TRANSPIRATION, STOMATAL BEHAVIOUR AND GROWTH OF *EUCALYPTUS* HYBRID SEEDLINGS UNDER DIFFERENT SOIL MOISTURE LEVELS

P.S. RAWAT, D.S. NEGI, J.S. RAWAT AND K. GURUMURTI

Plant Physiology Branch
Forest Research Institute & Colleges, Dehra Dun (India)

Introduction

During the last few years the transpiration by *Eucalyptus* has been a subject of controversy. Ghosh *et al.*(1978) reported that certain species of *Eucalyptus* were planted in marshes near Rome in order to effect water drainage. In wet and swampy areas of Uganda and East Africa *Eucalyptus robusta* was planted to drain the swamps and to prevent the mosquito breeding. The success in draining the swamps has lead to the belief that *Eucalyptus* is a heavily transpirer. Alverez *et al.* (1982) contend that *Eucalyptus* spp. extract water out of soil and transpire heavily leading to desertic conditions. Vandana Shiva and Bandyopadhyay (1985) contend that planting *Eucalyptus* in arid regions results in high water uptake leading to soil aridization and ground water depletion. Statements of drying effect of *Eucalyptus* should be based on water income and water usage and not on the part of their framework. Rawat *et al.*(1984) concluded that *Eucalyptus* has the capacity to transpire water abundantly under conditions of adequate soil moisture which they termed as "Luxury consumption". They also reported that in this plant under conditions of moisture stress, the water conserving mechanisms are triggered. This view was however criticised by Vandana Shiva and Bandyopadhyay (1985) on the ground that operation of water conserving mechanism through stomatal closure would lead to cessation of growth. Their contention, however, was not supported with any experimental evidence. The result reported in present paper purport to show that both "Luxury consumption" and water conserving mechanisms are in operation in this species and that it is conditioned by the soil moisture availability.

Material and Methods

Seeds of *Eucalyptus* hybrid were sown in well drained soil in wooden boxes. Seedlings of uniform height (12 cm) with six leaves per seedling were pricked and transplanted in plastic pots containing fixed amount of sand, soil, farmyard manure (1:2:1) mixture. The moisture content at field capacity of this soil was found to be 23 to 24 per cent. All the potted seedlings were watered lightly till they recovered from transplanting shock and started showing healthy growth. The above procedure were completed by the first week of April. Immediately after the seedlings showed normal growth watering was withheld in all the pots till the soil moisture declined to around 7-8 per cent. A set of pots with the equal quantity of soil without plants was also equilibrated to a soil moisture level of 7-8 per cent. By this time (first week of May) all seedlings were of 15 cm height with 12 leaves each. At this two stage potted seedlings were divided into four groups, each containing at least five pots. To the first group of plants, measured quantity of water was added so that the soil moisture was around 26-28 per cent. This group represented a near flooded treatment. To the second group of plants, quantity of water added was such that soil moisture was around 22-23 per cent. This group represented near field capacity treatment. The third group was watered to maintain it at 15 per cent soil moisture, equivalent to around 63 per cent field capacity. The fourth group was watered to maintain it at 7.5 per cent soil moisture equivalent to around 31 per cent of field capacity. It must be pointed out here that in plants maintained at 26-28 per cent soil moisture which was above field capacity often there was incipient seepage from the pots. However, our intention were to maintain these plants at near flooded canditions to study the effect of excess water supply. Thus, the data obtained in this treatment may not be very accurate, yet it served the purpose of simulating near flooded condition to test the earlier contention of "Luxury consumption" of water by *Eucalyptus*. It also served the purpose of assessing the growth and development of plants when they are maintained at near flooded conditions throughout the period of experimentation.

All the pots in all the treatments were weighed regularly at 48 hour intervals to estimate the water loss and the lost water was replenished so that the plants were continuously maintained in their respective soil moisture levels. While the loss of water in pots with plants was due to both transpiration and evaporation (evapotranspiration) from the soil, the water loss from pots maintained in respective soil moisture levels, but without the plants, accounted for evaporative loss only (soil evaporation). By deducting the value for soil evaporation from the value of evapotranspiration it was possible to assess the loss due to transpiration only. In such an assessment, the increase in weight as a result of plant growth was not taken into consideration. Thus, the data on transpiration rates obtained is an underestimate. However, the experiment helped to assess the comparative growth responses and transpiration trends by the plants maintained at different soil moisture levels. The height and leaf number of individual plant in different treatments were recorded at monthly intervals.

