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Performance of Greater Yam (*Dioscorea alata* L.) Under Different Staking Systems

Greater yam (*Dioscorea alata* L.) popularly known as Ratalu and Khamalu and Chupri aloo in Hindi, is an important commercial vegetable crop grown throughout India. In India, greater yam is cultivated in the states of Andhra Pradesh, Kerala, West Bengal, Bihar, Odisha, North Eastern states, Uttar Pradesh, Tamil Nadu, Gujarat and Maharashtra (Chadha, 2002). In Gujarat, it is cultivated in Valsad, Navsari, Dangs, Panchmahals, Surat and Tapi districts. The yam tubers are rich source of carbohydrates, proteins and amino acids. Normally tubers are consumed as boiled, baked or fried vegetables. It is also useful for making chips, flakes and flour. In southern Gujarat, greater yam is used to prepare certain dishes such as 'Undhiyu' and 'Ubadiyu' especially during winter season and for making delicious 'Pakoras' during marriage ceremony. Yam tubers contain small amount of sapogenins and alkaloids like diosgenin, which are used for preparing contraceptive drugs, for curing leprosy, piles, arthritis and gonorrhea.

Greater yam is a climber and responds well to artificial support or staking. Staking is a costly practice next to seed material in commercial yam cultivation. If yams are planted without staking, the crop will be devastated by anthracnose (*Colletotrichum gloeosporioides* Penz.) disease (Chadha, 2002). Staking exposes the leaves to sunlight resulting in greater photosynthesis. In homestead farming, the yam crop can be trailed on trees. Yams are also staked on different live supports such as casuarina and bamboo poles. Intercropping yams with maize is practiced in many parts of Africa and Odisha, India. Yams are also cultivated without staking in Andhra Pradesh (Misra and Nedunchezhiyan, 2013). The objective of the prevent study was to find out suitable alternative for live staking as well as to reduce the cost of cultivation.

A field experiment was carried out at the Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, during 2011 in randomized block design with six treatments and four replications. The treatments were

T_1: Control (no staking)

T_2: Central bamboo pole staking (vines trailed on central bamboo pole through strings)

T_3: Greater yam + elephant foot yam (1 row of elephant foot yam in between 2 rows of greater yam)

T_4: Greater yam + sweet corn maize (1 row of sweet corn maize in between 2 rows of greater yam)

T_5: Greater yam + pigeon pea (1 row of pigeon pea in between 2 rows of greater yam)

T_6: Greater yam + sorghum (1 row of sorghum in between 2 rows of greater yam)

Greater yam cv. local procured from the All India Co-ordinated Research Project on Tuber Crops Centre at Regional Horticultural Research Station, Navsari, Gujarat, was used for the study. Greater yam setts of 250-300 g size and elephant foot yam cut corms of 500-750 g size were cut and dipped in a mixture of cow dung slurry with *Trichoderma viride* in order to prevent soil borne fungi. Treated setts were kept under the shade for 3 h before planting. Yam was planted as main crop at a spacing of 90 x 90 cm. The crops used for staking were sweet corn maize (cv. Madhuri) sown at a spacing of 90 x 30 cm, pigeon pea (cv. Vaishali) at 90 x 30 cm, sorghum (cv. local) at 90 x 30 cm and elephant foot yam (cv. local) planted at 90 x 90 cm. The greater yam setts were planted on ridges at a depth of 15 cm. Setts were covered properly with soil and each plot was irrigated immediately after sowing/planting. After a month, gap filling was done for maintaining uniform plant stand. Subsequent irrigations, weeding, interculturing and suitable plant protection measures were employed as and when required as per the recommended package of practices.

Vermicompost @ 1.5 t ha^{-1} and NPK @ 80:60:80 kg ha^{-1} were applied. Phosphorus was given as basal dose. Nitrogen and potash were applied in two equal splits at

3rd and 4th months after planting. The rates of application of NPK (kg ha^{-1}) for the intercrops were as follows: sweet corn maize, 120:60:0; sorghum, 80:40:0; pigeon pea, 20:40:0 and elephant foot yam, 100:50:150.

There was significant effect of staking systems on growth characters of greater yam (Table 1). The maximum number of main shoots per plant (4.17) was observed in T_5 (greater yam + pigeon pea). This could be attributed to the pattern of shoot production and branching, which in turn determines the pattern of canopy development. Greater yam usually produces only one or two main shoots. Sometimes due to disturbance to canopy growth, it produced more number of main shoots (Roy Chowdhury, 1998). Elephant foot yam provided favourable support for greater yam growth. Production of main shoots continued up to 5th and 6th months after planting. Continuous production of main shoot has been reported in different yam species (Roy Chowdhury et al., 2000).

