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Effect of water stress on growth and yield of Tenera oil palm

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Abstract

In a field investigation conducted over six years, the Tenera oil palms subjected to intermittent water stress showed 88.46% reduction in fresh fruit bunches yield as compared to yield under irrigated condition. Production of leaves due to water stress was reduced by 30% during early growth phase and by 12.5% in later growth phase. Stem growth showed greater sensitivity (49.41% reduction) than foliage production. Production of male inflorescences was least affected but female inflorescences were reduced by 86% under intermittent water stress over six years. This resulted in more than 91% reduction in number of FFB and ultimately caused 88.46% reduction in FFB yield.

Key words: Water stress, Tenera oil palm, foliage, female inflorescences, fresh fruit bunches (FFB).

Introduction

Water stress is regarded as the major limiting factor for yield in several crops. Unavailability of water reduces the productivity by hampering crop establishment, alterations of physiological and biological mechanisms, and predisposition of crops to insects and diseases that ultimately hampers the quantity and quality of economically important products (Larsen, 1981). Turner (1976) has reported the effects of drought on oil palm yield in South East Asia and the South Pacific region. The Konkan region of Maharashtra (India) is a 720 km long coastal belt having a width of about 45 km. It is a hilly area receiving the rainfall between 2000 to 4000 mm during June to September. In remaining eight months of a year there is practically no rainfall. Soil in Sindhudurg and Ratnagiri districts are lateritic, sandy loam and acidic. They have poor water holding capacity (FC=27.15, PW*P*=16.50) with a high infiltration rate (Dongale *et al.*, 1987). Hence during October to May the crops are subjected to severe water stress which is usually terminated with onset of monsoon in June or by giving irrigation, whenever possible. The current investigation is aimed at assessing the growth and yield performance of Tenera oil palm under rainfed and irrigated condition.

Materials and methods

The investigation was undertaken at Agricultural Research Station, Mulde, Sindhudurg with a view to assess the effect of intermittent water stress on growth and yield of Tenera oil palm. The palms were planted in August 1989 under All India Co-ordinated Research Project on palms. A unit of six palms receiving the treatments 'no irrigation' and 'basin irrigation' each from the experiment entitled, "Studies on adaptability of oil palm in different agro- climatic regions of India and to assess their irrigation and nutrient requirements" was used as an experimental material. The soil of experimental plot was loam sand in nature with water holding capacity of 38 to 43% and of high infiltration rate. The palms under the treatment 'no irrigation' received water only through the monsoon rains during June to September. From October up to May the precipitation does not occur in Konkan region. The rainfed palms therefore have to grow only on stored soil moisture during post monsoon season and due to high infiltration rate are subjected to ever increasing water stress up to the onset of monsoon. With commencement of monsoon the stress is terminated for a period of about four months. Thus the rainfed palms experienced an intermittent water stress of about eight months every year during the course of growth. The other unit of palms receiving 'basin irrigation' every 4th days had stress free condition. The data on number of total inflorescences, male, female inflorescence, number of fresh fruit bunches (FFB), average weight of bunches, and total yield of FFB was recorded every year from 1993-94 to1998-99. The height of open stem and number of scars on it as well as number of functional leaves were recorded in June 1999. The cumulative totals of number of total inflorescence, number of male and female inflorescence, individual weight of FFB over six years were worked out. The percent reduction in expression of the character due to water stress was estimated.

Results and discussion

Foliage development is a critical aspect of plants response to water stress. According to Hsiao *et al.* (1985) the attributes of leaf growth are very sensitive to water stress. In current investigation, however, it was noticed that production of leaves was less sensitive than stem growth to water stress. The stressed oil palm had 42 functional leaves as against 48 in irrigated palms whereas the height of open stem of stressed palm over six years was only 0.86m as against 1.70 m in irrigated palms.

Thus water stress caused only 12.5% reduction in number of leaves as against 49.41% reduction in stem length over six years. Number of leaf scars indicated the number of leaves produced on

oil palm in earlier growth period. Stressed palms had 80 scars as against 114 scars in irrigated palm over six years period. Thus the leaf production in early growth phase was inhibited to the extent of 30 percent due to stress. This suggested that the process of leaf production was hampered to greater extent in early growth period than in later phase of growth. The number of scars per meter length of stem was greater (93.02) in stressed palm than in irrigated palm (67.06). Thus the leaf production occurred in a crowded manner on stem under stress condition.

Occurrence of male and female inflorescences is a result of the process of differentiation that is known to occur 27 to 35 months before anthesis and is concurrent with the process of leaf production (Hartley, 1988). In current investigation the extent of reduction in number of functional leaves (12.5%) and total number of inflorescences (12.91%) was nearly equivalent. It is to note that the number of male inflorescences was stable under stress

Table 1. Effect of water stress on attributes of growth and yield in Tenera oil palm

Characters	Stress (Rainfed)	No stress (Irrigated)	Per cent loss due to stress
No. of leaf scars /palm	80.00	114.00	30.00
Functional leaves /palm	42.00	48.00	12.50
Height of open stem(m)	0.86	1.70	49.41
Scars per meter stem	93.02	67.06	—
Total inflorescences over six years	44.70	51.33	12.91
No. of male inflorescences over six years	41.22	43.89	6.08
No. of female inflorescences over six years	3.45	24.66	86.00
No. of FFB per palm over five years	1.63	18.89	91.37
FFB yield (kg) per palm over five years	18.18	157.51	88.46
Av. bunch wt. (kg)	4.06	6.87	40.90

(41.22 over six years) as well as irrigated condition (43.89 over six years). The reduction in number of male inflorescences due to water stress was only 6.08 percent and was lowest among all the characters.

Number of female inflorescences is considered as the determinant of high yield in oil palm. Stressed palms showed hardly 3.45 female inflorescences as against 24.66 in stress free palms over six years. Thus among the reproductive attributes production of female inflorescences appeared to be highly sensitive to water stress showing the reduction to the extent of 86 percent. The number of FFB depends upon the number of female productive inflorescences. Hardly 1.63 FFB were produce in stressed palms as against 18.89 in stress free palms. The stress-induced loss in number of FFB/palm was 91.37%. The average bunch weight was found to be relatively less sensitive (40.90 % reduction).

Leaves are pivotal to overall growth of the plants. Thirty percent reduction in number of leaves in early growth phase as revealed from number of scars and 12.5 per cent reduction in later growth phase resulted in 49.41 percent reduction in stem growth due to stress. Leaves and stem have a concurrence with reproductive growth. A small reduction in these two attributes due to water stress showed an amplification of the inhibitory effect of water stress on number of female inflorescences and number of FFB per palm over six years. This ultimately resulted in reduction of FFB yield by 88.46 percent under water stress condition.

The water stress thus showed a high reduction in number of female inflorescences, number of FFB and ultimately resulted in 88.46 percent reduction in yield of fresh fruit bunches.

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