manure and 100 per cent P_2O_5 to rice at all the stages of crop growth in both the years. This supports its earlier findings by Sudhakar (1985).

Varying levels of N also significantly influenced the P uptake. Application of 100% N significantly maintained higher levels of P uptake over other levels of N at all stages of crop in both the years. This might be due to the complementary effect between N and P.

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Sustainable weed management programme for rainfed cotton based cropping system

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Abstract : Field experiments were conducted for two seasons (September '97 to April '98 and October'98 to May '99) at Fredrick Institute of Plant Protection and Toxicology (FIPPAT), Padappai, to develop a sustainable weed management programme in rainfed cotton. Results revealed that, intercropping of soybean and sesame led to weed suppression in rainfed cotton to the extent of 39.6 and 28.4 per cent respectively. The seed cotton yield obtained from cotton + soybean intercropping system under unweeded conditions was similar (1196 kg ha^{-1}) to the yield of sole cotton supplemented with single hand weeding alone (1220 kg ha^{-1}). Similarly, single hand weeding operation in the cotton + soybean cropping system resulted in a substantially higher seed cotton yield (1528 kg ha^{-1}), than the yield of sole cotton crop supplemented with two hand weedings (1432 kg ha^{-1}). So, the adoption of Soybean, as a intercrop in rainfed cotton is an effective method for checking the weeds population as well as enhancing the yield potential in rainfed cotton and also labour saving, by minimising to one hand weeding. Similar effects were also found in cotton + sesame intercropping system. Furthermore, in labour scarce situation, the application of pre-emergence herbicide Fluchloralin @ 1.0 kg a.i ha^{-1} in cotton-soybean intercropping system could be an alternative method. *(Key words : Weed management, Rainfed cotton, Fluchloralin)*

Rainfed farming has a distinct place in Indian Agriculture, occupying 67 per cent of the total cultivated area, contributing 68 per cent fo the rainfed area under cotton. Cotton, the most fibre crop of the world, stands with an area of 33.73 million hectares and a production of 19.7 million tonnes (1997-1998) which showed a meagre increase of 0.72 per cent over the previous year. Whereas in India, it showed a decrease of about 21.8 per cent, registering an estimated production of 111.5 lakh bales for 1997-98 as compared with 1996-97 (142.5 lakh bales) as per the report of International Cotton Advisory Committee (ICAC). India has a yield of 530 kgs per hectare under irrigated conditions and 170 kg per hectare under rainfed conditions. One of the major constraints observed in its cultivation under rainfed

Table 1. Weed dry weight (kg ha^{-1}) (pooled over 1997-98 and 1998-99)

Cropping system	No weeding	Manual weeding once	Manual weeding twice	Fluchloralin (1.0 kg/ha)	Mean
Cotton sole	2364	817	284	679	1036
Cotton + Soybean	1428	205	138	356	532
Cotton + Sesame	1692	334	216	597	710
Mean	1828	452	213	544	

LSD at 5% : Cropping System (C) = 146 Weed control (W) = 146 C x W = 297

Table 2 : Yield of Inter crops (Kg/ha) (Mean of 2 years)

Cropping system	No weeding	Manual weeding once	Manual weeding twice	Fluchloralin (0.90 kg/ha)	Mean
Cotton sole	859	1220	1432	1317	1207
Cotton + Soybean	428	982	1036	749	799
Cotton + Sesame	184	496	568	294	386

condition, is to manage the weed which are self grown, appearing simultaneously with crop plants and result in intense crop-weed competition during the early stage of growth and cause drastic reduction in the seed cotton yield. Weeds in cotton crop may be managed mechanically, chemically and using cultural method or by the combination of these methods. Mechanical weed control cannot be done alone, until the weeds put forth sufficient growth. Lack of availability of labourers for timely weed control by mechanical means is posing a serious problem. Intercropping has proved to be superior to its single component crops in weed suppression (Bantilan & Harwood, 1973). Thus, it provides on opportunity to utilise the crops themselves as tools for weed management. It was, therefore, though worthwhile to undertake this study to develop a sustainable weed management programme in rainfed cotton by practicing different intercropping systems compared with manual methods and the use of herbicide to quantify the effectiveness for controlling weeds in rainfed cotton.

