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## INTEGRATED NUTRIENT MANAGEMENT IN GARDENLAND CROPPING SYSTEM

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### ABSTRACT

An experiment on the integrated nutrient management in gardenland cropping system was conducted at the Tamil Nadu Agricultural University, Coimbatore. The study revealed that cropping systems viz., Ragi (cotton + greengram)- (sorghum + cowpea)(C<sub>4</sub>) and Ragi-cowpea-maize (fodder) - (wheat + coriander) (C<sub>3</sub>) recorded the highest dry matter production of 23393 and 18871 and 6927 and 40267 kg/ha. Highest economic returns were obtained in the C<sub>4</sub> cropping system which gave RS. 20710 and Rs. 21212 per hectare in the two years. Nutrient uptake pattern was found to follow the same trend as that of the dry matter production. Based on the post-harvest soil analysis, it was observed that the soil fertility status was not altered due to various cropping systems, if the crops included in the cropping systems were supplied with 100% recommended N,P and K to all the crops based on the soil test values.

**KEY WORDS** : Cropping system, Integrated Nutrient management, Cropping system.

To find out the suitable cropping system and also fertilizer requirement for the cropping system as a whole, the

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study on the integrated nutrient management in the gardenland cropping system was undertaken.

## MATERIALS AND METHODS

The study was conducted during two consecutive years (1985-86 and 1986-87). The treatments comprised of four cropping systems viz., (cotton + greengram) - (Sorghum + cowpea) - (wheat + coriander) (C<sub>1</sub>); sorghum - cotton, (Farmers practice) (C<sub>2</sub>); Ragi-cowpea-maize (fodder) - (wheat + coriander), (C<sub>3</sub>) and Ragi - (Cotton + greengram) - (sorghum + cowpea), (C<sub>4</sub>, allotted to the main plots and six fertilizer levels viz., 150% recommended N, P and K fertilizers to all the crops based on blanket recommendation (T<sub>1</sub>); 100% recommended N, P and K fertilizers to all the crops based on blanket recommendation (T<sub>2</sub>); 50% recommended N, P and K fertilizers to all the crops based on blanket recommendation, (T<sub>3</sub>); 100% recommended N, P and K fertilizers to all the crops based on soil test values, (T<sub>4</sub>); 75% recommended N, P and K fertilizers to all the crops based on soil test values plus Azospirillum, (T<sub>5</sub>) and control (no fertilizer application) (T<sub>6</sub>) to the sub-plot treatments. Thus there were twenty four treatment combinations tried in a split-plot design with three replications. The initial soil sample analysis revealed that the soil pH was 8.15. The available soil N, P and K were 204, 6.41 and 594.5 kg ha<sup>-1</sup> respectively. The plant samples were collected and analysed for the total nitrogen (Humphries, 1956), phosphorus and potash (Jackson, 1973). The yield of grain and straw obtained in the various treatments were recorded and analysed. The corresponding economic values were

calculated and analysed for valid conclusions.

## RESULTS AND DISCUSSION

The data on the total dry matter production and the economic returns were presented in Table 1. It was observed that the cropping system C<sub>4</sub> and C<sub>3</sub> viz., Ragi - (cotton + greengram)-(sorghum + cowpea) and Ragi -cowpea - maize (fodder) - (wheat + coriander) recorded the highest dry matter production of 23393 and 40267 kg/ha in 1985-86 and 1986-87 respectively. Among the different fertilizer levels, the treatment (T<sub>1</sub>) viz., 150% recommended N, P and K fertilizers to all the crops based on blanket recommendation produced the highest dry matter production of 15728 and 26578 kg/ha in 1985-86 and 1986-87 respectively. This was closely followed by T<sub>4</sub> viz., 100% recommended N, P and K to all the crops based on soil test values which recorded 15458 and 26419 kg/ha dry matter production. The control plots (no fertilizer application) (T<sub>6</sub>) produced only 4127 and 16603 kg/ha dry matter production during the two years of study. The reason for the increased dry matter production in C<sub>4</sub> and C<sub>3</sub> cropping systems could be attributed to the more number of crops included in the cropping systems which had utilized the environmental factors fully and the crops were more or less complementary to each other. Sharma et al. (1987) concluded that three crop based sequences were better than two crop based sequences in terms of production potential and profit. The plots receiving 150% recommended N, P and K fertilizers to all the crops based on blanket recommendation (T<sub>1</sub>) recorded the increased dry matter.

