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RESIDUAL EFFECT OF METHODS OF PLANTING, WEED CONTROL MEASURES AND NUTRIENT MANAGEMENT ON YIELD ATTRIBUTES AND YIELD OF RICE - CASSAVA INTERCROPPED WITH GROUNDNUT CROPPING SYSTEM

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ABSTRACT

A field experiment was conducted at the Instructional farm, College of Agriculture, Vellayani, Kerala, India during the period from 2013 to 2014, to study the effect of methods of planting, weed control measures and nutrient management on yield attributes and yield of rice (*Oryza sativa* L.) and their residual effect on the succeeding minisett cassava (*Manihot esculenta* L.) intercropped with groundnut (*Arachis hypogaea* L.) in upland condition. The experiment was laid out in split plot design, comprising three main plot treatments which included methods of planting in combination with weed control measures [M_1- broadcasting of sprouted seeds, M_2- dibbling (sprouted seeds with drum seeder along with weeding by power weeder) and M_3- dibbling (sprouted seeds with drum seeder along with stubble mulching)] and five methods of fertilizer application as sub plot treatments [F_1- broadcasting (60-30-30 kg NPK ha^{-1}), F_2- band placement (60-30-30 kg NPK ha^{-1}), F_3- foliar spray of complex foliar fertilizer 19-19-19 @ 0.5 %, F_4- foliar spray of diammonium phosphate (DAP) and sulphate of potash (SOP) each @ 2 %, F_5- control]. These treatments were replicated five times for upland rice. For cassava intercropped with groundnut recommended dose of fertilizer along with 0.5 % foliar spray of 19-19-19 was applied at 30 days interval. The results showed that the yield attributes and yield of first crop rice was significantly influenced by the effect of dibbling of rice seeds using drum seeder + power weeding along with band placement of 60-30-30 kg NPK ha^{-1}. However, the yield attributes and yield of succeeding crops (cassava intercropped groundnut) was significantly increased by the residual effect of dibbling of rice seeds using drum seeder + stubble mulching @ 3 t ha^{-1} along with broadcasting of 60-30-30 kg NPK ha^{-1} applied to first crop rice. Therefore, direct as well as residual effect of stubble mulching and basal application of nutrients applied to preceding rice would help to increase the residual nutrients and better productivity of rice- minisett cassava intercropped groundnut cropping system in upland condition.

(Key words: Foliar fertilizers, methods of planting, minisett, nutrient management, residual effect, rice based cropping system)

INTRODUCTION

Rice is one of the most important cereal crops and provides food security and livelihood for millions of people across the globe. It has been estimated that one-fourth of rice grown in the world is upland rice. Among many factors, method of sowing, seed rate, integrated nutrient management etc, influence the crop yield under upland situations.

Cropping systems research has shown that short duration cassava varieties can be grown successfully in rice- based cropping system. Since the development of cassava in initial stages is very slow, a short duration crop such as groundnut also can be incorporated in the system to make more efficient use of resources. Therefore, inclusion of oilseeds in the system is more beneficial than conventional cereal year after year. Foliar formulations are gaining importance in crop production owing to its quick response in plant growth.

Any intensive cropping aims at full exploitation of the residual effect of the applied fertilizer from one crop to another resulting in fertilizer economy and efficient crop production. For sustainable productivity an integrated nutrient supply and management system with minimum deleterious effect on soil health and to harness the natural nutrient capability and mining of soil reserve is the need of the day (Singh *et al*., 2004)

With this background, the present study was undertaken to evaluate the residual impact of methods of planting along with weed control measures and nutrient management on the yield attributes and yield of rice –

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cassava (intercropped with groundnut) cropping system in an upland condition.

