Journal of Root Crops, 2020, Vol. 46 No. 1, pp. 3-7
Indian Society for Root Crops
ISSN 0378-2409, ISSN 2454-9053 (online)

Phenology of Greater Yam (*Dioscorea alata* L.) Under Humid Tropical Conditions of Kerala

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Abstract

Phenology of greater yam (*Dioscorea alata* L.) was studied by planting two greater yam varieties viz., Sree Keerthi and Sree Karthika for three seasons (2013, 2014 and 2015) at ICAR-CTCRI, Thiruvananthapuram, Kerala. Sree Keerthi took 16 to 23 days for sprouting, 88 days for tuber initiation, 236 to 243 days for senescence, which lasted for 24 to 39 days. Sree Karthika took 17 to 28 days for sprouting, 83 days for tuber initiation, 236 days for senescence which lasted for 26 to 45 days. Active tuber development was noticed between 6 to 8 months of planting (180 to 240 days). Timely planting resulted in more tuber yield in Sree Keerthi (26.4 to 31.5 t ha^{-1}) than Sree Karthika (22.65 to 29.3 t ha^{-1}). Delayed planting although resulted in early emergence and tuber initiation, senescence was also early resulting in yield loss in both the varieties. However, Sree Keerthi resulted in less yield loss compared to Sree Karthika, indicating its suitability for delayed planting.

Key words : Greater yam, phenology, senescence, sprouting, tuber initiation

Introduction

Yams belonging to the genus *Dioscorea*, family Dioscoreaceae, are important food crops in the tropical and subtropical regions. Root crops are the main food source of the tropics of which yams are the high valued crops (O' Sullivan, 2010). The productivity of yam ranges from 6.03 t ha^{-1} in Fiji to 29.17 t ha^{-1} in Ethiopia with a global average productivity of 8.53 t ha^{-1} (FAO, 2017). *Dioscorea alata*, known as greater yam or purple yam is superior to most edible yam species in terms of high yield potential, high nutritious value and storability of tubers (Wu et al., 2005) and is the most widely cultivated yam species throughout the tropics. *D. alata* is used as staple food by many communities of tropical world.

Yams are generally cultivated throughout India as vegetable crops in homestead or semi commercial scale mostly under rainfed conditions. Yams grow well in warm humid conditions, with a mean temperature of 30°C and a well distributed annual rain fall of 1200-2000 mm. Yams are planted mostly in the later part of the dry season from March-May and tubers start sprouting with the onset of pre monsoon showers. In Kerala, the most ideal time for planting greater yam is March-April. The crop utilizes both the monsoon seasons for its growth and production. It is generally harvested at 9-10 months after planting. Yellowing of leaves and complete drying up of the vines indicates the maturity of crop.

There are four different phases identified in the generalized growth cycle of yam plants, first phase starting from emergence to about six weeks where profuse root system development occurs with vine elongation, second phase, with development of foliage which lasts up to tenth week, the third phase coinciding with tuber development and the last senescence phase (Onwueme and Charles 1994). The crop goes through all these phases during its life cycle but the exact duration varies with yam species, varieties and the climatic conditions. Hence an attempt was made to study the phenology of greater yam under humid tropical conditions of Kerala, India, with particular emphasis to tuber yield and yield attributes.

Materials and Methods

Field experiments were carried out at ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala during three consecutive seasons, 2013, 2014 and 2015. The location lies between 8.54° North latitude and 76.91° East longitude and comes under the humid tropical climatic zones of India with an altitude of 50 m

above mean sea level. The tubers harvested during the second fortnight of January were used for planting in all the seasons. The soil in the experimental area was deep, well drained, sandy clay loam, moderately acidic in reaction. Maximum temperature varied between 30-35°C and minimum temperature, 23-26°C having a relative humidity of 64 to 81%. The crop received 1425, 1330, and 1546 mm of rainfall during the three growing seasons respectively. The first crop was planted during April second week, second crop during March last week and third crop during April last week of consecutive years. Two promising varieties of greater yam viz., Sree Keerthi and Sree Karthika, released from ICAR-CTCRI were used for the study. Sree Keerthi is a high yielding variety of greater yam with large sized tubers, good cooking quality and excellent taste. They climb upto a height of 4-5 m. The maturity period is 9-10 months and average yield is 25-30 t ha^{-1}. It is suitable for intercropping with banana and can be grown in mature coconut gardens. Sree Karthika is a high yielding greater yam variety having long, oval tubers with excellent cooking quality. Maturity period is 9 months and average yield is 30 t ha^{-1}.

