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INVESTIGATION ON WEED SUPPRESSING ABILITY OF SMOTHER CROPPING SYSTEMS IN RELATION TO CANOPY DEVELOPMENT AND LIGHT INTERCEPTION

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ABSTRACT

A weed suppressing 'smother' cropping system was developed at ICRISAT which involved inclusion of quick growing, early maturing and good canopy structured crops like cowpea (*Vigna unguiculata* (L.) Walp) and mungbean (*Vigna radiata* (L.) Wilezek) in betwen the rows of main crop – sorghum 6(*Sorghum bicolor* (L.) Moench). This inclusion of an additional 'smother' crop not only resulted in better weed suppression but also resulted in additional 'smother' crop yields. In the present investigation a detailed analysis of canopy development and pattern of light interception was conducted to understand the eco-physiological mechanisms behind the observed advantage of sorghum/mungbean smother cropping systems.

The weed biomass accumulation in sorghum/cowpea and sorghum/mungbean 'smother' cropping systems with one hand weeding was observed to be less than that observed in sorghum sole situation with two hand weedings. Light interception pattern and leaf area index (LAI) observations revealed that inclusion of 'smother' crop *viz*, cowpea and mungbean resulted in quicker and earlier attenuation of maximum LAI and maximum percentage of light interception by component crops. Significant positive correlation was observed between LAI and percentage light interception. Significant negative correlation was observed between percentage light interception by component crops and weed biomass accumulation. The growth and resource use by different cropping systems are analysed and the net productivity with different systems are computed.

INTRODUCTION

Earlier studies on weed management at ICRISAT revealed that many biological and cultural factors like crop species, varieties and row arrangements etc., influence the nature and extent of weed growth in cropping systems (Shetty and Rao, 1977; Rao, 1980). Intercropping was proved to be superior to component crops in its weed suppressing ability (Bantilan and Harwood, 1973; Shetty and Rao, 1977; Shetty and Rao, 1979) and thus it provided an opportunity to utilize crops themselves as tools of weed management. At ICRISAT a concept of Smother cropping system was developed which involves the inclusion of rapid growing early maturing and good canopy structured crops like cowpea and mungbean in between the rows of main crops (ICRISAT, 1977 and 78). The ability of 'smother' cropping system in suppressing the weed growth without reducing the total productivity was also demonstrated.

The advantage with 'smother' cropping system or with other intercrop situation referred earlier was attributed to less weed growth in such systems. The need for ecophysiological studies to better understand the resource utilization and the

causes of weed suppression in intercrop and smother cropping systems was stressed earlier (Moody and Shetty, 1979, Shetty and Rao, 1979). Such ecophysiological studies also provide a basis for further yield improvement through shifting the crop weed balance more in favour of crops rather than weeds, besides indicating how weed suppressing ability of smother crop systems and the grain yield advantage are likely to be affected by different growing conditions. The present study was therefore conducted to examine the physiological mechanism of observed advantage of sorghum/cowpea and sorghum/mungbean 'smother' cropping systems through a detailed analysis of canopy development and pattern of light interception by different systems.

MATERIAL AND METHODS

The experiment was conducted on Alfisols of ICRISAT – with available water of about 100 mm in the top of 90 cm of the profile. The experiment was conducted during the monsoon season of 1979. Even though the total rainfall during the year was about normal (631 mm), there was a brief dry spell during flowering stages which necessitated two irrigations.

Sorghum both with and without the inclusion of 'smother crop' (cowpea or mungbean) was grown at 45 cm row width. The sorghum population was maintained at 180,000 plants/ha. A basal fertilizer application of 50 kg/ha of P_2O_5 was applied to all plots and soghum was top dressed at a rate of 80 kg/ha in two split doses. Cultivars grown were CSH-6 sorghum, local cowpea and H8 mungbean. The experiment was Randomised Block Design with the following treatments replicated thrice: (*a*)sorghum sole system, one hand weeding; (*b*) sorghum sole system, two hand weedings; (*c*) sorghum/cowpea 'smother' cropping system, one hand weeding; (*d*) sorghum/mungbean 'smother' cropping system, one hand weeding; (*e*) sorghum sole system – kept weed free (*f*) sorghum/cowpea system – kept weed free; (g) sorghum/mungbean system – kept weed free.