In order to study the stomatal behaviour of plants maintained at different soil moisture levels, the following procedure was adopted. Selected plants in different treatments were watered to bring them to respective soil moisture levels. They were then allowed to equilibrate for two hours. Stomatal impressions were immediately taken using polystyrene film coating of the leaves. Later, the stomatal impressions were taken regularly at 24 hour intervals up to 146 hours during which period no additional water was given to the plants. As most of the stomates remain open between 11 A.M. and 12 Noon, stomatal impressions of both adaxial and abaxial surfaces were always recorded during this period. Stomatal impressions were recorded from two top fully expanded leaves in all the treatments. From each leaf three replications were studied. Thus, the data for stomatal opening is a mean of six replications for each surface. Polystyrene solution was prepared by dissolving 9.0 gm polystyrene in 50 ml solution of Benzene and Toluene in ratio of 1:1. This solution was coated uniformly on the leaf surfaces with the help of a glass rod and allowed to dry for two minutes. The dried film was lifted off the leaf surface with the help of forceps. This film which makes the instant and permanent impression of stomata was observed under the compound microscope to determine the number of opened and closed stomata. The stomatal pore width and pore length was also recorded with the help of a micrometer and the product of these two was taken as the pore area, which is an approximation that sufficed for comparative assessment in different treatments.

On completion of the experiment the individual plant in each treatment was uprooted, washed throughly and the componentwise fresh weight later dry weight were recorded. Thus, the data for fresh weight and dry weight is a mean of five replicates. Leaf area was recorded from the leaf impression on the graph paper and with the help of planimeter.

Results and Discussion

Measurement of various parameters commenced in different treatments from the month of May, the different parameters monitored were height and number of leaves, measured at monthly intervals, transpirational water loss at 48 hours intervals, fresh and dry weight of leaves, stem and root recorded at the termination of experiment i.e. December. The data for transpiration rate per unit leaf surface per 48 hours was computed taking into consideration the water loss per plant every 48 hours and the corresponding leaf area of all the leaves of the plants in their respective treatments.

The height of plants in all the treatments at the beginning of experiment was nearly 15 cm. Within one month of the commencement of the treatment the effect were discernable. Thus, flooded plants and the plants maintained at 15 per cnet soil moisture recorded an average height of 21.0 cm followed by plants maintained at 22.5 per cent soil moisture which recorded an average height of 19.2 cm whereas the plants maintained at 7.5 per cent soil moisture recorded an average height of 18.8 cm. The data for average height of plants under different treatments in different months presented in Table 1 show that there is a direct correlation between the soil moisture level and height upto the month of September. Thus, in month of September maximum height was recorded in plants which were flooded. Later, however it was found that the plants flooded with water did not show any further increase in height whereas, the plants maintained at 22.5 per cent, 15 per cent and 7.5 per cent soil moisture levels continued to show increment in height. The rate of increment however declined in all the treatments from November onwards. Maximum average height increment of 159.8 cm was recorded in plants maintained at 22.5 per cent soil moisture followed by plants maintained at 15 per cent soil moisture, the average height being 148.5 cm, the flooded plants showed an average height of 145 cm and the plants maintained at 7.5 per cent soil moisture had the lowest average height of 107.0 cm.

The leaf number was observed to be maximum in plants maintained in flooded condition upto the month of July though it was not significantly higher as compared to the plants maintained at 22.5 per cent and 15 per cent soil moisture levels. From the month of August onwards the maximum number of leaves was observed in plants maintained at 22.5 per cent soil moisture level. The lesser number of leaves in flooded plants, despite the adequate soil moisture availability is due to the fact that in this treatment the older leaves started abscissing early whereas this phenomenon was not observed in other treatments. Maximum number of leaves, 273 per plant, was recorded in plants maintained at 22.5 per cent soil moisture level in the month of November. The number of leaves per plant in other treatments being 243, 178 and 84 in 15 per cent, flooded and 7.5 per cent soil moisture treatments, respectively. These results show that flooding the *Eucalyptus* hybrid plants significantly affects both height as well as leaf number, the latter is due to the early abscission of older leaves.

In order to bring out the effect of soil moisture on growth of plants, the ratio of number of leaves to that of height was worked out which is presented in Table - 3. The results computed in such a manner show a very interesting trend. It was found that in the flooded plants this ratio remains steady at 1.26 from the month of August to October and there after it declined whereas in plants maintained at 22.5 and 15 per cent soil moisture levels, this ratio steadily increased upto the month of November, the rate of increment being higher in plants maintained at 22.5 per cent soil moisture level. It was further observed that this ratio was always between 0.7 and 0.8 in plants maintained at 7.5 per cent soil moisture whereas in all the other treatments it was always more than one. From these results it may be inferred that in the

