simultaneous to checking of soil moisture losses through evaporation and maximum (135.3mm) water use was recorded under weeding and hoeing treatment. RUE was observed higher under maize stalk mulch treatment due to increase in yield in higher magnitude as compared to weeding and hoeings treatment. The unfertilized-N crop gave the lowest water use (124.7mm) as well as RUE (8.56 mg grain/ha/mm and 23.78 kg drymatter/ha/mm) which gradually increased with increasing dose of N, the maximum water use (135.8mm) as well as RUE (11.87 kg grain/ha/mm and 32.86 kg dry matter/ha/mm) but thereafter slightly declined under higher dose of 90 kg N/ha. Method of 1/2 basal + 1/2 foliar application of N led to higher water use and RUE than under full basal at sowing. These results are in conformity with the findings of Singh and Ramakrishna (1975).

Uptake of N, P and K

It is evident from the data that increase in row spacing resulted in significant increase in N, P and K contents in wheat grain upto 30cm row spacing but the highest N, P and K uptake by grain was observed with 25cm row spacing due to higher grain yield. Maize stalk mulch increased all the three nutrients as compared to weeding and hoeings plot due to the conservation of higher amount of moisture in the soil and in the presence of optimum amount of moisture, nutrient availability increased and plant tapped them easily. Application of N improved N, P and K contents in grain with each increase in dose of nitrogen, N, P and K uptake increased significantly upto 60 kg N/ha due to the highest grain yield at this level. Beyond this level, a gradual reduction in uptake was noticed. Rathore and Singh (1978) also observed similar trend in case of nutrient uptake in wheat. Nutrient content and uptake by grain under the treatment of half basal at sowing + half applied through foliar application was significantly higher as compared to drilling of its full basal at sowing.

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BIOSYNTHATE PRODUCTION BY DIFFERENT RICE BASED CROPPING SYSTEMS

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ABSTRACT

Experiments conducted with five different rice based cropping systems, two irrigation regimes and two fertilizer levels, at Madurai, revealed that the production of biosynthates *viz.*, carbo hydrate, fat and protein was higher in rice-rice-greengram, groundnut + blackgram-rice-sesamum and sorghum + vegetable cowpea- rice-soybean systems in that order. The bio-synthates production was higher with irrigation to the rice crop to 5cm depth on the day of disappearance of ponded water and irrigating the *kharif* and summer crops at 0.75 and 0.60 IW/CPE ratios, respectively. Application of N, P and K as per soil test recommendations recorded higher carbohydrate output in the first year only.

Focussing attention on the output of biosynthates (carbohydrate, fat and protein) by multiple cropping systems is a recently added dimension and has attracted increased attention in view of the need to overcome the problem of malnutrition and undernutrition of the increasing population in developing countries. Protein is one of the most important food factors supplying building materials for the body and replenishing lost tissues needs hardly any reiteration. But the protein content in rural diet is dismally modest and there is therefore an imperative need to improve the same.

MATERIALS AND METHODS

Field experiments were conducted with five different rice based cropping systems, two fertilizer levels and two irrigation regimes during 1986-'88 at Agricultural College and Research Institute, Madurai, in split plot design replicated three times. The main plot comprised of cropping system *viz.*, rice-rice - fallow (C_1), rice- rice-green gram (C_2), sorghum + vegetable cowpea-rice-soybean (C_3), maize + soybean-rice-vegetable cowpea (C_4) and groundnut + black gram-rice-sesamum (C_5). The sub-plot comprised of two fertilizer levels and two irrigation regimes.

Fertilizer levels

F_1 - Application of N, P and K as per soil test values

F_2 - As in F_1 for all crops except for rice to which P and K alone skipped.

Irrigation regimes (as indicated against each crop)

Rice: I_1 - Irrigation to 5cm depth on the day of disappearance of ponded water (recommended)

I_2 - Maintaining submergence of 5 cm depth at reproductive stage (critical stage)

Irrigated dry crops (depth of irrigation - 6 cm)

a) Sorghum, maize and groundnut :

I_1 - Irrigation at 0.75 IW/CPE ratio (recommended)

I_2 - Irrigation at critical stages (as in Table I)

b) Green gram, soybean, vegetable cowpea and sesamum :

I_1 - Irrigation at 0.60 IW/CPE ratio (recommended)

I_2 - Irrigation at critical stages (as in Table 1)

Various treatments included in the rice based cropping systems were evaluated in terms of total biosynthate production *viz.*, carbohydrate, fat and protein. Yield of carbohydrate, fat and protein from each component crop in the cropping system was computed as outlined in the bulletin on 'Nutrition Value of Indian Foods and the Planning of Satisfactory Diets' (IFPSD, 1938 and CPG, 1985).

