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Short Communication

Productivity of lesser yam [*Dioscorea esculenta* (Lour.) Burkill] as affected by seed tuber size and spacing

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Abstract

A field experiment was conducted to study the effect of seed tuber size and spacing on the productivity of lesser yam during May to December 2018 at KAU campus, Vellanikkara, Thrissur. Tubers weighing 50 g, 100 g and 150 g were planted at spacings of 50 cm x 50 cm (high density), 75 cm x 50 cm (medium density) and 75 cm x 75 cm (low density: recommended spacing), adopting randomized block design with nine treatments. Significant effect of large seed tubers contributing to higher total dry matter accumulation per plant was observed at 180 days after planting (DAP), while spacing had no significant effect. Leaf area index was higher for vines from large seed tubers and closer spacing at all growth stages except towards senescence. The highest tuber yield per plant was realized from 150 g seed tubers (1270 g/plant), followed by 100 g (1053 g/plant) and 50 g seed tubers (929 g/plant). Wider spacing showed significantly higher per plant yield (1217 g), compared to medium (1062 g) and closer spacing (972 g). However significantly higher productivity of 44.20 t/ha was realized with 150 g tubers under high density. The next best and comparable productivity was realized with 100 g (37.09 t/ha) and 50 g (35.36 t/ha) tubers, planted at closer spacing of 50 cm x 50 cm, and 150 g tuber at a spacing of 75 cm x 50 cm (31.80 t/ha)

Key words: High density planting, Lesser yam, Seed tuber size, Spacing.

Root and tuber crops are the major cultivated sources of carbohydrates after cereals in the tropical regions of the world. Among the cultivated tuber crops, yams constitute the predominant starchy staple food in tropics where food security for growing populations is a critical issue. These crops are adapted to varied soil and climatic conditions, and are comparatively free of pest and disease attacks, which make them suitable in low input production systems (Onwueme, 1978). *Dioscorea esculenta* is a member of the yam family, Dioscoreaceae, with characteristic small clustered underground tubers at the base of the vine. In Kerala, lesser yam (*Cherukizhang/ Nanakizhang/ Cheruvallikizhang*) is commonly grown as an intercrop in homesteads. Commercial cultivation of such minor and under-exploited tuber crops is gaining importance now especially due to health benefits. The development of package of practices for intensive cultivation can help the farmer to maximize income especially in the context of limitation in area expansion. Lesser yam is vegetatively propagated through whole tubers weighing 100 to 150 g planted at a spacing of 75 cm x 75 cm (KAU, 2016). For this, the seed tuber requirement will be about 1.8- 2.7 t/ha. Hence a considerable part of the harvest has to be set apart as planting material for the next crop. In yam production, seed tubers are expensive accounting sometimes to about as much as 50 per cent of total variable cost (Manyong, 2000). A saving in quantity of seed tubers can considerably reduce the cost of cultivation and can maximize the profit. In addition, the proportion of small seed tubers at harvest is usually higher than large and medium

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sized tubers. Although the larger tubers of 100-150g are recommended for seed purpose, farmers have the tendency to use the small unmarketable tubers for planting. This would also allow the accommodation of more plants by adjusting the planting geometry. Hence, the study was undertaken with the main objective of finding optimum spacing and seed tuber size to maximize productivity of lesser yam for intensive agricultural production systems.

The field experiment was conducted for one season at College of Horticulture, Vellanikkara, Thrissur, Kerala during 2018. The soil of the experimental site was sandy clay loam in texture with a pH of 3.80 and organic carbon content of 1.13 per cent, available nitrogen of 155 kg/ha, available phosphorus of 26 kg/ha and available potassium of 283 kg/ha.

