compared with untreated control. However, they showed differential effects in controlling the disease under field conditions (Table 1). The fungicides difenconazole (0.1%) was the most effective followed by hexaconazole (0.1%) and chlorothalonil (0.2%). Plants in these treatments also showed better performance; pod yield was high and a similar trend was observed as for disease control.

Jadeja et al. (1999) reported 67% disease control and 68% increase in yield of groundnut with difenconazole. Dubey (1997) reported that three sprays of chlorothalonil was found to be economical for the management of leaf spots of groundnut.

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Field Evaluation of Plant Extracts for Control of Late Leaf Spot in Groundnut

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Late leaf spot (LLS), caused by *Phaeoisariopsis personata* is an important disease of groundnut (*Arachis hypogaea*) throughout the world and causes substantial loss of both haulm and pod yields (Subrahmanyam et al. 1995). The disease has been effectively controlled by chemical fungicides, which cause environmental pollution. The need to find eco-friendly disease control measures is desirable. The secondary metabolites produced by plants possess antifungal activity against a wide range of plant pathogenic fungi. These metabolites can be used either alone or in combination with other disease management strategies to reduce the use of chemical fungicides. In an earlier study, aqueous leaf extracts of *Datura metel* and *Lawsonia inermis* were found to inhibit the in vitro conidial germination of *P. personata* and control LLS in greenhouse environment (Kishore et al. 2001). We report further evaluation of these two leaf extracts for control of LLS under field conditions.

Field experiments were conducted at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India during 1999 and 2000 rainy season. The experiments were conducted in a completely randomized block design with three replications. Four rows, each 9 m long, were maintained in each plot. Groundnut cultivar TMV 2, susceptible to LLS was used in these experiments. To obtain uniform disease pressure, an infector row of TMV 2 was maintained on either side of each plot. Infected crop debris of the previous season was evenly spread on infector rows at 35 days after sowing (DAS). Infector rows were also spray inoculated with conidial suspension (20,000 conidia ml^{-1}) of

P. perosnata in the evening on a cloudy day. Subsequently, sprinkler irrigation was provided in the evening for about 30 min up to 10 days after inoculation to maintain leaf wetness at night. Freshly prepared aqueous leaf extracts of *D. metel* (2% w/v) and *L. inermis* (5% w/v) (Kishore et al. 2001) and Kavach (chlorothalonil, 0.2% w/v) were tested for control of LLS. The leaf extracts and kavach were applied as a foliar spray at 500 L ha^{-1} at 45, 60, 75, 90, and 105 DAS. Plots sprayed with water were maintained as control. The disease severity was recorded on a 1–9 rating scale (Subrahmanyam et al. 1995) at an interval of 10 days starting from 45 DAS. At harvest, pods from each plot were hand picked, sun dried, weighed, and yield was calculated. Disease development was similar in both the seasons; hence the data was pooled and analyzed.

In control plots complete defoliation occurred at 95 DAS and the LLS severity was rated 9.0. The extract of *D. metel* continuously reduced the disease progress up to 115 DAS and severity of LLS at harvest (115 DAS) was significantly less than in the control. In comparison to control, *L. inermis* extract could contain the disease progress up to 95 DAS (7.3 severity) and the disease severity at harvest was at par with control. Severity of LLS was significantly less in plots sprayed with Kavach than in plots sprayed with extracts of *D. metel* and *L. inermis* (Fig. 1).

Table 1. Pod yields of groundnut cultivar TMV 2 after control of late leaf spot with antifungal compounds[1].

Treatment	Pod yield (t ha^{-1})	Increase in pod yield over control (%)
Datura metel leaf extract (2% w/v)	0.89	48.3
Lawsonia inermis leaf extract (5% w/v)	0.72	20.0
Kavach (0.2% w/v)	1.23	105.0
Control	0.60	–
LSD (P = 0.01)	0.18	

1. Values are means of six replications from two sets of experiments.

Pod yields in plots sprayed with *L. inermis* and *D. metel* leaf extracts were respectively 20.0% and 48.3% higher than in the control plots (Table 1). With an increase of 48.3% in pod yields, *D. metel* extract offers an economical and eco-friendly alternative for fungicidal application to control LLS. Also, the antifungal activity of *D. metel* extract against *P. personata* was heat stable and unaltered even after an incubation of 180 days at 28°C (Kishore et al. 2001). *Datura metel* extract has been reported as inhibitory to other pathogenic fungi such as *Colletotrichum capsici* and increases the activities of defense related enzymes, peroxidase, and polyphenol oxidase in *Capsicum annuum* (Asha and Kannabiran 2001). The increase in pod yield by application of *L. inermis* extract was due to less disease severity till seed maturation stage. This supports the earlier observation that leaf extract of *L. inermis* reduces the severity of both LLS and rust and increases pod yields by 15–40% (Ghewande 1989). Though Kavach has increased the pod yield by 105% it has to be sprayed five times to double the pod yield. Further, integration of *D. metel* extract with the existing disease management