Table 1

Mean height of the plants in cm in different treatments at different months

Treatments	MONTHS May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
28.0% soil moisture (Flooded)	21.2	54.0	89.5	123.1	140.5	144.1	144.8	145.4
22.5% soil moisture	19.2	45.1	79.5	105.0	133.9	155.2	158.6	159.8
15% soil moisture	21.1	47.6	73.7	103.3	123.6	143.4	146.9	148.5
7.5% soil moisture	18.8	34.2	51.0	80.3	90.9	97.8	104.6	107.0

Table 2

Mean number of leaves per plant in different treatments at different periods

Treatments	MONTHS May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
28.0% soil moisture (Flooded)	15.25	54.8	109.4	156.0	176.8	181.8	178.4	168.4
22.5% soil moisture	15.40	51.0	110.0	162.0	205.6	252.8	273.6	253.8
15% soil moisture	14.8	54.2	110.0	152.2	170.2	198.8	243.8	223.8
7.5% soil moisture	14.6	21.0	45.6	58.8	68.8	79.6	84.4	81.8

plants maintained at 7.5 per cent soil moisture, the general growth itself is significantly affected. It also shows that in plants which were maintained in flooded condition the rate of growth increment tends to ramain constantly at lower level as compared to the plants maintained at 22.5 per cent and 15 per cent soil moisture level. The growth rate in the latter two treatments continuously increase right upto the month of November. Obviously, this behaviour is reflected in the final drymatter production of plants maintained under different soil moisture regimes.

The data on the amount of water transpired in gms. per plant every 48 hours in different treatments is presented in Table 4. The maximum transpiration rate was observed in plants maintained in flooded condition and the minimum in plants maintained at 7.5 per cent soil moisture level. This was however true only upto the month of September. From October onwards the plants maintained at 22.5 per cent soil moisture showed the more transpiration rate than those maintained under flooded condition. This reduced transpiration per plant maintained at flooded condition is only an apparent reduction due to the lesser number of leaves present in this plant. This is obvious from the data presented in Table 5 which shows that the rate of transpiration per unit surface area of the plants maintained in flooded condition was always higher throughout the period of study. Thus, despite the larger number of leaves in plants maintained in both 22.5 and 15 per cent soil moisture, the transpiration per unit area was lower as compared to the plants maintained in flooded condition. The plants maintained at 7.5 per cent soil moisture showed lowest transpiration rate both on per plant basis and as well as on per unit leaf area basis.

These results lend evidence to the contention made in an earlier study (Rawat *et al.* 1984) that *Eucalyptus* transpires heavily under conditions of adequate soil moisture whereas under conditions of restricted soil moisture reduce the transpiration rate due to the limitation imposed on the turgar pressure of leaf cells resulting in stomatal closure. To test this contention that the stomatal opening and closing is directly affected by soil moisture regimes, following study was carried out. All the plants were brought to their respective moisture regime. Subsequently, the number of stomata opned was periodically recorded upto 146 hours (Seven days) between 11 A.M. and 12 Noon daily. It may be mentioned that the plants were brought to respective soil moisture regime and allowed to remain without any further watering for a period of 146 hours. The per cent stomata open and the area of opened stomatal pore/100 mm^2 of abaxial and adaxial surfaces of the leaves is presented in Fig. 1 and 2, respectively. It was observed that the number of stomates on the adaxial surface of the leaves per unit area was less than 30 per cent of that of abaxial surface. After watering almost

Table 3

Leaf height ratio in different treatments at different periods

Treatments	MONTHS							
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
28.0% soild moisture (Flooded)	0.71	1.01	1.22	1.26	1.26	1.26	1.23	1.16
22.5% soil moisture	0.80	1.13	1.38	1.54	1.53	1.63	1.73	1.59
15% soil moisture	0.70	1.13	1.49	1.47	1.38	1.39	1.66	1.50
7.5% soil moisture	0.78	0.61	0.89	0.73	0.76	0.81	0.80	0.76

Table 4

Mean transpiration in gms/plant/48 hours

Treatments	MONTHS							
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
28.0% soil moisture (Flooded)	137.33	173.3	342.7	486.6	547.9	521.7	276.3	178.7
22.5% soil moisture	116.27	156.9	312.4	412.9	556.0	675.5	395.6	209.7
15% soil moisture	105.33	150.1	275.0	333.7	365.5	392.9	226.5	116.5
7.5% soil moisture	93.66	62.6	99.1	130.3	153.8	167.0	102.6	57.98

