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Yield Augmentation in Tannia (*Xanthosoma sagittifolium* (L.). Schott) as Influenced by Tillage, Soil Conditioner and Nutrition

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Abstract

An investigation was undertaken at College of Agriculture, Vellayani, Kerala to identify ideal tillage system, soil conditioner and nutrition for yield augmentation in tannia during the year 2015-16. The experiment was laid out in split plot design with four replications. The main plot treatments consisted of four tillage systems (l_1- conventional tillage with pit system, l_2- conventional tillage with mound system, l_3- deep tillage with pit system and l_4- deep tillage with mound system) and sub plot treatments were two soil conditioners along with a control (s_1- control, s_2- coir pith @ 500 g plant^{-1} and s_3- rice husk @ 500 g plant^{-1}) and two nutrient management practices (n_1- integrated nutrient management (INM) – FYM @ 25 t ha^{-1} + 80:50:150 kg NPK ha^{-1} and n_2- organic nutrition- FYM @ 37.5 t ha^{-1} + wood ash @ 2 t ha^{-1}). In the case of INM, half the quantity of FYM and full P were applied as basal dose and remaining FYM and full N and K were applied in three equal splits each at two, four and six months after planting. For organic nutrition, 2/3rd quantity of FYM was given as basal dose and remaining FYM and wood ash were given in three equal splits each at two, four and six months after planting. Dolomite @ 1 t ha^{-1} was applied uniformily to all plots at land preparation. Results revealed that for yield augmentation in tannia, deep tillage to a depth of 30 cm with pit system of planting, amending the soil with coir pith @ 500g plant^{-1} and organic nutrition (FYM @ 37.5 t ha^{-1} + wood ash @ 2 t ha^{-1}) in three splits viz. 2, 4 and 6 MAP along with intercultural operations and earthing up are to be adopted.

Key words: Coir pith, organic nutrition, tannia, tillage, yield

Introduction

Belonging to the family Araceae, tannia (*Xanthosoma sagittifolium* (L.). Schott) is one of the most important root and tuber crops grown world-wide (Onwueme and Charles, 1994). Tannia is cultivated for its edible mother corm and cormels. The cormels have a comparable nutritional value to potato (Onwume and Charles, 1994, Agueguia, 2000). The tender leaves which are similar to spinach are rich in protein. Industrially, the cormels are used for production of starch (Lauzon et al., 1995) and foliage as poultry feed. The mother corms are more acrid than the cormels and are used as planting material and human food after cooking. The crop is best suited for intercropping in coconut plantation as it is a shade tolerant crop (Pushpakumari and Sasidhar, 1996). Soil tillage is one of the most important factors affecting soil physical and mechanical properties and by adopting proper tillage practices there is scope for productivity enhancement in tannia. Tuber yield of sweet potato, elephant foot yam and taro were improved due to use of soil conditioners like coir pith (Mukherjee, 2001). Tannia responds well to organic manures and chemical fertilizers

(Suja, et al., 2009). There is considerable yield variation in tannia when grown in different soil types. Hence the present study was undertaken to identify ideal tillage system, soil conditioner and nutrient management for yield augmentation in tannia.

