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Pruning in guava (*Psidium guajava*) and appraisal of consequent flowering phenology using modified BBCH scale

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ABSTRACT

The guava (*Psidium guajava* L.) shows well defined phenological stages during growth, flowering and fruiting stages depending upon climatic conditions which of course is amenable to manipulations through cultural interventions. The BBCH scale (Biologische Bundesantalt Bundessortenant and Chemiscle Industrie) is used for recording the data of the different phenological stages in coded form starting from bud development, vegetative stages, floral stages and ends in fruit maturity. Pruning is an important tool for increasing the production but it impacts the normal phenological stages by causing variation in the occurrence of principal and secondary stages. Therefore, the normal BBCH scale proves to be erroneous. In order to assess the quantum of variation on the normal phenology, an experiment was carried out in the guava cv. Lalit for collection of phenological data using the traditional nomenclature described by Fleckinger (1945) and to relate them to the BBCH general scale in pruned or unpruned trees. Significant variation in the principal growth stages was observed as a result of pruning during February, May and September. The duration between the pruning and the beginning bud sprout was from 11 to 15 days during different times of pruning. In contrast, the control unpruned tree showed bud emergence within 2-3 days. The flowering in February and September pruned trees ranged from 78 to 93 days from flower opening and took 153 and 150 days, respectively, for the fruit ripeness as compared to control (129-146 days). Interestingly, beginning of bud sprout occurred in 7 days in May pruning as compared to 3 days in control and the 50 % flowering was hastened and occurred in 43 days and fruit ripening took 136 days. Thus the normal BBCH scale proved to be erroneous in trees subjected to pruning. Phenology of guava according to the traditional Fleckinger Code and the aberrations in the BBCH General Scale resulting from pruning is described in this paper.

Key words: Flowering, Guava, Modified BBCH scale, Phenology, *Psidium guajava*

The guava (*Psidium guajava* L.) is an evergreen fruit species well adapted to a wide range of soils and agro climates and acclaimed as 'Super fruit' owing to its high nutritional and nutraceutical profile. Under the present climate change scenario, timely implementation of precise crop management practices are important to make guava production profitable. The sequence of all periodical events involved in a plant life cycle (phenology) are used to monitor and evaluate plant development and the interval between blooming and fruit ripening are the most important phenological stages (Schwartz 1999). In 1945, Fleckinger defined "phenological stages" as external physiological changes occurring at specific periods of time, which coincide with the natural growth cycle. Phenological studies are important for understanding the influence of the weather dynamics on the vegetative and reproductive growth period. In order to decide the best suitable time of each cultural operation the phenological stages should be clearly defined. It helps the growers in precise decision making to adopt cultural practice in a particular time frame. The BBCH scale (Biologische Bundesantalt Bundessortenant and Chemiscle Industrie) is used for recording the data of the different phenological stages in coded form starting from bud development, vegetative stages floral stages and ends in fruit maturity. Each principle growth stage is classified into secondary growth stages that describe the shorter developmental interval in the major stage and is based on a code system. The method is basically a decimal system that identifies different developmental stages by a two digit code. Both the digits (referring to major and minor stages) use values between zero and nine.

Under natural conditions, guava tree produces flowers and fruits thrice in a year in Northern India (Rathore 1976). The spring season flowering begins during February-March for harvesting during July-September (rainy season). Likewise, monsoon season flowering begins during June-July and fruiting during November-January (winter season) while winter flowering occurs during October-November

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and fruiting during March-April. Guava tree bears flowers and a fruits on the current season recently matured shoots either from lateral buds on older wood or shoot terminals (Crane and Balerdi 2005, Pratibha and Goswami 2013 and Thakre *et al.* 2013). Therefore, increase in the number of current season new shoots has a significant impact on the production. Pruning is an important tool for increasing the fruiting units in guava tree, however, it influences the normal phenological stages in particular season causing aberrations in the normal BBCH codes. The new BBCH General Scale, unified previous codes that were employed for some temperate and sub-tropical fruit species (Salazar *et al*. 2006, Meier *et al*. 2009, Rajan *et al*. 2011). In order to assess the quantum of variation caused on the normal phenological stages based on BBCH codes, an experiment was carried out in guava cv. 'Lalit' having pink pulp and prolific bearing habit. The collection of phenological data using the traditional nomenclature was collected and related to the BBCH General Scale in pruned or unpruned trees for assessing the best period for field operations to get high yield with best quality guava fruits under North Indian conditions.

