Effect of organic nutrient management on growth attributes and cormel yield of taro [*Colocasia esculenta* (L) Schot]

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ABSTRACT

Investigations were done at the College of Agriculture, Vellayani, Thiruvananthapuram, Kerala to study the effect of organic nutrition on growth and yield of taro over two seasons during June 2019 to January 2020 and June 2020 to January 2021. The experiment was laid out in randomized block design with three replications. The treatments comprised six levels of organic sources, two levels of in situ green manuring with three control treatments. During both the years, the highest leaf area index was recorded with application of poultry manure along with wood ash, PGPR mix I and vermiwash. Cormel yield was also the highest under the same treatment during both the years. In situ green manuring with dhaincha was found superior to cowpea in producing higher leaf area index and cormel yield during both the years. The treatment poultry manure + wood ash + PGPR-I + vermiwash and in situ green manuring with dhaincha was found equally effective as chemical nutrient management and superior to existing ad hoc organic management of Kerala Agricultural University package and absolute control in case of both growth parameters and cormel yield. Based on the results of the study, it was concluded that the organic nutrition involving application of poultry manure and wood ash along with PGPR mix I, vermiwash and in situ green manuring with dhaincha can be adopted for organic cultivation of taro.

Keywords: Taro; organic nutrition; vermiwash; leaf area index; cormel yield

INTRODUCTION

Taro (*Colocasia esculenta*) is an underexploited crop grown throughout the tropics especially in the warmer regions for its edible cormels, leaves and petioles. It is a staple food in many countries of Pacific, Caribbean and Asia and a supplement to potatoes in the southern United States. In India, taro is mostly cultivated in northern and eastern states. Taro is adapted to a wide variety of soils and climatic conditions and is an integral component of different farming systems adopted in the state of Kerala. The crop is mainly used as vegetable in the state and has good keeping quality as compared to other vegetables. It is also exported in raw tuber form mainly to gulf countries. Growing concerns regarding food safety, environmental degradation and human health have generated interest in alternative agricultural systems like organic farming. The demand for organic food is steadily increasing both in developed and developing countries. There is scope for increasing the export of organically produced cocoyams (taro and tannia) fetching higher price in the market. Taro is highly responsive to organic manures and has fewer pest and disease problems as compared to other vegetables. One of the researchable issues in organic production of tuber crops is the scientific use of available organic sources of plant nutrients and adoption of organic nutrition to enhance crop productivity while maintaining the soil health. However the current knowledge of effect of organic nutrition on performance of the taro crop is limited.

MATERIAL and METHODS

The experiment was conducted in a farmer's field at Peringamala, Thiruvanathapuram, Kerala near the College of Agriculture, Vellayani, Kerala during June 2019 to January 2020 and June 2020 to January 2021. The taro variety Muktakeshi used in this study

was sourced from Central Tuber Crops Research Institute, Sreekaryam, Kerala. The experiment was laid out in two factorial arrangement in a randomized block design and replicated thrice. The treatments comprised six levels of organic sources (s_1- FYM + wood ash, s_2- FYM + wood ash + PGPR-I, s_3- FYM + wood ash + PGPR-I + vermiwash, s_4- poultry manure + wood ash, s_5- poultry manure + wood ash + PGPR-I and s_6- poultry manure + wood ash + PGPR-I + vermiwash) and two levels of in situ green manuring (g_1- in situ green manuring with cowpea and g_2- in situ green manuring with dhaincha) with three controls (C_1- nutrient management through chemical fertilizers as per KAU PoP (NPK 80:25:100 kg/ha, C_2- nutrient management as per KAU organic PoP (ad hoc) and c_3- absolute control). The site was double-ploughed and divided into three blocks which represented the replicates. Each block was divided into fifteen experimental plots of 4.8 m x 4.5 m size thus forming forty five plots. A uniform dose of farmyard manure @ 12 tonnes/ha was applied at the time of land preparation. One cormel weighing about 25-35 g was planted at a spacing of 60 cm x 45 cm. The recommended dose of NPK for colocasia @ 80:25:100 kg/ha was supplied through organic sources on N equivalent basis as per the treatments as basal dose except wood ash (applied while incorporating green manure). Corm treatment with 5 per cent suspension of PGPR mix I followed by soil application of PGPR enriched cow dung @ 10 g/pit (mixture of dry cow dung and PGPR mix I in 50:1 proportion) was done at planting and 2 months after planting (MAP) in treatments s_2, s_3, s_5 and s_6. Vermiwash (10% dilute) was sprayed after 2, 3 and 4 months after planting in respective treatments. Green manure crops were raised (seed rate 30 kg/ha) as per the treatments in the interspaces and incorporated in basins at 50 per cent flowering stage by uprooting. All plots were kept weed free by manual weeding. All other crop management practices were followed as per Kerala Agricultural University package of practices. Four cocoyam plants were randomly selected from each net plot, tagged and used for the determination of leaf area at bimonthly interval. The length and breadth of each leaf was measured. The length was taken from the apex of the leaf to the sinus region while the breadth was measured across the point of petiole attachment. The leaf area (cm^2) was estimated according to the formula put forth by Biradar et al (1978):

