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Harvest Index and its Relationship with Runner Yield in Swamp Taro (*Colocasia esculenta* (L.) Schott.)

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Abstract

Dry matter production and runner yield of five swamp taro cultivars, viz., BCST 23, BCST 21, BCST 2, BCST 4 and BCST 15 were studied by growing them in marshy water-logged conditions at Directorate of Water Management, Bhubaneswar, Odisha, India. The cultivar BCST 15 produced significantly highest total runner yield and runner dry matter production at 6 and 9 months after planting (MAP). The total runner yield was the lowest in BCST 2. In BCST 15 greater proportion of dry matter was diverted to the leaf and petiole at the grand growth period, i.e. 6 MAP. However, exponential increase in runner dry matter with increase in harvest index both at 6 and 9 MAP suggested that harvest index could be used as a reliable selection index in breeding programme for increasing runner dry matter and yield in swamp taro.

Key words : Leaf dry matter, marshy, petiole dry matter, runner dry matter, harvest index, swamp taro, water-logging, yield

Introduction

Taro (*Colocasia* spp.) is grown in lowlands or uplands under irrigated or rainfed conditions and the edible portion of taro is corm and cormels in *dasheen* and *eddoe* types respectively. But there are few *Colocasia* cultivars that can grow under marshy or swampy conditions, therefore known as swamp taro. Swamp taro (*Colocasia esculenta* (L.) Schott.), locally known as "panikachu lati" or "kachu lati", normally comes up in marshy or swampy conditions and a commercial crop can give an income of about Rs.52,000 per ha (Saud and Barua, 2000). The crop produces runner (stolon) which is preferred as a vegetable and is very popular in Assam, Bihar, West Bengal and adjoining Bangladesh. Depending upon cultivars, runners, leaves or petioles are used as vegetable (Roy Chowdhury et al., 2004). The crop can sustain growth in water-logged environment, tolerate brief submergence (Roy Chowdhury et al., 2010) and has better light utilization strategies even under low light conditions prevalent during cloudy monsoon (Roy Chowdhury et al., 2008; 2009).

Leaves play an important role on the productivity of taro (Roy Chowdhury, 1995; Roy Chowdhury et al., 2004). The runner yield in swamp taro was found to be significantly influenced by canopy development and dry matter production rate (Roy Chowdhury et al., 2004). Hence, strategic dry matter diversion to the economically important part i.e. runner, is imperative to augment productivity of swamp taro under water-logged or marshy conditions. Therefore, to develop better understanding of the dynamics of dry matter production in swamp taro and to identify the critical physiological trait which influences the runner production capability under water-logged conditions, dry matter partitioning to the different plant parts was studied in five swamp taro cultivars at different periods of crop growth.

Materials and Methods

A field experiment was conducted in a swampy area at the research farm of Directorate of Water Management (under Indian Council of Agricultural Research), Mendhasal (20°30' N and 87°48'10" E, Bhubaneswar, Odisha, India, from January to October during 2001. Five cultivars of swamp taro (*Colocasia esculenta* (L.) Schott.) viz., BCST 23, BCST 21, BCST 2, BCST 4 and BCST 15 were planted in a Randomized Block Design with four replications at a spacing of 60 x 75 cm during the month of January in marshy water-logged conditions. Farmyard manure @ 8 t ha^{-1} was applied at the time of field preparation and N:P:K @ 52:60:63 kg ha^{-1} were applied in three doses at 2nd, 5th and 8th month of the crop growth period. Hand weeding was done before application of fertilizers.

Biomass harvests were done at regular intervals from three plants selected at random from each plot. The samples were homogenized to minimize sample heterogeneity in the plot. The combined samples were carefully washed and the respective plant parts i.e. roots, leaves, petioles and runners were separated and dried at 70°C in hot air oven till constant weight was attained. The weight of the dried plant samples was recorded. The tender runners were harvested by selecting runners not more than 45-50 cm length. This was done as over mature runners are unacceptable in the market. The harvest of runners started from 4th month onwards and continued up to 10th month. The sum total of periodical harvests of runners was expressed as total runner yield by each cultivar.

The statistical analyses of the data were done by following standard procedures (Gomez and Gomez, 1984).

