1994 and 10.1 percent in 1995. Water saving in ADT 38 and CO 45 due to adoption of I_2 irrigation level compared to I_1 was 9.6 percent.

REFERENCES

ALEXANDER, D., SADANANDAN, N. and KARUNAKARAN, K. (1988). Azolla growth under different rice planting methods in Kerala. **IRRN,13(4):** 24-25.

ARASGON, E.L. AND DEDATTA, S.K. (1982). Drought response of rice at different nitrogen levels using line source spinkler system. **Irrig.Sci.,3** :63-73.

CHANDRAGIRI, K.K. (1988). Studies on the influence of planting geometry and time of application of N on growth and yield of short duration rice varieties. Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore.

IRUTHAYARAJ, M.R. and MORACHAN, Y.B. (1980). Note on the effect of seasons, stages, water management and nitrogen levels on the uptake of phosphorus in two swamp rice varieties. **Indian J. Agric. Res., 14(4)** : 254-258.

ISLAM, M.Z., HAG, K.A. and BHUIYAN, L.R.(1986). Effect of different water management practices on grain yield, weed population and recovery of applied nitrogen in rice cultivation. **Bangaladesh J. Agric. 1(I):** 57-64.

MALI, C.V. and VARADE, S.B. (1981). Response of rice to varying soil moisture conditions in vertisols. I Studies on soil pH and nutrient availability. **Zeithrift fur Aucker-Und Pflanzenbau 150(2):** 129-139.

MUTHUKRISHNAN, P. (1990). Studies on irrigation, weed and biofertiliser management in transplanted lowland rice. Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore.

NELSON, W.L. (1981). Interaction of potassium with moisture and temperature. **Potash Rev.Sub. 16, Suite, 87** : 1-11.

PANDEY,N., TRIPATHI, R.S. and MITTRA, B.N. (1992). Yield, nutrient uptake and water use efficiency of rice as influenced by nitrogen and irrigation. **Annals Agric., Res.,** :372-374.

SAH, R.N. and MIKKELSON, D.S. (1983). Availability and utilisation of fertiliser by rice under alternate flooding. **Plant and Soil, 75** : 2127-234.

SAHRAWAT, K.L. (1981). Influence of water regime on growth yield and nitrogen uptake of rice. **Comm. soil sci. Pl. Analysis, 12:** 919-932.

SINGANDHUPE, R.B. and RAJPUT, R.K. (1990). Nitrogen use efficiency in rice under varying moisture regimes, sources and levels in semi-reclaimed sodic soil **Indian J. Agron., 35** : 73-81.

(Received : August 1998 Revised : September 1999)

Madras Agric. J., 86(7-9): 351 - 355 July - September 1999
https://doi.org/10.29321/MAJ.10.A00615

ALTERNATE CROPPING SYSTEM FOR SINGLE RICE BASED LOWLANDS OF KARAIKAL REGION OF UNION TERRITORY OF PONDICHERRY

J. RAMMOHAN, B. CHANDRASEKHARAN, R. POONGUZHALAN and M. SUBRAMANIAN

P.J.N. College of Agriculture and Research Institute.
KARAIKAL - 609603

ABSTRACT

Field experiments were conducted during 1993-95 at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal for evolving alternate cropping systems for the Karaikal region of Union Territory of Pondicherry, which is situated at the tail end of Cauvery delta zone. Rice-cotton system was found to be the best system since it outyielded the conventional system (rice-blackgram)) and other cropping systems evaluated (rice-soybean, rice-vegetable cowpea and rice-sesame). The system rice-cotton recorded the maximum gross and net returns followed by rice-vegetable cowpea system. The rice-cotton system may be adopted in areas where water is available for atleast ten irrigations during summer and in areas where water is available for only five irrigations rice-vegetable cowpea system may be economical. Among the four levels of N (o,75, 112.5 or 150 Kg ha^{-1}) applied to rice, application of 150 Kg N ha^{-1} increased not only the yield of rice but also the production potential of the system in all the cropping systems studied.

KEY WORDS: Rice based system, Alternative system

Rice is the principal food crop cultivated in the lowlands of Karaikal region which is situated in the tail end of Cauvery delta. With augmented and controlled supplies of water from Mettur reservoir, rice is cultivated during three different seasons in a year *viz.*, kuruvai (June-July to

September - October), samba (August-September to January-February) and thaladi (october-November to January-February). The second and third rice crops are usually followed by rice fallow blackgram as a conventional practice, which is cultivated from January-February to March.