The number of primary branches per plant were found to be non significant during the cropping period. However, the maximum number of primary branches per yam plant (5.22) was observed in T_3 (greater yam + elephant foot yam). The number of secondary branches per yam plant (4.74) and number of tertiary branches per yam plant (2.02) was maximum in the treatment T_3 (greater yam + elephant foot yam). Elephant foot yam supported the spread of greater yam foliage. This was due to more staking area developed by elephant foot yam available for yam canopy spread. In yam, secondary and tertiary branches started at 2nd and 3rd month and continued up to 5th month. Due to drying and senescence of the yam crop, primary, secondary and tertiary branches decreased at later stages of crop growth.

Light interception was significantly affected by staking systems. The effect of different staking systems on light interception of greater yam plant is presented in Table 2. The treatment, T_3 (greater yam + elephant foot yam) resulted in maximum light interception by yam plants at 90 DAP (bottom, 33.76%; middle, 66.03%), 120 DAP (bottom, 29.24%; middle, 58.56%) and 150 DAP (bottom, 24.63%; middle 62.81%). The efficiency of interception of solar radiation depends on the crop canopy (Rodriguez et al., 2001). Ironically, at later stage (150 DAP) light transmission to the lower canopy decreased drastically due to more leaf production by greater yam in all the staking systems. When no staking was done, vines were trailing on the ground and the leaves were horizontally oriented in 1-3 overlapping layers. Most of the incident solar radiation was intercepted at

Table 1. Influence of staking systems on canopy development of greater yam

Treatments	Staking systems	Main shoots	Primary branches	Secondary branches	Tertiary branches
		Number $plant^{-1}$			
T_1	Control (no staking)	4.05	4.49	3.21	1.74
T_2	Central bamboo pole staking (vines trailed on central bamboo pole through strings)	3.28	5.08	4.36	2.02
T_3	Greater yam + elephant foot yam (1 row of elephant foot yam in between 2 rows of greater yam)	3.20	5.22	4.74	2.02
T_4	Greater yam + sweet corn maize (1 row of sweet corn maize in between 2 rows of greater yam)	3.33	4.70	3.61	1.99
T_5	Greater yam + pigeon pea (1 row of pigeon pea in between 2 rows of greater yam)	4.17	4.37	2.94	1.47
T_6	Greater yam + sorghum (1 row of sorghum in between 2 rows of greater yam)	3.55	4.52	3.47	1.92
C.D. (0.05)		0.63	NS	0.46	0.27

Table 2. Percentage of light interception of greater yam in different staking systems at 90, 120 and 150 days after planting

Treatments	Staking systems	90 DAP		120 DAP		150 DAP	
		Bottom	Middle	Bottom	Middle	Bottom	Middle
T_1	Control (no staking)	27.98	55.45	23.87	49.31	20.44	40.92
T_2	Central bamboo pole staking (vines trailed on central bamboo pole through strings)	33.15	62.59	28.06	56.77	24.19	59.15
T_3	Greater yam + elephant foot yam (1 row of elephant foot yam in between 2 rows of greater yam)	33.76	66.03	29.24	58.56	24.63	62.81
T_4	Greater yam + sweet corn maize (1 row of sweet corn maize in between 2 rows of greater yam)	32.82	59.75	27.17	56.44	23.37	55.62
T_5	Greater yam + pigeon pea (1 row of pigeon pea in between 2 rows of greater yam)	22.87	52.86	21.10	46.91	18.30	40.76
T_6	Greater yam + sorghum (1 row of sorghum in between 2 rows of greater yam)	28.93	59.03	24.39	51.08	21.06	43.44
C.D. (0.05)		2.16	7.80	2.37	6.04	2.15	5.56

the top 1-2 layer only. Very little quantity of diffused light reached the lower layers and for most of the period it was shaded. Thus, light interception in greater yam without staking was found to be highest at early stage, whereas during later stages senescence of lower leaves (caused due to mutual shading) decreased the light interception.

The staking systems significantly affected the tuber yield of greater yam (Table 3). The maximum tuber girth (30.15 cm), tuber length (13.49 cm) and tuber yield (14.83 t ha^{-1}) was obtained in T_3 (greater yam + elephant foot yam). The treatment T_5 (greater yam + pigeon pea) resulted in minimum tuber girth, tuber length and tuber yield (17.47 cm, 8.34 cm and 2.25 t ha^{-1}, respectively). The tuber length and tuber yield of the treatments, T_2 (central bamboo pole staking) and T_3 (greater yam + elephant foot yam) were on par. The highest tuber yield was observed under greater yam + elephant foot yam (T_3) staking method. This increase in yield of greater yam was due to vertical spread of the foliage up to the height of the elephant foot yam.

