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Effect of irrigation and fertilizer on leaf production of betel vine (*Piper betle* L.)

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ABSTRACT

A study was conducted in a two year old stand of betel cultivation, to investigate the effect of three irrigation methods and three fertilizer mixtures on leaf productivity. Leaf production was significantly improved by daily irrigation at 5 mm per day using either manual splash method or drippers. The present departmental recommendation of straight fertilizer mixture proved to be still valid for betel vines.

Betel vine (*Piper betle* L.) is a perennial creeper belonging to the family *Piperaceae*. The betel leaf is the economic product obtained from the betel vine (Anon, 2002a). Betel leaf export in Sri Lanka has remained either increased or constant since 1995 (Anon, 2002b). The principal betel growing districts in Sri Lanka include Kurunegala (65%) and Gampaha (22%) mainly for export. Currently farmers use traditional splash irrigation methods using a bucket or pot for betel cultivation at various frequencies that are more time consuming and less efficient. Some farmers in this region used to irrigate their betel beds at 2 or 3 day intervals with bigger quantities at a time. Factors such as requirement of continuous supply of nitrogen in limited quantities for optimum yield of good quality leaves (Mishra *et al.*, 1995), and fairly high profitability from export quality betel leaves (*kalubulath*) instigate farmers to apply expensive new granular form fertilizer mixtures or in excess of recommended straight betel fertilizer mixture. The cost of irrigation and fertilizer for betel production varies from 34% to 36% of total cost over five year duration budget (Anon, 1997). Therefore, the objectives of the present investigation were to compare the effect of supplementary irrigation methods and three different fertilizer mixtures on betel leaf production.

This experiment was conducted in a 2 year old betel cultivation at Muthugala Estate, closer to the Intercropping and Betel Research Station, Narammala during April to September 2004. Two vines have been trained on opposite sides of each dead support (*Kowla*) spaced at 45 cm x 30 cm on standard sunkenbeds.

Following irrigation treatments and fertilizer mixtures were tested in a factorial combination using split plot design with four replicates.

Main plot treatments:

I- 1 - daily drip irrigation (5 mm/Day)
I- 2 - once in three days drip irrigation at 15 mm/application
I- 3 - daily manual irrigation (5 mm/Day) as control

Assumptions,

Readily Available Water (RAW) was taken as 20 mm for betel root zone (Herath, 2004).Mean daily potential evapotranspiration (E_t) was assumed as 4 mm based on 10 year class A pan data of Makandura Agricultural

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Research Station. Daily rainfall was measured at the site. The actual quantities of water supplied through drippers as well as manual method were crossed checked using catch can tests. Irrigation was implemented using estimated daily soil water budget and actual soil water budget was calculated at the end of the study (Sumanasena *et al.*,2004).

Sub plot treatments: -

F-1 -Department of Export Agriculture recommendation for Betel (Urea 23.4 g, TSP 7.8 g, MOP 12 g and Kieserite 7.2 g/12 Sticks) as control

F-2 - Double the amount of F-1

F-3 -120g/12 sticks granular fertilizer containing micronutrients (N 12%, P_2O_5 11%, K_2O 18% and MgO 2.7% + S 8% + TE (Fe 0.2%, Zn 0.02%, B 0.015%, and Mn 0.02%)

Betel leaves were harvested at 21 day intervals as per the requirement of export market. Leaves were categorized into four groups namely, large *peedunu kola*, small *peedunu kola*, large *kanda kola* and small *kanda kola* as per Department of Export Agriculture guide lines (Anon, 2002a) prior to the collection of data. Number of leaves and fresh weight of leaves were recorded on vine basis

Water balance in the root zone

Slightly positive total soil water balance was observed during the study period (Table 1). Nevertheless, the irregular rainfall distribution pattern with 20 consecutive dry days out of 54 days of negative daily water balance during the study period, justified the need of supplementary irrigation for a soil water sensitive species like betel (Balasubramanium, 1987).

Table 1. Summary of total water balance for the study period

Irrigation treatments	Number of irrigation days	Quantity (mm)	Total rainfall (mm)	Estimated total *Et* (mm)
1-1	57	285	505	427
1-2	17	255	505	427
1-3	57	285	505	427

According to the preliminary statistical analyses, treatment effects were evident only in large *peedunu kola* and large *kanda kola*. Therefore, the results of small *peedunu kola* and small *kanda kola* were not reported.