The experiment consisted of nine treatment combinations of three seed tuber sizes and three planting densities, replicated thrice in a randomized block design. Lesser yam variety Sree Latha (released from ICAR-CTCRI, Thiruvananthapuram, Kerala) was used in the study. This variety has a duration of 7.5 – 8 months and average yield of 25 t/ha. Seed tubers weighing 50 g, 100 g, and 150 g were planted at spacings of 50 cm x 50 cm (high density planting), 75 cm x 50 cm (medium density planting) and 75 cm x 75 cm (low density planting-KAU recommended spacing). The plant populations at low, medium and high densities were 17780, 26680 and 40,000 plants per hectare respectively. The treatments were: T_1-50 g seed tuber at 75 cm x 75 cm; T_2 -50 g at 75 cm x 50 cm; T_3-50 g at 50 cm x 50 cm; T_4- 100 g at 75 cm x 75 cm; T_5- 100 g at 75 cm x 50 cm; T_6- 100 g at 50 cm x 50 cm; T_7- 150 g at 75 cm x 75 cm; T_8- 150 g at75 cm x 50 cm; T_9- 150 g at 50 cm x 50 cm.

The field was ploughed thoroughly with disc plough followed by a cultivator, and weeds and stubbles were removed and the land leveled. The plots size was 5 m x 3 m and mound method of planting was adopted. Seed tubers were planted during the first week of May 2018 with the onset of pre-monsoon showers. As per the treatments, the tubers were graded into 50 g, 100 g and 150 g and a single tuber was planted per mound. Lime (@ 30-40 g per mound) was applied one week prior to planting as per soil test results and dried cattle manure, (@ 1 kg per mound) at the time of planting (KAU, 2016). Mulching was done using leaves of *Macaranga peltata* immediately after planting. Nitrogen, phosphorus and potassium were applied on per plant basis based on N: P_2O_5: K_2O recommendation of 80:60:80 kg per hectare. Each plant was supplied with 7.5 g urea, 7.5 g rock phosphate and 5 g muriate of potash. The fertilizers were applied in two splits. The first dose of fertilizers was applied two weeks after complete sprouting, supplying half dose each of N and K_2O and full dose of P_2O_5 and light earthing up was done. The remaining quantity was applied as ring placement, one month after the first application, after weeding, and then final earthing up was done.

For trailing, pyramidal method of staking was adopted using 2 m long poles of *Casuarina equisetifolia.* The poles were fixed in the interspace at the middle of four mounds and separate coir ropes were tied at the top of poles to a small stake fixed near the individual mounds. Five plants were selected at random as observation plants from each plot omitting the border rows and were tagged. Observations on growth parameters were recorded at regular intervals and the mean values were worked out. The leaf area, number of tubers per plant and dry matter production were estimated through destructive sampling of another set of randomly chosen plants at 45 days interval (45, 90, 135, 180 and 225 DAP).Harvesting was done at 225 DAP when the aerial portion dried completely. Yield observations were expressed on per plant (g/plant) and per hectare (t/ha) basis. Tubers were graded into small (about 50 g), medium (about 100g) and large tubers (about 150 g) and their number was counted.

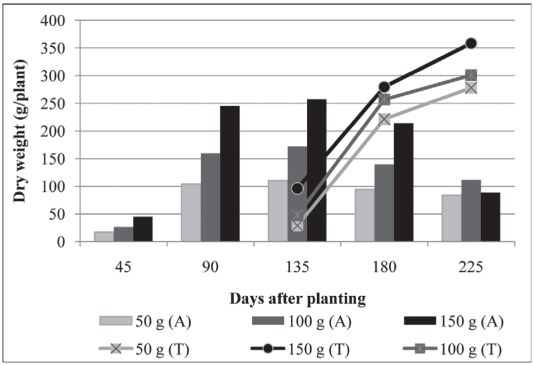

Figure 1. Effect of seed tuber size on dry weight of aerial portion (A) and tubers (T) of lesser yam at various growth stages