$$\text{Leaf area} = 0.917 \times L \times B$$

where L= Length and B= Breadth of the leaf

The total leaf area was worked out by adding the leaf area of all the fully opened leaves at the time of observation and leaf area index was calculated as follows:

$$\text{Leaf area index} = \frac{\text{Leaf area of the plant}}{\text{Land area occupied by the plant}}$$

Yield of cormels obtained from net plot area was noted and from this corm yield per hectare was calculated and expressed in tonnes/ha.

KAU organic PoP (ad hoc) for taro consisted of cattle manure or compost @ 12 tonnes/ha as basal dressing; green manuring (cow pea/sunhemp) @ 30 kg/ha; 10 kg P_2O_5 as rock phosphate to be applied for the green manure crop at sowing time; at flowering (40-45 DAS) the plants incorporated with 4 tonnes FYM/2 tonnes PM/2 tonnes vermicompost/2 tonnes coir pith compost and 1,500 kg wood ash.

RESULTS and DISCUSSION

Leaf area index (LAI)

LAI increased from 2 to 4 MAP after which it showed a declining trend up to harvest during both the years irrespective of treatments (Table 1a). During I year, organic sources significantly influenced the LAI at all stages of crop growth. At 2 MAP, the highest LAI (0.72) was recorded in treatment s_3 (FYM + wood ash + PGPR mix I + vermiwash) which was on par with s_6 (0.67), s_2 (0.63) and s_5 (0.62). At 4 MAP, 6 MAP and harvest, the highest LAI was recorded in s_6 (1.04, 0.56 and 0.32 respectively) in which poultry manure along with wood ash, PGPR mix I and vermiwash were applied. During II year, LAI was significantly influenced by organic sources at 2 MAP, 4 MAP and 6 MAP and the highest values were recorded in s_6 (0.62, 1.14, and 0.52 respectively). At 2 MAP, s_5, s_3 and s_1 were on par with s_6 and at 6 MAP, s_3, s_5 and s_2 were on par with s_6. With respect to in situ green manuring, significantly higher LAI was produced by dhaincha (g_2) at all stages (0.97, 0.52 and 0.31 at 4 MAP, 6 MAP and at harvest respectively) except 2 MAP during I year. During II year in situ green manuring had significant effect only at 4 and 6 MAP and higher value was recorded by dhaincha (0.99 at 4 MAP and 0.48 at 6 MAP). The interaction s x g had significant effect on LAI only at

4 and 6 MAP and the treatment combination s_6g_2 recorded significantly highest value (1.05 at 4 MAP and 0.57 at 6 MAP) during I year. During II year, s x g interaction significantly influenced the LAI only at 4 MAP and the highest value was recorded in s_6g_2 (1.17) followed by s_6g_1 (1.10). The s_6g_1 was however on par with s_5g_1, s_5g_2 and s_3g_2.