MATERIALS AND METHODS

An orchard of guava located at ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow (elevation of 128 m above sea level and situated between 26.55^{o}N latitude and 80.59^{o}E, having coarse loam soil, mixed hyperthermic family of Typic Ustochrepts pH 7.8, low total N <0.5%, high available P >12 ppm and low K <80 ppm) was selected to study the impact of pruning on phenological changes based on BBCH scale during 2011-12 and 2012-13. The trees were planted under normal density (6m × 6m accommodating 277 trees per hectare). Uniform irrigation was provided through drip irrigation by 2 lph drippers with four drippers per tree (8 l/hr). Black polyethylene mulching with 100 micron thick sheet was done in each tree along with other cultural practices (Singh *et al.* 2015). Seven healthy trees were randomly selected and observations were recorded on 60 shoots per tree tagged in South-East direction of the canopy and replicated three times. Pruning by 50% removal of recently matured shoots were carried out in February, May and September for producing flowering and fruiting during rainy, winter and summer season, respectively. Phenological data was recorded and analysed for interpretation in order to access the suitability of the BBCH scale for describing the sequential phenological pattern under pruning vis-à-vis control trees. The observations were recorded in the three seasons of each year and all trees in the orchard were monitored to ascertain the predominant developmental stage. Depending on changing phenology, the frequency of data collection was twice a week. The principal phenological changes that occurred between bud-break and fruit maturity were also recorded photographically. After pruning different modified stages in terms of the duration of their occurrence were identified throughout the growth period, starting at bud dormancy and ending at fruit ripening. Each phenological stage was coded according to the BBCH General Scale and Fleckinger's code and the duration was measured in both days and "Growing degree days" (GDD). The latter was used to assign a heat value to each day for ascertaining the amount of heat required for the plants to move to the next phenological stage (Miller *et al*. 2001, Raoofi and Javadi 2014)) The Base temperature (16^{o}C) below which plant development stopped was subtracted from the average daily temperature. All the values were added to give an estimate of the amount of seasonal growth the plants had achieved to arrive to cumulative degree days in pruned along with unpruned plants.

RESULTS AND DISCUSSION

All the experimental trees produced flowers and fruits three times. The spring season flowering began during February-March and the fruits were harvested during July-September (rainy season). Likewise, monsoon season flowering produced fruits during November-January and the winter flowering (October- November) gave fruiting during March-April. During the study period, all the trees exhibited consistent pattern of sequential phenophases. The different stages as well as the BBCH codes and duration of occurrence of phenological stages are shown in Table 1. Variation in principal growth stages of shoots, viz. vegetative bud emergence, leaf, flower and fruit development was observed due to delay in bud emergence during the initial stages as a result of pruning. The duration between the pruning and the beginning of bud sprout (A:0) was from 11 to 15 days during different times of pruning. In contrast, the unpruned tree showed bud emergence within 2-3 days. The flowering (A:0 to F:65) ranged from 78 to 93 days during February and September pruning from the opening of flower (F:65) and took 153 and 150 days for the fruit ripeness (K:89) as compared to control (129-146 days) as shown in Fig 1 and Fig 2. Interestingly, trees pruned in May showed a different trend beginning of bud sprout in 7 days as compared to control (3 days). The 50 % flowering (F:65) was hastened and occurred in 43 days during rainy season and took 136 for fruit ripening (K:89). The difference in the occurrence of phenophases in the pruned trees as compared to control may be due to changes in the internal physiology of the pruned plants resulting from the stress due to pruning, whereas, the control trees followed the normal phenological behaviour. The difference of periods of phenophases among different times of pruning may be attributed to the fact that May pruning produced the fruits during November to January and low temperature predominant at that time delayed the process of fruit maturity and ripening increasing the fruit size, better quality and higher yield. Hence, it can be inferred from the present study that more the amount of assimilates may be diverted to the fruits and more time taken for the attainment of full size and vice versa may improve the yield. This clearly indicated the effect of pruning though delays the emergence of buds due to dormancy but hastens the post flowering phenophases which may be attributed to more

