RESEARCH ARTICLE

An Understanding of fertilizer application to oil palm in India and projected yield of fresh fruit bunch (FFB) – A Note

H. Hameed Khan*

ICAR-Project Coordinator (Palms)
* Author for correspondence : khanhh.in@gmail.com

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ABSTRACT

The oil palm is the most productive crop in terms of oil yield per hectare and resource use efficiency. Oil palm is planted in a triangular system with a population of 143 palms per hectare. The juvenile phase of three years assumes importance as a large proportion of total costs apportioned to that palm-stand, during its life time has already been accrued. The uptake for potassium is high in the initial four years and then stabilizes. Under favorable environment for growth, production of FFB is expected to gradually increase and by the end of 7th year and around 1293 bunches are harvested with a mean bunch weight of 11.6 kg and a FFB yield of 15t/ha.

Key words: fertilizer, oil palm, India, FFB

INTRODUCTION

Oil palm is now recognized as a viable alternative to meet a large extent of the growing edible oil demand in India. The oil palm is the most productive crop in terms of oil yield per hectare and resource use efficiency. Oil palm cultivation was started in 1986-87 as a small farmers' irrigated crop in the West Godavari district of Andhra Pradesh. Simultaneously four All India Coordinated Research Project centers on oil palm under the Indian Council of Agricultural Research (ICAR) were started, one each at Aduthurai (Tamil Nadu), Vijayarai (Andhra Pradesh), Gangavathi (Karnataka) and Mulde (Maharashtra). These centers served as testing grounds for regional adaptability of indigenous and exotic teneras of oil palm and to evaluate their yield potential under Indian agro-climate conditions, to define the nutrient (fertilizer) and irrigation requirement and agro-techniques for optimum yields.

PLANTING AND FERTILIZERS

Oil palm is planted in a triangular system with a population of 143 palms per hectare. The recommended fertilizer schedule of N, P, K, Mg and B suggested for Indian conditions is given in Table 1.

Potassium, magnesium and boron requirement are commonly observed in view of the high demand and as they manifest in the form of typical symptoms and act as yield limiting nutrients. P deficiency is rare and other micronutrients as well. Mostly basin irrigation is practiced during the first year, at 40 liters/palm and during 2nd year, 80-90 liters / palm and later by micro-sprinklers to wet the nutrient applied circle around the palm. However, irrigation is practiced based on the pan evaporation data as per guidelines suggested. Organic manures are rarely applied. Under Indian conditions oil palm is grown mostly in red sandy loam soils (Alfisols, Inceptisols) besides alluvial soils and paddy growing soils and in black soils with good drainage.

GROWTH AND NUTRIENT REQUIREMENT

The growth of the palm can be divided into (1) Nursery phase (10-12 months), (2) Immature (juvenile) phase 24-30 months; and (3) Production phase > 30 months. The immature phase lays foundation for a strong root system, leaf development and development of stem (girth) by storing of carbohydrates (assimilates) aided by ablation as a major activity in partitioning nutrients for growth and root development. It is mentioned that the juvenile phase of three years assumes importance as a large proportion of total costs apportioned to that palm-stand, during its life time has already been accrued. Therefore, to reduce or compromise on the maintenance standards especially

Table 1: Fertilizer recommendation for oil palm

Age of the palm (years)	**Urea**	**SSP**	**MOP**
	(grams/palm/year)		
1st year	870	1250	667
2nd year	1740	2500	1333
3rd year onwards	2100	3750	2000
with Di Ammonium Phosphate (DAP)			
1st year	700	435	667
2nd year	1400	870	1333
3rd year onwards	2100	1305	2000
Urea 46%N; **S.S.P** 16% P_2O_5; **DAP** 18 % N & 48 % P_2O_5 ; **M.O.P**. 60% K_2O			

Note: SSP: Single Super Phosphate; MOP: Muriate of Potash; DAP: Di Ammonium Phosphate

nutrition at this stage will never be economical at later stages.

Following field planting, under favorable conditions the palm establishes and develops a good root system. The nutrient demand is less in the first year (Table 1). This fertilizer dose is expected to enrich the rhizosphere to meet the growth demand which increases following ablation activities and influences the growth the trunk, besides serves as reserve and paving way for more uniform yield (Corley and Teo, 1976). Doubling the fertilizer dose in the second year of establishment is justified to aid the growth demand of the palms, though it appears to be in excess. The discussion of Ng (2002) on the exponential form of nutrient uptake supports the fertilizer prescription in the production phase of the oil palm starting from 3rd year. An analysis of fertilizer recommendation for oil palm in India is presented in the table 2, which holds good of the expected yield, yield components (bunches and weight of bunch), given by ASD Costa Rica.

