Fertilizer Use Efficiency in Oil Palm is Increased under Irrigation in Ecuador

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Since the early 1960s, oil palm (*Elaeis guineensis* Jacq.) has been grown in Ecuador in response to the growing demand for vegetable oils for human and industrial consumption. Currently, the planted area comprises 113,000 ha, with an expected expansion of 10,000 ha per year over the next five years.

Approximately 20 percent of Ecuador's oil palm plantations are located in the region of Quevedo, Los Rios province. This area is prone to soil water deficits. An experiment was carried out to investigate the effect of irrigation and improved mineral nutrition on oil palm growth and yield.

Characteristics of the Experimental Site

The experiment was conducted at the Pichilingue Experiment Station, near Quevedo, Los Rios province. The site is 120 m above sea level with a mean annual rainfall of 2,021 mm. Rainfall exceeds requirements from January to April, but a water deficit occurs from May to December (**Figure 1**). The mean annual temperature at the site is 24.3º C with 914 sunshine hours.

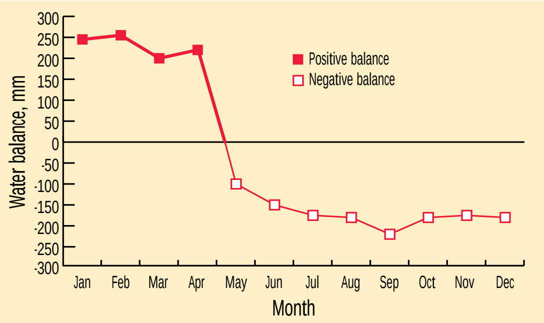

Figure 1. Balance between water availability and oil palm demand for the years 1992 to 1996 at Quevedo, Ecuador.

Soil at the experimental site is representative of the area and is classified as a Melanudand, a volcanic soil having a moist water regime with a dark surface horizon. Soil exchangeable cation and available phosphorus (P) status is very high (**Table 1**). The experiment was located in a 100 ha commercial field of palms planted to National Institute of Agronomic Research (INIAP) *tenera* material in 1991. The triangular planting density was 143 palms/ha.

Table 1. Chemical characteristics of the soil at the experimental site in 1991.

Depth, cm	pH	P (Olsen), mg/kg	K	Ca, cmol(+)/kg	Mg
0 to 10	6.3	24	0.51	10.9	1.3
10 to 25	6.7	7	0.42	7.7	1.0

Table 2. Nutrient rates applied to the different treatments from 1992 to 1997.

Year	N	P_2O_5	K_2O	MgO	S	$CaCO_3$
	kg/palm/year					
1992	0.40	0.16	0.15	0.08	0.069	1.95
1993	0.40	0.16	0.15	0.08	0.069	1.95
1994	0.49	0.18	0.18	0.10	0.085	2.45
1995	0.98	0.50	1.40	0.25	0.223	6.85
1996	1.00	0.50	1.40	0.35	0.307	6.85
1997	1.60	0.50	2.00	0.35	0.307	6.85

Materials and Method

The effect of irrigation on fruit bunch yield at five levels of mineral fertilizer was measured from the onset of harvest in 1993 for a period of five years. The plots were arranged in a split plot design with the irrigation treatment as the main plot and fertilizer treatments as sub-plots. Nutrients in the fertilizer treatments included nitrogen (N), P, potassium (K), magnesium (Mg), sulfur (S), and calcium (Ca). The irrigated plots were supplied with 60 mm water three times during the dry season. Fertilizer treatments were comprised of a control, +N, +NPK, +NPKMgS, and +NPKMgSCa at amounts shown in **Table 2**. Fertilizer sources were urea, triple superphosphate (TSP), potassium chloride (KCl), magnesium sulfate ($MgSO_4$) and calcium carbonate ($CaCO_3$). Fertilizers were applied in a band in the weeded circle. Urea, KCl and $MgSO_4$ fertilizers were applied in two equal split applications in January and April. The TSP and $CaCO_3$ were applied in February.