The superiority of the organic source s_6 (application of poultry manure along with wood ash, PGPR mix I and vermiwash) in leaf area index may be due to the combined effect of poultry manure, PGPR mix I and vermiwash. The mineralization pattern of poultry manure has indicated that nearly 60 per cent of nitrogen in this manure is present as uric acid which quickly changes to ammoniacal form that can be easily utilized by the crop (Smith 1950). The PGPR mix I is a microbial consortium for supplementing all the major nutrients which contains component cultures viz *Azospirillum lipoferum, Azotobacter chroococcum, Bacillus megaterium* and *B sporothermoduransas* as reported by Gopi et al (2020). Vacheron et al (2013) pointed out that PGPR can produce phytohormones and promote enzymatic activities which in turn may improve the root growth, uptake of minerals and water and growth of the whole plant. Suja et al (2017) and Soubeih Kh and Mahmoud (2019) also reported the enhanced plant height in taro by the application of biofertilizers. Vermiwash is very good liquid manure which favourably affects the growth and productivity of crop when applied as foliar spray (Subasashri 2003). Ansari et al (2015) also reported the excelled shoot growth and number of leaves of colocasia plants with vermiwash hydroponic solution. The initial immobilization of nutrients on applying large quantity of FYM compared to continuous availability of nutrients from poultry manure may be the reason for higher growth parameters recorded with poultry manure containing treatments. Poultry manure is a bulky organic manure having higher content of mineralizable nitrogen due to its narrow C-N ratio. Singh et al (1973) also attributed the higher efficiency of poultry manure to its narrow C-N ratio and comparatively higher content of mineralizable nitrogen.

The superiority of dhaincha over cowpea in producing higher leaf area index may be due to the higher biomass production and higher content of nitrogen and phosphorus of dhaincha compared to cowpea (Table 2). This might have resulted in higher available soil nutrients and uptake of nutrients by crops in turn resulted in higher growth parameters. Irin et al (2019) also reported the higher biomass production of daincha over cowpea. Singh and Shivay (2014) stated that the increase of biomass accumulation of *Sesbania* might be due to its fast and determinate growth habit leading to enhanced biomass incorporation/addition and nutrient availability in soil. Khind et al (1987) opined that *Sesbania aculeata* could produce 21.1 tonnes/ha of green biomass and accumulate about 133 kg N/ha. Sanjoy et al (2015) reported that among the summer green manuring crops, dhaincha recorded significantly higher total fresh and dry matter compared to cowpea.

Regarding treatments vs control effect on LAI (Table 1b), the organic treatments resulted in significant variation when compared with nutrient management through chemical fertilizers as per KAU PoP (C_1) at all stages of crop growth during I year. All organic treatments were on par with C_1 except s_1g_2, s_4g_1 and s_4g_2 at 2 MAP; s_1g_1, s_1g_2, s_2g_1, s_2g_2, s_4g_1, s_4g_2 and s_5g_1 at 4 MAP; s_1g_1, s_1g_2, s_2g_1, s_2g_2, s_4g_1, s_4g_2 and s_5g_1 at 6 MAP and s_1g_1, s_1g_2, s_2g_2 and s_4g_1 at harvest, which recorded significantly lower values of LAI than C_1. During II year, the significant difference between treatments and C_1 were observed only at 4 MAP and the treatments s_6g_2, s_6g_1, s_5g_2, s_5g_1 and s_3g_2, which produced the LAI values 1.17, 1.10, 1.06, 1.06 and 1.06 respectively were on par with C_1 (1.14) while all other treatment combinations produced significantly lower LAI. The on par effect of treatments especially s_3g_2, s_5g_1, s_5g_2, s_6g_1 and s_6g_2 with the C_1 indicates the efficiency of organic treatments as that of chemical nutrient management in the growth of taro. While comparing C_2 [nutrient management as per KAU organic PoP (ad hc)] with treatments with respect to LAI, significant difference was observed only at 4 and 6 MAP during I year and the treatments s_6g_1 and s_6g_2 at 4 MAP and s_2g_2, s_3g_1, s_3g_2, s_5g_2, s_6g_1 and s_6g_2 at 6 MAP were found significantly superior to C_2. During II year, significant difference was observed only at 4 MAP and s_5g_1, s_5g_2, s_6g_1, s_6g_2, s_2g_2, s_3g_1 and s_3g_2 recorded higher LAI than C_2 while the treatments s_1g_1 and s_4g_1 recorded significantly lower values of LAI than C_2. The superiority of organic treatments in leaf area index compared to KAU organic PoP indicates the higher growth promoting effect of treatments especially s_5g_1, s_5g_2, s_6g_1, s_6g_2, s_3g_2 and s_3g_1 compared to the existing organic management practice. This may be due to the effect of additional organic sources like PGPR mix I and vermiwash. In case of s_5g_1, s_5g_2, s_6g_1 and s_6g_2, quick nutrient release of poultry manure compared to FYM (used in KAU ad hoc organic PoP) also might have enhanced the plant growth. The

