7	23.62	12.17	15.46
SE ±	0.46	0.61	1.64	0.37
CD (P=0.05)	NS	NS	NS	1.04
Fertilizers				
F_0	3.5	20.59	9.97	8.99
F_1	3.8	24.06	12.49	13.60
F_2	3.3	24.45	11.36	14.27
F_3	4.6	24.65	15.84	18.08
SE ±	0.37	1.07	1.09	0.25
CD (P=0.05)	1.16	NS	3.76	0.72
Interaction				
I_0F_0	3.6	19.03	9.60	6.74
I_0F_1	3.6	22.70	11.48	11.83
I_0F_2	3.4	24.51	11.46	10.30
I_0F_3	4.1	20.97	12.16	12.70
I_1F_0	3.7	19.69	10.16	10.27
I_1F_1	4.9	23.96	15.77	15.78
I_1F_2	3.0	26.84	11.60	15.49
I_1F_3	4.6	29.11	18.09	19.89
I_2F_0	3.2	23.06	10.14	9.96
I_2F_1	2.8	25.52	10.22	13.19
I_2F_2	3.6	22.01	11.03	17.03
I_2F_3	5.2	23.87	17.27	21.65
SE ±	0.67	1.98	2.42	0.90
CD (P=0.05)	N.S.	N.S.	N.S.	2.43

NS = Not significant

It is clear from the data presented in Table 1 that irrigation did not show any significant effect on any of the yield attributes during the year 2005-06. However, basin irrigation (I_1) recorded maximum number of FFB (4.04), weight of FFB (24.90 kg) and yield per hectare (13.90 t/ha) followed by drip irrigation (I_2). Number of FFB and yield of FFB were significantly affected due to fertilizer application. The highest number of bunches (4.6) per palm was recorded at F_3 level. Similarly, yield of FFB was significantly increased due to fertilizer at F_3 level and recorded 15.84 t/ha FFB yield.

Interaction of irrigation and fertilizer during the year 2006 was also non significant for any of the characters. However, interaction of drip irrigation and fertilizer at F_3 level (I_2F_3) recorded more number of FFB(5.2), while bunch weight (29.11kg/bunch) and yield of FFB(18.09 t/ha) were maximum in I_1F_3 combination i.e. basin irrigation with fertilizer at 1200:600:2700 g NPK/ palm/ year.

II) Pooled effect on yield of FFB

Effect of irrigation: It could be seen from the data presented in the Table1 that irrigation had significant effect on pooled yield during 2001-02 to 2005-06 in which drip irrigation (I_2) recorded significantly higher yield. However, pooled data showed that drip irrigation and basin irrigation were at par with each other and recorded significantly higher yield over rainfed condition. Similar results were recorded by Masthana Reddy *et al*. (2009). Among the irrigation treatments, the highest FFB yield of 15.46 t/ha was recorded in drip irrigation followed by 15.36 t/ha in basin irrigation, whereas rain fed palms recorded only 10.39 t/ha of FFB yield.

Effect of fertilizer: A critical perusal of the data revealed that fertilizer application caused significant increase in the average FFB yield as against no fertilizer (control). Analysis on pooled yield for a period of five years revealed that F_3 level recorded significantly higher FFB yield of 18.08 t/ha as against 14.27 t/ha in F_2 level and 8.99 t/ha in control (F_0).

Interaction effect: Pooled yield over a period of five years revealed that treatment combination I_2F_3 recorded significantly highest FFB yield of 21.65 t/ ha. The results are in agreement with those reported by Masthana Reddy *et al*. (2009). The treatment combination I_1F_3 which recorded 19.89 t/ha yield became the second choice. Mite *et al.* (1999) reported positive interaction between irrigation and fertilizers. They further stated that the interaction becomes more remarkable as the palm grows old. In present study also, the fertilizer use efficiency increased remarkably by irrigation with more prominent effect of drip irrigation.

In the present investigation pooled yield data analysis revealed that irrigation either by basin or through drip system along with fertilizers @ 1200:600:2700 g NPK /palm/year could give more than 19 t/ha of FFB yield under Konkan conditions of Maharashtra.

III) Water use efficiency (WUE) and soil nutrient status: With the data collected from different treatments, WUE for the year 2006 was calculated (Table 2). The post treatment soil analysis was also done and data regarding available N, P and K at 0-25 cm soil depth is also presented in Table 2. Water Use Efficiency did not differ significantly due to irrigation. However, drip irrigation recorded higher WUE i.e. 3.8 kg/ha mm. WUE was significantly higher in all the fertilizer treatments with increasing trend from F_0 to F_3 level and it was maximum at F_3 level i.e. 4.4 kg/ha mm. Interaction of irrigation and fertilizer treatments had no significant effect on WUE. However, the highest mean WUE of 5.2 kg/ha mm was noticed in the treatment combination I_2F_3 i.e. drip irrigation with fertilizer @ 1200, 600, 2700 g NPK/palm /year.