Materials and Methods

Field experiments were carried out at the Fredrick Institute of Plant Protection and Toxicology (FIPPAT) in Padappai during the rainfed seasons of September '97 to April '98 (Season I) and October '98 to May '99 (Season II). Three cropping systems *viz.* (sole cotton, cotton + soybean, cotton + sesame) were grown with three weed control measures *viz.* manual weednig at 20 days after sowing, manual weeding at 20 and 40 days after sowing and Fluchloralin @ 1.0 kg a.i ha^{-1} and were compared with unweeded treatment. Plots were 8 m x 5 m in size and are arranged in randomised block design with three replicates per treatment. The soil of the experimental field was black soil. The rainfall received during the cropping periods was 1166.0 mm and 935.0 mm during first and second years of field experimentation, respectively. Winter rainfed cotton. var. Paiyur 1 (150 days duration) was sown with the spacing between the plants of 30 cm and the distance between the paired rows of 90 cm apart, during both the seasons. Sesame, var. TMV 5 (85 days duration) and Soybean, var. Co.1 (85 days duration) were sown between the rows in cotton. Fluchloralin @ 1.0 kg a.i ha^{-1} sprayed by mixing with 500 lts ha^{-1} of water, on the third day after sowing by using Knapsack sprayer. Cotton crop as well as the other inter crops (soybean & sesame), were harvested at maturity. The data collected were subjected to statistical analysis.

Results and Discussion

Effect on weeds

The major weeds infesting the experimental

Table 3 : Seed cotton Yield (Kg ha^{-1}) (Pooled over 1997-98 and 1998-99)

Cropping system	No weeding	Manual weeding once	Manual weeding twice	Fluchloralin (0.90 kg ha^{-1})	Mean
Cotton sole	859	1220	1432	1317	1207
Cotton + Soybean	1196	1528	1679	1492	1474
Cotton + Sesame	1014	1326	1551	1387	1320
Mean	1023	1358	1554	1399	-

LSD at 5% :Cropping system (C) = 102 Weed control (W) = 102 C x W = 203

plots were, Garden spurge (*Euphorbia hirta*), Day flower (*Commelina benghalensis*), Niruri (*Phyllanthus niruri*), Amaranthus (*Digera* sp), Nut grass (*Cyperus rotundus*), Bermuda grass (*Cynodon dactylon*), Field bind weed (*Convolvulus arvensis*) and Cocklebur (*Xanthium strumarium*) etc.

The weed dry weight in terms of kg ha^{-1} was significantly influenced by the inclusion of intercrops, such as soybean and sesame between the rows of cotton (Table 1). Intercrops smothered the weeds substantially and reduced the weed competition for space, nutrients and light. In the present investigation, average reductions in weed dry weight, in unweeded treatments, was 39.6 per cent and 28.4 per cent, due to intercropping of soybean and sesame. However, intercropping of soybean in association with cotton gave the least weed dry weight of 138 kg/ha for manual weeding twice given at 20 & 40 days after sowing of cotton, which was on par with the single hand weeding treatment given at 20 days after sowing, in the same intercropping system (205 kg ha^{-1}). Fluchloralin (1.0 kg ha^{-1}) gave effective control of the associated weeds in the intercropping situation as well as the sole cropping situation in cotton.

Yield of Intercrops

Perusal of the data presented in Table 2 revealed that, in cotton + soybean intercropping situation, administered with twice handweeding, gave the soybean pod yield of 1036 kg ha^{-1} which was followed by the single handweeding treatment (at 20 DAS) thus recorded 982 kg ha^{-1} soybean crop yield. As seen from this results of the yield data, there is not much difference, when compared to twice hand weeding treatment in cotton + soybean intercropping with the single hand weeding treatment in the same cropping system. However, the similar trend was followed in cotton + sesame intercropping system. Fluchloralin gave an appreciable increase in the yield of inter crops as a result of reduced weed competition.

Seed cotton yield

Results obtained from this trial showed that, good response of seed cotton yield increase was obtained with the cotton / soybean mixture (1474 kg ha^{-1}), followed by the cotton/sesame mixture (1320 kg ha^{-1}) (Table 3). Similar results were reported by Ali (1986). The seed cotton yield in soybean intercropping weeded only once at 20 days after sowing (1528 kg ha^{-1}) was similar to the yield of sole cotton with two manual weeding done at 20 and 40 days after sowing (1432 kg ha^{-1}). Thus, intercropping saved one weeding. Inconnection with this Rao & Shetty (1981) reported that, inclusion of cowpea or green gram as an intercrop in sorghum virtually replaced one hand weeding without reducing sorghum yield. Fluchloralin was an alternative to a single hand weeding without reducing cotton yield. These results are in agreement with the observations of Tewari and Rathi (1997).

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