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Study on Feasibility of Growing Oil Palm (*Elaeis guineensis*) under Alluvial Plain of Bihar

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ABSTRACT

The present investigation was carried out from 2009-2019. To assessing the feasibility of growing oil palm crop in sandy-loam soil under All India Co-Ordinated Research Project on Oil Palm. The crop was grown in sub-tropical climatic condition at 103 above mean sea level. Oil palm, is a perennial oil yielding crop, was widely spaced at a distance of 9 m × 9 m × 9 m in a triangular/hexagonal manner. The Oil palm is the highest edible oil yielding crop (per unit area) providing up to 4-6 t/ha per year. The crop has great advantage in terms of oil yield as compared to other major oil crop. For the successful cultivation of oil palm, it requires evenly distributed rainfall of 150 mm per month or 1800 – 3000 mm per annum, humidity around 80% and sunshine hour at least 5 hs as well as maximum temperature between 29-33°C and minimum temperature 22-24°C. Under uneven rainfall condition the crop has been grown with ensured irrigation and adopting recommended package of practices. The experiment has been formulated under RBD, with planting of oil palm (cv *Costarica*) at hexagonal spacing of 9 m × 9 m × 9 m. A total number of 66 palms have been maintained for its feasibility testing. The data showed that average palm height (8.69 m), No. of annual functional leaves production (15) and palm girth (4.76 m), attained at the age of ten years. At this age oil palm produced on an average nine fresh fruit bunch (FFB) per palm with an average fresh fruit bunch weight of 14.7 kg. The good growth of oil palm indicated as FFB weight of 132.3 kg/palm/year and FFB Yield of 18.91 t/ha. The findings suggest that the successful cultivation of oil palm is possible with good growth and yield under the climatic condition of Bihar.

Keywords Oil palm, Yield attributes, Yield, FFB, Bihar.

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INTRODUCTION

The oil palm (*Elaeis guineensis* Jacq.) is indigenous to West Africa (though now planted in all tropical areas of the world) and the fruits grow in bunches weighing up to 10-40 kg and containing hundreds of fruitlets,

like small plums with the fleshy mesocarp enclosing a kernel that is covered by a hard shell (Shuit *et al.* 2009). Oil palm,is a monoecious plant which bears male and female inflorescences, separated from one another on the same vegetative axis. The oil palm tree provides employments for youth in the formal and informal sectors (Erhabor *et al*. 2002). In the informal sector, most youths earn their living through cutting of palm fruits for clients, as well as making local baskets and trays. It promotes other industries like cosmetic industries and manufacture of house hold articles such as candle, rope, plate and house decorating article. It also maintains the ecosystem. Several industrial uses of palm oil have led to the creation of more jobs for the populace. In the food industry, palm oil is used as cooking oil. Due to its high resistance to oxidation and consequent long shelf life, it is suitable for use in hot climates as frying fat in the snack and fast food industry. Palm kernel cake (PKC) and palm kernel oil (PKO) are produced from palm kernel and are used in many industrial manufacturing activities including the manufacture of margarine, compound cooking fats, soap, candles, cosmetics, confectionery and as a lubricant in tin plating. Palm kernel cake, a by-product from the extraction of palm kernel oil, contains about 20% protein and is widely used as livestock feed (Erhabor *et. al.* 2002, Aderungboye 1977). Palm oil, an edible vegetable oil that is naturally reddish in color because of high beta-carotene content (a precursor of vitamin A) is derived from the mesocarp of the palm fruit (Demirbas 2003). The palm oil is cholesterol free vegetable oil with high protein content. Each fruit consists of a single seed (the palm kernel) which is surrounded by a soft oily pulp (Shuit *et al.* 2009). The oil from the flesh of the fruitlets can be recovered by very simple means such that some authors are of the opinion that: 'it is probable that palm oil has been recovered and used for human food for tens of thousands of years' (Demirbas 2003).