At this stage bunch production is estimated to be around 500 gm, most of them are small, devoid of proper fruit set with an average bunch weight of 3 kg and around 1.5 tons of FFB / ha is harvested (Table 2). Many of these bunches may be rejected at the grading yard at the mill. Compared to the fertilizer input in three years *viz.,* 600.6 kg Urea, 373.26 kg DAP, 572.28 kg MOP, 125 .09 kg $MgSO_4$ applied per hectare, the yield output is low indicating that most of the absorbed nutrients are consumed by growth demand partitioning the assimilates to build up vegetative dry matter related to high yield at later stage of development.

The steep ascent stage sets in the demand and uptake of nutrients is high synchronizing with the development of sufficient leaf area, root and trunk development for resource capture and building sufficient biomass (Ng, 2002). They also clearly indicated the uptake pattern of nutrients matching the demand in producing the yield. The yield plateau is also linked to the nutrient uptake. This is a period in growth where fertilizer prescription can be modified to improve yield of FFB or reduce nutrient application based on soil and leaf analysis.

The uptake for potassium is high in the initial four years and then stabilizes. The nitrogen uptake increases gradually followed by magnesium and phosphorus (Ng, 1977). From the small farmers' point of view under Indian conditions, this stage can be 'plantation care and build up stage' where the genetic potential of the planting material translates into yield of FFB. Some palms exhibit a good sex ratio with good number of FFBs and in some cases the sex ratio is low under the given conditions of agronomic management. No plausible reason has been attributed to this, but if a palm produces around 10 to 12 FFB it is considered as normal. However, Ng (1960) indicated that this may be due to improved mineral absorption without change in CHO status as might be occurring following fertilizer application in light limited situation should result in lower sex ratio.

YIELD AND YIELD PARAMETERS

Under favorable environment for growth, production of FFB is expected to gradually increase and by the end of 7th year and around 1293 bunches are harvested with a mean bunch weight of 11.6 kg and a FFB yield of 15t/ha. This is firmly aided by the fertilizer the system received *viz.,* 2100 g Urea, 1305 g DAP and 2000 g MOP per palm besides Mg and B (Table 2). It is to mention here that the trunk is the obvious storage organ, because it constitutes about 50% of above ground biomass. Corley and Tinker (2003) reported that after about 10 years of planting the leaf area stops increasing and canopy size stabilizes.

From the 7th or more precisely 8th year onwards the yield is expected to be at steady state and thus entering a 'Care and Maintenance Phase' where the cultivator is expected to get maximum returns for the investment. This is the period of maximum activity of harvesting FFBs, maintaining optimum application of manures and irrigation schedules. Depending upon the season, the harvesting rounds vary between 10 and 15 days. During this period of 8th to 17th year, considering that the average yield is uniformly 18 t/ha, the system produces 9212 bunches with a yield of 18 ton FFB/ ha. Interestingly the average bunch weight increases from 13.8 kg in the 8th year to 23.1 kg in the 17th year. Bunch weight tends to increase with palm age as a result of an increase in bunch size which is influenced by number

