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Effect of Date of Planting on Growth, Yield and Economics of Sweet Potato (*Ipomoea batatas* L.) Varieties in Keonjhar District of Odisha, India

N. Mishra*, T.R. Mohanty, M. Ray and S. Das

Regional Research and Technology Transfer Station (OUAT), Keonjhar, Odisha, India

**Corresponding author*

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A B S T R A C T

Sweet potato (*Ipomea batatas* L.) is one of the most important tuber crops of tropical and sub-tropical countries which belong to the family Convolvulaceae. The present study was conducted to assess the appropriate planting time and suitable variety of sweet potato for Keonjhar district of Odisha. Four sweet potato varieties (Kishan, ST-13, ST-14 and Local Check) were planted in three different dates (20 July, 30 July and 9 August) in factorial randomized block design with three replications. Among the varieties, 'Kishan' produced the highest yield of (41.92 t ha^{-1}) with B:C ratio of 3.0. Among three dates of plantings, sweet potato planted on 9 Aug shown the highest yield (31.93 t ha^{-1}) which was at par with 20 July, planting (29.89 t ha^{-1}). However, Kishan variety planted on 20 July registered the highest yield (57.03 t ha^{-1}) with B:C ratio of 4.1.It was also noticed that sweet potato varieties ST-13, ST-14 and Local Check responded better to delayed planting whereas variety Kishan responded well to early date of planting i.e. 20 July.

Introduction

Sweet potato (*Ipomoea batatas* L.) is amongst the oldest crops in the world, especially in the wet tropics, and was among the first staple crops before the introduction of cereals (Mosta *et al.*, 2015). Now, globally, it is considered an important, versatile and underutilized food security crop especially in developing countries (Bovell-Benjamin, 2007; Woolfe, 1992 and Laurie *et al.*, 2015). Sweet potato has a wide ecological adaptation, drought tolerance and a short maturity period of 3 to 5 months (Agili, 2012; Ezumah *et al.*, 1987). It can also be harvested sequentially, thus ensuring continuous food availability and access, an important dimension of food security.

Tubers are main usable part of the sweet potato, although leaves can also be used. The main nutritional material in sweet potato tubers are carbohydrates (starch 15-28% and sugars 3-6 %, Harvat *et al.*, 1991), protein, dietary fibre, fat and fat-soluble vitamins. Moreover, cultivars with a yellow flesh also contain significant amounts of carotenes (Maloney *et al.*, 2012 and Allen *et al.* 2012). In addition to these, it has a long shelf life of about two to three months which is advantageous for resource poor people who have no specialised food storage equipment

(Wang *et al.* 1999). Mid-season and terminal droughts can reduce the sweet potato yield but there is no chance of crop failure (Nedunchezhiyan *et al.*, 2010).

Among the Asian countries, China rank first in area and production and accounts 80 percent of worlds production (Allolli*et al.*, 2011). India is the largest sweet potato producer in South Asia and occupies sixth position in the world with an area of 0.14 million hectare and annual production of 1.7 million tonnes and the productivity of 8.3 t ha^{-1}. In India the districts of Odisha, Bihar and Uttar Pradesh account for89 percent area and 88 per cent production (Allolli*et al.*, 2011).Odisha tops in area as well as production of sweet potato among all the states of India (Vanitha *et al.,* 2013). As it is grown in most of the districts in Odisha, farmers are raising local cultivars with traditional cultivation practices. Therefore, average productivity of sweet potato in Odisha is only 9.3 t ha^{-1} compared to the Asian average of 15 t ha^{-1} (Maharana *et al.*, 2015).

Sweet potato is a dominant kharif vegetable in Keonjhar and cultivated in 2700ha of Keonjhar and it is among the top five sweet potato growing districts of Odisha (Fig. 1). But, Farmers receive low yield and income in this crop due to cultivation of local varieties and improper planting time. So, the study aimed at identifying the most appropriate planting dates for three high yielding potential sweet potato varieties for optimum yields under rain-fed farming systems in Keonjhar district of Odisha.

Materials and Methods

The experiment was conducted at experimental field of Regional Research and Technology Transfer Station, Keonjhar during Kharif 2016. It is situated at 21° 37' 44.1588" N of latitude and 85° 34' 54.0768" E longitude in North Central Plateau zone of Odisha. The texture ofthe soil was loamy sand, having pH 6.3 and EC 0.05 dS/m. The initial status of soil was Organic carbon0.70% and the available N, P and K was 159.0 kg/ha, 9.0 kg/ha and 120.0 kg/ha respectively.

Weather parameters

The rainfall recorded during the cropping season of 1st (20 July to 20 Nov.) date of planting, 2nd date of planting (30 July to 30 Nov.) and 3rd date of planting (9 Aug. to 9 Dec.) are 433.3 mm, 683.6 mm and 475 mm respectively. The maximum and minimum temperature of 1st, 2nd, and 3rd date of planting is 30.19 ^{0}C and 21.04 ^{0}C, 30.10 ^{0}C and 20.20 ^{0}C and 29.96 ^{0}C and 19.47 ^{0}C respectively. The average of monthly maximum and minimum temperature, total monthly rain fall and total number of rainy day were presented in Figure 2.