Oil palm crop is one of the highest oil (palm oil) yielding crops among the all perennial crops. Oil palm tree produces edible palm-oil as well as palm kernel-oil. This oil palm is considered as golden palm due to its high yielding capacity. Oil palm produces 4 to 5 tonnes per ha of crude palm oil (CPO) and 0.40 to 0.50 tonne per ha of palm kernel oil (PKO) from 4th to 30th year of its productive life spam. Oil palm crop provides the excellent substitute of importing the oil.

In India, oil palm is being cultivated in 13 states by covering about 3,00,000 hectares by 2016-17 under irrigated conditions. In India, an area of 19.33 lakh ha has been identified by the Department of Agriculture, Cooperation and Farmers Welfare for oil palm cultivation in 19 states of the country including 2.18 lakh ha area in North Eastern States during the year 2012. Out of 19.33 lakh ha area more potential States are Andhra Pradesh (4.69 lakh ha), Gujarat and Karnataka with 2.60 lakh ha and Tamil Nadu and Bihar with 2.00 lakh ha area. The potential districts area identified for oil palm cultivation in Bihar state are Banka, Katihar, Purnia, Madhepura, Saharsa, Kisanganj, Araria, Supaul, Darbhanga, East Champaran and West Champaran.

Thus considering the future prospectus of oil palm cultivation, the experiments had been carried out in the experimental plots at RRS, Madhopur, in West Champaran district of Bihar, with an assumption that, the oil palm crop will come up well with good growth and yield under the climatic condition of Bihar.

MATERIALS AND METHODS

Location of experimental site

The seedling of oil palm was obtained from Indian Institute of oil palm, Pedavegi, Andhra Pradesh. It was planted in the year 2009, for testing the feasibility of growing oil palm crop under climatic condition of Bihar and continued up-to 2019, at the experimental farm (which is located between North latitude 27 ° 03' 54" and East longitude 84° 20' 31" of the equator) of Regional Research Station, Madhopur, West Champaran which comes under Agro-climatic zone-I, of Bihar.

Soil sampling of experimental site

Soil samples were collected with auger having six spots were selected for each composite sample. All the composite soil samples were air-dried, ground

and passed through 2 mm sieve for chemical analysis. All the samples were stored in the polythene bags for further analysis. Soil pH and electrical conductivity (EC) were determined by potentiometer and direct reading conductivity meter using 1: 2.5 soil water suspensions (Jackso 1973). The composite soil samples were analyzed for available nitrogen (Subbiah and Asija 1956), available P_2O_5 (Bray and Kurtz 1945), neutral ammonium acetate extractable K_2O (Jackson 1973) and organic carbon (Walkley and Black 1934). The available Zn, extracted with DTPA (Lindsay and Norvell 1978) was determined on an Atomic Absorption Spectrophotometer. The hot water soluble B was estimated by UV-VIS Spectrophotometer (Wear 1965 Table 1).

Climatic requirements for oil palm cultivation

For the successful cultivation of oil palm, it requires evenly distributed rainfall of 150 mm per month or average annual rain fall ranges from 1800 mm to 3000 mm per annum, high humidity around 80% and bright sunshine hour for at least 5 h as well as maximum temperature between 29-33°C and minimum temperature 22-24°C.

Nutrient requirement

The age-wise nutrient requirement for the oil palm crop is as follow, for 1st year: NPK $MgSO_4$: 400:200:400:125 g/palm/year; for 2nd year: 800: 400: 800: 250 g/palm/year; for 3rd year and above: 1200:600:1200:500 g/palm/year.

In the early age of the crop, ablation carried out up-to age of 4 years of the planting. The methodologies adopted in the experiments while taking the observations related to growth and yield attributing character of oil palm are as follows:

Palm height: (For palms above 3 years): It is measured from the base of the 25th leaf to ground level, by using large measuring poles or by altimeter and expressed in Meter (m). Palm height is taken once in a year.