The data pertaining to intercrop yield are also given in Table 3. The intercrop yields were as follows: elephant foot yam, 2.41 t ha^{-1}; sweet corn maize, 2.6 t ha^{-1}; pigeon pea, 2.84 t ha^{-1} and sorghum, 6.75 t ha^{-1}. The tuber equivalent yield and production efficiency of tuber were significantly affected by staking systems. The tuber equivalent yield varied from 3198.18 to 18049.42 kg ha^{-1}. The higher tuber equivalent yield (18049.42 kg ha^{-1}) was obtained in the treatment, T_3 (greater yam + elephant foot yam), while minimum yield (3198.18 kg) was in the treatment, T_5 (greater yam + pigeon pea). This can be attributed to the higher yield of greater yam in addition to the yield of elephant foot yam. The maximum production efficiency of tuber (59.96 kg ha^{-1} day^{-1}) was observed in the treatment, T_3 (greater yam +

Table 3. Yield of greater yam in different staking systems

Treatments	Staking systems	Tuber girth (cm)	Tuber length (cm)	Tuber yield (t ha^{-1})	Inter crop yield (kg ha^{-1})	Conversion of inter crop yield to greater yam yield (kg ha^{-1})	Tuber equivalent yield (kg ha^{-1})	Production efficiency (kg ha^{-1} day^{-1})
T_1	Control (no staking)	22.38	10.70	3.56	-	-	3564.62	11.84
T_2	Central bamboo pole staking (vines trailed on central bamboo pole through strings)	25.33	12.16	14.58	-	-	14582.53	48.45
T_3	Greater yam + elephant foot yam (1 row of elephant foot yam in between 2 rows of greater yam)	30.15	13.49	14.83	24149.91	3219.99	18049.42	59.96
T_4	Greater yam + sweet corn maize (1 row of sweet corn maize in between 2 rows of greater yam)	24.09	11.56	7.62	2596.45	216.37	7839.41	26.04
T_5	Greater yam + pigeon pea (1 row of pigeon pea in between 2 rows of greater yam)	17.47	8.34	2.25	2835.65	945.22	3198.18	10.63
T_6	Greater yam + sorghum (1 row of sorghum in between 2 rows of greater yam)	22.31	11.33	6.79	675.15	225.05	7014.80	23.30
C.D. (0.05)		2.45	1.41	1.31	-	-	1369.61	4.55

elephant foot yam. This might be due to the better growth characters, less competition between the species for resources and less allelopathic effect, when different species were alternated. Present findings were in agreement with the earlier findings of Gyansaeasmon (2000), Rodriguez (2000) and Nedunchezhiyan et al. (2008).

The economics in terms of gross and net return for different staking systems is presented in Table 4. The different staking systems were more or less good in terms of benefit: cost ratio, except T_1 and T_5. This indicated that the cultivation of greater yam without staking as well as with pigeon pea as live staking is not economical under south Gujarat conditions. The live staking of greater yam with elephant foot yam (T_3) (1 row of elephant foot yam in between 2 rows of greater yam) resulted in tuber equivalent yield of 18.05 t ha^{-1} and resulted in maximum benefit: cost ratio of 4.52, which was closely followed by the treatment T_4 (greater yam + sweet corn maize) with a tuber equivalent yield of 7.84 t ha^{-1} and benefit: cost ratio of 3.59. The present findings are in agreement with those reported by Nedunchezhiyan et al. (2008). It is concluded that the live staking with elephant foot yam and sweet corn maize had positive effects on growth, yield and economics of greater yam. By this way, we can also reduce the cost of cultivation of greater yam.

Table 4. Economics of staking systems in greater yam

Treatments	Staking systems	Tuber equivalent yield (kg ha^{-1})	Gross cost (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	Benefit : Cost ratio
T_1	Control (no staking)	3564.62	92160.52	213877.20	121716.68	1.32
T_2	Central bamboo pole staking (vines trailed on central bamboo pole through strings)	14582.53	277520.52	874951.80	597431.28	2.15
T_3	Greater yam + elephant foot yam (1 row of elephant foot yam in between 2 rows of greater yam)	18049.42	196245.21	1082965.20	886719.99	4.52
T_4	Greater yam + sweet corn maize (1 row of sweet corn maize in between 2 rows of greater yam)	7839.41	102452.68	470364.60	367911.92	3.59
T_5	Greater yam + pigeon pea (1 row of pigeon pea in between 2 rows of greater yam)	3198.18	101260.08	191890.80	90630.72	0.90
T_6	Greater yam + sorghum (1 row of sorghum in between 2 rows of greater yam)	7014.80	101070.14	420888.00	319817.86	3.16

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