MATERIALS AND METHODS

The experiment was conducted at the Instructional farm, College of Agriculture, Vellayani, Kerala during the period from August 2013 to August 2014. A total rainfall of 1518.1 mm was recorded during the cropping period. The soil of the experimental site was sandy clay. The sequential cropping system consisted of rice succeeded by cassava (intercropped with groundnut). The investigation was carried out in split plot design with five replications. The main plot treatments included combinations of methods of planting and weeding [M_1- broadcasting of sprouted seeds, M_2- dibbling (sprouted seeds with drum seeder along with weeding by power weeder) and M_3- dibbling (sprouted seeds with drum seeder along with stubble mulching)] and the sub plot treatments included five methods of fertilizer application [F_1- broadcasting (60-30-30 kg NPK ha^{-1}), F_2- band placement (60-30-30 kg NPK ha^{-1} at 10 DAP, tillering and panicle initiation stage), F_3- foliar spray of 19-19-19 @ 0.5 % (at tillering, panicle initiation and flowering stage), F_4- foliar spray of diammonium phosphate and sulphate of potash each @ 2% (at tillering, panicle initiation and flowering stage), F_5- absolute control (without any fertilizer and organic manure)] for upland rice. FYM @ 5 t ha^{-1} was applied as basal uniformly to all the plots except absolute control at the time of land preparation. Urea, mussorie rock phosphate and muriate of potash were applied to the respective plots as per the treatments to supply N, P_2O_5 and K_2O. Weeding using power weeder was done at 20 and 40 DAS to the respective treatment plots. Stubble mulching was done using paddy straw @ 3 t ha^{-1}.

Nutrient recommendation of crops (Anonymous, 2011) was as under -

Crop	FYM	N- P_2O_5- K_2O kg ha^{-1}
Rice	As per the treatments	As per the treatments
Cassava + groundnut	12.5 t ha^{-1}	50-100-50 - basal 10-20-20 - 1 month after planting (groundnut) 50-0-50 - for the main crop after the harvest of groundnut

Along with the recommended nutrients, 0.5 % foliar spray of 19-19-19 was applied on cassava + groundnut at 30 days interval. The varieties used for the study were 'Aiswarya' (rice), 'Vellayani Hraswa' (cassava) and 'TMV-2' (groundnut). Rice seeds were sown as per the treatments, cassava planted with minisett (raised in portrays for 3 to 4 weeks before field planting) after the harvest of rice, while groundnut seeds were sown as intercrop in between two rows of cassava. Rice crop was raised from August to November, cassava intercropped with groundnut was raised from December to May in the same field.

Observations on yield and yield attributes of rice (number of productive tillers m^{-2}, number of grains $panicle^{-1}$, thousand grain weight, grain yield and straw yield), cassava (top yield, tuber yield and utilization index) and groundnut (haulm yield, pod yield and harvest index) were collected. The data were subjected to analysis of variance (ANOVA) as applied to Split Plot Design (Panse and Sukhatme, 1985). Wherever significant difference among treatments were observed, CD values at 5 % level of significance were provided for effective comparison of means.

RESULTS AND DISCUSSION

Effect of treatments on yield attributes and yield of rice:

The yield attributes and yield of rice were significantly influenced by the treatments (Table 1). Among the methods of planting and weed management, M_2 (dibbling of sprouted seeds with drum seeder along with power weeding) and M_3 (dibbling of sprouted seeds with drum seeder along with stubble mulching) treatments recorded significantly higher values for number of productive tillers m^{-2} and thousand grain weight which leads to the higher grain yield (2085.42 and 2068.18 kg ha^{-1} respectively) and straw yield compared to M_1 (broadcasting of sprouted seeds). The number of grains $panicle^{-1}$ (86.50) was found to be higher in dibbling of sprouted seeds + power weeding (M_2) which was significantly higher than other two treatments. The increase in yield was observed in dibbling of sprouted seeds with drum seeder along with power weeding and stubble mulching could be due to proper spacing, the plants showed better growth and establishment of more number of productive tillers. This resulted in more number of grains $panicle^{-1}$ and thousand grain weight which cumulatively produced higher grain and straw yield. Mechanical weeding as well as straw mulching also contributed in enhancing the yield characters by suppressing the weeds, conserved the nutrient reserves and the moisture in soil. Laary *et al.* (2012) reported that direct seed dibbling and direct seed drilling had better plant establishment and was significantly higher than pre-germinated seed broadcasting.