Table 2: Fertilizer input, yield components and yield of oil palm

Year	Urea (kg)	DAP (kg)	MOP (kg)	Mg SO_4 (kg)	Borax (kg)	Yield FFB tons /ha	No. of Bunches	Average weight (kg)
1	100.1	62.21	95.38	17.87	3.58	0	0	0.0
2	200.2	124.42	190.76	35.74	7.16	0	0	0.0
3	300.3	186.63	286.14	71.48	10.74	1.5	500	3.0
Total	**600.6**	**373.26**	**572.28**	**129.09**	**21.48**	**1.5**	**500**	**3.0**
4	300.3	186.1	286.14	71.48	10.74	5.0	1220	4.1
5	300.3	186.1	286.14	71.48	10.74	8.0	1212	6.6
6	300.3	186.1	286.14	71.48	10.74	11.0	1209	9.1
7	300.3	186.1	286.14	71.48	10.74	15.0	1293	11.6
Total	**1201.2**	**744.4**	**1144.56**	**125.09**	**42.96**	**39.0**	**4934**	**31.4**
Grand Total (7 years)	**1801.8**	**930.5**	**1716.84**	**254.18**	**64.44**	**40.5**	**5434**	**34.4**
8	300.3	186.1	286.14	71.48	10.74	18.0	1304	13.8
9	300.3	186.1	286.14	71.48	10.74	18.0	1065	16.9
10	300.3	186.1	286.14	71.48	10.74	18.0	989	18.2
11	300.3	186.1	286.14	71.48	10.74	18.0	933	19.3
12	300.3	186.1	286.14	71.48	10.74	18.0	882	20.4
13	300.3	186.1	286.14	71.48	10.74	18.0	849	21.2
14	300.3	186.1	286.14	71.48	10.74	18.0	818	22.0
15	300.3	186.1	286.14	71.48	10.74	18.0	804	22.3
16	300.3	186.1	286.14	71.48	10.74	18.0	189	22.8
17	300.3	186.1	286.14	71.48	10.74	18.0	119	23.1
Total	**3003**	**1861.0**	**2861.4**	**714.80**	**107.40**	**180.0**	**9212**	**200.0**
Grand Total (17 years)	**4804.8**	**2791.5**	**4578.4**	**998.98**	**171.84**	**220.5**	**14646**	**234.4**
18	300.3	186.1	286.14	71.48	10.74	16.5	708	23.3
19	300.3	186.1	286.14	71.48	10.74	18.0	638	23.5
Total	**600.6**	**372.2**	**572.28**	**142.96**	**21.48**	**34.5**	**1346**	**46.8**
Total	**5405.4**	**3163.7**	**5150.52**	**1268.77**	**193.32**	**255**	**15992**	**281.2**

(Note: Yield of FFB, No. of bunches Average weight (kg) Source ASD Costa Rica) * Indian recommendation

Table 3: A summary of fertilizer inputs (kg) and yield (tons) of oil palm.

Fertilizer consumption	Urea	DAP	MOP	Mg SO_4	Borax
One palm (19 yrs)	37.8	30.41	36	8.8	1.35
143 palms one ha (kg)	5405.4	4350	5150	1269	194
One ha (tons)	5.4	4.4	5.2	1.3	0.0194
One ha yield	255 t FFB ; 15992 bunches (all size) ; average yield 13.4 t/15.02 t				

of developing bunches on the palm and the supply of carbon assimilates (Mohammed Hanif Harun, 2000). Mean number of bunches decreased over the same period. The fertilizer applied for the growth, buildup of the plantation and yield from planting to 17 years is 4.804 t urea, 2.997 t DAP, 4.578 t MOP besides 1.126 t Mg SO_4 and 172 kg borax. The average yield realized is 1.5 t/ha in the 3rd year, 9.5 tons/ha during 4th to 7th year, 18 tons / ha during 8th to 17th year and 17.25 t/ha during the declining phase of first two years (18 and 19th year). Several reasons are attributed to yield decline like substantial increase in non-photosynthesizing tissues compared to photosynthesizing tissue, limitation in dry matter production of palms due to inter-palm competition for light, height of the palm and difficulty to harvest etc.

Summarizing the data it can be realized that during a field period of 19 years one hectare of the plantation has received 5.4 tons of urea, 4.3 tons of DAP, 5.15 tons of MOP, 1.27 tons of Magnesium sulphate and 194 kg of borax (Table 3), besides an unaccounted amount of usufructs recycled in the system to harvest/produce 255.5 t/ha FFB accounting to 13.44 t FFB / palm in a year. If the active productive 17 years alone is considered, the average yield will be 15.03 t/ha, which is 107 kg/ palm. This indicates the importance of total inorganic nutrition to the system and more so adequate care during the active yielding phase where the yield gradually increases and even stabilizes.

CONCLUSION

There is scope to reduce the fertilizer input in the system by analyzing nutrient export data in the harvested produce; frequency of fertilizer application to be properly judged considering the irrigation method /season; gaining experience from fertilizer trials in major oil palm growing belt in the country. Use of soil series data to extend yield gap analysis information. It is a monoceous species and irrigation is critical in getting desirable sex ratio/yields and both can be judiciously managed for yield maximization. As area expansion takes place, less productive lands will be brought under oil palm cultivation and integrated nutrient management and irrigation is important.

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