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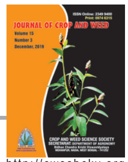

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Quality augmentation through tillage and nutrition in Tannia (X*anthosomas agittifolium* (L.). Schott)

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ABSTRACT

A two-year field study was conducted at the Instructional farm attached to College of Agriculture, Vellayani, Kerala during 2014 to 2016 to study quality augmentation through tillage and nutrition in tannia. The design was split plot and it was replicated four times. The treatments were l_1(conventional tillage followed by pit system), l_2(conventional tillage followed by mound system), l_3(deep tillage followed by pit system) and l_4(deep tillage followed by mound system). The sub plot treatments were combinations of soil conditioners s_1(control), s_2(coir pith), s_3(rice husk) and two nutrition systems n_1(integrated nutrient management-INM) and n_2(organic nutrition). Results of the experiment revealed that the quality characters of tannia like, total dry matter production, harvest index, cormel dry matter, starch, protein and shelf life can be augmented by adopting deep tillage with pit system of planting, applying coir pith @ 500g plant^{-1} as soil conditioner and by providing organic nutrition (FYM @ 37.5 t ha^{-1} + wood ash @ 2 t ha^{-1}).

Keywords : Protein, quality augmentation, shelf life, starch and tannia.

Aroids are important root crops playing a significant role in the livelihood of millions of relatively poor people in developing countries. They are grouped with underutilized crops which have not received much research attention.Tannia (*Xanthosomas agittifolium* (L.). Schott) also known as'new cocoyam', belongs to the family Araceae and is considered as one of the six most important root and tuber crops grown world-wide (Onwueme and Charles, 1994). Tannia, in terms of protein digestibility and mineral composition, has superior nutritional value over major root and tuber crops (Boakye *et al*., 2018).Tannia is cultivated for its edible tubers (mother corm and cormels) and tender leaves and in many of the tropical areas they play a major role in the lives of smallholder farmers. Cormels of tannia are consumed after boiling, baked or partly boiled and fried in oil. Young tender leaves have protein content of 22.2 g 100 g^{-1}and is similar to spinach. When tannia is grown in different soils there is considerable variation in yield and quality. Hence there is scope for yield and quality enhancement in tannia by adopting proper tillage practices. There are reports of increased tuber yield of sweet potato, elephant foot yam and colocasia due to use of soil conditioners like coir pith. Tannia responds well to organic manures and chemical fertilizers. But there are no specific studies on the effect of tillage system, soil conditioner and nutrient management for improving quality of tubers in tannia. Hence the present study is undertaken to identify ideal tillage system, soil conditioner and nutrient management for quality augmentation in tannia.

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MATERIALS AND METHODS

A two-year experiment was conducted at College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during August 2014 to May 2015 and from May 2015 to February 2016 (Plate 1). Usually Vellayani has a warm, humid tropical climate. The soil of the experimental site had a pH of 5.7 and was sandy clay loam. The soil was high in organic carbon, available P and low in available N. Available K content was in medium range. The experiment was done in split plot design with four main plot treatments (l_1-conventional tillage followed by pit system, l_2-conventional tillage followed by mound system, l_3 - deep tillage followed by pit system and l_4 - deep tillage followed by mound system). The sub plot treatments were combination of three soil conditioners (s_1- control, s_2- coir pith, s_3- rice husk) and two nutrient management systems (n_1- integrated nutrient management(INM) and n_2- organic nutrition). The soil conditioners were applied @ 500g plant^{-1}. The integrated management system involved application of farmyard manure (FYM) @ 25 t ha^{-1} + 80:50:150 kg NPK ha^{-1}. Half of the quantity of FYM and full dose of P were applied as basal dose.The remaining half of FYM along with N and K were given in three split doses each at 2, 4 and 6 months after planting (MAP). Organic nutrition comprised of FYM @37.5 t ha^{-1} + wood ash @ 2 t ha^{-1}. Here, two-third quantity of FYM was applied as basal dose and remaining FYM and wood ash were given in three split doses at 2, 4 and 6 months after planting. Dolomite @

1t ha^{-1} was applied uniformly to all plots at land preparation.