The yield attributes were found to have significant difference among the nutrient management except thousand grain weight, grain yield and straw yield. Band placement of

60-30-30 kg NPK ha^{-1} (F_2) and foliar spray of 19-19-19 @ 0.5 % (F_3) recorded significantly higher productive tillers m^{-2} (310.14 and 297.34 resp) which were on par with the foliar spray of DAP and SOP each @ 2 % (F_4) while, the number of grains panicle^{-1} was highest by the foliar spray of 19-19-19 @ 0.5 % (F_3). Superiority of foliar as well as band placement of basal fertilizers might be due to the better uptake of nutrient by the plants. Foliar spray helps in nutrient absorption at faster rate reported by Sarangi and Sharma (2004).

The interaction effect of treatments showed that m_3f_2 (dibbling of seeds + stubble mulching along with band placement of 60-30-30 kg NPK ha^{-1}) and m_2f_2 (dibbling of seeds + power weeding along with band placement of 60-30-30 kg NPK ha^{-1}) produced significantly higher number of productive tillers m^{-2}. Maximum number of grains panicle^{-1} and thousand grain weight was observed in dibbling of seeds + power weeding along with band placement of 60-30-30 kg NPK ha^{-1} (m_2f_2) which was significantly different from all other treatments except m_2f_4 (dibbling of seeds + power weeding along with foliar spray of DAP and SOP each @ 2 %) for number of grains panicle^{-1} and m_2f_1 (dibbling of seeds + power weeding along with broadcasting of 60-30-30 kg NPK ha^{-1}), m_3f_3 and m_3f_4 (dibbling of seeds + stubble mulching along with foliar spray of 19-19-19 @ 0.5 % as well as DAP and SOP each @ 2 %) for thousand grain weight. Grain yield showed significant difference among interaction effect. Dibbling of seeds + power weeding along with band placement of 60-30-30kg NPK ha^{-1} (m_2f_2) (2927.97 kg ha^{-1}) was significantly superior to all the other treatments. The highest straw yield was registered in m_1f_3 (broadcasting of seeds along with foliar spray of 19-19-19 @ 0.5 %) (4917.00 kg ha^{-1}) which was significantly different from all the other treatments, but it was on par with dibbling of seeds + power weeding along with broadcasting as well as band placement of 60-30-30 kg NPK ha^{-1} and dibbling of seeds + stubble mulching without any fertilizer.

Carry over effect of treatments of rice on yield attributes and yield of sequential crops (cassava intercropped groundnut)

Cassava

Carry over effect was observed in the yield of succeeding cassava crop (Table 2). Among the main plot treatments, the highest tuber yield and top yield was recorded under residual effect of stubble mulching (M_3) and the increase in yield was 1.81 and 6.05 per cent compared to residual effect of M_1 (broadcasting of sprouted seeds of rice) and M_2 (dibbling of seeds + power weeding) respectively. But the utilization index was found to be higher in the residual effect of treatments M_1 (broadcasting of sprouted seeds of rice) and M_2 (dibbling of seeds + power weeding). The stubble mulching and intercrop grown might helped in increasing the soil moisture content as well as reduced the weeds and might have fixed some amount of nitrogen by groundnut at the time of incorporation. These results are supported by the findings of Robinson (1997). The residual effect of soil application of 60-30-30 kg NPK ha^{-1} as broadcasting as well as band placement produced higher tuber yield and utilization index while maximum top yield was observed by the foliar spray of 19-19-19 @ 0.5 % (F_3) and foliar spray of DAP and SOP each @ 2 % (F_4). Moreover, the high residual soil nutrients of the previous rice along with the nutrients (soil and foliar) applied to cassava as well as nutrients supplied from the incorporated groundnut haulms have contributed to higher yield. The residual effect of combination of dibbling of seeds + stubble mulching along with broadcast application of 60-30-30 kg NPK ha^{-1} (m_3f_1) was significantly superior to all the other combinations by producing highest tuber yield and utilization index except m_1f_1 (broadcasting of seeds along with broadcast application of 60-30-30 kg NPK ha^{-1}) which was statistically similar. While the maximum top yield was observed in the combination dibbling of seeds + stubble mulching along with foliar spray of 19-19-19 @ 0.5 % (m_3f_3). The residual nutrients and moisture conserved by stubble mulching also added to the higher tuber yield.

