Indian Journal of Agronomy **61** (1): 127–130 (March 2016)

Research Communication

Impact of organic management on yield, quality and economics of Chinese potato (*Plectranthus rotundifolius*)

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Received : September 2015; Revised accepted : January 2016

ABSTRACT

A field experiment was conducted during August–December, 2011 at College of Agriculture, Vellayani, Thiruvananthapuram, Kerala to standardize technologies for organic production of Chinese potato (*Plectranthus rotundifolius* Spreng.). The treatments consisted of factorial combinations of 3 levels of organic manure (to supply 100%, 75% and 50% recommended dose of 60, 60 and 100 kg N, P and K/ha), 2 levels of biofertilizer (with PGPR mix 1 and without biofertilizer) and 2 varieties ('Sree Dhara' and 'Suphala'). The trial was laid out in 3 × 2 × 2 asymmetrical factorial randomized block design with 3 replications. Neem-cake @ 1 t/ha and farmyard manure @ 10 t/ha were applied uniformly to all the plots. Application of PGPR mix 1 exerted profound influence on yield, yield components and net income. Variety 'Sree Dhara' dominated over the var. 'Suphala' in yield, yield components and profit. Tuber yield showed an increasing trend with incremental doses of organic manure, resulting in the highest yield with 100% level. Application of PGPR mix 1 improved the yield. Higher net income and benefit: cost ratio could be obtained by the application of 100% or 75% level of organic manure. Thus, an application of 100% recommended dose of N, P and K (60, 60 and 100 kg/ha) through organic manures (6 t farmyard manure + 3 t coirpith compost + 3 t wood ash/ha) along with PGPR mix 1 and the recommended basal dose of farmyard manure @ 10 t/ha is necessary for getting higher yields of organic Chinese potato.

Key words : Biofertilizer, Coirpith compost, Chinese potato, Farmyard manure, Neem cake, Organic management, Wood ash

Chinese potato (*Plectranthus rotundifolius* Spreng.), belonging to the family Labiatae, is a minor tuber crop grown in the homesteads for its edible tubers. It is commonly known as 'koorka' or Chinese potato. The plant is a small herbaceous bushy annual with succulent stems and aromatic leaves. It grows to a height of 30–60 cm. Leaves are opposite, petiolate and rounded to ovate in shape with serrated margin. It bears a cluster of dark-brownish heteromorphous tubers. The tubers are used as vegetable having an aromatic flavour and delicious taste on cooking. It is a short-duration crop of about 5 months and hence is fitted in multiple cropping programmes. Unlike most other vegetables, tubers of Chinese potato possess good-keeping quality. The tubers are rich in minerals like calcium and iron and certain vitamins including thiamine, riboflavin, niacin and ascorbic acid. The tubers possess anti-oxidant, anti-cancer and anti-ageing properties. The saponins (2–20%) and alkaloids (15–25%) present in the plant are the primary source of its significant medicinal properties (Palaniswami and Peter, 2008). Being a component of export market of vegetables to Middle East countries, lot of potential exists for its commercial cultivation.

Increasing consciousness about environment conservation and health hazards associated with the indiscriminate use of agrochemicals and consumer preference for safe and chemical free food led to growing interest in organic farming. Tuber crops, as they are adapted to marginal environments and low input management with high flexibility in mixed farming systems, have wide potential for organic cultivation. Results of field experiments indicated the superiority of organic farming compared to integrated nutrient management [FYM + chemical fertilizers to supply recommended dose (RD) of NPK] in providing higher yields of tannia (Suja *et al.,* 2009). On farm trials revealed the superiority of organic farming over farmer's practice and conventional practice (POP- FYM @ 25 t/ha + N: P: K @ 100:50:150 kg/ha) in elephant foot yam as reported

Based on a part of M.Sc. thesis of the first author submitted to College of Agriculture, Kerala Agricultural University, Kerala (unpublished)

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by Suja *et al*. (2010). Dhanya (2011) observed that organic production system was economically feasible in sweet potato. Swadija *et al.* (2011) found that organic management had significant influence on rhizome yield of arrow root intercropped in the homesteads.Like other tuber crops, coleus also responds well to application of organic manures. Moreover, there is a premium price for organically produced tubers both nationally and internationally. Hence present research was taken up to study the impact of organic management on yield, quality and economics of cultivation of Chinese potato.

An investigation was carried out at the Instructional Farm attached to the College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, to standardize an organic nutrient package for Chinese potato and work out the economics of cultivation during August–December, 2011. The soil was sandy clay loam belonging to the order Oxisols of Vellayani series. The soil was acidic, with a *p*H of 5.8. It was high in organic carbon (1.46%) and available P (48.16 kg/ha), low in available N (188.16 kg/ha) and medium in available K (125.89 kg/ha) contents.