The land was thoroughly ploughed.Corm pieces weighing about 80g with atleast one sprout was used for planting. The crops were planted during two years (August 2014 and May 2015) at a spacing of 0.75 m x 0.75m and was mulched with green leaves immediately after planting.Interculture operations and earthing up were done along with top dressing at 2, 4 and 6 months after planting (MAP). The first crop was ready for harvest by May 2015 and the second crop by February 2016. After harvest, the dry matter production was recorded. The sample plants uprooted were separated into blade and petiole (leaf or pseudostem), corm and cormels. Fresh weight of each part was recorded and sub samples were taken for estimating the dry weight. The sub samples were dried in a hot air oven at 65 ± 5 ^{O}C to constant dry weight. The dry weight of each part was worked out and was used for computing total dry matter production (TDMP) in t ha^{-1}. Harvest index which is the ratio of cormel yield to total biomass on dry weight basis (Suja *et al*., 2009) was also worked out. Starch content of cormel was estimated by using potassium ferri cyanide method (Ward and Pigman, 1970). The values were expressed as percentage on dry weight basis. Protein content (%) of cormel on dry weight basis was calculated by multiplying N content (%) in cormel with the factor 6.25 (Simpson *et al*., 1965). 100 g cormel samples, taken from each treatment were spread on floor over newspaper under ambient conditions and observed for sprouting, decay and shelf life. The weight of samples was recorded once in three days to calculate physiological loss in weight (PLW) using the formula as given below.

$$\text{PLW}(\%) = \frac{(\text{Initial weight} - \text{Final weight})}{\text{Initial weight}} \times 100$$

Plate 1: General layout of the experimental field

RESULTS AND DISCUSSION

Total dry matter production (TDMP)

A scrutiny of the data from Table 1a revealed significant effects of treatments on TDMP during both the years of study. Among tillage systems, deep tillage and pit system (l_3) registered significantly higher dry matter production (4.36 and 5.94 t ha^{-1} during I and II year, respectively) followed by deep tillage and mound system (l_4) during both the years. Significantly higher TDMP was recorded by deep tillage and also by pit system which were revealed from contrast analysis.The plants had produced bigger sized leaves in deep tillage followed by pit system of planting and this might be the reason for improved production of assimilates which resulted in the highest dry matter production. Deep tillage and pit system of planting favourably influenced the partitioning of dry matter to the economic parts especially cormels. Higher TDMP was recorded with the application of soil conditioner over control (s_1) during both the years. Among the soil conditioners, coir pith (s_2) was found to be superior (3.95 t ha^{-1} and 5.08 t ha^{-1} during I and II year respectively) to rice husk (s_3) as soil conditioner. During both the years, organic nutrition (n_2) proved its dominance in its effect on TDMP (3.90 t ha^{-1} and 5.13 t ha^{-1} during I and II year, respectively).The impact of these treatments on growth and yield of tannia might have resulted in higher dry matter production and efficient dry matter partitioning.

Higher leaf area recorded by the treatments (coir pith as soil conditioner and organic nutrition) intercepted more light and produced more photosynthates resulting in higher dry matter production by the treatments. Similar results were obtained by Suja *et al*. (2009) who reported that organic nutrition was found to favour effective partitioning of assimilates to cormels resulting in higher tuber yield of tannia. Among the interactions of L x S, L x N and S x N (Table 1b), only L x N and S x N had significant effects on TDMP that too only during I year (2014-15). The treatment combinations l_3n_2 and s_2n_2 were found superior. In L x S x N interaction, significance was found only during I year when the effects of the treatment combinations $l_3s_2n_2$ and $l_3s_3n_2$ were on a par but superior to others (Table 1c). Although the interaction effects were not significant during II year, the treatment combination $l_3s_3n_2$ recorded the highest TDMP followed by $l_3s_2n_2$.

