RADIATION INTERCEPTION AND RAIN WATER USE EFFICIENCY IN COTTON BASED INTERCROPPING

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Abstract

Field experiment was conducted on crop diversification in cotton based vegetable intercropping at Agricultural Research Station, Kovilpatti Tamil Nadu, India during the monsoon season 2005-06 in randomized block design with three replications. In this investigation, productivity, radiation and rain water use efficiency of cotton intercropped with vegetables were tried in rainfed vertisol condition. The highest cotton equivalent yield was obtained from cotton + radish intercropping followed by cotton + onion. The rain water utilization efficiency for that combination was 1.98 and 1.93 kg ha^{-1} mm^{-1}. Substitution of cotton with short duration vegetables intercrops found more beneficial.

Key words: Radiation interception, intercropping, rain water use efficiency, rainfed cotton, vegetables.

Introduction

Cotton, popularly known as 'White Gold' is one of the most important and extensively grown cash crops of the world and plays an important role in agrarian and industrial economy. India accounts for approximately 21 % of the world cotton area but the average productivity of cotton is markedly low at about 293 kg lint cotton /ha as compared to 600 kg/ha of world average (Sen, 2003). In spite of low and unstable yield of cotton due to erratic monsoon, moisture stress during crop growth period, existence of biological constraints like weeds, diseases and pests, the traditional farmers of dry tract region grow cotton on such land because of high economic return when compared to other crops. Cotton crop is intercropped with either blackgram or greengram in southern dry tract of Tamil Nadu. Pothiraj and Srinivasan (1993) found cotton + redgram intercropping to be the most superior and concluded that multi-tier crop combination provided an efficient means of harvesting solar energy. Under this situation, crop diversification through intercropping with less duration and low water requiring crops may be one of the best options to the hands of the farmers for mitigating drought and increasing productivity (Kar et al, 2004). However, not much experiment has been reported in cotton with introduction of vegetables as intercropping. Cotton with vegetables in rainfed areas not only provides food security but also nutritional and economic security as well. Idea of crop diversification with vegetables in rainfed tract is to emphasize that these crops can provide an assured income under low rainfall situation. Hence, a detailed study was made of radiation interception and its utilization efficiency as influenced by substituted sole and intercropping form as an important supplementary component to improve the productivity of

rainfed cotton area of Southern India. The light use efficiency is function of interplant and intra plant spacing and their competition for light and water. Intercropping intercepts photosynthetically active radiation more efficiently than does the sole crop under rainfed conditions (Singh et al, 2002)

Materials and methods

Field trial was conducted in rainfed area during September - February 2005 at Agricultural Research Station, Kovilpatti, Tamil Nadu, India. The climate of the experimental site was warm and dry. The soil of the experimental field was heavy textured and taxonomically belonged to category of vertisol under Kovilpatti series is a member of gneiss, Smectic Isohyperthermic family of typic chromusterts. The clay content of the soil varied from 13 - 24 %. The pH ranged between 7.8 - 8.3 which was moderately saline. The organic carbon content is 0.3 indicated low fertility status. In this investigation, the productivity, radiation and rain water use efficiency of cotton based intercropping consisting of Cotton + Radish, Cotton + Onion, Cotton + Cluster bean, Cotton + French bean, Cotton + Green chilli, Cotton + Tomato and Cotton + Bhendi were compared with that of sole cotton. The compodia Cotton KC 2 was used as test variety. The experimental design was randomized block design replicated thrice.

For measurements of biometric observations, one square meter sampling area was selected randomly from each experimental unit size of 5x 4 m. Dry weight of the plant materials was measured after drying the samples for 48 hours in a hot air oven at 80 °C. The amount of incoming, reflected and transmitted photosynthetic active radiation (PAR) was

measured with Line Quantum Meter (Model LQ100-20 - Apogee Instruments Inc., USA.)

PAR inteception (%) was obtained as under:

$$\text{Intercepted PAR (\%)} = \frac{\text{PAR (I)} - \text{PAR(T)} - \text{PAR(R)}}{\text{PAR(I)}} \times 100$$

where PAR(I)-PAR incoming above the canopy, PAR(T)-PAR transmitted to the ground, PAR(R) -PAR reflected from the canopy

Heat use efficiency (HUE) was computed by using the formula as follows:

$$\text{Heat use efficiency g m}^{-2}\,^{\circ}\text{C days} = \frac{\text{Dry matter production (g m}^{-2})}{\text{GDD (°C days)}}$$

The growing degree days were computed by subtracting the base temperature from daily mean temperature as suggested by Ketring and Wheless(1989).

Several crops are involved in intercropping system, it is not logical to compare the total yield of different crops in one system with the other. The yields of different intercrops are converted into equivalent yield of main crop based on price of produce. The experimental data were analyzed statistically and the standard errors for mean difference (SEd) and critical difference (CD) were worked out at 5 % probability level (Gomez and Gomez, 1984) for comparison of different treatments.