Two varieties of Chinese potato namely, 'Sree Dhara' and 'Suphala' were used. 'Sree Dhara' is a high-yielding (25 t/ha) variety released from ICAR-CTCRI (Central Tuber Crops Research Institute), Thiruvananthapuram, Kerala. It has duration of 5 months and is recommended for the normal planting season of Chinese potato which is between July and October. 'Suphala' is a high yielding (15.93 t/ha), photo-insensitive variety released from the Kerala Agricultural University, Thrissur, Kerala. It is adapted for year-round cultivation with a duration of 120–140 days (KAU, 2007)**.**

The treatments consisted of factorial combinations of 3 levels of organic manure (to supply 100%, 75% and 50% recommended dose of 60, 60 and 100 kg N:P:K/ha) with and without the biofertilizer, PGPR mix 1 and 2 varieties ('Sree Dhara' and 'Suphala'). The trial was laid out in 3 × 2 × 2 asymmetrical factorial randomised block design with 3 replications. Half the dose of organic manure was applied as farmyard manure and half the dose as coirpith compost. The doses of organic manure were fixed on nitrogen-equivalent basis. Farmyard manure @ 6 t/ha, coirpith compost @ 3 t/ha and wood ash @ 3 t/ha were required to supply100% recommended dose of N:P:K (60, 60 and 100 kg/ha). The quantities of organic manures were reduced correspondingly to supply 75% (4.5 t FYM + 3 t coirpith compost + 3 t wood ash) and 50% (3 t FYM + 1.5 t coirpith compost + 1.5 t wood ash) recommended doses of NPK.

The experiment was laid out as per the design and neem-cake @ 1 t/ha was applied uniformly to all the plots as a prophylactic measure against nematode attack. Raised beds of 15 cm height were taken in each plot and farmyard manure @ 10 t/ha were applied uniformly to all the plots. The required quantities of farmyard manure and coirpith compost as per the treatments were applied to the plots and well incorporated into the soil. The biofertilizer, PGPR mix 1, received from the Department of Microbiology, College of Agriculture, Vellayani, Kerala, is a combination of N-fixing and P-and K-solubilizing bacteria. It was applied @ 2% along with basal dose of organic manures.

Chinese potato cuttings were planted during the first week of August 2011, at a spacing of 30 cm × 15 cm. Shade was provided immediately after planting and uniform irrigation was given. Gap-filling was done a week after planting to have uniform stand of the crop. The first intercultural operation, weeding and earthing up were done 3 weeks after the planting. Second weeding, application of wood ash and earthing up were done 6 weeks after planting. A portion of the vine was covered with soil to promote tuber formation. Five plants were selected randomly from the net plot and tagged as observational plants for recording biometric observations. The crop was harvested by the third week of December 2011. Harvesting was done by digging out tubers carefully and tubers were separated from shoot portion. Total number of tubers from the plants was counted and their average was worked out. Marketable tubers were separated based on visual observation and average number recorded. Weight of tubers and weight of marketable tubers/plant from the plants were recorded and the average was worked out. Yield of tubers obtained from each net plot was recorded and expressed in t/ha.

Tuber samples were collected for analysing the quality characters like starch and protein contents. Starch content of tuber was estimated by using potassium ferricyanide method (Ward and Pigman, 1970). The values were expressed as percentage on dry weight basis. Protein content of tuber on dry-weight basis was calculated by multiplying % of N in tuber with the factor 6.25 (Simpson *et al*., 1965). The economics of cultivation of the crop in terms of net income and benefit cost ratio was worked out. The experimental data was analysed statistically by applying the technique of analysis of variance (ANOVA) for 3 × 2 × 2 factorial randomized block design experiment and the significance was tested by F test (Cochran and Cox, 1965). Wherever 'F' test was significant in ANOVA, the critical difference (CD) is provided.

Number of tubers/plant varied significantly with levels of organic manure, biofertilizer and varieties. The tuber number showed an increasing trend as the dose of organic manure was increased. Application of the biofertilizer PGPR mix 1 produced significantly higher number of tu-

bers/plant. Among the varieties tried, the var. 'Sree Dhara' produced significantly higher number of tubers/plant than the var. 'Suphala'. As in the case of total tuber number/plant, the levels of organic manure, biofertilizer and varieties had significant influence on number of marketable tubers/plant also. Biofertilizer-treated plants showed significantly higher number of marketable tubers/plant. The var. 'Sree Dhara' produced significantly higher number of marketable tubers/plant.

Tuber weight/plant was also significantly influenced by levels of organic manure, biofertilizer and varieties (Table 1). The tuber weight/plant significantly increased with the increase in the level of organic manure from 50% to 100% with the highest value recorded at full recommended dose. Significant increase in tuber weight/plant was observed with the application of PGPR mix 1. The variety 'Sree Dhara' was found superior to the var. 'Suphala' in producing higher tuber weight/plant. The weight of marketable tubers/plant was also significantly influenced by all the treatments. The weight of marketable tubers/plant significantly increased with the increase in the level of organic manure as in the case of tuber number/plant. Application of biofertilizer significantly increased the weight of marketable tubers/plant from 77.43 g (without biofertilizer) to 92.72 g. The var. 'Sree Dhara' dominated to the var. 'Suphala' in respect of weight of marketable tubers/plant.