Harvest index

The data in Table 1a revealed the significant effects of treatments on harvest index during both the years. During I year, tillage systems except conventional tillage followed by mound system (l_2) were found on a par in their effects on harvest index. During II year, deep tillage followed by pit system (l_3) registered the highest harvest index (0.38) and l_2 registered the lowest index (0.29). During both the years, application of soil conditioner significantly increased the harvest index and the effects of coir pith (s_2) and rice husk (s_3) were found on a par. Organic nutrition (n_2) registered the higher harvest index during both the years compared to INM (n_1). Among the interactions (Table 1b), only L x S had significant effect on harvest index that too only during II year. The treatment combination l_3s_2 was found superior in its effect on harvest index. The treatment combination $l_3s_2n_2$ registered the highest harvest index during both the years (0.35 during I year and 0.41 during II year) even though the effect of L x S x N interaction (Table 1c) was not significant.

Table 1a: Effect of tillage systems, soil conditioners and nutrient management on total dry matter production (TDMP) and harvest index

Treatments	TDMP (t ha^{-1})		Harvest index	
	I year	II year	I year	II year
Tillage systems (L)				
l_1- Conventional tillage- pit system	3.39	4.68	0.31	0.34
l_2- Conventional tillage-mound system	3.08	3.98	0.29	0.29
l_3- Deep tillage-pit system	4.36	5.94	0.32	0.38
l_4 - Deep tillage-mound system	3.71	5.14	0.31	0.36
SEm±	**0.030**	**0.017**	**0.005**	**0.002**
CD (0.05)	**0.110**	**0.062**	**0.018**	**0.008**
Soil conditioners (S)				
s_1- Control	3.30	4.79	0.30	0.33
s_2- Coir pith	3.95	5.08	0.32	0.35
s_3- Rice husk	3.66	4.93	0.31	0.35
SEm±	**0.036**	**0.008**	**0.004**	**0.003**
CD (0.05)	**0.103**	**0.024**	**0.011**	**0.008**
Nutrient management (N)				
n_1- INM	3.37	4.73	0.29	0.33
n_2- Organic nutrition	3.90	5.13	0.32	0.35
SEm±	**0.030**	**0.007**	**0.003**	**0.002**
CD (0.05)	**0.084**	**0.019**	**0.009**	**0.006**

Dry matter content

The treatments had significant influence on dry matter content of cormel (Table 2a). Deep tillage with pit system of planting (l_3) registered significantly higher (31.90 and 29.83 per cent during I and II year, respectively) dry matter content of cormel. The dominance of deep tillage over conventional tillage and pit over mound system of planting was revealed from contrast analysis. Significantly higher content of dry matter in cormel was observed with application of soil

Table 1b: Interaction effect of tillage systems, soil conditioners and nutrient management on total dry matter production (TDMP) and harvest index

Treatments	TDMP (t ha^{-1})		Harvest index	
	I year	II year	I year	II year
L x S interaction				
l_1s_1	2.94	3.64	0.30	0.33
l_1s_2	3.54	3.99	0.32	0.34
l_1s_3	3.35	3.85	0.31	0.34
l_2s_1	2.65	3.40	0.28	0.29
l_2s_2	3.37	3.77	0.31	0.29
l_2s_3	2.94	3.56	0.29	0.29
l_3s_1	3.93	4.46	0.32	0.37
l_3s_2	4.54	4.77	0.33	0.40
l_3s_3	4.38	4.86	0.32	0.38
l_4s_1	3.26	3.96	0.30	0.35
l_4s_2	3.97	4.23	0.33	0.37
l_4s_3	3.68	4.09	0.30	0.37
SEm±	**0.049**	**0.055**	**0.007**	**0.005**
CD (0.05)	**NS**	**NS**	**NS**	**0.015**
L x N interaction				
l_1n_1	3.03	3.57	0.29	0.33
l_1n_2	3.53	4.08	0.33	0.34
l_2n_1	2.80	3.39	0.27	0.28
l_2n_2	3.17	3.77	0.31	0.30
l_3n_1	3.84	4.45	0.31	0.37
l_3n_2	4.72	4.95	0.34	0.39
l_4n_1	3.33	3.92	0.30	0.36
l_4n_2	3.94	4.27	0.32	0.37
SEm±	**0.040**	**0.044**	**0.006**	**0.004**
CD (0.05)	**0.113**	**NS**	**NS**	**NS**
S x N interaction				
s_1n_1	2.96	3.70	0.28	0.33
s_1n_2	3.43	4.03	0.31	0.34
s_2n_1	3.53	3.95	0.31	0.34
s_2n_2	4.17	4.43	0.34	0.36
s_3n_1	3.26	3.84	0.29	0.33
s_3n_2	3.91	4.34	0.32	0.36
SEm±	**0.034**	**0.038**	**0.005**	**0.004**
CD (0.05)	**0.098**	**NS**	**NS**	**NS**

