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Harvest Index in Productivity Management

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Abstract

Optimum diversion oftotal Biomassmanufactured by plants to parts supporting economic end product is vital in commercial agriculture. The fraction of bio mass used for economic end product out of total biomass manufactured by the plants is termed as Harvest index Factors that decide optimization of Harvest index for maximizing productivity in terms of economic end product vary with crops and their relevance In Tea cultivation are brought out in this paper.The physiological concepts have helped Agronomist to formulate guide lines for managing Harvest in Tea culture

Keywords

Harvest index. Biomass apportioning, productivity

Introduction

Plant growth could be defined as the continual addition of biomass to various parts. It has two stages ;!) fixing carbon – photosynthesis and manufacture of carbohydrates, 11) conversion of them to various organic chemicals by fixing Nitrogen, Phosphorus, Sulfur, and Calcium in various bio-cycles controlled by specific enzymes and associated mineral nutrients Biomass production therefore is a function of 1) climate, defined in terms of rainfall, sun shine hours and temperatue,2) photo synthetic area expressed as leaf area index by Plant physiologist or as density of planting by Agronomist 3) nutrients for biomass production. and 4) soil factors for nutrient and water retentivity and release of them to plant growth.Bio-mass produced is used for overall growth of plants and only a fraction of it is harvested as economic end product. Agronomic and cultural practices are evolved over the years to ensure optimal diversion of total bio-mass manufactured by the plants to maximize harvest of economic end product for which a particular crop is grown. In this article the discussions are limited to Tea. The economic end product in Tea is the growing points and the harvest index aims in keeping the health of plant by balancing diversion of biomass to growing pointsagainst their continual removal as harvest and, to other parts for overall growth and enough retention of foliage for supporting new growing points.

Biomass apportioning in TEA

A typical apportioning of biomass in tea is given in Table-1

In young Tea before first prune ,the emphasis is on development of frame of the plants and hence harvest index is low as more biomass is needed for frame development. After the first prune when the plants are brought under regular plucking the harvest index is high. In tea,Harvest index is the fraction (expressed also as percentage) of total biomass produced in a given time that is plucked as crop to manufacture tea . The productivity in Tea could then be expressed as follows

"Productivity = MadeTea (kg ha^{-1} yr^{-1}) = Biomass produced (kg ha^{-1} yr^{-1}) * Harvest index"

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Table 1 : Apportioning of biomass to various parts in Tea

No.	Parts	Parts by weight as %			
		A	B	C	D
1	Plucks (made Tea)	12.5	8.0	20.0	22.0
2	Foliage on the bush	15.0	16.5	13.0	13.0
3	Fallen leaves (tea litters)	10.0	9.0	3.0	5.0
4	Wood(Stem ,Branches)	40.0	43.0	44.0	42.0
5	Roots	22,5	23.5	20.0	17.0
	Total	100.0	100.0	100.0	100.0

A,B – young tea prior to formative prune*MAGAMBO and OTHIENO 1977 Personal communication*
C,D – High yielding bushes in regular pluckingAnnual Reports UPASI TRI 1976-1986

Under unlimited supply of nutrients and good climatic condition which determine biomass production, the productivity depends on management of Harvest index Data of on crop removal, annual leaf fall, and pruning weights and root weights maintained in various nutrient trials over the years are used to study the influence of Harvest index on productivity .

Absolute/Physiological and Apparent Harvest index

Harvest index is the ratio of economic biomass to total biomass produced by the plant.IT is calculated based on total biomass produced and apportioned to all the parts of the plant including roots as show in Table 1 is called absolute Harvest index or the Physiological Harvest index. Digging the soil after pruning the plants to record root weight is laborious and carried out in limited measure to collect basic data on Harvest index. But it is easy to collect information on above ground parts at the time of pruning and it is done as a regular practice in experimental plots. Harvest index calculated based on total biomass content of above ground parts pruned is called Apparent harvest index. While interpreting and making decisions, one should keep in mind that the amount of biomass removed as prunings decrease as the pruning height increases (the pruning becomes lighter) and the values appear unrealistically high. However ,this index gives information on apportioning of biomass to growing points and non-photosynthetic parts . Wood portion removed at different degrees of severity of pruning are given and they can be used to get the absolute harvest index values Harvest index referred here afterwards in this article is apparent harvest index. Typical mean harvest index values observed in South India are shown in Table2 Generally the harvest index is low in the pruned year as more of biomass is utilized for developing new frame and foliage Harvest index is high in the second and third years of the pruning cycle and declines thereafterwards. Main reasons are ; 1) Accumulation of too much older foliage which and