Experimental design

The experiment received 12 treatments (four varieties and three date of planting) in Factorial Randomised Block Design with three replications. The four varieties were: V_1- Kishan (A pink skinned clonal selection, suitable for rainfed as well as irrigated medium to uplands, V_2- ST-13 (An exotic variety introduced from Japan, purple colour flesh variety, rich in anthocyanin, V_3- ST-14 (Cream skin and orange fleshed variety rich in β- carotene and suitable for rainfed as well as irrigated area) and the fourth one V_4- Local Check (A pink skinned local variety) and three date of planting were 20 July, 30 July and 9 August.

Vine cuttings of 30 cm long were used as planting materials. The planting materials of variety Kishan, ST-13 and ST-14 were collected from CTCRI, Bhubaneswar and the

local check variety was collected locally. Each treatment consists of 5 rows and 10 plants per row. The ridges were made at 60 cm apart and vines were planted in ridges with a plant to plant spacing of 25 cm. FYM @ 10 t ha^{-1} was applied in the field during last ploughing and 40:60:80 Kg N:P:K was applied as basal and the rest 40 Kg of nitrogen was top dressed 30 days after planting. Weeds of the experimental plots were controlled by three times light hoeing and hand weeding at three weeks interval. The trial was done in rainy season but need based irrigation was applied to the crop.

Harvesting was done four months after planting and yield measured (Table 1). Five randomly selected plants from each plot were peg marked. The plants were uprooted upon maturity (four months after planting) and data on above ground biomass(g), below ground biomass (storage roots)(g)/plant, yield, tuber length(cm), tuber girth (cm) were recorded plot wise and presented in Table 1. The net return (gross return- cost of cultivation) and return per rupee invested (Gross return/ cost of cultivation) were calculated on the basis of prevailing market price of different inputs and outputs. The data recorded during post-harvest stages were analyzed statistically by applying Analysis of variance (ANOVA) technique for factorial RBD (Gomez and Gomez, 1984).

Results and Discussion

Above ground plant biomass showed significant difference among planting dates. Sweet potato planted on 30 July resulted the highest weight of the above ground plant parts (766.75 g) which was significantly higher than planting of 20 July (662.32 g) and 9 August (436.83 g). This might be due to the sweet potato plants planted on July 30 (D_2) received more rainfall than other two dates which promotes more vegetative growth of the crop. Martin (1987) also confirmed that the smallest yield occurred after periods of heavy rains when vines were growing vigorously. Among varieties, the highest above ground plant biomass was found in variety Kishan which was significantly superior to other varieties. However, the lowest value was recorded in V_2(ST-13). Among interaction effects the variety Kishan planted in July 30 produced the highest above ground biomass (1461.33 g) which was significantly much higher than rest other combinations. However, the lowest value was recorded in the treatment in which variety ST-13 was planted on 9 August (D_3V_2). The result corroborates the findings of Haynes *et al*., (1967), Gollifer (1980), Martin (1987) and Allolli *et al.,* (2011).

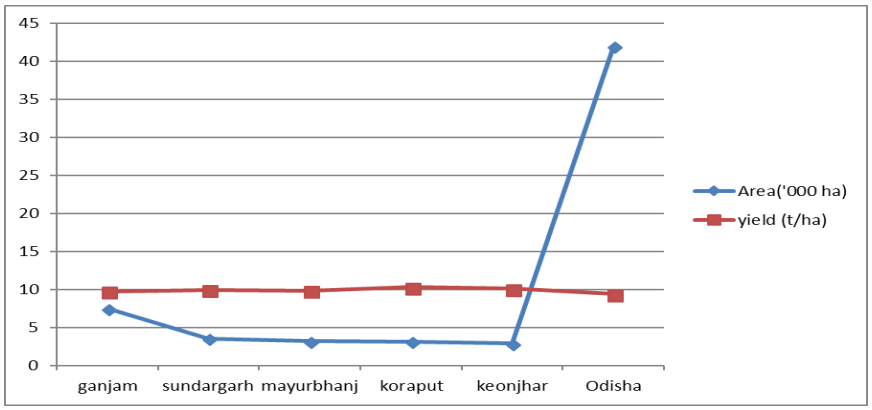
The total number of storage tubers per plant was found to be the highest on 30 July planting (7.11) which were significantly higher than rest other treatments. However, this date of planting (30 July) recorded the lowest tuber weight of 395.42 g, which was due to production of more number of poor quality, small sized (with lowest average tuber length14.98 cm and girth 13.45 cm), unmarketable tuber. This might be due to water logging condition of the soil caused by heavy rainfall resulted poor growth of storage root (Fredrick *et al.,* 1996).

Martin (1987) also confirmed that there was a negative correlation of root weight with rainfall. On the other hand, 20 July planting (D_1) produced lowest number of storage tubers (5.72) which are of good quality large sized tubers with average length of 15.14 c.m. and girth of 17.00 c.m resulted per plant yield of 448.30g.Planting of Sweet Potato on 9 August (D_3) produced the highest yield per hectare which was at par with 20 July planting (D_1).

