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Effect of Organic Management on Growth and Yield of Chinese Potato (*Plectranthus rotundifolius*)

Chinese potato (*Plectranthus rotundifolius*) belonging to the family Labiatae, is a minor tuber crop, the tubers of which are used as vegetable. It is commonly known as "country potato" or "Hausa potato" in English, 'koorka' or 'cheevakizhangu' in Malayalam. The quality of tubers seems to be comparable with that of potato and hence it is known as poor man's potato. It is a short-duration crop of about five months and hence can be fitted in multiple cropping systems. Even though Chinese potato has high potential for organic production, especially for export oriented market, the full exploitation is still to be recognized as there is no definite recommendation for the same. This paper focuses on the effect of organic manures on the growth and productivity of Chinese potato.

The soil of the experimental site was sandy clay loam in texture with a pH of 5.8. It was high in organic C (1.46%), low in available N (188.16 kg ha^{-1}), high in available P (48.16 kg ha^{-1}) and medium in available K (125.89 kg ha^{-1}). The treatments consisted of factorial combinations of three levels of organic manure (to supply 100%, 75% and 50% of NPK @ 60:60:100 kg ha^{-1} as recommended by KAU, 2007)` two levels of biofertilizer (with PGPR mix 1 and without PGPR mix 1) and two varieties (Sree Dhara and Suphala). The trial was laid out in 3 x 2 x 2 asymmetrical factorial randomised block design with three replications. Sree Dhara is a high yielding (25 t ha^{-1}) variety of Chinese potato with a duration of five months and released from Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala, India. Suphala is a high yielding (15.93 t ha^{-1}), photo-insensitive variety released from Kerala Agricultural University, Vellanikkara, Thrissur, Kerala, India and which is adapted for year round cultivation with a duration of 120-140 days (KAU, 2007). Half the dose of organic manure was given through farmyard manure (FYM) and the remaining half dose through coir pith compost (CPC). The doses were fixed on N equivalent basis and additional requirement of K was supplied through wood ash (Table 1). The recommended dose (RD) of FYM @ 10 t ha^{-1} and neem cake @ 1 t ha^{-1} were applied uniformly to all the plots at the time of land preparation. Neem cake was applied as a prophylactic measure against nematode attack. The required quantities of FYM and CPC as per the treatments were applied as basal dose. The biofertilizer, PGPR mix 1, was applied at 2% along with the basal dose of organic manures.

Growth characters were recorded at monthly intervals from planting up to harvest and the average was calculated. The leaf area was computed by adopting the non destructive method (Ravi et al. 2011) and leaf area index (LAI) was calculated. The yield and yield components and dry matter production were recorded at harvest.

Growth characters like plant height, number of branches and leaves per plant were not significantly influenced by levels of organic manure or biofertilizer application (Table 2). But levels of organic manure exerted significant influence on LAI during later period of crop growth. During the later period of crop growth, LAI increased with increase in the level of organic manure. Application of PGPR mix 1

Table 1. Quantity of organic manures applied to supply recommended dose of NPK

Levels of organic manure (treatments)	Organic manures applied
100 % RD	FYM @ 6 t ha^{-1} + coir pith compost @ 3 t ha^{-1} + wood ash @ 3 t ha^{-1}
75 % RD	FYM @ 4.5 t ha^{-1} + coir pith compost @ 2.25 t ha^{-1} + wood ash @ 2.25 t ha^{-1}
50 % RD	FYM @ 3 t ha^{-1} + coir pith compost @ 1.5 t ha^{-1} + wood ash @ 1.5 t ha^{-1}

Table 2. Effect of levels of organic manure, biofertilizer and varieties on growth characters of Chinese potato

Treatments	Plant height (cm)		Number of branches per plant		Number of leaves per plant		Leaf area index	
	2 MAP	4 MAP	2 MAP	4 MAP	2 MAP	4 MAP	2 MAP	4 MAP
Levels of organic manure								
100% RD	25.69	35.99	12.00	8.00	92.00	30.00	3.40	0.86
75 % RD	23.91	33.47	12.00	7.00	92.00	34.00	3.37	0.60
50% RD	22.83	32.43	12.00	7.00	92.00	33.00	2.93	0.29
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	0.100
Biofertilizer								
With PGPR mix 1	24.61	35.05	13.00	7.00	93.00	34.00	3.32	0.64
Without PGPR mix 1	23.68	32.88	11.00	7.00	92.00	31.00	3.14	0.52
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	0.082
Varieties								
Sree Dhara	25.53	39.03	13.00	8.00	101.00	44.00	3.24	0.81
Suphala	22.76	28.90	11.00	7.00	84.00	21.00	3.23	0.35
CD (0.05)	NS	4.119	NS	0.972	10.763	3.426	NS	0.082

MAP: Months after planting

produced higher LAI towards the end of the crop growth period. It is seen that application of 100% RD of NPK through organic manures and biofertilizer was beneficial for producing greater LAI during later period of the crop. The var. Sree Dhara produced significantly taller plants with more number of branches and leaves per plant and greater LAI than the var. Suphala.

