Journal of Root Crops, 2018, Vol. 44 No. 1, pp. 66-69
Indian Society for Root Crops
ISSN 0378-2409, ISSN 2454-9053 (online)

Influence of Sources of Organic Manure and N and P Levels on the Performance of Cassava var. Vellayani Hraswa in Lowlands

Cassava *(Manihot esculenta* Crantz) belonging to the family Euphorbiaceae, is the king of tropical tuber crops. Apart from being an important food crop, it provides raw material for starch and animal feed industries. Being climate resilient, cassava is branded as future crop for ensuring food and livelihood security of people. Short duration cassava can be grown in rice based cropping system for effective utilization of resources like land, moisture and nutrients as well as for ensuring profitability of the cropping system. Among short duration varieties, var. Vellayani Hraswa is becoming popular in Kerala. The variety Vellayani Hraswa is an early maturing (5 to 6 months duration) variety having good cooking quality acceptable to the Keralites (KAU, 2016). Since it cannot tolerate drought, it is more suited for cultivation in lowlands.

Although cassava is adapted to soils of low fertility, timely and proper nutrient management is necessary for realizing higher yields. Inadequate availability of farmyard manure has necessitated the need of alternate sources of organic manure. Poultry manure is being commonly used by farmers in lowlands. Besides, green manuring *in situ* can add substantial quantity of organic matter which can reduce the dose of FYM as well as N for the crop. Documented evidences revealed that P is required in smaller quantities for tuber crops in general, compared to N and K. Hence, there is scope for reducing the dose of P for cassava especially in soils with high P. So, it is necessary to explore the possibility of substitution of FYM with poultry manure and green manuring *in situ* and reduction in the doses of N and P for short duration cassava in lowlands. In the light of the above facts, an investigation was carried out at College of Agriculture, Vellayani, Thiruvananthapuram, Kerala to study the influence of sources of organic manure and N and P levels on the performance of cassava var. Vellayani Hraswa in lowlands.

The field experiment was conducted at Integrated Farming System Research Station, Karamana, Thiruvananthapuram from September 2017 to February 2018. The region enjoys a humid tropical climate experiencing temperature of 24-32^{o}C and relative humidity of 86%. A total of 90.2cm rainfall has been received in 59 days during the cropping period. There was sufficient rainfall up to four months of the crop. The soil of the experimental site was clay loam in texture and acidic with a pH of 5.2. It was high in organic carbon (2.5%) and available P (68.76 kg ha^{-1}) and medium in available N (249.91 kg ha^{-1}) and K (257.56 kg ha^{-1}) status.

The treatments consisted of three sources of organic manure (m_1-FYM @ 12.5 t ha^{-1}, m_2-FYM @ 6.25 t ha^{-1} + green manuring *in situ* and m_3 - poultry manure @ 2.5 t ha^{-1} + green manuring *in situ*), two levels of N (50 and 75 kg ha^{-1}) and two levels of P (25 and 50 kg P_2O_5 ha^{-1}) along with a uniform dose of 100 kg K_2O ha^{-1}. The experiment was laid out as 3 x 2 x 2 factorial experiment with three replications in randomized block design. Organic manures were applied at land preparation. Cassava var. Vellayani Hraswa was planted on ridges at a spacing of 90 cm x 90 cm after applying ½ N + full P + ½ K of fertilizer dose as per the treatments. Cowpea @ 30 kg ha^{-1} was sown along the two sides of the ridges in between cassava plants for green manuring *in situ* and was incorporated 50 days after planting (DAP). Interculture, weeding and earthing up were done at 30, 50 and 70 DAP in all the plots along with top dressing (½ N + ½ K) for cassava at 50 DAP. The crop was harvested at 6 months after planting.

Sources of organic manure had profound influence on yield attributes of cassava *viz* number of tubers per plant, percentage of productive roots and weight of tubers per plant (Table 1). Green manured plots registered higher values of number and weight of tubers and percentage of productive roots per plant. It was estimated that, on an

Table 1. Effect of sources of organic manure and levels of N and P on yield attributes and yield of cassava