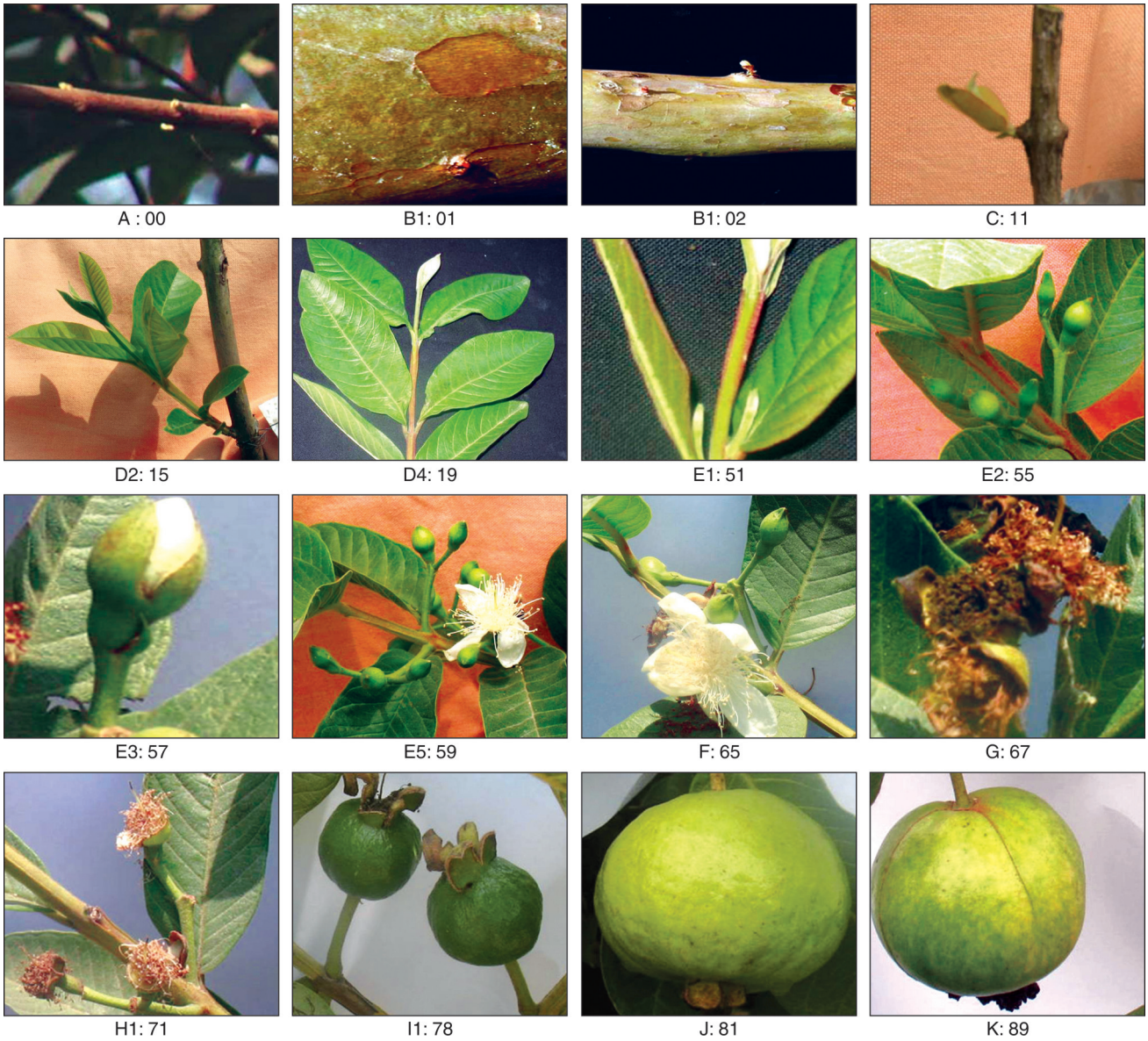

Fig 1 Phenological stages in guava *Psidium guajava*. cv. Lalit. A:00: Bud Appear : Bud is greenish brown, completely closed and firmly linked to twig. B1: 01: Bud swelling : Bud swells and becomes greenish. B2: 02: Bud growth begins : Bud elongates, scales start opening. C: 11: First leaves sprouting : First leaf appears and is visible. D2: 15: More leaves unfolded : Leaves not attain full size. D4: 19 : Leaves completely developed : Leaf growth completed. E1: 51 : Appearance of flower buds : Flower buds becomes visible, internode lengthening stops. E2: 55: Flower buds visible: Sepals still closed. E3: 57: Flower petals elongating : Sepals slightly open, petals just visible. E5: 59 : Sepals totally opened : Sepals fully extended so that petals can open. F: 65 : 50% open flowers : First petals falling. G : 67 : Petal fall : Flowers fading and most petals collapse. H1: 71 : Fruit setting : Fruit size up to 10 mm. I1: 78 : Fruit growth : Fruit increases up to 80% final size. J: 81 : Fruit colour changing : Beginning of ripening, fruit reaching the final volume, colour changes from green to pale green. K: 89 : Fruit ripening : Fruit becomes completely yellow, release pleasant aroma and ready for harvest.

photosynthate assimilation at source and reduced sink activity in the pruned shoots along with efficient translocation of assimilates from mature leaves and roots (Venkateswarlu and Visperas 1987). Enhancement in rate of photosynthesis and stomatal conductance in the pruned tree with higher yield in guava were reported by Singh and Singh (2007). The significant differences in terms of Growing Degree Days (GDD) among different times of pruning was also recorded as indicated by °C days (Table 1). The amount of heat units accumulated during a particular phenological stage may directly impact the occurrence of the subsequent stage and finally result