The tuber pieces of 250 g each were planted at a spacing of 90 x 90 cm with a gross plot size of 25 plants in three replications. The vines were trailed on casuarina poles after two months of planting and observations were recorded from the 9 plants in net plots. FYM and fertilizers were applied as per recommendations of ICAR-CTCRI, ie., 10 t FYM and 80-60-80 kg N, P_2O_5 and K_2O in two split doses, coinciding with 50% sprouting and one month thereafter. Observations on number of days taken for first sprouting and 50% sprouting, tuber initiation, senescence and duration of senescence were recorded. Destructive sampling was done at monthly intervals from 5 months onwards up to senescence and the rate of tuber bulking was assessed. Dry matter partitioning and the harvest indices were also estimated at monthly intervals. Tuber yield per plant and per ha were recorded at harvest stage from all the replications. The average value of three replicated values in each season were computed and were compared.

Weather data viz., minimum temperature, maximum temperature and rainfall during the crop period were also recorded during the growing seasons.

Results and Discussion

Days taken for sprouting

Sree Keerthi took 23.7, 22.3 and 16 days for initiation of sprouting of planted tubers during the first, second and third seasons respectively. Sree Karthika took 28.3, 17.7 and 18.7 days for initiation of sprouting respectively during the first, second and third seasons. Sree Keerthi took 49.3 days for achieving 50% sprouting during the first season, 56 and 24.3 days during second and third seasons respectively. 50% sprouting in Sree Karthika was achieved within 50, 55.3 and 30.3 days respectively during the three seasons. On an average, Sree Keerthi took 20.7 days for initiating emergence of planted tubers, whereas Sree Karthika took 21.5 days for first emergence of sprout. For 50% sprouting, 43.2 days and 45.2 days was required by Sree Keerthi and Sree Karthika respectively.

Vine growth and canopy development

Once sprouted, vines elongated fast reaching 2-3 m within four weeks in all the seasons. Thereafter foliage covers the ground if not trailed properly. Fertilizer application and earthing up along with monsoon rains resulted in fast growth and development of canopy during 2-5 months.

Days for tuber initiation

Sree Keerthi took 88 days for tuber initiation during the first season, whereas Sree Karthika took 83 days. During second and third seasons, tuber initiation occurred in Sree Keerthi in 88.3 days and 38 days and in Sree Karthika, 81.7 days and 32.7 days respectively. On an average it took 71.4 days in Sree Keerthi and 65.8 days in Sree Karthika for initiating the tuber growth.

Rate of tuber bulking

In general after tuber initiation, tuber bulking started at a low pace during the initial stages. The rate of tuber development slowly increased from 6 months after planting, reached the peak during 7-8 months period. Then it started declining slowly. This trend was observed in both the varieties, with the values varying between the seasons. During the third season, senescence occurred early, however, bulking rate was comparatively higher during 6-7 months compared to the first two seasons. Towards maturity also, bulking rate was less during the third season. It can be inferred that the

maximum tuber development occurs in greater yam between 6-8 months of planting (Fig. 1 & 2). After senescence, further tuber bulking occurs at a slow rate.

Harvest indices

Harvest indices recorded from 5th month onwards indicated a steady increase during 5, 6,7 and 8 MAP in both the varieties. Sree Karthika recorded more harvest index values than Sree Keerthi during the initial stages of bulking (Fig. 3). Towards harvest, Sree Keerthi recorded maximum values in all the three seasons.

Days to senescence

Sree Keerthi took more days for initiating senescence in all the seasons. Days to senescence ranged from 237 to 243 days and Sree Karthika took 236 to 237 days for senescence during the first two seasons. During the third season where planting was little delayed senesced early within 222 and 215 days respectively in Sree Keerthi and Sree Karthika.