Table 1. Dry matter production (kg/ha) and economic returns (Rs.ha<sup>1</sup>)

Treatments	Dry matter production		Economic returns		Mean	
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
T <sub>1</sub>	6688	20985	20410	9973	13836	15191
T <sub>2</sub>	6029	29258	18711	9214	13143	13962
C <sub>1</sub> T <sub>3</sub>	2875	18846	9163	8381	10860	8792
T <sub>4</sub>	6189	22134	19362	10573	14161	14967
T <sub>5</sub>	5351	18340	16267	9395	11845	12831
T <sub>6</sub>	1473	15298	5314	6235	8385	5774
T <sub>1</sub>	15416	16967	19369	13264	16191	16330
T <sub>2</sub>	14639	19199	17676	11340	16919	14508
T <sub>3</sub>	9312	15216	10114	10969	12264	10541
C <sub>2</sub> T <sub>4</sub>	15187	16638	18321	9751	15912	14036
T <sub>5</sub>	13313	14283	15429	9810	13798	12619
T <sub>6</sub>	3250	13737	5314	8155	8493	6734
T <sub>1</sub>	13159	46872	21663	12502	30030	17082
T <sub>2</sub>	11448	45087	17786	12888	28267	15337
T <sub>3</sub>	7410	42741	11031	12009	25075	11520
C <sub>3</sub> T <sub>4</sub>	12267	46281	19772	13491	29274	16631
T <sub>5</sub>	10094	37499	16206	10394	237679	13300
T <sub>6</sub>	3356	23127	5604	6731	13241	6167
T <sub>1</sub>	27622	21491	26725	16226	24556	21475
T <sub>3</sub>	20167	18684	17077	12052	19425	14564
T <sub>4</sub>	28192	20623	25707	55581	24407	40644
T <sub>5</sub>	26376	18299	23542	13906	22337	18724
T <sub>6</sub>	8431	14251	9354	10678	11341	10016
			Main Plot			
SE	109	932	606	5189		
CD (5%)	521	4465	2886	24701		
			Sub plot			
SE	2040	1952	6276	6006		
CD (5%)	4999	4784	15376	14714		

**Table 1.** Mean dry matter production (kg/ha) cropping systems

Year	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>
1985-86	4767	11849	9627	23393
1986-87	19310	16006	40267	18871

## Mean dry matter production (kg/ha) fertilizers levels

Year	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>6</sub>
1985-86	15728	15422	9946	153458	13783	4127
1986-87	26578	26105	23871	26419	22105	16603

## Mean economic returns Rs./ ha cropping system

Year	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>
1985-86	8961	10514	11335	20710
1986-97	14871	14375	15343	21212

## Mean economic returns Rs/ha fertilizer levels

Year	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>6</sub>
1985-86	22048	19760	9346	20790	17861	6396
1986-87	12991	12315	10853	22349	10876	7950

production of 15728 and 26578 kg./ha during 1985-86 and 1986-87 respectively. Hundred per cent recommended N,P and K fertilizers to all the crops based on soil test values (T<sub>2</sub>) produced 15458 and 26419 kg./ha dry matter during 1985-86 and 1986-87 respectively which was on par with T<sub>1</sub> fertilizer level. Purushothaman and Palaniappan (1986) found that recommended level of N, P and K fertilizers to all the crops in the cropping system was only marginally better than the treatments with fully recommended N applied to each crop and than the recommended dose of P and K applied to summer crop only in the rice based cropping system. The fertilizer levels T<sub>2</sub> and T<sub>5</sub> recorded the dry matter production of 15422 and 26105, and 13783 and 22105 kg/ha during 1985-86 and 1986-87 respectively and were higher than the control (T<sub>6</sub>) but less than the T<sub>1</sub> and T<sub>4</sub> fertilizer levels. The reason for the high dry matter

production in T<sub>2</sub> and T<sub>5</sub> fertilizer levels was due to fertilizer application and inclusion of bio-fertilizer in the sequence and due to large quantity of biomass added to the soil by way of roots and stubbles. Palaniappan et al. (1986) reported that fertilizer application could be substantially reduced because of complementary nature of the crops in the sequence and large quantity of biomass added to the soil by way of roots and stubbles.