Materials and Methods

The experiment was conducted during May 2015 to February 2016 at College of Agriculture, Vellayani, Kerala with a view to identify of ideal tillage, soil conditioner and nutrient management for yield augmentation in tannia. Tannia was raised as a rainfed crop and a rainfall of 2132.1mm was recorded during the period of study. The soil belongs to the order Oxisol of Vellayani series and was sandy clay loam. It was strongly acidic (pH - 5.5), high in organic carbon (1.29%), low in available N (213.25 kg ha^{-1}) and high in available P (173.43 kg ha^{-1}) and K (220.86 kg ha^{-1}). The design used was split plot with tillage and planting systems as the 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). Deep tillage was done to a depth of 30 cm using a customized rotavator. The sub plot treatments were a combination of two soil conditioners along with a control (s_1- control, s_2- coir pith and s_3- rice husk) and two nutrient management systems (n_1- integrated nutrient management (INM) and n_2- organic nutrition). Soil conditioners were applied at the time of planting @ 500 g per plant. For nutrition, the INM involved application of farmyard manure (FYM) @ 25 t ha^{-1} along with N P_2O_5 and K_2O @ 80:50:150 kg ha^{-1} of which, half the quantity of FYM and full dose of P were applied as basal and the remaining quantity of FYM along with N and K were given in three split doses each at 2, 4 and 6 months after planting (MAP) along with intercultural operations and earthing up. Organic nutrition comprised of FYM @37.5 t ha^{-1} and wood ash @ 2 t ha^{-1}. Two-third quantity of FYM was applied as basal and the remaining quantity of FYM and wood ash were given in three split doses at 2, 4 and 6 MAP along with intercultural operations and earthing up. Dolomite @ 1 t ha^{-1} was applied uniformly to all plots at land preparation. Since there are no released varieties in tannia, local variety was used for planting. The land was prepared as per the treatments and corm pieces ensuring atleast one sprout (weighing about 80g) were used for planting. The crop was planted during May 2015 and harvested by February 2016. A spacing of 0.75 m x 0.75 m was adopted and the plants were mulched with green leaves immediately after planting.

At harvest, number of cormels in the observational plants was counted and the average was worked out to find the number of cormels per plant. To calculate mean weight of cormel, the total weight of the cormels in the observational plants was divided by the total number of cormels and expressed in grams. Cormel yield per plant was found out by recording the average weight of the cormels in the observational plants and expressed in g $plant^{-1}$. Corm yield per plant was also worked out similar to cormel yield per plant. Cormel to corm ratio was calculated as the ratio of the weight of cormels to the weight of corm per plant. Cormel yield per ha was worked out by recording the yield of cormels obtained from each net plot and expressed in t ha^{-1}. Corm yield per ha was also worked out similar to cormel yield per ha. The yield of corms obtained from each net plot was expressed in t ha^{-1}.

Results and Discussion

Number of cormels per plant

The treatments had significant effect on number of cormels per plant (Table 1). Among the tillage systems, deep tillage to a depth of 30 cm followed by pit system (l_3) resulted in the highest number of cormels per plant (5.92) followed by deep tillage to a depth of 30 cm with mound system (l_4). The lowest number of cormels per plant was recorded in plants from the field of conventional tillage followed by mound system of planting (l_2) with 4.23 cormels per plant. Contrast analysis also revealed that deep tillage to 30 cm depth with pit/mound planting produced more cormels per plant than under conventional tillage. Under conventional and deep tillage systems, pit system of planting tannia resulted in higher cormel number. The use of soil conditioners significantly improved the cormel number per plant. Among soil conditioners, coir pith (s_2) was found to be superior (5.38) to rice husk (s_3). Organic nutrition (n_2) proved superior (5.37) in producing higher cormel number per plant to INM (n_1). Considering interaction effect (Table 2), in L x S interaction, the treatment combinations l_3s_2 and l_3s_3

Table 1. Effect of tillage systems, soil conditioners and nutrient management on yield components

Treatments	Cormel number per plant	Mean weight of cormel (g)
Tillage systems (L)		
l_1- Conventional tillage-pit system	4.78	55.68
l_2- Conventional tillage-mound system	4.23	53.36
l_3- Deep tillage-pit system	5.92	57.02
l_4 - Deep tillage-mound system	4.89	60.6
SEm±	0.039	0.503
CD (0.05)	0.146	1.862
Contrast analysis- Conventional vs Deep tillage		
Conventional tillage	4.51	54.52
Deep tillage	5.4	58.81
F test	S	S
Contrast analysis – Pit vs Mound system of planting		
Pit system	5.35	56.35
Mound system	4.56	56.98
F test	S	NS
Soil conditioners (S)		
s_1- Control	4.37	61.49
s_2- Coir pith	5.38	53.79
s_3- Rice husk	5.12	54.72
SEm±	0.045	0.518
CD (0.05)	0.128	1.465
Nutrient management (N)		
n_1- INM	4.54	59.17
n_2- Organic nutrition	5.37	54.16
SEm±	0.037	0.423
CD (0.05)	0.104	1.196

S- Significant NS- Not significant

produced significantly higher (6.38) cormel number per plant over other combinations. Among L x N interaction, significantly higher results were obtained for l_3n_2 (6.10) and in S x N interaction, s_2n_2 resulted in the highest cormel per plant. The interaction L x S x N had significant effects on cormel number (Table 3). The treatment combination of $l_3s_3n_2$ and $l_3s_2n_2$ (6.63 and 6.56 respectively) resulted in significantly higher number of cormels compared to other treatment combinations.