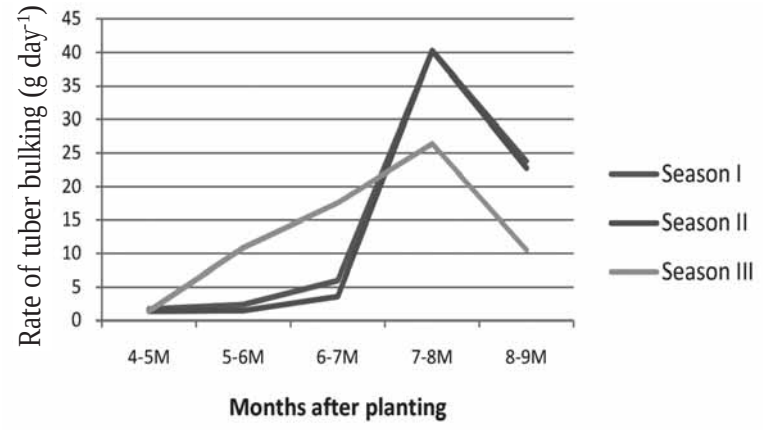

Fig. 1. Rate of tuber development in Sree Keerthi during the 3 seasons

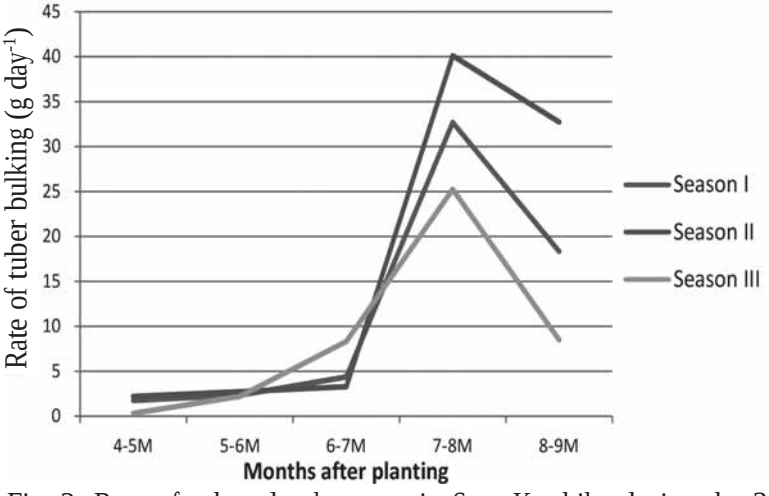

Fig. 2. Rate of tuber development in Sree Karthika during the 3 seasons

Period of senescence

The period of senescence varied from 24 to 39 days in Sree Keerthi whereas in Sree Karthika, the period ranged from 26 to 45 days. The rate of senescence was found faster in Sree Keerthi.

Tuber yield

In Sree Keerthi, tuber yield per plant ranged from 1.74 to 2.64 kg in different seasons. In Sree Karthika, yield varied from 1.37 to 2.47 kg per plant. Per hectare tuber yield varied from 21.5 to 31.5 tha^{-1} in Sree Keerthi and 16.9 to 29.3 kg ha^{-1} in Sree Karthika. The lowest tuber yield was recorded during the third season in both the varieties (Fig. 4). The yield data indicated that the crop performed better during the second season of planting (March), followed by first and third season.

Yam is propagated by planting whole tubers or cut tuber pieces of 200- 250 g size. For culinary purposes, the tubers can be harvested once senescence starts. Almost it takes another two months to complete its life cycle and attains physiological maturity for seed purpose. Usually the crop is harvested during January- February for seed purpose and next planting is undertaken during March-April. During this lean period, tubers undergo some sort of dormancy for 2-3 months which is common in potato, yams and aroids depending upon the crop, species and variety. Finger et al. (2005) define the physiological rest or dormancy as the period during which buds of the rhizomes do not present visible signs of growth, even if stored under ideal sprouting conditions of temperature, light, and air composition. After harvesting, seed rhizomes usually remain dormant for nearly three months in yams (Oliviera et al., 2008). After this period, if environmental conditions of temperature and light favours hormonal balance between growth promoters and growth inhibitors, first