Samples areas of two 1.0 m^2, one from each end of each of the replicated plots were harvested for the estimation of dry matter and the area of green lamina at 10 day intervals starting from 15th day of planting. From the same area the weed biomass was recorded at the time of first hand weeding, second hand weeding, 'smother' crop harvest and at sorghum harvest.

For final estimation of total dry matter and grain yield, harvest area of approximately 40 m^2 were taken.

Light interception was measured at 10 day intervals with 90 cm tube solarimeters sensitive to all solar radiation wave lengths. (Szeicz *et al.* 1964). Solarimeters were placed at ground level and the difference between these and a control solarimeter recording total incident light was measured. Using solarimeters light interception readings were taken thrice *viz.*, morning (8-30 to 9-30 a.m.), afternoon (12-30 to 1-30 p.m.) and evening (4 to 6 p.m.) at five different spots of each replicated plot and the average value was taken as percent total light interception.

RESULTS AND DISCUSSION

Leaf Area Index

Leaf area index pattern of component crops under different treatments was studied – until 75th day (Fig. 1).

Peak values of leaf area index attained by sorghum/cowpea and sorghum/mungbean smother cropping systems given one hand weeding were found to be higher than the peaks observed by all sorghum sole situations inc-

luding weed free sole sorghum. Among the two smother cropping systems, when given one hand weeding maximum leaf area index was observed – in sorghum/cowpea system which was nearly 66%, 44% and 29% higher than peak leaf area index attained by sorghum sole sorghum given one hand weeding, two hand weedings and weed free situations respectively. The leaf area index of sorghum/mungbean given one hand weeding was 63%, 41%, 26.5% higher than that observed in above compared systems. However, the leaf area index of sorghum alone under both the smother cropping systems was lesser than that observed in sorghum given two hand weedings and sorghum weed free system.

Even under weed free situation, inclusion of 'smother' crop resulted in attenuation of higher leaf area index within first 35 days only, the implications of which are discussed later in relation to associated weed growth.

Light interception

The pattern of leaf area development in turn affects the light interception pattern. In comparison to the light interception peak attained by sorghum sole with one hand weeding, the peak percentage light interception by sorghum/cowpea and sorghum/mungbean smother cropping systems were 34.9% and 29.8% higher when given same weed management (Fig. 2*a, b*). Even on 35th day the percentage light interception by sorghum/cowpea and sorghum/mungbean systems given one hand weeding were 48% and 40% higher than sorghum sole given one hand weeding. Thus the introduction of 'smother' crops resulted in quicker attenuation of maximum percentage of light interception than sole sorghum system. After smother crops harvest sharp decline in percentage light interception occurred. Light intercepted under sorghum/cowpea and sorghum/mungbean systems after smother harvest was less than that observed with sorghum given two hand weedings but was higher than intercepted by sorghum given one hand weeding.

Weed growth

Weed growth was maximum in association with sole sorghum given one hand weeding. At smother crop harvest, the weed biomass observed in sorghum/mungbean, sorghum/cowpea 'smother' cropping systems given one hand weeding was less than that in sorghum given two hand weedings. After 'smother' crop harvest a trend of increase in weed dry matter was observed under both the 'smother' cropping systems (Fig. 3).

Grain yield and net monitor returns

Grain yield reduction of 43% occurred when only one hand weeding was given to sole sorghum as compared to sorghum sole weed free system. However, the inclusion of cowpea and mungbean as 'smother' crop in addition to one hand weeding resulted in a reduction of only 23.6% and 22.7% respectively. Under two hand weeding situation the sole sorghum yield reduction was about 18% when compared to weed free sorghum yields.

Under weed free situation also the inclusion of cowpea and mungbean resulted in some reduction of sorghum grain yields. The grain yields of cowpea and mungbean were 36.1% and 38% lesser under one hand weeding situation when compared to weed free situation.