Because of the food habits of the people, drainage constraints imposed by land topography and rains during North-East monsoon period, it is not possible to completely give up rice cultivation in this region. The receipt of water from Mettur dam is not timely and the discharge is also sub-normal and inadequate for irrigation. Therefore, raising of first crop (kuruvai) in June and commencement of samba crop in August with river water irrigation has become bleak. Therefore, an imperative change of the cropping pattern in Karaikal region of the Union Territory of Pondicherry and evolving new cropping systems to meet the exigency of water scarcity and to boost the income of the farmer with the available water facilities are the immediate needs at this critical situation. Hence, a rice based cropping system along with some irrigated remunerative dry crops with better resource utilization is a necessity, since the prevailing system of rice-blackgram is not remunerative to the farming community of this region.

MATERIALS AND METHODS

The field experiments were conducted in fields B_7 and C_{10} of Western Block of Pandit Jawaharlal Nehru College of Agricuture and Research Institute, Karaikal, Union Territory of Pondicherry during 1993-95. The soil was Typic Chromustert and sandy clay loam in texture. Experiment-I (Early sowing) was conducted in soil which had a pH of 7.90 with an EC of 0.40 dS m^{-1} and the soil was low in OC (0.40%) and available N (181.0 kg ha^{-1}), P_2O_5 (18.2 kg ha^{-1}) and K_2O (86.0 Kg ha^{-1}). Experiment-II (late sowing) was conducted in soil with a pH of 7.80 and an EC of 0.50 dS m^{-1} and the soil was low in OC (0.41%) and available N_2 P_2O_5 and K_2O (184.0, 18.7 and 88.0 kg ha^{-1} respectively).

The treatments included five cropping systems viz., rice-blackgram (S_1), rice-cotton (S_2), rice-soybean (S_3), rice-vegetable cowpea (S_4) and rive-sesame (S_5) and four levels of N application to rice viz., O(N_1), 75(N_2), 112.5(N_3) or 150(N_4) kg ha^{-1} in all the systems. The experiments were laid out in a split plot design with three replications, assigning the cropping systems to main plots and N levels to rice in sub-plots. The medium duration rice cv. ADT 39 (120-125 days duration) was transplanted at a planting density of 66 hills per sq.m. The rice-fallow crops were sown as per the treatment after the harvest of rice crop. Recommended package of practices were followed

Table 1a. Economic produce of the component crops in cropping systems (early sowing)

System	Yield of rice (kg ha^{-1})					Yield of rice-fallow crops (kg ha^{-1})*				
	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean
S_1 : Rice - blackgram	1997	4053	4833	5340	4056	292	492	797	981	640
S_2 : Rice - cotton	1820	4367	5543	6050	4445	1515	1805	1991	2127	1859
S_3 : Rice - Soybean	1853	4310	5393	6077	4408	387	732	836	939	724
S_4 : Rice - Vegetable cowpea	1957	4157	5210	5813	4284	2918	4450	5197	5700	4567
S_5 : Rice - Sesame	1770	3760	5027	5700	4064	204	421	614	751	498
Mean	1880	4130	5200	5800						
		S.Em. ±	C.D. at 0.05			Not analysed				
For S		156	510							
For N		122	352							
For N at S		273	786							
For S at N		283	849							

* Data are mean of two years (1993-94 and 1994-95)

Table 1b. Economic produce of the component crops in cropping systems (late sowing)

System	Yield of rice (kg ha^{-1})					Yield of rice-fallow crops (kg ha^{-1})*				
	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean
S_1 : Rice - blackgram	1880	3267	4330	4950	3607	240	367	534	690	458
S_2 : Rice - cotton	1673	3363	4847	5217	3775	1350	1577	1852	1943	1680
S_3 : Rice - Soybean	1583	3057	4283	5010	3483	336	580	749	795	615
S_4 : Rice - Vegetable cowpea	1790	3197	4563	5340	3723	2689	3855	4499	4855	3974
S_5 : Rice - Sesame	1673	2923	4113	4817	3382	181	407	566	721	468
Mean	1720	3160	4430	5070						
		S.Em. ±	C.D. at 0.05			Not analysed				
For S		72	235							
For N		45	130							
For N at S		101	290							
For S at N		113	343							

* Data are mean of two years (1993-94 and 1994-95)

for rice and the rice-fallow crops (CPG, 1994).

The parameters like yield of component crops, Rice Yield Equivalent (RYE), per day productivity of cropping systems and economics were used for evaluating the systems. The RYE of the cropping systems were calculated as per the method suggested by De et. al (1978). Pooled analysis of the data was carried out.

