Turmeric - maize and onion intercropping systems. IV. PAR interception

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ABSTRACT

Experiments conducted at Coimbatore (Tamil Nadu, India) to study the pattern of interception of photosynthetically active radiation in intercropping systems with turmeric (*Curcuma longa*) - maize (*Zea mays*) and onion (*Allium cepa*) indicated that with a high maize population, the mixed canopy could effectively intercept more of available photosynthetically active radiation throughout the growing season, than the sole crop of turmeric, maize or onion.

Key words : intercropping systems, maize, onion, photosynthetically active radiation, turmeric.

Abbreviations

DAP : Days after planting

PAR : Photosynthetically active radiation

In many crops, the rate of growth during the vegetative phase is directly proportional to the quantity of radiation intercepted (Biscoe & Gallagher 1977), and the final dry weight and yield is often strongly related to the radiation intercepted during growth (Bierhuizen, Ebbens & Koomen 1973; Scott *et al.* 1973). Since the rate of photosynthesis depends upon the quantum content of radiation in the photosynthetically active wave band (0.4 - 0.7 µm, usually referred to as PAR) it is appropriate to measure the fraction of the incident quantum flux intercepted by the crop canopies. The responses of many individual crops to physical factors such as light, water or temperature are well known (Monteith 1977; Doyle & Fisher 1979). However, such relations have rarely been established for intercrops where two or more species are grown in close association; this is particularly true in the case of turmeric based cropping systems.

The field design and materials used were as described previously (Sivaraman & Palaniappan 1994; 1995). Therefore, only the facets relevant to this paper are presented here. The study was undertaken only at Coimbatore (Tamil Nadu,

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India). The treatments consisted of five intercropping systems and four levels of nitrogen with one of the treatments involving a biofertilizer (*Azospirillum brasiliense*) and adopting a split plot design with three replications. The treatment details are given below (since this paper deals with PAR interception with regard to various intercropping systems only, details of nitrogen levels are not included here):

Main plots : Intercropping systems

T - Sole crop of turmeric

$T+M_1$ - Turmeric (100)+Maize (100)

$T+M_2$ - Turmeric (100) + Maize (100) + Alternate rows of maize cut for fodder on 60th day

$T+M_3$ - Turmeric (100) + Maize (50)

$T+M_3+O$ - Turmeric (100) + Maize (50) + Aggregatum onion (23)

(Figures in parentheses indicate percentage of the recommended sole crop population)

Maize and onion were also raised as sole crops at 100 per cent population adopting recommended package of practices for comparison.

The PAR incident above the maize canopy was measured with a point quantum sensor (LI-COR, LI-190 SALICOR, NE). Transmitted PAR was measured with a 1 m line quantum sensor (LI-COR, LI-191 SA) placed diagonally across the plot both above and below the turmeric canopy in the same plot as the point sensor. For recording measurements simultaneously, a LI-COR LI-1000 data logger was used.

PAR interception by the maize and turmeric canopy reached its maximum at 60 and 210 DAP, respectively, in the intercropping system (Fig 1). However, the percentage of PAR intercepted by the sole crop turmeric was very little

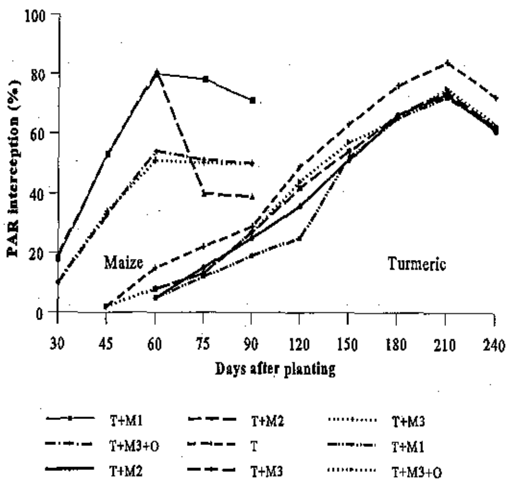

Fig. 1. PAR interception by component crops in intercropping systems

until 45 DAP but it rose progressively as the canopy developed. The canopy covered the area between rows almost completely around 210 DAP, and at that stage 84 per cent of PAR was intercepted. It decreased to around 72 per cent at 240 DAP and thereafter the canopy cover fell sharply due to senescence. When maize was planted at 100 per cent of the recommended sole crop population of turmeric, the maize canopy developed rapidly and intercepted around 80 per cent 60 DAP ($T+M_1$ and $T+M_2$). PAR interception at this stage was maximum (86 per cent) in $T+M_2$ by the component crops put together. In $T+M_1$, maximum interception of 90 per cent was reached at 75 DAP which continued until 90 DAP.

Increasing the maize population reduced the PAR available to the turmeric canopy. At 100 per cent population, less than 20 per cent of the PAR recorded in the open was measured at the upper surface of the intercropped turmeric canopy, whereas, in the other treatments it ranged from 25 to 29 per cent at 90 DAP. Total PAR interception was maximum (90 per cent) between 75 and 90 DAP when the crops were planted at 100 per cent population (Fig. 2).

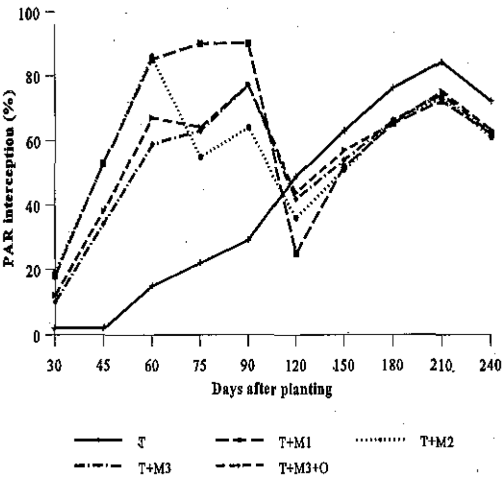

Fig. 2. PAR interception in intercropping systems

PAR interception by onion varied from 5 per cent at 30 DAP to 10 per cent at 60 DAP. Low radiation regime under maize caused etiolation of turmeric in the early stages resulting in increased plant height of turmeric. The dominating nature of maize was obvious by the taller and closed canopy of maize in T + M_1.

Values of leaf area index and dry matter production of turmeric were consistently higher in sole cropped turmeric than in the intercropped plots due to the absence of competition from maize for nutrients (Sivaraman & Palaniappan 1995) and PAR. PAR interception by turmeric in the intercropped plots were lower by 10 per cent at all stages except at 90 DAP since radiation interception is largely by leaf area growth and efficiency of leaf display in intercropping situations (Trenbath 1986) with increasing green leaf area index. Though intercropped turmeric grew tall and luxuriant in the shade provided by maize, the total dry matter production recorded was higher in sole cropping of turmeric. Similar results were reported by Ridley (1912) who observed that turmeric grew luxuriantly in shade but it developed larger and better rhizomes in the open ground exposed to sun. Shading was found to decrease the rhizome yield of all the turmeric varieties studied (KAU 1989). The observation that total interception of PAR did not decrease drastically with declining green leaf area index is attributed mainly to the persistence of senescent leaf material in the canopy covering the radiation sensors and also to some extent due to interception by the stems. The data indicated that with a high maize population, the mixed canopy could both effectively intercept more of available PAR throughout the growing season, than a sole crop of turmeric, maize or onion. The tall stature and leaves of maize canopy apparently contributed to more light interception in the mixed turmeric-maize canopy. Similar results were reported by Tsay, Fukai & Wilson (1988) in cassava-soybean intercropping systems.

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