absolute control (C_3) significantly differed from all organic treatments at all stages of observation during both the years with respect to LAI. During I year, the treatments s_3g_2 and s_6g_2 at 2 MAP, all treatments except s_1g_1 at 4 Map, all treatments except s_1g_1, s_1g_2 and s_4g_1 at 6 MAP and the treatments s_2g_2, s_3g_1, s_3g_2, s_5g_2, s_6g_1 and s_6g_2 at harvest recorded significantly higher values of LAI compared to absolute control. During II year, s_5g_2 and s_6g_2 at 2 MAP, all treatments at 4 MAP, s_2g_2, s_3g_1, s_3g_2, s_5g_1, s_5g_2, s_6g_1 and s_6g_2 at 6 MAP and s_6g_2, s_5g_2 and s_6g_1 at harvest were found significantly superior to C3. The effect of organic sources and in situ green manuring was reflected in the superiority of organic treatments in growth parameters compared to absolute control.

Cormel yield

Cormel yield (Table 3a) was the highest for the organic source in which application of poultry manure along with wood ash, PGPR mix I and vermiwash was done (s_6) during both the years (20.89 tonnes/ha during first year and 16.47 tonnes/ha during second year). During first year s_6 was on par with s_5 (20.28 tonnes/ha) wherein poultry manure along with wood ash and PGPR mix I was applied which in turn was on par with s_3 (19.45 tonnes/ha). During second year, s_6 (poultry manure along with wood ash, PGPR mix I and vermiwash) was found on par with s_5 (15.72 tonnes/ha) and s_3 (14.55 tonnes/ha). The lowest value was recorded with the organic source s_1 (12.63 tonnes/ha) which was on par with s_4 (12.74 tonnes/ha). Pooled data also indicated the same trend. The organic source s_6 recorded the highest cormel yield (18.68 tonnes/ha) and was on par with s_5 (18.00 tonnes/ha), which in turn was on par with s_3 (17.00 tonnes/ha) and s_2 (16.64 tonnes/ha). Application of FYM and wood ash alone (s_1) resulted in the lowest cormel yield of 14.91 tonnes/ha. Cormel yield during both the years and also the pooled mean was significantly increased by in situ green manuring with dhaincha over cow pea. Cormel yield recorded by in situ green manuring with dhaincha was 19.57, 14.99 and 17.28 tonnes/ha during first year, second year and for pooled mean respectively. Significant effect of treatment combinations on cormel yield (Table 3b) was observed during both the years and in the pooled analysis. The treatment combination s_6g_2 (application of poultry manure along with wood ash, PGPR mix I and vermiwash + in situ green manuring with dhaincha) recorded the highest cormel yield of 21.27, 16.77 and 19.02 tonnes/ha during first year, second year and in the pooled analysis respectively. The s_1g_1 (application of FYM and wood ash + in situ green manuring with cow pea) recorded the lowest cormel yield per hectare during first year, second year and in the pooled analysis also. Improvement in growth characters of taro by s_6g_2 culminated in the improvement in yield. The quick release of nitrogen from the poultry manure coupled with direct availability of nutrients through vermiwash application and increased nutrient availability consequent to the PGPR application would have resulted in higher tuber yield by s_6g_2. As explained earlier, the higher biomass production of dhaincha compared to cowpea resulted in the higher soil nutrient availability and it might have resulted in higher yield. The green manure applied to soil undergoes a series of chemical changes wherein the carbon compounds are converted to carbon dioxide and water; the nitrogenous compounds like protein are finally converted to nitrate and mineral constituents like phosphorus, potassium, calcium, magnesium etc present in the organic form or to some extent in the inorganic form are converted to more soluble forms and they become readily available to the succeeding cop (Palaniappan and Annadurai 1999).