Table 2. Interaction effect of tillage systems, soil conditioners and nutrient management on yield components of tannia

Treatment	Cormel number per plant	Mean weight of cormel (g)
L x S interaction		
l_1s_1	4.31	59.18
l_1s_2	5.22	52.49
l_1s_3	4.81	55.38
l_2s_1	3.88	56.00
l_2s_2	4.44	52.72
l_2s_3	4.38	51.34
l_3s_1	5.00	64.44
l_3s_2	6.38	54.17
l_3s_3	6.38	52.44
l_4s_1	4.28	66.36
l_4s_2	5.47	55.76
l_4s_3	4.91	59.69
SEm±	0.090	1.036
CD (0.05)	0.255	2.930
L x N interaction		
l_1n_1	4.27	59.43
l_1n_2	5.29	51.94
l_2n_1	3.85	55.59
l_2n_2	4.60	51.12
l_3n_1	5.73	55.66
l_3n_2	6.10	58.37
l_4n_1	4.29	66.01
l_4n_2	5.48	55.20
SEm±	0.074	0.846
CD (0.05)	0.208	2.392
S x N interaction		
s_1n_1	4.14	61.60
s_1n_2	4.59	61.39
s_2n_1	4.84	57.71
s_2n_2	5.91	49.86
s_3n_1	4.63	58.21
s_3n_2	5.61	51.22
SEm±	0.064	0.732
CD (0.05)	0.180	2.072

Table 3. Effect of L x S x N interaction on yield components of tannia

Treatment	Cormel number per plant	Mean weight of cormel (g)
$l_1s_1n_1$	3.88	61.67
$l_1s_1n_2$	4.75	56.68
$l_1s_2n_1$	4.75	55.99
$l_1s_2n_2$	5.69	48.99
$l_1s_3n_1$	4.19	60.62
$l_1s_3n_2$	5.44	50.15
$l_2s_1n_1$	3.75	54.69
$l_2s_1n_2$	4.00	57.32
$l_2s_2n_1$	3.94	57.14
$l_2s_2n_2$	4.94	48.31
$l_2s_3n_1$	3.88	54.95
$l_2s_3n_2$	4.88	47.73
$l_3s_1n_1$	4.88	62.27
$l_3s_1n_2$	5.13	66.61
$l_3s_2n_1$	6.19	53.18
$l_3s_2n_2$	6.56	55.15
$l_3s_3n_1$	6.13	51.53
$l_3s_3n_2$	6.63	53.36
$l_4s_1n_1$	4.06	67.76
$l_4s_1n_2$	4.50	64.95
$l_4s_2n_1$	4.50	64.53
$l_4s_2n_2$	6.44	46.99
$l_4s_3n_1$	4.31	65.73
$l_4s_3n_2$	5.50	53.66
SEm±	0.127	1.465
CD (0.05)	0.361	4.143