The data on the economic returns obtained in the various cropping system revealed that the C<sub>4</sub> cropping system, Ragi (cotton + greengram) - (sorghum + cowpea) resulted in the highest net returns of Rs. 20,710 and 21, 212 per hectare in both the years of study. Among the fertilizer levels, T<sub>4</sub> treatment viz., 100% recommended N,P and K fertilizers to all the crops based on the soil test values recorded the highest return



Rs. 20790 and Rs. 22349 per hectare during 1985-86 and 1986-87 respectively eventhough the returns obtained in the T<sub>4</sub> was less than T<sub>1</sub> during 1985-86 year only. The control plots gave only Rs. 6396 and Rs. 7950 per hectare as returns during 1985-86 and 1986-87 respectively eventhough the returns obtained in the T<sub>4</sub> was less than T<sub>1</sub> during 1985-86 year only. The control plots gave only Rs.6396 and Rs. 7950 per hectare as returns during 1985-86 and 1986-87 respectively. Reddy et al. (1980) indicated that the total monetary returns were increased substantially due to

intercropping of greengram with sorghum. Reddy (1986) stated that the gross/net returns were higher in the case of intercropping and sequence cropping system indicating that the cropping system was more profitable and viable. Satyanarayan and Reddi (1979) noticed that the association of pulse crop with rabi sorghum was found to be beneficial in increasing the total income of the farmer.

The data on the nutrient uptake by the crops in the cropping systems at harvest stage is presented in Table 2.

Table 2. Nutrient uptake (kg/ha)

Fertilizer levels	Nitrogen							
	C <sub>1</sub>		C <sub>2</sub>		C <sub>3</sub>		C <sub>4</sub>	
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
T <sub>1</sub>	318.4	228.9	279.5	251.0	440.2	534.3	394.6	249.9
T <sub>2</sub>	275.2	212.1	229.9	229.6	351.7	514.4	320.7	222.3
T <sub>3</sub>	133.1	194.8	167.6	197.8	223.3	454.8	223.3	211.8
T <sub>4</sub>	292.8	222.1	242.6	154.7	406.2	542.7	341.5	224.3
T <sub>5</sub>	240.5	192.1	198.3	164.2	322.2	417.6	307.6	200.6
T <sub>6</sub>	59.9	138.0	81.9	185.3	109.6	224.3	125.5	160.4
Mean	219.9	198.0	199.9	197.1	308.8	428.9	285.5	211.5

Fertilizer level	Phosphorus							
	C <sub>1</sub>		C <sub>2</sub>		C <sub>3</sub>		C <sub>4</sub>	
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
T <sub>1</sub>	37.4	26.9	22.9	14.9	46.9	49.3	35.4	23.8
T <sub>2</sub>	31.4	26.4	19.9	14.7	36.1	45.6	31.9	21.8
T <sub>3</sub>	14.4	20.8	12.4	11.5	21.6	38.3	26.3	23.4
T <sub>4</sub>	33.2	25.1	20.9	10.2	38.9	41.8	36.3	22.2
T <sub>5</sub>	27.2	25.3	17.6	11.3	30.3	34.8	34.2	19.2
T <sub>6</sub>	6.8	17.6	7.0	10.1	9.6	19.1	14.5	14.8
Mean	25.06	23.68	16.78	12.11	30.56	38.15	29.76	20.86