Table 2 : Harvest Index (*under South Indian conditions)*

are less photo-synthetically active and use more carbohydrate than what they manufacture and, also physiologists have shown that foliage beyond a critical level enhances the diversion of biomass to non- photosynthetic parts particularly for thickening of wood and,2)the inefficient plucking due to in increase in the height of plucking surface,smallness of leaves and increased bhanjiness. Factors that have bearing on Harvest index are discussed below.

A: Pruning Cycle

The influence of length of pruning cycle is shown in Table3.

As 2nd and 3rd year fields have maximum Harvest index ,the pruning cycles are managed in such a way that the percentage of 2nd and 3rd year fields form bulk of tea area under plucking all the time

B: Plucking rounds

As plucking alone activates the buds in leaf axils below the point of plucking for future crop, the plucking interval in relation to growing conditions it plays an vital role in achieving optimum Harvest index as the growing point are stimulated by regular plucking it leads to continual syphoning of biomass to growing points. The intensity of plucking that is plucking above 90 % of pluckable shoots at the time of plucking ensures sustaining growing points at high levels. The impact of plucking rounds on Harvest Index is shown in Table4.

Longer intervals , at the outset ,may appear beneficial to increase leaf weight but actually after 10 to 12 days there is a gradual loss of weight of leaves as their photosynthetic efficiency falls and respiratory losses increase. A balance is struck for optimizing shoot weight and Harvest index and it is in between 7 and 10 days during growing season and 10 and 15 days during lean months .

Table 3 : Harvest index For the pruning cycle – influence of Type of prune

No.	Type of Prune	Length of cycle in years				
		2	3	4	5	6
1	Medium Prune	21.9	24.2	24.8	23.9	23.0
2	Light prune, cut across prunes	22.4	24.5	25.6	24.5	23.4

Harvest index (%) based on total biomass of above ground parts at the time of pruning

C: Style and standard of Plucking

There are two facets of plucking- what is taken away for manufacture and what is left behind for supporting future crop. The former is termed as 'Standard of plucking'- finemedium and coarse depending on the proportion of two leaf and a bud, three leaf and a bud, coarser than 3 leaf and a bud and banjhi leaves.The later is termed 'style of plucking', light, hard and combination of both of them and refers at what level the pluckings are done. The former is important for quality control and it is related to type of manufacture practiced. How style and standard of plucking affect the harvest index is shown in Table 5.

The light plucking is done over a fish leave or mother leaf from where the plucked leaf originated. Hard plucking refers to plucking over a scale leaf from where the mother leaf originated thus the style of plucking is related to the depth at which plucking is carried out. Light plucking ensures the health of tea bushes as adequate foliage is left on the surface to support future crop .If more foliage than what it is required to support the plucking points is left on the surface , then the biomass will be diverted to non-

Table 4 : Harvest index-influence of plucking interval

Table 5 : Harvest index-influence of Style and Standard of plucking

No.	Standard of plucking	Light Plucking A	Hard Plucking B	Combination A & B
1	Fine	25.0	35.0	32.0
2	Medium Plucking	23.0	33.0	30.0
3	Coarse Plucking	20.0	30.0	27.0

Harvest index (%) based on total biomass of above ground parts at the time of pruning

Table 6 : Optimal ratios of Biomass apportioned to various parts

No.	Ratio between	Ratio
1	Shoot :root	2.5 to 4.5 : 1
2	Wood : Maintenance Foliage	2.0 to 3.5 : 1
3	Maintenance Foliage : Harvested crop in a year	0.8 to 1.2 : 1
4	Non-photosynthetic Parts : Photosynthetic parts	1.5 to 4.0 : 1
5	Non-photosynthetic Parts :Maintenance foliage	2.5 to 4.5 : 1

Non-photosynthetic Parts - wood (Stem + branches) + roots
Photosynthetic parts –Foliage on the bush (Maintenance Foliage) + harvested crop (growing points)

photosynthetic parts which on long run become sinks for biomass at the cost of growing points resulting in reduction in Harvest index. On the other hand Hard plucking stimulates diversion of biomass to growing points bestowing positive effect on Harvest Index , But continual hard plucking weaken the bushes as enough biomass is not diverted for non - photosynthetic parts for their sustenance. Therefore, in practice, a balance is struck between harvesting and retention of optimum foliage on the surface for health of the bush and adequate photo synthetic surface to support the next generation of crop. It is achieved by adopting a system in which a combination of light and hard styles are followed depending on weather conditions ,i.e., Hard plucking during rush season when the growing conditions favors high rate of biomass production and light plucking during dry or lean months when the growth is slow.