Table 1. Critical stages of crops

Crop	Critical Stages
Sorghum	1. 4-5 leaf stage 2. Flowering 3. Grain filling
Maize	1. Early vegetative 2. Tasseling 3. Silking 4. Grain filling
Groundnut	1. Flowering 2. Peg formation 3. Pod formation
Sesamum	1. Flowering 2. Capsule formation
Pulses	1. Flowering 2. Pod formation

RESULTS AND DISCUSSION

Biosynthate production of cropping system (Table 2)

Carbohydrate output

Cropping of rice-rice-green gram recorded highest carbohydrate output followed by sorghum + vegetable cowpea-rice-soybean. Higher carbohydrate output in rice-rice-green gram was noticed because of higher carbohydrate content in rice and green gram followed by sorghum + vegetable cowpea - rice - soybean, where higher level of carbohydrate was contributed by sorghum and rice. The least carbohydrate output was produced by groundnut + black gram-rice- sesamum. Higher quantity of water used by the *kharif* and summer crops in recommended level of irrigation resulted in higher carbohydrate output due to higher grain production.

Residual effect of P and K applied to preceding rice as well as the application of P and K in addition to N for rice in application of N, P and K as per soil test values, during first year, increased the economic yield which, in turn, produced higher carbohydrate output. Further, P availability in fertilizer application as per soil test values was mostly related to photosynthesis and utilisation of carbohydrate and K availability increased the synthesis and translocation of carbohydrate. During second year, the different fertilizer levels were not favourably influenced and this might be due to the addition of nutrients through crop residue, residual effect of applied fertilizer and biological N fixation

Table 2. Biosynthates production (Kg ha^{-1})

Treatments	Carbohydrate output		Fat output		Protein output	
	1986 - '87	1987 - '88	1986 - '87	1987 - '88	1986 - '87	1987 - '88
Cropping system						
C_1 Rice - rice - fallow	7576	7797	58	60	874	739
C_2 Rice - rice - green gram	8474	8988	79	85	1256	1304
C_3 Sorghum + vegetable cowpea - rice - soybean	8048	8457	637	669	1981	2230
C_4 Maize + soybean - rice - vegetable cowpea	7384	7739	335	394	1276	1378
C_5 Groundnut + black gram - rice - sesamum	5643	5834	1698	1805	1524	1556
SE_D	46	52	17	31	9	56
CD (5%)	106	120	39	72	21	128
Fertilizer levels						
F_1 N, P & K as per soil test values	7542	7862	572	605	1391	1455
F_2 As in F_1 for all crops except for rice to which P and K alone skipped	7307	7684	551	600	1353	1448
SE_D	79	81	20	30	26	61
CD (5%)	192	NS	NS	NS	NS	NS
Irrigation regimes						
I_1 Recommended	7531	7920	595	662	1450	1521
I_2 Critical stage	7318	7606	528	544	1294	1382
SE_D	79	81	20	30	26	61
CD (5%)	192	199	48	73	63	NS

by legumes together with the improvement of fertility status over initial level.

Interaction between cropping system and irrigation levels was noticed. The superiority of critical stage irrigation in rice-rice- fallow, due to higher productive tiller hill^{-1}, more number of filled grain panicle^{-1} and test weight of grain was the result of continuous submergence during reproductive stage of rice in both the seasons. Higher yield of rice and higher carbohydrate content in rice contributed for higher carbohydrate output. The superiority of recommended level of irrigation in cropping of sorghum + vegetable cowpea-rice-soybean, maize + soybean-rice-vegatable cowpea and groundnut + black gram-rice-sesamum was due to irrigated dry crops raised during *kharif* and summer which was maintained at higher moisture regime. At recommended level of irrigation, cropping system sorghum + vegetable cowpea- rice - soybean produced higher carbohydrate output as a result of better economic yield under adequate moisture supply.