Results and Discussion

The total root dry matter in all the five swamp taro cultivars showed an increasing trend from 3 to 9 months after planting (MAP), except for cultivars BCST 23 and BCST 4. In cultivar BCST 23 there was a marginal decrease in root dry weight at 9 MAP compared to 6 MAP, whereas in cultivar BCST 4 slight decrease was evident at 6 MAP followed by an increase at 9 MAP. However, at all these periods of crop growth, the root weight did not vary significantly (Table 1). Among the cultivars, even though BCST I5 maintained greater plant height (Roy Chowdhury et al., 2004; 2010), the petiole dry matter showed different trend (Table 1). At 3 MAP, BCST 15 showed greater petiole dry matter, though on par with BCST 4, BCST 2 and BCST 23. In cultivars BCST 23, BCST 2 and BCST 4, the petiole dry matter increased to a maximum at 6 MAP and declined at 9 MAP, whereas in BCST 2 and BCST 15 the petiole dry matter increased consistently till 9 MAP. At 9 MAP, BCST 15 had the highest petiole dry weight. The cultivar BCST 15 also exhibited petiole elongation ability faster than the other cultivars in response to brief submergence (Roy Chowdhury et al., 2010). Therefore, for cultivation in low lying areas, ability of BCST 15 to allocate more dry matter to petiole at later stages of crop growth is a desirable trait (Table 1). Leaf area development is a critical component for determining crop yield (Monteith and Elston, 1983). Maintenance of greater leaf area has been found to be important for getting better yield in *eddoe* type *Colocasia* (Roy Chowdhury, 1995) and hence one of the promising traits for yield improvement (Paul and Bari, 2011). In swamp taro, leaf area index showed significant positive correlation with runner yield (Roy Chowdhury et al., 2004). But negative correlation of runner yield with leaf area ratio, i.e. proportion of leaf area per unit total dry matter produced, suggested the role of expanding canopy in controlling runner yield (Roy Chowdhuy et al., 2004). The leaf dry weight at 3 MAP was found to be the highest

Table 1. Dry weight of root and petiole of swamp taro cultivars at different periods of crop growth (under marshy conditions)

Cultivars	Root dry weight (g $plant^{-1}$)			Petiole dry weight (g $plant^{-1}$)		
	3 (MAP)	6 (MAP)	9 (MAP)	3 (MAP)	6 (MAP)	9 (MAP)
BCST 23	1.08	1.33	0.94	3.42	7.57	5.80
BCST 21	0.94	1.54	1.81	2.47	6.98	5.10
BCST 2	0.88	1.18	1.63	3.39	5.86	6.13
BCST 4	1.11	0.99	1.24	3.64	7.89	6.44
BCST 15	0.96	1.07	1.52	3.80	6.43	7.34
CD (0.05)	NS	NS	NS	0.82	1.23	1.89

Table 2. Dry weight of leaf and runner and total runner yield of swamp taro cultivars at different periods of crop growth (under marshy conditions)

Cultivars	Leaf dry weight (g plant^{-1})			Runner dry weight (g plant^{-1})		Runner yield (t ha^{-1})
	3 MAP	6 MAP	9 MAP	6 MAP	9 MAP	
BCST 23	2.90	10.58	2.81	12.47	4.57	9.16
BCST 21	2.13	11.01	1.91	22.15	5.97	10.19
BCST 2	2.30	8.98	2.55	12.81	1.77	5.34
BCST 4	1.98	11.90	2.55	18.72	2.60	11.63
BCST 15	2.21	12.47	2.83	30.53	6.11	19.95
CD (0.05)	0.48	2.19	0.82	8.49	2.07	3.63

in BCST 23 (Table 2). At 6 MAP, leaf dry weight increased in all the five cultivars and the extent of increase was the highest in BCST 15 followed by BCST 4. The increase in dry matter allocation to the leaf at 6 MAP is presumably due to greater leaf area during the growth period (Roy Chowdhury et al., 2004). However, at 9 MAP, the dry matter allocation to the leaf decreased in all the five cultivars, while the cultivar BCST 15 maintained the highest leaf dry matter compared to the other cultivars (Table 2). The cultivar BCST 15 has been reported to maintain larger leaf area (Roy Chowdhury et al., 2004; 2010) and also longer leaf area duration (Roy Chowdhury et al., 2004) and is corroborated with high dry matter distribution to the leaves. The production of runners started from 4 MAP. However, runner yield increased significantly from 5 MAP reaching its peak at 7th month during peak monsoon period of July-August, which is a lean period for availability of other vegetables in the market. At the beginning of peak production at 6 MAP, the runner dry matter was the highest in BCST 15 followed by BCST 21 and BCST 4 and the lowest in BCST 2 and BCST 23 (Table 2). The runner yield as well as dry matter decreased from 8th month onwards. The runner dry matter at 9 MAP decreased in all the cultivars while the cultivar BCST 15 maintained the highest