NS- Not significant

Table 1c: Effect of LxSxN interaction on total dry matter production and harvest index

Treatments	TDMP (t ha^{-1})		Harvest index	
	I year	II year	I year	II year
$l_1s_1n_1$	2.80	3.41	0.28	0.32
$l_1s_1n_2$	3.10	3.86	0.31	0.33
$l_1s_2n_1$	3.29	3.72	0.31	0.34
$l_1s_2n_2$	3.80	4.25	0.34	0.35
$l_1s_3n_1$	3.05	3.58	0.29	0.33
$l_1s_3n_2$	3.69	4.12	0.33	0.35
$l_2s_1n_1$	2.47	3.21	0.25	0.29
$l_2s_1n_2$	2.84	3.60	0.30	0.29
$l_2s_2n_1$	3.10	3.62	0.29	0.28
$l_2s_2n_2$	3.63	3.92	0.33	0.30
$l_2s_3n_1$	2.85	3.34	0.27	0.28
$l_2s_3n_2$	3.03	3.78	0.31	0.30
$l_3s_1n_1$	3.61	4.33	0.30	0.35
$l_3s_1n_2$	4.25	4.60	0.34	0.38
$l_3s_2n_1$	4.05	4.46	0.32	0.39
$l_3s_2n_2$	5.02	5.07	0.35	0.41
$l_3s_3n_1$	3.86	4.56	0.31	0.36
$l_3s_3n_2$	4.88	5.16	0.34	0.39
$l_4s_1n_1$	2.97	3.87	0.28	0.35
$l_4s_1n_2$	3.53	4.05	0.31	0.36
$l_4s_2n_1$	3.69	4.04	0.32	0.37
$l_4s_2n_2$	4.24	4.46	0.34	0.37
$l_4s_3n_1$	3.32	3.89	0.29	0.37
$l_4s_3n_2$	4.03	4.28	0.32	0.38
SEm±	**0.069**	**0.077**	**0.010**	**0.008**
CD (0.05)	**0.197**	**NS**	**NS**	**NS**

NS- Not significant

conditioner and coir pith (s_2) was found superior (31.55 and 29.30 per cent during I and II year, respectively) to rice husk (s_3) as soil conditioner during both the years. Organic nutrition (n_2) resulted in significantly higher dry matter content (31.91 and 29.35 per cent during I and II year, respectively) of cormel than INM (n_1) during both the years.Table 2b depicts interaction effects and it indicates that L x S interaction was not significant during both the years. For L x N interaction, the treatment combination l_3n_2 produced the highest dry matter content during both the years, although its effect was not significant during II year. In S x N interaction, the treatment combination s_2n_2 registered the highest dry matter content of cormel which was significant only during II year. The effect was on a par with s_3n_2. L x S x N interaction was not significant during both the years (Table 2c).

Starch content

The main effects of treatments were significant during both the years (Table 2a). During I year, deep tillage followed by pit system (l_3) registered the highest content of starch (66.05 per cent) in cormel but was found to be on a par with deep tillage with mound system of planting (l_4). During the II year, l_3 registered significantly higher starch content. Contrast analysis indicated the dominance of deep tillage and pit system of planting. Coir pith when used as soil conditioner (s_2) registered significantly higher starch content (64.04 and 69.76 per cent during I year and II year, respectively) than control (s_1) and rice husk (s_3) during both the years. Significantly higher starch content (63.39 and 69.04 per cent during I and II year, respectively) during both the years was recorded by organic nutrition (n_2). Improvement in tuber quality of elephant foot yam due to organic nutrition has been reported by Suja *et al*. (2010; 2012a; 2012b), Suja (2013) and Kolambe *et al*.