RESULTS AND DISCUSSION

Effect of N levels on yield of rice and rice-fallow crops

A positive relationship between rice yield and N level was observed in all the systems in both the experiments (Tables 1a and 1b). The mean grain yield was 202 per cent higher at 150 kg N ha^{-1} over control. The increased grain yield is attributed to the production of more number of productive tillers hill^{-1} and grains panicle^{-1} and higher test weight. In addition, the increase in N level increased the LAI which would have helped the plants in utilizing the solar light more efficiently resulting in higher yields. This falls in line with the findings of Wankhade and Pandrangi (1988) and Thiagarajan *et. al* (1994).

The increase in N level to rice increased not only the yield of rice but also the yield of rice-fallow crops. This may be attributed to the reason that application of higher levels of N to rice increased the residue addition to soil by rice which upon mineralization would have released more nutrients for the rice-fallow crops.

Rice Yield Equivalent

Due to the diversity in crop yields, the economic produce of the system was varied and hence it may not be a meaningful parameter to evaluate the performance of the cropping systems. The Rice Yield Equivalent (RYE) would be the ideal yardstick to compare the production potential of the cropping systems, since the yields of different crops are converted into yields equivalent that of rice. The RYE differed significantly due to systems and N levels to rice (Table 2). The system S_2 registered the maximum RYE (9576 to 11066 kg ha^{-1}) followed by S_4 (7154 to 8192 kg ha^{-1}) and the increase in yield was 95 and 44 per cent over the conventional system (S_1), respectively. This is due to higher economic value of cotton in S_2 and higher yield of *samba* rice and green pods in S_4.

Per day productivity of biomass

Significant and higher per day productivity of biomass (Table 3) was recorded in S_4 (76.29 to 90.42 kg ha^{-1} day^{-1}) followed by S_2 (62.19 to 72.08 kg ha^{-1} day^{-1}). The system S_1 recorded the lowest per day productivity which was on par with S_3. An

Table 2. Rice Yield Equivalent (kg ha^{-1}) of cropping systems

System	Early sowing (September)*					Late sowing (October)*				
	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean
S_1 : Rice - blackgram	2841	5478	6419	8178	5729	2577	4329	5876	6947	4932
S_2 : Rice - cotton	7218	10789	12631	13626	11066	6475	8976	11440	12133	9756
S_3 : Rice - Soybean	2695	5899	7206	8113	5978	2313	4319	5909	3734	4819
S_4 : Rice - Vegetable cowpea	4453	7970	9656	10689	8192	4090	6492	8529	9504	7154
S_5 : Rice - Sesame	2764	5813	8016	9365	6490	2554	4893	6871	8314	5658
Mean	3994	7190	8786	9994		3602	5802	7725	8727	
		S.Em. ±	C.D. at 0.05				S.Em. ±	C.D. at 0.05		
For S		627	2043				273	891		
For N		467	1347				226	652		
For N at S		209	603				101	291		
For S at N		276	857				126	389		

* Data are mean of two years (1993-94 and 1994-95)

increasing trend was observed in all the systems with increasing levels of N to rice.

The production potential of the system was higher when sown in september than in October. Delaying the sowing by one month lead to poor performance of samba rice as well as rice-fallow crops which ultimately reduced the production potential of the system. The poor performance of rice as well as rice-fallow crops when sown in October as compared to September may be attributed to reduced solar radiation, higher relative humidity and low temperature prevailed during crop growth period. Similar results were also

Table 3. Per day productivity of biomass (kg ha^{-1} day^{-1})

System	Early sowing (September)*						Late sowing (October)*					
	Total duration (days)	Nitrogen levels					Total duration (days)	Nitrogen levels				
		N_0	N_1	N_2	N_3	Mean		N_0	N_1	N_2	N_3	Mean
S_1 : Rice - blackgram	187	32.17	58.93	72.45	79.21	60.69	183	31.82	51.70	66.05	74.16	55.93
S_2 : Rice - cotton	255	42.41	69.13	78.92	83.63	68.52	252	39.57	59.16	73.80	77.64	62.54
S_3 : Rice - Soybean	206	29.71	61.29	71.44	78.37	60.20	205	25.97	47.25	61.28	68.53	50.76
S_4 : Rice - Vegetable cowpea	196	48.25	85.77	100.18	107.77	85.49	194	45.42	70.80	91.98	100.55	77.19
S_5 : Rice - Sesame	210	27.14	53.82	69.42	79.17	57.39	207	26.09	45.72	60.95	72.18	51.23
Mean		35.94	65.79	78.48	85.63			33.77	54.92	70.81	78.61	
		S.Ed	C.D. at 0.005					S.Ed	C.D. at 0.005			
For S		4.37	14.26					2.28	7.44			
For N		2.53	7.32					2.83	8.17			
For N at S		1.13	3.27					1.27	3.65			
For S at N		1.76	5.53					1.33	4.01			