Groundnut

Data presented in table 2 revealed the residual effect of stubble mulching using rice straw (M_3) resulted in the highest haulm yield, pod yield and HI of groundnut, which was significantly different from the carry over effect of the other two methods of weed control practices in rice. The residual effect of available soil nutrient content after the rice crop might have enhanced the yield attributes of succeeding groundnut. The improvement in the number of pods plant^{-1} and pod dry weight plant^{-1} might be due to the increased availability of nutrients through organic crop residues and favorable soil environment through balanced soil moisture which enhanced nitrogen fixation and rate of photosynthesis consequently led to better growth and development of groundnut crop was reported by Naveen and Babalad (2017). Comparing the fertilizer application methods, the residual effect of broadcast application of 60-30-30 kg NPK ha^{-1} (F_1) resulted in the highest HI and pod yield of 789.06 kg ha^{-1} which was on par with F_5 (control) in which higher haulm yield of the treatment contributed to the maximum yield. The residual effect of treatment combination, m_3f_1 (dibbling of seeds + stubble mulching along with broadcast application of 60-30-30 kg NPK ha^{-1}) was found to record the highest pod yield which was significantly different from the residual effect of other combinations except m_1f_5 (broadcasting of seeds without any fertilizers) (highest HI) and m_3f_3 (dibbling of seeds + stubble mulching along with foliar spray of 19-19-19 @ 0.5 %) (highest haulm yield) which were on par. The higher yield attributes obtained in the soil as well as foliar application of fertilizers might be due to the added residual effect of nutrients by soil application and better uptake of nutrients in foliar spray which caused the plant to pump more sugars and other exudates from its roots into the rhizosphere and increase the availability of nutrients as suggested by Kuepper (2003).

In this study, basal application of nutrients along with foliar spray of complex fertilizers would help to increase the residual nutrients of rice based sequential cropping system in upland condition. It is concluded that dibbling of rice seeds using drum seeder + power weeding along with soil application of 60-30-30 kg NPK ha^{-1} as band placement produced the maximum yield attributes and yield of rice in upland rice field. The residual effect of dibbling of rice seeds using drum seeder + stubble mulching @ 3 t ha^{-1} along with soil application of 60-30-30 kg NPK ha^{-1} as broadcasting to rice would help in the better production of cassava intercropped groundnut in upland situation

Table 1. Yield attributes and yield of rice influenced by the methods of planting, weed and nutrient management