Table 2a: Effect of tillage systems, soil conditioners and nutrient management on quality characters of cormel

ITreatments	Cormel dry matter(%)		Starch content(%)		Protein content(%)	
	I year	II year	I year	II year	I year	II year
Tillage systems (L)						
l_1- Conventional tillage- pit system	29.68	27.48	61.32	64.98	6.86	7.33
l_2- Conventional tillage-mound system	28.25	26.57	57.78	62.08	6.53	6.78
l_3- Deep tillage-pit system	31.90	29.83	66.05	75.08	7.26	7.66
l_4 - Deep tillage-mound system	30.22	28.61	65.57	71.10	7.00	7.40
SEm±	**0.272**	**0.302**	**0.136**	**0.134**	**0.043**	**0.070**
CD (0.05)	**1.007**	**1.118**	**0.503**	**0.496**	**0.160**	**0.259**
Soil conditioners (S)						
s_1- Control	28.56	26.55	61.44	66.96	6.48	6.92
s_2- Coir pith	31.55	29.30	64.04	69.76	7.14	7.55
s_3- Rice husk	29.92	28.53	62.56	68.21	7.11	7.41
SEm±	**0.246**	**0.237**	**0.117**	**0.155**	**0.065**	**0.070**
CD (0.05)	**0.695**	**0.671**	**0.331**	**0.439**	**0.184**	**0.198**
Nutrient management (N)						
n_1- INM	28.11	26.89	61.97	67.59	6.73	7.09
n_2- Organic nutrition	31.91	29.35	63.39	69.04	7.09	7.50
SEm±	**0.201**	**0.194**	**0.095**	**0.127**	**0.053**	**0.057**
CD (0.05)	**0.568**	**0.548**	**0.270**	**0.358**	**0.150**	**0.162**

(2013). Suja (2013) and Kaswala *et al*. (2013) also reported similar results in yams. Considering the effect of L x S interaction (Table 2b), the treatment combination l_3s_2 recorded the highest content of starch in cormel but its effect was significant only during II year. Regarding L x N interaction, the treatment combination l_3n_2 registered the highest content of starch but it was on a par with l_4n_2 during I year when its effect was significant. Among S x N interaction, the treatment combination, s_2n_2 produced the highest content of starch but its effect was significant only during I year. The interaction L x S x N (Table 2c) failed to produce any significant effect of starch content during both the years.

Protein content

As presented in Table 2a, during both years of study, the main effects of treatments were significant. During I year, deep tillage followed by pit system (l_3) dominated in producing higher protein content (7.26%) than other treatments but during the II year, it was on a par with deep tillage followed by mound system (l_4). Contrast analysis also revealed the dominance of deep tillage and pit system of planting. Among the soil conditioners, coir pith (s_2) was found to be superior to rice husk (s_3) as soil conditioner and control (s_1) in its effect on protein content during both the years. Similar to dry matter and starch content, organic nutrition (n_2) proved its superiority in producing higher protein content in cormel during both the years (7.09 and 7.50% per cent during I year and II year, respectively). As shown in Table 2b, L x S interaction had significant effects on protein content during the II year only. The treatment combinations, l_3s_2, l_3s_3, l_4s_2 and l_1s_3 were on a par during both the years. Although L x N interaction was not significant during both the years, the treatment combination l_3n_2 recorded the highest content of protein. There were no significant effects for S x N interaction during both the years. But the effects of the treatment combinations s_2n_2 and s_3n_2 were on a par and superior to others. The interaction L

Table 2b: Interaction effect of tillage systems, soil conditioners and nutrient management on quality characters of cormel

