seated megaspore mother cell undergoes a normal meiosis. The megaspore tetrad is linear of which the chalazal functions (figure 5). The early degeneration of micropylar dyad without meiosis II (figure 3), at times, results in a megaspore triad (figure 4). The development of megagametophyte conforms to monosporic Polygonum type (figure 6). The egg is elongated and synergids are without hooks.

The course of development referred to above, at times, undergoes modification. Occasionally both the archesporial cells function The periclinal division in one of the sporogenous cells results in differentiation of three megaspore mother cells (figure 7), which elongate and without undergoing meiosis function to give rise to the unreduced embryo sacs (figure 11). However, synchronization does not appear to be present in their development. The supernumerary embryo sacs may even abort before reaching maturity (figure 11). The archesporial cell/cells, unlike in normal development divide periclinally a few times to produce a parietal tissue of 1–3 layers only (figures 8, 8a). The latter degenerate soon after formation (figures 8, 10) so that megaspore mother cells come to lie directly below the nucellar epidermis (figures 9, 10). Such megaspore mother cells increase in size and divide mitotically (figures 8–13). However, one embryo sac alone reaches maturity while the rest degenerate at different stages of development (figures 8–11, 13, 15). The parietal tissue if present gets absorbed during development.

The unreduced embryo sac consists of rather inconspicuous egg with dense cytoplasm and a nucleus and two large hooked synergids. The outer lateral walls of synergids extend into spine like structures. There are presently three hypertrophied antipodals. The secondary nucleus situated a little away from the egg apparatus is closer to the antipodals (figure 15).

Further, the integuments, in those ovules which give rise to unreduced embryo sacs, show arrested growth. The initials differentiated at the megaspore mother cells stage but fail to grow upward (figure 12) and no micropyle is organized even at the mature embryo sac stage (figure 14).

The agamospory has been reported in several angiospermic taxa[6–8]. Singh and Dathan[9] reported aposporic development of embryo sac in *Cucumis metuliferous*. The development of unreduced embryo sac in the present investigation refers to a case of diplospory[10], and conforms to *Antennaria alpina*[11] which is fairly widespread.

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PHYSIOLOGY OF ALUMINIUM TOXICITY IN RICE

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ALUMINIUM toxicity is one of the major limiting factors of rice production, particularly in acid upland soils. Excess Al in plants interferes with cell division, especially in plant roots, decreases root respiration, interferes with certain enzymes governing the deposition of polysaccharides in cell walls, increases cell wall rigidity and interferes with the uptake, transport and use of several elements and water by plants[1]. Nevertheless, the exact physiological mechanisms of Al toxicity in plants are still debated[2]. The effect of Al on certain physiological parameters in rice plants is reported in this communication.

Fifteen-day-old seedlings of rice (cv. Supriya) were transferred to culture solution and after a week, Al as $AlCl_3 \cdot 6H_2O$ was added at 0, 10, 20 and 40 ppm. The culture solution was maintained at pH 4.5 and renewed once every week. The plants were grown inside wire mesh house during dry season. Two replications were maintained for each treatment. Leaf samples were collected for the study 21 days after the addition of Al.

The photosynthetic rate, photorespiration and dark respiration and gross photosynthesis of the freshly

excised leaves were determined by employing infrared gas analyser (IRGA, A.D.C., England). The concentrations of chlorophyll (a, b and total)[3], reducing and total soluble sugars[4], total soluble amino acids[5], soluble protein[6] and total RNA[7] were also estimated in the leaf samples. Non-reducing sugars were derived by subtracting the reducing sugars from the total soluble sugars. All the determinations were done in duplicate.

Increasing concentrations of Al supply markedly decreased both the gross photosynthesis and photosynthetic rate (table 1). Correspondingly, Al caused parallel reductions in the quantity of chlorophyll pigments (table 2). In addition, the ratio between chlorophyll a and b also declined. Obviously, the inhibition of photosynthetic rate might be due to low level of photosynthesising pigments. Such a decreasing trend of chlorophyll pigments caused by Al in buckwheat[8] is known. However, Al enhanced both photorespiration and dark respiration. On the other hand, the total respiratory rate decreased with increased supply of Al. In support of this, Sung and Kwon[8] reported a similar reduction in leaf respiration in *Phaseolus vulgaris* grown at 100 ppm of Al. The ratio of the respiratory losses to that of assimilation rate was of ascending order (table 1).

Al markedly influenced the carbohydrate metabolism of plants, for the present study clearly showed that the concentration of soluble carbohydrates including reducing sugars conspicuously decreased upon Al addition. Moreover, carbohydrates, form the major substrate for respiration. Therefore, the decreased respiratory rate caused by Al might be ascribed to the low level of soluble carbohydrates in plant tissues.