## Potassium

Fertilizer level	C <sub>1</sub>		C <sub>2</sub>		C <sub>3</sub>		C <sub>4</sub>	
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
T <sub>1</sub>	353.9	312.9	279.9	258.3	779.7	1007.0	491.6	533.2
T <sub>2</sub>	300.9	286.6	267.5	309.4	444.1	831.7	457.2	480.3
T <sub>3</sub>	148.7	255.9	183.2	228.1	297.6	820.0	369.9	473.7
T <sub>4</sub>	349.7	331.4	264.3	185.6	518.9	999.4	472.3	483.5
T <sub>5</sub>	280.2	226.5	243.0	186.5	400.5	741.6	442.1	425.5
T <sub>6</sub>	68.3	187.6	89.8	192.9	123.7	396.5	203.8	358.7
Mean	250.28	266.81	219.78	226.8	445.91	799.36	406.15	459.15

## Mean uptake of nutrients kg/ ha cropping systems

Fertilizer level	C <sub>1</sub>		C <sub>2</sub>		C <sub>3</sub>		C <sub>4</sub>	
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
N	220.0	198.0	199.9	197.1	308.8	448.0	285.5	211.5
P	25.1	23.7	16.8	12.1	30.6	38.1	29.8	20.9
K	250.3	266.8	219.8	226.8	445.9	799.4	406.1	459.1

It could be seen that C<sub>3</sub> cropping system (Ragi-cowpea-maize) (fodder) - (coriander + wheat) recorded the highest uptake of nutrients viz., N,P and K of 308.8, 30.6 and 445.9 kg/ha respectively. This was closely followed by C<sub>4</sub> cropping system viz., Ragi-(cotton + Greengram) - (Sorghum + cowpea) which had removed 285.5, 29.8 and 406.1 kg per hectare of N,P. and K respectively. The C<sub>2</sub> cropping system viz., sorghum cotton recorded 199.9, 16.8 and 219.8 kg per hectare of N,P and K. The reason for the increased nutrients removal from the soil in C<sub>3</sub> and C<sub>4</sub> cropping systems could be attributed to the more number of crops included in the cropping systems which had resulted in the higher dry matter production. But with regard to the fertilizer levels on the nutrient uptake, it was observed that 150 per cent recommended N, P and K fertilizers to

all the crops based on blanket recommended N, P and K fertilizers to all the crops based on blanket recommendations (T<sub>1</sub>) removed more quantities of nutrients viz., 358.2 kg N, 35.6 kg P and 476.3 kg/ha respectively. This was closely followed by 100% recommended N,P and K fertilizers to all the crops based on soil test values (T<sub>4</sub>) which had removed 320.8, 32.3 and 401.3 kg/ha respectively. The control plots where no fertilizers were applied recorded the lowest removal of nutrients viz., 94.2 kg N, 9.5 kg P and 121.4 kg K/ha. The T<sub>5</sub> treatment viz., 75% recommended N, P and K fertilizers to all the crops based on soil test values plus Azospirillum recorded higher values of 267.1 kg N, 27.3 kg p and 339.2 kg k/ ha than the T<sub>3</sub> treatment viz., 50% recommended N, P and K fertilizers to all the crops based on blanket recommendation which

had removed 186.3, 18.7 and 249.3 kg of N, P and K/ha respectively and equal to the uptake pattern obtained in the T<sub>2</sub> treatment viz., 100% recommended N, P and K fertilizers to all the crops based on blanket recommendation. The T<sub>2</sub>

treatment recorded 294.4, 29.8 and 395.2 kg N, P and K uptake per hectare. This showed that various crops included in different cropping systems had responded to the bio-fertilizer application as well as fertilizer application. Shah and Joshi

**Table 3. Post-harvest soil analysis (kg/ha) at the end of 1986-87**

Fertilizer levels	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	Mean
T <sub>1</sub>	160.0	218.0	183.0	212.0	193.25
T <sub>2</sub>	173.0	221.0	190.0	227.0	202.75
T <sub>3</sub>	149.0	212.0	180.0	188.0	182.25
T <sub>4</sub>	187.0	222.0	190.0	203.0	200.50
T <sub>5</sub>	179.0	207.0	201.0	208.0	198.75
T <sub>6</sub>	177.0	205.0	187.0	231.0	200.00
Mean	170.83	214.16	188.5	211.5	