all the stomates in both adaxial and abaxial surfaces opened within two hours. In all the treatments, per cent open stomata declined with time on both the surfaces. Stomates on adaxial surface did not show any significant trend with respect to soil moisture treatments. It was, however, noticed that 98 hours after watering the number of stomata opened suddenly increased in all the treatments except 22.5 per cent soil moisture wherein this effect was noticed at 122 hours after watering. This increased number of open stomata was followed by sharp decline in all the treatments. Such a behaviour of sudden opening of large number of stomata followed by closing may be attributed to "Iwanoff effect" which is often noticed in many plants when subjected to water stress (Iwanoff, 1928). Britain and Negarajah (1971), Aston (1978) have also observed such an affect in Cotton and Sunflower leaves restricted to adaxial portion of leaves. The delay of such an effect in plants maintained at 22.5 per cent soil moisture is understandable since the critical water stress in these plants might have been delayed. Its early occurrance in flooded plants may be due to the uncontrollec water loss through very widely open stomata (Fig. 1). Infact, such an "Iwanoff effect" seems to be also exhibited by the stomates of abaxial surface in the plants maintained in flooded condition and at 7.5 per cent soil moisture level. Such an effect was, however, not discernable in abaxial surface of leaves of the plants maintained at 22.5 and 15 per cent soil moisture levels. Stomates on abaxial surface, however, showed certain significant trend with respect to soil moisture availability. Thus, in flooded plants, the per cent stomata opened

Table 5

Transpiration rate in mg/cm^2 of leaf/48 hours

Treatments	MONTHS							
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
28.0% soil moisture (Flooded)	295.25	103.69	102.71	102.27	101.61	94.1	50.78	34.79
22.5% soil moisture	255.93	104.28	96.27	86.39	91.61	90.58	49.01	28.0
15.0% soil moisture	277.46	107.96	97.5	85.48	83.0	77.05	36.25	20.29
7.5% soil moisture	229.52	106.65	77.69	79.23	79.92	75.0	43.49	25.35