Results

Intercepted photosynthetic active radiation and Heat unit efficiency:

The intercepted photosynthetically active radiation of sole cotton and cotton based intercropping was computed. The cotton based intercrops intercepted more PAR than sole crop. The radiation interception was found more (45%) when the crop was grown with radish that occurred at 30 days after sowing followed by onion. Heat use efficiency of different intercrops combination revealed that cotton intercropped with radish, onion, cluster bean and french bean registered the higher heat use efficiency (Table 1). Cotton intercropped with radish significantly showed higher HUE of 0.39 g m^{-2} ^{o}C days which was on par with cotton + onion (0.38) where as pure crop of cotton recorded lesser HUE followed by cotton +chilli (0.20)

From the study, it was revealed that radiation interception was higher in intercropping than that of sole crop. Cotton intercropped with radish followed by onion significantly registered higher interception of PAR than cotton intercropped with long duration vegetables. Similar results were reported in sorghum based intercropping system (Bandopadhey, 1987)

Cotton equivalent yield and Rainwater use efficiency

For better comparison, productivity of different cotton substituted crops was converted into cotton equivalent yield. Among the intercrops, cotton + radish recorded significantly the highest cotton equivalent yield followed by cotton + onion intercropping system.

Rain water use efficiency was computed in terms of cotton equivalent yield (kg ha^{-1}) produced per mm of rain water received during the growth period (Table 2). From the study, it was found that among different intercropping combinations, rain water use efficiency was the highest in cotton + radish intercropping followed by cotton + onion where as sole cotton achieved the lowest rain water use efficiency.

Discussion

Cotton equivalent yield in case of cotton intercropped with short duration vegetables (radish, onion, cluster bean) was higher than with long duration vegetables (green chilli, tomato, bhendi). It might be due to less competition between these two crops for light, nutrient and space owing to their different growth habits. In addition increased PAR absorption and heat use efficiency might have put forth increased growth parameters which in turn reflected on increased yield and higher rain water use efficiency when cotton was intercropped with radish and onion. Sole cotton registered lower heat use efficiency in the early stage might have due to slow growth and less canopy development. This is in agreement with the findings of Singh. *et al.,* (2002).

Conclusions

From the crop diversification studies in rainfed cotton, it can be concluded that cotton substitution with low water requiring vegetables like radish, onion, cluster bean and french bean were more efficient to utilize rain water and photosynthetically active radiation than long duration vegetables and pure crop of cotton which in turn reflected on increased yield.

References

Bandopadhey. S.K. 1987. Solar radiation interception, soil water and nitrogen use in sorghum based intercropping system with legumes, Indian J. Agron. 33 (1):1 - 36.

Gomez, K.A and Gomez, A.A 1984. Statistical procedure for Agricultural Research. John Wiley and Sons, Newyork.

Kar. G., Singh. R and Verma. H.N. 2004. Alternative cropping strategies for assured and efficient crop production in upland rainfed rice area of eastern India based on rainfall analysis. Agric. Water Manag. 67 (1) : 47 - 62.

Ketring, D.L and Wheless, T.G 1989. Thermal requirements for phenological development for Peanut. Agron. J. 8(16) 910-917

Okibo, B.N. 1981 Evaluation of plants interactions and productivity in complex mixture as a basis for improved cropping system designs. In. Proc. International Workshop on intercropping , ICISAT, Patancheru, Hyderabad pp.155-179

Pothiraj, P and Srinivasan, G 1993. Evaluation of cotton based multi-tier cropping system under rainfed conditions. J. Maharashtra agric.Univ.18:293-294

Sen. A. 2003 The cotton scenario in India . www.indiaonestop.com. Global Business Network.

Singh. P.K., Jadhav, A.S. and Varshney. M. 2002. Light interception and light use efficiency in sorghum based intercropping system. J. of Agrometeorology 4 (1): 93 - 96.

Table 1. Effect of cotton based intercropping on Heat Use Efficiency (HUE) and Intercepted Photosynthetic Active Radiation

Treatments	HUE (g m^{-2} ^{o}C days)	Intercepted PAR (%)
Cotton sole	0.200	27.30
Cotton + Radish	0.393	45.00
Cotton + Onion	0.383	40.60
Cotton + Cluster bean	0.300	39.60
Cotton + French bean	0.306	38.00
Cotton + Green chilli	0.203	34.00
Cotton + Tomato	0.210	32.00
Cotton + Bhendi	0.236	37.00
SEd	0.022	7.50
CD $_{5\%}$	0.047	3.30

Table 2. Effect of cotton based intercropping on yield and rain water use efficiency

Treatments	Seed cotton yield (kg ha^{-1})	Yield of intercrops (kg ha^{-1})	Seed cotton equivalent yield (kg ha^{-1})	Rain water use efficiency (kg ha^{-1} mm^{-1})
Cotton sole	500	-	500	1.00
Cotton + Radish	375	5483	989	1.98
Cotton + Onion	410	3633	966	1.93
Cotton + Cluster bean	370	3166	750	1.50
Cotton + French Bean	360	1950	758	1.52
Cotton + Green Chilli	338	1433	509	1.02
Cotton + Tomato	310	2666	523	1.05
Cotton + Bhendi	368	2250	638	1.28
SEd	16	-	61	-
$CD_{5\%}$	34	-	128	-