The data presented in Table 2 revealed that the soil available N and P did not differ significantly due to irrigation and had significant effect on available K only. Available N (434.7 kg/ha) and K (495.9 kg/ha) were maximum at I_0 level but available P (74.6 kg/ha) was minimum at I_0 level. Fertilizer levels showed significant effect on available N, P and K. Available P and K was increased with increasing levels of fertilizer treatments from F_0 to F_3 level i.e from 9.0 to 100.0 kg/ha for P and 149.0 to 547.8 kg/ha in respect of K. However, such definite trend was not noticed in respect of available N. Similar results were reported by Masthana Reddy *et al*. (2009) under Tungabhadra command area.

Interaction of irrigation and fertilizer did not show significant effect on available N and P. However, it was noticed that an increase in the levels of fertilizers could increase available K_2O in the soil, irrespective of irrigation treatments and levels were higher in no irrigation and fertilizer combination. These findings are in agreement with the results reported by Masthana Reddy *et al*.(2009).

IV) Economics of oil palm cultivation in Konkan region: Data on various items of expenditures on oil

palm cultivation incurred over the period of 16 years from planting given in Table 3 revealed that the net returns from drip irrigated oil palm crop was Rs. 26,583 /ha, Rs. 21,917 from basin irrigated crop and Rs. 2,403 from rain fed crop with fertilizer. However, net returns from rain fed oil palm crop without fertilizer is Rs. -682 showing negative impact and huge loss.

Table 2. Water Use Efficiency and soil available nutrients under fertilizer levels and methods of irrigation

Treatment	Water Use Efficiency (kg/ha. mm)	Available N (kg/ha)	Available P_2O_5 (kg / ha)	Available K_2O (kg / ha)
Irrigation				
I0	3.6	434.7	74.6	495.9
I1	3.3	426.9	77.2	262.1
I2	3.8	411.2	77.2	308.5
SE ±	0.4	8.1	6.3	4.1
CD(P=0.05)	N.S.	N.S.	N.S.	16.0
Fertilizers				
F0	2.4	408.6	9.0	149.0
F1	3.6	466.1	96.5	321.7
F2	3.8	402.9	100.0	381.3
F3	4.4	419.5	100.0	547.8
SE ±	0.3	3.4	5.5	9.9
CD(P=0.05)	0.9	11.9	19.0	34.3
Interaction				
I0F0	2.6	405.8	8.97	90.0
I0F1	4.2	447.8	89.6	493.0
I0F2	3.6	428.9	100.0	600.0
I0F3	4.0	456.5	100.0	734.0
I1F0	2.3	456.4	8.96	159.0
I1F1	3.4	465.1	100.0	240.0
I1F2	3.3	391.3	100.0	308.0
I1F3	4.0	394.9	100.0	341.3
I2F0	2.2	363.7	8.96	198.0
I2F1	3.2	485.4	100.0	232.0
I2F2	4.6	388.4	100.0	236.0
I2F3	5.2	407.2	100.0	568.0
SE ±	0.5	20.5	8.65	12.2
CD(P=0.05)	N.S.	N.S.	N.S.	37.6

NS = Not significant

The Benefit Cost ratio is the highest in drip irrigated oil palm crop (1.54) followed by basin irrigated oil palm crop (1.46) and 1.06 for rain fed crop with fertilizer whereas it was less than one (0.97) under rain fed cultivation.

The comparative economics of oil palm under drip, basin, rain fed and rain fed with fertilizer are presented in Tables 4 and 5. The results revealed that the input cost for drip irrigation and basin irrigation was almost similar (Rs.19,700/ha and Rs.19,320/ha, respectively), whereas, input cost for rain fed crop with fertilizer was Rs.15,495/ha and that to rain fed crop was Rs. 14,311/ha. However, the total returns at input cost are the highest in drip irrigation (Rs.75,775/ ha) followed by basin irrigation (Rs.69,615) rain fed with fertilizer (Rs.44,450/ha) and the lowest under rain fed condition (Rs.23,590/ha). The additional returns through drip irrigation was Rs. 52,185/ha, Rs. 46,025/ ha through basin irrigation and Rs. 20,860/ha under the rain fed condition.

