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Water balance technique to optimize the plant population of mango in dry land horticulture

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ABSTRACT

Eastern Dry zone of Karnataka where normal annual rainfall is 868 mm and annual PET is 1181 mm favours the establishment of the perennial horticultural crops. Using the crop co-efficient, PET and the geometry of the fully matured trees, the plant population that could be accommodated per hectare area under rainfed horticulture with minimum period of stress druing the year, has been fixed using the FAO water balance model. Under the existing rainfall scenario, about 44 mango tress per hectare area could be accommodated with 15 meter by 15 meter spacing that have the maximum spread of 6 meter radius from the main trunk, so that the life span of the tree is not effected by moisture stress.

Key words : Water balance, Mango, Plant population.

The State of Karnataka which has been producing enormous amount of mango under rainfed agriculture has 10 Agroclimatic zones. Mango is the major horticulture fruit crop grown in Karnataka especially in Eastern Dry Zone (Zone No. 5) of the State with geographical area of 17.96,838 ha. The zone normally receives 868 mm of annual rainfall, which is bi-model in nature. May in premonsoon perod and September-October months during s-w monsoon period receive the highest rainfall. The farming community is increasing the area under mango cultivation. Rainfall and irrigation help the farming community to raise the trees successfully. For minimizing the stress and effective utilization of rainwater, use of the FAO water balance technique is found feasible, so that the trees are not subjected to much moisture stress. The water balance for dry land crop in the Easter Dry zone of Karnataka has been attempted by Rajegowda *et al* (1996, 2000 and 2001) and Rukmini *et al* (1996). Knowing the quantity of water required for the growth of the mango under rainfed condition, the number of plants that could be accommodated in a unit area can be fixed.

MATERIALS AND METHODS

Eastern dry zone region, is also called the "Tank fed" region and lies between 12° 50'N and 14° 55" N lat., 75° 30' and 77° 20' E long. at an altitude of 800 - 900 m.a.s.l. The daily weather data of GKVK, Bangalore for the period 1972-2000 was used to work out the water balance of the region.

The monthly normal potential evapotranspiration values have been computed using Penman's method (Doorenbos and Pruitt, 1977). The crop coefficient (Kc) values given by Doorenbos and Pruitt (1977) were used.

Water Balance

Water holding capacity (WHC) of the soil is considered as 170 mm for every 100 cm depth of the soil and the permanent wilting point (PWP) as 1/3 of WHC at its field capacity. Therefore, it is estimated that only 115.5 mm of water would be available (AWC) for every 100 cm depth of the soil for the plant.

ET requirement (ETi) by the crop has been computed using the equation.

$$ETi = Kci \times PETi \quad \ldots \quad (a)$$

Where, ETi = Evapotranspiration by the crop during i^{th} month
Kci = Crop coefficient during i^{th} month and
PETi = Potential evapotranspiration during i^{th} month

Actual evapotranspiration (AET_i) by the crop depending upon the availability of moisture in the soil has been calculated using the procedure adopted by Frere and Popov (1979). Soil water storage (mm) at the end of i^{th} month has been calculated following the FAO water balance method of using the equation

$$S_i = S_{i-1} + P_i - AET_i \quad \ldots\ldots (2)$$

Where, S_i = Water retained (mm) in the soil at the end of i^{th} month
S_{i-1} = Water available (mm)at the beginning of i^{th} month
P_i = Precipitation (mm) during the i^{th} month
and AET_i = Actual amount of water available to crop during i^{th} month

where

$AET_i = ET_i$, when $S_{i-1} > ET_i$ and ... (3)
$AET_i < ET_i$, when $S_{i-1} < ET_i$ and ... (4)
$AET_i = 0$, when S_{i-1} O ... (5)

RESULTS AND DISCUSSION

In Table 1, monthly values of rainfall, PET, crop coefficient (Kc), ET, water used and mean rainwater storage are tabulated. The maximum root depth of the mango plant has been considered as three meters and the water available in the soil of this agroclimatic zone has been worked out and it is 346.5 mm.

The total water requirement works out to be 1133 mm. The normal soil moisture that is available at the end of the year would be about 142.3 mm for 300 cm depth. The Table 1 indicates that there is no water stress during January and February months. However, from March to June there is inadequate moisture. Since these are the summer months, the leaf area decreases due to withering of leaves and reduces the evapotranspiration though the water requirement per unit area of the crop canopy increases. The stress during fruit maturity reduces the fruit expansion and also restrict the flesh initiation and hence fruits are forced to mature (Hsiao *et al.* 1976). Further, July onwards there is no stress till the end of the

Table 1. Monthly Water Balance For Mango.

Months	Rainfall (mm)	PET (mm)	Kc	ET	Water used AET (mm)	Water storage
JAN	1	85	0.80	68.0	68.0	75.3
FEB	9	108	0.75	81.0	81.0	3.3
MAR	15	138	0.85	117.3	18.3	0.0
APR	30	139	0.95	132.1	30.0	0.0
MAY	104	126	1.05	132.3	104.0	0.0
JUN	71	93	1.15	107.0	71.0	0.0
JUL	114	86	1.15	98.9	98.9	15.1
AUG	104	88	1.15	101.2	101.2	17.9
SEP	216	85	1.10	93.5	93.5	140.9
OCT	135	80	0.90	72.0	72.0	203.4
NOV	55	78	0.85	66.3	66.3	192.1
DEC	14	75	0.85	63.8	63.8	142.4
TOTAL	868	1181		1133	868.0	

year as there is sufficient rainwater to meet the water requirement of the plants and there is vegetative growth in the plant. In this agroclimatic zone normal rainfall is 868 mm, PET is 1181 mm, ET is 1133 mm.

Plant population

Normally the mango trees are hemispherical in shape. Based on the geometry of the plant, if the radius of the branch of the tree that they spread from the main trunk of a fully growing mango tree as 6 meters, then the area coverd by a single tree is

$$= \pi R^2 = 3.1415 \times 6 \times 6 = 226.15 \text{ m}^2$$

Therefore total number of plants per hectare that can be supported is given by

$$\frac{100 \times 100 \text{ m}^2}{226.15 \text{ m}^2} = 44.2 = 44 \text{ plants}$$

Therefore it is suggested that 44 plants could be planted in one hectare so that no plant would suffer with severe moisture deficiency in year barring in a few months. These 44 trees could be planted at the spacing of 15 meters by 15 meters.

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