Fat output

Higher fat output of 1698 and 1805 kg ha^{-1} during 1986-'87 and 1987-'88 respectively, from groundnut + black gram-rice-sesamum might be due to higher fat content in oilseed crops of groundnut and sesamum. This was followed by sorghum + vegetable cowpea-rice- soybean due to higher fat contribution of soybean in this system. Cropping of sorghum + vegetable cowpea-rice-soybean and rice-rice- fallow were comparable.

Higher use of water in recommended level of irrigation increased the production of economic yield of groundnut and sesasum which ultimately resulted in higher fat output. The lower yield in critical stage of irrigation might be due to reduced water supply to irrigated dry crops in *kharif* and summer crops. It is also emphasized that groundnut and sesamum being C_3 plants, high temperature due to reduced moisture supply might have resulted in higher photorespiration leading to lower yield (Patel *et al.*, 1988) and the reduced yield of oilseed crops of groundnut and sesamum, ultimately resulted in lower fat output.

The interaction between cropping system and irrigation levels was observed. Cropping of sorghum + vegetable cowpea-rice-soybean, maize + soybean-rice-vegetable cowpea and groundnut + black gram- rice-sesamum recorded, their superiority in recommended level of irrigation due to higher moisture level provided for irrigated dry crops in *kharif* and summer. At both the irrigation

levels, groundnut + black gram-rice-sesamum due to the inclusion of two oilseed crops (groundnut and sesamum) produced higher fat output.

Protein output

It was higher in sorghum + vegetable cowpea-rice-soybean. It was mainly due to the inclusion of protein rich soybean. Cropping of sorghum + vegetable cowpea-rice-soybean was followed by groundnut + black gram-rice-sesamum due to comparatively higher protein content of groundnut, black gram and sesamum. Protein output was higher in recommended level of irrigation, which was due to higher protein content and moderate yield of soybean. Cropping of rice-rice- green gram, sorghum + vegetable cowpea-rice-soy bean, maize + soybean-rice-vegetable cowpea, and groundnut + black gram-rice- sesamum produced more protein output under recommended level of irrigation, which was due to adequate moisture supply through the crop growth stages of *kharif* and summer crops leading to higher yield and ultimately protein output. At both the irrigation levels, the cropping of sorghum + vegetable cowpea-rice-soybean could produce higher protein output as a result of higher protein content in both soybean and vegetable cowpea.

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SPACING AND FERTILIZER REQUIREMENT OF NEW VARIETIES OF COTTON

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ABSTRACT

Field experiments conducted at Coimbatore revealed that the new cotton varieties *viz.*, TCH.959, 77/10, ACP 27-1/1 and TCH.1002 recorded higher seed cotton with a spacing of 50 x 20cm and with a fertilizer level of 80:40:40 kg NPK ha^{-1}.

To obtain the maximum yield of cotton it is obligatory to find out the optimum combination of nutrients and spacing in relation to the varieties. The chief objective of manuring is to make up the deficiency of certain nutrients in the soil and to nutralise others that are in excess, thereby providing with all essential elements in the right proportion needed for growth. Yield from an area depends on the plant population though the yield of seed cotton per plant may be adjusted by the number of bolls per plant (Asana, 1975). Hence, an experiment was conducted to study the effect of plant population (spacings) and fertilizer levels on some new varieties of cotton.

MATERIALS AND METHODS

Field experiments were conducted at Coimbatore during the winter seasons of 1987-88, 1988-89 and 1989-90 under All India Coordinated Cotton Improvement Project to find out the spacing and fertilizer requirement of new varieties of cotton under irrigated conditions. The treatments comprise of three varieties during 1987-88 (TCH.959, 77/10 and ACP.27-1/1, three varieties during 1988-89 (77/10, ACP.27-1/1 and TCH.1002) and two varieties during 1989-90 (77/10 and TCH.1002) with two spacings (75 x 30 cm. and 50 x 20cm.) and with three fertilizer levels viz., 80:40:40, 120:60:60 and 160:80:80 kg NPK ha^{-1}. The experiment was laid out in a split plot design with varieties and spacings in main plot and fertilizer levels in the sub plot with three replications. The soil type was clay loam with low (182 kg ha^{-1}), medium (18 kg ha^{-1}) and high (640 kg ha^{-1}) in available N,P205 and K_2O respectively. The crop was sown on 26.8.87, 21.8.88 and 2.9.89 during the respective years. Half of N was applied as basal at the time of sowing and remaining half was applied at 45 days after sowing as per the treatment schedule. Full dose of P_2O_5 and K_2O were applied