Net monitory returns from sorghum/cowpea (Rs. 3,869) and sorghum/mungbean (Rs. 3,784) given one hand weeding were cosiderably higher than the sorghum sole system given one hand weeding (2398) or two hand wee-

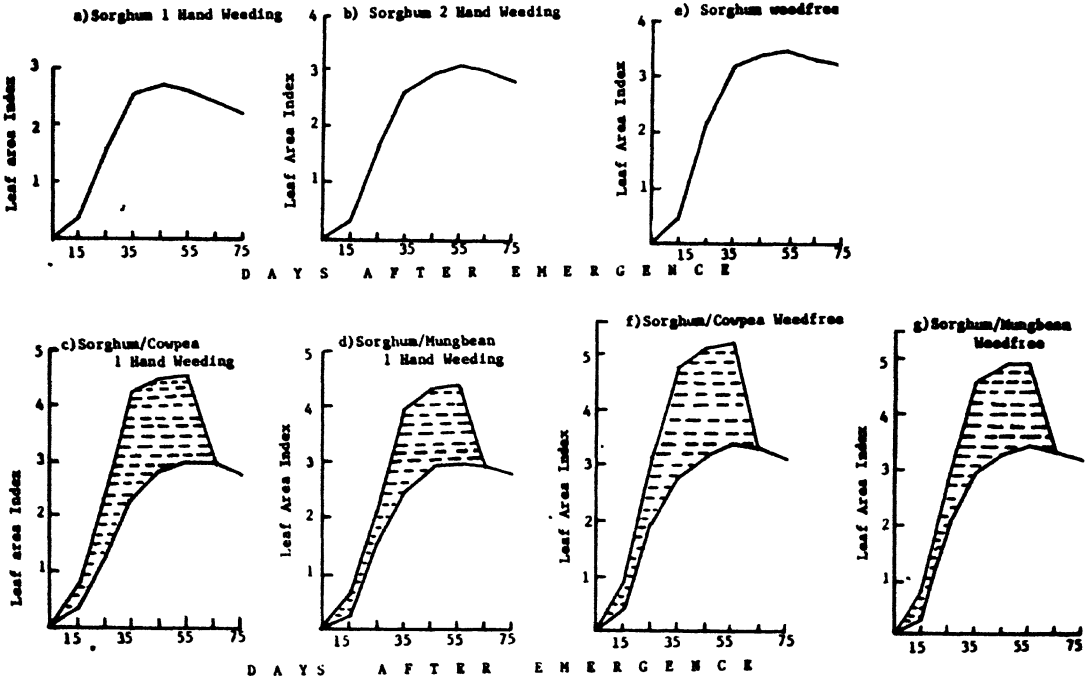


Fig.1. Leaf area index of component crops in different cropping systems

Table 1 Effect of smother cropping system on grain yield of sorghum and smother crop and on net production in terms of grain products monetary value.*

	Sorghum Grain yield kg/ha	Sorghum Stover yield kg/ha	Cowpea kg/ha	Mungbean kg/ha	Weed dry matter at harvest g/m^2	Total production (Rs/ha)	Net production (Rs/ha)
Sorghum 1 HW	3652	4660.0	-	-	78 71	2518 50	2398 50
Sorghum 2 HW	5264	6598.0	-	-	16 97	3629 40	3389 40
Sorghum/Cowpea 1 Hand Weeding	4895	6083 0	223.81	-	8.30	4049 00	3869 00
Sorghum/mungbean 1 Hand Weeding	4952	6136.0	-	173 10	14 70	3936 18	3784 00
Sorghum Weed free	6408	7637	-	-	-	4416 00	3936 00
Sorghum/cowpea Weed free	6142	7237 0	350 20	-	-	5286 60	4866 60
Sorghum/mungbean Weed free	6183	7360 0	-	281 10	-	5104.20	4712.20
LSD at 5%	391	534.2	-	-	7 72	-	-

*Considered monetary values Sorghum 1 q = Rs 69, Cowpea 1 q = Rs 300, Mungbean 1 q = Rs 300

**Net production = Total production – Hand Weeding Cost (Rs 120/each Weeding) and Smother crop seed cost (Cowpea Rs. 60/ha., Mungbean Rs. 32/ha)