Effects of irrigation and fertilizer on number of large *Peedunu Kola* (large leaves from plageotropic branches):

The number of large *Peedunu Kola* at I-2 always remained at the lowest level for each harvest (Figure 1). The number of large *Peedunu Kola* at I-1 was significantly greater than that of I-2 for each harvest taken on 12 August and 6 September. The difference between I-1 and I-3 was not substantial. This indicated that the large *Peedunu Kola* production was consistently and substantially dropped at I-2 with the increase number of consecutive dry days (intermittent dry spell).
The number of large *peedunu kola* production was significantly lower at F1 in comparison to F2 and F3 only on 22 July harvest (Figure 2). Application of double the quantity of departmental recommendation (F2) appeared to be a waste of fertilizer as number of large *Peedunu Kola* production did not improve significantly during this period

Effects of irrigation and fertilizer on betel leaf weight.

In general, unit weight of a large *Peedunu Kola* (leaf weight) was in increasing order from June

to September 2004, irrespective of treatment effects. Consistently greater leaf weight was observed at daily drip irrigation (I-1) compared to other two irrigation methods throughout the harvest (Figure 3).

A clear difference in unit leaf weight cannot be distinguished between once in three days

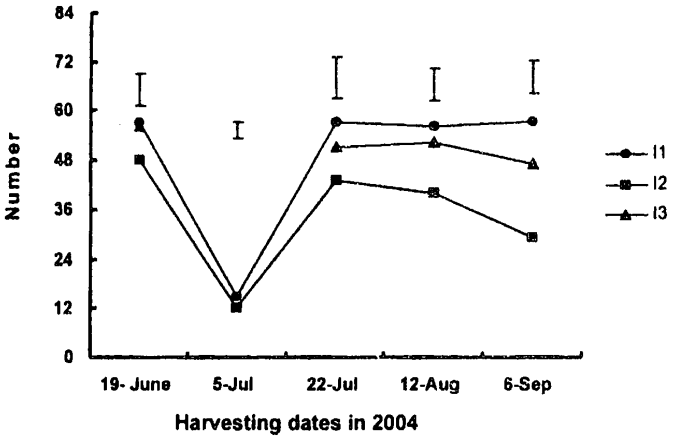

Figure 1. Effects of irrigation on number of large *Peedunu Kola* per two sticks (4 vines). Error bar represent the LSD (P=0.05) values

drip irrigation (I-2) and daily manual irrigation (I-3). The effect of fertilizer on unit leaf weight was not seen for any of the harvests (Figures not shown).

This indicated that the present departmental fertilizer recommendation (F-1) seems to be almost similar to the granular fertilizer in betel leaf production potential. Arulmozhiyan and Thamburaj (1998) revealed that application of 150 kg N/ha (Urea +FYM, 1:1) plus bio agent gave the greatest betel leaves yield. Application of inorganic N content in the present study is equivalent to 67 kg/ha per 3 weeks.

Interaction between irrigation and fertilizer on betel yield

The interaction between irrigation treatment and fertilizer treatments was significant

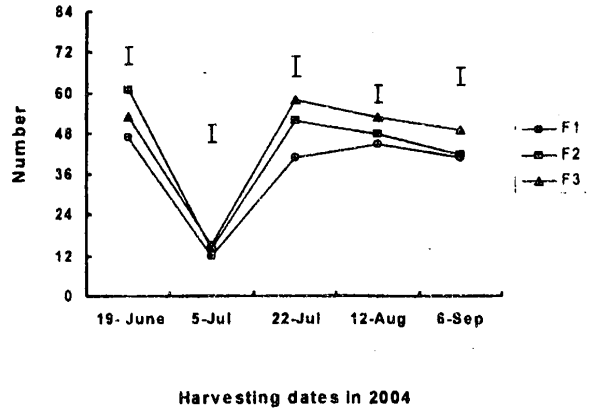

Figure 2. Effects of fertilizers on number of large *Peedunu Kola* per two sticks (4 vines). Error bar represent the LSD (P=0.05) values.

(P<0.01) for the number of large *Kanda Kola* on 6 September (Figure 4).