* Data are mean of two years (1993-94 and 1994-95)

Table 4. Economics of cropping systems

System	Early sowing (September)*				Late sowing (October)*		
	Cost of cultivation (Rs ha^{-1})	Gross Returns (Rs ha^{-1})	Net Returns (Rs ha^{-1})	C:B	Gross Returns (Rs ha^{-1})	Net Returns (Rs ha^{-1})	C:B
S_1 : Rice - blackgram	14494	25206	10712	1:1.74	21447	6953	1:1.48
S_2 : Rice - cotton	22443	45377	22934	1:2.02	40198	17755	1:1.79
S_3 : Rice - Soybean	14869	25186	10317	1:1.69	20857	5988	1:1.40
S_4 : Rice - Vegetable cowpea	18508	33662	15154	1:1.82	29945	11437	1:1.62
S_5 : Rice - Sesame	16376	27569	11193	1:1.68	23992	7616	1:1.47

(Not analysed)

* Data are mean of two years (1993-94 and 1994-95)

obtained at Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu (Anon. 1996).

Economics

Among the systems, S_2 required the highest investment which was 55 per cent higher than the conventional system (Table 4) owing to higher fertiliser and labour requirement. It resulted in maximum gross and net returns which were 84 and 135 per cent higher than the conventional system, respectively with a C:B ratio of 1:1.79 to 1:2.02. This may be attributed to the higher potential of the system and higher market value of cotton. This is in line with the findings of Ram et al.(1991) who also recorded the highest net profit in rice-cotton system. The next best system was S_4 which recorded a net returns of Rs. 11,437 to Rs. 15,154 and 53 per cent higher than S_1 with a C:B ratio of 1:1.62 to 1:1:1.82. Jayakumar and Alagappan (1994) had reported a C:B ratio of 1:2.76 in rice-cowpea system. The systems S_3 and S_5 recorded lower C:B ratio than S_1 due to higher added cost and lesser added returns.

Cognizing the several parameters in unison, the system S_2 (rice-cotton) is brought into limelight as a preferable alternative for the single rice based lowland situation in both early (September) and late (October) sowings, when water is not a constraint / irrigation is supplemented to give 10 irrigations during rice-fallow period. The next system characterized by favourable economic incentives was S_4 (rice-vegetable cowpea) which can be preferred when water is available for five irrigations during rice-fallow period. The system S_5 (rice-sesame) performed well over the conventional system S_1 (rice-blackgram) and is preferable in areas of limited water supply with two irrigations during rice-fallow period. It was also found that application of 150 kg N ha^{-1} to rice increased not only the rice yield but also the total yield potential of the cropping system in single rice based lowland situation.

REFERENCES

ANONYMOUS. (1996). Influence of planting time on grain yield of rice varieties in samba/thaladi seasons. *IRRI Report*, Tamil Nadu Rice Research Institute, Tamil Nadu Agric. Univ., Aduthurai, Tamil Nadu, India.

CPG. (1994). Crop Production Guide. Dept. of Agriculture and Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

DE, R.S. GUPTA, S.P. SINGH, M. PAL, S.N. SINGH, R.N. SHARMA and S.K. KAUSHIK (1978). intercropping maize, sorghum and pearl millet with short duration grain legumes. **Indian J. Agric. Sci., 48:** 132-137.

JAYAKUMAR, K. AND RM. ALAGAPPAN. (1994). Studies on rice-based cropping system. **Madras Agric. J.81(3):** 152-153.

RAM, G., B.S. JOSHI and K.S. PANDYA. (1991). An economic analysis of rice-based rabi crops under assured irrigation. **Indian J. Agric. Res., 25(4):** 206 - 210.

THIAGARAJAN, T.M., R. SIVASAMY and H.F.M. TEN BERGE. (1994). Nitrogen and Rice: Influence of nitrogen application levels and strategy on growth, leaf nitrogen content and notrogen use efficiency. In : *SARP Res. Proc.* Los Banos, Philippines. pp 56-69.

WANKHADE, S.G. AND R.B. PANDRANGI. (1988) Growth and nutrient uptake behaviour of upland paddy as influenced by N and P fertilization. **Ann. Rev. Physiol. 2:** 30-36.

(Received : August 1998 Revised : September 1999)