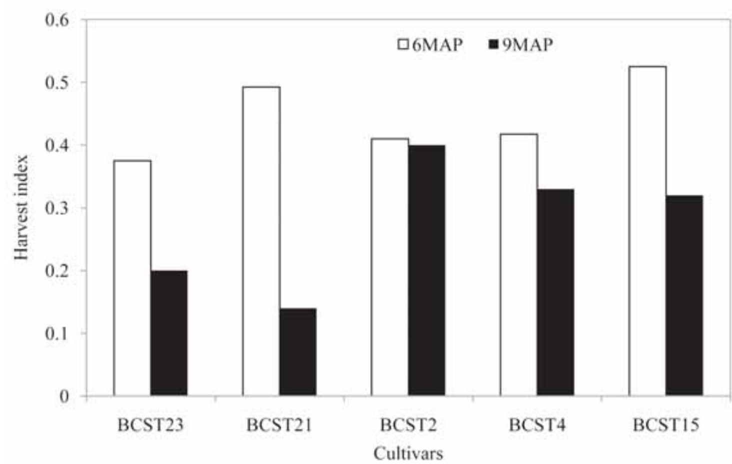

Fig.1. Harvest index at 6 and 9 MAP in swamp taro cultivars

runner dry matter compared to the other cultivars. The cultivar BCST 15 produced the significantly highest total runner yield (19.95 t ha^{-1}) and it was lowest in BCST 23 and BCST 2 (9.16 and 5.34 t ha^{-1} respectively) (Table 2). In general, the harvest index was considerably higher at 6th month than at 9th month in all the cultivars, except for cultivar BCST 2, where it was only slightly higher (Fig. 1). At 6th month, harvest index was significantly highest in BCST 15 and at 9th month it was highest in BCST 2 (Fig.1). The intercultivar relationship between runner dry matter and harvest index at 6 MAP showed exponential increase in runner dry matter (Y) with increase in harvest index (x) where $Y = 1.919e^{5.008x}$; $R^2 = 0.82^*$ (Fig. 2a). The relationship remained identical at 9 MAP also i.e. $Y = e^{4.670x}$; $R^2 = 0.86^*$ (Fig. 2b). Based on harvest index and total runner yield, BCST 15 can be adjudged as an ideal genotype for marshy conditions. The trait of harvest index has been extensively utilized in cereals and other crops for yield improvement (Hay, 1995; Sinclair, 1998). Therefore, harvest index at grand

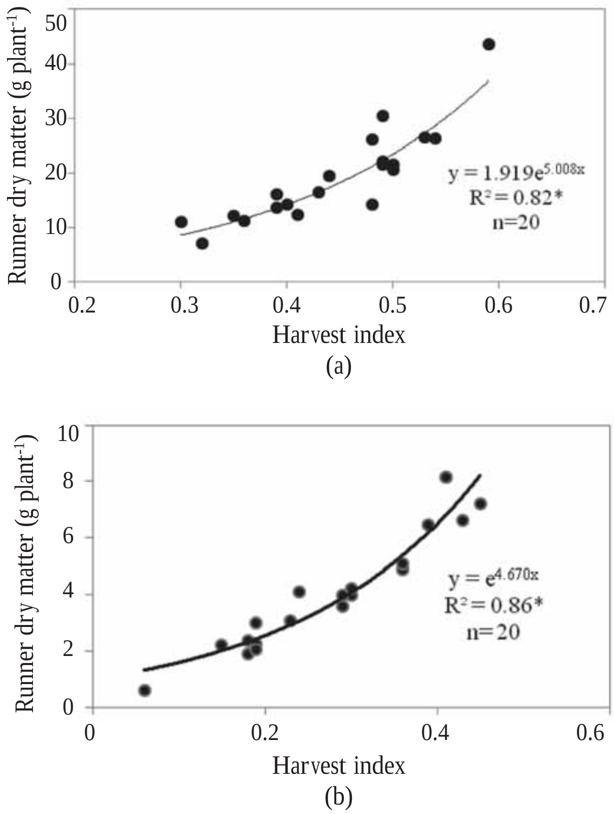

Fig.2. The relationship between runner dry matter and harvest index at 6 (a) and 9 MAP (b) in swamp taro cultivars

growth period or the peak runner producing period (5-7 MAP) can be used as a target trait in yield improvement programme (for higher runner fresh yield and dry matter) of swamp taro cultivars under water-logged conditions.

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