Palm girth: (For palms above 5 years): It is measured 50 cm above ground level by using measuring tape around the trunk and expressed in meter (m). Palm girth is taken once in a year. Girth recording, stopped, if it is constant for 3 or 4 years.

Number of leaves: (Annual leaf production): Consider the young fully opened leaf as first leaf and mark it. And after a quarter, mark again the just fully opened leaf. And now the no. of leaves is counted from first marked leaf to the 2nd marked fully opened leaf. Expressed as number of leaves per palm per year. Observations to be recorded every quarter and expressed on numbers per year.

No. of bunches: Count only the harvested bunches whenever the harvesting is done during the period and expressed as no. of bunches per palm in year.

Fresh fruit bunch (FFB) weight on per palm per year basis: Total bunch weight per palm is weighed at every harvesting by using accurate weighing machine. Expressed in kg/palm/year.

FFB Yield/ha: Expressed in tones/ha. This is obtained by multiplying bunch weight per palm per year and oil palm population in one hectare area. Number of palms present in one hectare is 143 at spacing of 9 m × 9 m × 9 m.

RESULTS AND DISCUSSION

Initial soil analysis report of the experimental site

The initial soil samples were analyzed for knowing the nutrient status of soil. The texture of soil was: Sandy loam; pH 8.28; Organic carbon (%): 0.61; Available nitrogen (kg/ha): 265; Available P_2O_5 (kg/ha): 22 kg/ha; Available K_2O (kg/ha): 172; Available zinc (ppm): 0.65; Available boron (ppm): 0.31.

Weather variables of experimental site

Best possible FFB yields are obtained under opti-

Fig. 1. View of oil palm garden. **Fig. 2.** Intercropping in oil palm garden. **Fig. 3.** Female Inflorescence. **Fig. 4.** Male inflorescences emitting pollen grain. **Fig. 5.** Release of pollinating weevils. **Fig. 6**. Palm bearing fruit bunch (Source of oil).

mal climatic conditions, with at least 2,000 mm of rainfall homogeneously distributed throughout the year corresponding to around 167 mm/month. Also, minimum temperatures should be between 22 and 24 °C and maximum temperatures between 29 and 33 °C, while relative humidity should be greater than 85%. Finally, at least Sunshine of 5-7 hrs/day should be required. Composites of rainfall (1342.67), minimum temperatures (27.10°C to 11.95°C) and maximum temperatures (38.17°C to 19.37°C) and relative humidity (87.29% to 75.52%) are constructed following identified years of lower and higher FFB production. The inflorescence abortions (upto 24 to 36 months) and bunch failures (2-3 months, Data not shown) were also reported in the different stage of oil palm. The climatic conditions of experimental

site at RRS, Madhopur, West Champaran, Bihar; have average Rainfall ranges from 1050 mm - 1350 mm, which fulfill almost the requirement of irrigation for oil palm. However the rainfall was erratic in the alluvial plains of Bihar, since rainfall distribution is not even and adequate in the climatic zone-I of Bihar, even under this situation, the crop has been grown under ensured irrigated condition, and the bumper growth of oil palm crop (Fig.1-6) occurs.

Technology developed for enhancing fruit setting in oil palm under climatic condition of Bihar