Table 3. Cost of cultivation of oil palm (Rs./ha)

Sl. No.	Particulars	Cost (Rs./ha) Drip irrigation	Basin irrigation	Rain fed (control)	Rain fed with fertilizers
1	Hired labour	10,116	9,786	11,426	12,610
2	Manures and fertilizers	8,344	8,344	2,145	8,344
3	Plant protection	810	760	740	740
4	Irrigation (electricity charges)	430	430	-	-
	Input cost	19,700	19,320	14,311	21,694
5	Depreciation on implements and machinery	690	690	330	340
6	Land revenue & other cesses	50	50	50	50
7	Interest on working capital @ 13% for 12 months	2,561	2,511	1,860	2,014
	Cost A	23,001	22,571	16,551	24,098
8	Interest on fixed capital @ 10 %	1400	1400	660	780
9	Rental value of land (1/6 th) of the gross value	12,629	11,602	3,931	7408
10	Amortization value	10,191	10,191	1,698	8,310
	Cost B	47,221	45,765	22,841	40,596
11	Supervision charges @ 10 % of input cost	1,970	1,932	1,431.10	1,449.50
	Total cost Cost C	49,191	47,697	24,272	42,046
12	Yield (t/ ha)	21.65	19.89	6.74	12.70
	Gross Returns - Main product @ Rs. 3500 /t	75,775	69,615	23,590	44,450
13	Net Returns at				
	i) Input cost	56,075	50,295	9,279	22,756
	ii) Total cost	26,583	21,917	(-) 682	2,403
14	Benefit Cost ratio	1.54	1.46	0.97	1.06

Table 4. Comparative economics of oil palm production under different management conditions (Rs./ha)

Particulars	Drip irrigation	Basin irrigation	Rain fed (control)	Rain fed with fertilizers
Input cost	19,700	19,320	14,311	15,495
Total cost	49,191	47,697	24,272	42,046
Total returns	75,775	69,615	23,590	44,450
Net returns at input cost	56,075	50,295	9,249	22,756
Net returns at total cost	26,583	21,917	(-) 682	2,403
Benefit : Cost Ratio	1.54	1.45	0.97	1.06

Table 5. Comparative economics of oil palm production (Rs./ha)

Particulars	Total Cost	Total Returns	Additional cost over	Additional returns control	B:C ratio
Control	21,200	23,590			
Drip	49,191	75,775	27,990	52,185	1.86
Basin	47,697	69,615	26,496	46,025	1.74
Rain fed with fertilizer	42,046	44,450	20,845	20,860	1.00

Thus, the present study revealed that the yield of oil palm under drip and basin irrigation conditions were the highest over control condition but statistically at par with each other. Similarly, the benefit cost ratio in both cases is almost equal. Hence, it is suggested that as per the availability of water and financial strength of the cultivator, cultivation of oil palm under irrigation either by drip or through basin along with fertilizer @ 1200:600:2700 g NPK/ palm/year could be recommended as the optimal practice for oil palm cultivation under Konkan conditions.

References

Abdul Halim Hassan., Mohamad Ali Sekak and Mohd Hanif Harun.1988. Plant growth regulators in oil palm. pp.451 - 458. In :*Proceeding of International Congress of Plant Physiology*, New Delhi, India. February 15 - 20, 1988. Volume I.

Corley,R.H.V. 1982. Clonal planting material for oil palm industry. *Journal Perak Planters Association*. pp.35-49.

Gawankar, M.S., Devmore, J. P. and Jamadagni, B.M. 2003. Critical input management for cultivation of oil palm in Konkan region of Maharashtra. *International Journal of Oil Palm* **3& 4**: 43-47.

Gomez, K.A. and Gomez, A.A. 1985. Statistical Procedures for Agricultural Research. Second Edition, John Wiley and Sons, New York.

Heartley, C.W.S. 1988. The nutrition of oil palm. p.761.In: The Oil Palm Tropical Agriculture Series, (3rd edition), London, Longman, Scientific and Technical.

Masthana Reddy, B.G., Patil, D.R., Pattara, Arulraj S and Shetty Hanama. 2009. Irrigation and NPK requirement of oil palm for Tungabhadra Command Area. *International Journal of Oil Palm* **6**(1): 35-38.

Michael, A.M. 2008. *Irrigation theory and practices*. Second edition. pp.525-526.

Mite, F., Carillio, B. and Espinasa, J. 1999. Fertilizer use efficiency in oil palm is increased under irrigation in Ecuador. *Better Crops International* **13**(1):30-32.

Nigam, A.K. and Gupta, V.K. 1979. Analysis of Agricultural Experiments. A publication of Indian Agricultural Statistics Research Institute, New Delhi.

Rankine Jan and Fairhurst, T.H. 1999. Management of phosphorus, potassium and magnesium in mature oil palm. *Better Crops International* **13**(1):10-15.