Mean weight of cormel

There was significant variation in mean weight of cormel due to tillage systems (Table 1). Deep tillage to 30 cm depth followed by mound system (l_4) resulted in the highest weight of cormel (60.60 g) followed by deep tillage to 30 cm depth with pit system (l_3). The mean cormel weight was the lowest in plants from the field of conventional tillage followed by mound system of planting (l_2). The results were confirmed by contrast analysis also. Planting in pit/mound system did not produce any significant variation in cormel size. Plants from the plots which did not receive any soil conditioner (s_1) produced cormels with significantly higher (61.49 g) mean weight of cormel. The mean weight of cormel was significantly higher (59.17 g) under INM (n_1) than under organic nutrition (n_2). Interaction effects (Table 2) revealed significant effects for L x S, L x N and S x N interactions on mean weight of cormel. With respect to L x S interaction, the effect of treatment combination l_4s_1 was found superior (66.36 g) to other combinations but was on a par with l_3s_1. In the case of L x N interaction, l_4n_1 (66.01 g)resulted in cormels with higher weight. Regarding S x N interaction, the treatment combination s_1n_1 (61.60 g) resulted in cormels with higher weight and was found on par with s_1n_2 (61.39 g). In L x S x N interaction (Table 3), the treatment combination $l_4s_1n_1$ was found to be significantly superior to others but was on par with $l_3s_1n_2$, $l_4s_3n_1$, $l_4s_1n_2$ and $l_4s_2n_1$ resulted in plants producing heavier cormels.

Cormel yield per plant

Deep tillage to a depth of 30 cm with pit system of planting (l_3) resulted in significantly higher cormel yield per plant (Table 4) with 333.66 g followed by deep tillage to 30 cm depth with mound system of planting (l_4). The lowest cormel yield per plant was produced by plants in conventional tillage followed by mound system (l_2). The superiority of deep tillage over conventional tillage and pit system over mound system was further confirmed with contrast analysis. Significant improvement in cormel yield per plant was observed by the application of soil conditioner. The highest yield (285.53 g) was produced by coir pith as soil conditioner (s_2) followed by 277.14 g by using rice husk as soil conditioner (s_3). Organic nutrition (n_2) proved its superiority over INM (n_1) by producing significantly higher cormel yield per plant of 288.45 g. Considering the interaction effects (Table 5), significance was recorded for all interactions. The treatment combinations l_3s_2, l_3n_2 and s_2n_2 resulted in significantly higher cormel yield per plant compared to other respective treatment combinations. The effect of L x S x N interaction (Table 6) was found significant and the treatment combination $l_3s_2n_2$ (361.52 g) was found superior.

Table 4. Effect of tillage systems, soil conditioners and nutrient management on yield components (continued)

Treatments	Cormel yield per plant (g)	Corm yield per plant (g)	Cormel: Corm ratio
Tillage systems (L)			
l_1- Conventional tillage- pit system	262.90	407.67	0.65
l_2- Conventional tillage-mound system	223.36	399.52	0.56
l_3- Deep tillage-pit system	333.66	478.39	0.70
l_4 - Deep tillage-mound system	288.86	418.22	0.69
SEm±	0.933	1.543	0.003
CD (0.05)	3.458	5.718	0.009
Contrast analysis- Conventional vs Deep tillage			
Conventional tillage	243.13	403.59	0.60
Deep tillage	311.26	448.3	0.70
F test	S	S	S
Contrast analysis – Pit vs Mound system of planting			
Pit system	298.28	443.03	0.67
Mound system	256.11	408.87	0.63
F test	S	S	S
Soil conditioners (S)			
s_1- Control	268.91	420.91	0.64
s_2- Coir pith	285.53	432.00	0.66
s_3- Rice husk	277.14	424.94	0.65
SEm±	0.470	1.394	0.003
CD (0.05)	1.330	3.942	0.007
Nutrient management (N)			
n_1- INM	265.94	413.93	0.64
n_2- Organic nutrition	288.45	437.97	0.66
SEm±	0.384	1.138	0.002
CD (0.05)	1.086	3.219	0.006

S- Significant

Corm yield per plant

The dominant effect of deep tillage to 30 cm depth followed by pit system (l_3) in plants producing higher cormel yield per plant was also similar in producing higher corm yield per plant (478.39 g). The lowest corm yield per plant was recorded in plants from the field of conventional tillage followed by mound system (l_2) as indicated in Table 4. Application of coir pith as soil conditioner (s_2) resulted in significantly higher corm yield per plant (432 g) followed by rice husk (s_3) and control (s_1). Organic nutrition (n_2) resulted in significantly higher corm yield per plant (437.97 g) over INM (n_1). Interaction effects shown in Table 5 revealed the significant effects of L x S, L x N and S x N interactions on corm yield per plant. In the case of L x S interaction, significantly higher corm yield per plant was obtained from l_3s_3 and l_3s_1 which were on par. Among L x N interaction, the treatment combination l_3n_2, resulted in significantly higher corm yield per plant. In the case of S x N interactions s_2n_2 (443.18 g) resulted in the highest corm yield per plant which was on par with s_3n_2. The L x S x N interaction (Table 6) showed significant effects of which $l_3s_3n_2$ proved its superiority with corm yield per plant (510.05 g).