Treatments	Cormel dry matter content(%)		Starch (%)		Protein (%)	
	I year	II year	I year	II year	I year	II year
L x S interaction						
l_1s_1	28.09	26.07	60.18	63.22	6.35	6.78
l_1s_2	31.51	28.51	62.62	66.60	6.89	7.44
l_1s_3	29.43	27.87	61.15	65.13	7.33	7.77
l_2s_1	26.10	25.29	56.26	61.15	6.13	6.35
l_2s_2	30.28	27.55	59.53	62.77	6.78	7.11
l_2s_3	28.38	26.88	57.55	62.33	6.67	6.89
l_3s_1	31.14	27.99	65.04	74.03	6.89	7.55
l_3s_2	32.56	31.18	67.39	77.07	7.44	7.88
l_3s_3	32.01	30.32	65.71	74.15	7.44	7.55
l_4s_1	28.92	26.84	64.29	69.46	6.57	7.00
l_4s_2	31.86	29.95	66.61	72.62	7.44	7.77
l_4s_3	29.88	29.03	65.82	71.23	7.00	7.44
SEm±	**0.492**	**0.475**	**0.234**	**0.310**	**0.130**	**0.140**
CD (0.05)	**NS**	**NS**	**NS**	**0.878**	**NS**	**0.396**
L x N interaction						
l_1n_1	27.51	25.86	60.34	64.20	6.71	7.07
l_1n_2	31.85	29.11	62.30	65.77	7.00	7.59
l_2n_1	25.81	25.46	57.44	61.66	6.42	6.71
l_2n_2	30.70	27.69	58.12	62.51	6.64	6.86
l_3n_1	30.23	28.81	65.42	74.45	6.93	7.37
l_3n_2	33.57	30.85	66.67	75.71	7.59	7.95
l_4n_1	28.90	27.45	64.67	70.05	6.86	7.22
l_4n_2	31.55	29.77	66.48	72.16	7.15	7.59
SEm±	**0.401**	**0.388**	**0.191**	**0.253**	**0.106**	**0.114**
CD (0.05)	**1.135**	**NS**	**0.540**	**NS**	**NS**	**NS**
S x N interaction						
s_1n_1	26.69	26.10	60.88	66.16	6.35	6.78
s_1n_2	30.43	26.99	62.01	67.77	6.62	7.06
s_2n_1	29.58	27.72	63.03	68.85	7.00	7.39
s_2n_2	33.52	30.88	65.04	70.68	7.28	7.71
s_3n_1	28.06	26.86	61.99	67.75	6.84	7.11
s_3n_2	31.79	30.19	63.12	68.67	7.39	7.71
SEm±	**0.348**	**0.336**	**0.165**	**0.219**	**0.092**	**0.099**
CD (0.05)	**NS**	**0.949**	**0.467**	**NS**	**NS**	**NS**

NS- Not significant

x S x N had no significant effect on protein content during both the years (Table 2c).

Shelf life

Upto 45 days of storage no decay of cormel was observed. The cormels started to sprout from the 32^{nd} day. About 50 per cent sprouting was reached on 46^{th} day. Archana (2001) reported 50 per cent sprouting of tubers in the stored samples of coleus within 30 to 40 days of storage irrespective of the treatments. Similar results were obtained by Jayapal *et al*. (2015) and no decay of the tubers was observed due to microbial attack even when the tubers were stored for more than two months. The data on physiological loss in weight (PLW)

Table 2c: Effect of L x S x N interaction on quality characters of cormel

Treatments	Cormel dry matter content (%)		Starch (%)		Protein (%)	
	I year	II year	I year	II year	I year	II year
$l_1s_1n_1$	26.17	25.32	59.21	62.52	6.35	6.78
$l_1s_1n_2$	30.01	26.82	61.14	63.93	6.35	6.78
$l_1s_2n_1$	29.09	26.35	61.31	65.42	6.78	7.22
$l_1s_2n_2$	33.94	30.67	63.93	67.78	7.00	7.66
$l_1s_3n_1$	27.26	25.90	60.49	64.66	7.00	7.22
$l_1s_3n_2$	31.60	29.85	61.82	65.61	7.66	8.32
$l_2s_1n_1$	23.61	24.96	55.70	60.48	6.13	6.35
$l_2s_1n_2$	28.58	25.63	56.82	61.82	6.13	6.35
$l_2s_2n_1$	27.75	26.03	59.21	62.50	6.78	7.00
$l_2s_2n_2$	32.82	29.06	59.84	63.03	6.78	7.22
$l_2s_3n_1$	26.07	25.40	57.40	61.99	6.35	6.78
$l_2s_3n_2$	30.69	28.37	57.70	62.68	7.00	7.00
$l_3s_1n_1$	29.67	27.59	64.66	73.05	6.57	7.22
$l_3s_1n_2$	32.60	28.40	65.42	75.01	7.22	7.88
$l_3s_2n_1$	31.01	29.88	66.18	76.28	7.22	7.66
$l_3s_2n_2$	34.10	32.48	68.60	77.87	7.66	8.10
$l_3s_3n_1$	30.02	28.97	65.42	74.03	7.00	7.22
$l_3s_3n_2$	34.00	31.68	65.99	74.27	7.88	7.88
$l_4s_1n_1$	27.31	26.55	63.93	68.60	6.35	6.78
$l_4s_1n_2$	30.53	27.13	64.66	70.32	6.78	7.22
$l_4s_2n_1$	30.49	28.61	65.42	71.20	7.22	7.66
$l_4s_2n_2$	33.24	31.30	67.81	74.05	7.66	7.88
$l_4s_3n_1$	28.89	27.20	64.66	70.34	7.00	7.22
$l_4s_3n_2$	30.87	30.87	66.98	72.12	7.00	7.66
SEm±	**0.695**	**0.671**	**0.330**	**0.439**	**0.184**	**0.198**
CD (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

