Kenya (Laxman Singh, Silim, S.N., Ariyanayagam, R.P., and Reddy, M.V., eds.), Eastern Africa Regional Cereals and Legumes [EARCAL] Program, International Crops Research Institute for the Semi-Arid Tropics.

Le Pelley, R.H. 1959. Agricultural Insects of East Africa. Nairobi, Kenya. East African High Commission. 307 pp.

Materu, M.E.A. 1970. Damage caused by *Acanthomia tomentosicollis* Stal and *A. horrida* Germar (Hemiptera: Coreidae). East African Agricultural and Forestry Journal 35: 429-435.

Minja, E.M., Shanower, T.G., Songa, J.M., Ong'aro, J.M., Mviha, P., Myaka, F.A., and **Okurut-Akol, H. 1966.** Pigeonpea seed damage from insect pests on farmers' fields in Kenya, Malawi, Tanzania and Uganda. International Chickpea and Pigeonpea Newsletter 3:97-98.

Sithanantham, S., and **Reddy, Y.V.R. 1990.** Arthropods associated with pigeonpea in Kenya, Malawi, and Zambia. International Pigeonpea Newsletter 11: 17-18.

Solarization to Protect Pigeonpea Seeds from Bruchid Damage during Storage

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Bruchids [*Callosobruchus* spp.) are important storage pests of grain legumes, known to cause substantial economic losses (Ramzan et al. 1989; Srivastava and Pant 1989). This is one of the reasons farmers are often reluctant to grow legumes. Their produce has to be sold and cleared immediately after the harvest even though the market price may not be very remunerative at that time. Sometimes, even storing seeds for sowing becomes difficult, and farmers are forced to buy seed from other sources. In many developing countries of the semi-arid tropics (SAT), the seed industry is not well developed and the availability of quality seed is a major limitation. As farmers are not able to store their seed under pest-free conditions, these are often damaged by insects, particularly bruchids. Seeds damaged by bruchids do not germinate well and thus affect plant stand and consequently yield. This is especially so when the time between harvest and the next sowing is very long, as is the case with several short-season legumes. For example, the interval between harvest and sowing of the next season's crop of extra-short-duration pigeonpea [*Cajanus cajan* (L.) Millsp.] can be 6-9 months as compared to merely 2 months for long-duration pigeonpea cultivars. Thus, a cost-effective technique needs to be developed to protect seeds from postharvest bruchid damage.

Farmers currently use several chemical and nonchemical methods to protect seeds from bruchid attack. Chemical methods such as fumigation or admixture of insecticides such as malathion, though effective, are hazardous and environmentally unsafe. On the other hand, nonchemical methods do not provide foolproof protection either. Sun-drying in an open yard is a common practice employed by SAT farmers. This process in its current form depends upon a variety of environmental factors such as the prevailing temperature, humidity, and cleanliness of the drying area. The process could be enhanced with a little improvization. As in the case of soil solarization (Chauhan et al. 1988), the effectiveness of the sun's rays in disinfecting seeds may be enhanced substantially if seeds were kept in small polythene bags instead of being spread in the open. This study examined the level of accumulation of temperature in polythene bags and its effect on bruchid survival and infestation in the pigeonpea seed contained in them.

Eight polythene bags of 21 x 28 cm size and 100 mm thickness were each filled with 1 kg seed of a medium-duration pigeonpea variety, ICPL 87119. Twelve adult bruchids (*Callosobruchus maculatus* F) in pairs (male and female) were introduced in each bag and the bags were then sealed using adhesive tape. Four of the sealed bags with seeds and insects were exposed to the sun for a week (maximum outside air temperature 42°C) and the same number was kept in the laboratory at 30-35°C in June 1998. The rise in temperature inside the bag was measured using a mercury thermometer inserted into it. The edges at the contact point between thermometers and bags were also sealed with adhesive tapes so that hot air inside the bag did not escape. Germination was tested in the laboratory at 25°C in three replications in petridishes lined with filter paper, holding 10 mL of distilled water. Ten seeds were placed in each petridish and germination was recorded after 3-4 days.