#### Phosphorus

Fertilizer levels	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	Mean
T <sub>1</sub>	19.4	45.4	20.5	37.5	30.80
T <sub>2</sub>	10.5	30.6	22.3	39.0	25.60
T <sub>3</sub>	11.2	26.3	20.5	25.9	20.97
T <sub>4</sub>	15.4	35.1	22.2	40.1	28.20
T <sub>5</sub>	14.1	22.6	26.7	38.1	25.37
T <sub>6</sub>	5.0	5.8	9.7	10.6	7.77
Mean	12.60	27.63	20.31	31.93	

#### Potassium

Fertilizer levels	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	Mean
T <sub>1</sub>	978.0	1068.0	1056.0	937.0	1009.75
T <sub>2</sub>	970.0	926.0	1098.0	907.0	975.25
T <sub>3</sub>	939.0	948.0	1090.0	857.0	958.50
T <sub>4</sub>	959.0	978.0	1030.0	821.0	947.00
T <sub>5</sub>	918.0	941.0	1027.0	825.0	927.75
T <sub>6</sub>	941.0	843.0	1049.0	881.0	928.5
Mean	950.83	950.66	1058.33	871.33	

(1986) reported that reduced recommended dose of nitrogen plus *Azotobacter* potentially could yield at least on par or slightly better compared to the recommended dose. Sharma et al. (1987) observed the maximum N, P and K uptake in the rice-wheat-greengram and this was closely followed by maize - wheat- greengram.

The effect of the cropping systems and different fertilizer levels on the post-harvest soil analysis is presented in Table 3. It was noticed that the nutrient content in the post-harvest soil analysis in general was higher in the C<sub>2</sub> cropping system than the other cropping system, C<sub>1</sub>, C<sub>3</sub> and C<sub>4</sub>. The reason for the high N, P and K content in the C<sub>2</sub> cropping system might be due to the inclusion of only two crops in the sequence viz., sorghum - cotton which had resulted the lesser dry matter production consequent to the low uptake of nutrients resulting in the higher nutrient content in the post-harvest soil. When the effect of different levels of fertilizers on the nutrient content of the post-harvest soil was considered, it was observed that the fertility status of the soil was not much altered irrespective of the cropping systems. The reason for this could be attributed to the inclusion of more crops including of legumes in the intercropping and crop sequence trial which had resulted in the increased biomass as well as root stubble residues in the soil contributing to the high nutrient content in the soil. The nutrient content in the control plots was found to be the lowest. The crops like ragi and leguminous crops such as greengram and cowpea were included in the cropping systems viz., ragi-cowpea-maize (fodder) - (wheat + coriander)

and ragi - (cotton + greengram) - (sorghum + cowpea) which had resulted in the easily decomposable residues and maintained soil fertility (Palaniappan et al., 1986). Kadam et al. (1987) reported that sorghum + blackgram cropping system was beneficial in general by increasing the available nitrogen status in the soil. The inclusion of legumes in the cropping systems had the characteristic capacity to fix atmospheric nitrogen through root nodule bacteria which had resulted in the increased nutrient content in the post-harvest soil (Singh et al., 1970; Ramshe and Patil, 1987). Thus the results showed that the soil fertility status was not changed much due to the various cropping systems if the crops thus included in the cropping systems were applied with 100% recommended N,P and K fertilizers to all the crops based on the soil test recommendations.

The experimental results revealed that the cropping systems viz., C<sub>3</sub> and C<sub>4</sub> (ragi-cowpea-maize (Fodder) - (wheat + coriander) and ragi - (cotton + greengram) - (sorghum + cowpea) recorded the highest dry matter production in 1985-86 and 1986-87 respectively. The maximum economic returns was obtained in the C<sub>4</sub> cropping system (ragi - (cotton + greengram) - (sorghum + cowpea). The nutrient uptake pattern was found to follow the same trend as that of the dry matter production. The post-harvest soil analysis showed that the nutrient content of the soil was not altered much due to the various cropping systems provided the crops that were included in the cropping systems were applied with 100% recommended N, P and K fertilizers to all the crops based on the soil test values.



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