Table 5. Interaction effect of tillage systems, soil conditioners and nutrient management on yield components (continued)

Treatment	Cormel yield per plant (g)	Corm yield per plant (g)	Cormel: corm ratio
L x S interaction			
l_1s_1	254.00	391.78	0.65
l_1s_2	271.56	425.88	0.64
l_1s_3	263.13	405.35	0.65
l_2s_1	216.71	377.72	0.57
l_2s_2	231.11	433.48	0.54
l_2s_3	222.26	387.35	0.57
l_3s_1	322.05	489.59	0.66
l_3s_2	344.80	452.04	0.77
l_3s_3	334.13	493.53	0.68
l_4s_1	282.86	424.55	0.67
l_4s_2	294.66	416.60	0.71
l_4s_3	289.04	413.51	0.70
SEm±	0.940	2.787	0.005
CD (0.05)	2.660	7.883	0.015
L x N interaction			
l_1n_1	252.43	389.39	0.65
l_1n_2	273.36	425.96	0.64
l_2n_1	214.05	390.52	0.55
l_2n_2	232.68	408.52	0.57
l_3n_1	315.64	466.22	0.68
l_3n_2	351.69	490.55	0.72
l_4n_1	281.65	409.60	0.69
l_4n_2	296.07	426.85	0.70
SEm±	0.768	2.276	0.004
CD (0.05)	2.172	6.436	0.012
S x N interaction			
s_1n_1	255.06	413.30	0.62
s_1n_2	282.76	428.52	0.66
s_2n_1	276.51	420.82	0.66
s_2n_2	294.56	443.18	0.66
s_3n_1	266.26	407.67	0.65
s_3n_2	288.03	442.20	0.65
SEm±	0.665	1.971	0.004
CD (0.05)	1.881	5.574	0.011

Table 6. Effect of L x S x N interaction on yield components of tannia (continued)

Treatments	Cormel yield per plant (g)	Corm yield per plant (g)	Cormel: corm ratio
$l_1s_1n_1$	238.76	385.74	0.62
$l_1s_1n_2$	269.24	397.83	0.68
$l_1s_2n_1$	264.89	400.78	0.66
$l_1s_2n_2$	278.23	450.99	0.62
$l_1s_3n_1$	253.65	381.66	0.67
$l_1s_3n_2$	272.62	429.05	0.64
$l_2s_1n_1$	204.64	359.02	0.57
$l_2s_1n_2$	228.79	396.42	0.58
$l_2s_2n_1$	224.86	440.58	0.51
$l_2s_2n_2$	237.36	426.38	0.56
$l_2s_3n_1$	212.64	371.96	0.57
$l_2s_3n_2$	231.88	402.75	0.58
$l_3s_1n_1$	303.37	482.35	0.63
$l_3s_1n_2$	340.73	496.83	0.69
$l_3s_2n_1$	328.09	439.31	0.75
$l_3s_2n_2$	361.52	464.77	0.78
$l_3s_3n_1$	315.45	477.01	0.66
$l_3s_3n_2$	352.81	510.05	0.70
$l_4s_1n_1$	273.46	426.10	0.64
$l_4s_1n_2$	292.27	423.00	0.69
$l_4s_2n_1$	288.20	402.61	0.72
$l_4s_2n_2$	301.13	430.60	0.70
$l_4s_3n_1$	283.29	400.08	0.71
$l_4s_3n_2$	294.80	426.94	0.69
SEm±	1.330	3.941	0.007
CD (0.05)	3.762	11.148	0.021