Treatment	Number of tubers per plant	Percentage of productive roots	Tuber weight per plant (kg)	Tuber yield (t ha^{-1})	Shoot yield (t ha^{-1})	Harvest index
Sources of organic manure (M)						
m_1	4.26	50.85	2.55	27.18	7.29	0.70
m_2	4.73	53.12	2.91	31.29	8.37	0.71
m_3	5.19	59.67	3.34	33.85	9.64	0.69
SEm ±	0.17	1.89	0.07	0.33	0.10	0.005
CD (0.05)	0.514	3.655	0.200	0.958	0.298	NS
Levels of Nitrogen (N)						
n_1	4.38	45.93	2.83	29.33	8.20	0.70
n_2	5.06	63.15	3.04	32.21	8.65	0.71
SEm ±	0.20	1.54	0.06	0.27	0.08	0.004
CD (0.05)	0.418	2.986	0.167	0.782	0.233	NS
Levels of Phosphorus (P)						
p_1	4.77	53.76	2.99	31.05	8.48	0.69
p_2	4.69	55.34	2.88	30.49	8.39	0.71
SEm ±	0.20	1.543	0.06	0.27	0.08	0.004
CD (0.05)	NS	NS	NS	NS	NS	NS

average, 10.13 and 11.3 t ha^{-1} of green matter was produced by green manure cowpea in m_2 and m_3 treatments respectively. Higher availability of nutrients in green manured plots due to biological N fixation and decomposition of incorporated cowpea plants might have led to higher uptake of nutrients by cassava in those plots resulting in better vegetative growth and higher values of yield attributes. Among green manured plots, the plots given poultry manure @ 2.5 t ha^{-1} + green manuring *in situ* with cowpea registered higher values of number and weight of tubers per plant and percentage of productive roots. Superior response of cassava, in terms of yield components, to application of poultry manure than FYM has been reported by Pamila *et al.* (2006). The yield attributes markedly increased when the level of N was increased from 50 to 75 kg ha^{-1}. This is in agreement with the findings of Pamila et al. (2006). But levels of P had significant influence only on percentage of productive roots per plant and tuber weight per plant. Application of 50 kg P_2O_5 ha^{-1}produced higher percentage of productive roots per plant while 25 kg P_2O_5 ha^{-1} produced higher tuber weight per plant. Combined application of poultry manure @ 2.5 t ha^{-1} + green manuring *in situ*, 75 kg N ha^{-1} and 25 kg $P_2O_5ha^{-1}$ registered significantly higher tuber weight per plant (Table 2) reflecting the main effects. Mhaskar et al. (2013) also obtained higher tuber weight per plant due to combined application of organic manure, green manure and inorganic fertilizers in cassava.

Even the application of recommended dose of FYM (12.5 t ha^{-1}) for cassava could produce an yield of 27.18 t ha^{-1} (Table 1). However, higher tuber yields were obtained from green manured plots which might be due to significant improvement in yield attributes by green manuring *in situ*. The highest tuber yield of 33.85 t ha^{-1} was produced by the treatment poultry manure @ 2.5 t ha^{-1} + green manuring *in situ* followed by the treatment FYM @ 6.25 t ha^{-1} + green manuring *in situ*. Similar trend was observed in the case of top yield also. Pamila *et al.* (2006) also obtained the highest tuber yield of cassava in lowlands from poultry manure compared to FYM applied plots along with chemical fertilizers. Temegne and Ngome (2017) suggested combined application of poultry manure and chemical fertilizers to obtain a stable increase in cassava yields.The results of the present study suggested poultry manure and green manuring *in situ* as alternatives to FYM for cassava cultivation for enhanced tuber yield. Substitution of 50%

Table 2. Interaction effect of sources of organic manure and levels of N and P on cassava yield

Treatment combinations	Tuber weight per plant (kg)	Tuber yield (t ha^{-1})	Top yield (t ha^{-1})	Harvest index
$m_1n_1p_1$	2.14	25.23	6.75	0.70
$m_1n_1p_2$	2.07	24.62	6.53	0.71
$m_1n_2p_1$	2.34	27.88	7.38	0.70
$m_1n_2p_2$	2.30	30.97	8.51	0.72
$m_2n_1p_1$	2.52	31.11	8.45	0.70
$m_2n_1p_2$	2.41	28.84	8.08	0.71
$m_2n_2p_1$	2.74	33.14	8.57	0.70
$m_2n_2p_2$	2.59	32.06	8.42	0.70
$m_3n_1p_1$	2.85	32.70	9.65	0.69
$m_3n_1p_2$	2.79	33.48	9.80	0.72
$m_3n_2p_1$	3.23	36.22	10.04	0.70
$m_3n_2p_2$	2.98	32.96	9.03	0.69
SEm ±	0.03	0.65	0.20	0.01
CD (0.05)	0.079	1.916	0.587	NS