Regarding the treatments vs C_1 (nutrient management through chemical fertilizers) effect, there was significant difference between organic treatments and C_1 during both the years and for pooled mean with respect to cormel yield (Table 3b). The organic treatments s_2g_2, s_3g_2, s_5g_1, s_5g_2, s_6g_1 and s_6g_2 during first year and s_1g_2, s_2g_2, s_3g_2, s_4g_1, s_5g_1, s_5g_2, s_6g_1 and s_6g_2 during second year were found on par with C_1 (21.08 tonnes/ha during first year and 18.03 tonnes/ha during second year). As in the case of first year, the organic treatments s_2g_2, s_3g_2, s_5g_1, s_5g_2, s_6g_1 and s_6g_2 were found on par with C_1 (19.55 tonnes/ha) for pooled mean also. As in the case of growth characters, some of the treatments were found as effective as nutrient management through chemical fertilizers in case of cormel yield. This is in agreement with the findings of Suja et al (2017) who reported the similar performance of organic system to that of conventional with slight yield reduction (-5%) at on station trial and 29 per cent higher yield at farm level over chemical-based farming.

The significant difference was observed between treatments and control C_2 (nutrient management as per KAU organic ad hoc PoP) during both the years and for pooled mean. The treatments

Table 1a. Effect of organic sources and in situ green manuring on leaf area index

Treatment	Leaf area index							
	I year				II year			
	2 MAP	4 MAP	6 MAP	Harvest	2 MAP	4 MAP	6 MAP	Harvest
Organic source (s)								
s_1: FYM + wood ash	0.50	0.87	0.48	0.26	0.46	0.71	0.36	0.23
s_2: FYM + wood ash + PGPR mix I	0.63	0.94	0.50	0.30	0.39	0.98	0.46	0.29
s_3: FYM + wood ash + PGPR mix I + vermiwash	0.72	0.99	0.53	0.31	0.50	1.02	0.51	0.33
s_4: PM + wood ash	0.41	0.92	0.47	0.27	0.31	0.79	0.43	0.29
s_5: PM+ wood ash + PGPR mix I	0.62	0.96	0.52	0.30	0.60	1.06	0.47	0.32
s_6: PM + wood ash + PGPR mix I + vermiwash	0.67	1.04	0.56	0.32	0.62	1.14	0.52	0.36
SEm(±)	0.041	0.004	0.002	0.011	0.059	0.016	0.023	0.028
$CD_{0.05}$	0.121	0.011	0.007	0.032	0.172	0.046	0.068	NS
In situ green manuring (g)								
g_1: Cowpea	0.57	0.93	0.50	0.28	0.46	0.91	0.44	0.29
g_2: Dhaincha	0.62	0.97	0.52	0.31	0.50	0.99	0.48	0.32
SEm(±)	0.024	0.002	0.001	0.006	0.034	0.009	0.013	0.016
$CD_{0.05}$	NS	0.006	0.004	0.018	NS	0.027	0.039	NS

Table 1b. Effect of s x g interaction and treatment vs control on leaf area index

Treatment	Leaf area index							
	I year				II year			
	2 MAP	4 MAP	6 MAP	Harvest	2 MAP	4 MAP	6 MAP	Harvest
s x g interaction								
s_1g_1	0.55	0.86^{a}	0.46^{a}	0.25^{a}	0.43	0.69^{abc}	0.34	0.21
s_1g_2	0.45^{a}	0.89^{ac}	0.49^{a}	0.27^{a}	0.50	0.74^{ac}	0.38	0.26
s_2g_1	0.66	0.91^{ac}	0.50^{ac}	0.29	0.38	0.94^{ac}	0.43	0.28
s_2g_2	0.60	0.97^{ac}	0.51^{abc}	0.31^{c}	0.40	1.02^{abc}	0.49^{c}	0.30
s_3g_1	0.60	0.98^{c}	0.53^{bc}	0.30^{c}	0.52	0.98^{abc}	0.49^{c}	0.33
s_3g_2	0.85^{c}	0.99^{c}	0.52^{bc}	0.32^{c}	0.49	1.06^{bc}	0.52^{c}	0.33
s_4g_1	0.41^{a}	0.90^{ac}	0.47^{a}	0.26^{a}	0.34	0.70^{abc}	0.42	0.29
s_4g_2	0.42^{a}	0.95^{ac}	0.47^{ac}	0.28	0.29	0.87^{ac}	0.44	0.29
s_5g_1	0.59	0.94^{ac}	0.50^{ac}	0.30	0.50	1.06^{bc}	0.45^{c}	0.28
s_5g_2	0.65	0.98^{c}	0.53^{bc}	0.30^{c}	0.70^{c}	1.06^{bc}	0.49^{c}	0.35^{c}
s_6g_1	0.61	1.02^{bc}	0.55^{bc}	0.31^{c}	0.60	1.10^{bc}	0.49^{c}	0.34^{c}
s_6g_2	0.74^{c}	1.05^{bc}	0.57^{bc}	0.34^{c}	0.64^{c}	1.17^{bc}	0.55^{c}	0.38^{c}
SEm(±)	0.058	0.005	0.004	0.015	0.083	0.022	0.033	0.04
$CD_{0.05}$	NS	0.016	0.01	NS	NS	0.065	NS	NS
C_1: KAU PoP	0.76	1.02	0.56	0.35	0.62	1.14	0.52	0.38
Treatment vs C_1	S	S	S	S	NS	S	NS	NS
C_2: KAU organic PoP	0.61	0.89	0.47	0.30	0.50	0.84	0.44	0.31
Treatment vs C_2	NS	S	S	NS	NS	S	NS	NS
C_3: Absolute control	0.43	0.79	0.45	0.24	0.27	0.55	0.31	0.17
Treatment vs C_3	S	S	S	S	S	S	S	S

