crop condition was very good and no fungal diseases were observed, except for crown rot in some fields. Other virus diseases (e.g., peanut stripe, peanut mottle, and cowpea mild mottle viruses) were not observed.

Short- or medium-duration varieties are likely to be introduced in the near future to help farmers obtain two crops per year, wheat in the postrainy season and groundnut in the rainy season. We suggest that new introduced varieties should have resistance to PBNV. Fortunately, the local variety appears to have tolerance to PBNV, judging by comparative field observations with a newly introduced semi-spreading variety that showed very high PBNV incidence. This variety has not been identified. As for PCV, the new wheat-groundnut rotation being discussed for possible extension to farmers, will create conditions that will increase disease incidence; this has already happened in the states of Punjab and Rajasthan in India.

Various groundnut lines were sown at NARC in Jul 1995, in a sandy soil block where wheat is grown once every 2 years. In Sep, the crop was severely affected by PCV (30% incidence). We suggest that a non-preferred host for *Polymyxa* sp (the fungal vector of PCV), such as rapeseed, should be grown prior to groundnut in PCV-infested fields.

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Confirmation of the Effects of Plant Density and Irrigation on Peanut Bud Necrosis Disease Incidence

H Bhatnagar, M V Reddy, J N Rao, and **P Singh** (ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India)

Peanut bud necrosis disease (PBND), caused by peanut bud necrosis virus (PBNV), is an important disease in the major groundnut-producing countries (Reddy et al. 1992). The virus is transmitted by *Thrips palmi* (Vijayalaxmi et al. 1995). Several options are available for the management of PBND. These include the use of resistant cultivars, insecticides, and cultural practices (adjustment of sowing date and/or plant density, intercropping, elimination of alternative hosts, rogueing of diseased plants, etc.) (Reddy et al. 1991). This paper reports results from a field trial conducted at ICRISAT Asia Center during the 1993 rainy season to study the effect of irrigation and plant population on PBND in a sole groundnut cropping system.

Table 1. Effect of plant density and irrigation on bud necrosis disease on groundnut cv Robut 33-1, ICRISAT Asia Center, 1993 postrainy season.

Plant density ha^{-1}	Disease incidence (%)		
	Nonirrigated	Irrigated	Mean
100 000	12	8	9.8
200 000	7	3	5.3
300 000	3	1	1.9
400 000	2	1	1.2
Mean	5.8	3.3	
	SE	LSD	CV (%)
Population density (P)	±0.72	2.48	
Irrigation (I)	±0.45	1.46	
P × I	±0.96	2.91	34.1

Groundnut cv Kadiri 3 (Robut 33-1) was sown at four plant densities (100 000, 200 000, 300 000, and 400 000 plants ha^{-1}), and grown under perfo irrigation (at 10-15 day intervals) and without irrigation, on an Alfisol. The trial was laid out in a split-plot design with four replications, with plant densities as main plots and irrigation treatments as subplots of 36 m^2. PBND incidence was recorded on each plot 3 months after sowing. The total rainfall during the experimental period was 640.7 mm.

PBND incidence decreased significantly ($P = 0.05$) with increase in plant density up to 300 000 plants ha^{-1} (Table 1), confirming previous reports (Reddy et al. 1991). At 100 000 and 200 000 plants ha^{-1}, PBND incidence was significantly lower ($P = 0.05$) in irrigated plots than in nonirrigated plots. High PBND incidence under drought stress conditions has also been reported by Wheatley et al. (1989), who suggested that the lower incidence in irrigated plots was due to the distribution pattern of the thrips vectors.

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Improved Diagnosis and Control of Peanut Stripe Virus—Progress and Future Directions of an ACIAR-Funded Project Involving Australia, Indonesia, and China

R G Dietzgen[1] and **R G Birch**[2]
(1. Department of Primary Industries, Queensland Agricultural Biotechnology Centre, Gehrmann Laboratories, University of Queensland, St Lucia, Q 4072, Australia.
2. Botany Department, The University of Queensland, Brisbane, Q 4072, Australia)

Peanut stripe virus (PStV) causes severe reductions in groundnut yields in Southeast Asia and China. Prevention of the disease is difficult because the virus is both seedborne and aphid-transmitted in a non-persistent manner. No sources of resistance to PStV have been found in *Arachis hypogaea* or genetically compatible lines derived from resistant wild *Arachis* species. The project 'Improved Diagnosis and Control of Peanut Stripe Virus' aims to genetically engineer commercial groundnut cultivars to make them resistant to PStV through the expression of novel resistance genes derived from the viral pathogen. The project also aims to develop a molecular diagnostic kit for the identification of a number of viruses that infect groundnut in Asia. The project, which is funded by the Australian Centre for International Agricultural Research (ACIAR), has operated for 3 years. A recent external review recommended continued funding to realize the potential of the set goals.

Before useful genes can be expressed in groundnut, it is necessary to develop an efficient regeneration system for explants amenable to transformation, and methods to deliver the gene to such explants.

Gene transfer and plant regeneration. There have been several recent reports of genetic transformation of groundnut. However, none of these reports provides a system that is practical for the routine transfer of genes into commercial groundnut cultivars. Essential requirements for such a practical gene transfer system are efficiency, fertility, and reproducibility.

In our work, high frequency transient expression of introduced genes was observed in regenerable tissue regions following particle bombardment. Using optimized conditions, 2500 embryonic leaflets (cv McCubbin) were bombarded with p35SlucK and 2500 were co-bombarded with pGN1 and pDO432, cultured on a sub-lethal level of kanamycin (50 mg L^{-1}) and assayed for *luc* activity. Stable expression of the firefly luciferase (*luc*) reporter gene was observed in embryonic leaflet callus for 9 weeks, using a non-toxic bioluminescence assay (Livingstone and Birch in press). No *luc*-expressing shoots were obtained although 10 regenerated plantlets grew vigorously on 50 mg L^{-1} of kanamycin.

Somatic embryogenesis was observed in immature embryos of cvs Gajah and NC 7 cultured on MS medium supplemented with 1 mg L^{-1} picloram; and in mature embryos of McCubbin, NC 7, Gajah, and Florunner cultured on MS medium supplemented with 5 mg L^{-1} picloram. Prolonged expression of the *luc* reporter gene was observed (4 weeks after bombardment) in somatic embryos and embryogenic callus (cv NC 7) which originated from immature embryos. Somatic embryos derived from immature embryos (cvs Gajah and NC 7) were shown to proliferate in liquid culture, and the resulting embryogenic callus was shown to have the potential to regenerate in vitro.

The potential of direct meristem bombardment of mature embryos was also investigated, and bombardment conditions optimized so that the number of cells in the meristematic region transiently expressing the *gus* reporter gene approached that of the published protocol