Table.1 Effect of date of planting and variety on growth, yield and economics of sweet potato

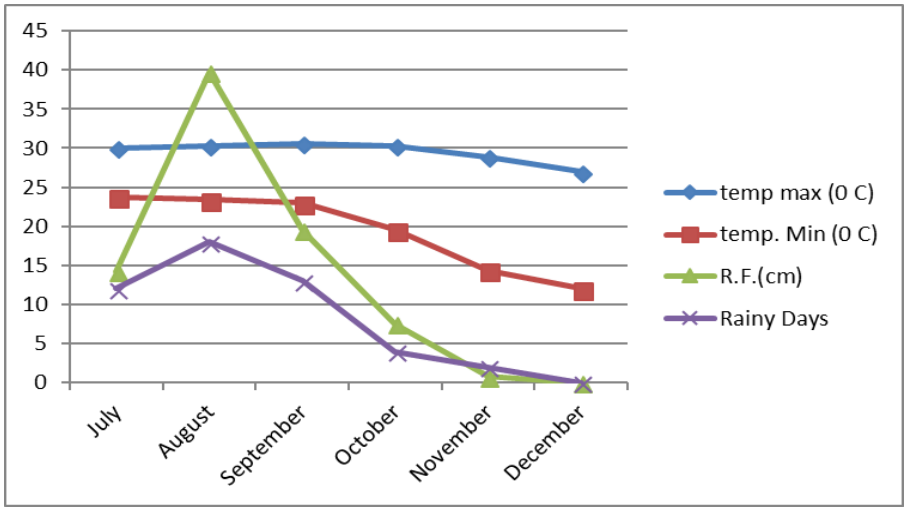
Treatments	Wt of the plants (g)	length of tuber (cm)	Girth of tuber (cm)	Total No. of tuber per plant	Total weight of tuber/plant (g)	Yield (qha^{-1})	net income	B:C
V1	934.8	17.46	17.95	5.82	628.84	419.23	196961	3.0
V2	443.78	15.98	14.61	6.31	326.33	217.56	55792	1.6
V3	506.36	13.85	15.58	4.46	329.95	219.97	57479	1.6
V4	602.93	16.81	14.95	9.31	478.38	318.92	126744	2.3
D1	662.32	15.14	17.00	5.72	448.30	298.86	112702	2.2
D2	766.75	14.98	13.45	7.11	395.42	263.61	88027	1.9
D3	436.83	17.96	16.88	6.60	478.92	319.27	126989	2.3
D1V1	823.07	14.39	21.80	5.00	855.53	570.36	302752	4.1
D1V2	554.67	16.35	13.83	7.07	343.67	229.11	63877	1.7
D1V3	528.07	12.41	17.67	2.60	257.18	171.46	23522	1.2
D1V4	776.80	17.41	14.70	8.53	336.80	224.53	60671	1.6
D2V1	1461.33	19.05	14.69	8.00	546.33	364.22	158454	2.6
D2V2	426.67	12.13	13.07	5.17	239.33	159.56	15192	1.2
D2V3	646.67	13.74	13.38	4.20	250.33	168.00	21100	1.2
D2V4	532.33	15.01	12.64	11.03	544.00	362.67	157369	2.6
D3V1	553.33	18.94	17.37	4.57	484.67	323.11	129677	2.3
D3V2	350.00	19.46	16.93	7.03	379.33	264.00	88300	1.9
D3V3	344.33	15.40	15.69	6.57	480.67	320.45	127815	2.3
D3V4	533.00	18.03	17.51	8.40	554.33	369.56	162192	2.7
CD								
D	61.89	1.42	2.03	0.76	47.04	92.62		
V	71.46	1.64	2.34	0.88	54.32	106.94		
DXV	123.78	2.84	4.05	1.52	94.08	185.23		

Fig.1 Area and Yield of Top 5 sweet potato growing districts of Odisha



(Source: Odisha agriculture statistics 2013-14)

Fig.2 Weather data during cropping period (July- Dec, 2016)



As, the quality of the produce and size of the tuber is smaller in 9 August planting (D_3),s weet potato planted on 20 July is more economical with a B:C ratio of 2.2. Among varieties variety Local check produced the highest number of tubers per plant (9.31) but lower tuber weight per plant(478.38g) indicates more number of small sized, unmarketable tubers in this variety. The variety Kishan produced highest tuber yield per plant (628.84g) with less number of good sized marketable tubers (5.82) with the highest average length (17.46 cm) and girth (17.95 cm) of the tubers. Variety Kishan also produced the highest yield (419.23 qha^{-1}) with a B:C ratio of 3.0.

The interaction revealed that variety Kishan planted on 20 July produced the highest yield per plant (855.53g) and the highest yield per hectare (570.36qha^{-1}) with a benefit-cost ratio of 4.1 which was significantly higher than rest other treatments. Planting period during the early season registered higher yields with good quality marketable tubers than the late rainy season which might be due to the reduction of sunlight hours accompanied by reduced photosynthetic activities during the late rainy season (Parr *et al.*, 2014).

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