Fig. 1

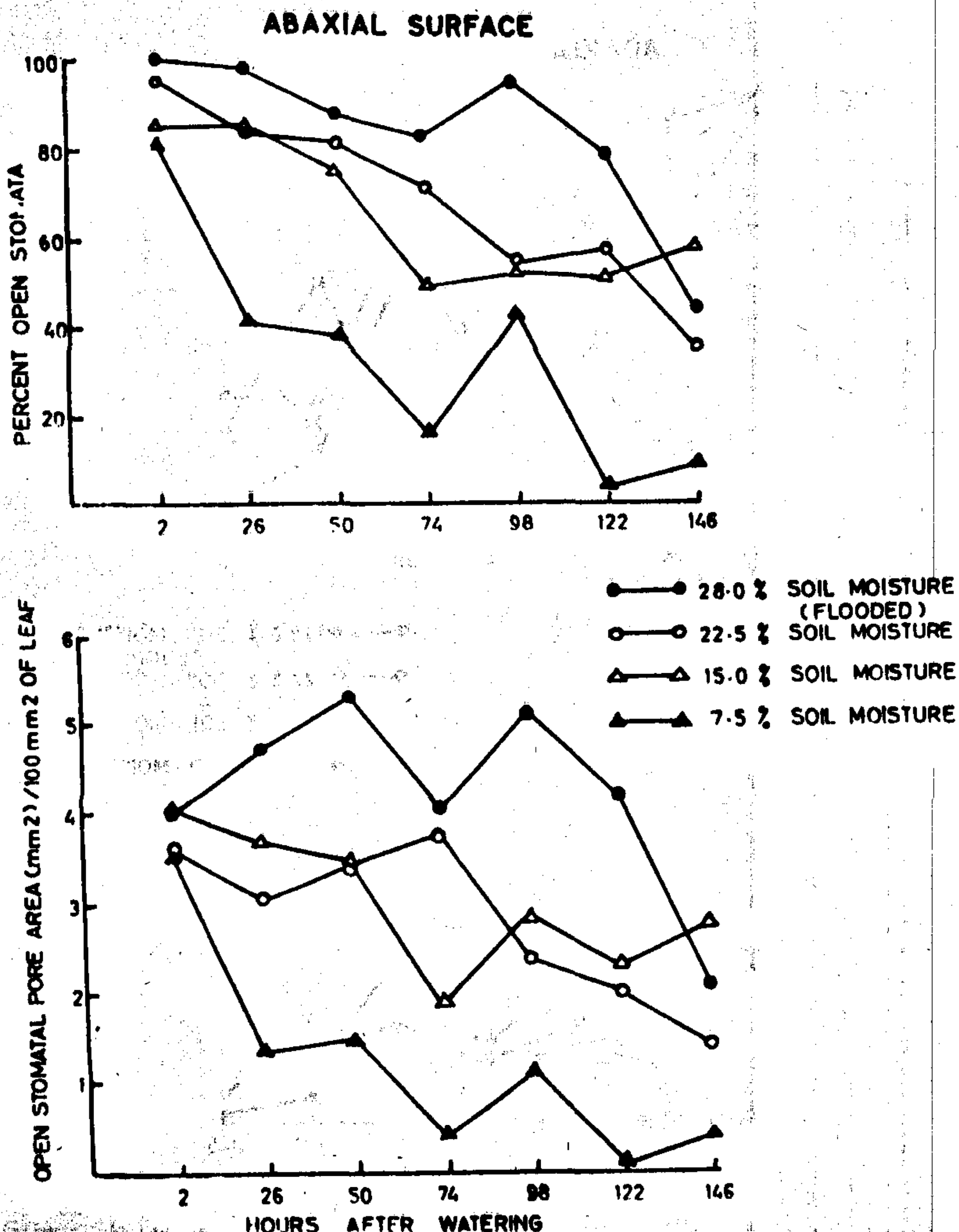
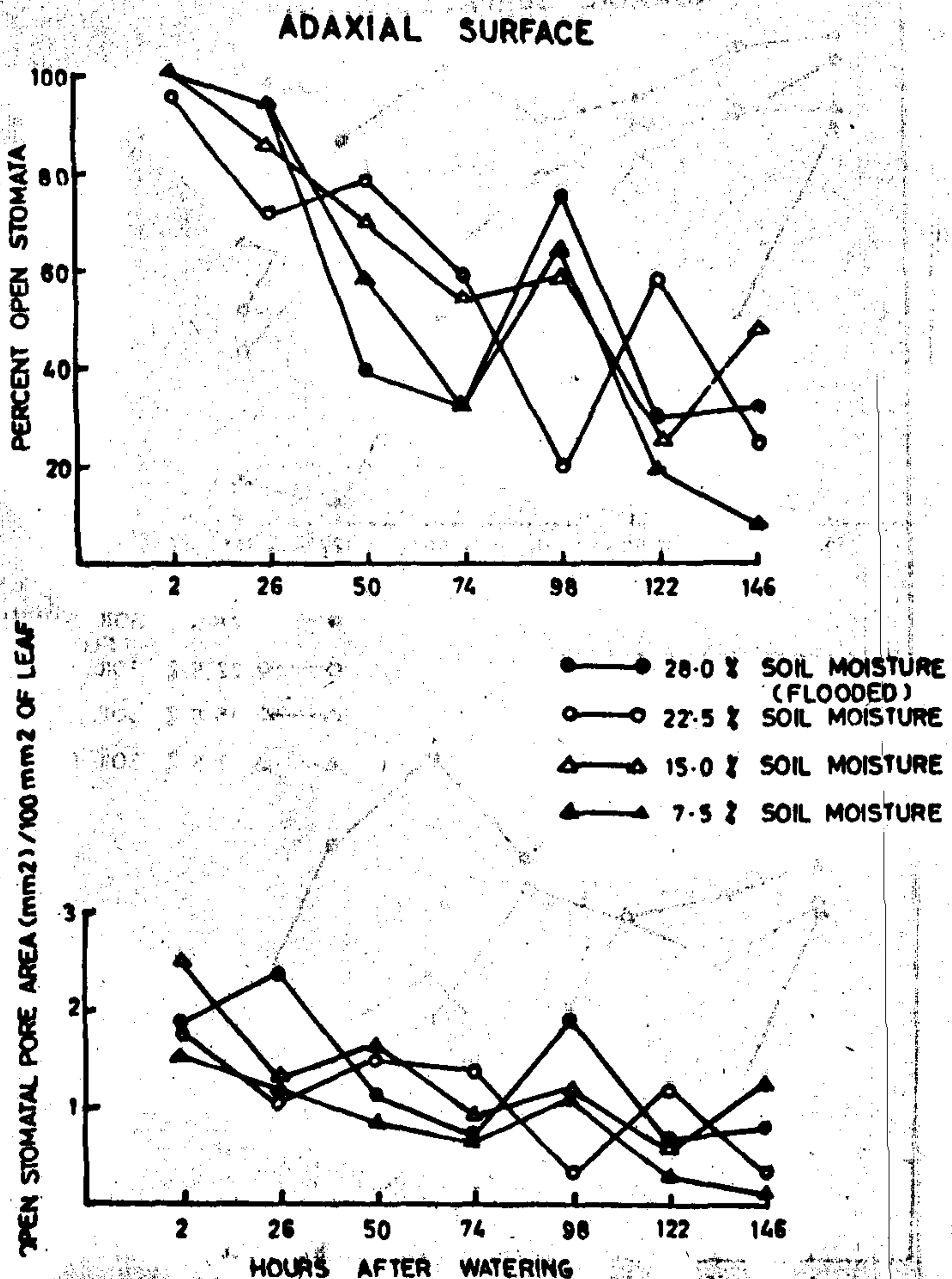