NS- Not significant

of cormel after 45 days of storage is given in Table 3a, 3b and 3c. Tillage systems differed significantly in registering PLW of cormel during storage (Table 3a). During both the years, PLW was recorded minimum (12.71 per cent and 14.47 per cent during I and II year, respectively) after 45 days of storage with deep tillage followed by pit system of planting (l_3) and maximum with conventional tillage followed by mound system (l_2). As the loss in weight over time is minimum in deep tillage with pit system of planting, it shows the superior quality during storage. Contrast analysis also revealed the superiority of deep tillage over conventional tillage and pit system over mound system of planting.The cormels from control plots (s_1) *i.e*, without soil conditioner recorded minimum (14.09 per cent) PLW after 45 days of storage during I year (Table 3a) while it recorded maximum loss (16.19 per cent) during II year. During II year, the effects of coir pith (s_2) and rice husk (s_3) were on a par in this respect but superior to control. The plots with organic nutrition (n_2) produced cormels which recorded lower values of PLW after 45 days of storage compared to INM (n_1) during both the years. Kumar *et al*. (2011) also observed significant variation in PLW per cent in stored potato tubers due to nutrient management. Regarding interaction effects (Table 3b and 3c), only L x S and L x N interaction effects were significant, that too only during II year. In the case of L x S interaction, the effects of the treatment combinations l_3s_1, l_3s_2 and l_3s_3 were on a par, but superior to others. With regard to L x N interaction, l_3n_1 and l_3n_2 were on a par but superior to others.

TDMP and harvest index was profoundly improved by deep tillage with pit system of planting. Coir pith as soil conditioner produced marked increase in TDMP over rice husk and control. Coir pith or rice husk as soil conditioner increased harvest index over control.

Table 3a: Effect of tillage systems, soil conditioners and nutrient management on physiological loss in weight of cormel after 45 days of storage

Treatments	Physiological loss in weight (%)	
	I year	II year
Tillage systems (L)		
l_1- Conventional tillage- pit system	15.31	15.91
l_2- Conventional tillage-mound system	16.16	17.77
l_3- Deep tillage-pit system	12.71	14.47
l_4 - Deep tillage-mound system	13.41	15.76
SEm±	**0.035**	**0.043**
CD (0.05)	**0.130**	**0.161**
Contrast analysis- conventional vs deep tillage		
Conventional tillage	15.74	16.84
Deep tillage	13.06	15.11
F test	S	S
Contrast analysis – Pit vs Mound system of planting		
Pit system	14.01	15.19
Mound system	14.78	16.76
F test	S	S
Soil conditioners (S)		
s_1- Control	14.09	16.19
s_2- Coir pith	14.63	15.88
s_3- Rice husk	14.47	15.87
SEm±	**0.037**	**0.033**
CD (0.05)	**0.104**	**0.094**
Nutrient management (N)		
n_1- INM	14.59	16.12
n_2- Organic nutrition	14.21	15.83
SEm±	**0.030**	**0.027**
CD (0.05)	**0.085**	**0.077**