D: Leaf Area Index

Optimal ratios exist between various parts o f a plant. They are divided mainly into two groups -non-photosynthetic and Photosynthetic ones The ratio between them is important as it decides the health of the plant and the harvest of the economic end product. In tea, the economic end product is the growing points–buds, one leaf and a bud, two leaf and a bud and three leaf and a bud. Biomass has to flowcontinually to growing points without affecting the supply to other parts for their specific activities. The ratios found in yielding Tea are given in Table 6.

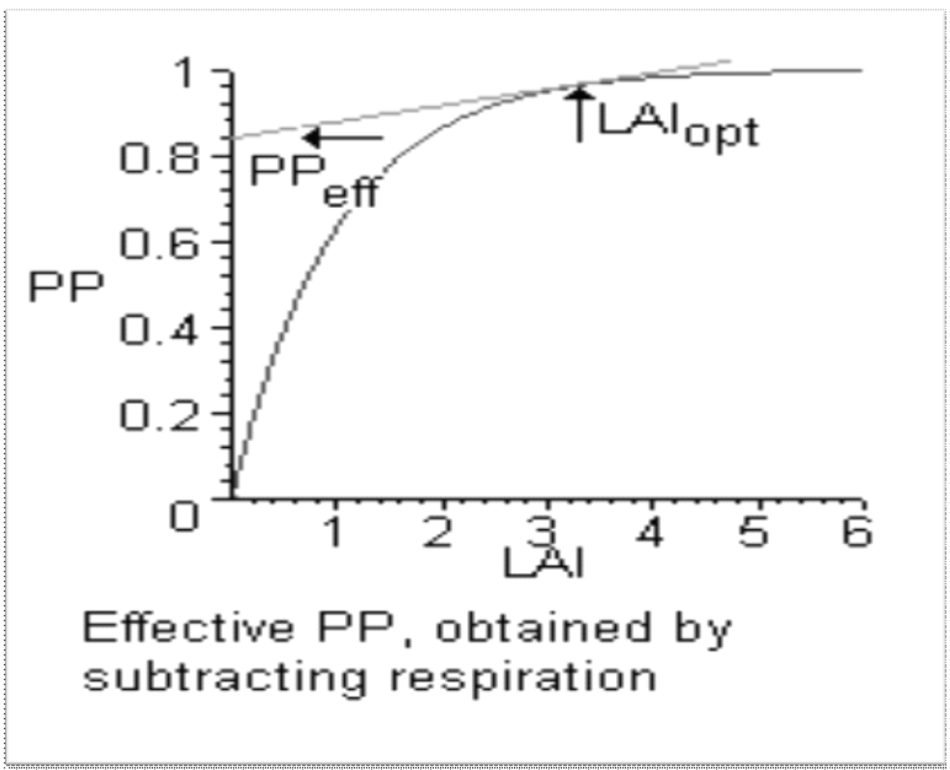
Roots act as sink for carbohydrates when the growing conditions are not favorable as in dry months This also helps in restoring growth rates when the conditions turn favorable for growth and also for recovery of bushes after the prune.Shoot- root ratio thus becomes important in storing and distributing carbohydrates to various parts for their sustained activities .

E: Physiological aspects

Metabolic and growth studies by Physiologists have shown that the net growth rate (or biomass accumulation) increases with leaf area index up to an optimal level and then decreases up to a ceiling value, after which there is a negative growth and debilitation starts.(Fig-1)

Increasing the leaf area index beyond an optimum limit increases the fattening of non-photosynthetic parts resulting in more respiratory losses of carbohydrates .In tea optimum yield occurs before optimal leaf area forhighest net growth rate is achieved. Any plucking policy in Tea culture should aim at keeping the leaf area index below the optimum

Fig. 1 : Leaf Area Index vs. primary product function the free encyclopedia Version ID: (641194753 2015 13:10 UTC)



negative effect on Harvest index on the long run.

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