ABAXIAL SURFACE
PERCENT OPEN STOMATA
100
80
60
40
20
2
26
50
74
98
122
146
28·0 % SOIL MOISTURE (FLOODED)
22·5 % SOIL MOISTURE
15·0 % SOIL MOISTURE
7·5 % SOIL MOISTURE
OPEN STOMATAL PORE AREA (mm2)/100 mm2 OF LEAF
6
5
4
3
2
1
2
26
50
74
98
122
146
HOURS AFTER WATERING

Fig. 2



Stomatal behaviour on adaxial surface of the declined from nearly 100 on the date of watering to around 45 after 146 hours whereas in plants maintained at 7.5 per cent soil moisture, the per cent stomata opened declined from 80 on the date of watering to nearly 40 at 26 hours. It continuously declined, so much so, that in plants at 7.5 per cent soil moisture treatment, it was less than 10 per cent at 146 hours. The plants maintained at 22.5 and 15 per cent soil moisture showed intermediate trend. The area of stomatal opening (stomatal pore) per 100 mm^2 of leaf also showed an identical trend. The results are suggestive that in flooded plants, the stomates open rather widely. These results show that soil moisture stress directly affects not only the number of stomates that are open but also the extent of its opening. Wider opening of stomata in plants maintained in flooded condition coupled with large percentage of stomata which remained open for longer duration of time, is clearly reflected as higher rate of transpiration per unit surface area of leaf despite the number of leaves in flooded plants being less as compared to that in plants maintained at 22.5 and 15 per cent soil moisture levels. The lower number of leaves coupled with rapid closure of stomata in plants maintained at 7.5 per cent soil moisture level is reflected as reduced rate of transpiration in these plants. It may further be added that in plants maintained at 7.5 per cent soil moisture 10 per cent of stomata continue to remain open to facilitate Co_2 exchange for photosynthesis. These results show both "Luxury consumption" and water conserving mechanisms are operative in this plant.

The componentwise dry matter produced by plants maintained in different soil moisture regimes is presented in Table 6. The maximum dry matter in all the components was observed in plants maintained at 22.5 per cent soil moisture and the minimum in plants maintained at 7.5 per cent soil moisture. The total dry matter produced was in the following order in different treatments: 22.5 per cent > 15 per cent > flooded > 7.5 per cent. It is also pertinent to mention here that the moisture per cent of different components in all the treatments was almost similar. This suggests that despite moisture stress in plants maintained at 15 per cent and 7.5 per cent soil moisture, the tissue hydration was not seriously affected which is further reinforced by the finding that stomates close rapidly to conserve the tissue moisture by reducing the transpiration rate. The fact that the moisture per cent in plants maintained in flooded condition was also same as that maintained at 22.5 per cent soil moisture, suggests higher transpiration rate by these plants without retaining excess water in the tissue, the excess available water being lost by widely open stomates (Fig. 1). These finding lends support the contention of Rawat *et al.* (1984) that the "Luxury consumption" is a feature of this species. It also supports their finding that in this plant water conserving mechanisms are triggered under conditions of moisture stress.

The reduced dry matter production in flooded plants is due possibly to reduced number of leaves and reduced stem growth in these plants (Table 3). Clemens and Pearson (1977) have shown that continuous water logging in plants of *Eucalyptus robusta* cause both leaf abscission and reduction in stem elongation. The results reported in this paper also show reduced height growth in flooded plants which is reflection of reduced stem elongation. Further, reduced number of leaves in flooded plants was actually due to early abscission of older leaves from August onwards. However, differentiation of new leaves was not significantly affected. Thus, the higher number of leaves found in plants maintained at 22.5 per cent and 15 per cent soil moisture is due to the non-absci-ssion of older leaves. As opposed to this lower number of leaves found in plants maintained at 7.5 per cent soil moisture was due to the reduced rate of differen-tiation which is obvious from the data presented in Table 3. Quraishi and Krammer (1970) have also shown that severe water stress considerably reduced shoot as well as leaf growth in *Eucalyptus rostrata.*

The stomatas which permit the entry of Co_2 into the leaf also permit the water vapour to escape into the air. This exchange efficiency is of paramount importance to the water economy of plants when water supply becomes limiting, particularly so with *Eucalyptus* which has often been accused of transpi-ring water heavily (Vandana Shiva and Bandyopadhyay, 1985). The subject of Co_2 fixed viz-viz water loss through transpiration is of both practical and theoritical interest in many plants which has been reviewed by Cowan (1977) and Fischer and Turner (1978). The amount of Co_2 gained per unit of water loss over an extended period of time is termed as water use efficiency. Measurement of integrated water use efficiency in term of dry matter production over an extended period of time have been worked out by Dabral (1970) and chaturvedi (1983) for number of species. They reported highest water use efficiency for *Eucalyptus* though the total quantum of water consumed per plant was also the highest. The experiments were, however, conducted under adequate soil moisture regimes. The reports on water use efficiency by *Eucalyptus* under different soil moisture regimes are not known.