A significantly higher number of *Kanda Kola* was obtained at each F-1 as well as F-3 under daily application of drip irrigation. Although some farmers' believe that they can get more yields by doubling the amount of departmental recommendations (F-2), the current experimental results indicated the possibility of wastage of such inputs under F-2. Considering the growth response of all leaf attributes, cost of production associated with granular fertilizer, high fertilizer inputs for export quality betel (*Kalubulath*) cultivation in comparison to the Indian situation and soil

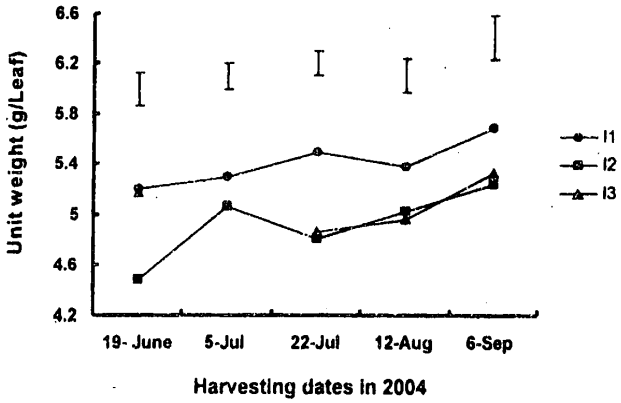

Figure 3 Effects of irrigation on unit weight of large *Peedunu Kola* per two sticks (4 vines). Error bar represent the LSD (P=0.05) values.

health in view, application of present departmental recommendation of inorganic fertilizer seems to be justifiable. Further experimentation on long-term benefits of granular fertilizer under drip irrigation is suggested.

The study revealed that both *Kanda Kola* and *Peedunu Kola* production were significantly improved by daily irrigation at 5 mm per day irrespective of the method of irrigation. This suggests that adoption of daily watering with small quantities preferably at a depth sufficient to replenish the daily potential evapotranspiration i.e. about 5 mm for Kurunegala area would be ideal. This is equivalent to the even application

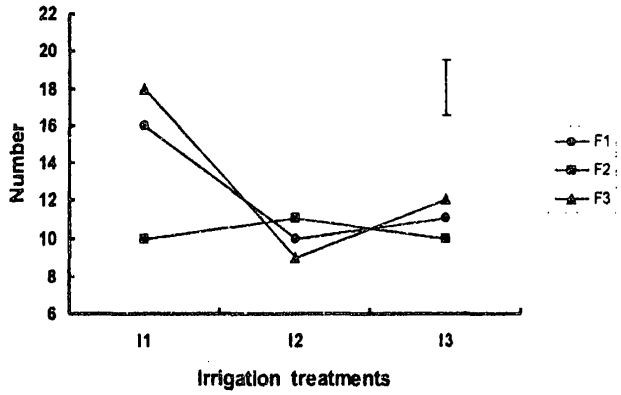

Figure 4. Interaction of irrigation and fertilizer treatments for large *Kanda Kola* as number of leaves per two sticks (4 vines) on 6 September. Error bar represents the LSD (P=0.05) value.

of 5 L/m^2 of the betelbed. Furthermore, leaf production in this study did not change clearly with the change of irrigation method from conventional manual splash irrigation using a domestic bucket to improved drip irrigation system.

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REFERENCES

Anon 2002a. Technical bulletin on betel cultivation number 11. Department of Export Agriculture, 1095, Peradeniya, Sri Lanka. Pp 04-20.

Anon 2002b. Administrative Report, Department of Export Agriculture, 1095, Peradeniya, Sri Lanka. Pp51.

Anon 1997. Betel industry of Sri Lanka: Present problems and future prospects. Occasional publication, Department of Export Agriculture, 1095, Kandy Road, Peradeniya, Sri Lanka. Pp16.

Arulmozhiyan R and Thamburaj S 1998. Integrated nutrient management in betel vine (*Piper betle* L.) for increased productivity. Journal of plantation crops. 26(1):25-30.

Balasubramainam 1987. Microclimate manipulation in betel vine gardens. India, 05/05/2004.http://WWW.botanical.com/botanical/mgmh/b/betel133.html.

Herath HMIUK 2004. Development of irrigation schedules based on soil moisture for betel (*Piper beetle* L.) cultivation. An unpublished BSc thesis, Faculty of Agriculture, University of Peradeniya, Sri Lanka. 30Pp.

Mishra SK, Chaurasia RS and Balasubramainam VR 1995. Effect of graded levels of slow release fertilizers on the yield and quality of betel leaves. Journal of Plantation Crops. 23(1):48-51.

Sumanasena HA, Horne DJ, Scotter DR and Kemp PD 2004. The effects of Irrigation Scheduling on Nitrogen and Phosphorus Leaching under Pasture. *Tropical Agricultural Research 16:*193-203.

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