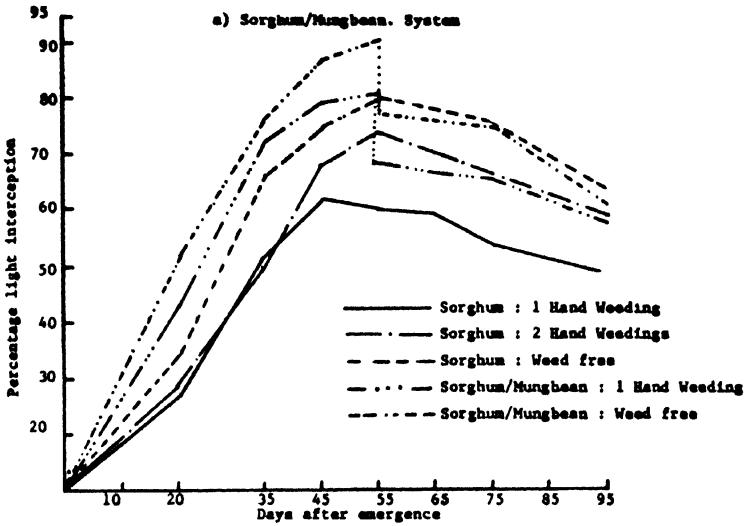
dings (3389). Under weed free situation inclusion of smother crop resulted in even higher net monitory returns (Table 1).

CONCLUSION

Poor competitive ability of sorghum especially during seedling stage due to relatively small and weak seedlings is well known (Shetty, 1978; Rao, 1978). Abundant moisture availability, weak crop seedlings and greater space and light availability together resulted in immediate germination and rapid growth of weeds offering severe competition against the associated crop after first hand weeding. Inclusion of additional 'smother' crops viz., cowpea and mung resulted in less weed growth which is in conformity with observations in other intercrop situations (Moody and Shetty, 1979).

The leaf area index was positively and significantly correlated with the percentage light interception (Fig. 4) Hence introduction of smother crops resulted in increased leaf area index and increased percentage light interception. The percentage light interception was observed to be negatively correlated with weed drymatter (Fig. 5). Such correlation was significant especially during first 45 days of the sorghum growth period. The inclusion of 'smother' crop thus resulted in less light interception by weeds and additional competition for space, light and nutrients which otherwise would have been wasted and used by weeds. This inturn resulted in observed reduced weed growth under smother cropping systems.

Sorghum grain yield under one hand weeding situation of smother cropping



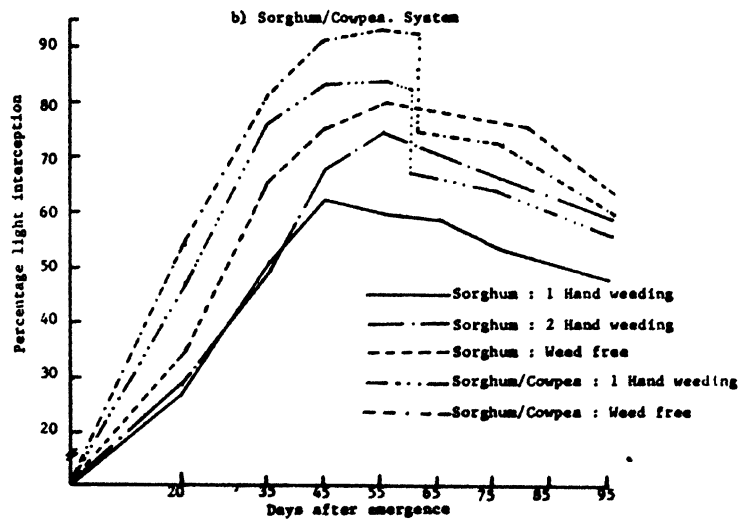


Fig. 2. Pattern of light interception by sorghum based another cropping system Under different weed managements

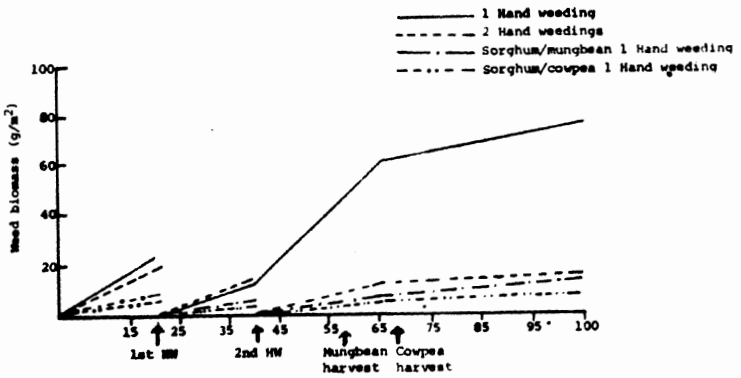


Fig. 3. WEED GROWTH IN VARIOUS 'SMOTHER' CROPPING SYSTEMS UNDER DIFFERENT WEED MANAGEMENT SITUATIONS (ALFISOLS, 1979, RAINY SEASON)