Strictly followed the all recommended package of practices for cultivation of oil palm crop. The maximum temperature is best suited as per their ideal requirement for growth of oil palm crop but the requirement of minimum temperature is about 22-24°C, which is mismatching for this crop, because the lowest temperature under the climatic condition of Bihar goes upto 6 ˚C – 8˚C which is extremely low and eventually leads to lower production of FFB yield of oil palm. This happens because of lower temperature reaches in winter season in Bihar as compare to South India. Actually at this low temperature in winter, the pollinating weevils (*Elaeidobius kamerunicus* Faust.) died, which affects the pollination of oil palm crop. Bunch failure may occur, that drastically reduced the yield of oil palm fruit nut, for 2 to 3 month period, from December upto end of February. Therefore technology we have developed for release of pollinating weevils in the end of winter viz, February, from this month onwards the temperature starts to shoot up. The source of pollinating weevils is old orchard of oil palm which has been maintained at IIOPR, Pedavegi, AP or any other center where this crop has been maintained in other state. The pollinating weevils has bring from IIOPR, Pedavegi, AP and released in oil palm garden at Madhopur center in the first week of March. So every year this methodology has been adopted for 4-5 years. As a result the development of colony of pollinating weevil (*Elaeidobius kamerunicus* (Faust.) build up in the oil palm garden, which help in transfer of pollen grain from male inflorescences to female inflorescence (Fig. 3). In this way the pollinating weevils, enhance pollination extent which escalates more fruit nut set in female inflorescence of oil palm that increases the size of fresh fruit bunch on palm (figure 6). Side by side, the colony of pollinating weevils has gradually established in this area and now they are surviving even under this harsh climatic condition for the oil palm garden of Bihar. The host climber plant for the survival of this pollinating weevil in adverse condition has also brought from IIOPR, Andhra Pradesh and planted in the oil palm garden, of Madhopur center. A result obtained from the oil palm garden of Madhopur center of Bihar is very encouraging.

Demonstration on oil palm production potential in Bihar state

The layout and planting of this trial were done during the year 2009, the growth parameters and yield attributing characters of the palm recorded as per described methods and presented in Table 2. The total number of oil palm maintained under this

Table 1. Initial soil analysis report of the experimental site.

Soil parameters	Value	Category ()
PH (1:2.5)	8.28	Saline
EC (dS/m) (1:2.5)	0.73	Normal
Organic carbon (%)	0.61	Medium (0.5-0.75)
Available nitrogen (kg/ha)	265	Medium (250-560)
Available P_2O_5 (kg/ha)	22	Medium (10-25)
Available K_2O (kg/ha)	172	Medium (110-280)
Available zinc (ppm)	0.65	Medium (0.50 - 1.00)
Available boron (ppm)	0.31	Low (< 1.0)

Table 2. Growth and yield attributing characters of oil palm grown at Madhopur (P/Y: 2009).

Characters	Mean of 6 palms (2019)	Mean of 6 palms (2018)	Mean of two years	% increase over previous year
Palm height (m)	8.69	7.56	8.13	14.94
No. of functional leaves	15	12	13.5	25.0
Palm collar girth (m)	4.76	3.83	4.30	24.28
No. of fruit bunch/palm	9	8	8.50	12.5
Fruit bunch wt (kg)	14.7	11.30	13.0	30.08
FFB weight (kg/palm year)	132.3	90.40	111.35	46.34
FFB yield (t/ha)	18.91	12.93	15.92	46.24

Table 3. Nutrient and minerals contents in oil palm cakes.

Nutrient contents	Mean of six samples
Ash (%)	5.97
Fat (%)	13.87
Crude protein (%)	6.90
Crude fiber (%)	23.47
Minerals contents	
Calcium (%)	0.29
Phosphorus (%)	0.66
Magnesium (%)	0.16
Zinc (%)	0.21
Sodium (%)	0.17
Potassium (%)	0.33
Copper (%)	0.23
Manganese (ppm)	1.2
Iron (ppm)	0.79

Table 4. The weather data of RRS Madhopur from April 2017 to March 2018.