Al also affects the synthesis of macro-molecules such

Table 1 *Effect of Al on photosynthesis and respiration in rice*

	Photosynthesis	Photorespiration + Dark respiration	Gross photosynthesis		
Al added ppm	$mgCO_2\,dm^{-2}\,h^{-1}$			Photorespiration %	Respiratory losses/ Assimilation
0	43.39	21.56	64.95	33.19	0.76
10	34.83 (−19.7)	19.56 (−19.3)	54.39 (−16.3)	35.96 (+8.4)	1.03 (+35.5)
20	28.84 (−33.5)	19.05 (−11.6)	47.89 (−26.3)	31.78 (−4.3)	1.38 (+81.6)
40	21.72 (−49.9)	20.16 (−6.5)	41.88 (−35.52)	48.14 (+45.0)	2.22 (+192.1)
Mean	32.20	20.08	52.23	37.27	1.35

Figures in parentheses indicate % difference over control.

Table 2 *Effect of Al on some plant constituents of rice*

Al added ppm	Chlorophyll mg/g fr.wt. a	b	Total	a/b	Sugars (mg/g fr.wt.) Total	Reducing	Non-reducing	RNA μg/g fr.wt.	Protein mg/g fr.wt.	Aminoacids mg/g fr.wt.
0	1.65	1.05	2.70	1.6	38.13	3.11	35.01	170	51.0	2.70
10	1.20 (−27.3)	0.84 (−20.0)	2.04 (−24.4)	1.4 (−12.5)	25.00 (−34.4)	1.75 (−43.7)	23.25 (−33.6)	110 (−35.3)	50.0 (−2.0)	3.38 (+25.2)
20	1.25 (−24.2)	1.15 (+9.5)	2.40 (−11.1)	1.1 (−31.3)	23.01 (−39.7)	1.23 (−60.5)	21.75 (−37.9)	70 (−58.8)	48.5 (−4.9)	3.82 (+41.5)
40	1.25 (−24.2)	1.10 (+4.8)	2.35 (−13.0)	1.1 (−31.3)	120.31 (−46.7)	0.43 (−86.2)	19.88 (−43.2)	62 (−63.5)	45.5 (−10.8)	7.35 (+172.2)
Mean	1.34	1.04	2.37	1.30	26.61	1.63	24.97	103	48.8	4.31

Figures in parentheses indicate % difference over control

as protein and nucleic acids. Al is known to decrease the contents of high bond energy P in peas[9]. Obviously this would limit the availability of energy compounds like ATP for the synthetic activities of the plant. Evidently, Al supply decreased the protein and RNA content of rice plant.

Thus, increasing concentrations of Al seemed to affect adversely the vital physiological processes of rice resulting in a serious physiological stress.

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CALONECTRIA THEAE LOOS AND ITS ANAMORPH *CYLINDROCLADIUM THEAE* (PETCH) ALF. AND SOB. A NEW RECORD ON *EUCALYPTUS* FROM INDIA*

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DURING the monsoon of 1983 (June–September) a severe leaf blight disease was noticed in *Eucalyptus grandis* Hills ex Maiden plantations in high elevated areas of Kerala. The disease was so severe that within two months it defoliated prematurely the entire 1- to 3-year-old plants in various plantations in Wynad (Periya, Chandanathode), Idukki (Kulamavu, Meenmutty, Manjakkuzhy) and Pamba (Uppupara and Kakki) areas. Severe infection also caused large scale mortality (> 50 %) of *E. grandis* saplings in 1-year-old plantations due to repeated infections on new flushes. Initially the disease appeared as small water soaked lesions on leaves of the lower branches. Under high humidity and incessant heavy rain these lesions enlarged and coalesced together to cover the entire area of the leaf. The affected leaves turned greyish black and later brown and dropped. The disease also affected branches, causing cankers which resulted in die-back of shoots. The infection spread rapidly from lower whorl of branches towards the terminal shoots and within a short period the entire canopy of young trees got affected, giving a brownish appearance to the tree.

A fungus repeatedly isolated on potato-dextrose-agar (PDA) medium, from the diseased specimens collected from various plantations, was identified as *Calonectria theae* Loos and its anamorph *Cylindrocladium theae* (Petch) Alf. and Sob. Identity of the isolate was confirmed by CMI, England where cultures of *C. theae* have been deposited (IMI 280734 to 280737, 280739 to 280741).

Colony of *C. theae* is fast growing on PDA with abundant aerial mycelium. Conidiophore branches arise laterally from a stipe. Phialides hyaline, conidia hyaline, cylindrical, 3 septate, 42–66 × 3.9–6.6 μm. Sterile hyphae septate, 242–385 μm long, terminates in a broadly clavate vesicle. Chlamydospores and microsclerotia are produced in culture. Perithecia, produced in culture after 2 weeks of incubation, superficial, scattered, arising from a stroma, globose to ovoid, yellowish orange later turning reddish brown, 208–420 μm high, 210–390 μm diam. Asci club-shaped, hyaline, thin-walled, long stalked, 8 spored, 68.7–128.2 × 16.3–24.1 μm. Ascospores hyaline, elongate-fusoid, 3 septate 47–68.1 × 4.9–7.8 μm.

Pathogenicity of the isolate was confirmed by spraying conidial suspension mixed with 2 drops of Tween-20 on leaves of one-year-old *E. grandis* plants and by reisolating *C. theae* from infected leaves. The foliar symptoms produced by *C. theae* were more or less similar to those of *C. quinqueseptatum* Boedijn and Reitsma, *C. ilicicola* (Hawley) Boedijn and Reitsma, *C. clavatum* Hodges and May, and *C. scoparium*