[a]Significantly different from C_1, [b]Significantly different from C_2, [c]Significantly different from C_3

Table 2. Nutrient content and quantity of green manure crops (on dry weight basis)

Crop	Nutrient content (%)			Quantity (tonnes/ha)
	N	P	K	
Cowpea	1.18	0.12	0.83	1.57
Dhaincha	1.34	0.26	0.53	4.55

Table 3a. Effect of organic sources and in situ green manuring on cormel yield (tonnes/ha)

Treatment	Cormel yield		
	I year	II year	Pooled mean
Organic source (s)			
s_1: FYM + wood ash	17.20	12.63	14.91
s_2: FYM + wood ash + PGPR mix I	19.14	14.14	16.64
s_3: FYM + wood ash + PGPR mix I + vermiwash	19.45	14.55	17.00
s_4: PM + wood ash	17.91	12.74	15.33
s_5: PM + wood ash + PGPR mix I	20.28	15.72	18.00
s_6: PM + wood ash + PGPR mix I + vermiwash	20.89	16.47	18.68
SEm(±)	0.363	0.713	0.533
$CD_{0.05}$	1.066	2.093	1.565
In situ green manuring (G)			
g_1: Cowpea	18.72	13.76	16.24
g_2: Dhaincha	19.57	14.99	17.28
SEm(±)	0.21	0.412	0.308
$CD_{0.05}$	0.615	1.208	0.903

Table 3b. Effect of s x g interaction and treatments vs control effect on cormel yield (tonnes/ha)

Treatment	Cormel yield		
	I year	II year	Pooled mean
s x g interaction			
s_1g_1	16.43^{ac}	11.34^{a}	13.88^{a}
s_1g_2	17.96^{ac}	13.91^{c}	15.94^{ac}
s_2g_1	18.03^{ac}	11.63^{a}	14.83^{ac}
s_2g_2	20.26^{bc}	16.64^{bc}	18.45^{bc}
s_3g_1	18.59^{abc}	12.90^{a}	15.74^{ac}
s_3g_2	20.31^{bc}	16.20^{bc}	18.26^{bc}
s_4g_1	18.34^{ac}	13.77^{c}	16.05^{ac}
s_4g_2	17.49^{ac}	11.72^{a}	14.60^{ac}
s_5g_1	20.40^{bc}	16.74^{bc}	18.57^{bc}
s_5g_2	20.15^{bc}	14.71^{c}	17.43^{bc}
s_6g_1	20.51^{bc}	16.17^{bc}	18.35^{bc}
s_6g_2	21.27^{bc}	16.77^{bc}	19.02^{bc}
SEm(±)	0.514	1.009	0.754
$CD_{0.05}$	1.508	2.959	2.213
C_1: KAU PoP	21.08	18.03	19.55
Treatments vs C_1	S	S	S
C_2: KAU organic PoP	16.25	11.35	13.80
Treatments vs C_2	S	S	S
C_3: Absolute control	13.15	9.60	11.37
Treatments vs C_3	S	S	S

[a]Significantly different from C_1, [b]Significantly different from C_2, [c]Significantly different from C_3

s_2g_2, s_3g_1, s_3g_2, s_5g_1, s_5g_2, s_6g_1 and s_6g_2 during first year; s_2g_2, s_3g_2, s_5g_1, s_6g_1 and s_6g_2 during second year and s_2g_2, s_3g_2, s_5g_1, s_5g_2, s_6g_1 and s_6g_2 for pooled mean recorded significantly higher cormel yield than C_2 (16.25 tonnes/ha during first year, 11.35 tonnes/ha during second year and 13.80 tonnes/ha for pooled mean) and all other treatments were at par with C_2. The enhancement of growth parameters by the treatments s_2g_2, s_3g_2, s_5g_1, s_5g_2, s_6g_1 and s_6g_2 over ad hoc organic KAU PoP reflected in the cormel yield also.