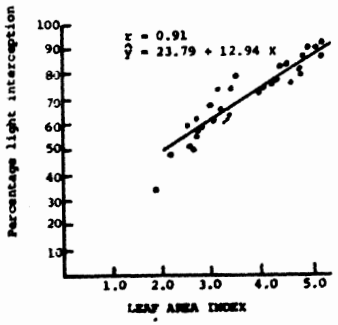


Fig. 4. RELATIONSHIP BETWEEN LEAF AREA INDEX AND LIGHT INTERCEPTION BY COMPONENT CROPS UNDER DIFFERENT CROPPING SYSTEMS

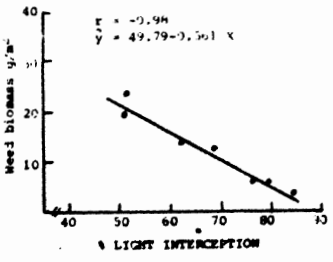


Fig. 5. RELATIONSHIP BETWEEN % LIGHT INTERCEPTION AND WEED BIOMASS DURING FIRST 40 DAYS CRITICAL PERIOD OF CROP WEED COMPETITION

system was less than that observed under sorghum given two hand weedings. However, it was not significantly different from that occurred with sorghum sole given two hand weedings. This is in conformity with earlier ICRISAT observations (ICRISAT, 1978). The smother crop yields observed during the present investigation were comparatively lesser than earlier ICRISAT observations (Cropping Systems Annual Report, 1976, ICRISAT 1978). This can be explained on the basis of crop cultivar incorporated as smother crop, since variation in competitive ability and production potentiality among crop cultivars is known (Shetty and Rao, 1977; Moody, 1978). Thus screening of cowpea and mungbean for their efficient weed 'smothering' ability would enable further improvement of 'smother' cropping which was improved to be superior in terms of monetary returns too.

LITERATURE CITED

Batilan, R. T. and Harwood, R. R., 1973. Weed management in intensive cropping systems. Saturday seminar paper, 28 July 1973. Int. Rice Res. Inst. Los Banos, Laguna, Philippines, p. 7.

Cropping Systems Annual Report 1976. Report of work 1975-76, FSRP, ICRISAT, Hyderabad, India.

ICRISAT 1977 and 78. Annual Reports. Int. Crops Res. Inst. Semi-Arid Tropics, Hyderabad, India.

Moody, K., 1978. Weed control in intercropping in tropical Asia. Paper presented at an International Weed Science Conference 3-7 July 1978. Int. Rice. Res. Inst. Los Banos, Laguna, Philippines.

Moody, K. and Shetty, S. V. R., 1979. Weed management in intercropping systems. Paper presented at International Workshop on Intecropping held at the ICRISAT, Hyderabad, India, 10-13, January 1979.

Rao, A. N., 1978. Ecophysiological responses of crops and weeds against herbicides and their residues. Ph.D. Thesis, Vikram University, Ujjain (MP), India.

Rao, A. N., 1980. Some ecophysiological aspects of weed management in different cropping systems. Report of work done at ICRISAT, Hyderabad, India. p. 119.

Szeicz, G., Monteith, J. C. and Dos Santos, J. M., 1964. Tube solarimeter to measure radiation among plants. J. Appl. Ecol. 1: 169-174.

Shetty, S. V. R., 1978. Weed control in sorghum in the tropics. 10th Anniversary Meeting of the Weed Science Society of Philippines, Manila, p. 21.

Shetty, S. V. R. and Rao, M. R., 1977. Weed management studies in pigeonpea based intercropping. 6th Asian Pacific Weed Science Society Conference, Jakarta, Indonesia, July 11-17, p. 25.

Shetty, S. V. R. and Rao A. N., 1979. Weed management studies in sorghum/pigeonpea and pearlmillet/groundnut intercrop systems – some observations. International Work-shop on Intercropping, ICRISAT, Hyderabad, India, 10–13, January, p. 15.