Table 7 presents data on the total amount of water transpired per plant, dry matter produced per plant, amount of water transpir-ed per gm of dry matter produced and amount of dry matter produced per litre of water transpired. It was observed that the water transpired quantitatively was found to be maximal in plants maintained at 22.5 per cent soil moisture whereas plants maintained in flooded condition transpired less water on quantitative basis. This was despite the fact that the water transpired per unit area in flooded plants was higher. This appearant descrepancy is

Table 6

Fresh weight, dry weight (gms) and per cent moisute of leaf, shoot and root and total plant dry weight (Mean of 5 replications)

Treatments	Leaf			Stem			Root			
	Fresh weight	Dry weight	Moisture (%)	Fresh weight	Dry weight	Moisture (%)	Fresh weight	Dry weight	Moisture (%)	Total plant dry weight
28.0% soil moisture (Flooded)	68.25	26.80	60.73	99.00	45.88	53.66	75.25	33.38	55.64	106.06
22.5% soil moisture	87.00	34.08	60.82	121.75	55.87	54.11	76.25	34.13	55.24	124.08
15.0% soil moisture	81.00	34.54	57.36	96.8	44.5	54.03	68.6	32.0	53.35	111.04
7.5% soil moisture	33.00	13.49	59.12	36.75	17.75	51.70	28.27	13.02	53.91	44.26

Table 7

Water use efficiency of Eucalyptus hybrid under different soil moisture levels

Treatments	Total water transpired (Litre)	Total dry matter produced (g)	Water transpired in Litre/gm of dry matter	Dry matter produced in g/Litre water
28.0 soil moisture (Flooded)	40.80	106.06	0.385	2.60
22.5% soil moisture	43.39	124.08	0.350	2.86
15.0% soil moisture	30.095	111.04	0.271	3.69
7.5% soil moisture	13.28	44.26	0.300	3.33

due to early abscission of older leaves in flooded plants. Water transpired per gm dry matter produced was found to be highest in flooded plants. It is also significant to note that the water transpired per gm of dry matter produced was lowest in plants maintained at 15 per cent soil moisture level. Obviously, the dry matter produced per liter of water consumed was also highest in this treatment. Though, the total dry matter produced in plants maintained at 22.5 per cent soil moisture was highest, the amount of dry matter produced per litre of water utilized was found to be lower as compared to plants maintained at 15 per cent soil moisture. This is suggestive of the fact that the plants maintained at 22.5 per cent soil moisture do not use water optimally. Also the excessive water supply in plants maintained at flooded conditions leads to abundant water usage since the water transpired per gm of dry matter production in these plants was maximum which further supports the "Luxury consumption" behaviour of this species. The relatively high dry matter produced per litre of water utilized by the plants maintained at 7.5 per cent soil moisture clearly proves that under conditions of restricted soil moisture supply the water conserving mechanisms come into operation which is also evident from the reduced transpiration rate in these plants (Table 4 and 5). The reduced transpiration rate as result of stomatal closure thus blocks water loss which is crucial for survival of plants providing them an opportunity for osmotic adjustment. Brown *et al* (1976), Jones and Rawson (1979) and Ackerson (1980) have shown that when plants are subjected to repeated cycles of water stress a certain amount of osmatic adjustment occurs in leaf tissue. The higher dry matter produced per litre of water consumed in plants maintained at 7.5 per cent soil moisture may be attributed to change in osmotic behaviour of the leaf tissue. At the same time it should also be reckoned that the stomatal closure, which is not complete, also restricts the uptake of Co_2 leading to certain loss in photosynthetic capacity (Berry and Downton, 1982). This is reflected as reduced dry matter produced in plants maintained at 7.5 per cent soil moisture. These results show that reducing the soil moisture from 22.5 per cent (near field capacity) to 15 per cent (62 per cent field capacity) causes only 10.5 per cent reduction in dry matter yield but reduces the total amount of water transpired per plant by as much as 35 per cent. In otherwords, growing *Eucalyptus* hybrid at 15 per cent soil moisture level brings about optimal water usage without any serious reduction in dry matter production.

Summary

Experiments were designed to test the "Luxury consumption" of water by Eucalyptus hybrid. the results show that under flooded conditions as well as at near field capacity Eucalyptus hybrid transpires water copiously. Results also show that under conditions of restricted soil moisture supply, controlled stomatal closure occurs leading to reduction in transpiration rate. It is concluded that 'growing Eucalyptus hybrid around 15 per cent soil moisture level brings about optimal water usage without serious reduction in dry matter production.