The temperature in the bags exposed to sunlight began to rise with time of the day until evening (Fig. 1). The maximum recorded temperature was about 65°C. This rise in temperature is comparable to the rise noted in surface layers of soils covered by transparent polythene (Chauhan et al. 1988). Unlike soil, where temperature declines in deeper layers due to close packing of soil particles preventing free air flow, there is considerable space between seeds due to their larger size and often irregular shape. This permits quick and uniform distribution of hot air in the bag. There was no abrupt rise in the temperature in bags kept in the laboratory (Fig. 1). The difference in temperature between the two treatments was very large after 1200 h and remained high until evening.

Bruchids in all the solarized bags died without laying eggs (Table 1). In contrast, in the bags kept in the laboratory, the bruchids laid a considerable number of eggs. Bruchids were also seen alive in two of the four bags after 5 weeks of storage. In the non-solarized bags, there were dead bruchids which may have completed their life cycle. After 9 weeks of storage, bruchid damage was noted in the non-solarized bags, whereas no damage recorded in the solarized bags (data not shown). This indicated that seed solarization was effective as a means of protecting seeds from bruchid damage. Although we used bags of 1 kg seed capacity, larger bags with more seed are unlikely to yield different results as the surface area to trap solar energy would increase proportionately. The main consideration in fixing the size could be ease of handling and storage.

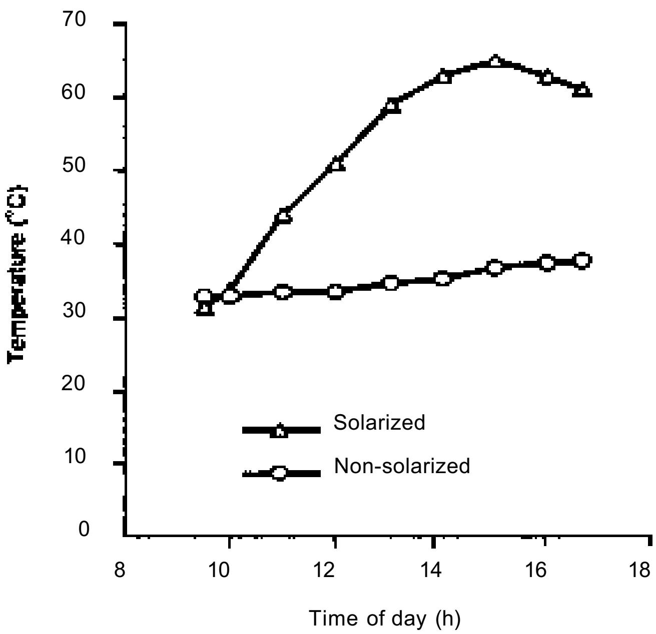

Figure 1. Differences in temperature build-up at different times of the day in polythene bags containing pigeonpea seeds exposed to the sun and kept in shade on a typical sunny day.

Germination was 90% before solarization. Rise in temperature did not adversely affect germination of seeds in solarized bags. For example, germination was 92% immediately after a week-long solarization (Table 1). We recorded up to 89% germination in the solarized bags after 26 weeks of storage (results not shown). Thus rise in temperature in solarized bags was perfectly safe for seeds.

Even though in the present study pigeonpea was used as a test material, we propose that the results on bruchid infestation may be equally applicable to other grain legume crops. However, the effect of high temperature on seed germination needs to be determined for individual crops as sensitivity of crops to high temperature may differ. We also suggest that the storage of seed in transparent polythene bags may also be used to lower seed moisture content immediately after harvest. This can be done by leaving the bags slightly open to allow the moisture to escape through the openings. This may be especially useful in humid environments. The duration of drying can be standardized for local conditions. Seed solarization could have other uses as well. For example, for such crops as groundnut (*Arachis hypogea* L.), reduced moisture in the storage bags with well dried seeds may

Table 1. The effect of seed solarization on bruchid egg laying and survival 5 weeks after storage, and seed germination of pigeonpea cultivar ICPL 87119 immediately after solarization.

