Portable Rainout Shelter, a Useful Tool in Drought Research

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Drought is a major abiotic factor causing significant yield reduction, especially in rainfed agriculture. Globally, several research institutions are engaged in developing genotypes that are resistant to drought. Drought is a complex problem with three components; timing, intensity, and duration, all varying widely in space and time, making it very difficult to apply simple screening tools and selection procedures to develop drought resistant genotypes. It is, however, possible to overcome this difficulty by developing devices that can exclude the rain from the experimental area and simulate various types of drought under field conditions.

To tackle the problem of untimely rainfall vitiating drought experiments, large automated rainout shelters have been designed and constructed at several research institutions. For example, a large automated rainout shelter has been in operation at ICRISAT Asia Center (IAC) since 1988. It is, however, an expensive facility to build and operate, especially in developing countries. Moreover, it is fixed at a given location and therefore cannot be readily moved to different fields or locations. It was therefore considered necessary to develop portable, simple to operate, and less expensive rainout shelters, which can be constructed using locally available materials. This paper describes the development of a portable rainout shelter with proven capability to fulfill the above needs.

At IAC, simple Silpaulin® rainout shelters have been used to exclude rain from chickpea plots grown for advancing generations during the rainy season since 1980 (Sethi et al. 1981). Rainfall when accompanied with high temperatures predisposes this crop to diseases. These shelters were at a fixed place and as plants grew permanently under the shelters, they were shaded by the Silpaulin® covers which excluded about 60% of light (to reduce temperature buildup). The shades caused physiological disorders, such as etiolation and lodging resulting in low yield, and sometimes crops even failed. A rainout shelter which could be moved over the crop only during a rainfall event was thus, felt necessary. This was achieved by redesigning rainout shelters and fixing wheels to the trusses so that the shelter could be move along the fixed rails. This substantially increased the seed multiplication rate from the off-season nurseries of chickpea at IAC. With the enhanced mobility within the field, it was felt that such rainout shelters would also be useful to exclude rain from drought stress treatments. The potential for using these shelters for a drought experiments was first realized on chickpea grown in the post rainy season but still subject to rainfall events, and subsequently on pigeonpea and groundnut grown in the rainy season. Rainout shelter simulated drought (RSSD) reduced groundnut yield 16-26%. In pigeonpea RSSD reduced yield by 8-30% depending on the phenological stage of the crop when the drought was imposed (Photo 1). In the automated shelters at ICRISAT, RSSD reduced yield of pigeonpea by 21 to 49%. While the magnitude of response varied between the two types of shelters, the trends in the genotypic differences remained more or less similar. It is therefore clear that portable rainout shelters were effective in producing a drought response in both of these rainy season crops. Due to height restrictions imposed by the structural considerations, such rainout shelters would be mainly effective for short-statured crops reaching less than 1m height.

The rainout shelters we have thus designed are 15m long and 7.2m wide. It consists of 6 trusses each 7.2m wide and spanned 3m apart. The individual trusses are fastened together by purlins. The trusses are basically triangular frames with vertical pipes at both ends fastened to caster wheels through steel base plates. The caster wheels move freely on steel rails laid on both sides. The rails can be readily moved between experimental sites. The trusses are made of 19mm 'B' class mild steel pipes and purlins are made of 19mm 'A' class mild steel pipes. The castor wheels are made of hard rubber 200mm diameter and 50mm width. The base plates used for fastening the vertical pipes and castor wheels are made of 8mm thick MS plates. The track is made of rolled steel channels. A special jig is made for fabricating the individual trusses with the vertical pipes. Special angle iron cleats are welded to the trusses to facilitate fastening of purlins using nuts and bolts. The vertical pipes are welded to base plates and castor wheels are fastened to these base plates using nuts and bolts. Silpaulin® covers are fixed on the top of trusses and tied with a nylon rope to the purlins. The whole structure can be easily pushed by one person along the track on to either the parking lot or the experimental area. Since a shelter is parked over the crop during a rain event and during night and is open on either side, it only marginally (<1°C) increases temperature inside the canopy. Incident light reaching the drought stress treatment is similarly marginally reduced as the shelters only cover the crop when rain clouds are present. Drainage channels are made along the 30m length of the rails to drain the rain water off the experimental plots. These channels could be lined up by polythene sheets to prevent infiltration into the treatment plots. The shelters are tied with chains to the rails at four corners to prevent being blown off by winds and rains. The structure can be disassembled back easily and transported to another place. The maintenance includes seasonal greasing of castor wheels and proper storage of the individual components. At IAC it cost about US $1400 to build each unit. It is possible to use other substitute materials that may be more cost effective. The blueprint of the portable rainout shelter described above is available on request.

References

Sethi, S.C., Byth, D.E., Gowda, C.L.L., and Green, J.M. 1981. Photoperiodic response and accelerated generation turnover in chickpea. *Field Crops Research* 4:215-225.