in variation in production. Major phenological stages depicted in this study conform to those found by Salzar (2006). The current description of phenology is more appropriate since several sub-stages, viz. A:0 to B:1, B:2 to C:11, D:2 to D:4, E:1 to F65, G:67 to K:89 were aggregated in terms of °C days and modified according to temporal shift arising from pruning. The aggregation of

Table 1 Phenological codes and duration of occurrence of phenological stages and °C days in guava cv. Lalit

Phenological stages	Fleckinger code	BBCH General scale	Duration (days)								
			February pruning	Control (No pruning)	°C days	May pruning	Control (No pruning)	°C days	September pruning	Control (No pruning)	°C days
Bud appear	A	0	15	2	3.63±0.19	7	3	17.39±3.44	11	2	13.4±2.4
Bud swelling	B1	1	19	4	7.62±0.23	8	4	18.83±2.11	15	4	12.0±2.11
Bud growth begins	B2	2	28	5	9.99±0.34	14	6	16.25±3.56	26	16	10.8±2.36
First leaves sprouting	C	11	34	7	13.78±1.21	16	7	13.68±2.33	31	22	6.8±1.87
More leaves unfolded	D2	15	39	10	15.61±2.33	19	9	13.87±3.41	38	30	5.0±0.12
Leaves completely developed	D4	19	48	13	68.02±3.44	23	11	94.54±4.23	45	39	50.9±0.14
Appearance of flower buds	E1	51	54	18	18.83±2.11	28	15	14.00±2.56	56	52	0.7±0.02
Flower buds visible	E2	55	61	27	16.25±3.56	34	18	13.45±2.33	70	68	3.8±0.11
Flower petals elongating	E3	57	71	41	13.68±2.33	39	27	14.41±2.56	81	80	2.6±0.08
Sepals totally opened	E5	59	75	46	13.87±3.41	41	32	14.37±2.33	88	89	10.8±0.23
50% open flowers	F	65	78	51	77.15±4.23	43	34	67.52±3.41	93	92	17.9±1.22
Petal fall	G	67	80	58	14.00±2.56	44	36	10.03±1.71	97	95	13.1±1.11
Fruit setting	H1	71	83	63	13.45±2.33	47	40	9.02±1.08	101	98	15.4±2.25
Fruit growth (80% final size)	I1	78	144	128	14.41±1.23	119	110	4.20±0.65	138	131	16.7±4.11
Fruit colour changing	J	81	150	137	14.37±2.33	129	120	2.44±0.12	146	137	17.2±2.36
Fruit ripening	K	89	153	144	212.69±3.41	136	129	188.54±0.07	150	146	145.0±2.11