	Non-solarized			Solarized		
Bag no.	Egg-laying	Bruchid survival (%)	Seed germination (%)	Egg-laying	Bruchid survival (%)	Seed germination (%)
1	+[1]	0	83.3	-	0	86.7
2	+	8	96.7	-	0	93.3
3	+	0	93.3	-	0	93.3
4	+	33	93.3	-	0	96.7
Mean		10	91.7	0		92.5

1. The + ve sign indicates an abundance and - ve sign a complete absence of eggs.

prevent contamination by *Aspergillus flavus,* a highly carcinogenic aflatoxin-producing fungi (Diener and Davis 1977). Thus, considering the potential advantages, the positive aspects of this low - cost technology need to be systematically researched and disseminated among farmers of the SAT.

References

Chauhan, Y.S., Nene, Y.L., Johansen, C., Haware, M.P., Saxena, N.P. Sardar Singh, Sharma, S.B., Sahrawat, K.L., Burford, J.R., Rupela, O.P., Kumar Rao, J.V.D.K., and **Sithanantham, S. 1988.** Effects of soil solarization on pigeonpea and chickpea. Research Bulletin no. 11. Patancheru, AP 502 324. India: International Crops Research Institute for the Semi-Arid Tropics.

Diener, U.L., and Davis, N.D. 1977. Aflatoxin formation in peanuts by *Aspergillus flavus.* Bulletin of the Alabama Agricultural Experimental Station (No. 493). Auburn, Albama, USA: Auburn University. 49 pp.

Ramzan, M., Chahal, B.S., and Judge, B.K. 1990. Storage losses to some commonly used pulses caused by pulse beetle, *Callosobruchus maculantus.* Journal of Insect Sciences 3(1):106-108.

Srivastava, K.M., and Pant, J.C. 1989. Growth and developmental response of *Callosobruchus maculantus* (Fabr.) to different pulses. Indian Journal of Entomology 51(3):269-272.

Agronomy/Physiology

Association of Plant Height and Maturity Duration with Seed Yield in Pigeonpea

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Pigeonpea is a minor pulse crop grown in the Punjab province of Pakistan. However, the crop may have good potential and efforts should be made to popularize it among farmers. A study was conducted to collect information about the association of yield with certain morphological traits in order to devise criteria for the selection of genotypes suited to the climatic conditions and cropping systems of the province. Yield is a complex character which can be influenced by its major and minor components. Pandey (1984) reported that seed yield and days to flowering were not associated. Mahmood et al. (1996) reported that yield per plant was positively and significantly correlated with height and days to flowering, but the association between yield and days to maturity was nonsignificant. The present study was undertaken to further evaluate the association of plant height and phonology.

Fifty-five genotypes of ICRISAT origin were evaluated for plant height, days to flowering, days to maturity and yield per plant along with three local controls at the Pulses Research Institute, Faisalabad during the rainy season, 1997. The experiment was sown in a medium loam soil in augmented design with five blocks under irrigated conditions. Each block comprised 11 test entries and 3 controls. The plot size was 5 m x 0.6 m accommodating a single row. The data for the traits mentioned were recorded for 10 guarded plants per entry and were analyzed to calculate correlations following Steel and Torrie (1980).

Plant height varied from 51.55 to 193.30 cm with a mean height of 118.87. Days taken to flowering ranged from 65 to 108 with a mean value of 83.4 and days taken to maturity ranged from 112 to 160 with a mean value of 138.87. Grain yield per plant was in the range of 115 to 1050 g with a mean value of 314.32 g. This showed that the varieties studied differed greatly in terms of mentioned traits.

The correlations between all the plant characteristics being studied were nonsignificant. This indicated that there is no effect of days to maturity and plant height on seed yield in pigeonpea. These traits were inherited independently. These results are in partial agreement