Treatments	No of productive tillers m^{-2}	No. of grains $panicle^{-1}$	Thousand grain wt (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Methods of planting and weed management (M)					
M_1	268.05	70.95	24.33	1654.31	3541.68
M_2	287.85	86.50	26.50	2085.42	3977.22
M_3	293.64	78.26	26.49	2068.18	4098.75
SE m±	5.610	2.490	0.578	65.452	140.661
CD (0.05)	12.938	5.742	1.335	150.931	324.363
Methods of fertilizer application (F)					
F_1	292.14	75.28	26.09	1922.27	3788.17
F_2	310.14	83.05	25.65	2053.26	4012.62
F_3	297.34	84.93	25.60	1981.30	4047.33
F_4	298.19	76.76	26.01	1996.92	3569.78
F_5	218.08	75.28	25.51	1726.07	3944.84
SE m±	7.243	2.306	0.407	113.074	216.167
CD (0.05)	14.565	4.638	-	-	-
Interaction (m x f)					
m_1f_1	268.28	52.09	24.34	1679.16	3110.37
m_1f_2	282.15	64.29	23.78	1598.62	3542.22
m_1f_3	300.04	71.79	23.88	1727.97	4917.00
m_1f_4	285.90	79.33	24.34	1693.80	2535.65
m_1f_5	203.87	87.24	25.30	1572.00	3603.15
m_2f_1	288.20	82.91	27.56	2207.12	4238.15
m_2f_2	319.95	98.36	28.26	2927.97	4652.59
m_2f_3	298.65	81.87	24.82	1603.84	3340.82
m_2f_4	302.87	99.33	25.82	2221.96	4114.81
m_2f_5	242.98	70.04	26.04	1753.81	3539.72
m_3f_1	306.53	83.54	26.38	1880.54	4015.97
m_3f_2	341.73	86.49	24.92	1705.00	3843.06
m_3f_3	293.33	83.65	28.10	2533.00	3884.16
m_3f_4	305.80	69.07	27.86	2075.00	4058.88
m_3f_5	207.39	68.57	25.18	1852.41	4691.66
SE m±	12.545	3.995	0.704	195.850	374.412
CD (0.05)	25.228	8.033	1.416	393.854	752.943

Table 2. Yield attributes and yield of sequential crops (cassava and groundnut) influenced by the residual effect of methods of planting, weed and nutrient management in rice

Treatments	Cassava			Groundnut		
	Top yield (t ha^{-1})	Tuber yield (t ha^{-1})	Utilization index(UI)	Haulm yield (kg ha^{-1})	Pod yield (kg ha^{-1})	Harvest index(HI)
Methods of planting and weed management (M)						
M_1	14.09	30.31	2.23	1441.56	600.00	0.29
M_2	13.28	29.10	2.22	1219.82	552.19	0.31
M_3	15.28	30.86	2.11	1858.67	817.19	0.32
SE ± (d)	0.103	0.103	0.027	85.509	24.209	0.004
CD (0.05)	0.336	0.237	0.088	197.184	55.826	0.013
Methods of fertilizer application (F)						
F_1	13.59	31.90	2.38	1829.99	789.06	0.31
F_2	13.13	31.68	2.43	1293.05	626.04	0.32
F_3	15.50	27.82	1.97	1735.07	560.94	0.26
F_4	15.60	29.88	1.97	1233.49	597.40	0.32
F_5	13.26	29.18	2.19	1441.82	708.85	0.32
SE ± (d)	0.259	0.873	0.047	91.399	40.970	0.011
CD (0.05)	0.563	1.756	0.132	183.805	82.391	0.029
Interaction (m x f)						
m_1f_1	14.48	33.67	2.53	2277.50	815.63	0.27
m_1f_2	13.80	31.38	2.27	1153.75	451.56	0.28
m_1f_3	9.85	26.48	2.68	1085.94	434.38	0.29
m_1f_4	19.06	28.39	1.49	1967.19	332.81	0.26
m_1f_5	13.26	28.13	2.10	1723.44	965.63	0.36
m_2f_1	10.94	28.13	2.55	1108.73	521.88	0.32
m_2f_2	13.70	30.00	2.20	1397.91	764.06	0.35
m_2f_3	15.55	29.27	1.89	1085.94	360.94	0.26
m_2f_4	12.97	30.31	2.33	1419.13	779.69	0.35
m_2f_5	13.23	27.81	2.12	1087.40	334.38	0.24
m_3f_1	15.36	36.69	2.83	2103.75	1029.69	0.32
m_3f_2	11.90	30.39	1.98	1327.48	662.50	0.34
m_3f_3	21.09	27.71	1.33	3033.32	887.50	0.23
m_3f_4	14.76	30.94	2.10	1314.16	679.69	0.34
m_3f_5	13.29	31.61	2.33	1514.63	826.56	0.35
SE ± (d)	0.449	1.513	0.081	158.309	70.962	0.018
CD (0.05)	0.974	3.042	0.229	318.359	142.705	0.052

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