Threshold temperature: 16°C.

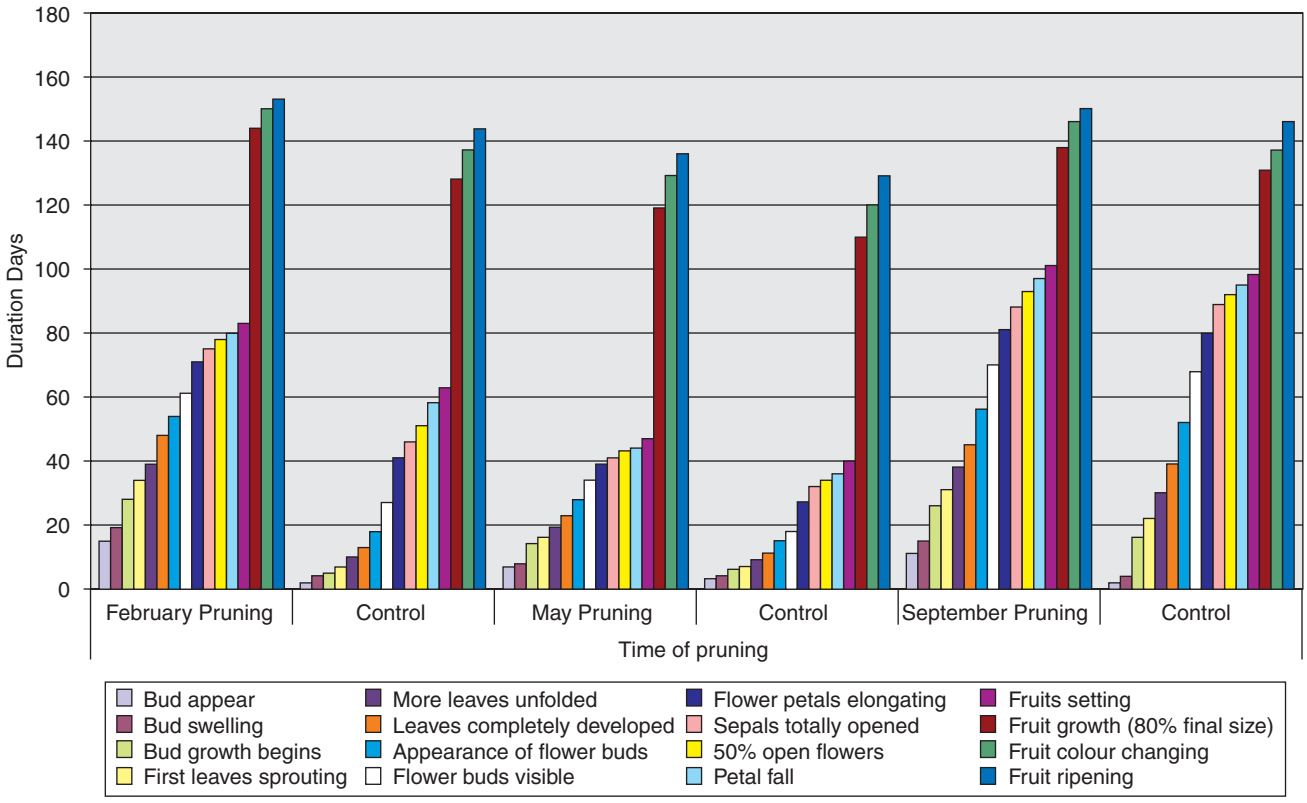

Fig 2 Duration of occurrence of different phenological stages in guava cv. Lalit

more °C days during bud stage (A:0 to D:4) and lesser °C days accumulation during the post flowering stages (E:1 to K:89) in May pruning may be translated into higher yield with better fruit quality. The occurrence of high and low temperatures during principal phenological stages affects the variation in normal BBCH scale. The modified BBCH