Levels of organic manure, biofertilizer and varieties significantly influenced the tuber yield (Table 1). The highest tuber yield was recorded by 100% level, closely followed by 75% level. The effect of incremental levels of organic manure on yield components was reflected in the tuber yield. The full recommended dose of NPK is to be applied through organic manures for getting higher yields of chinese potato. Dhanya (2011) also observed that the full recommended dose of nutrients through organic manure was required for expressing the yield potential of sweet potato. Application of the biofertilizer, PGPR mix 1 significantly increased the average tuber yield from 20.78 t/ha to 23.07 t/ha which might be owing to the significant effect of the biofertilizer on yield components. This is in conformity with the reports of Suja *et al*. (2008) and Suja *et al*. (2009), who obtained increase in tuber yield of elephant foot yam and tannia owing to biofertilizer application along with farmyard manure than owing to conjoint use of farmyard manure and chemical fertilizers.The potential yield reported for the var. 'Sree Dhara' is 25 t/ha and for the var. Suphala is 15.93 t/ha (KAU, 2007). In the present study, the var. 'Sree Dhara' produced 22.86 t/ha of tubers and the var. 'Suphala' produced 20.99 t/ha. The var. 'Sree Dhara' is recommended for normal planting season of chinese potato (July to September) with a duration of 5 months. But the var. Suphala is found to be early maturing and is recommended for year-round cultivation.

The results on quality characters of tuber in terms of starch and protein contents are shown in (Table 1). No significant difference in quality of tubers was observed with incremental levels of organic manure. The starch and pro-

Table 1. Effect of levels of organic manure, biofertilizer and varieties on yield, quality and economics of Chinese potato

Treatment	Tubers/ plant	Marketable tubers/plant	Tuber weight/ plant (g)	Marketable tuber weight/ plant (g)	Tuber yield (t/ha)	Starch (%)	Protein (%)	Net returns (₹/ha)	Benefit: cost ratio
Level of organic manure to supply									
100% recommended dose of NPK	30	13	114.6	97.7	23.5	71.9	7.6	231.7	2.92
75% recommended dose of NPK	28	12	104.3	86.9	22.4	71.8	7.4	221.5	2.93
50% recommended dose of NPK	23	10	85.6	70.7	19.9	71.0	6.6	189.2	2.73
SEm±	0.9	0.4	2.1	1.5	0.33	0.95	0.5	5.0	0.04
CD (P=0.05)	2.8	1.3	6.2	4.3	0.98	NS	NS	14.7	0.13
Biofertilizer									
With PGPR mix 1	29	12	107.6	92.7	23.1	71.8	7.3	225.0	2.86
Without PGPR mix 1	25	11	95.4	77.4	21.0	71.4	7.1	203.3	2.87
SEm±	0.8	0.4	1.7	1.2	0.27	0.8	0.4	4.1	0.04
CD (P=0.05)	2.3	1.0	5.0	3.5	0.80	NS	NS	11.9	NS
Varieties									
'Sree Dhara'	34	13	106.0	88.2	22.9	72.5	7.6	228.1	2.99
'Suphala'	20	10	97.0	82.0	21.0	70.7	6.8	200.2	2.74
SEm±	0.8	0.4	1.7	1.2	0.27	0.8	0.4	4.1	0.04
CD (P=0.05)	2.3	1.0	5.0	3.5	0.80	NS	NS	11.9	0.11

tein contents increased with the increase in the level of organic manure and owing to biofertilizer application, though the effect was non-significant. The var. 'Sree Dhara' recorded higher starch and protein content on dry-weight basis than the var. 'Suphala'.

Chinese potato is generally infected with the root-knot nematode (*Meloidogyne incognita*). In the present study, neem-cake @ 1 t/ha was applied uniformly to all the plots at the time of land preparation as a prophylactic measure against the incidence of root-knot nematode as reported by Nisha (2005). There was no incidence of nematode attack in the crop. The analysis of soil sample from the field at 3 months after planting did not reveal the presence of the nematode. But there was the attack of leaf roller at 45 days after planting and of tinged at 90 days after planting in few plants in some plots which were controlled as and when observed by giving a uniform spray of neem-based pesticide.

The economics of cultivation was worked out in terms of net income and benefit cost ratio (Table 1). Higher net income and benefit: cost ratio could be obtained by the application of 100% or 75% level of organic manure indicating that application of even 75% level of organic manure is sufficient for providing economic yields of organic Chinese potato. Higher net income was observed with the application of PGPR mix 1. But no improvement or no decline in benefit: cost ratio was noticed due to biofertilizer treatment. The var. 'Sree Dhara' recorded higher net income and benefit: cost ratio than the var. 'Suphala' which might be owing to higher tuber yield given by the var. 'Sree Dhara' at the same level of organic manure.

Nutrient management for organic production of Chinese potato includes the application of farmyard manure @ 16 t + 3 t coirpith compost + 3 t wood ash/ha. The full dose of farmyard manure and coirpith compost can be applied along with PGPR mix 1at the time of land preparation. Neem-cake @ 1 t/ha is to be applied and well incorporated into soil as a prophylactic measure against nematode attack. Wood ash is to be applied 6 weeks after planting along with second weeding and earthing up.

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