Months	Rainfall (mm)	Temperature (^{0}C) Maximum	Minimum	Humidity (%)
April 2017	12.54	35.50	22.41	75.52
May	91.03	36.33	21.89	82.33
June	145.0	38.17	27.10	84.70
July	329.0	27.84	19.10	86.72
August	109.0	29.12	26.40	84.18
September	401.0	29.95	23.73	86.68
October	52.0	29.50	24.46	83.56
November	12.9	25.80	18.80	83.88
December	28.4	19.37	11.95	87.29
January 2018	2.50	18.32	12.81	86.23
February	11.3	27.5	17.57	84.36
March	148.0	32.5	21.97	80.94

experiment was 66. The results related to growth and yield attributing characters of oil palm under the experiment demonstration on oil palm production potential in Bihar state shown that the oil palm crop grows well under the climatic condition of Bihar. The growth and yield attributing characters of oil palm recorded and presented in Table 2. Presently 66 oil palm tree (varieties: *costarica*) has been maintained under this experiments, which were planted in 2009 in the maximization plot design at spacing of 9 m X 9 m X 9 m (triangular) where maintained plant population are 6 palms/plot. All the recommended crop management practices have been adapted to attained maximum yield potential of this crop. The average palm height, collar girth and number of leaves per plant during the year 2018, were recorded 8.69 m, 4.76 m and 15 leaves per palm respectively. Pollinating weevil brought from ICAR-IIOPR, Pedavegi and was released in the oil palm plantation. After releasing the pollinating weevil in the plantation, fruit set has been improved by 46.24 % in comparison to previous year. The number of FFB produced per palm was 9 with an average fresh fruit bunch weight of 14.7 kg, FFB weight (kg/palm/year) was 132.3 and FFB Yield (t/ha) recorded up-to 18.91 t/ha. The results obtained from the above experiment shows that the oil palm crop grows well under the climatic condition of Bihar. The oil palm cultivation was found technologically feasible and economically viable in term of FFB yield. This is at par with the national levels. The FFB yield of oil palm in the national hub of India is approximately 20 t/ha.

Nutrient contents in oil palm cakes:

A nutrient and minerals content in oil palm cakes has been shown in Table 3. Feeding palm kernel cake on dairy cattle is one of the best options for supplementing mineral with this feed. A feed is important factors affecting milk production and animal performance. Therefore, using agro-industrial by-products are very important to minimize the cost of feeds by including cheaper source of energy and protein without any adverse effect on animal productivity. Palm kernel cake is relatively high in minerals contents as shown in Tables 3, 4. Palm kernel cake plays a significant role in utilization has effectively reduced the cost of milk production as a result of replace expensive conventional feedstuffs, such as maize and soybean meal with a more economical and locally available one that also meets the nutrient requirements of livestock. Various literature have indicated that the crude protein content of palm kernel cake ranges between 14-20% (Sundu *et al* 2006, Atil 2009, Akinyeye 2011). The crude fiber is consists mainly of cellulose, hemicellulose and lignin. Crude fiber is an index that can used to be predicting the feeding value and nutrients digestibility of the feeds. There was reversed relationship between crude fiber and nutrients digestibility to the

animals Onuora and King (1985), Alimon (2004). The composition of crude fiber content of mechanically extracted was lower compared to solvent extracted of palm kernel cake, Ezieshi, and Olomu, 2004. The crude fiber content of palm kernel cake was 23.47% which is almost contradictory of the work of Onifade and Babatunde (1998). The total ash content of palm kernel cake as recorded in studies is 5.97% which is in conformity with the work of Akinyeye (2011). Palm kernel cake is relatively high in minerals content were calcium 0.29%, phosphorus 0.66%, magnesium 0.16%, zinc 0.21%, sodium 0.17%, potassium 0.33%, copper 0.23%, manganese 1.2 ppm and iron, 0.79 ppm was recorded, this is also support by the work of the Akinyeye (2011). It was observed that the Ca:P ratio is low and most diets based on palm kernel cake need to be supplemented with calcium to cover the requirement of animals.