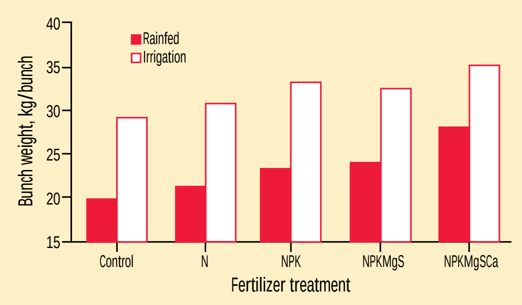

Figure 2. Effect of irrigation and fertilizer application on bunch weight in the fifth year of harvest in Quevedo, Ecuador.

Results and Discussion

Harvesting commenced in 1993. The number of bunches per palm was increased under irrigation, but was not affected by the fertilizer treatments. There was, however, a significant positive interaction between the effect of irrigation and fertilizer application on bunch weight, particularly as the palms grew older (**Figure 2**). Bunch weight was increased under balanced fertilizer application for both irrigated and rainfed treatments, but bunch weight was 7 to 10 kg larger in the irrigated plots compared with the rainfed conditions (**Figure 2**).

Due mainly to the increase in bunch weight, cumulative yield was 26 to 33 t/ha higher under irrigation compared with rainfed conditions and, the cumulative yield increase was largest when all six nutrients were applied together (**Figure 3**).

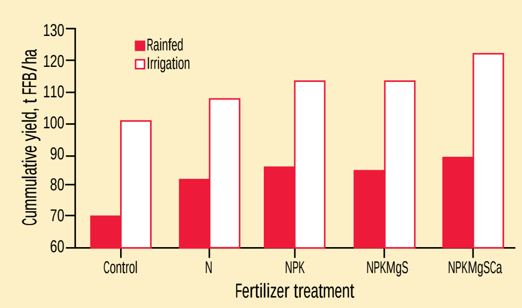

Figure 3. Effect of irrigation and fertilizer application on cumulative yield (1993 to 1997) of fruit bunches in Quevedo, Ecuador.

Photo 1. Inadequate nutrition during immature stage may be a cause of low yields later.

Conclusions

Adequate nutrition is essential during the growth and development stages of the oil palm since nutrient uptake establishes the plant's production potential (see graph of nutrient uptake on page 6). This fact is often neglected by producers. The trunk is a sink for nutrients accumulated by the plant during the immature stage. Later, when harvest begins, the trunk provides a buffer against nutrient removal in fruit bunches and the transient and temporary availability and supply of nutrients by the soil. Large yields can thereby be sustained because the palm can withstand stress without changing from reproductive to vegetative growth phase. Trunk size was larger in the complete nutrient application plot compared with the control (**Photos 1** and **2**). Low yields obtained by many oil palm growers in Ecuador may be attributed to inadequate nutrition during the immature stage of oil palm development.

Palm growth and production are limited by water deficits in many oil palm producing areas of Latin America. Since palms take up nutrients from the soil solution, low soil moisture availability limits nutrient uptake. Some growers suspected that low yields in the Quevedo oil palm area of Ecuador were partly explained by low soil moisture availability. This experiment documented for the first time the extent and impact of water deficits on yield and clearly demonstrates that proper water management in oil palm is important for obtaining large yields. The interaction between irrigation and nutrient application is evident from this experiment, as plots without irrigation and fertilizer produced an accumulated yield of 70.1 tonnes of fruit bunches in 5 years, while the irrigated and fertilized plots produced 122.8 tonnes during the same period (**Figure 3**).

Photo 2. Trunk size of oil palms was larger in the complete nutrient application plot.

Balanced nutrient application is important even in high soil fertility status volcanic soils found in many of the oil palm growing areas of Ecuador. However, irrigation is required in the dry season in order to achieve the maximum response to mineral fertilizer. The increase in cumulative yield under balanced fertilizer application and irrigation was equivalent to an additional two-years of production in the control plots. BCI

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