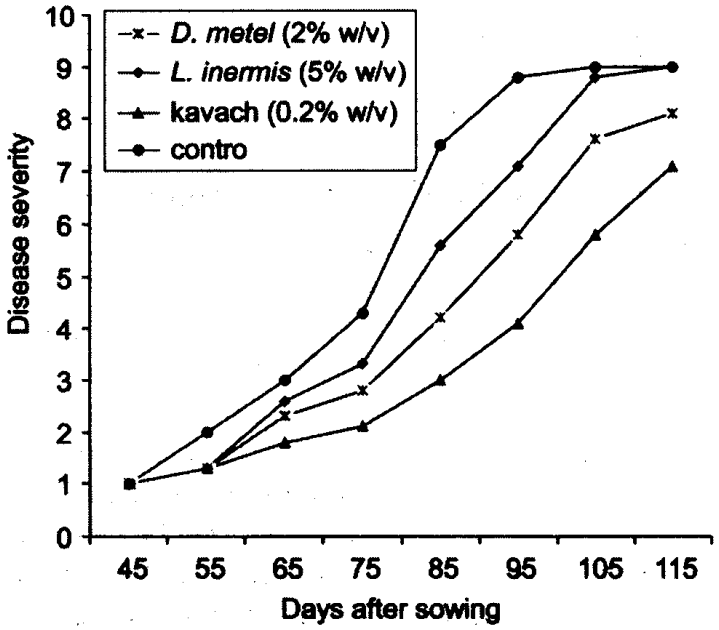

Figure 1. Effect of leaf extracts (*Datura metel*, *Lawsonia inermis*) and Kavach on severity of late leaf spot groundnut cultivar TMV 2 (Note: Each point is the mean of six replications from two sets of experiments).

strategies may drastically reduce the dependency on fungicides for control of LLS.

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Entomology

Groundnut Leaf Miner *Aproaerema modicella* in Southern Africa

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The groundnut leaf miner (GLM) (*Aproaerema modicella* Deventer) (Lepidoptera: Gelechiidae) was recorded on groundnut (*Arachis hypogaea*) in South Africa during 2000. An outbreak of the pest was first noticed on the Vaalharts Irrigation Scheme (27°50′ S and 24°50′ E). During 2001, GLM was observed over the entire groundnut production area in the Free State, Northern Cape, North West and Mpumalanga provinces, causing severe damage to groundnut crops. It was also recorded on soybean (*Glycine max*) and lucerne (*Medicago sativa*).

Aproaerema modicella has only been reported from countries in south and southeast Asia, namely Pakistan, India, Sri Lanka, Bangladesh, Myanmar, Thailand, Laos, Kampuchea, Vietnam, China, the Philippines, Indonesia, and Malaysia (Mohammad 1981). It is an important pest of groundnut in India (Shanower et al. 1993). The first report of *A. modicella* in Africa was on groundnut in Uganda during 1998 (Page et al. 2000), in Mozambique in 1999 (NF Madogolele, personal communication), and in Malawi in 2000 (Subrahmanyam et al. 2000).

Adults of *A. modicella* are grayish moths that lay eggs singly on the underside of leaves and on petioles. Yellowish green larvae hatch, tunnel into the leaves, and feed between the upper and lower epidermis of leaves. Damaged leaves become brown, rolled, and desiccated, resulting in premature loss of leaves. Later instars appear on the leaf surface to roll and web it, or to web two or more leaves together. Pupation takes place inside the webbed leaflets. Loss of leaves results in poor groundnut haulm production and causes a reduction in yield under heavy GLM infestations.

Page et al. (2000) speculated that GLM was confined to a particular area in Uganda while Subrahmanyam et al. (2000) suggested that it may be a poor migratory pest. However, within two years after it was first noticed in Uganda, it was also noticed as a pest in Malawi (Subrahmanyam et al. 2000) and Mozambique (NF Madogolele, personal communication). Due to the widespread occurrence and devastating damage inflicted by GLM to groundnuts in Africa, research is currently being conducted by the Agricultural Research Council - Grain Crops Institute, South Africa to develop an integrated pest management program for GLM on groundnuts.

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