CONCLUSION

Based on above findings it may be concluded that oil palm can be successfully grown under sub-tropical region of north Bihar. The oil palms planted in experimental plots under AICRP-on Palms at RRS, Madhopur, have provided the FFB yield, 18.91 t/ha, which reflects that crop come up well with excellent growth and yield potential. The release of pollinating weevils has enhanced the FFB yield upto 46.24 % in comparisons to previous year. The economic yield of oil palm can be achieved after 6 years of plantation. Under the climatic condition of north Bihar the oil palm is producing d highest yield attributes and yield for sustaining productivity of oil palm. Thus the initial outstanding performance indicates that oil palm could be promoted for cultivation in the Bihar region.

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REFERENCES

Aderungboye FO (1977) Diseases of the oil palm. *Int J Pest Manag*. 23 (3) : 305-326.

Adesehinwa AOK (2007) Utilization of palm kernel cake as a replacement for maize in diets of growing pigs: Effects on performance, serum metabolites, nutrient digestibility and cost of feed conversion. *Bulg J Agric Sci* 13: 593-600.

Akinyeye RO, Emmanuel IA, Olayinka F, Adedunke A (2011) Physico-chemical properties and anti-nutritional factors of palm fruit products (*Elaeis guineensis* Jacq.) from Ekiti State Nigeria. *Electron J Environ Agric Food Chem* 10: 2190-2198.

Alimon AR (2004) The nutritive value of palm kernel cake for animal feed. *Palm Oil Dev* 40: 12-14.

Atil O (2009) Enhancing the MPOB-Q-Palm kernel cake in poultry diet, animal feedstuffs in Malaysia-issues, strategies and Opportunities. *Malaysian Acad Sci* pp 57-67.

Bello KM, Oyawoye EO, Bogoro SE (2008) Effect of processing on chemical composition of Palm Kernel meal (*Elaeis guineensis*). Proceedings of the 13th Annual Conference of the Animal Science Association of Nigeria, September 15-19, 2008, ABU, Zaria, pp: 201-207.

Bray RH, Kurtz LT (1945) Determination of total, organic and available forms of phosphorus in soils. *Soil Sc*i 59 : 39-45.

Demirbas A (2003) Fuel conversional aspects of palm oil and sunflower oil. *Energy Sources* 25(5): 457-466.

Erhabor JO, Aghimien AE, Filson GC (2002) The root distribution pattern of young oil palm (*Elaeis guineensis* Jacq) grown in association with seasoned crops in southwestern Nigeria. *J Sustain Agric*. 19 (3):97-110.

Ezieshi EV, Olomu JM (2004) Comparative performance of broiler chickens fed varying levels of palm kernel cake and maize offal. *Pak J Nutr* 3: 254-257.

Jackson ML (1973) Soil chemical analysis. Prentice Hall of India Pvt Ltd, New Delhi India

Lindsay WL, Norvell WA (1978) Development of DTPA soil test for Zn, Fe, Mn and Cu. *Soil Sci Soc Am J* 42: 421- 428.

Onifade AA, Babatunde GM (1998) Comparison of the utilization of palm kernel meal, brewers' dried grains and maize offal by broiler chicks. *Br Poult Sci* 39: 245-250.

Onuora JO, King RD (1985) Preliminary study of enzymic solubilization of nitrogenous constituents of palm kernel cake. *Food Chem* 17: 297-302.

Shuit SH, Tan KT, Lee KT, Kamaruddin AH (2009) Oil palm biomass as a sustainable energy source: A Malaysian case study. *Energy* 34:1225–1235.

Subbiah BV, Asija GL (1956) A rapid procedure for estimation of available N in soil. *Curr Sci* 25: 259-260.

Sundu B, Kumar A, Dingle J (2006) Palm kernel meal in broiler diets: Effect on chicken performance and health. World's *Poult Sci J* 62: 316-325.

Walkley AJ, Black IA (1934) Estimation of soil organic carbon by chromic acid titration method. *Soil Sc*i 37: 29-38.

Wear JI (1965) Boron. In: (Black CA *et al*. eds. Methods of soil analysis Part II. American Society of Agronomy, Madison, Winconsin, USA.