scale is thus an important, simple and accurate tool to predict the occurrence of a particular phenological stage during different time of the year and adopt suitable pruning strategy for higher quality yield in guava.

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REFERENCES

Crane J H and Balerdi C F 2005. Guava Growing in the Florida Home Landscape. Horticultural Sciences Department document HS4, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, pp 1–8.

Fleckinger J. 1945. Notations phe´nologiques et repre´sentations graphiques du de´veloppment des bourgeons de poiriers. *(In)* C.R. Congre's de Paris de l'Association franc¸aise pour l'avancement des Sciencies. Bibliographical reference in ''Fruticultura de Coutanceau'', 1971, Oikos-tau, Barcelona: p 118.

Meier U W E, Bleiholder H, Buhr L, Feller, C, Hack H, Heb M, Lancashire P D, Uta Schnock, Staub R, Theo van den Boom, Weber E and Zwerger P. 2009. The BBCH system to coding the phenological growth stages of plants – history and publications. *Journal für Kulturpflanzen,* **61** (2): S 41–52.

Miller P, Lanier W, Brandt S. 2001. Using Growing Degree Days to Predict Plant Stages. Extention communications coordinator, communications services, Montana State University, Bozeman, MO, 1–8.

Pratibha, Lal S and Goswami A K. 2013. Effect of pruning and planting systems on growth, flowering, fruiting and yield of guava cv. Sardar. *Indian Journal of Horticulture* **70**(4): 496–500.

Rajan S, Tiwari D, Singh V K, Saxena P, Singh S, Reddy Y T N, Upreti K K, Burondkar M M, Bhagwan A and Kennedy, Richards. 2011. Application of extended BBCH scale for phenological studies in mango (*Mangifera indica* L.) *Journal of Applied Horticulture* **13**(2): 108–14.

Raoofi, Faranak and Javadi, Seyed Akbar. 2014. Modeling phonological stages of *Artemisia sieberi* using GDD. *International Journal of Biosciences*. **4** (1): 225–30.

Rathore, D.S. 1976. Effect of season on the growth and chemical composition of guava (*Psidium guajava* L.) fruits. *Journal of Horticultural Science.* **51**: 41–7.

Salazar D M, Melgarejo P, Martinez R, Martinez J J, Hernandez F and Burguera M. 2006. Phenological growth stages of guava tree (*Psidium guava* L.). *Scientia Horticulturae* **108**: 157–61.

Schwartz M D 1999. Advancing to full bloom: planning phenological research for the 21st century. *International Journal of Biometeorology*. **42** (3): 113–8.

Singh V K and Singh G. 2007. Photosynthetic efficiency, canopy micro climate and yield of rejuvenated guava trees. *Acta Hortlcultural (ISHS)* **735**: 249–57.

Singh V K, Soni MK, and Singh, Anurag. 2015. Effect of drip irrigation and polyethylene mulching on fruit yield and quality of guava cv. Allahabad Safeda under ultra high density planting. International conference on dynamics of smart horticulture for livelyhood and rural development., 28-31 May, Chitrakoot, Satna, Madhya Pradesh, pp 56–7.

Thakre M, Goswami A K and Pratibha Lal, S. 2013. Effect of various methods of crop regulation in guava under double-hedge row system of planting. *Indian Journal of Horticulture* **70**(2): 211–6.

Venkateswarlu B and Visperas R M. 1987. Source- sink relationships in crop plants. *IRRI Research Paper Series* No. **125**, pp 1–19.