Key words : Eucalyptus hybrid, transpiration, stomatal behaviour, *water use efficiency,* Luxury consumption

विभिन्न मृदा नमी स्तरों पर संकर युकेलिप्टस के पौधों का वाष्पोत्सर्जन और मुखीय व्यवहार

पी० एस० रावत, डी० एस० नेगी,
जे० एस० रावत व के० गुरुमूर्ति

सारांश

संकर युकेलिप्टस द्वारा पानी का ऐश्वर्यपूर्ण उपयोग किए जाने के परीक्षण के लिए कुछ संपरीक्षण आकल्पित किए गए। परिणामों से पता चलता है कि क्षेत्र धारिता के लगभग बराबर और बाढ़ प्रभावित दशा में भी संकर युकेलिप्टस से प्रचुर वाष्पोत्सर्जन होता है। परिणामों से यह भी पता चलता है कि सीमित नमी मिलने पर नियंत्रित मुख - बंद क्रिया होती है जिससे वाष्पोत्सर्जन की दर घट जाती है। निष्कर्ष यह रहा कि 15 % मृदा नमी स्तर पर संकर युकेलिप्टस उगाने पर शुष्क पदार्थ उत्पादन में किसी तरह की गंभीर कमी आए बिना पानी का इष्टतम उपयोग किया जाता है।

References

Ackerson, R.C. (1980). Stomatal response of cotton to water stress and abscisic acid as affected by water stress history. *Plant Physiol* 65: 455-459.

Alvarez, C. (1982) Social Forestry - The likely distortions. *Bio-Energy Re. News.* 1(1) : 1-6.

Aston, M.J. (1978). Differentiation behaviour of adaxial and abaxial stomata of amphistomatour Sunflower leaves, inherent or environmental ? *Aust. J. Plant Physiol.* 5, 211-218.

Berry, J.A. and *W.J.S. Downton,* (1982). Environmental regulation of photosynthesis. In : Govindjee (Ed.). *Photosynthesis: Carbon metabolism and plant productivity* : 263-343 pp. Academic Press, London.

Brittain, E.G. and *S. Nagarajah,* (1971). Iwanoff effect on leaves of cotton (*Gospium hirsutum*). *Physiol. Plant.* 25: 441-447.

Brown, K.W., W.R. Jordan & J.C. Thomas (1976). Water stress induced alterations of the stomatal response to decreases in leaf water potential. *Physiol. Plant.* 37: 1-5.

Chaturvedi, A.N. (1983). *Eucalyptus* for farming. *U.P. Forest Bulletin* No. 48.

Clemens, J. and *C.J. Pearson.* (1977). The effect of water logging on the growth and ethylene content of *E. robusta* (Swamp Mahogony). *Oecologia.* 29 (3) : 249-255.

Cowan, I.R. (1977). Water use in higher plants. In : A.K. Milnlyre (Ed.). *Water : Planets Plants and People* : 71-107 pp. *Aust. Acad. Sci.* Canberra.

Dabral, B.G. (1970). Preliminary observation in potential water requirement in *Pinus roxburghii, Eucalyptus citriodora, Populus casale* (488) and *Dalbergia latifolia. Indian For.* 96 : 775-780.

Fischer, R.A. and *N.C. Turner,* (1978). Plant productivity in arid and semi-arid zones. *Ann. Rev. Plant, Physiol.* 29 : 277-371.

Ghosh, R.C., O.N. Kaul and *B.K. Subba Rao,* (1978). Some aspects of water relation and nutrition in *Eucalyptus* plantation. *Indian For.* 107 (7) : 517-524.

Iwanoff, L. (1928). Zur Methodik der Transpirations - bestimmung am standort Ber. dt. *Bot. Ges* 46, 306-310.

Jones, M.M. and *H.M. Rawson* (1979). Influence of rate of leaf water deficit upon photosynthesis leaf conductance, water use and osmatic potential in *Sorghum. Physiol Plant.* 45 : 103-11.

Quraishi, M.A. and *P.J. Krammer* (1970). Water stress in three species of *Eucalyptus. For. Sci.,* 16 (1) March 1970.

Rawat, P.S., B.B. Gupta & J.S. Rawat (1984). Transpiration as affected by soil moisture in *Eucalyptus tereticornis* seedlings. *Indian For.* 110(1): 35-39.

Vandna Shiva and *J. Bandyopadhyay* (1985). Ecological audit of *Eucalyptus* cultivation. The Indian Book Depot, Dehra Dun, India.