All the organic treatments during first year, all organic treatments except s_1g_1, s_2g_1, s_3g_1 and s_4g_2 during second year and all treatments except s_1g_1 for pooled mean recorded significantly higher cormel yield than C_3 (absolute control). As observed in the case of growth attributes, the higher yield of organic treatments over absolute control could be undoubtedly the effect of applied organic sources and in situ green manuring which enhanced soil nutrient status and direct feeding of nutrients through vermiwash spraying.

CONCLUSION

The results of the study revealed that the best organic source for taro cultivation is the application of poultry manure along with wood ash, PGPR mix I and vermiwash. In situ green manuring with dhaincha resulted in higher leaf area index and higher cormel yield. The study also indicated that the application of poultry manure, wood ash, PGPR mix I and vermiwash along with in situ green manuring with dhaincha was equally effective as chemical fertilizer application and superior to existing ad hoc organic KAU PoP and absolute control.

REFERENCES

Ansari A A, Pereira M and Jaikishun S 2015. Effect of vermiwash obtained from different sources (neem, rice straw and bagasse) and standardised hydroponics solution on the growth of *Colocasia esculenta* (Australian Poi) in Guyana. American Journal Experimental Agriculture **7(5):** 275-283.

Biradar RS, Venkateswaralu T and Hrishi N 1978. Leaf area estimation in *Colocasia*. Journal of Root Crops **4(2):** 51-53.

Gopi GK, Meenakumari KS, Anith KN, Nysanth NS and Subha P 2020. Application of liquid formulation of a mixture of plant growth promoting rhizobacteria helps reduce the use of chemical fertilizers in amaranthus (*Amaranthus tricolor* L). Rhizosphere **15:** 212-217.

Irin IJ, Biswas PK, Ullah MJ, Roy TS and Khan MA 2019. Influence of green manuring crops on dry matter production and soil health improvement. Bangladesh Agronomy Journal **22(1):** 39-45.

Khind CS, Maskina MS and Meelu OP 1987. Effect of green manuring on rice. Journal of Indian Society of Soil Science **35:** 135-145.

Palaniappan SP and Annadurai K 1999. Organic farming: theory and practice. Scientific Publishers, Jodhpur, Rajasthan, India, 257p.

Sanjoy K, Chand S and Gautam BPS 2015. Enhance the soil health, nutrient uptake and yield of crops under rice-wheat cropping systems through green manuring. International Journal of Tropical Agriculture **33(3):** 2025-2028.

Singh A and Shivay YS 2014. Enhancement of growth parameters and productivity of basmati rice through summer green manuring and zinc fertilization. International Journal of Bio-resource and Stress Management **5(4):** 486-494.

Singh K, Minhas MS and Srivastava OP 1973. Studies on poultry manure in relation to vegetable production. II. Potato. Indian Journal of Horticulture **30:** 537-541.

Smith R 1950. Poultry manure- a fertilizer. Poultry Digest **9:** 550-551.

Soubeih KAA and Mahmoud HF 2019. Response of taro (*Colocasia esculenta* L) to natural and biofertilizers under Siwa Oasis conditions. Middle East Journal of Applied Sciences **9(2):** 297-309.

Subasashri M 2003. Vermiwash collection and its pesticidal properties. The Hindu **17:** 1-2.

Suja G, Byju G, Jyothi AN, Veena SS and Sreekumar J 2017. Yield, quality and soil health under organic vs conventional farming in taro. Scientia Horticulturae **218:** 334-343.

Vacheron J, Desbrosses G, Bouffaud M-L, Touraine B, Moenne-Loccoz Y, Muller D, Legendre L, Wisniewski-Dye F and Prigent-Combaret C 2013. Plant growth promoting rhizobacteria and root system functioning. Frontiers in Plant Science **4:** 356-375.