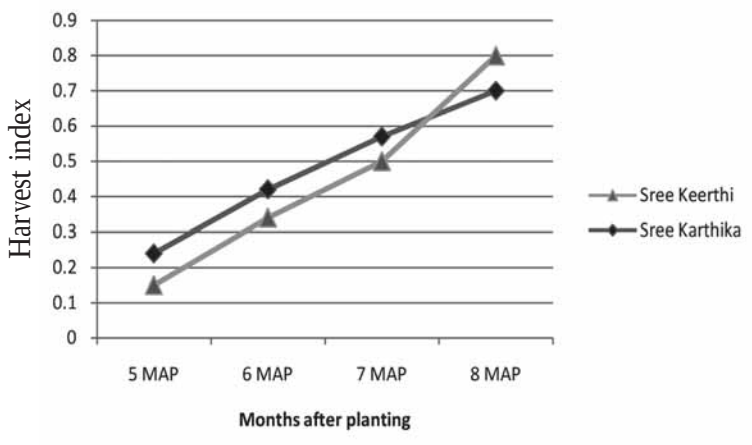

Fig. 3. Harvest indices of varieties at different stages

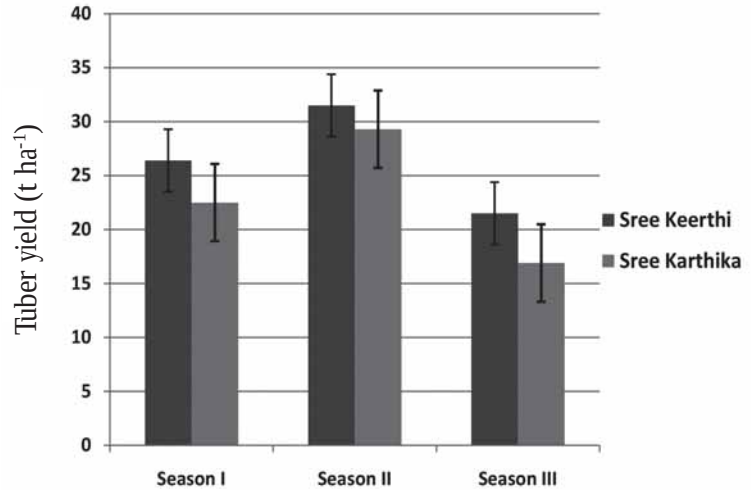

Fig. 4. Tuber yield in different seasons of planting

sprouts appear out the apical bud (Souza, 2003). Once the dormancy period is over, seed tubers sprout even in storage without planting as reported by Santos (1996). In the present study the variation in days taken for emergence is mainly due to difference in time of planting from last week of March to last week of April. Oliveira et al. (2008) also reported a linear increase in emergence of planted rhizomes with increased duration of physiological rest period until 60 days.

Though the initial growth of vines is dependent on the food reserves of planted setts, with established root system which start absorbing nutrients from soil, shoot growth and canopy development become faster during the second phase and this phase necessitates proper trailing of vines to expose the canopy to sun light. In the present study, it took 11-12 weeks for proper establishment of the canopy in both the varieties. Tuber initiation was found 88 DAP in Sree Keerthi whereas in Sree Karthika tuber initiated little early during the first two seasons. During the third season, tuber initiation was found early within 32-38 days, indicating that physiological rest period, ie., the period from harvest to the planting of next crop, highly influenced the emergence of tubers also irrespective of the time of planting. Tuber development became active by 5th month and continued to 8-9 months with maximum reaching between 6-8 months after planting. More bulking rate during 6-7 months was noted for the third crop. Okoli (1980) found tuber initiation at 3.5th month and the dry matter accumulation in tuber increased steadily up to 7.5th month and then declined towards the end of 9th month in *D.alata*. In *Dioscorea*, the plants diverted a greater proportion of their dry matter to leaves and vines up to 3 MAP and after tuber initiation, with greater allocation and efficient utilization of dry matter towards tuber growth at later phases might have resulted in higher tuber DPR at 7 MAP (Suja et al. 2000 & 2005).

Significant increments in harvest index was noted with progressive stages of growth. Tuber initiation coupled with greater partitioning and efficient use of DM towards tuber growth at later stages resulted in higher HI values at 7 and 8 MAP. However, Suja et al (2005) reported a lower HI value (0.6) for *D. alata* compared to *D. rotundata* (0.7) at 7 MAP Roy Chowdhury (1998) also reported high harvest index values for *D. rotundata* followed by *D. alata* and *D. esculenta*. In the present study fallen leaves were not taken into account for calculating HI values, thus resulted in slightly higher HI values towards the later stages. Early tuber initiation resulted in early tuber development also, thus Sree Karthika recorded high HI values up to 7 MAP compared to Sree Keerthi.

Usually senescence starts by 8-10 months of planting after cessation of rains during November to December. Hence delayed planting resulted in early senescence also. Consequently reduction in tuber yield could

be noted for third season. In the same way that seed-rhizomes with long physiological rest periods reduced plant emergence, there was also a decrease in yield (Santos, 1996). Seed-rhizomes with a post-harvest period longer than 80 days should not be used for planting as it considerably reduces tuber yield (Oliveira et al., 2008).

Conclusion

Greater yam is comparatively a long duration tuber crop having 9-10 months longevity. Time of planting of seed tubers is very important, and as per the performance of the crop, the most ideal time being second fortnight of March to first fortnight of April as the crop can utilize both the monsoons for emergence, canopy and tuber development followed by senescence. The present study indicated that the crop takes 3-4 weeks for sprouting, 10-12 weeks for canopy establishment, 11-13 weeks for tuber initiation, 33-35 weeks for senescence under humid tropical conditions. Delayed planting resulted in reduced tuber yield.

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