Cormel : Corm Ratio

As indicated in Table 4, significantly higher cormel: corm ratio (0.70) was recorded by deep tillage to a depth of 30 cm followed by pit system (l_3) over other treatments. Coir pith as soil conditioner resulted in significantly higher cormel : corm ratio (0.66) over control (s_1) and rice husk as soil conditioner (s_3). Organic nutrition (n_2) resulted in significantly higher cormel: corm ratio (0.66) compared to INM (n_1). Among interaction effects, significant effects were observed for L x S, L x N and S x N. The treatment combinations l_3s_2 and $l_3n_2$resulted in significantly higher ratio among L x S and L x N interaction respectively. In the case of S x N interaction, s_1n_2, s_2n_1 and s_2n_2 were found to be on par and superior to other combinations. Considering L x S x N interaction (Table 6), the treatment combination $l_3s_2n_2$ resulted significantly higher cormel : corm ratio (0.78).

Cormel yield per ha

Table 7 depicts significant effect of treatments on cormel yield per ha. Deep tillage to 30 cm depth followed by pit system (l_3- 5.94 t ha^{-1}) resulted in the highest cormel yield per ha followed by deep tillage (to 30 cm depth) and mound system of planting (l_4). The lowest cormel yield was recorded from the field of conventional tillage followed by mound system (l_2). Contrast analysis revealed the superiority of deep tillage over conventional tillage which is in accordance with the findings of Ramesh et al., (2007) who reported superiority of deep tillage over conventional tillage for tannia. Kumar et al., (2015) also reported that with an increase in depth of tillage to 30 cm, an increase in yield for potato could be obtained. Contrast analysis also revealed the dominance of pit system over mound system of planting. Using a soil conditioner was found to improve the cormel yield ha^{-1} significantly. Among soil conditioners, coir pith (s_2- 5.08 t ha^{-1}) was found superior to rice husk (s_3). The favourable influence of coir pith might be due to its higher and longer moisture retention capacity as observed by Das (1992) and Savithri and Khan (1994) and slow release of nutrients on decomposition. Organic nutrition (n_2) resulted in significantly higher cormel yield per ha compared to INM (n_1). Similar results were also reported in tannia (Suja et al., 2009), elephant foot yam (Suja et al., 2012) and in cassava (Radhakrishnan et al., 2013). Among the interaction effects (Table 8), L x S, L x N and S x N interaction had significant effects on cormel yield per plant. The treatment combinations l_3s_2, l_3n_2 and s_2n_2 resulted in significantly higher cormel yield per plant compared to other respective treatment combinations. Among L x S x N interaction (Table 9), the treatment combination $l_3s_2n_2$resulted in significantly higher cormel yield per ha (6.44 t ha^{-1}) followed by $l_3s_3n_2$.

Corm yield per ha

Significantly higher corm yield per ha (8.50 t ha^{-1}) was recorded for deep tillage to a depth of 30 cm followed by pit system (l_3) and the lowest corm yield per ha was recorded in plants from the field of conventional tillage followed by mound system (l_2). The superiority of deep tillage over conventional tillage and pit system over mound system was also evident from contrast analysis (Table 7). Plants from the plots that received coir pith (s_2) as soil conditioner produced significantly higher corm yield (7.68 t ha^{-1}). Similarly, an increase in tuber yield was reported by Ayyaswamy et al., (1996) in cassava when coir waste @ 10 t ha^{-1} was incorporated. Mukherjee (2001) also obtained significant increase in yield of sweet potato, taro and elephant foot yam over control when soil was amended with coir pith. The lowest corm yield

Table 7. Effect of tillage systems, soil conditioners and nutrient management on tuber yield