S- Significant

Organic nutrition was superior over INM in its effects on TDMP and harvest index. Deep tillage followed by pit system combined with coir pith or rice husk as soil conditioner under organic nutrition resulted in higher dry matter production and harvest index. During both the years, quality characters like dry matter, starch and protein contents of cormel were improved by deep tillage followed by pit system. Application of soil conditioner improved the quality characters and coir pith was found to be superior. Organic nutrition was found superior to INM in influencing quality characters. When cormels were stored under ambient conditions, no decay due to microbial attack was observed upto 45 days of storage. Sprouting of cormel started from 32^{nd} day and 50 per cent sprouting was observed on 46^{th} day. Physiological loss in weight was minimum in cormels obtained from plots which received deep tillage and planted in pits with organic nutrition. Hence cormels could be stored for one month without sprouting, microbial decay and appreciable physiological loss in weight.

To conclude, the quality characters of tannia like, total dry matter production, harvest index, cormel dry matter, starch, protein and shelf life can be improved widely by adopting deep tillage to a depth of 30 cm followed by pit system of planting, applying coir pith @ 500g $plant^{-1}$as soil conditioner and by providing organic nutrition (FYM @ 37.5 t ha^{-1} + wood ash @ 2 t ha^{-1}) at 2, 4 and 6 MAP along with intercultural operations.

Table 3b:Interaction effect of tillage systems, soil conditioners and nutrient management on physiological loss in weight of cormel after 45 days of storage

Treatments	Physiological loss in weight (%)	
	I year	II year
L x S interaction		
l_1s_1	14.96	16.10
l_1s_2	15.58	15.79
l_1s_3	15.39	15.84
l_2s_1	16.01	17.99
l_2s_2	16.28	17.60
l_2s_3	16.20	17.71
l_3s_1	12.36	14.56
l_3s_2	12.99	14.41
l_3s_3	12.77	14.43
l_4s_1	13.03	16.09
l_4s_2	13.67	15.70
l_4s_3	13.52	15.48
SEm±	**0.074**	**0.066**
CD (0.05)	**NS**	**0.187**
L x N interaction		
l_1n_1	15.59	16.05
l_1n_2	15.03	15.77
l_2n_1	16.30	17.89
l_2n_2	16.02	17.65
l_3n_1	12.86	14.53
l_3n_2	12.55	14.41
l_4n_1	13.60	16.02
l_4n_2	13.22	15.50
SEm±	**0.060**	**0.054**
CD (0.05)	**NS**	**0.153**
S x N interaction		
s_1n_1	14.27	16.33
s_1n_2	13.91	16.05
s_2n_1	14.82	16.02
s_2n_2	14.44	15.74
s_3n_1	14.67	16.02
s_3n_2	14.27	15.71
SEm±	**0.052**	**0.047**
CD (0.05)	**NS**	**NS**

NS- Not significant

Table 3c: Effect of L x S x N interaction on shelf life of cormel in terms of physiological loss in weight of cormel after 45 days of storage

Treatments	Physiological loss in weight (%)	
	I year	II year
$l_1s_1n_1$	16.23	18.15
$l_1s_1n_2$	15.79	17.84
$l_1s_2n_1$	16.38	17.66
$l_1s_2n_2$	16.18	17.54
$l_1s_3n_1$	16.30	17.86
$l_1s_3n_2$	16.10	17.56
$l_2s_1n_1$	15.14	16.24
$l_2s_1n_2$	14.79	15.96
$l_2s_2n_1$	15.89	16.01
$l_2s_2n_2$	15.28	15.58
$l_2s_3n_1$	15.74	15.91
$l_2s_3n_2$	15.04	15.78
$l_3s_1n_1$	13.14	16.30
$l_3s_1n_2$	12.93	15.89
$l_3s_2n_1$	13.89	15.94
$l_3s_2n_2$	13.45	15.46
$l_3s_3n_1$	13.76	15.81
$l_3s_3n_2$	13.28	15.14
$l_4s_1n_1$	12.58	14.63
$l_4s_1n_2$	12.14	14.50
$l_4s_2n_1$	13.14	14.45
$l_4s_2n_2$	12.85	14.38
$l_4s_3n_1$	12.86	14.50
$l_4s_3n_2$	12.68	14.36
SEm±	**0.104**	**0.094**
CD (0.05)	**NS**	**NS**

NS- Not significant

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