Yield components viz., number of tubers and marketable tubers per plant were influenced by levels of organic manure but the effects of 100% and 75% levels were on par. But an increasing trend in the weight of tubers and marketable tubers per plant was observed with increase in the level of organic manure. Application of PGPR mix 1 exerted profound influence on the yield components. The var. Sree Dhara out performed the var. Suphala in yield components but the var. Suphala produced significantly greater number of marketable tubers per plant. It is due to the fact that the var. Suphala produced more number of bigger sized tubers than the var. Sree Dhara.

Tuber yield was significantly influenced by levels of organic manure, biofertilizer and varieties as evident from Table 3. Tuber yield increased with increasing levels of organic manure. The highest tuber yield (23.49 t ha^{-1}) was obtained from 100% level closely followed by 75% level (22.42 t ha^{-1}). The increasing trend shown by weight of tubers as well as weight of marketable tubers per plant with incremental levels of organic manure was reflected in the tuber yield. Increasing the level of organic manure from 75% to 100% could produce an yield increase of only 1.07 t ha^{-1} which may be due to the non significant increase in tuber number per plant when the level of organic manure was increased from 75% to 100% level. The result revealed the necessity for the application of full RD of NPK through organic manure (half the dose as FYM + half the dose as CPC) for getting higher yields in Chinese potato. This is in conformity with the findings of Dhanya (2011) who reported that the full RD of nutrients through organic manure was required for expressing the yield potential of sweet potato. The higher yields realised under organic management of Chinese potato emphasised the fact that the crop is suited for organic production.

Biofertilizer treatment with PGPR mix 1 significantly increased the average tuber yield from 20.78 t ha^{-1} (produced without biofertilizer) to 23.07 t ha^{-1} (Table 3). Significant improvement in yield components especially in the number and weight of tubers per plant due to application of PGPR mix 1 might have resulted in significant effect on tuber yield. The increase in tuber yield of elephant foot yam and tannia due to biofertilizer

application along with FYM than due to conjoint use of FYM and chemical fertilizers has been reported earlier (Suja et al. 2008; 2009; 2012).

The varieties differed significantly in their yield potential as shown in Table 2. The var. Sree Dhara produced an average yield of 22.86 t ha^{-1}, while the var. Suphala resulted in an average yield of 20.99 t ha^{-1} as shown in Table 3. This might be due to the significant varietal difference in yield components in the var. Sree Dhara out performing the var. Suphala. The potential yield reported for the var. Sree Dhara is 25 t ha^{-1} and the var. Suphala is 15.93 t ha^{-1} (KAU, 2011). Hence, this yield variation is as expected. But the var. Suphala is found to be early maturing and is recommended for year round cultivation, whereas the var. Sree Dhara with a duration of five months is recommended for normal planting season of July to September.

Utilization index significantly increased with incremental levels of organic manure and due to application of PGPR mix 1 as evident from Table 3. Increasing trend in the tuber yield exhibited by increasing levels of organic manure and due to biofertilizer application might have contributed to higher utilization index by the respective treatments. No significant varietal difference in utilization index was noticed.

It can be seen from Table 3 that the dry matter production increased with incremental levels of organic manure. Application of 100% level resulted in the highest quantity of dry matter (7.03 t ha^{-1}), followed by 75% level (6.36 t ha^{-1}). This might be due to the significant increase in tuber yield with increasing levels of organic manure and their significant effects on leaf number and LAI during the later period of crop growth. As in the case of tuber yield, application of 100% RD of NPK through organic manure (half as FYM and half as CPC) was necessary for higher dry matter production in Chinese potato.

Table 3. Effect of levels of organic manure, biofertilizer and varieties on tuber yield, utilization index and total dry matter production of Chinese potato

Treatments	Tuber yield (t ha^{-1})	Utilization index	Total dry matter production (t ha^{-1})
Levels of organic manure			
100% RD	23.49	2.44	7.03
75% RD	22.42	2.31	6.36
50% RD	19.88	2.06	5.68
CD (0.05)	0.979	0.201	0.231
Biofertilizer			
With PGPR mix 1	23.07	2.35	6.73
Without PGPR mix 1	20.78	2.18	5.99
CD (0.05)	0.799	0.164	0.189
Varieties			
Sree Dhara	22.86	2.25	6.69
Suphala	20.99	2.28	6.02
CD (0.05)	0.799	NS	0.189

Dry matter production was also promoted due to biofertilizer treatment. PGPR mix 1 treated plots produced 6.73 t ha^{-1} of dry matter as against 5.99 t ha^{-1} produced by the plots not treated with biofertilizer (Table 3). Improvement in tuber yield due to the application of PGPR mix 1and retention of higher LAI even during later period of the crop might have resulted in higher dry matter production due to biofertilizer application.

As in the case of growth characters, yield and yield components, the var. Sree Dhara was found superior in dry matter production than the var. Suphala. The early maturing character of the var. Suphala might have resulted in lower dry matter production.

The present study revealed that Chinese potato has great potential for organic production. Application of the recommended basal dose of FYM @ 10 t ha^{-1} and 100% RD of NPK (60:60:100 kg ha^{-1}) through organic manures (FYM @ 6 t ha^{-1} + CPC @ 3 t ha^{-1} + wood ash @ 3 t ha^{-1}) along with PGPR mix 1 was necessary for getting higher yields under organic production of Chinese potato. During the normal planting season, var. Sree Dhara produced higher yields and profit than the var. Suphala. But the var. Suphala which is recommended for year round cultivation was found to be early maturing than the var. Sree Dhara.

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