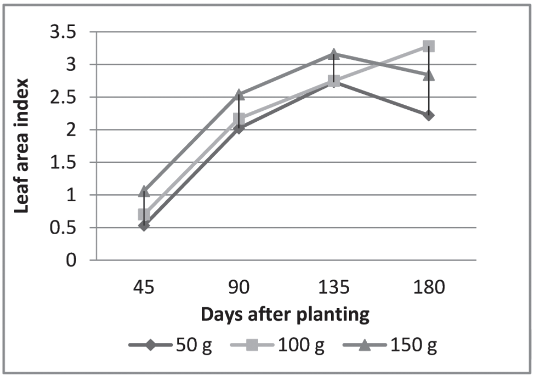

Figure 2. Effect of seed size on leaf area index of lesser yam at various growth stages

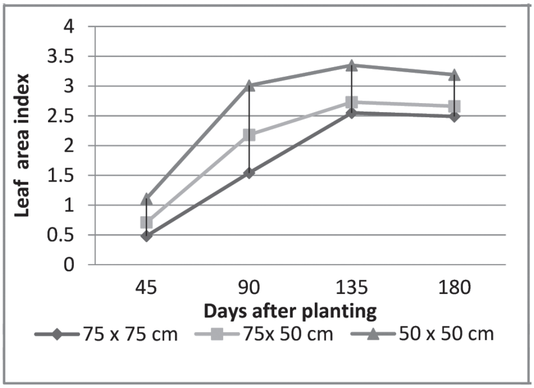

Figure 3. Effect of spacing on leaf area index of lesser yam at various growth stages

Leaf area index (LAI) is an important parameter in deciding the yield. In general, the LAI of vines increased from 45 DAP to 135 DAP and afterwards a decline was noticed (Fig. 2 and 3), as the plants attained peak vegetative growth by 135 DAP and declined towards later phase. Suja et al. (2000) observed that peak leaf area index in *D. esculenta* was at five months after planting. It is interpreted that this decline is due to leaf fall and plants diverting the photosynthates to tuber instead of to the aerial portions. It is also inferred that peak tuber bulking phase was attained after 135 DAP. According to Melteras et al. (2008), in lesser yam, leaf blades account for around 40 per cent of vine weight in early growth stage, increasing to around 60 per cent at peak vine development, and declining due to abscission during the senescence phase which reduces LAI towards senescence. The effect of both seed tuber size and spacing on LAI was evident. Significantly higher LAI was observed at a closer spacing of 50 x 50 cm as LAI is a function of land area available for individual plant. The positive effect of large seed tuber size was due to vigorous vegetative growth and a greater number of leaves per vine which resulted in more LAI. Enyi (1972) reported that LAI in lesser yam increased with increase in seed size from 15 g to 110 g and decreased with wider spacing as observed in the present study. Suja and Nair (2006) also observed a low leaf area index at wider spacing (120 x 120 cm) compared to that of medium (90 x 90 cm) and closer spacing (60 x 60 cm) in arrowroot.

The dry matter production (DMP) of lesser yam was influenced by seed tuber size and spacing (Fig.1). Higher dry matter accumulation in the aerial portion and tubers were observed in plants in the treatment combination of wider spacing and large seed tubers. This can be attributed to the vigorous vegetative growth of individual plants under wider spacing and the availability of more food reserves in seed tuber, which in turn enhanced photosynthesis.

Dry matter accumulation by aerial portion increased up to 135 DAP and remained almost stagnant, and a drastic decrease could be observed by 225 DAP from 180.07 g to 94.85 g per vine. This might have resulted from more storage of photosynthates in tubers and reduction in translocation to aerial vegetative portion after five months of planting and

Table 1. Effect of seed size and spacing on leaf area index of lesser yam

Treatments (Seed size x Spacing)		Leaf area index 75 cm x 75 cm	75 cm x 50 cm	50 cm x 50 cm
45 DAP	50 g	0.31	0.51	0.78
	100 g	0.47	0.66	0.96
	150 g	0.65	0.95	1.57
CD (0.05)			0.08	
90 DAP	50 g	1.31	2.06	2.69
	100 g	1.48	2.04	2.97
	150 g	1.83	2.43	3.37
CD (0.05)			0.24	
135 DAP	50 g	2.1	2.79	3.29
	100 g	2.64	2.37	3.24
	150 g	2.91	3.04	3.51
CD (0.05)			0.32	
180 DAP	50 g	2.08	1.93	2.66
	100 g	2.56	3.43	3.85
	150 g	2.83	2.62	3.06
CD (0.05)			0.32	