Treatments	Cormel yield (t ha^{-1})	Corm yield (t ha^{-1})
Tillage systems (L)		
l_1- Conventional tillage-pit system	4.68	7.25
l_2- Conventional tillage-mound system	3.98	7.1
l_3- Deep tillage-pit system	5.94	8.5
l_4- Deep tillage-mound system	5.14	7.44
SEm±	0.017	0.027
CD (0.05)	0.062	0.102
Contrast analysis- Conventional vs Deep tillage		
Conventional tillage	4.33	7.18
Deep tillage	5.54	7.97
F test	S	S
Contrast analysis – Pit vs Mound system of planting		
Pit system	5.31	7.88
Mound system	4.56	7.27
F test	S	S
Soil conditioners (S)		
s_1- Control	4.79	7.48
s_2- Coir pith	5.08	7.68
s_3- Rice husk	4.93	7.55
SEm±	0.008	0.025
CD (0.05)	0.024	0.07
Nutrient management (N)		
n_1- INM	4.73	7.36
n_2- Organic nutrition	5.13	7.79
SEm±	0.007	0.02
CD (0.05)	0.019	0.057

S- Significant

Table 8. Interaction effect of tillage systems, soil conditioners and management on tuber yield

Treatments	Cormel yield (t ha^{-1})	Corm yield (t ha^{-1})
L x S interaction		
l_1s_1	4.52	6.97
l_1s_2	4.83	7.57
l_1s_3	4.68	7.21
l_2s_1	3.86	6.72
l_2s_2	4.11	7.71
l_2s_3	3.96	6.89
l_3s_1	5.73	8.70
l_3s_2	6.14	8.04
l_3s_3	5.95	8.77
l_4s_1	5.04	7.55
l_4s_2	5.25	7.41
l_4s_3	5.15	7.35
SEm±	0.017	0.050
CD (0.05)	0.047	0.140
L x N interaction		
l_1n_1	4.49	6.92
l_1n_2	4.87	7.57
l_2n_1	3.81	6.94
l_2n_2	4.14	7.26
l_3n_1	5.62	8.29
l_3n_2	6.26	8.72
l_4n_1	5.01	7.28
l_4n_2	5.27	7.59
SEm±	0.014	0.040
CD (0.05)	0.039	0.114
S x N interaction		
s_1n_1	4.54	7.35
s_1n_2	5.03	7.62
s_2n_1	4.92	7.48
s_2n_2	5.24	7.88
s_3n_1	4.74	7.25
s_3n_2	5.13	7.86
SEm±	0.012	0.035
CD (0.05)	0.033	0.099

was obtained from plants from plots without soil conditioner. Organic nutrition (n_2) resulted in higher corm yield than INM (n_1). Significant effects of L x S, L x N and S x N interactions are evident from Table 8. In L x S interaction, the treatment combination l_3s_3 and l_3s_1 (on a par) resulted in significantly higher corm yield per ha. The treatment combination l_3n_2 (8.72 t ha^{-1}), among L x N interaction, resulted in significantly higher corm yield per ha. In the case of S x N interaction s_2n_2 resulted in the highest corm yield per ha, and it was on par with s_3n_2. The data on L x S x N interaction (given in Table 9) indicated significant effects with the treatment combination $l_3s_3n_2$resulted in the highest corm yield (9.07 t ha^{-1}).

Table 9. Effect of L x S x N interaction on tuber yield

Treatment	Cormel yield (t ha^{-1})	Corm yield (t ha^{-1})
$l_1s_1n_1$	4.25	6.86
$l_1s_1n_2$	4.79	7.07
$l_1s_2n_{1a}$	4.72	7.13
$l_1s_2n_2$	4.95	8.02
$l_1s_3n_1$	4.52	6.79
$l_1s_3n_2$	4.85	7.63
$l_2s_1n_1$	3.64	6.38
$l_2s_1n_2$	4.07	7.05
$l_2s_2n_1$	4.00	7.83
$l_2s_2n_2$	4.23	7.58
$l_2s_3n_1$	3.79	6.61
$l_2s_3n_2$	4.13	7.16
$l_3s_1n_1$	5.40	8.58
$l_3s_1n_2$	6.07	8.83
$l_3s_2n_1$	5.84	7.81
$l_3s_2n_2$	6.44	8.26
$l_3s_3n_1$	5.62	8.48
$l_3s_3n_2$	6.28	9.07
$l_4s_1n_1$	4.87	7.58
$l_4s_1n_2$	5.20	7.52
$l_4s_2n_1$	5.13	7.16
$l_4s_2n_2$	5.36	7.66
$l_4s_3n_1$	5.04	7.11
$l_4s_3n_2$	5.25	7.59
SEm±	0.024	0.070
CD (0.05)	0.067	0.198