FYM with green manuring *in situ* registered 15% increase and full substitution of FYM with poultry manure + green manuring *in situ* recorded 24.5% increase in tuber yield over FYM alone. The feasibility of raising cowpea in between cassava and incorporation in the field under lowland situation has been earlier reported by Mohankumar and Nair (1990). Significant increase in tuber yield as well as in top yield was observed when N level was increased from 50 to 75 kg ha^{-1} as evident from Table 1. This is in conformity of the findings of Pamila *et al.* (2006). No marked variation in tuber and top yields was observed due to levels of P which might be due to high initial status of available P in the soil. Lower level of P (25 kg P_2O_5 ha^{-1}) recorded higher tuber and top yields emphasizing low requirement of P for cassava. However, omission of P from fertilizer mixtures for cassava may result in yield reduction as observed by Essien (2009) and Kim *et al*. (2013). Hence, for sustaining the productivity of cassava, application of lower level of P is necessitated. Combined application of poultry manure @ 2.5 t ha^{-1} + green manuring *in situ* + 75 kg N ha^{-1} + 25 kg P_2O_5 ha^{-1} ($m_3n_2p_1$) recorded the highest tuber yield of 36.22 t ha^{-1} and top yield of 10.04 t ha^{-1}. The same treatment combination had produced the highest tuber weight per plant also. However, with respect to top yield, the treatment combinations $m_3n_1p_2$, $m_3n_1p_1$ and $m_3n_2p_1$ could produce higher top yield without significant variation between them. However, the treatments failed to produce any conspicuous variation in harvest index, since the treatments which recorded higher tuber yield also registered higher top yield.

The treatment effects on economics of cultivation in terms of net income (Fig. 1) and benefit cost ratio (Fig. 2) followed the same trend as in the case of tuber yield. Green manured plots resulted in higher productivity and profitability from cassava cultivation.Combined application of poultry manure @ 2.5 t ha^{-1} + green manuring *in situ* along with 75 kg N ha^{-1} and 25 kg P_2O_5 ha^{-1} ($m_3n_2p_1$) resulted in the highest net income of ₹ 373240 ha^{-1} and BCR of 3.19 because of maximum tuber yield obtained under this treatment. John et al. (2005) reported that the profitability of cassava cultivation could

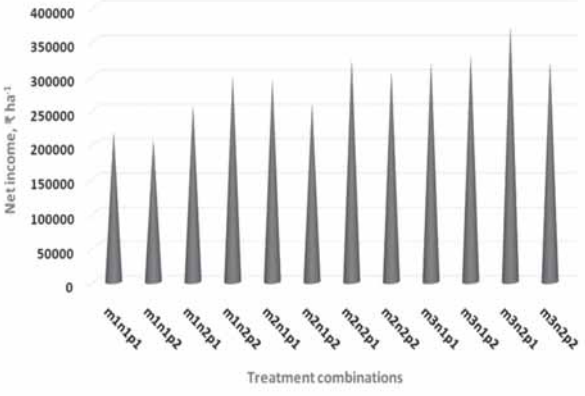

Fig. 1. Effect of treatment combinations on net income

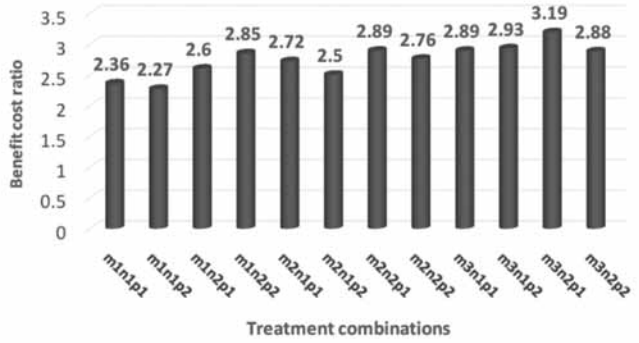

Fig. 2. Effect of treatment combinations on benefit cost ratio

be increased due to integrated application of manure and chemical fertilizers. Pamila *et al*. (2006) noticed the feasibility of poultry manure@ 5 t ha^{-1} as an alternative to FYM @ 12.5 t ha^{-1} along with 75:50:100 kg NPK ha^{-1} for obtaining higher returns from short duration varieties of cassava cultivated in lowlands.

The results of the study clearly indicated the feasibility of 50% substitution of FYM with green manuring *in situ* (cowpea) or full substitution of FYM with poultry manure + green manuring *in situ* and sufficiency of a lower dose of P for cassava. The results of the study also revealed that higher yield, net income and benefit cost ratio could be realized from cassava var. Vellayani Hraswa in lowlands by the application of poultry manure @ 2.5 t ha^{-1} + green manuring *in situ* with cowpea combined with 75 : 25 : 100 kg NPK ha^{-1}.

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College of Agriculture, Vellayani
Thiruvananthapuram 695 522, Kerala, India
Corresponding author: Pooja. A. P;
E-mail: appoojaap@gmail.com

A. P. Pooja
O. K. Swadija
Jacob John
Biju Joseph