leaf senescence towards maturity. The underground portion showed an increasing trend in dry matter accumulation even during the period from 180 to 225 DAP, evidently due to tuber bulking process. According to Okoli (1980), the total amount of dry matter accumulated in the aerial portions of yam plant was higher between 112 and 126 days after planting, after which it decreased as growth progressed. He attributed the decrease in dry matter of aerial portions partly to the emergence of the sink organ (tuber) in the developmental sequence of the plant and partly to abscission of leaves and senescence of vines.

Tuber dry weight per vine was not influenced by spacing and the values ranged from 295.56 g in closer spacing to 323.67 g in wider spacing, indicating the absence of competition for space even at the higher population. The trend in tuber DMP and that of total DMP was almost the same as a major share of total DMP was contributed by tubers. Of the total DMP, the underground portion accounted for 24 per cent at 135 DAP, whereas the corresponding value at harvest stage was 77 per cent. Melteras et al. (2008) observed that in *D. rotundata,* the tubers constituted 87 per cent of total dry matter at 45 weeks after planting. Similarly, Irizarry and Rivera (1985) reported that 84 per cent of total dry matter *in D. rotundata* was accounted by the tubers. Total DMP of tubers exceeded 50-67 per cent in *D. esculenta* as reported by Enyi (1972). Data on total dry matter production at harvest showed that spacing did not significantly influence per plant dry matter accumulation and values were 381.56 g per plant in 50 x 50 cm spacing whereas it was 418.33 g per plant at 75 x 50 cm and 422.33 g per plant at 75 x 75 cm. However due to seed tuber size, total dry matter production varied, and vines from 100 and 150 g seed tubers had higher and comparable DMP of 446.78 and 412.89 g per plant whereas, 50 g seed tuber had lower DMP of 362.56 g per plant.

The tuber initiation was found to commence within 45 DAP after planting. When the sample plants were uprooted at 45 DAP, modification of hypocotyl region as tuberous roots could be differentiated from normal feeder roots by their thickness and characteristic white color. Considerable tuber bulking was observed around 90 DAP, especially in the large and medium sized seed tubers planted at wider spacing. In yams, an excess of assimilates is necessary for tuber initiation to occur, and this excess might have been present in larger seed tubers than in smaller ones. Yield in tuber crops depends on the synthesis, translocation and accumulation of dry matter and hence is largely influenced by seed tuber size. It is reported that the minisetts of *D.*

Table 2. Effect of seed size and spacing on number of tubers of lesser yam at various stages of growth

Treatment (Seed size x Spacing)		Number of tubers per plant 45 DAP	90 DAP	135 DAP	180 DAP
50 g	75 cm x 75 cm	7.00	10.00	21.00	26.33
	75 cm x 50 cm	8.00	13.67	23.67	24.00
	50 cm x 50 cm	6.00	12.33	24.33	33.00
100 g	75 cm x 75 cm	9.00	19.00	32.00	35.33
	75 cm x 50 cm	9.33	17.33	38.67	41.00
	50 cm x 50 cm	10.33	14.67	35.67	42.33
150 g	75 cm x 75 cm	13.00	21.67	29.67	32.33
	75 cm x 50 cm	11.67	23.67	35.67	32.33
	50 cm x 50 cm	13.00	23.00	40.33	41.00
CD (0.05)		3.06	2.14	4.76	3.38

Table 3. Effect of seed size and spacing on tuber yield and number of tubers of lesser yam