Conclusion

Deep tillage to a depth of 30 cm with pit system of planting resulted in superior number of cormels per plant, cormel and corm yield per per plant, cormel:corm ratio and cormel and corm yield per ha. But higher mean weight of cormels was produced by plants from the field of deep tillage with mound system of planting. Application of soil conditioners significantly improved the tuber yield and other yield components except mean weight of cormels whereas plants from the plots which did not receive any soil conditioner produced heavier cormels. Among soil conditioners tried, coir pith was found to be the most promising. Organic nutrition had significant influence in producing better yield components. Mean weight of cormels was found to be higher in plants from INM plots.

To conclude, for yield augmentation in tannia, deep tillage to a depth of 30 cm with pit system of planting, amending the soil with coir pith @ 500g plant^{-1} and organic nutrition (FYM @ 37.5 t ha^{-1} + wood ash @ 2 t ha^{-1}) in three splits viz. 2, 4 and 6 MAP along with intercultural operations and earthing up are to be adopted.

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References

Agueguia, A. 2000. Importance and uses of cocoyam in Cameroonian diets. In: Nakatani, M. and Komaki, K. (eds), *Potential of Root crops for Food and Industrial Resources*. Proceedings of an International symposium, Tsukuba, Japan. International Society for Root and Tuber Crops, Japan pp. 512-514.

Ayyaswamy, M., Chinnuswamy, C. and Sundarsingh, S. D. 1996. Effect of irrigation regimes, comrade cropping and soil amendments on the yield and economics of cassava, groundnut and sesamum. *Madras Agric. J*., **83**(1): 338-341.

Das, A. R. 1992. Coir pith potential wealth in India. In: Proceedings of the National Seminar on Utilisation of Coir pith. Tamil Nadu Agricultural University, Coimbatore, pp. 1-8.

Kumar, V., Thomas, T., and Kumar, S. 2015. Response of tillage practices and farmyard manure on soil health, growth, yield and nutrient uptake by potato (*Solanum tuberosum* L.) cv. Kufri Badshah. *Asian J. Soil Sci.,* **10**(1): 108-113.

Lauzon, R. D., Shiraishi, K., Yamazaki, M., Swayama, S., Sugiyama, N., and Kawabata, A. 1995. Physicochemical properties of cocoyam starch. *Food Hydrocolloids,* **9**(2): 77-81.

Mukherjee, P. S. 2001. Use of coir pith as soil conditioner for growing tuber crops. *J. Root Crops,* **27**: 271-274.

Onwume, I. C. and Charles, W. B. 1994. Cultivation of Cocoyam. In: *Tropical Root and Tuber Crops, Production, Perspectives and Future Prospects.* FAO Plant Production and Protection Paper 126, Rome, 228p.

Pushpakumari, R. and Sasidhar, V. K. 1996. Fertilizer management of yams and aroids in coconut based cropping system. *J. Root Crops,* **18**(2): 99-102.

Radhakrishnan, A. R. S., Suja, G. and Anil, A. T. 2013. Organic vs conventional management in cassava: growth dynamics, yield and soil properties. *J. Root Crops,* **39**(2): 93-99.

Ramesh, V., Susan John, K. S., Ravindran, C. S. and Edison, S. 2007. Agro techniques and plant nutrition in tannia (*Xanthosoma* sp.): An overview. *J. Root Crops,* **33**(1): 1-11.

Savithri, P. and Khan, H. H. 1994. Characterisation of coconut pith and its utilization in agriculture. *J. Plantation Crops,* **22**: 1-18.

Suja, G., Sundaresan, S. John, K. S., Sreekumar, J. and Misra, R. S. 2012. Higher yield, profit and soil quality from organic farming of elephant foot yam. *Agron. Sustain. Dev*., **32**: 755-764.

Suja, G., John, K. S. and Sundaresan, S. 2009. Potential of tannia (*Xanthosoma sagittifolium* L.) for organic production. *J. Root Crops,* **35**:36-40.