Treatment	Tuber yield	Tuber yield	Number of tubers per plant at harvest			Total
Seed size	(g/plant)	(t/ha)	Small	Medium	Large	
50 g	929.22	25.77	13.22	5.11	3.56	26.22
100 g	1052.56	28.80	14.44	6.78	3.07	25.44
150 g	1269.67	34.29	12.79	8.09	4.51	26.22
CD (0.05)	110.05	3.18	0.57	0.59	0.57	NS
Spacing						
75 cm x 75 cm	1216.89	21.64	13.56	6.62	3.58	28.67
75 cm x 50 cm	1062.44	28.33	14.22	6.76	3.60	25.44
50 cm x 50 cm	972.11	38.88	12.67	6.60	3.96	23.78
CD (0.05)	110.05	3.18	NS	NS	NS	1.94

rotundata weighing 25 g showed significantly lower sprouting percentage and DMP which led to a lower yield compared to 50 g setts (Ayankanmi et al., 2005).

Generally, in all treatments, tuber number increased up to 180 DAP (Table 2). Among the treatment combinations, highest number of tubers was observed in 100g and 150g seed tubers planted at 75x 50 cm and 50 x 50 cm. This might be due to the better root system development and tuber growth in the initial growth stages of the vines from large and medium seed tubers. Higher LAI was also registered at 135 DAP in these treatments which also might have contributed more photosynthates for storage.

Tuber yield per hectare was significantly influenced by plant population (Tables 3 and 4). Higher planting densities resulted in higher tuber yield per hectare (38.88 t/ha at 50 x 50 cm spacing). This was due to the fact that tuber yield per unit area is a function of number of plants per unit area.

Table 4. Interaction effect of seed size and spacing on tuber yield of lesser yam

Treatments	Tuber yield (g/plant)		
	75 cm x 75 cm	75 cm x 50 cm	50 cm x 50 cm
50 g	993.33	910.33	884.00
100 g	1145.67	1084.67	927.33
150 g	1511.67	1192.33	1105.00
CD (0.05)	190.62		
Tuber yield (t/ha)			
50 g	17.66	24.28	35.36
100 g	20.37	28.92	37.09
150 g	26.88	31.80	44.20
CD (0.05)		5.52	

Spacing had influence on tuber yield per plant and wider spacing resulted in significantly higher yield (1217 g/plant), compared to 75 x 50 cm (1062 g/ plant) and 50 x 50 cm (972 g/plant). Significant effect of interaction could be observed and performance of 150 g seed tuber at 75 x 75 cm was superior to others with respect to per plant yield (1511.67g/plant).

However, the highest productivity of 44.20 t/ha was realized when 150 g seed tubers were planted at a closer spacing of 50 x 50 cm. The next best yields were 37.09 and 35.36 t/ha, realized from closer planting (50 x 50 cm) of 100 g and 50 g seed tubers respectively and 150 g tuber planted at 75X50 cm which were at par statistically. The combination of small seed tuber and wider spacing led to lower productivity in lesser yam (17.66 t/ha) as the number of plants per unit area was the lowest, together with lower per plant yield.

The data on tuber number per plant at harvest (Table 3) shows that on an average a single plant produced 14 small tubers compared to very few large tubers (4 tubers/plant). It was observed that seed tuber size had significant effect on the number of small, medium or large tubers produced, while the spacing had no significant influence (Table 3). On an average, 26 tubers were observed per plant at harvest. However, vines under wider spacing produced more tubers per vine. At 75 x 75 cm spacing, 28.67 tubers were produced per plant, whereas it was 23.78 tubers at 50 x 50 cm. But the increase in number of tubers was not high enough to compensate the effect of number of plants per unit area on yield and hence more yield was realized at closer spacing. Though higher productivity could be achieved by planting 150 g seed tubers at 50 x 50 cm spacing, there is a practical limitation with respect to availability of large tubers as vines produce only a few large sized tubers. Hence, medium and small sized tubers can be utilized as planting material to realize more productivity compared to large tubers at wider spacing of 75 cm x 75 cm .

The study indicated that there is scope for maximizing productivity of lesser yam by adopting high density planting. Even small tubers weighing 50 g can be utilized as planting material.

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